THE UNIVERSITY OF HULL

The Development of Stage Machinery in the Nineteenth Century British Theatre: A Study of Physical and Documentary Evidence.

Volume I

being a Thesis submitted for the Degree of Doctor of Philosophy

in the University of Hull

by

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CONTENTS

NOTES FOR THE READER.

VHS Videotape.

The video cassette which accompanies this thesis contains a copy of a short programme shot by Anglia Television in 1984 for the programme, Bygones. It contains footage of the stage machinery in operation at the Tyne Theatre and Opera House, Newcastle-upon-Tyne. Within the programme are some very interesting archive film clips. One is a film entitled, Joyland, made in 1925 and released in 1926. It features, Lupino Lane in a very exiciting chase sequence in which he utilises several different types of trap. In addition there is footage of the revolving stage operating at the Coliseum Theatre, London.

Method of Indexing

Due to the complicated nature of the material which is examined the following procedure of cross-referencing has been adopted.

(i) Every page containing a line-drawing has been given an "Illustration number".
However, because text associated with the drawing is often quoted the authors original reference number is also retained.
e.g. Plate 28, Fig.5., being the authors reference followed by [Illus.114], being the reference given to the illustration contained within the thesis.

(ii) Throughout the thesis reference is made to Contants Parallèle. The English text used is a translation of the original which can be referred to in Appendix 4.

(iii) Volume I of this thesis contains the text and associated line drawings. Volume II contains the photographs.

(iv) All passages quoted from M.J. Moynet's L'Envers du Théatre, are taken from the English translation, French Theatrical Production in the Nineteenth Century, by Allan S.Jackson and Glen M.Wilson.

HAIL TO THE PANTOS

A "Royal" door is opened to show "The Forty Thieves,"
Who nightly steal our hearts away, if worn upon our sleeves;
The "Tyne" is flowing merrily in fair enchanted scenes,
Which link our mundane natures with Sprites and Fairy Queens.

And charming "Cinderella", still moved by magic wand,
Now moves us to the Eastward, and makes us do the "Grand:"
We are back to trees that open, and temples that expand,
And flowers as big as warming pans into panto fairy-land.

We are back to traps and pitfalls - a land of sloats and stays -
And scruto-work, and profiling, and smiling "coryphees;"
To fires of changing colours, and dresses rich and rare,
To trellised garden portals, and castles in the air.

Ah! changed is now the Pantomime I knew in days of yore -
The poker hot, the butter slide, the Clown laid at the door.
That shopmen bland and affable might o'er him tumble down;
And the murdered babe whose body was sat on by the Clown.

The Columbine was something surpassing mortal grace,
And Harlequin bore mystery writ on his vizored face;
Ah! changed is now the Pantomime - more up-to-date I ween -
With dance, and song, and patter, and Transformation Scene.

I walk with young "Red Riding Hood" alone among the leaves;
I dream of Orient splendour when I see "The Forty Thieves;"
I smile with "Cinderella" as her fate becomes sublime;
A greybeard, I'm a boy again when comes the Pantomime.

Newcastle-on-Tyne, R.ELLIS GERRARD
January, 1902. (Of "Northern Gossip")

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1. This poem appeared in Theatre Annual, published by the Northern Gossip Co.Ltd., in 1902, and featured many of the pantomimes produced in and around the Newcastle area that season.

INTRODUCTION.

The development of scene changing machinery in Great Britain is perhaps one of the few disciplines in the field of mechanical engineering which have virtually never relied upon new discoveries in technology for their advancement. Instead it has always lagged behind, perhaps modifying, certainly adapting, existing techniques. This study aims to examine the evolution of stage machinery during the nineteenth century, when many techniques had already been in existence and traditions firmly established since the previous century. The degree of development in the course of the nineteenth century was in many ways a reflection of the type of drama presented. As time went by, the public's taste for spectacle and visual presentation intensified and fostered an increase in the complexity of scene changing equipment. This in turn meant that many of the theatres built in the eighteenth century, especially in the provinces, were sadly inadequate for housing the vast quantities of equipment which machinists needed to install above and below the stage. As a result architects, began improving and enlarging existing theatres as well as building new ones, with increased stage width and depth, increased flying space above and increased depth below the stage.

There was indeed an enormous rise in demand for scenic effects shortly after the beginning of the nineteenth century. This rapid growth caused the smaller existing Georgian playhouses, like the Theatre Royal, Ipswich, either to be modified in an attempt to cater for new trends, or to close. This dilemma alone must be acknowledged as a significant contributory factor in the decline of the Georgian playhouse and helps to explain the comparatively small number of such theatres surviving to the present day.

The techniques of the stage machinist in the first half of the nineteenth century relied almost totally on technology and basic engineering principles which had existed for many years. Certainly the comparison often made between the backstage of a theatre of this period and a sailing ship is a very apt one, since both relied on manually hauled ropes, sheaves and the principles of mechanical advantage. However, these techniques had also been utilised for other, non-theatrical purposes. For instance, housed in the central tower of Beverley Minster is a large treadwheel, which was, and is still, used to raise equipment from ground level into the roof space [see photo.1]. This is based upon the principles of mechanical advantage, in much the same way as many pieces of scene-changing equipment.

Thus, because the theatrical profession was slow to adopt new apparatus and constantly replacing old machinery with brand new near-replicas, its evolution was comparatively slow. The job of a stage machinist was quite often a family concern, as the techniques, traditions, secrets and tricks of the trade were passed from father to son. The Sloman family and the Grieve family were particularly well known in London for their knowledge and expertise in this field. Change was to a greater or lesser extent resisted and in any case many saw little need for change, especially those who were steeped in the traditions of the machinist and his machinery. It was, in fact, this basic resistance which caused a disruption in the evolutionary development of stage machinery. Many theatre architects were happy to furnish a traditional stage machinist with a blank drawing denoting "The Stage", requiring him to fill in the details as he saw fit, whilst the innovators devised all manner of new equipment, that which worked and sometimes that which emphatically did not. There was therefore a bifurcation, with the 'traditional school' refining the 'English wood stage' to a higher degree of sophistication, whilst the 'modern school' developed and attempted to apply the engineering technology associated with other disciplines. In essence, the latter attempted to replace muscle power with hydraulic or electrical power.

This thesis documents the development of stage machinery from its comparatively primitive state at the beginning of the nineteenth century, through years of growth and expansion, and finally into the last decade of the century, when theatrical productions were in truth exercises in spectacle.

"DRAMATIC MACHINERY" AS DESCRIBED IN REES'S CYCLOPAEDIA.

In the opening years of the nineteenth century Abraham Rees assembled information for the publication in 1819 of the Cyclopaedia; or Universal Dictionary of Arts Sciences, and Literature, with (according to the frontispiece) "the assistance of eminent professional gentlemen". In volume twelve of the thirty-nine volume work is an entry under the heading of 'Dramatic Machinery', which is reproduced in its entirety in Appendix 1 of this thesis.

It is not certain who actually wrote the text for this entry 1 although a clue is given by the writer when he states: "The plan of moving wings of the late theatre of Covent Garden, and that of the Theatre Royal of Glasgow, invented by the writer of this article, are represented in Plate X". He goes on to refer to "the new subscription Theatre Royal of Glasgow," thus identifying it as the theatre built to the designs of the architect David Hamilton, which opened on 24th April 1805. In another passage he comments that "although this machinery was constructed rather to correct an error in the general construction of the theatre than for any other reason; it appears, after four years' trial, to possess some important advantages over the plans of the London theatre", thus dating the text around April 1809, and not 1803 as Richard Southern suggests.[2]

The information contained in the Cyclopaedia is therefore of great significance as it represents the first major printed work on British stage machinery. Its importance is further enhanced by the fact that it was written by a man personally experienced in the field and capable of providing an invaluable insight into the profession of the early nineteenth century stage machinist.

The text relating to the 'Construction of the Stage' states that "it is usual to allow one inch of perpendicular ascent for every 36 inches of length from the front to the back of the stage". This ratio is similar to the rake shown by John Foulston in his drawings of the Theatre Royal, Plymouth [see page 19].

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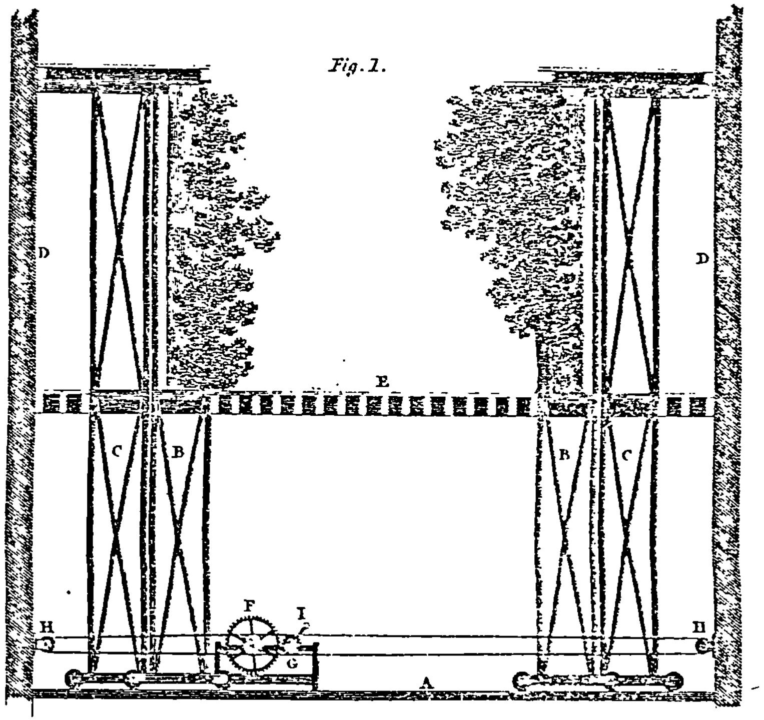
1. The Longman archive located at the University of Reading contains several of Abraham Rees's ledgers relating to The Cyclopaedia, but unfortunately there is no information concerning the name of the author of the section on 'Dramatic Machinery'.
2. Richard Southern, Changeable Scenery, (London: Faber and Faber Limited, 1952), p.219.

MISCELLANIES.

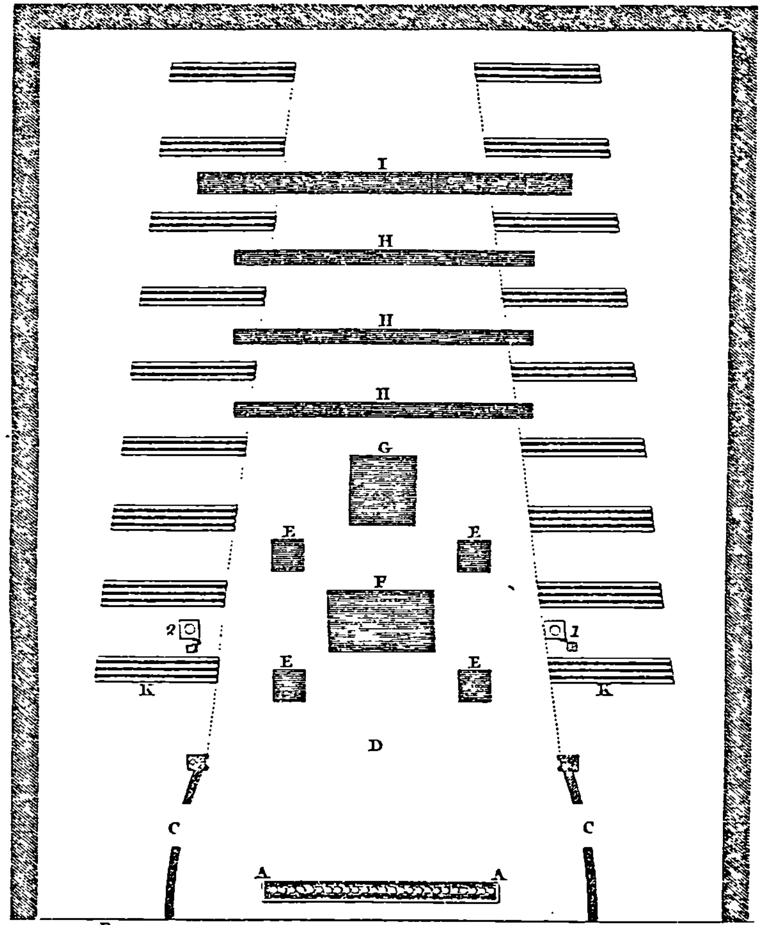
DRAMATIC MACHINERY.

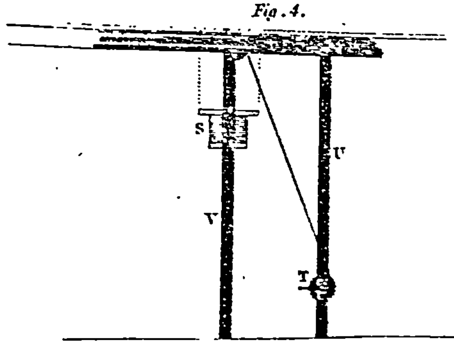
PLATE IX AND X.

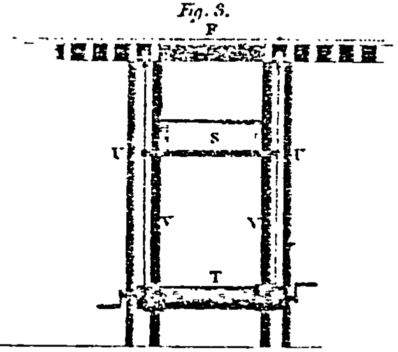


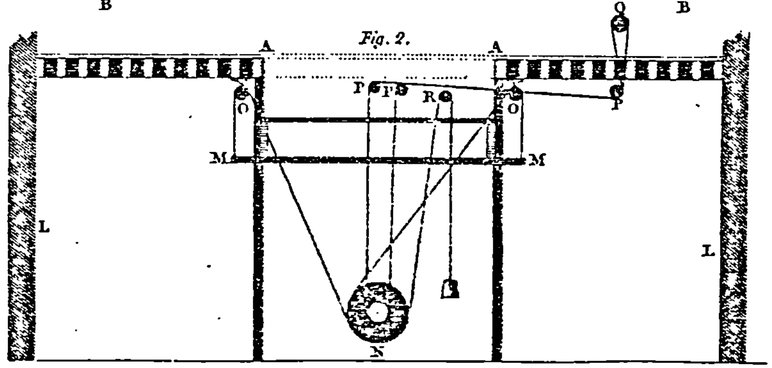
Illus.1 Details of 'Dramatic Machinery

A.Rees, op.cit., pl.IX, X, n.pag.









Towards the middle of the nineteenth century, however, there seems to have been a tendency to increase the rake, J.G.Buckle advocating in 1888 that "the floor should rise from the footlights towards the back wall of the stage, the rake varying from 1 in 18 to 1 in 24." [3] The latter was the ratio most commonly adopted until the introduction of the first flat stage in England at Her Majesty's Theatre, London, in 1897.

The surface of the stage, together with its apertures, was considered to be a difficult task for the architect to finalise with any certainty. It is, however, very interesting to note that Rees's contributor considers this work to be the sole responsibility of the architect and not the stage carpenter, a belief which was not to be upheld again until the end of the nineteenth century.

The stage plan, [see Illus.1], accompanying the text in the Cyclopaedia shows a series of apertures in the stage and nine sets of grooves arranged for perspective scenes. It is useful to consider in some detail what he says about each individual feature.

The Float.

> "The first aperture in the stage immediately behind the orchestra, and in front of the proscenium and curtain, is that for raising and lowering the footlights, both for purposes of trimming the lamps, and of darkening the stage when required. It is marked by the letters A,A, Fig.1, Plate IX, Miscellany, which is a horizontal plan of a stage 60 feet in length, and 25 feet in breadth at the curtain line."

This aperture and the accompanying mechanism indicated in Fig.2 shows an apparently unprotected float which does not stretch the full width of the proscenium opening. Terence Rees[4] suggests that this was probably because the large areas on either side of the float were lit by chandeliers suspended above the proscenium doors (C,C), as in Robert Smirke's Covent Garden Theatre

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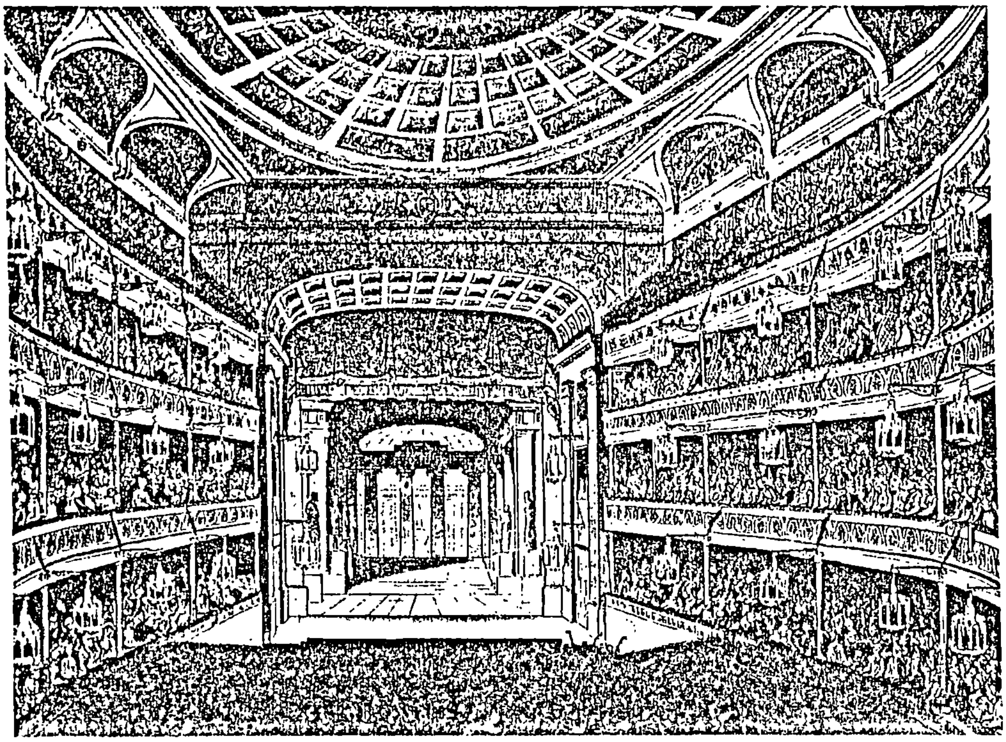
3. James G. Buckle, Theatre Construction and Maintenance, (London: The Stage, 1888), p.32.

4. Terence Rees, Theatre Lighting in The Age of Gas. (London:Society for Theatre Research, 1978), p.20.



Illus.2 Interior of Sir Robert Smirke's Covent Garden Theatre, c.1809.

opened in 1809 [see Illus.2]. A plan dated 1858 of the stage at the Theatre Royal, Ipswich, [see Illus.3] also depicts a set of footlights which do not stretch the full width of the proscenium opening. It may therefore have been a regular practice to suspend chandeliers above the proscenium doors because lamps were apt to be blown out by draughts caused by the opening and closing of the doors. The Ipswich plan does in fact show a distance of six feet between the proscenium door and the offstage edge of the float.

The Cyclopaedia float mechanism was operated by someone positioned in the cellar when the lamps were trimmed, but when the stage required "darkening" it was necessary to control the position of the float very precisely. This was therefore entrusted to the prompter, or a "person immediately under his inspection". The mechanism is shown in Fig.2, taken "with a slight variation, from a plan of Mr.George Sloper, of Covent Garden, and similar to what was used there." The two side walls of the theatre are represented by L,L and the horizontal frame which slides upon two upright posts located underneath the ends of the aperture, A,A. The frame is suspended at either end by ropes which pass over two pulleys, O,O, and are in turn attached to the circumference of the large drum, N, which is mounted on a stout framework omitted from the drawing for clarity. The weight of the frame, M,M, and the lamps is counterpoised by a weight attached to the rope passing over a pulley, R. A smaller drum is also mounted on the same axle as the large drum, N, to which is attached an endless line which passes over pulleys, P,P,P, to the small barrel or cylinder, Q, to be operated by the prompter or his assistant.

It is interesting to note that the Eyre Manuscript [5] contains details of a very similar float mechanism extant in the Theatre Royal, Ipswich, around 1803. This float consisted of twelve oil lamps fixed to a board, which was in turn attached to a pair of sloats controlled from a central drum or wheel. [see Illus.4].

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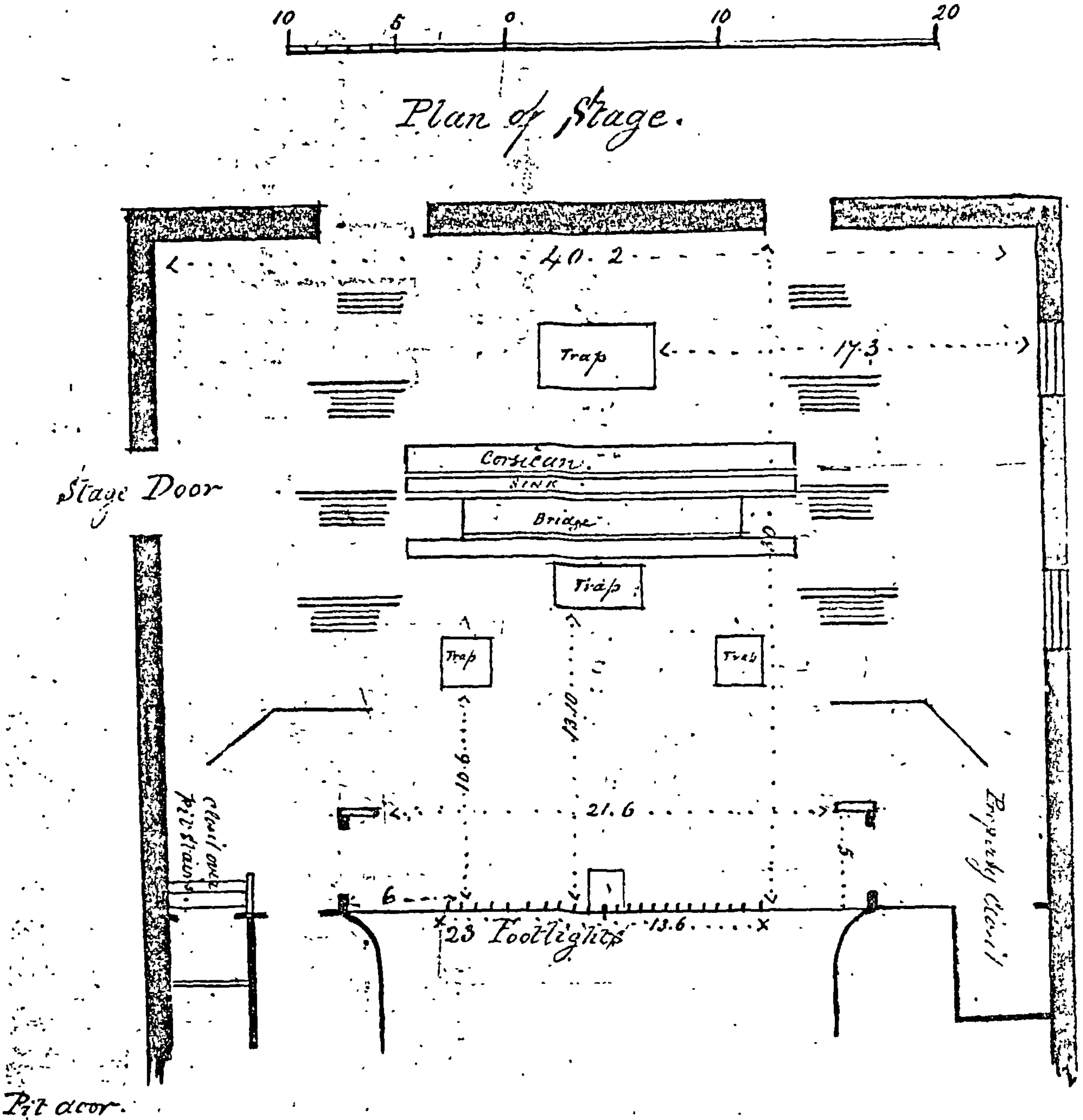
5. H.R.Eyre, Interesting Matter Relating to the Scenery, Decoration, etc., of the Theatre Royal, Tacket Street, Ipswich. M.S. in the Suffolk Record Office, Ipswich, Ref.No.6169, c.1895.



The small Traps are 1.9 × 1.10½

The next is 2.1 × 4.5 long.

The first sink is 8in wide 17ft long

The Bridge 1.10 wide 14 long.

The next sink is 8in wide 17ft long.

The Corsican Trap 1.3 wide 17ft long.

The last Trap. 3.3 × 5.5.

<u>Illus.3</u> Stage plan of the Theatre Royal, Ipswich, c.1858, <u>Eyre M.S.</u>, op.cit. [Courtesy of the Suffolk Record Office].

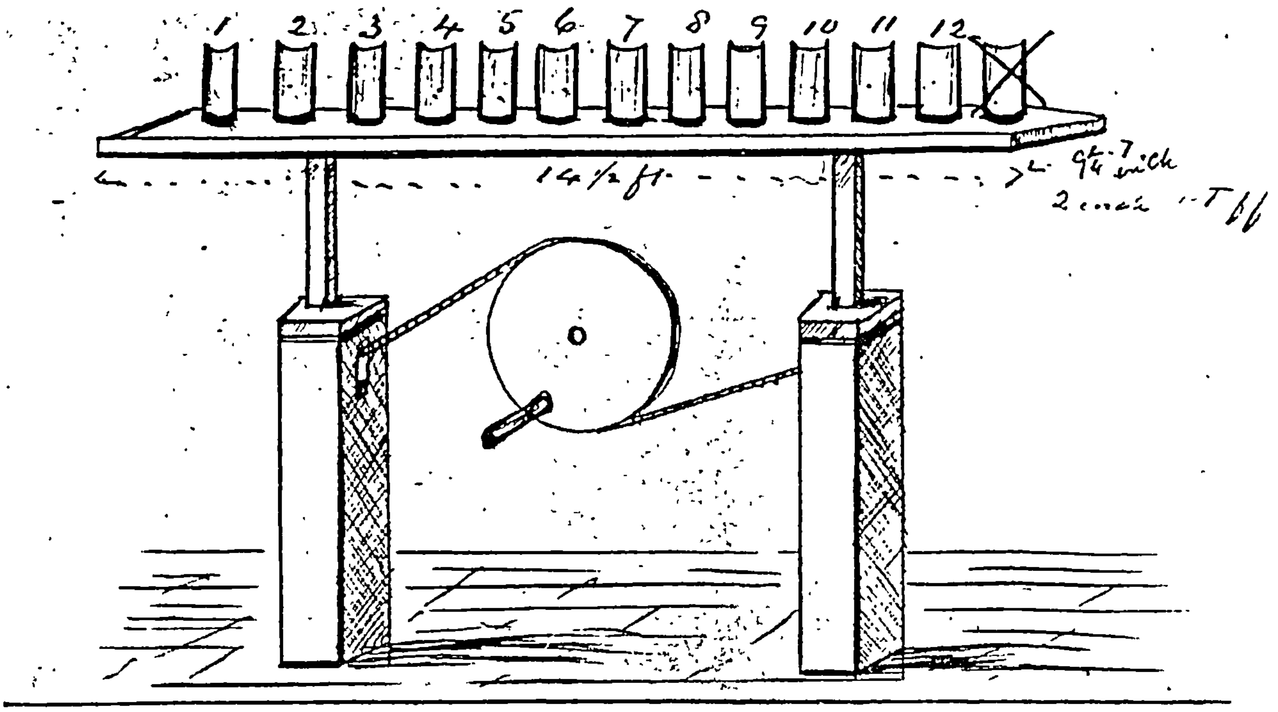
The Traps E,F,G.

The trap mechanism associated with the apertures E,F,G, in Figure 1 is shown in Figures 3 and 4. At either side of the aperture is an upright post V,V, upon which the trap platform slides. The platform consists of a series of horizontal boards made to fit the aperture at stage level. Below the platform is another horizontal board, S, which has grooves to accommodate the posts V,V, thus ensuring that the platform stays level as it rises and sinks. In front of the posts V,V, are another set of uprights U,U, which support the 'cylinder' or barrel of the windlass, T. Two ropes are attached to the cylinder and pass up to their respective pulleys located just beneath the stage. From here the ropes pass down to be attached to the trap platform, S, at some unspecified point. The windlass is secured by a catch and ratchet on the end of the cylinder (though not shown in Figure 3). The inclusion of a ratchet mechanism on the barrel of the windlass is very advanced in terms of the evolution of stage machinery, for, as will be shown later, many windlasses towards the end of the nineteenth century had no safety catches at all. The writer also states that the trap could be counterpoised, if necessary, "but this is seldom, if ever, done."

The trap, F, was described as "of an oblong form six to seven feet in length, and from three to four feet in breadth", and was most frequently used for the grave scene in Shakespeare's tragedy of Hamlet.

The trap, G, directly behind F, was apparently used for the sinking of the cauldron in Macbeth, whilst the side traps, "of which any convenient number may be constructed," are all positioned upstage of the proscenium opening and not contained within the forestage, as at Plymouth. It is however important to note that when Sir Robert Smirke rebuilt the Theatre Royal, Covent Garden, in 1808-9 he, or the appointed stage machinist, reinstated three small traps into the forestage [see Illus.5].

The text goes on to say: "The traps are worked under the stage, by an apparatus attached to each, and similar in all, according to the dimensions of the respective apertures." It must therefore be assumed that the mechanism shown in Figures 3 and 4 was common to all the traps, E,F, and G. Unfortunately no indication is given as to how the apertures were opened, although the text states that each aperture is closed by a board supported by an upright piece of wood or similar contrivance.



Illus.4 Machine for lowering footlights, Theatre Royal, Ipswich. Eyre M.S. op.cit. [Courtesy of the Suffolk Record Office].

Aperture H.

The text states that,

> "in large theatres, where many changes of the scenery are frequently required, there are a number of longitudinal apertures across the stage which are covered by planks moveable [sic.] upon hinges,so that by throwing them back, the stage may be opened in a moment. The use of these is to allow the flat scenes to sink through the stage when required. Three of these will be found in the plan, at the letters, H,H,H and are known by the name of **flaps.**"

The fact that the flaps are hinged is particularly interesting, for, as will be seen in later chapters, the longitudinal apertures were subsequently opened and closed with a sliding action. However, the use of hinged flaps was almost certainly the method by which many apertures of the eighteenth and early nineteenth century were opened and closed. In 1777, Denis Diderot published his work on French stage machinery [6], which includes an illustration [see Illus.6] of a hinged trap cover for the 'trapillon'. The joinery involved to construct a hinged 'flap' is less precise than that required to make a floor section slide smoothly without jamming and may therefore have been favoured for this reason alone. There must, however, have been several disadvantages to the 'flap' method, including the noise which the flap must have made as it hit the stage and the impossibility of closing it from the substage.

The word 'flap' in this context disappeared from technical theatrical terminology as soon as hinges were replaced by the sliding floor section or 'slider'. Even when the 'flap' was occasionally used to open a trap aperture for removing floor coverings for the stage, the term 'carpet cut' was preferred.

The Cyclopeadia writer states that the 'flap' was used to allow flat scenes to sink through the stage, although no details are given of any other mechanism. It is highly likely, however, that the scenes, and probably ground rows, were attached to a series of 'sloats' positioned in the substage. On the other hand, the text is quite specific in stating that "no machinery whatever is permanently attached to the flaps or slides, for as these apertures serve generally for the passage of the flat scenes through the stage, the machinery must depend upon the

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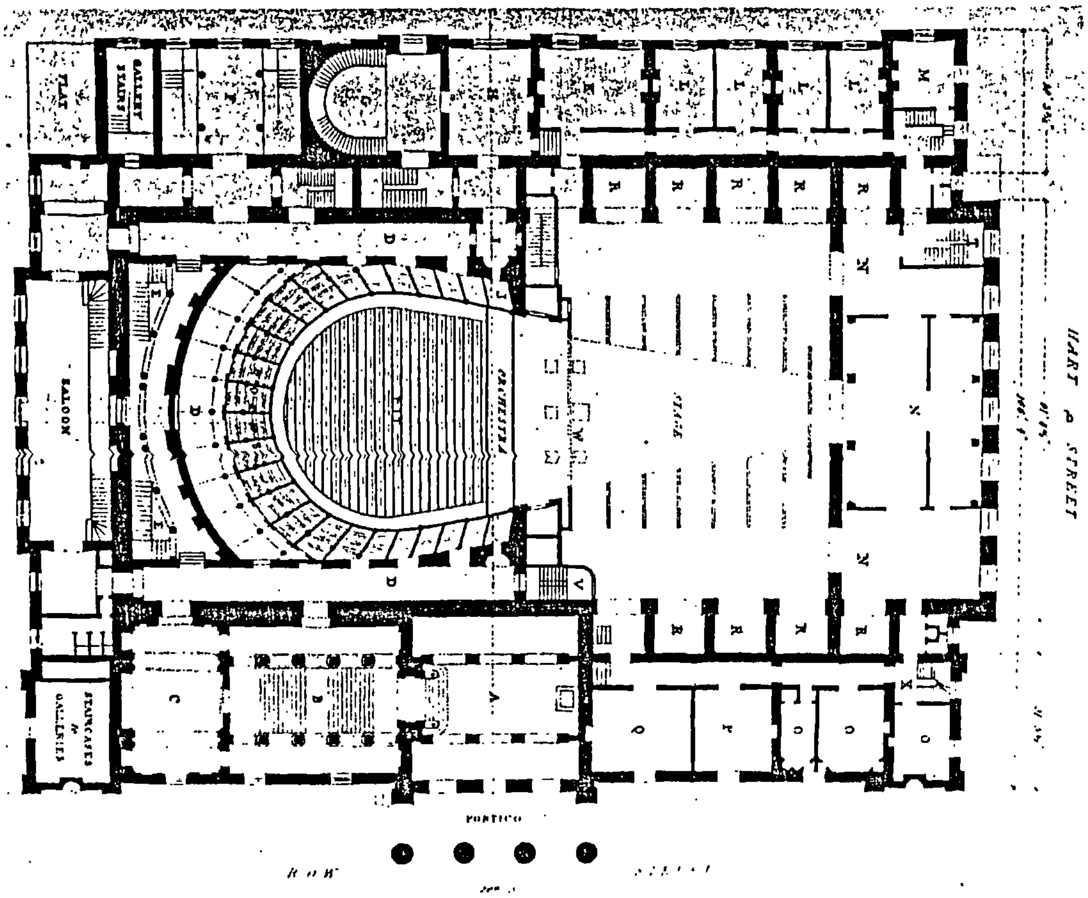
6. Denis Diderot and Jean Le Rond d'Alembert. Encyclopédie, ou Dictionnaire raisonné des sciences, des arts, et des métiers.(Paris: 1762-1772; rpt. New York: Arno Press, Inc., 1980).



Plan at first-tier level showing pit in 1824

0 50 100 ft

Illus.5 Plan of the Theatre Royal, Covent Garden, London, of 1808-9, by Sir Robert Smirke.

particular effect which it is necessary to produce. The flat scenery is generally raised by a crane, unless a very rapid ascent or descent be required, when it may be done by the application of a counterpoise."[7]

The use of the term 'crane' here may be an alternative for 'sloat', but the insistance on no permanent machinery is perhaps an indication of the fluidity of this machinery, a fact worth remembering when we come to consider the criticisms levelled at the later nineteeth century English wood stage on the grounds of its inflexibility - an allegation that was all too common.

Aperture I.

If, as previously estimated, the text was written in 1809, then the reference to the 'late Theatre Royal of Covent Garden' would refer to the theatre reconstructed by Henry Holland in 1792 which burnt down on 20th September 1808. This building apparently had a large stock of scenery, which when not in immediate use was stored in the cellar under the stage. To facilitate this practice, apertures such as I were made in the stage, to be opened by lifting out rectangular floor sections "which could be placed or displaced in a few minutes: these were called sliders", although there is no indisputable evidence to suggest that they actually slid.

The engraving of the stage plan, Figure 1, shows the aperture I, with apparently eight of the removable sections or 'sliders'.

Grooves and Wing Frames.

The stage plan (Figure 1, Plate IX) shows nine sets of grooves positioned on the stage for perspective scenes, the first three sets having three grooves each and the remaining six two each. The writer states that "the side frames are moved in grooves, composed of parallel pieces of wood fixed upon the stage, and so constructed that they may be removed with facility from one place to another." This description would seem to suggest that the grooves are simply parallel strips of wood which have no 'bed', perhaps joined together by small blocks or 'spacers' in a similar manner to the upper grooves at the Theatre Royal, Plymouth (see page33).

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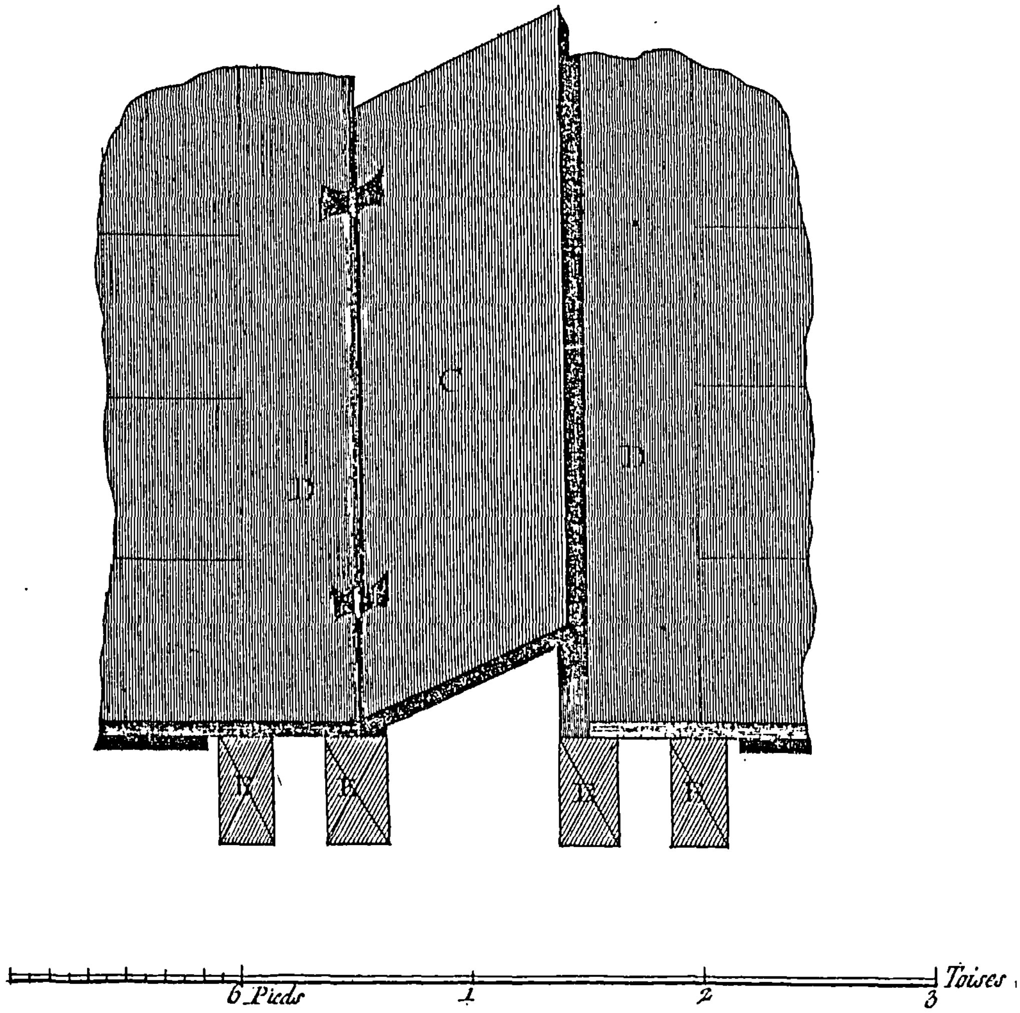
7. Abraham Rees, Cyclopaedia, or Universal Dictionary of Arts, Sciences and Literature. (London:Longman, Hurst, Rees, Orme, and Brown, 1819), XII, n.pag.



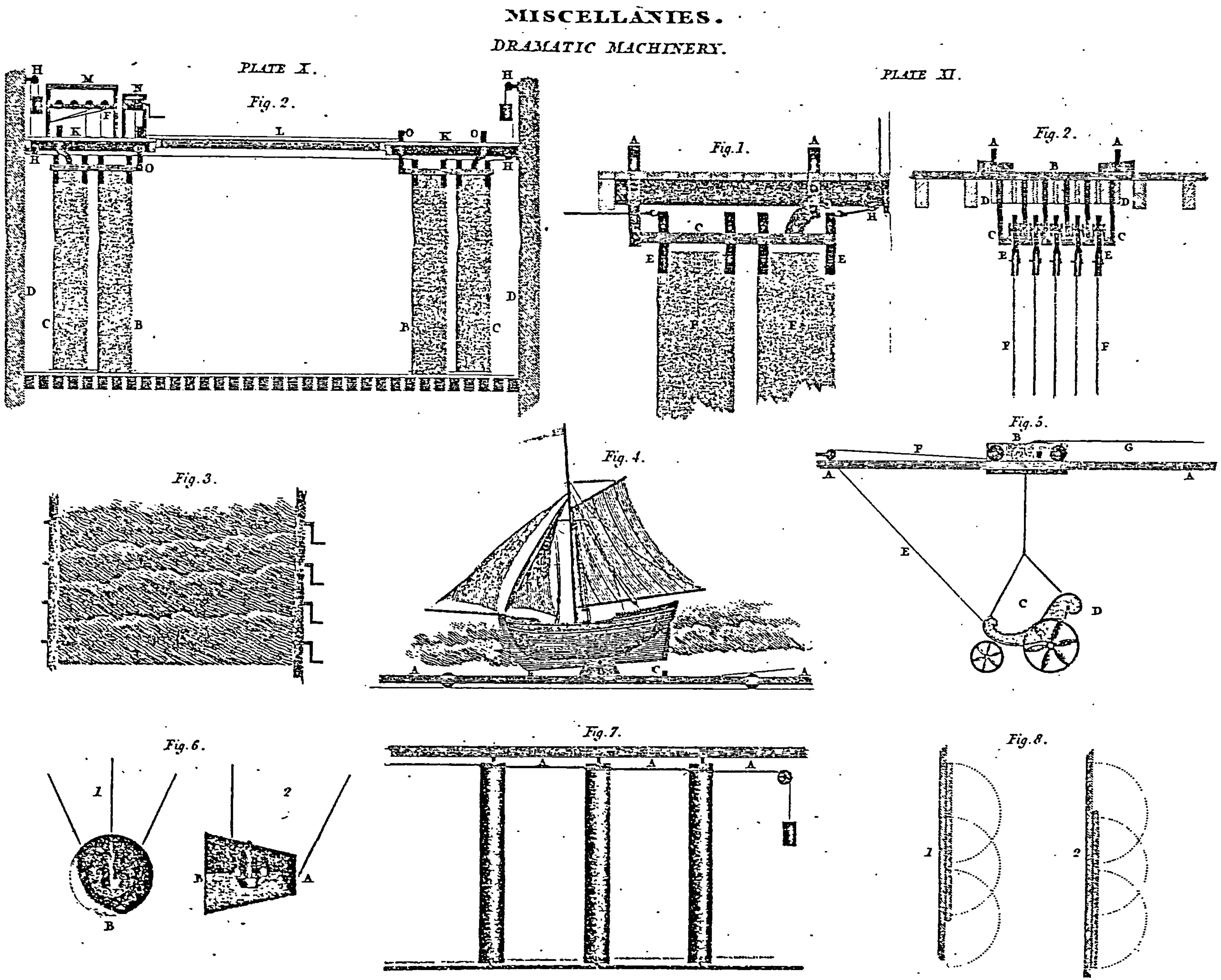
Illus.6 Details of hinged trap. Diderot, op.cit., p.65.

He continues: "A very important part of the scenery of a theatre is the wings. These also are stretched upon wooden frames, and slide in grooves fixed to the stage. In some large theatres they are moved by machinery, in others by manual labour."

Figure 1, Plate IX, shows a transverse elevated section of the cellar and stage areas of a theatre. It demonstrates an alternative method of scene-changing where A represents a strong horizontal beam of wood called a 'sleeper', laid upon the floor of the cellar. Many of these were laid in a parallel line to act as, railways, for the frames of the wings to run upon. Four such frames are shown in the diagram, B,B, representing the downstage pair. Each frame ran on two wheels, "to diminish the friction", and passed through longitudinal apertures which served as guides, thus removing the necessity for grooves. In this illustration only two frames at either side of the stage are in use for each set of wings. This presumably means that while one set was onstage in view of the audience the other set was in an offstage position, to allow the scenery fixed to the frames to be changed as required. F was "a long cylinder, or barrel of wood revolving upon iron axles", which ran from the front to nearly the back of the stage, allowing all the wings to be moved at once in a synchronised manner. The endless lines used to operate this machinery run from the frames to the barrel (F), over the "directing pulley" (H), and back to the same frame. This means that when the upper part of the barrel is rotated to the right, the downstage frames (B,B,) move onstage, while the upstage frames (C,C,) move offstage, and when the barrel is rotated in the opposite direction the frames change positions. The barrel (F) has a pair of gear wheels attached to one end which provide mechanical advantage to enable the mechanism to be operated smoothly and easily by turning the handle (I).

Wing Machinery at the Theatre Royal, Glasgow.

As mentioned earlier, the contributor of the entry on "Dramatic Machinery" in Rees's Cyclopaedia states that he personally designed the machinery which operated the wing mechanism at the Theatre Royal, Glasgow. The design was not initially intended as an improvement on the synchronised wing frame system but as an alternative method of scene changing necessitated by the bad planning of the theatre. The architect, David Hamilton, was not a theatre specialist, and by the time the writer was commissioned to design the stage machinery "the architectural part of the house was finished, and three apartments upon each



Illus.7 Details of 'Dramatic Machinery'. A.Rees, op.cit, pl.X, XI, n.pag.

side under the stage having been fitted up for dressing-rooms, there did not remain sufficient room to construct the barrel and apparatus to advantage in the stage cellar, which was sufficiently occupied by the footlights and trap framings already described." He was therefore faced with several alternatives. He could have asked the architect to remove the dressing rooms, abandon the idea of working the wings with machinery, or invent a new method, which is in fact what happened.[see Illus.7]

In describing the installation he gives several important indications of what was considered usual in theatres of this period (c.1809). For instance, he states that in every theatre it was necessary to have "platforms" at each side above the stage, as well as temporary flooring between these, to assist with the hanging up and taking down of the flats. (The side platforms are denoted K,K, and the intermediate movable flooring, L, in Plate X Figure 2). The use of the word platform is interesting, being apparently the precursor of the term fly gallery.

The provision of these platforms at the Theatre Royal, Glasgow, allowed the installation of "barrels" which were used to operate the wing pieces. Hauling lines were attached to the top of the flats and in order to ensure that they ran freely upon a track, the bottom of the scenery was suspended slightly above the level of the stage, though it apparently gave the impression that they were actually standing on the stage. Under the platforms, K, a number of horizontal boards, three-quarters of an inch thick and seven inches deep, were placed on edge. A constant spacing of the boards was achieved by the insertion of "square pieces of board" at either end, which were bound together by "a clasp of iron, O". This passed up through the platform, K, and was secured by wedges through the arms of the clasp in order to ensure that the height of the wing pieces could be adjusted so that the bases did not catch or ground on the stage floor.

The horizontal boards, which were seven feet long, acted as a railway for the suspended wings to run along. "The wings were suspended by sheers of iron, in each of which was placed a small friction roller resting upon the board, and the lower part of the sheers was screwed to the wing, so that its base might be nearly an inch clear of the stage." There are various definitions of sheer, one being " an apparatus for raising heavy weights", though in this context it would seem to be a bracket for suspending heavy weights.

"Between the pieces of wood which separate the railways in front were pulleys of about six inches diameter, two of which are represented at PP." (Figure 2, Plate X). The plate is however a little unclear, and although it is just possible to make out P,P, within the cross-section of the "platform", there is apparently only one pulley shown on the left hand portion of the plate. This may almost certainly be attributed to a mistake on the part of the engraver which was not spotted during the proof stages, and it is fairly safe to suppose that the missing pulley was in the same corresponding position on the other side of the stage.

A rope was attached to a staple fixed into the top of the sheers of each wing. It passed over the pulleys P,P, to one of the "barrels" at F. Each corresponding pair of wings was rigged onto the same barrel, so that when the barrel was turned both wings moved onstage. To enable them to be moved offstage ropes were attached to the offstage sheers and passed over directing pulleys H,H, where a counterweight was attached. This ensured that when the ropes were wound off the barrel there was a sufficient pulling force to overcome the effects of friction on the railways.

The frame, M, of the multiple barrel windlass consisted of wooden uprights measuring four by four inches, while the horizontal rails which carried the barrels were made of cast iron, with brass bushes to receive the axles of the barrels:

> "The barrels were solid pieces of fir, six inches diameter, and hooped with iron at each end; the longest, which moved six wings on each side of the stage, was divided into three pieces, and the journals connected by coupling boxes. Eight barrels were used, four of which were placed as represented in the figure, and the other four upon the rail at M; because the barrel, when pulling forward the wings, was obliged to raise all the weights for making them recede; a counterpoise, equal to the sum of all these weights, was placed upon the barrel in an opposite direction."

Each barrel was geared in a similar manner to the apparatus used for synchronised scene changes in Plate IX, Figure 1. This apparently enabled one man to operate twelve wings at the same time. Such a system appears to be highly advanced for 1809 and it is difficult to explain why the system was not adopted at many more theatres, for both the methods discussed by Rees's contributor would appear to be highly practical and not labour-intensive.

Provision was also made at Glasgow for the operation of 'drop-scenes', which were, 'tumbled' in a similar manner to that at the Theatre Royal, Plymouth [see page 34]. They were operated from a barrel, N, (Plate X Fig.2) only one is shown in the plate although twelve were employed. When the drop-scene had been rolled onto the tumbler it could then be secured by a 'ratchet-wheel' and catch, which was fitted to each barrel.

After the writer of the article has provided a full description of the machinery he proceeds to give an analysis of the problems encountered with the system and compares the two installations of synchronised wing changing he has described. This part of the article offers one of the very few serious critical accounts of stage machinery actually written by a practicising stage machinist in the early nineteenth century. It is therefore worth quoting at length:

"Although this machinery was constructed rather to correct an error in the general construction of the theatre than for any other reason; it appears, after four years trial, to possess some important advantages over the plans of the London theatres, whilst it is fair to state that it is equally liable to some objections. As it was constructed in a hurried manner, the practical part was not executed so perfectly as might have been wished; all the directing pullies were made of wood, and the grooves to receive the cords by no means sufficiently deep to prevent them from slipping occasionally, which must have frequently interrupted the motion of the wings. For this reason the counterpoise weights were substituted for the double or endless line; and this was more necessary, because the cordage being new, it was perfectly evident that the natural stretch would in a few days render it quite unserviceable in this respect, unless greater care had been taken than is generally to be expected. This machinery, with very little attention, has been found to answer the purpose remarkably well. Its advantages over that used in Covent Garden seem to be the following:

The frames which carry the scenes by the plan Fig.1, resting upon the floor of the stage cellar, require a strength of framing to keep them steady, which both renders them heavy to move and involves a very great expense for the timber and workmanship; besides this, many people must be employed to change the wings upon the frames when drawn back, and in this respect no saving of labour can arise, and the only advantage gained by the machinery is regularity of motion. The hanging wings of the Glasgow theatre are greatly lighter, and might be much more so than they are, for the whole frame-work was finished upon the presumption that they must rest upon their bases, as in the case of other wings. But it will at once occur, that a much greater strength of frame-work will be necessary for a scene upwards of 20 feet high, and resting upon its base, than for one suspended from above, where the force of gravitation acts in a contrary way, and which requires no other power than what is necessary to distend the canvas. Add to this, the weight of a framing passing through grooves in the stage and running upon a rail-way nearly 20 feet below, and without exactly measuring the dimensions of the wood, which must always depend upon those of the theatre, the disproportion of the one plan to the other will appear enormous. In the working of the wings according to either of these plans the superiority also evidently rests with the latter. A person or persons under the stage are situated in a most inconvenient place for observing the conduct of the drama, and regulating operations to forward its effect. On a platform above every thing is easily visible, and common attention to what passes below is all that is necessary. In the London theatres, as also in most respectable provincial ones, a whispering tube is placed, to convey sounds from the prompter to those employed above, for their occasional government; this tube is entirely similar to a common speaking trumpet.

The defects of the hanging machinery, as constructed at Glasgow, ought also to be noticed. The rail-ways, upon which the wings move, were found sometimes apt to warp, and had of course some tendency to interrupt the motion of the wing; this might be easily remedied by making the rail-ways of cast-iron, and if the upper edge should be well polished the friction would be very small indeed.

In a provincial theatre, where a certain set of wings are almost constantly used, the plan of screwing the sheers which carry the pullies to the wings may answer very well; it is, however, certainly more desirable that means should be devised for altering the wings with greater speed than can be done by the drawing of screw-nails. Many plans may be contrived to answer this purpose; one, which may do sufficiently well, is represented in Figs.1 and 2, Plate XI."

In this plate, Figure 1 represents a profile elevation of the "suspending apparatus" and upper part of the wings as in Figure 2, plate X. On this occasion C represents a cast-iron railway, and E a pair of sheers or clutch of malleable iron, through which is mounted an axle to carry a small friction wheel on either side of the sheer.

"The cordage and barrels may be either as in the former plate, or the endless line may be substituted if precautions are taken to prevent the cords slipping off the directing pullies."

Figure 2, Plate XI, shows the same apparatus viewed on the upstage side.

"The hanging part of all the divisions between the five wings represented may be of cast iron, and the projecting parts under the friction rollers may be cast as feathers, or separate pieces, and joined by counter-sunk screws. The intermediate pieces to preserve the distances, where the bolt D passes through, may be of well-seasoned plank.

By these means, and the application of the double rollers, an interval is left by which any wing may be speedily removed, without unfixing a single screw or bolt; and the moving cords, being merely hooked to the wing, may be instantly unfixed and placed upon hooks in the suspending apparatus, as represented in Figure 1, Plate XI until a new wing is placed on the railway. At the same time, by using cast iron, the whole may be compressed into so small a space, as to have all the wings, necessary for an evening representation, fitted in their places before the exhibition commences, unless in very extraordinary cases."

This improved method made the whole system far more practical, for it meant than no wings had to be replaced in the course of a performance.It follows that the number of scene-shifters and carpenters required during a performance could be drastically reduced, making this system far more practical in economic terms than that used at the Covent Garden Theatre. Moreover, the inclusion of cast iron in preference to timber helped to reduce the fire hazards of the backstage area.

One important question relating to the scene-changing mechanisms described remains unanswered. The writer omits to say whether the wing frames, etc., obeyed the rules of perspective. The grooves shown on the stage plan [Plate X Figure 1] are arranged for perspective scenes, but it would be considerably harder to arrange a synchronised wing changing mechanism along such lines. For instance, the upstage wings would have to be shorter than the downstage ones, creating problems of suspension if the Theatre Royal, Glasgow, method were adopted. Nevertheless, perspective scenery was in common use around 1809 at other provincial theatres, and at the Theatre Royal, Plymouth [see page26]. A possible solution could be that all the wing-pieces were of exactly the same size, but painted with a regard for perspective. This would mean that many of the upstage wing-pieces had no painting on their upper portion and this was simply masked out by the borders, which were positioned accordingly.

The co-ordinated or synchronised method of changing wing-pieces in British theatres during the early part of the nineteenth century is poorly documented. The text in Rees represents the most comprehensive account known to exist, although there are other sources of evidence which help to reinforce the belief that the information contained in the Cyclopaedia is representative of accepted scene-changing methods. For instance, the Eyre manuscript contains an interesting passage relating to a set of "book-wings", which were certainly in use at the Theatre Royal, Ipswich, in 1842 and may have dated from the 1815 alterations:

> "The 'book wings' had 4 on each barrel. 'Palace interior', 'Wood' 'Cottage interior' & 'Cave or Rock'. These remained in use until 1857 when they were converted in to the modern style [8] by Guyton, Mr.Gill's carpenter who added 12 inches in height [9]. The book wings were worked by means of a spindle passing through the stage at the end was a grooved wheel round which passed a rope connected with another wheel situated on the prompt side of the stage, so when a scene required changing a man had only to turn the wheel changing the entire number at once." [10]

This description does not make it clear whether the "spindle passing through the stage" did so in a vertical manner, forming a kind of periaktoid to which the book wings were attached; or whether the spindle ran in an upstage-downstage direction in the cellar in a similar manner to that described by Rees. The use of the word "book-wing" would in today's theatrical terminology imply that the wing was hinged and could be folded in half. It is not certain, however, that this is what is meant. But whatever direction the spindle ran in, it is undoubtedly another example of synchronised scene-changing which could be carried out by one man and probably supply all the necessary wing pieces for a single performance.

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8. This was the traditional groove system.
9. Making them around 9ft high and 3 or 4 feet wide.
10. H.R.Eyre, op.cit.

An even earlier example of the same procedure is mentioned by William Rufus Chetwood in his book, A General History of the Stage (more particularly the Irish Theatre):

> "When I came first from England [to Dublin] in the year 1741 I brought over an experienced machinist, who altered the Stage after the Manner of the Theatres in France and England, and formed a Machine to move the Scenes regularly all together." 11

Although this description is vague it might be supposed that this 'Machine' could also change all the wings at once. Hitchcock, in his History of the Irish Stage, relates that Chetwood went to the Smock Alley Theatre in Dublin and:

> "By his direction a machinist from one of the London theatres was engaged, who first worked the wings by means of a barrel underneath, which moved them together at the same time with the scenes. This was publicly boasted of as a master-piece of mechanism; at present [1788] it is well understood and constantly practised." 12

If this was, as he claims, a system in common use, it is surprising that very little evidence exists today to support the statement, and it would appear that this type of machinery was more akin to the continental traditions of scene-changing.

Although Rees's refers to several theatres, the illustrations he provides do not relate to one specific theatre and in consequence do not provide sufficient information to understand the working of the stage as a totally integrated unit. The information contained in the Cyclopaedia provides a useful datum line on stage machinery around the beginning of the nineteenth century. Yet it must be stressed that it is but one account and may or may not offer a representative view. Unfortunately descriptions of machinery installed into theatres around this time are often so vague that it is all too easy to interpret information incorrectly.

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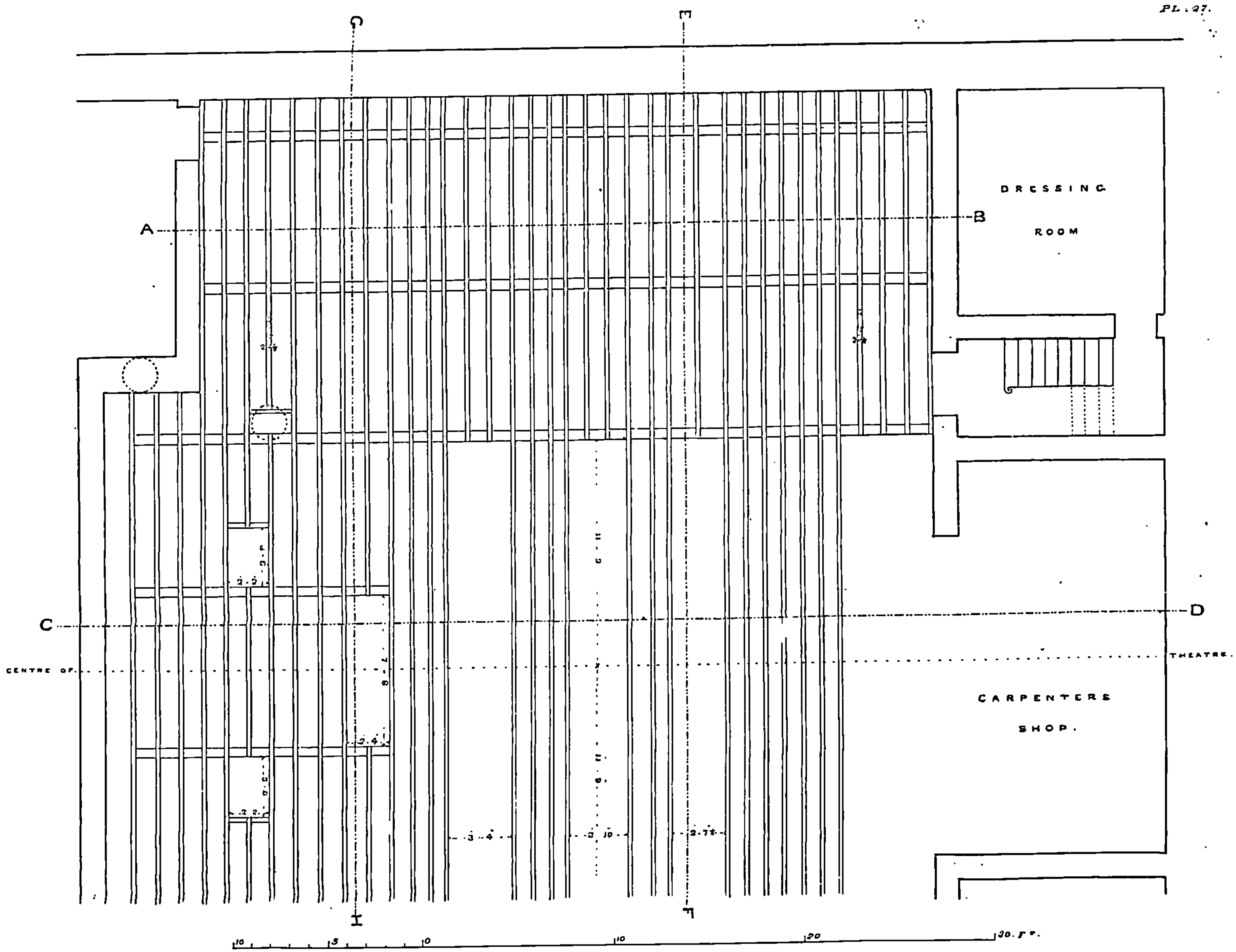
11. William Rufus Chetwood, A General History of the Stage (more particularly the Irish Theatre) (London: W.Owen, 1749), p.73.
12. Robert Hitchcock, A Historical View of the Irish Stage from the earliest period with theatrical anecdotes, (Dublin: 1788), vol.1, p.116.

The architectural design and treatment of theatres during the early years of the nineteenth century tended to reflect the style of the drama, as did the technical facilities provided backstage. It was not until later in the century that sensation melodramas and spectacle came to the fore, demanding large amounts of machinery and effects. The low fly towers and shallow cellars of the early part of the nineteenth century were not built for gargantuan presentations, rather for performances of a comparatively uncomplicated nature. During this period there appears to have been a more pronounced difference in size between the major theatres of London, such as the Theatre Royal, Drury Lane, and the provincial and in many ways parochial theatres of the rest of the country. This marked difference diminished with the advent of the theatre building boom of the latter part of the nineteenth century. Yet even before this period attempts were made to improve the general state of the provincial theatres, by introducing new building materials and new techniques, as will be seen from the first case study, which examines the stage machinery at the Theatre Royal, Plymouth, in Devon.



Illus.8 Plan of the Mezzanine Floor, Theatre Royal, Plymouth. Foulston, op.cit., pl.27.

THE THEATRE ROYAL, PLYMOUTH, 1811-13.

"To work these wonders, what immense machines,
What costly ornaments, what splendid scenes," [1]

In 1811, an architect named John Foulston won a competition to design a group of buildings in Plymouth consisting of the Royal Hotel, Assembly Rooms, and Theatre which opened on 23rd August, 1813. The design was particularly notable for the extensive use of cast and wrought iron in the 'fireproof' theatre, and for the way in which he combined three buildings, each with a separate function, into a single architectural composition. In 1838, after Foulston had retired, he published a book entitled The Public Buildings erected in the West of England as designed by John Foulston F.R.I.B.A. [2] Within this volume he reproduced detailed drawings of the Theatre Royal, Plymouth, which show not only the general arrangement of the auditorium but also the details of the stage machinery installation. This therefore represents an important piece of documentation giving an insight into an early nineteenth century provincial theatre, and a close examination of some of its plates is called for.

Plate 27 [Illus.8]
Plan of the Mezzanine Floor, under Stage, shewing [sic.] the Scantlings and method of framing the Timbers; the Carpenter's Shop; and Dressing Rooms.

There is a very definite relationship between the morphology of the traps and the orientation of the structural timbers in the substage. This is particularly well illustrated here where the larger timbers (6"x4") run in an upstage downstage direction, forming a basic framework for the narrower timbers (7"x2.5"), which help to provide the framing for the trap apertures. Because of the necessity for clear access through the trap apertures it is not possible to insert the large upstage downstage timbers at regular intervals. Consequently

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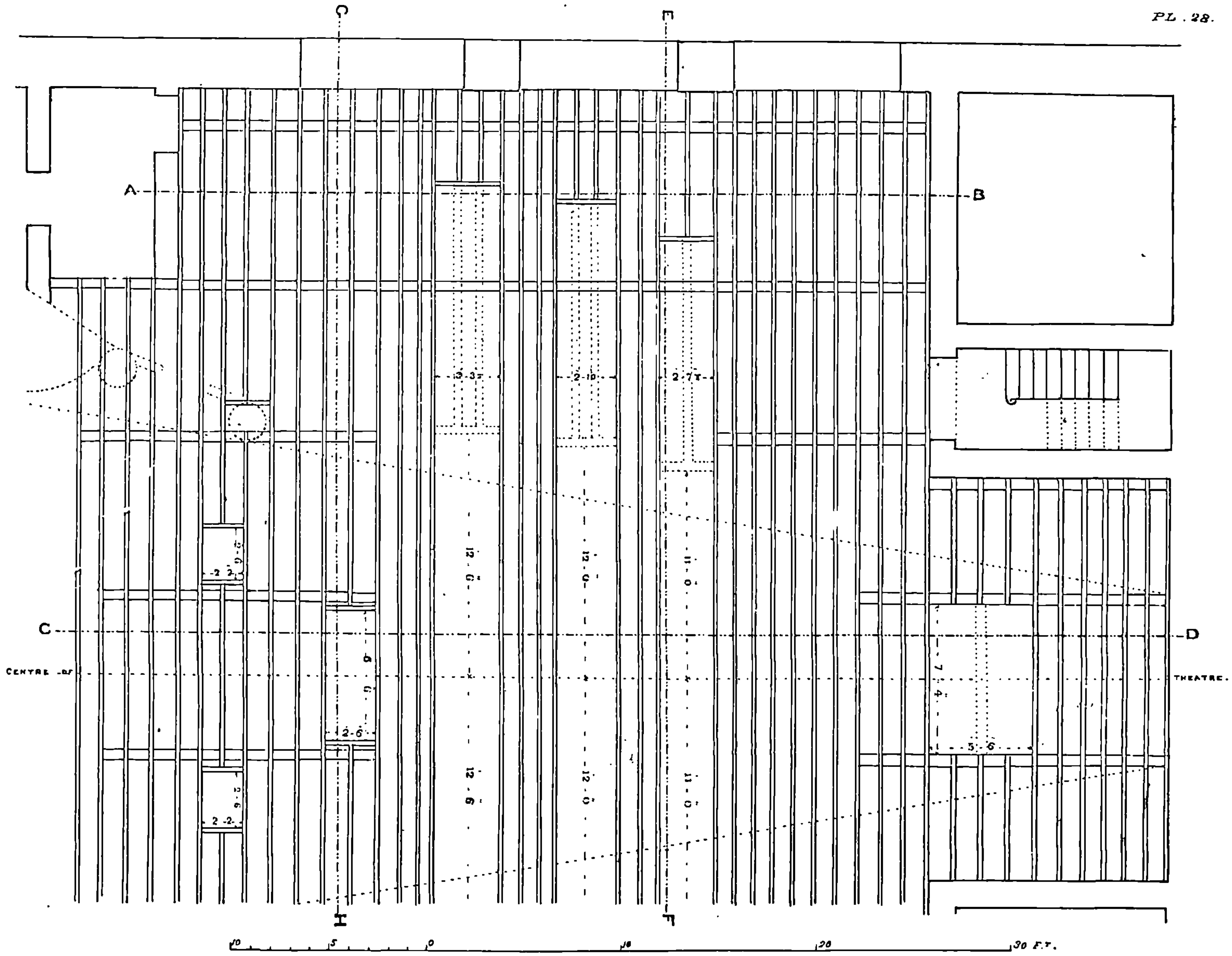
1. From an address by J.Wilde given at the opening of the Theatre Royal, Plymouth on 23rd August 1813.
"Opening of the New Theatre Royal, Plymouth," The Plymouth and Dock Telegraph or Naval and Commercial Register, 11th Sept., 1813, p.4.
2. John Foulston the Public Buildings in the West of England as Designed by John Foulston, F.R.I.B.A. (London: 1838).



Illus.9 Plan of Stage Floor, Theatre Royal, Plymouth.
Foulston, op.cit., pl.28.

the centre stage area, where the traps stretch the full width of the proscenium opening, must have had a certain amount of lateral instability [3].

At the rear of the mezzanine floor was the carpenter's shop, where small pieces of scenery and props may have been constructed. The 'shop' had an access door allowing items to be passed up to stage level as required. Although it was well sited for access it must have been a great fire hazard, being located amongst the timbers of the substage and lit by gas.

Plate 28, [Illus.9]

Plan of Stage Floor, shewing [sic.]the method of framing the Timbers, &c. for Traps, and Moveable [sic.] Floor.

The arrangement of the joists at stage level is almost identical to that in the previous plate, because the two levels are connected by vertical 4" x 2.5" timbers which continue into the cellar [Plate 33, Fig.II]. There is, however, a noticeable difference in the aperture size of the corner traps and the grave trap. The apertures at stage level are designed to accommodate only the trap cover, whereas the apertures at mezzanine level must also allow ropes to pass down into the cellar.

The spatial distribution of the trap doors is particularly interesting in that the two corner traps are located downstage of the "Green Curtain" [see Foulston's Plate 31]. Although the forestage is not part of the auditorium as in earlier Georgian theatres, the proscenium doors are retained. The relationship of the stage to the auditorium was therefore undergoing a change which is well reflected in Foulston's design. Iain Mackintosh [4] comments:

> "It is possible to pinpoint the time when the forestage started to shrivel, when the delicate balance between acting stage and scenic stage was tipped in favour of the latter. The year was 1790 when the first known English treatise on theatre design was published. The author, George Saunders, quotes an earlier work by Count Algarotti published in Italy in 1762: 'The great advance of some stages in the body of the theatre is too absurd ever again to be practised .... Such a continuance can only please

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3. See page 124 for a fuller discussion relating to this inherent problem.
4. Iain Mackintosh, Pit Boxes and Gallery: The Story of the Theatre Royal, Bury St.Edmunds 1819 to 1976. (London: The National Trust, 1979).

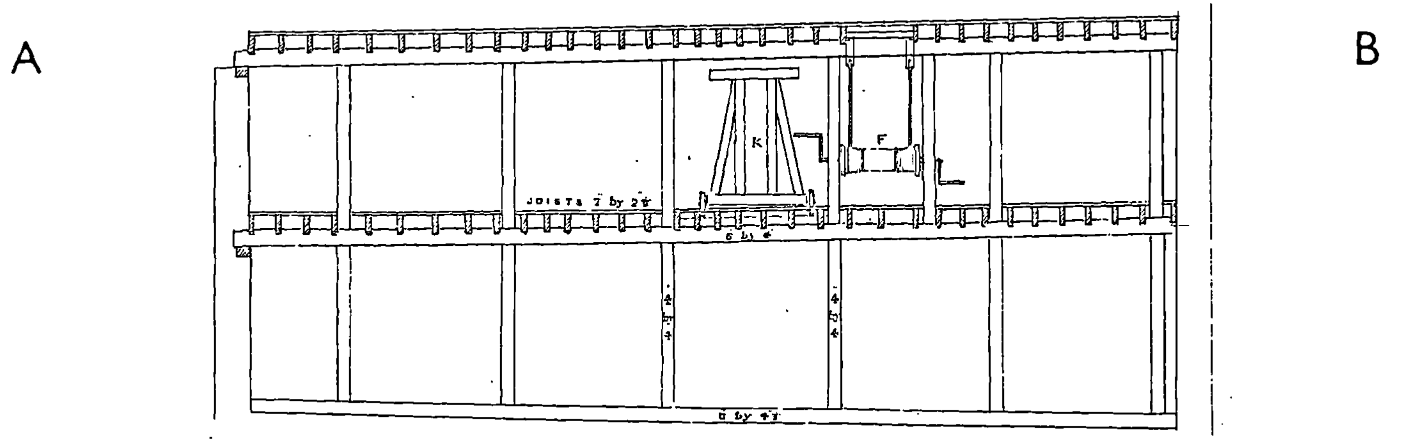

FIG. I.

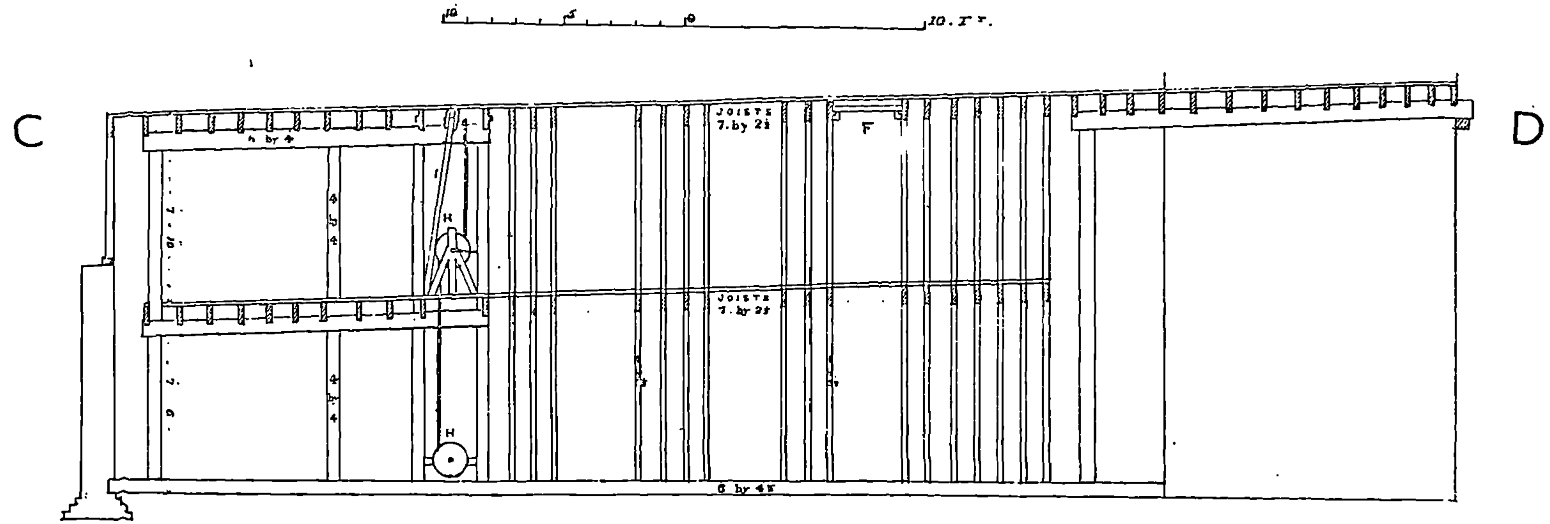

FIG. II.

Illus.10 Longitudinal Sections of Stage and Mezzanine Floors. Theatre Royal, Plymouth. Foulston, op.cit., pl.35.

those who are easily satisfied, for who that reflects can not see such a proceeding as subversive to all good order and prudent regulation? The actors instead of being so brought forwards, ought to be thrown back at a certain distance from the spectator's eye; stand within the scenery of the stage, in order to make a part of that pleasing illusion for which all dramatic exhibitions are calculated'. .... A division is necessary between the theatre and the stage and so characterised as to assist the idea of there being two separate and distinct places." [5]

The relationship between the forestage and the small traditionally downstage traps is therefore worthy of special consideration, but unfortunately there are no substage plans of the corner traps though details are given of the grave trap.

Plate 34, [Illus.12].

Fig.2 - Transverse Section at G,H, on Plans, Plates 27 and 28; H, H, Windlass for Working Traps on Stage; L, Movement for ditto.

The trap cover mechanism, L, appears to consist of a large handle, which is presumably hinged to the trap cover and supported by the mezzanine floor. Each windlass, H, has two ropes wound onto it. One is attached to a set of counterweights which descend into the cellar, while the second passes from the winch down into the cellar where it is attached to a small drum. Another pair of ropes are shown on the section, which appear to be attached at one end to a platform which is level with the mezzanine floor and framed with a 7" x 2.5" joist. The other ends of the ropes are not shown very clearly, although they may be attached to their respective counterweights. The function of the drum in the cellar is not at all clear, and the drawing seems somewhat confused, for it is very difficult to deduce exactly how the grave trap worked from the existing information.

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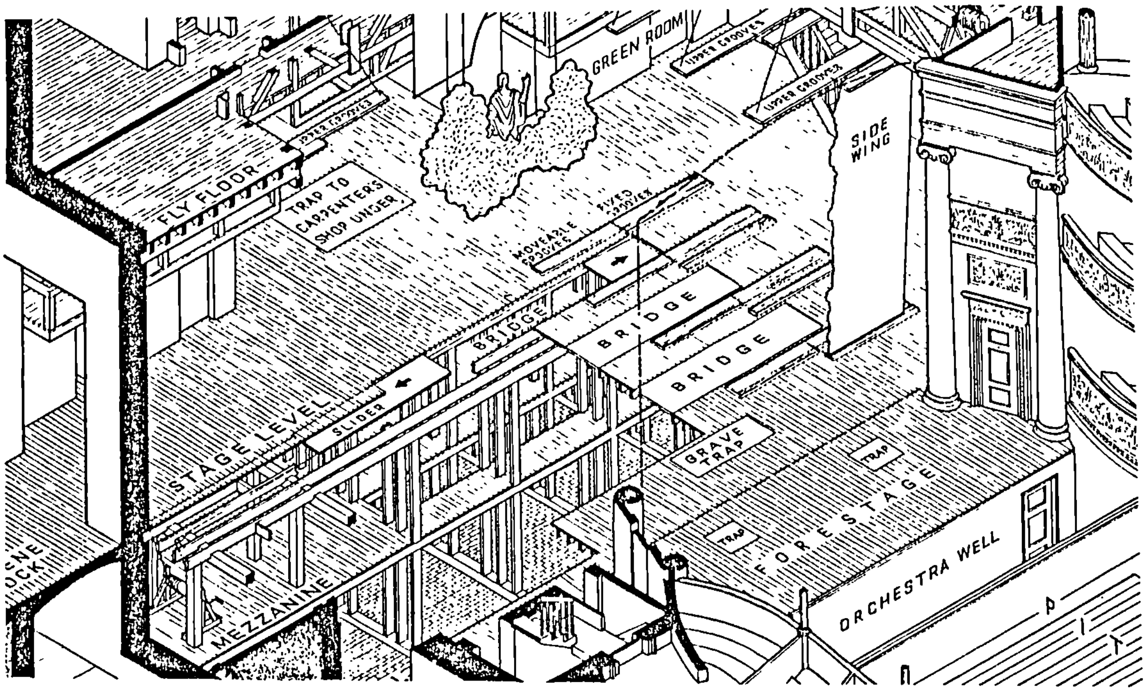
5. George Saunders, A Treatise on Theatres, (London: 1790; rpt.New York: Benjamin Blom, Inc., 1968).
Count Algarotti, An Essay on the Opera (London: L.Davies and C.Reymers, 1767).



<u>Illus.11</u> A reconstruction of the stage area, Theatre Royal, Plymouth. Leacroft, <u>The Development of the English Playhouse</u>, p.199.

Plate 33, [Illus.10]

Longitudinal Sections of Stage, and Mezzanine Floors, shewing [sic.] their inclination, and the method of framing the Timbers, with their Scantlings.
Fig.1 - From A to B on Plans, Plates 27 and 28; F, Windlass, for working the Sliding Floors of the Stage; K, Carriage for Moveable [sic.] Objects on the Stage.

The section A - B shows the stage and mezzanine floor to be raked, while the floor of the cellar is level. The caption above states that 'F' is a windlass for working the sliding floors of the stage and from Plate 34, Fig.1, it can be established that there was a windlass at either side of the mezzanine floor to remove the respective halves of the trap sliders. Plate 33, Fig.1, shows two ropes being attached to the windlass. The actual rigging of the ropes onto the sliding floor sections is a little unclear from the drawings, but it is probably safe to assume that one rope is attached to either end of the sections as shown in Plate 34, Fig.1,I, and operated in the conventional manner of the English wood stage.

Plate 33, Fig.1, also shows k, a 'carriage for moveable [sic.] objects on the stage', which also appears on Plate 34, Fig.1. It was apparently located directly underneath the three large apertures of the stage, but the actual operation of this type of the mechanism is somewhat contentious. Richard Southern in Changeable Scenery [6] gives the dimensions of the three large apertures, which he describes as "cuts", but omits, any description or explanation of the "carriages". An explanation was, however, offered by Richard Leacroft:

> "The sliding portions of stage which drew off to each side to allow a bridge to be raised with its cargo of actors or scenery can be seen in detail [Illus.11]. The bridges themselves are not shown but the sliders in the third bridge position are shown withdrawing. Below the stage was the mezzanine floor. At this level the machinery was worked and the actors gained access to the bridges in their lowered position, the substructure of the bridges being then accommodated at a lower level, known as 'the well'." 7

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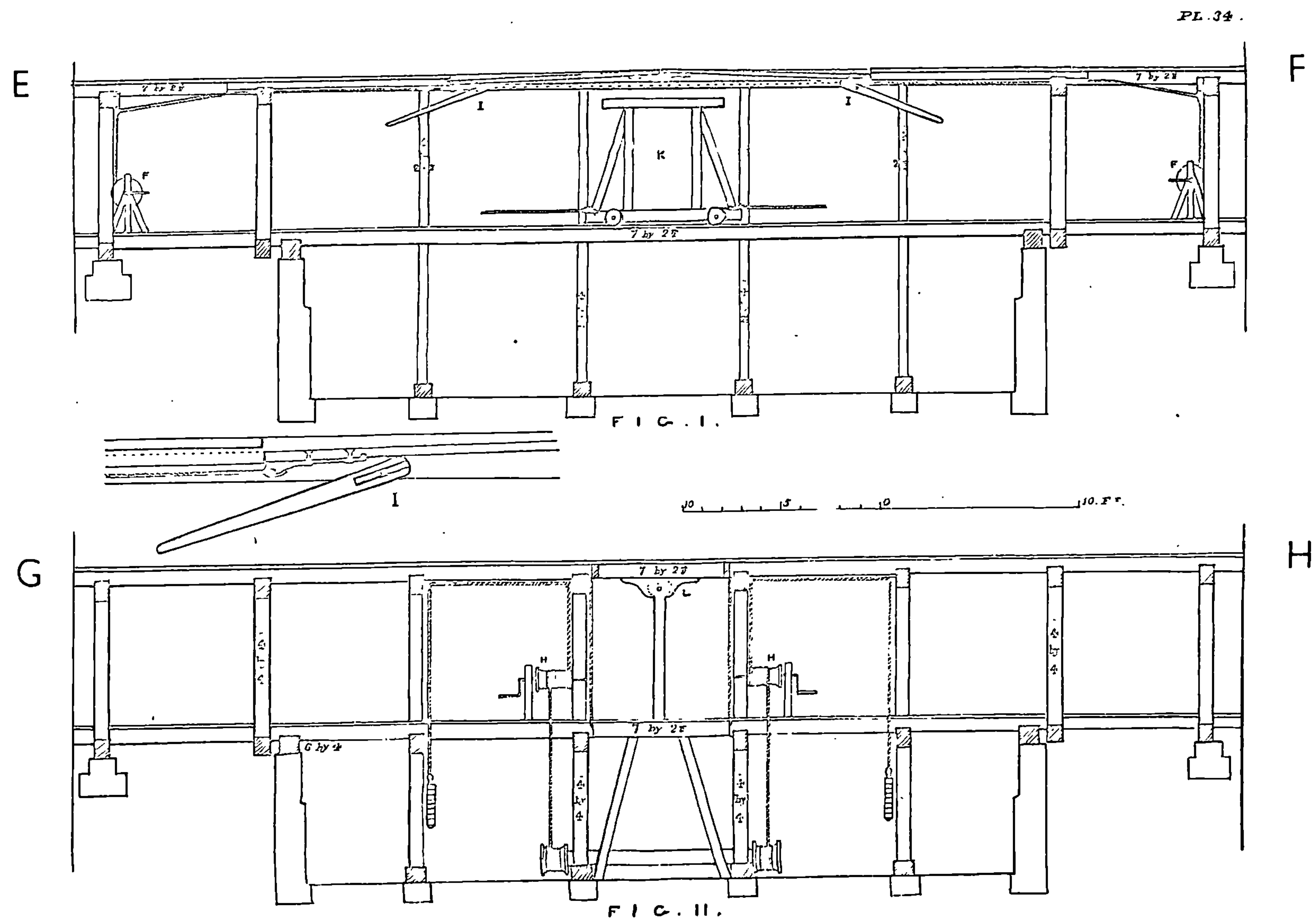
6. Richard Southern, op.cit., p.286.
7. Richard Leacroft, "The Theatre Royal, Plymouth - An Early Nineteenth Century Theatre" R.I.B.A. Journal, May, (1952), p.251.



Illus.12 Transverse section E-F of stage and mezzanine.
Transverse sections G-H of stage and mezzanine.
Theatre Royal, Plymouth, Foulston, op.cit., pl.34.

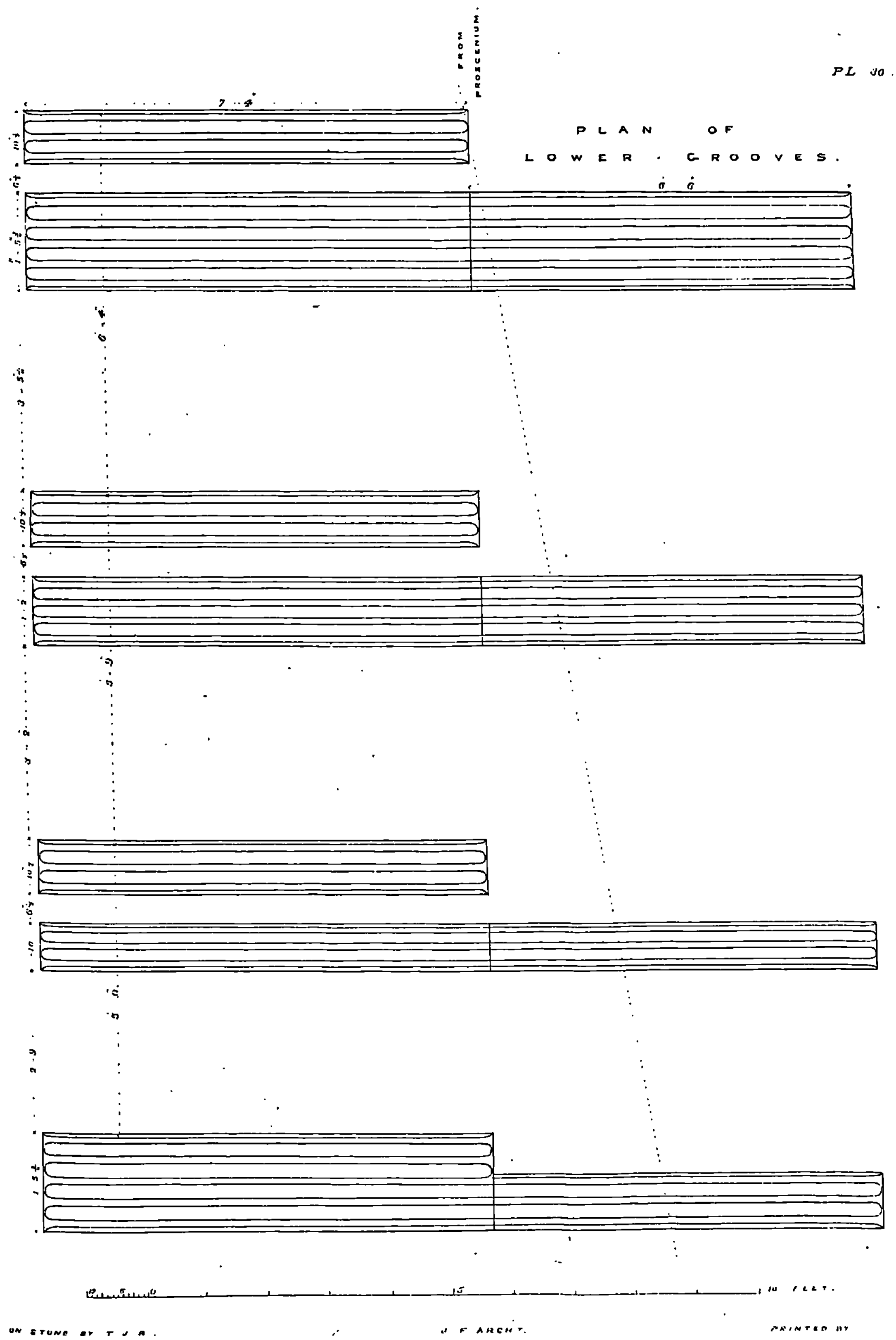
Despite Richard Leacroft's use of the word 'bridge' there is no reference to it in Foulston's drawings. In addition the plans and cross-sections show no evidence of such a structure or mechanism. Had Foulston intended to use 'bridges' he would almost certainly have included drawings. Assuming therefore that there were no bridges it is necessary to consider how the 'carriage' worked.

Plate 34, [Illus.12]

Fig.1 Transverse Section of Stage, and Mezzanine Floors, shewing [sic.] the method of framing Timbers, with their Scantlings at E, F, on Plans, Plates 27 and 28; F, F, Windlass for Working the Sliding Floor of Stage; I, I, Movement for lowering the end of Floor, previous to its being drawn over; and for forcing it up again when drawn back; k, Carriage for Moveable [sic.] Objects on Stage, also worked by the Windlass F,F.

From the drawings it would appear that the carriage consisted of a base mounted on four wheels. Four verticals are mounted upon the base and support a platform measuring approximately 6'6"x3'9", which traversed across the proscenium opening at approximately 2' below the level of the stage. According to the above caption the carriage is made to traverse across the stage by ropes attached at either end and connected to the respective windlasses, F,F, at either side of the stage. However, the ropes are not actually shown attached to the windlasses. Instead they are discontinued and end abruptly in mid-air. It is certainly very difficult to imagine a roping arrangement whereby the floor sections and the traversing carriage are all operated by the same windlasses. Perhaps a possible solution could be found by giving the windlass, F, two separate and independent barrels within the structure of the one windlass frame. This would then allow one operator to open the floor and another to traverse the carriage. Alternatively, despite the caption "worked by the windlass F,F,", it may be that the carriage was traversed manually by stage-hands pulling on the ropes. Whatever the method was, the function of the carriage, and its use in scenic presentation requires careful consideration.

The platform of the carriage is only approximately 2' below the level of the stage, and consequently no scenery, or props, and certainly no actors, could be preset on the platform before the floor sections were opened. It may therefore be that the carriages were designed to be 'loaded' out of sight of the audience.



Illus.13 Plan of Lower Grooves on the Stage Floor. Theatre Royal, Plymouth, Foulston, op.cit., pl.30.

If this hypothesis is correct, the sequence of operation would have been as follows:

1. The 'closing' of a 'flat-scene' in a set of downstage long grooves.

2. The opening of the sliding floor sections for the 'carriage', whilst a scene is taking place in front of the downstage grooves.

3. The 'loading' of the carriage platform.

4. The opening of the 'flat-scene' in the downstage long grooves to reveal the scenery, etc., on the carriage.

5. The traversing of the carriage, if required.

It is therefore very evident that the position of the grooves bears a direct relationship to the carriage cuts.

Unfortunately there is not a plan which shows the grooves and carriage cuts together, although from the various other plans it is possible to compile an approximate overall stage plan. It does, however, rapidly become obvious that there are a good many discrepancies in Foulston's measurements, and a considerable amount of approximation is necessary. The upstage edges of the sets of grooves run adjacent to the downstage edges of the carriage cuts (excluding the upstage set of grooves) and the movable grooves are set encroaching some 6'6"on stage. It would therefore be possible to slide flats onstage which did not meet in the middle, but which nonetheless provided sufficient masking for the carriage to be loaded behind those flats.

Richard Southern offers an alternative hypothesis to the effect that "the lower grooves are arranged to come almost exactly in the spaces between the slider openings. We presume, however, that since the long grooves were for flat scenes, when the flats were drawn together at any position no use could be made of the cut behind." [8]

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8. Richard Southern, op.cit., p.289.

Plate 30, [Illus.13].

Plan of Lower Grooves on the Stage Floor, to an enlarged scale.

The drawings in Plate 30 represent the first known detailed architectural drawings of the English groove system. The grooves are arranged in eight groups, four on either side of the stage. A single group of grooves can be further subdivided into:

a) short grooves on the downstage side;

b) long grooves on the upstage side.

Southern [9] states that "there are three short grooves in each set," but this is not strictly true. The upstage group has only two short grooves, and is totally different from the other groups because there is no spacing between the long and short grooves. He does qualify his statement by adding, "in the No.4 set they are in direct contact, and are made in such a way that the third short groove is in effect identical with the first large groove, so making only five grooves in all in No.4 set." [10] This being the case the third groove should be designated as a long groove and not, as he suggests, a short one.

In every case the short grooves measure 7'4" in length and the long grooves 13'10", which includes a 6'6" removable extension. The distance separating the onstage ends of the long groove extensions from their counterparts on the opposite side of the stage is approximately 11'.

Southern [11] comments: "In the plans of Inigo Jones, the long grooves met in the centre of the stage. We find that they no longer traverse the whole stage, but at what date this gap between the tips of opposite pairs came into tradition we do not know." However, it is perhaps unwise to regard a gap between the tips of the grooves as part of an evolutionary process. It must be remembered that the theatres of Inigo Jones had proscenium openings generally narrower than the 24' as at the Theatre Royal, Plymouth. It would undoubtedly be of great assistance to the stage carpenter if the grooves were continuous, but they also had to be movable. Consequently, if the proscenium opening was very wide, the removal of a continuous groove would be proportionately harder. This idea is supported by

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9. Ibid.p.287.
10. Ibid.p.288.
11. Ibid.

the recent discovery of a continuous upper groove at the Normansfield Amusement Hall, Teddington, which was built as late as 1879. Here, because the proscenium opening is comparatively small (17'4"), the hinged extension of each half of the upper groove is easily 'movable'. The two halves actually join in the middle by means of a dovetail joint. It may be that there were also corresponding lower grooves of comparable size, although none are now extant. Nevertheless, this discovery seems to suggest that the joining of the grooves may also be related to the size of the proscenium opening rather than solely to the date of construction.

The long grooves are all divided into two pieces, the offstage part being identical in length to the short grooves (7'4") and the onstage part extending an additional 6'6", to make a total length of 13'10". If these long grooves were used for 'flat-scenes', where flats were drawn across the whole width of the stage, then various depths of stage could be utilised while scene changes took place further upstage, out of sight of the audience. The number of long grooves varies in the different sets, as indicated in the summary table below. This shows that there are more long grooves in the downstage sets, implying that a higher percentage of 'flat-scenes' were employed in the downstage area. The distribution of the sets of grooves is also irregular:

		DISTANCE BETWEEN SETS
D.S. edge of 1st wing groove to D.S. edge	6'	
D.S. edge of 1st wing groove to D.S. edge of 2nd	6'4"	3'5.25"
D.S. edge of 2nd wing groove to D.S. edge of 3rd	5'9" [12]	3'2"
D.S. edge of 3rd wing groove to D.S. edge of 4th	5'0"	2'9"

There is therefore a progressive reduction in the distance between the sets of grooves, whereas on the stage plan published in Rees [13] the spacing is slightly increased in the upstage grooves. This reduction in the spacing of Foulston's grooves, is somewhat curious because of its effect upon the sightlines. Southern points out that "it satisfies one of the perspective demands for the shrinking of remoter distances, but, on the other, it lays the stage open to the fault of masking least efficiently at the point where the sight-line demands are greatest, that is, at the nearer part of the stage." [14]

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12. Not 5'10" as stated in Changeable Scenery, p.290.
13. Abraham Rees, op.cit., pl.X, n.pag.
14. Richard Southern, op.cit., p.290.

If a comparison is drawn once again with Rees's stage plan, and also the 1824 plan of Covent Garden previously cited, it is immediately obvious that the adjacent pairs of grooves converge upstage, i.e. their onstage tips become progressively closer together. Yet Foulston's grooves have a constant distance between the adjacent pairs. This is particularly unusual because a sight-line is actually drawn in on plates 28, 30 and 31, showing that it crosses the edge of the first set of wing grooves and continues to converge upstage, bearing no relationship to the remaining sets of grooves. Southern suggests that "it would have narrowed the deeper part of the acting-area too much to have had the wing lines converge as they did on older stages." [15] Indeed this may be the case as the sightlines reduce the acting-area to approximately only 8'6" at the rear of the stage.

The greatest anomaly with regard to sightlines is, however, in the relative positions of the proscenium and the first set of grooves, which are 6 feet apart. Seemingly the only solution, save that of having no masking at all, is the presence of a set of 'book-wings' between the proscenium and the first set of grooves. They would be a permanent feature of the stage, probably painted in a neutral colour or with a design harmonious to the proscenium. Certainly book wings were used for this purpose around about the beginning of the 19th century. The Eyre Manuscript relating to the Theatre Royal, Ipswich,[16] contains a stage plan of 1858, which indicates that book-wings were indeed used to reduce the gap between the proscenium and the first grooves, [see Illus.3]. The onstage half runs parallel to the proscenium opening and the offstage half angulates at approximately 140° in a downstage direction to provide adequate masking. This does not, however, resolve the problem of masking between the sets of grooves at the Plymouth Theatre. It may be that the upstage wing-flats were allowed to encroach onto the stage protruding out from the edge of the grooves and thus providing an arrangement of convergent wings as previously discussed. This would then comply with the dotted sightlines marked on the plates. However, if this method was used it seems somewhat strange that the grooves were not simply made longer. A possible explanation could be that if the wing grooves encroached any further onto the stage they would be in the way of the actors.

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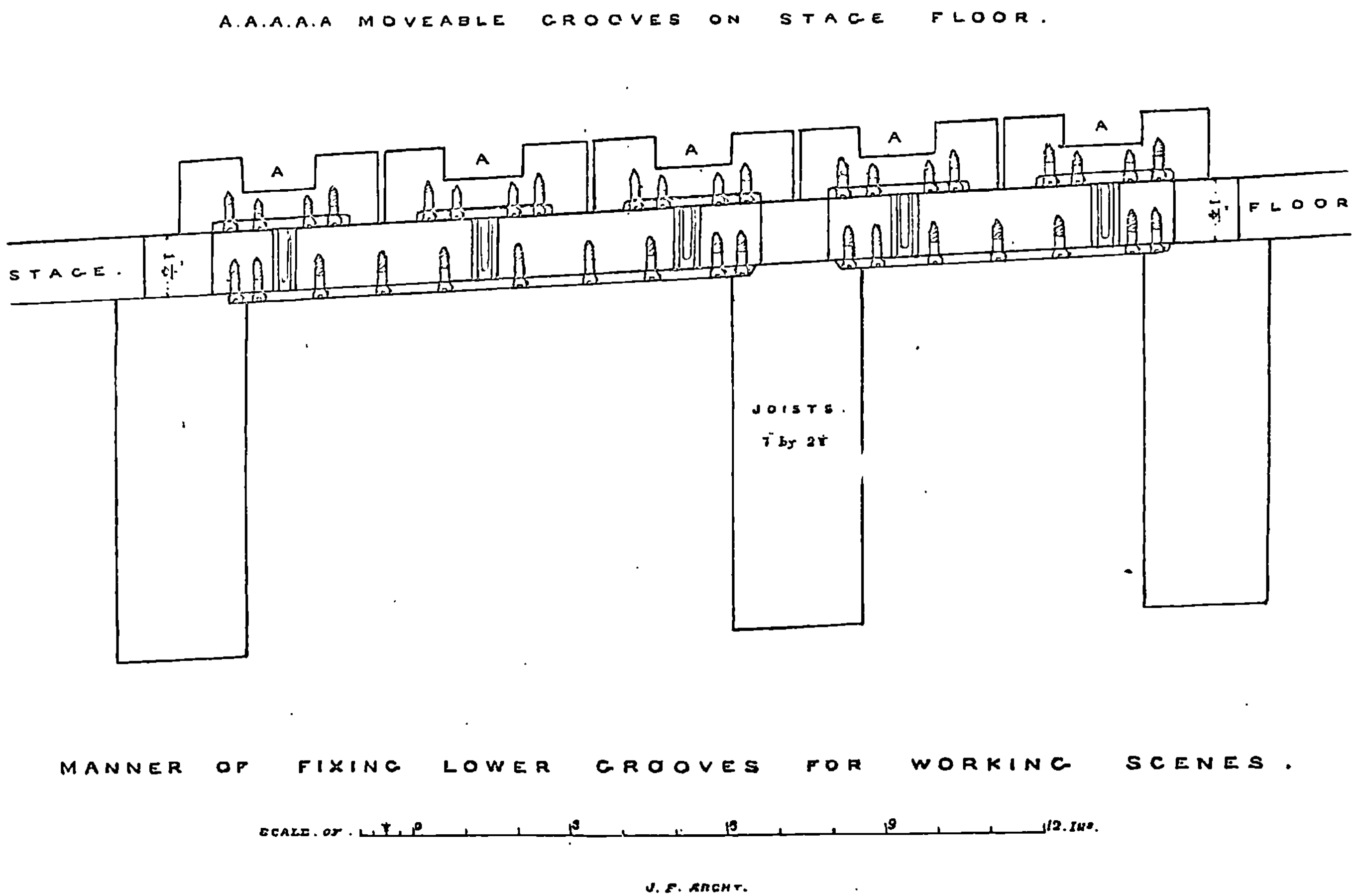
15. Ibid.
16. H.R.Eyre, op.cit.



Illus.14 Mannor of fixing, Movcablc [sic.] Groovcs. Theatrc Royal, Plymouth. Foulston, op.cit., pl.32.

Plate 32, [Illus.14]

Manner of fixing Moveable [sic.] Grooves in Stage Floor, for working Scenes.

This provides incontrovertible evidence that certain parts of the groove were movable. The plate shows a cross-section of a set of grooves set into the stage by means of a 'dowel' or 'slot' fitting, it is not clear which. Five grooves are shown, but no indication is given as to their position on the stage. The section may therefore belong either to the long grooves of the No.1 set or to the composite No.4 set. Consequently it remains uncertain whether only long grooves were removable or whether both types could be removed as required. The section does, however, show that each groove was a separate individual unit and could therefore be removed and replaced as each production demanded. Plate 30 shows a definite 'break' in the long grooves, at their onstage extremities. This suggests that only the long groove extensions were movable. In that case Plate 32 would be a cross-section of the No.1 set of long grooves. The question of movable groove extensions and the relative positions of flats for masking purposes can easily be misinterpreted if considered against the conventions of the twentieth century theatre. More simply it may be, as Southern suggests, "that in the eighteenth and nineteenth centuries masking was held in little account." [17] W.S. Gilbert once commented: "When we say the piece was put upon the stage as all Adelphi pieces are, it will be understood that the audience saw more 'flies', 'grooves', dead wall, dirty scenery, and unsatisfactory 'supers' than they would in any theatre in Whitechapel." [18]

Plate 38, [Illus.15], shows that the upper grooves are attached to a 6" by 4" timber on the underside of the fly gallery. It also makes clear that the fly gallery is raked to correspond with the rake of the stage and it is therefore possible to establish that all the flats used within the sets of grooves were of a uniform height. In considering the width of the flats, Southern puts forward the following argument:

> "We can set a limit for the width of each member of a pair of flats by halving the distance from the centre-line of the stage to the side wall. Clearly a flat could not be wider than that or it could not be completely withdrawn. But we have a further limitation. Were we to take that as the actual measurement, we should be in the unfortunate position of having all

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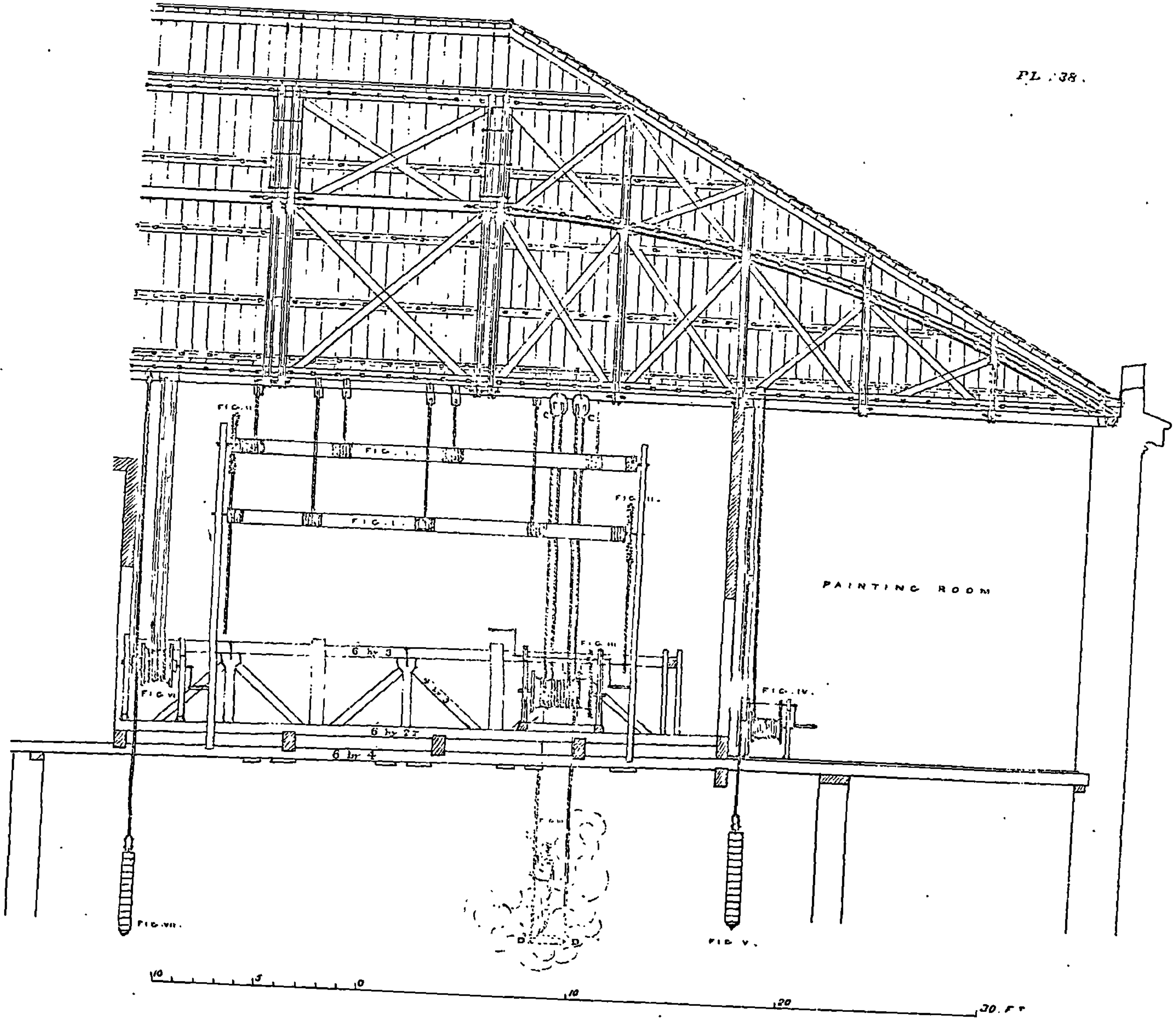
17. Richard Southern, op.cit., p.291.
18. W.S.Gilbert, Fun, (1865). Quoted in Southern, op.cit.,p.366.

PL. 38.



Illus.15 Longitudinal section of Flys, [sic.] Theatre Royal, Plymouth. Foulston, op.cit., pl.38.

> our flats, when they were withdrawn, completely blocking the wing-spaces, and allowing no passage for actors to their entrances. This we cannot allow. There must be left at least 3ft. between the edge of a withdrawn flat and the side-wall of the stage. Under these conditions, the maximum width of an individual flat on this particular stage must be 13ft., and therefore the width of a complete backscene should be 26ft." [19]

The paint-frame can also provide information about the size of the flats used.

<u>Plate 39, [Illus.16].</u>

Fig.1 - Elevation of the Painting Frame, and manner of raising and lowering ditto.

Fig.2 - Balance weight for ditto.

Fig.3 - Truss Partition across Building, at the back of ditto.

Fig.4 - Balance Weights to a larger scale.

Fig.5 - Plans of two detached Irons, shewing [sic.] their construction; for the convenience of increasing or diminishing the weight as required.

The paint frame measures 26ft in width and is suspended from pulley blocks in the roof trusses of the scene-painting room. The position of the frame is controlled by a geared windlass bolted to the floor of the scene-painting room, (Plate 40, Fig.VI) with the two 'end' lines attached directly to the windlass and the centre line to a set of counterweights (Plate 39, Figs.II, IV and V).

Given a width of 26ft for the paint frame, it is highly probable that none of the flat-scenes which ran in the long grooves was wider than this. This can be inferred from the fact that it would be preferable to place all the constituent flats on the paint frame at the same time, to avoid the complications of matching the paint-work at the join.

Within the collection of scenery discovered in recent years at the Normansfield Amusement Hall are several 'flat-scenes'. They do not, however, consist of two large flats pushed on from either side of the stage, but a series of narrower flats of a more manoeuvrable size. This method would of course have

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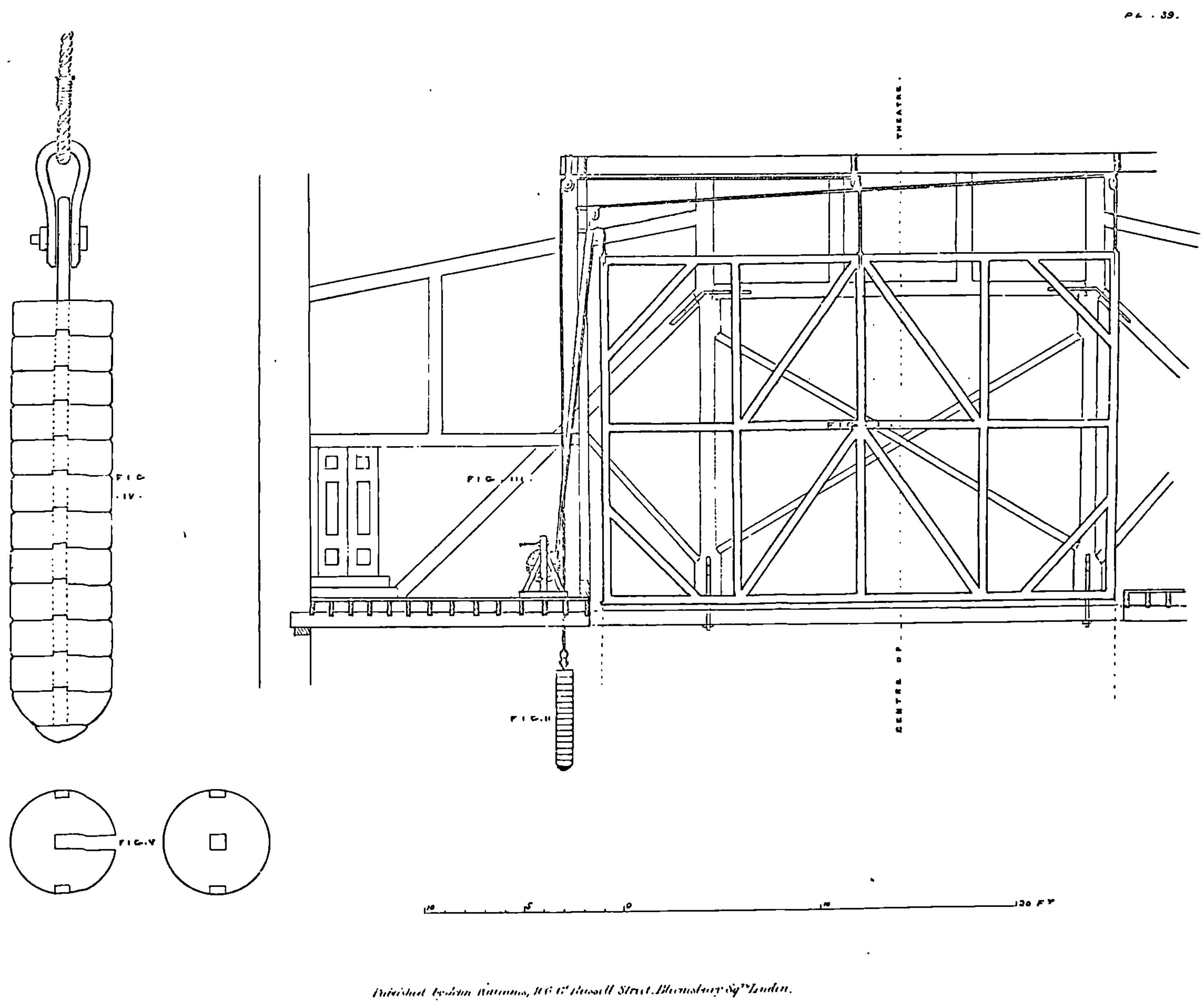
19. Southern, op.cit., p.292.



Illus.16 Details of paint frame and counterweights. Theatre Royal, Plymouth. Foulston, op.cit., pl.39.

allowed scenes to be stored in the rear of the stage at Plymouth and offered up to a specific set of grooves as and when they were required. Clearly if scenes could be changed during the course of a production, a greater flexibility of scenic representation was achieved.

The number and distribution of wing grooves at Plymouth are particularly interesting when they are considered in relation to the arrangement of the overstage machinery. However, it is initially important to understand how the wings were moved during a scene change. It may be that the presence of three wing grooves in each set of grooves (excluding set no.4) indicates that three basic types of wings were used in conjunction with the long grooves. An alternative possibility is that when the first groove in each set of grooves was in use, the second was primed with scenery for the next scene, while the scenery from the previous scene was being removed from the third and eventually replaced with new scenery. However, any scenery placed in the wing grooves also had to be complemented by a set of matching borders; hence a limitation on the number of pieces of scenery in the wing grooves is imposed by the capacity of the overstage machinery to fly 'in' and 'out' sets of matching borders.

Plate 35, [Illus.17].

Plan of Machinery on the Flys and Painting Room Floors.

Fig.1 - For Working the Green Curtain.

Fig.2 - For the Drop Scene.

Fig.3 and 4 - z,z, for the sky and ceiling borders and grooves.

Fig.5 - For the ascents and descents from and to the stage.

Fig.6 - For the painting frame.

Plate 36, [Illus.18].

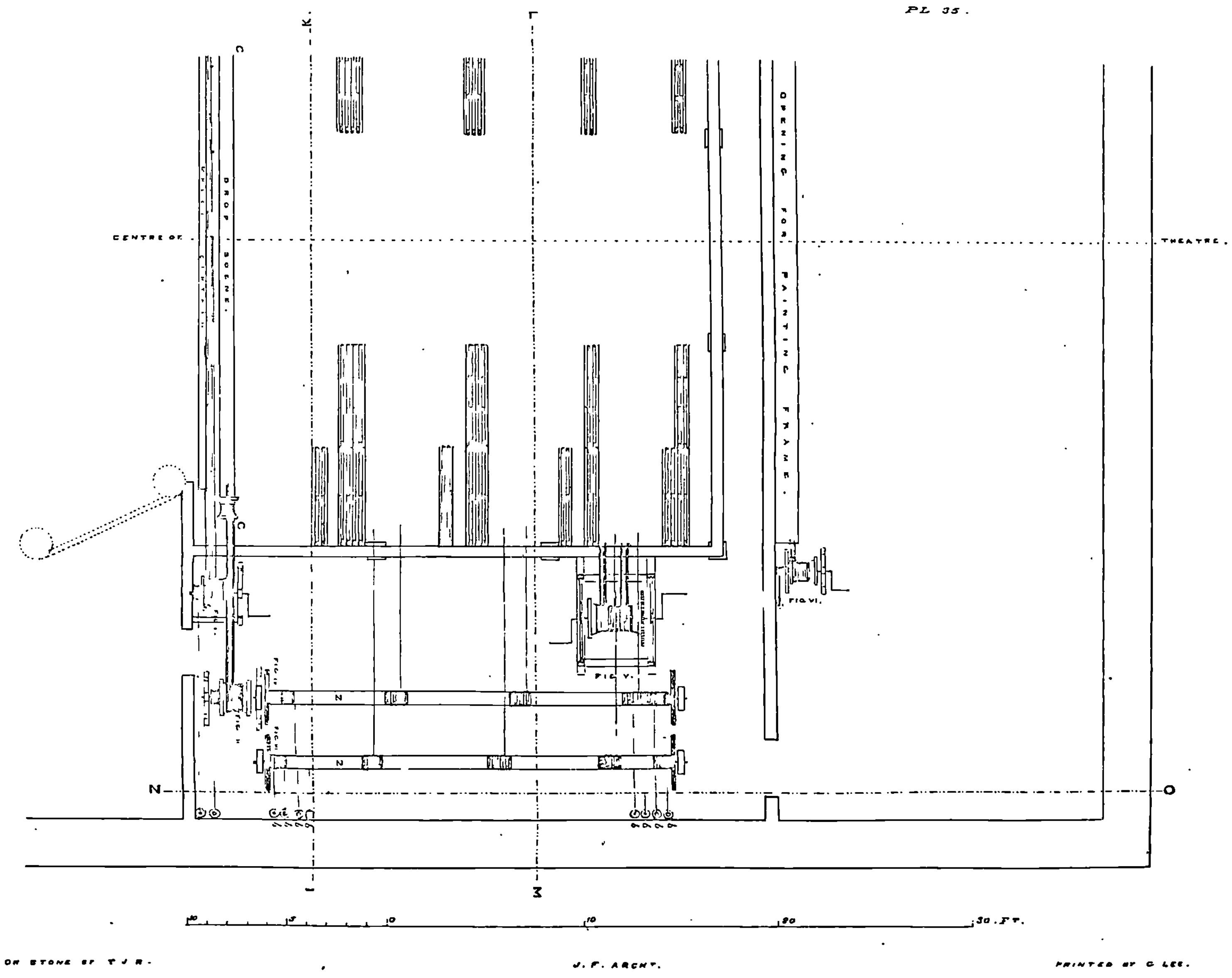
Transverse section of Flys, taken at I, K, Plate 35, looking towards the Proscenium.

Fig.1 - Machine for drawing up and letting down Green Curtain, by seven lines a, a, a, &c., as shewn [sic.] Fig.3, Plate 40, each passing over a Pulley a, a, a, a, a, a, a, in the board, fixed on Brackets from B to B.

Fig.5 - Balance Weights b,b, Pullies and Cords for suspending ditto.

Fig.2 - Machine for Working Drop Scene on Roller c to c, Plates 35 and 36.

Fig.3 and 4 - Wheels to two of the Beams, z, z, Plates 35 and 36, by which, and the Pullies and Lines E, E, the Sky and Ceiling Borders are worked; b, b, b, b, b, Pullies and Lines to suspend Balance Weights.



Illus.17 Plan of Machinery on the Flys [sic.] and Painting Room Floors. Theatre Royal, Plymouth. Foulston, op.cit., pl.35.

Plate 37, [Illus.19].

Transverse section of Flys, taken at L, M, Plate 35, looking towards the Painting Room.

Fig.1 - Machine for performing the ascent and descents from and to the Stage.

Fig.2 - shews [sic.]the operation; c, c, c, Ropes and Pullies, by which the frame is suspended, there being two in front and two at the back z, z, z, z, Wheels and ends of the four Beams, (Figs.3 and 4, Plates 35, 36, and 37, and Figures 1 and 2, Plate 38) by which the Grooves are raised or lowered; D, D,
D,

Pullies and Cords for ditto; b, b, Pullies and Cords for Balance Weights.

Fig.4 - Wheel and End of Beams, Figs.1 and 2, Plate 38, by which the Arch Borders are worked; E,E, Pullies and Cords for Arch and Sky Borders.

Fig.5 - Wheels to a larger scale for turning the Four Beams, Figures 1, Plate 38 and z,z,z,z, Plates 35,36 and 37, for working the Borders and Grooves, being placed at alternate heights - two Wheels at each end. See z,z,z,z, Figures 3 and 4, Plates 35, 36 and 37. These Wheels are worked by a Rope round them, larger than the thickness of the Wheel, binding on the Upper Cleets, [sic.]but being relieved by drawing it downward, as shewn by section of ditto, at B; c, Front of Cleet to a larger scale; D, Edge of Wheel, shewing Rope and Cleets.

Plate 38, [Illus.15].

Longitudinal section of Flys, from N to O, on Plate 35, shewing the Beams Figure 1, and Wheels Fig.2 as before described, for working the Borders and Upper Grooves.

Fig.3 - Windlass, &c. & c., for lowering or raising objects from the stage.

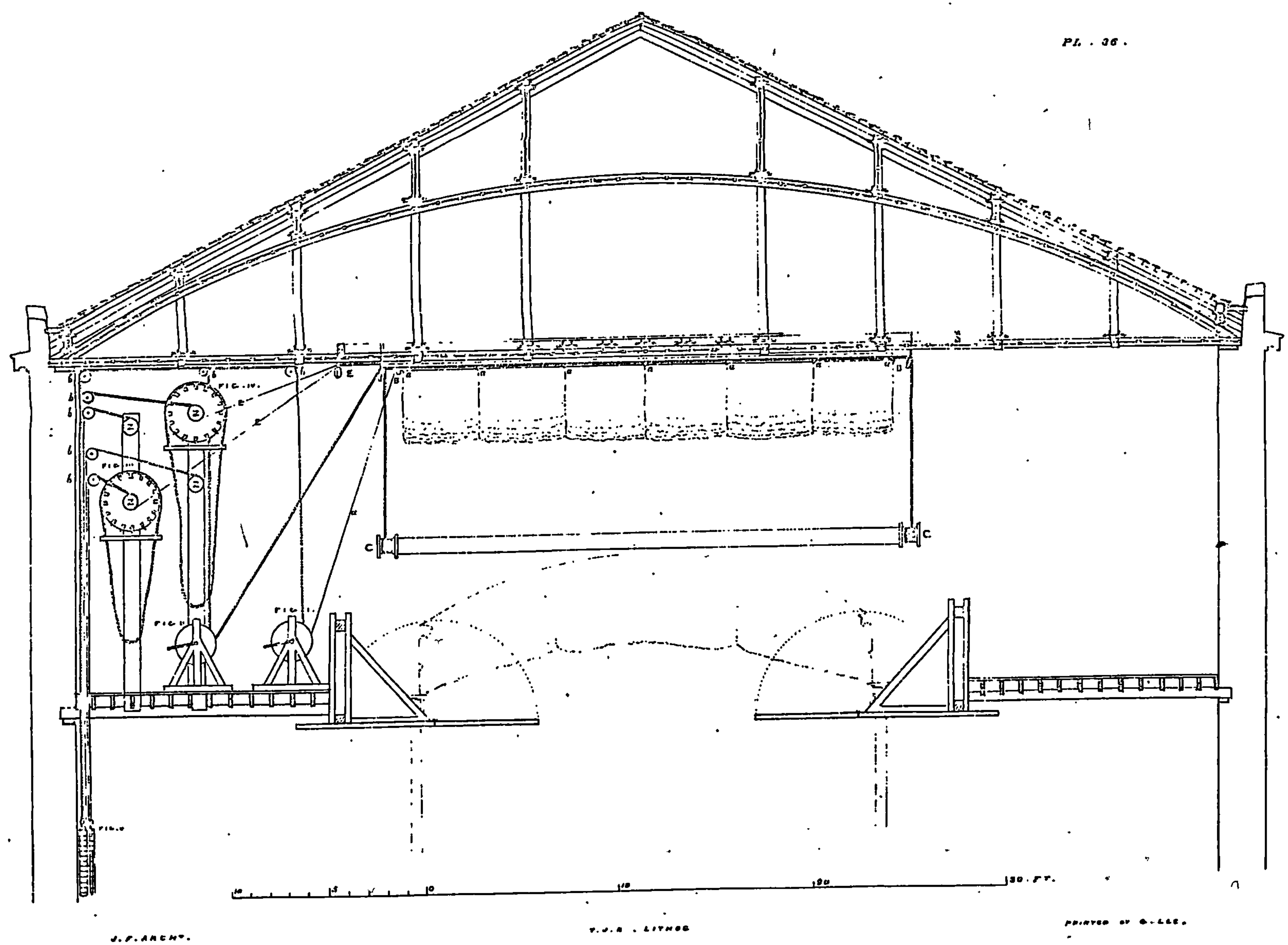
Fig.4 - Machinery for raising and lowering the Painting Frame.

Fig.5 - Balance Weights for ditto.

Fig.6 - Windlass and Cords for Green Curtain.

Fig.7 - Balance Weight for ditto.

From an examination of these plates it is apparent that the four long 'beams' or shafts, each with its own 'spiked' wheel, are positioned above the stage left fly gallery. More importantly their actual function is given in the text. One is used to raise the extensions of the upper grooves, which seems curious at first sight. However, the text also states that the other three shafts control the borders, which are specified as "Ceiling Borders", "Sky Borders" and "Arch Borders". Three definite types of border are thus identified, which supports the previous suggestion that only three types of wings were used in the wing grooves. Clearly, if wings and borders did not match, the effect would be visually unsatisfactory.



Ilus.18 Transverse Section of Flys [sic.].
Theatre Royal, Plymouth. Foulston, op.cit., pl.36.

The Arch Borders also make clear the reason for the raising of the upper groove extensions. Left in a horizontal position, they would have been visible because of the shape of the border and it was necessary to raise them out of sight of the audience. However, if this was the case, a problem would have occurred when the use of the arched borders was called for. Undoubtedly a scenic backing would be required, which could not have been provided by the scenery running in the long grooves, firstly because all the grooves would have been withdrawn, and secondly because there would have been a gap between the top of the grooves and the apex of the border, even if a set of long grooves had been retained. Unfortunately, no details are given of the rigging loft, but it may well be that a tumbled cloth was lowered into the required position, being operated in a similar manner to that of the Drop Scene shown in Plate 36.

The arrangement of three wing grooves, and three sets of borders may be one which was peculiar to Plymouth, but it seems more likely that it was part of a theatrical tradition which grew up in the 19th century. In 1939, Richard Southern discovered a groove fragment at the Theatre Royal, Bristol, in the 'loft of the theatre' above the auditorium, which also contained three wing grooves. This would seem to point towards a standard theatrical convention, though clearly it would be dangerous to draw positive conclusions from only two pieces of evidence. Nevertheless the use of standard types of borders is implicit in an article published in 1863 in All Year Round:

> "With regard to ceilings and skies is it not a fact that there are free-thinkers among us who have never been satisfied with those strips of canvas which, hanging in parallel lines across the top of the stage, have so long waved before the doubting eyes of many generations of play-goers?" [20]

All of the four shafts are assisted in their operation by counterweights which pass through the fly gallery floor in close proximity to the side of the stage wall (b,b,b,b Plate 35). The operation of this mechanism is very similar to the machinery which used to be at the Theatre Royal, Bath [see page 51]. During the summer of 1981 I paid a visit to this theatre, and just before its removal I re-rigged this machinery in a manner akin to that of the Theatre Royal, Plymouth. I found that in order to raise a piece of scenery it had to be almost perfectly counterbalanced. If it was not then the continuous line which ran

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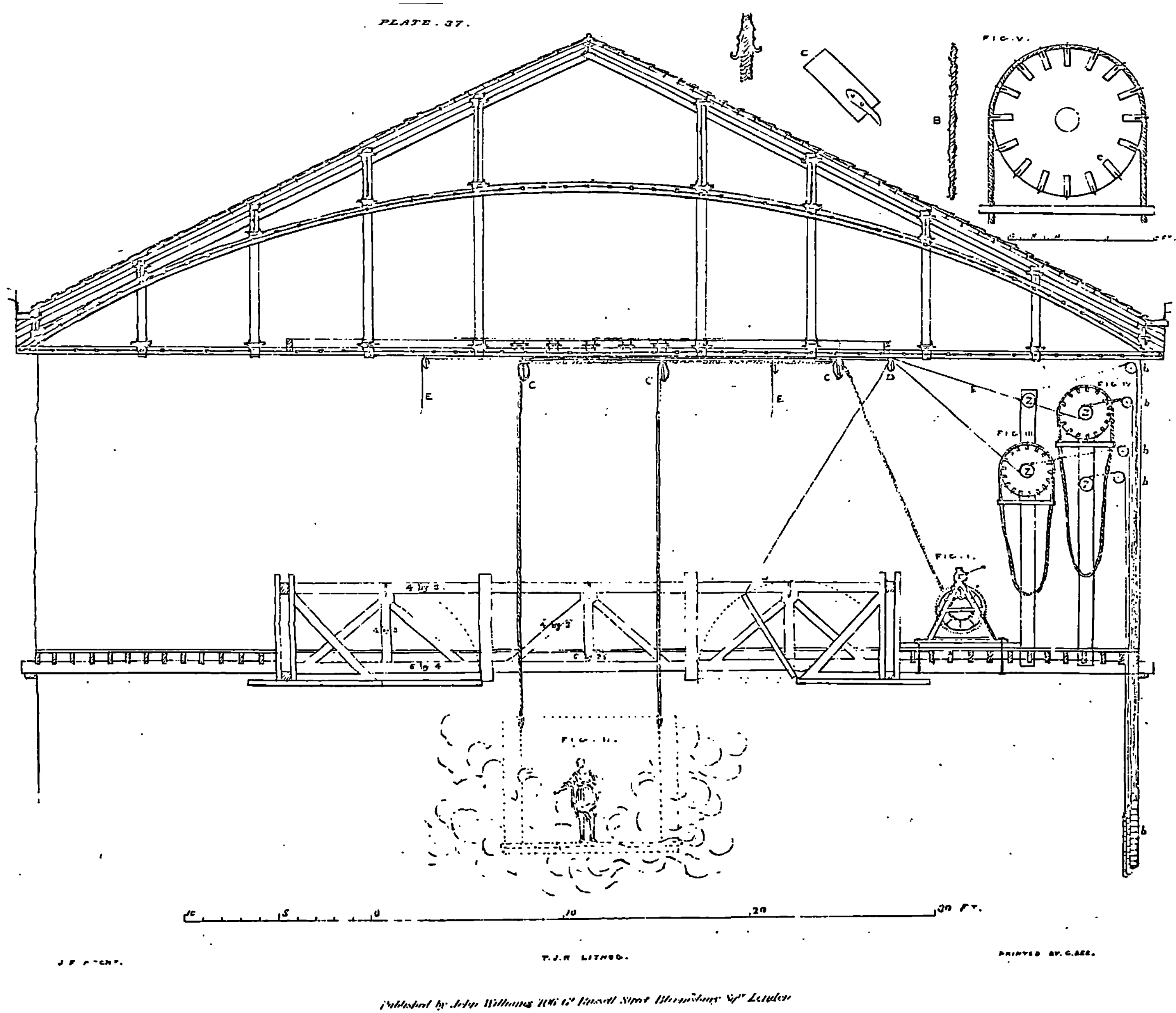
20. Anon., "A New Stage Stride", All Year Round, ed.Charles Dickens, X, 31st Oct. (1863), p.229.



Illus.19 Transverse Section of Flys [sic.] Theatre Royal, Plymouth. Foulston, op.cit., pl.37.

through the spiked drum would slip and a very dangerous situation would arise in which the 'flyman' had no means of 'braking' the machinery.

Having seen how the borders worked in relation to the wing grooves, it is now important to examine the upper long grooves and their relationship to the lower long grooves. Unfortunately, and indeed somewhat strangely, Foulston's drawings do not depict the relationship of the fly galleries to the stage. There is one plate which shows a longitudinal section of the whole block of buildings, but the scale is very small and there are discrepancies between this and other large scale drawings of various parts of the theatre. The small scale drawing suggests that the distance between the underside of the fly gallery and the stage was a constant 20ft (remembering that the fly gallery and the stage were raked at a constant angle). However, Southern suggests that,

> "since we found that the presumed width of a pair of flats was 26ft., and then had confirmation of this point in the discovery that the paint-frame, designed to carry them while they were painted, was exactly 26ft. wide, we may not be wrong perhaps in supposing that the height of that frame, which is 17'6", represents the height of the flats." [21]

If we accept this, then the actual height of the flats must have been 17'6", less the thickness of the groove beds. In plate 32 these are shown as 0.75". Unfortunately no details are given of the upper groove beds, but if we assume a similar thickness, this would mean that the distance from bed to bed was 17'4.5". However, the flats would presumably have been made a little smaller to allow for any swelling of the timber, and in any event too tight a fit would not facilitate the smooth and easy running of the scenery. It seems therefore probable that the flats were around 17'4". Conversely, however, if the measurement of 17'6" is taken as being the size of the flats, it may be that the thickness of the groove beds and manoeuvring space were compensated for by an increase in the height of the fly gallery to 17'8". Whichever was the case, the correct operation of the scenery in the grooves would have relied upon very accurate joinery. Indeed, almost too accurate, and it may well have been necessary to 'pack' the underside of the the lower grooves or adjust the height of the uper grooves from time to time.

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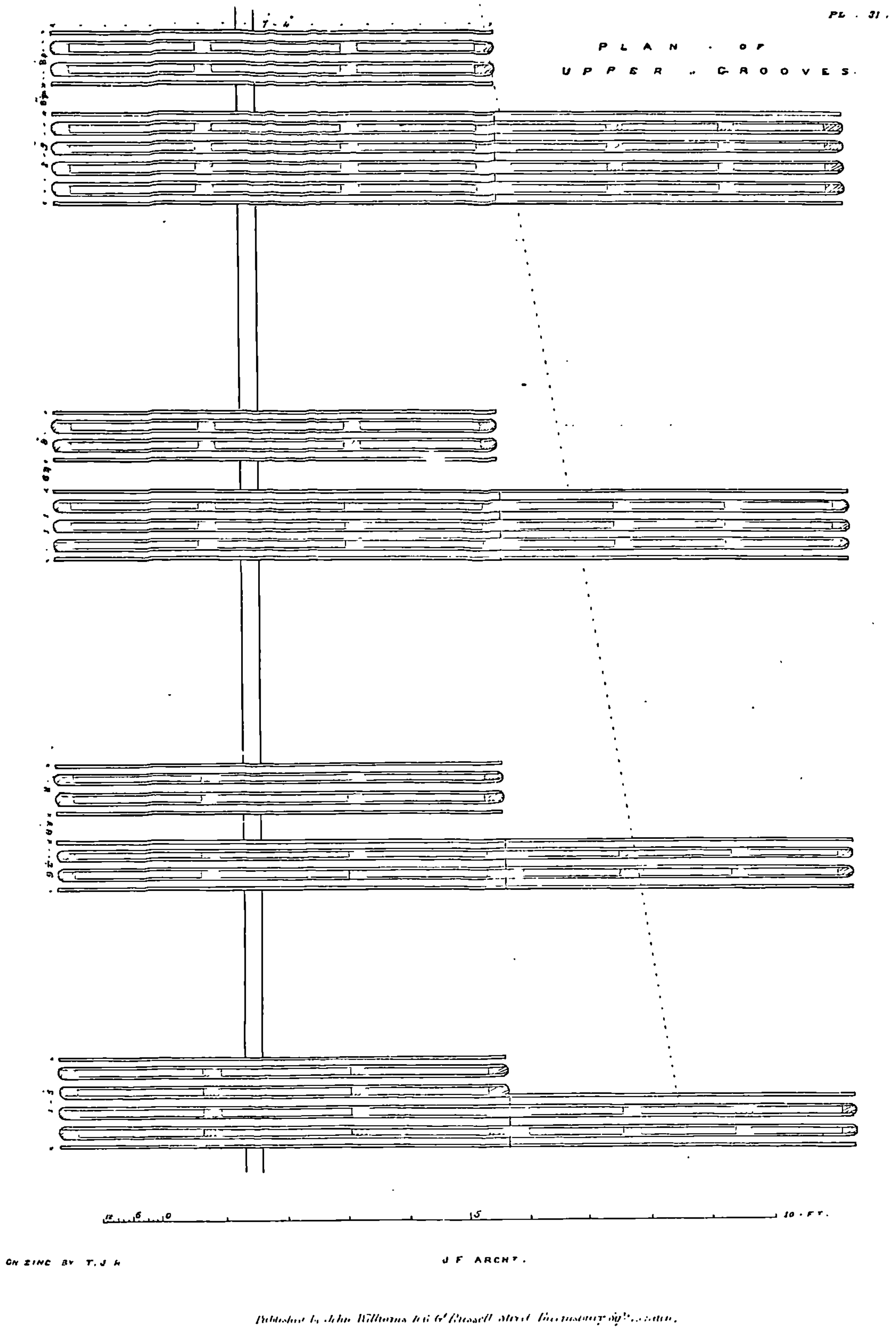
21. Southern, op.cit., p.247.



Illus.20 Plan of Upper Grooves. Theatre Royal, Plymouth.
Foulston, op.cit., pl.31.

As the upper groove and the corresponding lower groove support the same flat, it would be reasonable to expect them to be of equal dimensions. However, this is not the case, as can be seen from the table. "That the ratios of these reductions is not constant in the various sets of grooves is puzzling", says Southern, "but the main facts suggest that it may have been that these flats and wings were made (as some are today) not out of wood of a regular thickness, but with tapering stiles (or uprights) so that they were a fraction of an inch thinner at the top than at the bottom - which is a great help to balancing them easily on the run." [22]

If, however, the grooves were built to accommodate this taper, it would be normal to expect on alteration in the overall size of the upper grooves according to the number of grooves in a set. This is not the case and there seems to be no logical explanation. On the other hand the variation in size may also be due to a difference in the thickness of the outer walls of the set of grooves. A careful comparison of plates 30 and 31 [Illus.13, 20], shows that the lower grooves definitely have thicker walls, but unfortunately no measurements are given for comparison. The extra thickness may, however, be intentional to give the grooves added protection from the inevitable rough handling and kicking which they must have received. This still does not explain the inconsistent variation, but perhaps suggests that the variation in the overall width of the actual grooves was not as great as Southern supposes.

<u>Plate 40, [Illus.21].</u>

Machinery to a large scale.

Fig.1 - Plan of Windlass for lowering Green Curtain.

Fig.2 - Elevation of ditto.

Fig.3 - Side Elevation of ditto; the seven Cords at a, each pass through a Pulley in the Board, as shown in Plate 36, at a,a,a, &c., from B to B.

Fig.4 - Balance Weight and Cord, to suspend ditto.

The Windlass for raising the Drop Scene, as shewn Plate 36, Fig.2, is similar, but only having two cords; one secured at each end of the Roller, c,c, over which the Drop Scene is worked up and down.

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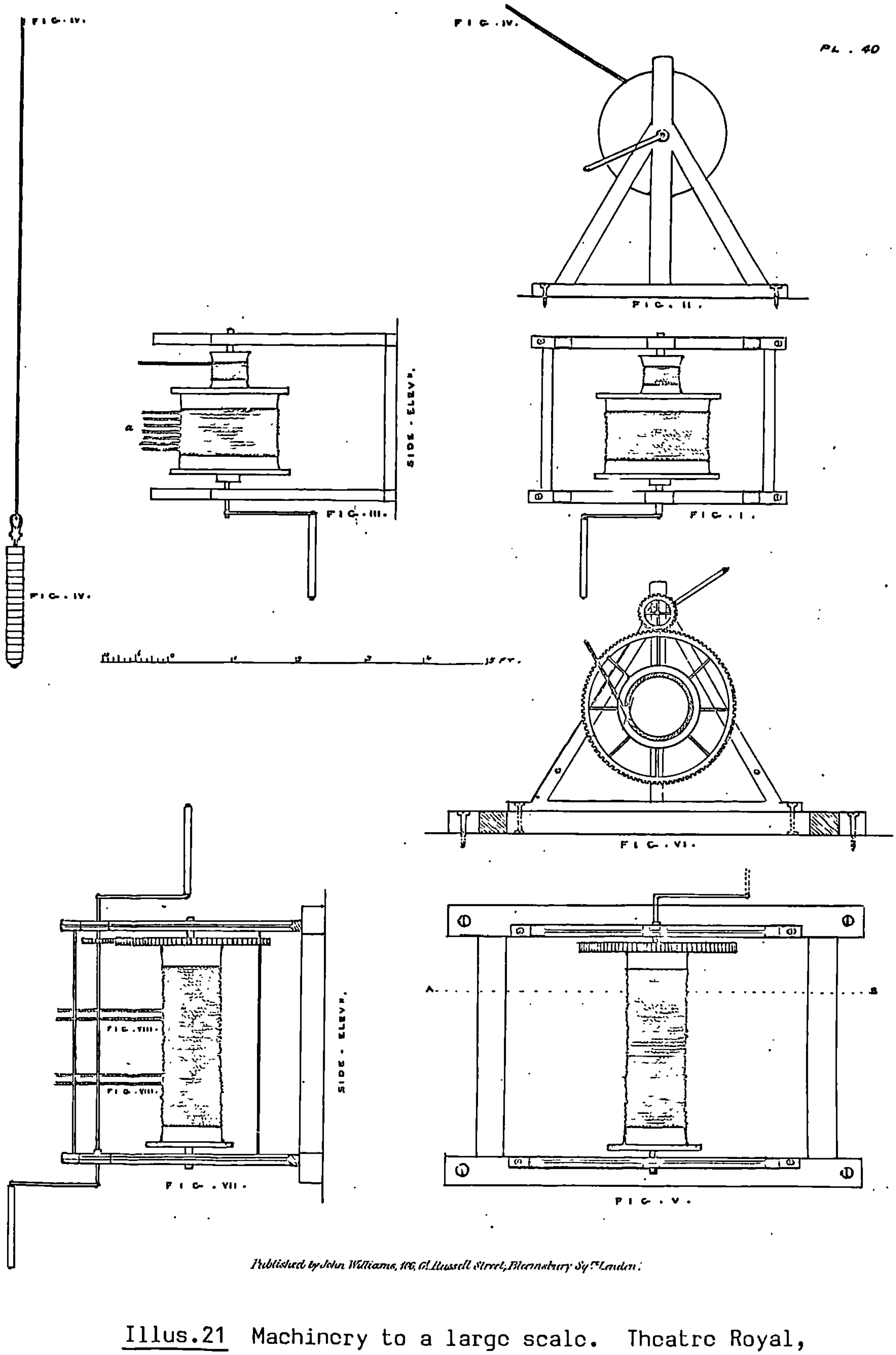
22. Southern, op.cit., pp.298-299.



Illus.21 Machinery to a large scale. Theatre Royal, Plymouth. Foulston, op.cit., pl.40.

The inclusion of both a "Green Curtain" and a "Drop Scene", in close proximity to one another, is particularly interesting. The former was almost certainly used at the beginning and end of the performance and is the equivalent of today's "Main House Tab". Plates 35,36, and 40 show how it was operated from a windlass on the stage left fly gallery. Seven lines were attached to the curtain at equidistant points along its length, and presumably sewn into the fabric. They then passed up to the respective pulleys and down to the windlass, giving the curtain a 'swagged' effect as it was raised. The raising of the curtain was assisted by counterweights which passed down the side wall and through the fly gallery floor (Plate 36). The counterweight line was wound onto a smaller barrel of the same windlass. This meant that the Green Curtain travelled a greater distance than the counterweights for every revolution of the barrel. This type of 'graduated barrel' was also used for the Drop Scene which is shown just upstage of the Green Curtain. The placing of this cloth raises several important issues regarding its function. Its location in such close proximity to the Green Curtain, carried with it a suggestion that it was used as an Act Drop rather than a Drop Scene, that is, it was lowered at the end of an act and was painted with a decorative scene which would amuse the audience during the interval or scene-change. Alternatively it was used, as its name suggests, as a scene which was lowered or dropped to be played in front of. If this was the case, then once it had been lowered the only access available to the actors was through the proscenium doors or, less probably, through the corner traps.

It must be said that the arrangement as given in Foulston's book (1838) does not agree with a description published in a local newspaper which reported the opening of the theatre:

> "There are two grand drop scenes - the first designed by Mr.Foulston, the architect, representing a grand entrance hall, the proscenium forming a part thereof; as this scene drops, the red curtain rises, which makes the whole unite perfectly with the proscenium, and produces a grand effect. The other drop is a view of the Acropolis of Athens." [23]

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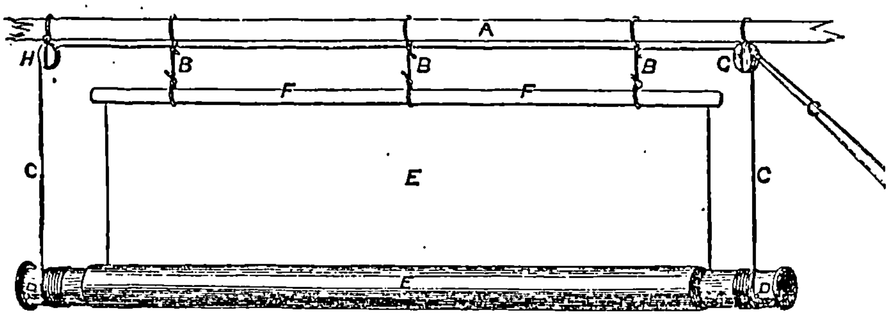
23. Anon., The Plymouth and Dock Telegraph or Naval and Commercial Register, op.cit.,



Illus.22 The working of the roller drop. Lloyds, op.cit.

It may well be that Foulston recorded what existed at the theatre immediately prior to the publication of the book, by which time a Green Curtain might have been installed in place of the aforementioned red one. In addition, there appear to have originally been two drops rather than the one shown on Foulston's drawings. It is however not exactly clear whether Foulston is showing an 'Act Drop', which would be positioned as shown in Plate 36, or just a general mechanism which could be used anywhere convenient for 'Drop Scenes' or backdrops. Perhaps the presence of a specially constructed windlass (Plate 40, Fig.1) to operate the tumbler suggests the former.

The tumbler mechanism is shown in Plate 36, where two lines are attached to the extremities of the roller and pass down to the windlass shown in Plate 40 Fig,1. Tumbler mechanisms were widely used in the 18th century, although nearly all the detailed evidence available dates from the 19th century. However, as Southern states, "the method is one which either exists or it does not - time is not likely to vary it in detail at any period or impose any development upon it." [24] Consequently to draw upon evidence from later in the 19th century is on this occasion acceptable. In 1875 a diagram appeared in Lloyds Scene Painting [25] showing in detail the operation of a tumbler mechanism [Illus.22]. A batten, F, was attached to the top of the drop, which was in turn attached to a convenient beam, A, (presumably the grid). Two lines, C,C, were then attached to a tumbler at D,D, and passed over pulleys, H & G, to the operator. The scene was then lowered by 'paying out' the lines, which allowed the tumbler to descend by gravity, thus unrolling the attached canvas while the lines rolled onto the tumbler.

This method of operation may well have been used at Plymouth, although the top batten is not shown. When the Normansfield Amusement Hall was examined in 1983, this exact method of tumbler operation was found to be still in use. The hollow tumblers were attached to the bottom of the drops, with a permanent 'sandwich' batten at the top. The actual construction of a tumbler is given by Contant [26] when writing of the 'Systeme Anglais':

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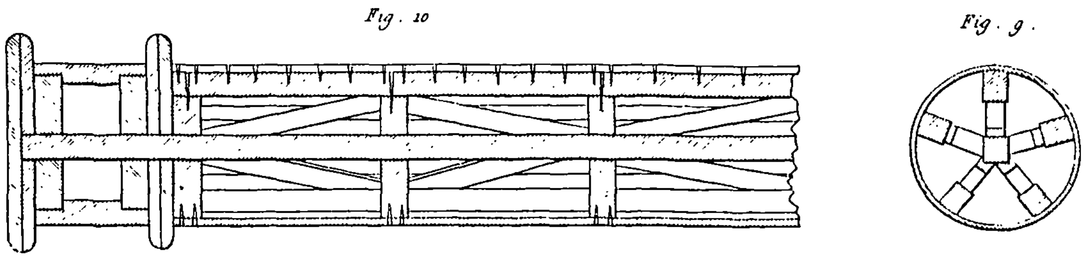
24. Southern, op.cit., p.171
25. Frederick Lloyds, Practical Guide to Scene Painting, (London: 1875).
26. Clément Contant and Joseph de Filippi, Parallèle des principaux Théatres modernes de l'Europe et des machines théatrales françaises, allemandes, et anglaises. (Paris: 1860, rpt.New York: Benjamin Blom, Inc.,1968). Plate 29, Fig.10, p.148-149.



Illus.23 Details of tumbler construction. Contant, op.cit., pl.29, figs.9, 10.

Plate 29, Fig.9 [Illus.23].

Section of a small cylinder on which the curtains are wound up. These cylinders are usually 20-25 cms in diameter and 13 to 14 metres in length. They are covered on the whole circumference by a canvas stuck or nailed down, so that they are quieter than if made of bare wood. The lower part of the curtain is fixed onto the cylinder, the upper part is set level to the joists of the grid, by means of dead ropes.

Fig.10

Section of the same cylinder which is finished off at both ends with complete end plates between the axles, receiving the hand-operated ropes, which are sent back onto a spiral-shaped drum.

This description, dating from about 1859, is accompanied by detailed drawings of the tumbler's construction. The dimensions which Contant quotes are much greater than those which would have been required at Plymouth, but it must be remembered that he was dealing with very large theatres in his treatise. The construction of the tumbler compares favourably with the tumblers discovered at Normansfield, while the statement that "the lower part of the curtain is fixed onto the cylinder" agrees with the evidence afforded by Lloyds Scene Painting (1875) and the tumblers at Normansfield (c.1879).

Rees [27], however, envisages a variation on the method which must be carefully considered, for his acccount, (c.1809) is almost contemporary with the building of Foulston's Theatre Royal:

> "The canvas is furled or unfurled upon a roller, placed either at the top or bottom of the scene. A difference of opinion exists as to the placing of the roller, which, as it is a mere matter of taste, may probably never be determined - both ways are used in London theatres. The rollers, in either case, are made to revolve by means of cords tightened or slackened as may be necessary; and when the scenes are large it is usual to wind them up by means of a cylinder and a winch, as in trap machinery".

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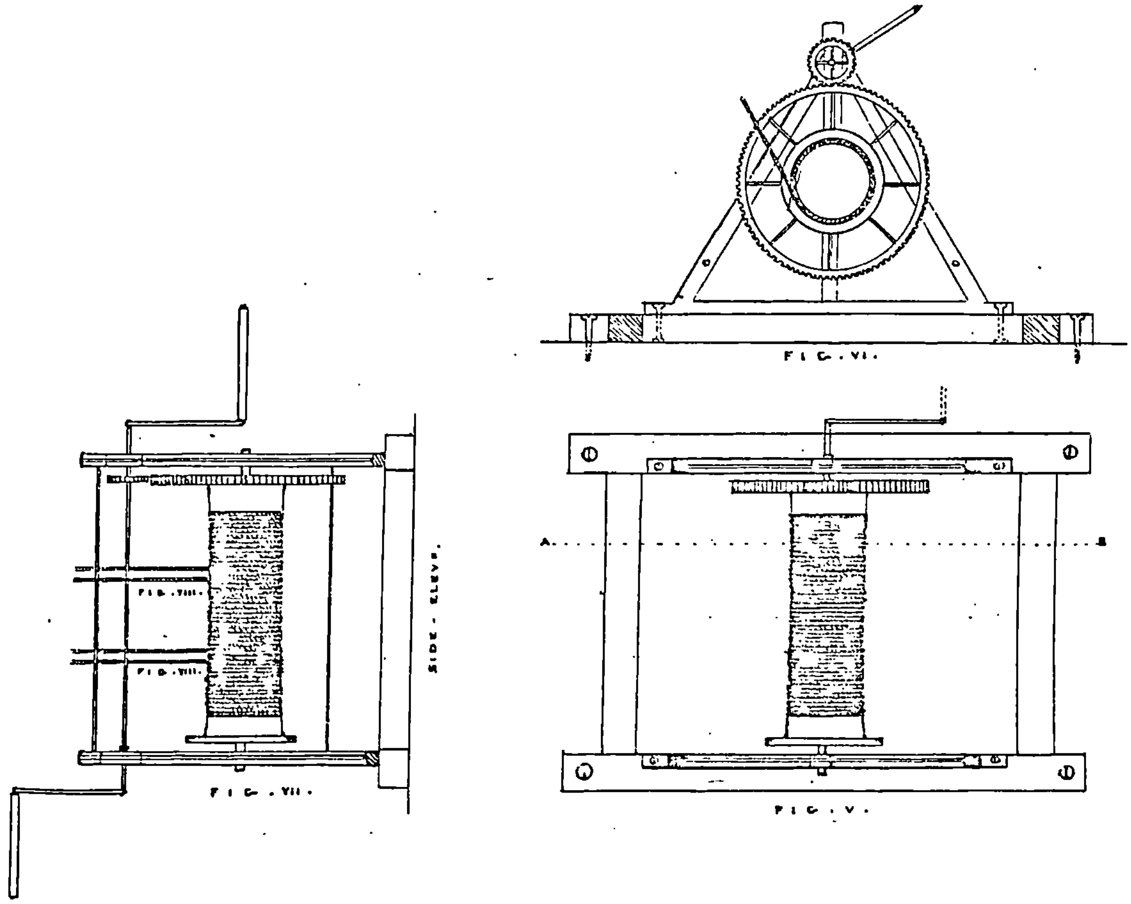
27. Abraham Rees, op.cit., n.pag.



Illus.24 Details of Windlass. Theatre Royal, Plymouth, Foulston, op.cit., pl.40.

Though Rees suggests that both methods were in use, almost all the evidence points towards the bottom roller method. However, Plate 36 does not show a permament top batten or a definite method of attachment. The conclusion must therefore be that either method may indeed have been used.

Plate 40, [Illus.24].

Fig.5 - Plan of Windlass, by which the ascents and descents from the Stage are performed.

Fig.6 - Section of ditto from A to B, on plan.

Fig.7 - Side Elevation of ditto; the 4 cords at Fig.8 pass through Pullies, shewn in Plate 37, Fig.1, at c,c,c, and in Plate 38, Fig.3, at c,c, and secured at front and back of Platform at D,D.

The geared windlass for operating the 'platform' is located on the stage left fly gallery, without the assistance of any counterweights. Four ropes are wound upon the barrel and pass up to a series of 'double blocks', 'c'. The platform could therefore be raised or lowered as the situation demanded. It does, however, appear as though the platform was not capable of traversing across the stage as later examples did. Plate 37 shows the platform carrying a person and surrounded by 'scenery' suggesting clouds. Consequently, in order to mask the suspension lines, it would be necessary to continue this above the platform until it met the corresponding scenery of the borders. Presumably the quantity of masking scenery which was required depended upon the lowest position to be achieved by the platform; or alternatively it may have been considered unnecessary to mask the lines. The actual construction of the platform is not given, but it was probably comparable to a 'glory platform' given in Contant [28]:

Plate 38, Figs.3, 4. [Illus.25].

Cross-section and elevation of an ordinary 'glory-floor'.

After having considered Foulston's installation in some detail, one must acknowledge the existence of several problems which cannot be resolved by the information provided in the drawings. Undoubtedly the drawings are the work of an accomplished architect, yet there are discrepancies in them where cross-sections do not agree with plans and measurements of one item vary from drawing to drawing. So although these drawings represent one of the earliest

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28. Contant, op.cit., pl.38, Figs.3, 4.

Fig. 4.

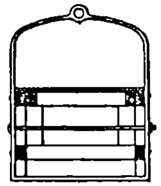
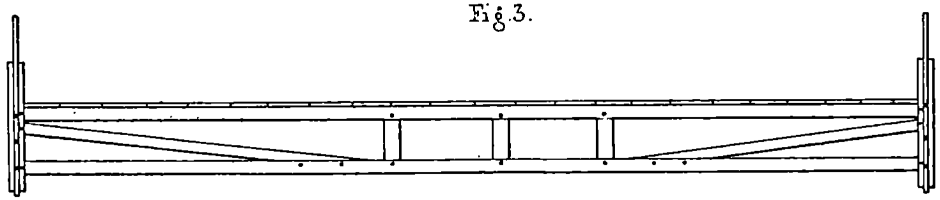


Fig. 3.



Illus.25 Cross-section and elevation of an ordinary 'glory-floor'. Contant, op.cit., pl.38. figs. 3, 4.

pieces of authoritative information on the subject, we must consider several other points bearing on their accuracy. John Foulston was not a specialist theatre architect and there is no evidence to suggest that he had any knowledge of stage machinery [29]. Consequently, he may have consulted someone experienced in these matters to produce a well equipped backstage area. If this was the case, it is highly unlikely that Foulston made any working drawings for this area of the theatre. Undoubtedly the drawings under present examination show a well equipped theatre, making no great innovations in stage machinery design. The majority of the materials used appear to be wood, yet the rest of the theatre, for which Foulston was certainly responsible, shows the extensive use of wrought and cast iron. There exists therefore a strange inconsistency between the stage and the rest of the theatre, and the possibility cannot be ruled out that they were the work of two different men.

The book in which these drawings appear was not published until 1838, a quarter of a century after the theatre was built. Itis conceivable therefore that when Foulston decided to publish, he returned to the theatre with his original drawings and augmented them. If the stage machinery had not been marked upon the original drawings, it is reasonable to suppose that within the space of twenty-five years it had undergone several changes, especially in the accessible substage and in the aforementioned alterations to the main curtain and drop scenes. Certain pieces might have been altered or fallen into disuse making it difficult for Foulston to discern exactly how the original machinery worked, and he may perhaps simply have recorded what was there in 1837-8, rather than what was originally installed in 1813.

Such a theory is purely conjectural but it does perhaps explain the confused nature of some of the drawings relating to the substage machinery. Nevertheless, the Foulston drawings undoubtedly constitute one of the most important documents on the stage machinery of an early 19th century provincial theatre. His work represents in many ways a transitional phase between the

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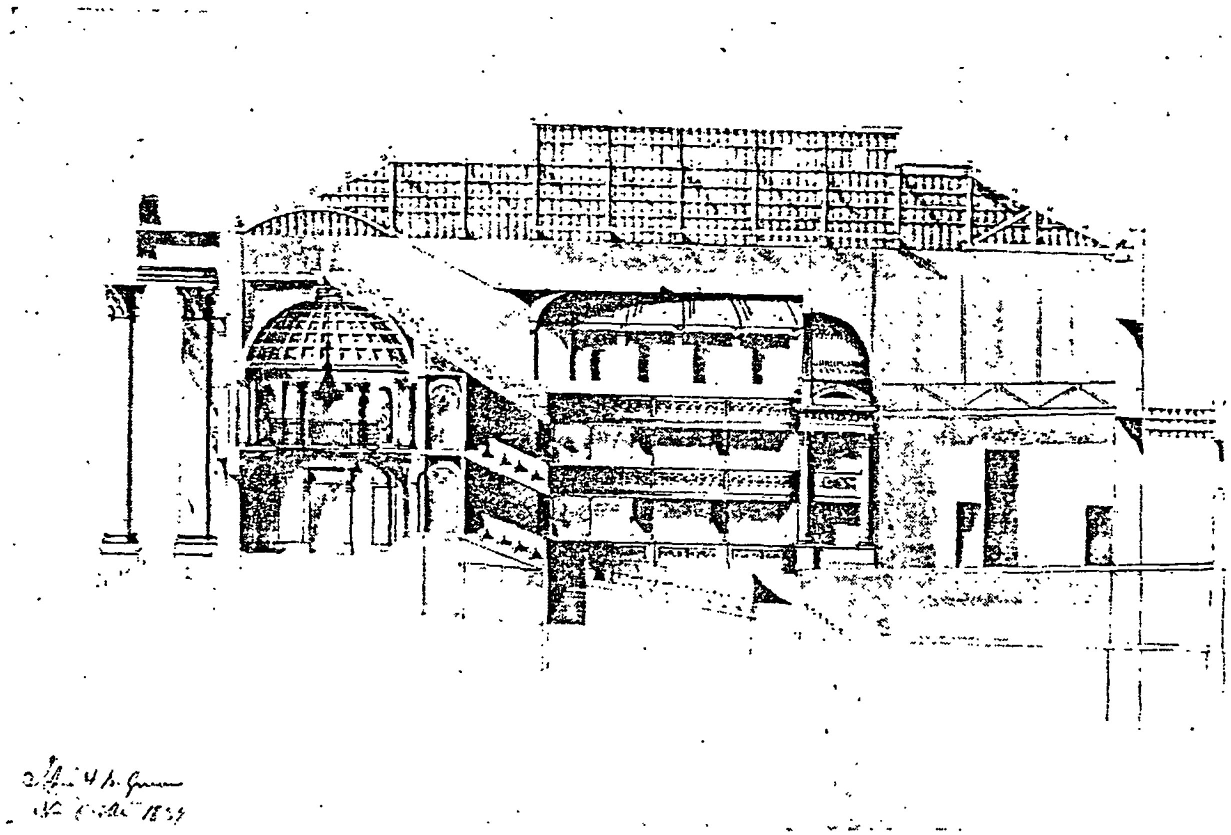
29. He was, however, invited to prepare plans for the reconstruction of the Theatre Royal, Drury Lane, in 1811, along with various other architects, including Rudolph Cabanel, designer of the stage machinery for Holland's Drury Lane of 1791-4, Peter Frederick Robinson, a pupil of Holland's, William Wilkins of the East Anglian theatre circuit and Phillip Wyatt. The successful candidate was of course Benjamin Wyatt.



Illus.26 Longitudinal section of the Theatre Royal, Newcastle upon Tyne, 1837, Drawing by Benjamin Green.

provincial theatres with limited scenic resources of the late eighteenth or early nineteenth century and the efflorescence of the English wood stage which characterised the later Victorian theatre. Although the Plymouth design, unlike that of many provincial theatres of this period, incorporated flying galleries as well as a modest fly tower, the large cloths still had to be tumbled. As the demand for grander and more spectacular presentations grew, the provincial theatres and indeed the smaller London theatres began to encounter the limitations imposed by accommodation designed for a bygone dramatic age.

This problem is well illustrated by the predicament of the Theatre Royal, Ipswich, as described in the Eyre manuscript [30] [see page 43]. This tells the story of a Georgian theatre constantly attempting to improve and update in order to make for increased scenic capability and increased audience capacity. And this was by no means an isolated example. The Theatre Royal, Leicester, built in 1836, also found it necessary to raise its fly tower by sixteen feet in 1888 in order to conform with building trends of later years. Existing theatres were faced with virtually no other option: they had either to adapt or to close. This fact is borne out by the survival intact of only a few Georgian theatres; they exist either in a modified form, as does the Theatre Royal, Bristol, or as an "artificially" intact theatre, which closed because it could no longer compete, was then put to other uses, but remained sufficiently undamaged to be restored in recent times, like the Georgian Theatre, Richmond, North Yorkshire.

The Theatre Royal, Newcastle-upon-Tyne, of 1837 was equipped with a stage bearing features of both eras. According to contemporary newspaper accounts the scenery included "twenty-four splendid rolled or drop-scenes, with the requisite wings and borders to each" [31], which suggests that there was insufficient height to fly out the cloths without tumbling. Yet an examination of Benjamin Green's longitudinal section of the building [see Illus.26], would seem to indicate that there was adequate provision to fly cloths unrolled. There is still further confusion concerning the fly tower, for the same section shows only one tier of fly galleries while the newspaper article states that there were two, "being in plain language, floors erected for receiving the machinery required in working the rolled or drop-scenes and the 'borders'." [32] (This comment again

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30. H.R.Eyre, op.cit.
31. Anon., The Newcastle Journal, 18th Feb., (1837), V, No.251, p.3.
32. Ibid.

identifies the cloths as rolled). The likeliest explanation seems to be that an additional fly gallery was included in the design after these drawings were made. There can be no doubt, however, that the technical facilities were far superior to those provided at the earlier Theatre Royal, Newcastle, built in 1804. The newspaper notes: "It is very considerably deeper and wider than that in the late Theatre, with an arrangement for adding nineteen feet additional to produce scenic effect when required. It has also the advantage of more height above it and the sink under the Stage is twenty-two feet", [33] the old theatre presumably having proved wholly inadequate for the expansion in technical complexity demanded by many new productions. There is even a suggestion that in the previous theatre drop-scenes had been controlled from stage level, the newspaper seeing fit to mention that the machinery in the new theatre was placed on the first tier of flies, "so that the person who effects the changes does not incommode the performers." [34]

Although thirty-three years had elapsed between the building of the previous Newcastle Theatre Royal and Benjamin Green's Theatre Royal, the techniques of the stage machinist remained very similar. Certainly the scale of the fly tower and of the substage was increased in later years, but the basic principles remained the same.

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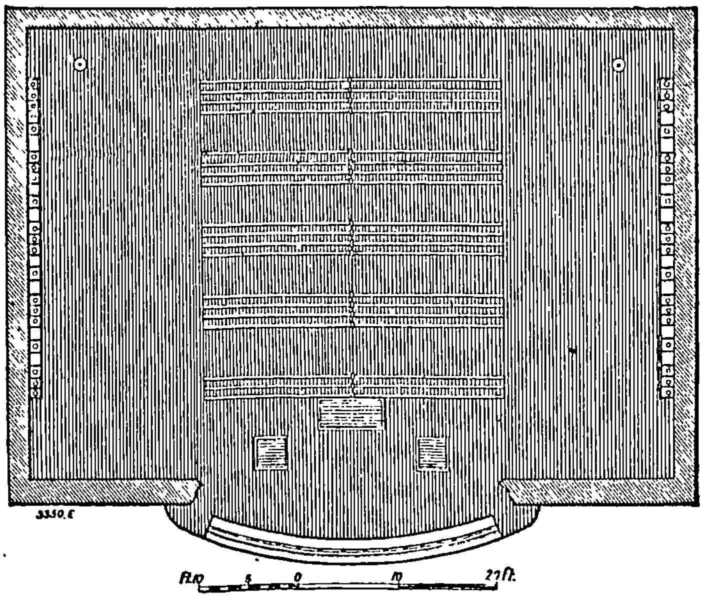
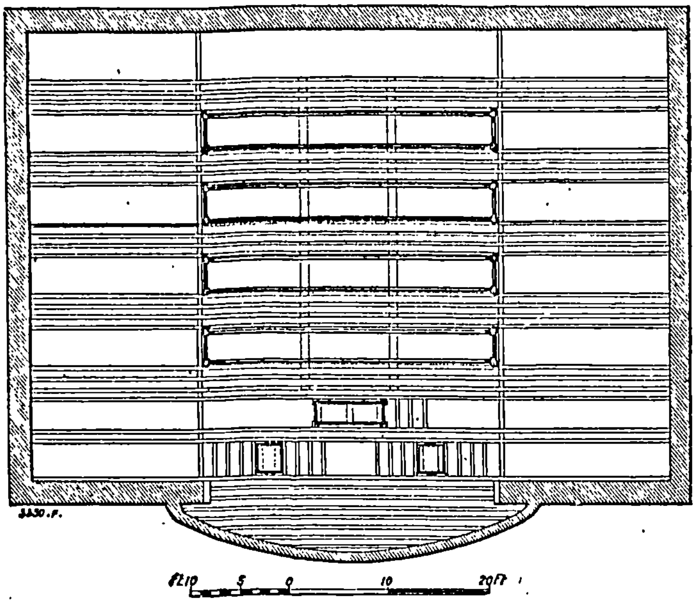
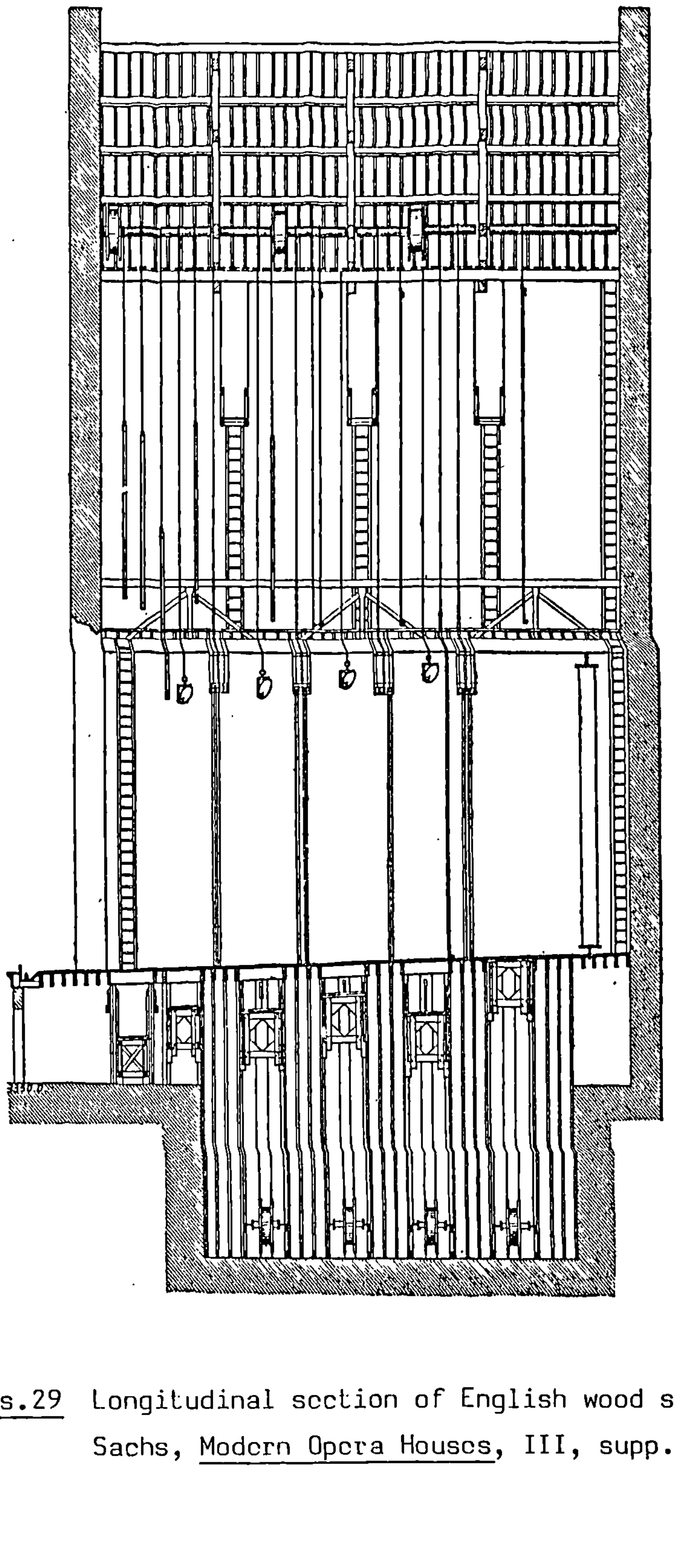
33. Ibid.
34. Ibid.



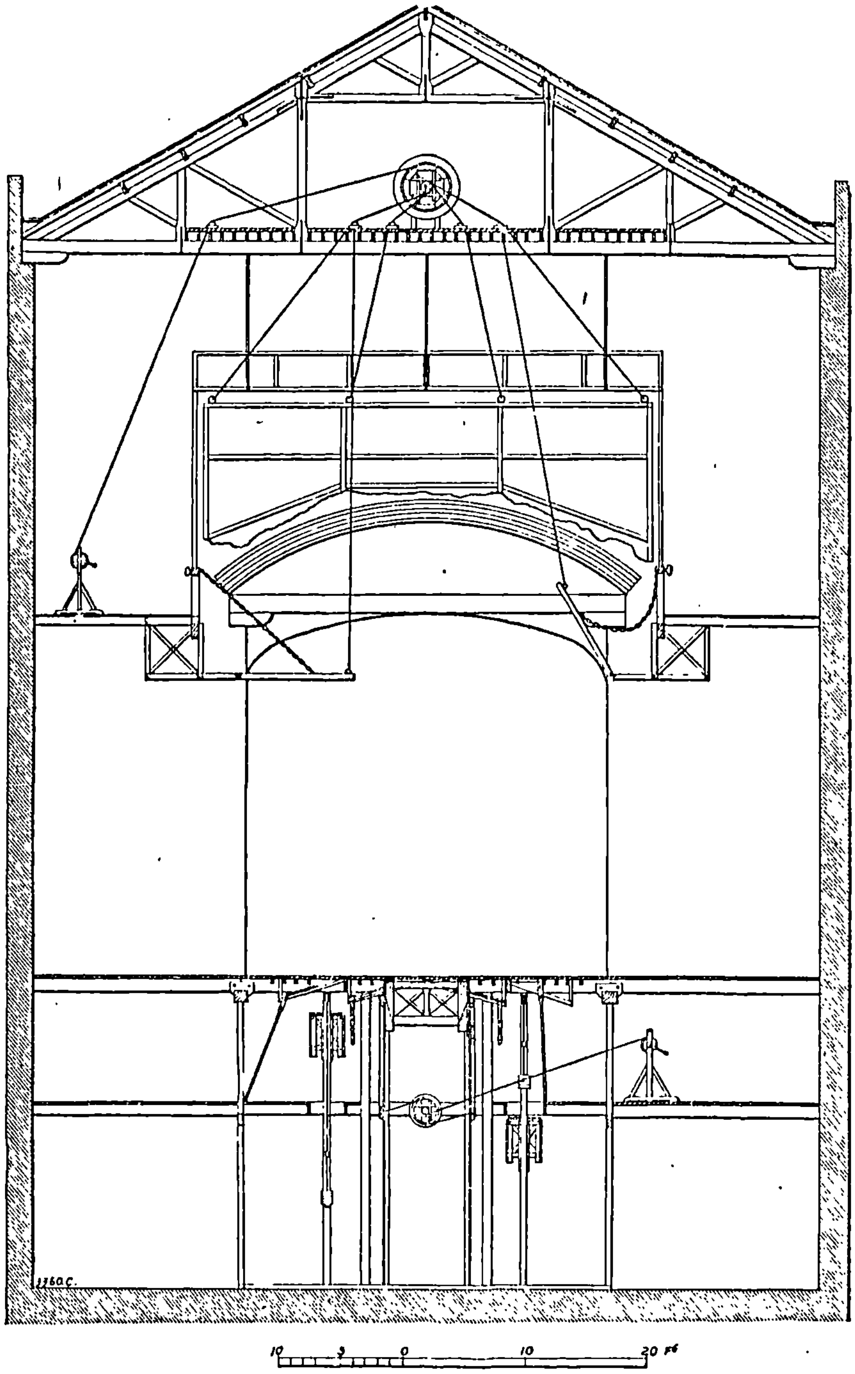
Illus.27 Plan of English wood stage. Sachs, Modern Opera Houses, III, supp.1, p.11.



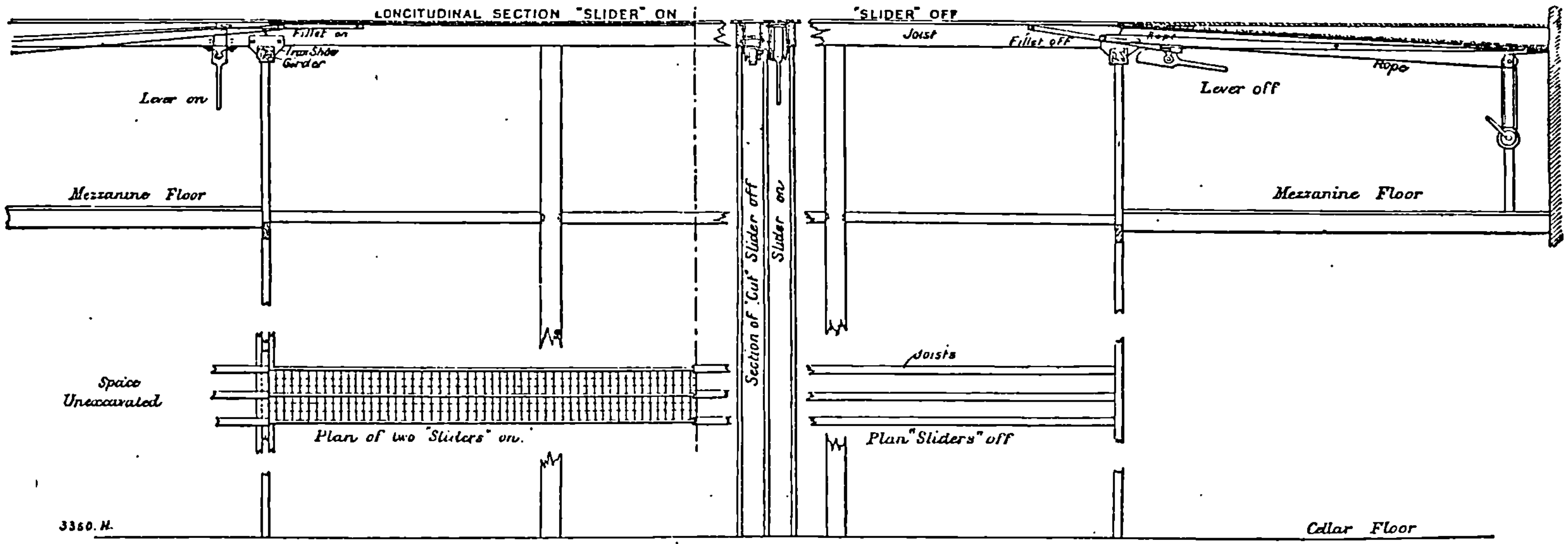
Illus.28 Plan of English wood stage at mezzanine level. Sachs, Modern Opera Houses, III, supp.1, p.11.



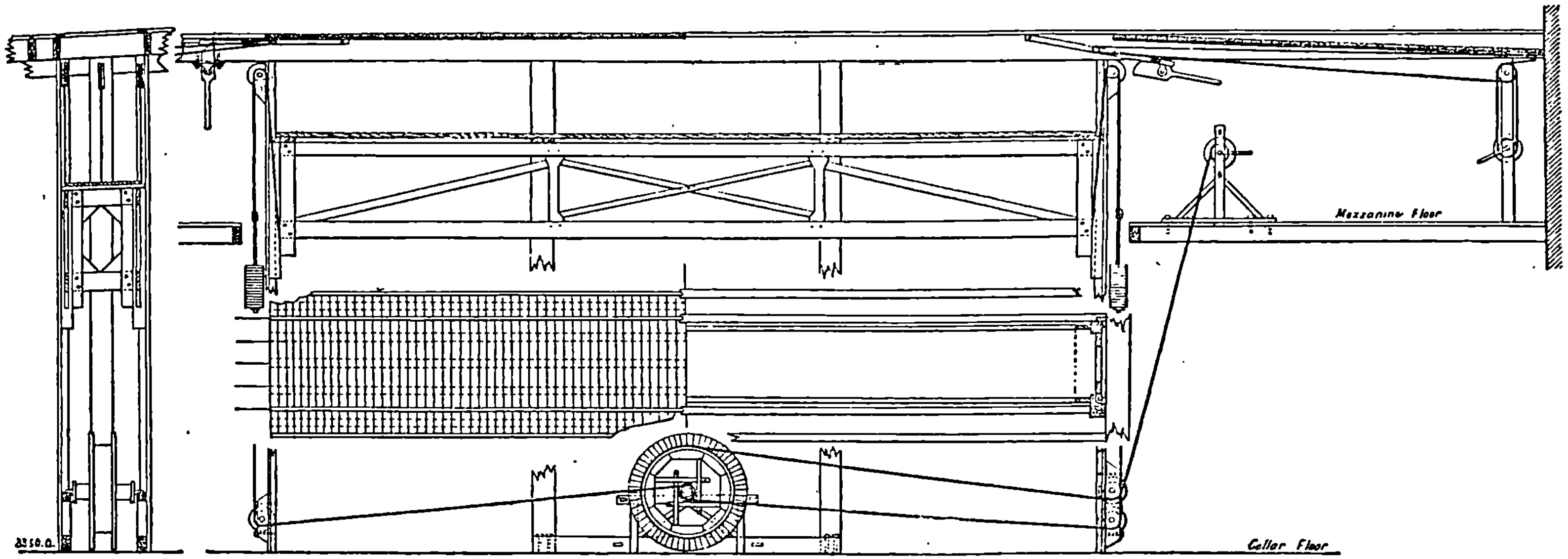
Illus.29 Longitudinal section of English wood stage.
Sachs, Modern Opera Houses, III, supp.1, p.13.



Illus.30 Transverse section of English wood stage.
Sachs, Modern Opera Houses, III, suppl.1, p.12.



Illus.31 Details of the sliders of an English wood stage.
Sachs, Modern Opera Houses, III, supp.1, p.14.



Illus.32 Details of a bridge from an English wood stage.
Sachs, Modern Opera Houses, III, supp.1, p.14.

THE ENGLISH WOOD STAGE.

In his treatise, Modern Opera Houses and Theatres, Edwin Sachs published several drawings of a typical English wood stage of the nineteenth century. They are reproduced here as Illus.27 - 32 and will serve as a basic reference point throughout the next section of this thesis. Whilst they do not relate to a specific theatre of the period, they may be considered as a very useful basic template. One of the purposes of this study, however, is to identify the diverse variations, and the influences which brought about such variations during the evolution of the English wood stage. With this in mind I now propose to contrast and compare many examples drawn from all over the British Isles, and from the published works of contemporary French machinists relating to British practice. For clarity's sake I shall examine each of its principal features in turn.

The Gridiron.

At the beginning of the nineteenth century it was unusual for a theatre to have a large, high fly tower surmounted by a gridiron, rigging loft or 'grid' as it is more usually known. Admittedly a few of the bigger London theatres, Wyatts, Drury Lane of 1811 for instance, had high fly towers, but the majority, especially in the provinces, relied upon the 'tumbling' and 'folding' techniques. Some theatres were provided with a grid of sorts within a low tower to make possible the suspension of tumbling battens, lighting battens, and permanent scenery, such as legs and borders. The Theatre Royal, Plymouth, also dating from 1811, employed just such a system (see page30), allowing cloths to be tumbled and small pieces of scenery to be flown, and operated from fly galleries.

The architectural treatment of the exterior of a Georgian theatre and its functional relationship to the fly tower are matters of particular interest. For instance provincial theatres such as the Theatre Royal, Bury St.Edmunds (1819) and the Theatre Royal, Barnwell near Cambridge (1808 or 1816), both by William Wilkins, as well as the Theatre Royal, Ipswich (1803), all had fly towers considerably lower than the roof-line above the auditorium, producing a definite break or separation between the two areas. Although the Theatre Royal, Plymouth, was contemporaneous with these theatres it should be remembered that it was designed by Foulston to be contained within an assemblage of public buildings which were executed as a single architectural treatment, and that he was in any case innovative by incorporating castiron into the roof truss configuration. With this theatre, as with the Theatre Royal, Leicester (1836), the roof line was continuous over the whole building. It was not until the latter half of the century that the fly tower began to emerge once more as a separate structure from the auditorium, but this time rising above the roof line of the rest of the building. This is made clear by an Appendix to J.G.Buckle's Theatre Construction and Maintenance (1888), which gives height above the stage of the gridiron in thirty-nine London theatres and twenty-six provincial theatres, the average height being forty-five feet in each case [1].

But perhaps the evolution of the fly tower is best examined through the life story of a single theatre rather than by a comparison of different theatres whose datum lines are not necessarily directly comparable. For this purpose it is once again useful to turn to the Eyre Manuscript and the various changes which the Theatre Royal, Ipswich, underwent. Originally built in 1803, the stage area was little more than a 'lean-to' structure with a 'hip-roof', providing no flying space whatsoever. Any scenery would have been tumbled or permanently suspended. This unsatisfactory arrangement does not appear to have been improved until as late as 1876 when:

> "they [the flies] were put in by a stage carpenter from the Adelphi Theatre, London who also put in 'gas battens' with colored [sic.] 'mediums' for moonlight and other effects. The ceiling of the roof over the stage having got into a very bad & insecure state in 1883 it was lined with fireproof canvas. Two large tie beams which were over the stage running from proscenium to back wall to support this gave a little addition to the height of the scenes & the next year two other large beams were taken out & the roof supported by pillars on each side this gave 3 feet more to be drawn up higher."[2]

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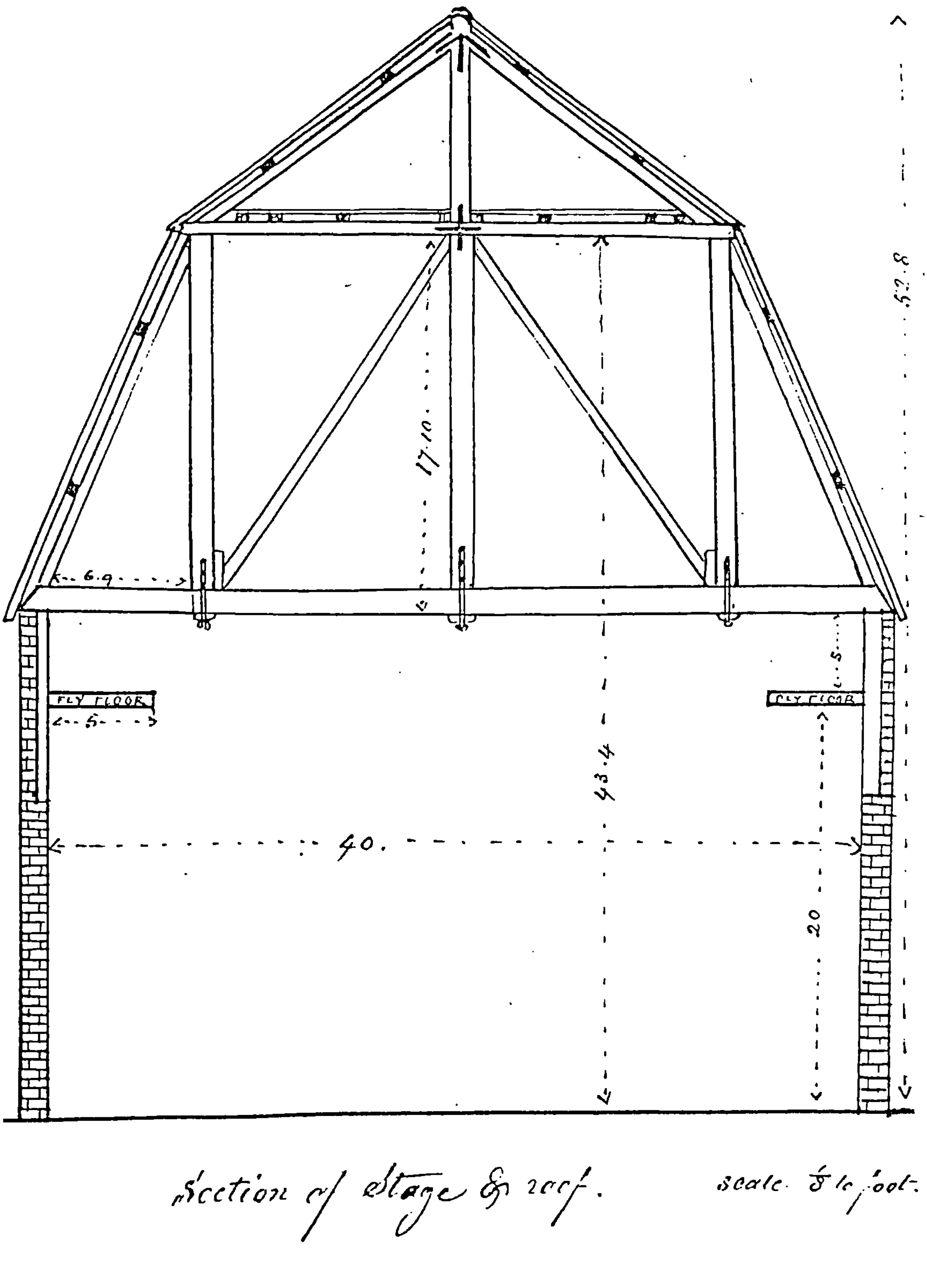
1. These tables are reproduced in Appendix 2.
2. H.R.Eyre, op.cit.



Illus.33 Transverse section of the stage, Theatre Royal, Ipswich, c.1889. Eyre, M.S. op.cit., [Courtesy of the Suffolk Record Office].

Although these alterations were undoubtedly an improvement upon the old arrangement they were still not ideally suited to the efficient operation of a provincial theatre in the 1880's. When Eyre became manager in 1887 he was obviously aware of this deficiency and decided to undertake another schedule of alterations in an attempt to bring the stage to an acceptable technical standard:

> "The roof was taken off, the walls carried up 10 feet higher and a pitched 'mansard' roof instead of the old 'hip' form put on which with the new 'flies', and 'grid' floor made the stage one of the best in the provinces, the scenes being made 16 feet high." [3]

Eyre includes a cross-section of the stage after these alterations [see Illus.33], which shows that the fly-floor was now some 20 feet above the stage. It may therefore be assumed that if grooves were attached to the underside of the fly floor, the maximum height of any "flats" would be a little under 20 feet. However, Eyre states that the "scenes",(presumably cloths as well as flats) were only 16 feet high. Consequently, as the distance from the fly gallery floor to the underside of the grid was 22 feet 10 inches, the cloths could be 'flown out' without 'tumbling' or 'folding'. Confirmation is provided by the East Anglian Daily Times, which in August 1889 reported that;

> "We have to record a further and most material improvement 'behind the scenes'. Very few people, indeed only those who have been 'behind' when a big piece was being produced, can imagine the difficulties which were experienced by the stage carpenters and scene shifters in disposing of surplus scenery, or in properly setting the various scenes. The roof of the stage was almost level with the top of the proscenium so that everything had to be rolled up or else carried off the stage and stowed away in the passages. These difficulties kept away many first-rate companies to whom elaborate scenic effects were essential, or compelled those that did come to leave a good deal of their special scenery behind them, and make up with what was obtainable at the theatre itself. The proprietors have overcome the difficulty in a most thorough and complete manner. They

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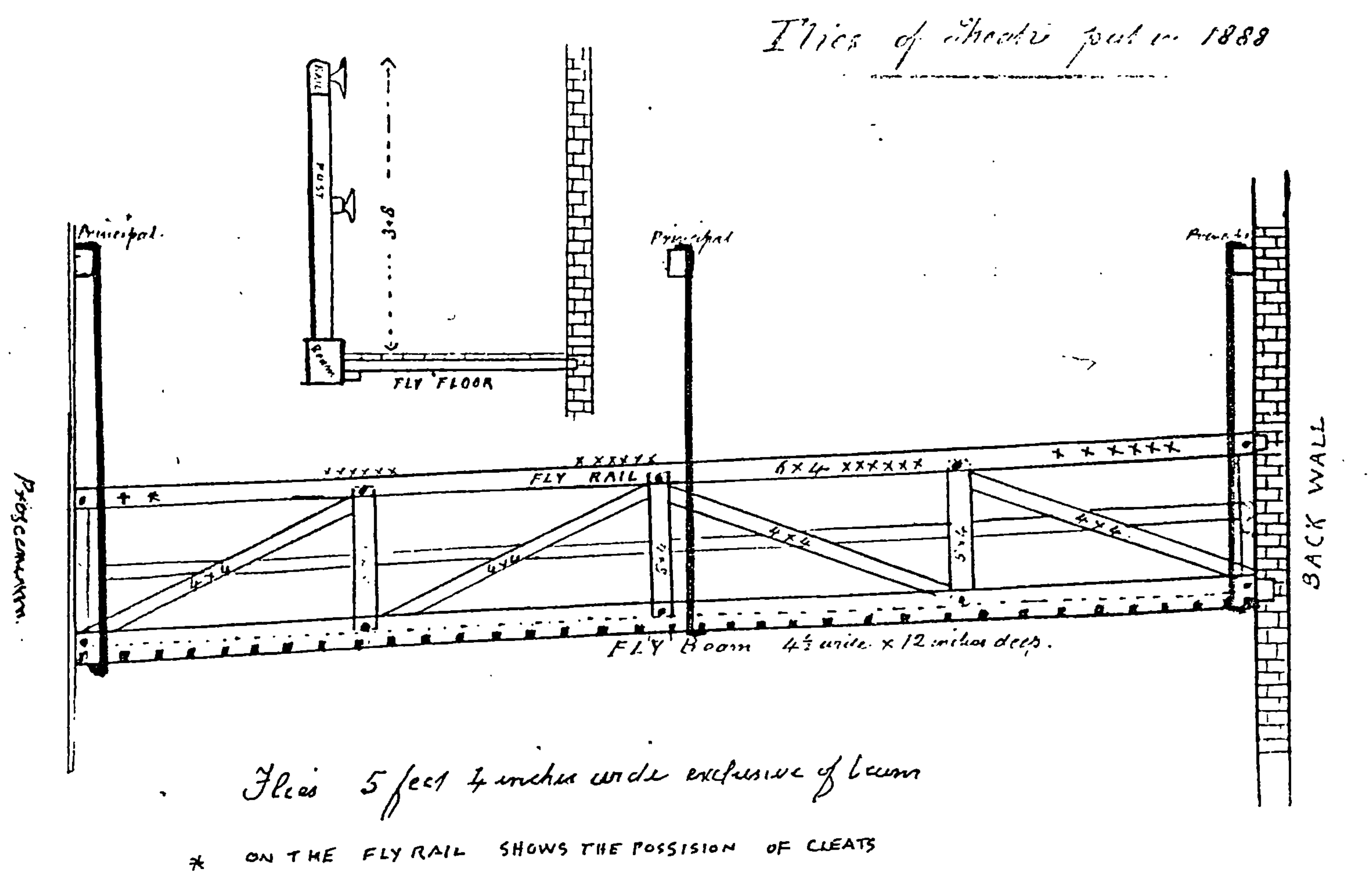
3. Ibid.



Illus.34 "Flics of Theatre put in 1888". Theatre Royal, Ipswich. Eyre, M.S. op.cit., [Courtesy of the Suffolk Record Office].

have carried up the roof of the stage to a height of 57 feet from the floor to the ceiling, so that if necessary the whole of the scenery can be lifted bodily off the stage, and carried into the flies. The appliances are all of the most modern description, and the work has been carried out under the supervision of experienced stage carpenters." 4

This very informative account amply corroborates the inference to be drawn from the manuscript itself, namely that previously most of the cloths had to be "rolled" and that this was a very unsatisfactory arrangement for a major provincial theatre. As Sachs remarked,

"There are many reasons why the scenes should be lifted without rolling or folding, and among others I would mention one which appeals most directly to the managerial mind, i.e. the fact that a 'scene' (or what is more technically known as a 'cloth') *which is not* rolled or folded has a longer life. The paint is not worn off, and there is not the cost of constant retouching or repairs. Moreover, the movement of the 'scene' is more even and the risk of fire is also greatly reduced, for a 'cloth' that 'drops' is not so likely to come in such close proximity to the gas-burners, and will remain longer in good condition. Further, there is the advantage that 'cloths' which are not folded take up less room when suspended from the 'gridiron', and a greater number of 'scenes' can, therefore, be hung if they have a simple 'drop'." 5

The cross-section of the "flies" which were installed in 1888 [see Illus.34], shows that the Ipswich fly gallery was raked, presumably parallel to the stage. Four areas on the upper fly rail show groups of six cleats, and in addition two cleats were positioned close to the proscenium wall. It is somewhat unusual to find localised groups of cleats rather than cleats spaced at regular intervals upon the fly rail and they may well

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4. Anon., "Re-opening of Ipswich Theatre Royal, East Anglian Daily Times, 20th Aug., (1889).
5. Edwin O.Sachs, Modern Opera House and Theatres, (London: B.T. Batsford, 1898), III, supp.,p.9.

relate to the positions of the borders and the grooves, but insufficient evidence is provided to confirm this conjecture. However, only one fly gallery is actually shown on the drawing, and it is possible that the other may have had a continuous line of cleats for all the necessary flying of the cloths.

The two cleats located close to the proscenium wall were probably used for "tying-off" the ropes of the main curtain and the act drop. [6] Before the alterations of 1888 the theatre had a green baize curtain, but in 1880,

> "during the very cold winter of that year, some rats formed their nests in it, while rolled up and so destroyed and mutilated it, that the proprietors decided in order to prevent a recurrence of the damage, to have instead of a baize a painted drop." [7]

By 1888, however, the theatre had a main curtain and a painted act drop, used in conjunction during the performance and therefore requiring at least two cleats.

The backstage facilities were undoubtedly better than they had ever been, but no radical alterations had been made, merely realistic improvements and compromises, and sadly in 1890 the theatre closed for the last time. Today the remains of the building appear to have been incorporated into a Salvation Army Hall which now stands on the site but the stage and its workings have long since disappeared. Hence the Eyre manuscript itself represents an invaluable insight into theatrical transition in nineteenth century England. Moreover, unlike many provincial theatres the shell of the building was never totally demolished, simply modified and rearranged, and this process charts in miniature the whole evolution of backstage facilities over a long period, from Georgian and Regency to late Victorian times.

Eyre's attempt to 'modernise' the backstage areas of the theatre in 1888 offers a useful point of comparison with the recommendations made by J.G. Buckle in his book <u>Theatre Construction and Maintenance</u> published by 'The

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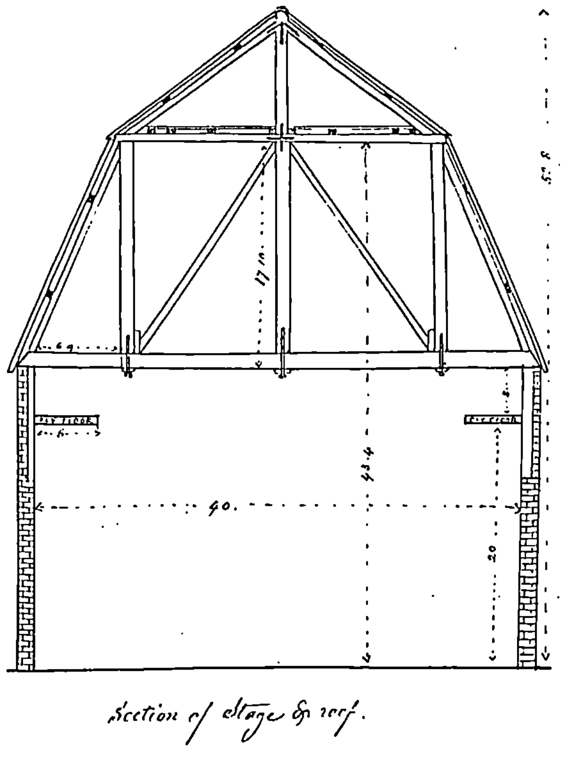
6. H.R.Eyre, op.cit.
7. Ibid.

Stage' in the same year.

> "The Gridiron, as its name suggests, is a species of naked flooring, and it forms an important and essential feature of the stage. The joists should be of more than average strength, and supported on the proscenium and back walls of the stage, and not on the tie-beams of the roof-trusses unless they are of increased strength and specially framed for the purpose, as the combined weights and strains upon the gridiron at times equal many c.g. tons." 8

This latter method of incorporating the roof-truss structure with the joist structure of the gridiron was in fact the one usually preferred by most architects, as it obviated the need to install two mutually exclusive structures within the same space. The result was that the roof trusses were far larger and stronger than was necessary simply to support the roof.



Illus.33 Transverse section of the stage, Theatre Royal, Ipwsich, c.1889. Eyre, M.S. op.cit., [Courtesy of the Suffolk Record Office].

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8. James G. Buckle, op.cit. pp.35-36.

Of course the main problem with the suspension of scenery from a gridiron is that quite often the load is distributed unevenly, being concentrated at particular points. Ernest Woodrow in his series of articles on 'Theatres' in The Building News pointed out that there was an additional strain to be accounted for, caused by the very raising and lowering of the scenery. He also advocated that the grid should be "at a height twice the height of the proscenium opening", [9] arguing like Sachs a few years later, that there was a double reason for this: firstly, an economy made by reducing the wear and tear on scenery which no longer required to be tumbled or folded; secondly, where scenes did not have to be folded there was less likelihood of them coming into contact with the lights. Writing in 1893 he also remarked that the height of the gridiron, as far as the building of new theatres in London was concerned, was governed by the fourteenth regulation of the London County Council, which stated that the height of the wall-plate carrying the rafters of the roof over the stage should not be less than twice the height being measured from the level of the stage at the curtain line.

A further drawback of a low fly tower was that a folded cloth required extra flymen to manipulate it and occupied the space of three cloths hung in the conventional manner. If this in itself constituted insufficient grounds for building a high fly tower during the initial construction of a theatre, then perhaps the figures quoted by Buckle would have convinced the most economically minded of theatre managers:

> "The importance of having the gridiron the requisite height may be estimated from the fact that at a representative London theatre an increased outlay of from £500 to £700 is required on each production, owing to the gridiron being a few feet too low, a fault in construction made by an architect, hitherto credited with having a monopoly of knowledge as regards theatrical requirements." [10]

Yet despite the explosion of theatre building in the latter part of the nineteenth century, the increase in the height of the fly tower and the

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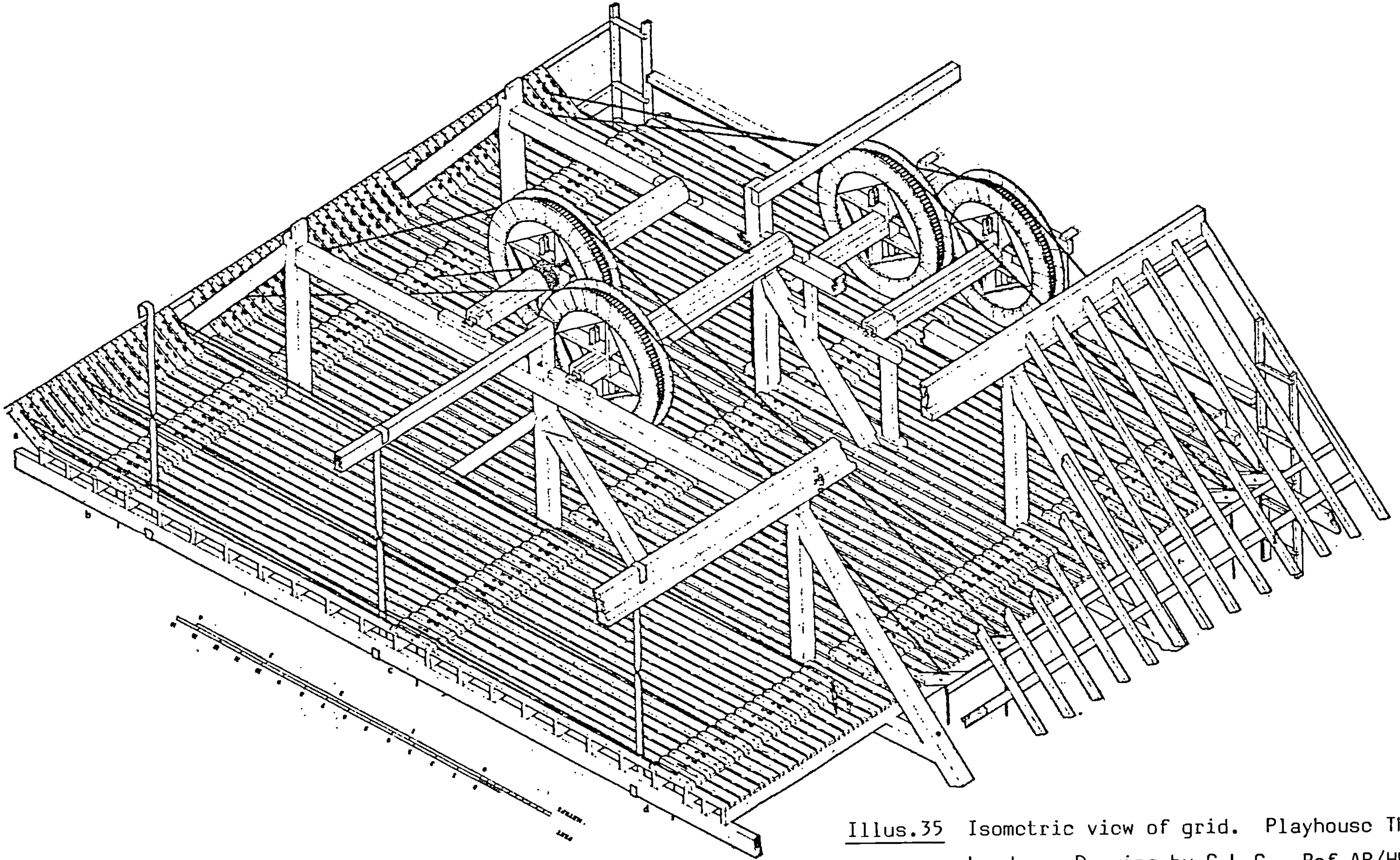
9. Ernest A.E.Woodrow, "Theatres - XIX" The Building News, 24th March, (1893), p.398.
10. Buckle, op.cit., p.33.

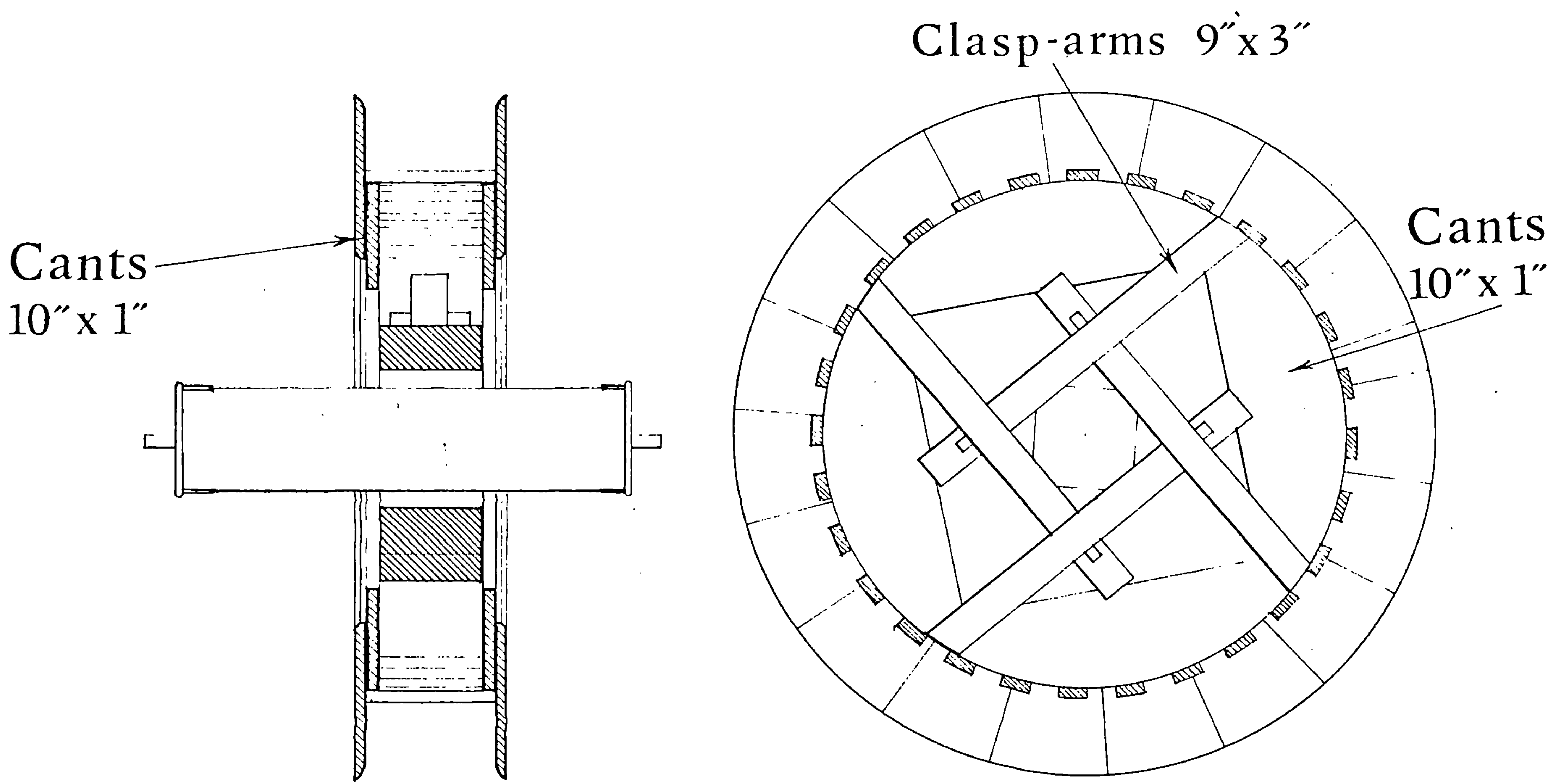


Illus.35 Isometric view of grid. Playhouse Theatre, London. Drawing by G.L.C., Ref.AR/HB/2914/9.

depth of the substage cellar, there was still in 1888 a large theatre in London which quite astonishingly did not have a proper grid, namely the Olympic, in Wych Street, Strand. Though this must have unquestionably hampered scenic presentation, the building survived with considerable success until January 1890 when it was demolished to make way for the Aldwych development.

As has already been said, the roof trusses of the fly tower often performed a double function; supporting the roof and bearing the load imposed upon the gridiron. Quite often, however, they were utilised for yet another purpose and provided a structural framework on which to mount the drum-and-shaft mechanism. This technique was employed at the Playhouse Theatre, London [see Illus.35], whilst at the Tyne Theatre, Newcastle-upon-Tyne, an independent structural framework mounted upon the gridiron was utilised. It seems to have been very much a matter of preference on the part of the stage machinist who designed the installation, there being no apparent evolutionary development. Similarly, the size and design of the drum-and-shaft mechanisms varied considerably, but no specific chronological pattern of development is evident, though, as might be expected, variation in design was usually associated with a variation in function.

The drum-and-shaft mechanism is often thought of as the pre-cursor to the modern theatre counterweight system. Yet although it was capable of lifting heavy loads it was also able to effect a synchronised scene-change, involving several pieces of scenery, under the co-ordinated control of a single person. Essentially this kind of mechanism employed the principle of mechanical advantage, acting in effect as a gearing device. The controlling line was wrapped around the circumference of the drum, and passed via a pulley on the grid to the fly gallery where the operator stood. The suspension lines, from which the scenery hung, were attached to the shaft and fed through the relevant pulley blocks on the grid. Consequently, depending upon which way the lines were wrapped, the scenery could be raised or lowered quite easily by a single man. The shaft was usually mounted in an upstage/downstage direction, and could measure in excess of forty feet. This allowed several pieces of scenery to be rigged at various points along the shaft, and yet be moved simultaneously. Similarly, if the rigging lines for one piece of scenery were wrapped in one direction upon the shaft, and the lines for another piece in the



Illus.36 Details of drum and shaft construction. Her Majesty's Theatre, London. Drawing by G.L.C. Ref: AR/HB/995/18.

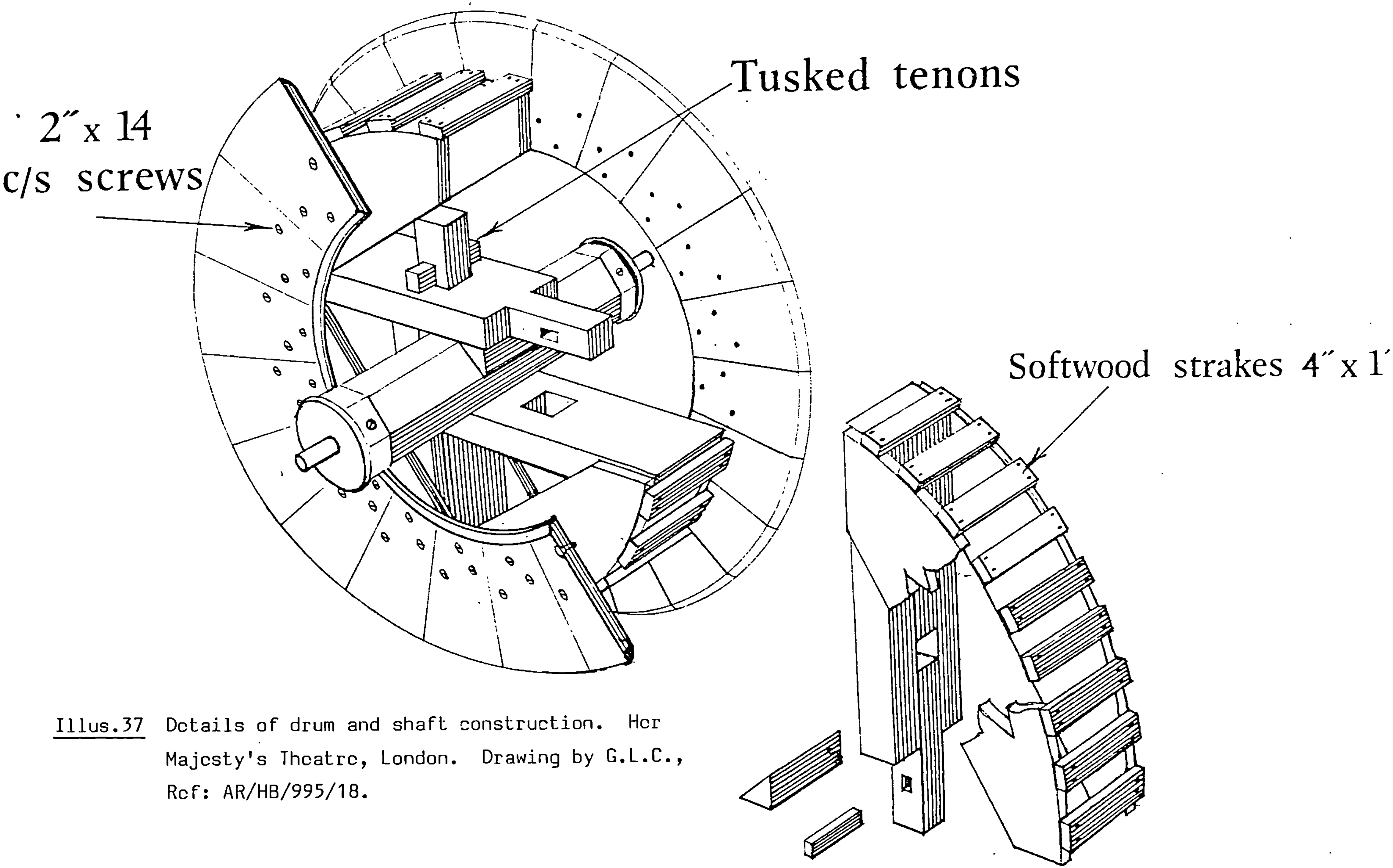
opposite direction, it was possible to raise one piece and lower another at the same time; in this case, should one be heavier than the other, an additional line attached to a counterweight could be rigged onto the shaft.

The shaft was usually turned out of a single piece of wood, although sometimes small slivers were mounted onto the four sides of a square section of timber to produce a circular shaft. Just such a method was employed in the construction of the overstage equipment installed at the Theatre Royal, Bath [see pages 51-55]. If, however, the shaft was turned in one piece, one section was left square to allow for the attachment of the large timber drum. It was of course very important to ensure that the metal mountings for the ends of the shaft were set in square so that the mechanism *would run concentrically abouts its axis. The axle pins were* usually a foot or more long [see photo.2] and ragged along their length to ensure a strong grip upon the wood.

The drum [see Illus.36,37] consisted of four 'clasp-arms' mounted around the shaft and secured by single tusked tenons, as at Her Majesty's Theatre, London, or double tusked tenons as at the Tyne Theatre, Newcastle-upon -Tyne. Around this basic framework, on either side, were mounted four cants, surmounted either by another set overlapping the joints of the previous layer or, as shown in the drawing by a series of flanges. Softwood strakes were then planted onto the edge of the cants as shown in the drawing to form the channel around which the controlling line was wound.

The size of the drum-and-shaft mechanism, and also the ratio of the two circumferences were constant but, equally, they were never drastically different. A shaft of one foot in diameter might be expected to bear a drum of some six or seven feet in diameter, or a ratio of six or seven to one. This ratio was often altered from time to time by the machinist if the flyman could not manage to operate the mechanism quickly enough. The alteration was achieved by simply nailing a number of laths onto the shaft, effectively increasing its circumference and thus the speed at which the scenery moved [see photo.3].

With the introduction of the modern counterweight system as we know it



Illus.37 Details of drum and shaft construction. Her Majesty's Theatre, London. Drawing by G.L.C., Ref: AR/HB/995/18.

today the drum-and-shaft has faded into archaeological obscurity. The many other items examined in this section often had operational drawbacks which to the modern stage technologist justify their demise, but with the drum-and-shaft it seems difficult to explain, for this mechanism offered the possibility of operating and co-ordinating several pieces of scenery together, and, perhaps more important, the changes could all be effected by a single person on the fly gallery controlling a single line wrapped around the drum.

The drum and shaft arrangement was therefore very versatile and could be put to use to perform may functions in the nineteenth century theatre. One particularly interesting installation was made at the Theatre Royal, Bath, in 1863, where according to The Bath Chronicle the stage was

> "constructed by Mr.W.Jones and Mr.S.Sloman of London in a most satisfactory and praiseworthy manner aided as to occasional supervision by Mr.D.Sloman, to machinist of Her Majesty's Theatre ." 11

It was apparently considered necessary to engage the services of stage machinists from London to supervise the installation of the stage and its accessories. As this was Charles Phipp's first theatre he would presumably not have been familiar with the backstage requirements of a large theatre, and in any case theatre machinery was traditionally designed and installed by specialists. The beams which supported the fly floors were twenty-two feet above the stage, while the fly floor itself was twenty-four feet above the stage and ten feet wide. At the same time 'cradles' were built on the underside of the floors so that the upper grooves could accommodate wing-pieces and flats which were eighteen feet high.

The newspaper account also related that:

> "The stage floor rises half-an-inch to the foot, and is composed entirely of sliders. Alternately two and three narrow cuts at the wings with wide ones at the entrances. They are all worked off by windlasses on the mezzanine floor. There are also the Corsican trap, four large traps in centre, and four smaller ones at sides in 1st and

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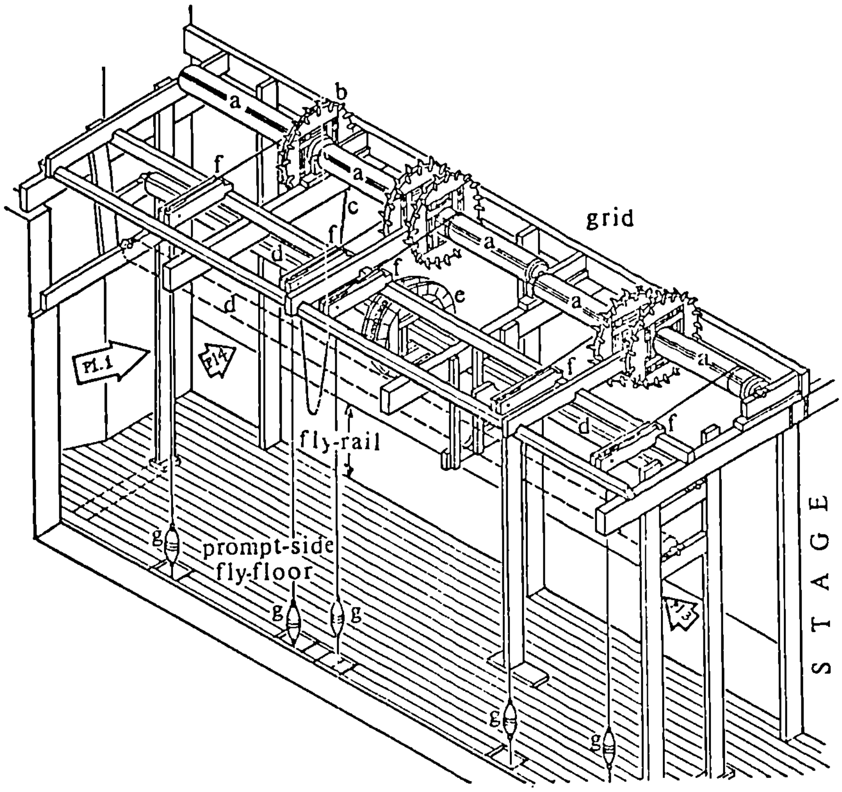
11. Anon., The Bath Chronicle, 5th March, (1863), p.7.



Illus.38 Isometric view of overstage machinery. Theatre Royal, Bath. Leacroft, Theatre Notebook, op.cit., p.23.

3rd entrances. A large bridge 12 feet long by four feet wide rises in the 5th entrance. The whole depth under the working part of the stage sinks to a depth of 16 feet, with a cement floor ." [12]

It was not until 1954, when Richard Leacroft surveyed the overstage areas of the theatre, that the existence of any stage machinery was known. He re-surveyed it in 1975 with additional observations and concluded that "it is to be hoped that any future up-dating of this theatre with more modern flying machinery will be designed as it could well be, to incorporate these elements within the overall system." [13] In 1981 the theatre closed for extensive renovation and I was consulted to examine the backstage area for the Historic Buildings Council of the Department of the Environment. The overstage machinery identified by Richard Leacroft was still in place.

The Overstage Machinery.

This installation was situated above, and operated from, the stage left fly gallery [see Illus.38,39]. It was possible to identify two distinct types of machinery, the variation in design presumably being related to the function. One type consisted of five shafts, 'a', of varying lengths, to which was attached in each case a large spiked wheel, 'b'. When the wheels were examined in 1981, one of them was still rigged with a continuous rope, which passed between the spikes and down to the operator who stood on the fly gallery [see photo 4]. The construction of these wheels bears a marked similarity to the overstage machinery at the Theatre Royal, Plymouth. A similiar type of wheel is also shown by Contant [14] [see Illus.40], and it seems likely therefore that it was an accepted alternative variation of the drum and shaft. Although all the spiked wheels were the same size the shafts varied in length, with a constant circumference of 3'1". Consequently the gearing ratio was always constant but the amount of rope which could be wound onto the shafts was variable. As the newspaper account specifically mentions that specialists were brought from London to supervise the installation of the stage, it may be supposed that the machinery was carefully designed to carry out the work required. The presence, therefore, of spiked wheels and two drum and shaft mechanisms implies that the two types were designed to perform different functions.

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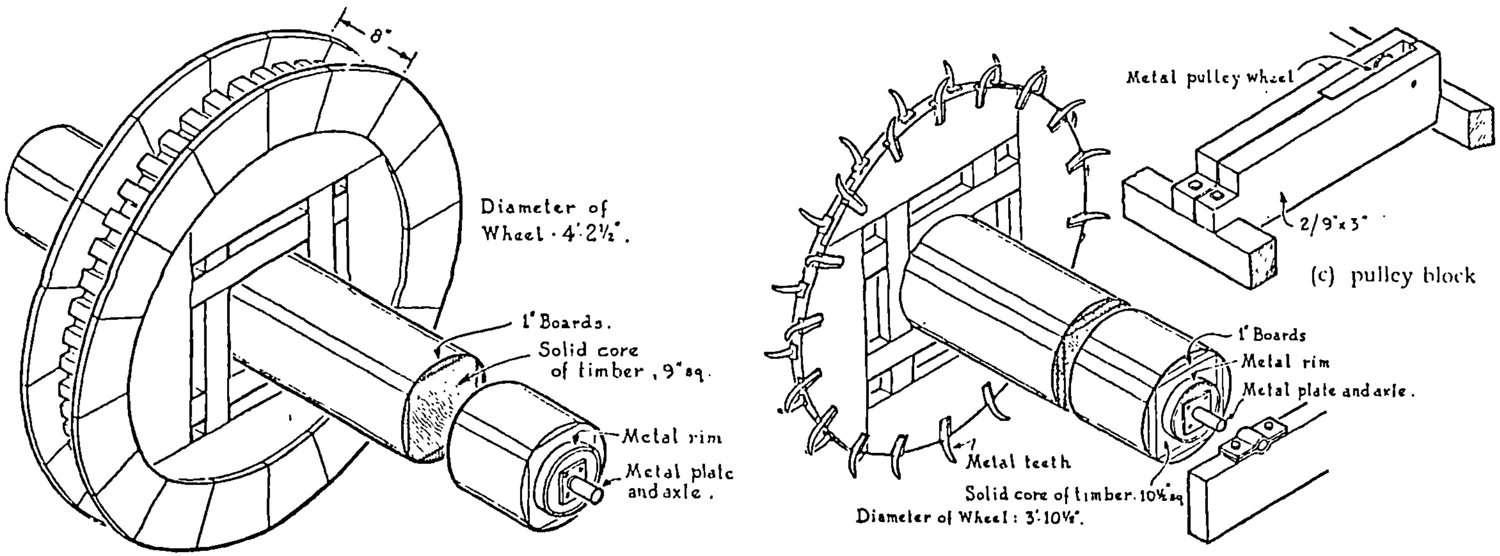
12. Ibid.
13. Richard Leacroft, "Nineteenth Century Machinery in the Theatre Royal, Bath", Theatre Notebook, XXX, (1976), No.1, p.24.
14. Contant, op.cit., pl.29,figs.5-6 and p.148.



Illus.39 Details of construction of overstage machinery. Theatre Royal, Bath. Leacroft, The Development of the English Playhouse op.cit., p.203.

With this in mind, it is interesting to note that according to a newspaper account:

> "On the tops of the main beams over the stage are longitudinal pieces which principally support the bridges and the machinery of the gas battens." 15

It is this last phrase which is of particular importance because it suggests that there was a specific piece of machinery designed to control the position of the gas battens. In the light of this evidence it is necessary to consider the suitability of the five spiked wheels for performing this task. If the gas battens were rigged onto a spiked wheel, they would require counterweighting for two reasons. Firstly, they would be too heavy to be raised and lowered with ease. Secondly, if the battens were not counterbalanced the continuous rope would simply slip through the spike of the large wheel, giving no control whatsoever. For, unlike the drum and shaft system, the working line, i.e. the continuous rope, was not physically attached to the spiked wheel. Consequently this method did not afford a way of securing the working line to the fly rail and had to be left hanging free. The counterweights were incorporated by attaching a rope around the shaft in an opposite direction to the 'hanging lines'. This then passed to a deflection pulley block, F, adjacent to the fly gallery wall. From there the rope passed down through a hole cut into the fly gallery floor to a counterweight hanger and weights attached at the end. Assuming that almost perfect counterbalancing was required to operate this machinery effectively, it seems essential that the load to be raised and lowered was not being constantly altered. The similar machinery installed at the Theatre Royal, Plymouth [see page 31] was designed to raise and lower the 'stock borders' which were in constant use. However, at Plymouth the shafts were long for co-ordinated scene-changing whereas at Bath they were much shorter. This suggests that individual units were hung on a permanent basis, but were subject to a variation in height from time to time. Such a function would therefore seem ideally appropriate to gas battens, for they would undoubtedly be required at different heights depending upon the shape and size of the scenery.

The distribution of the spiked wheels would also seem well suited to gas batten operations. There were five in number, running consecutively in an upstage/downstage direction, which would thus allow the gasman to hang five battens in

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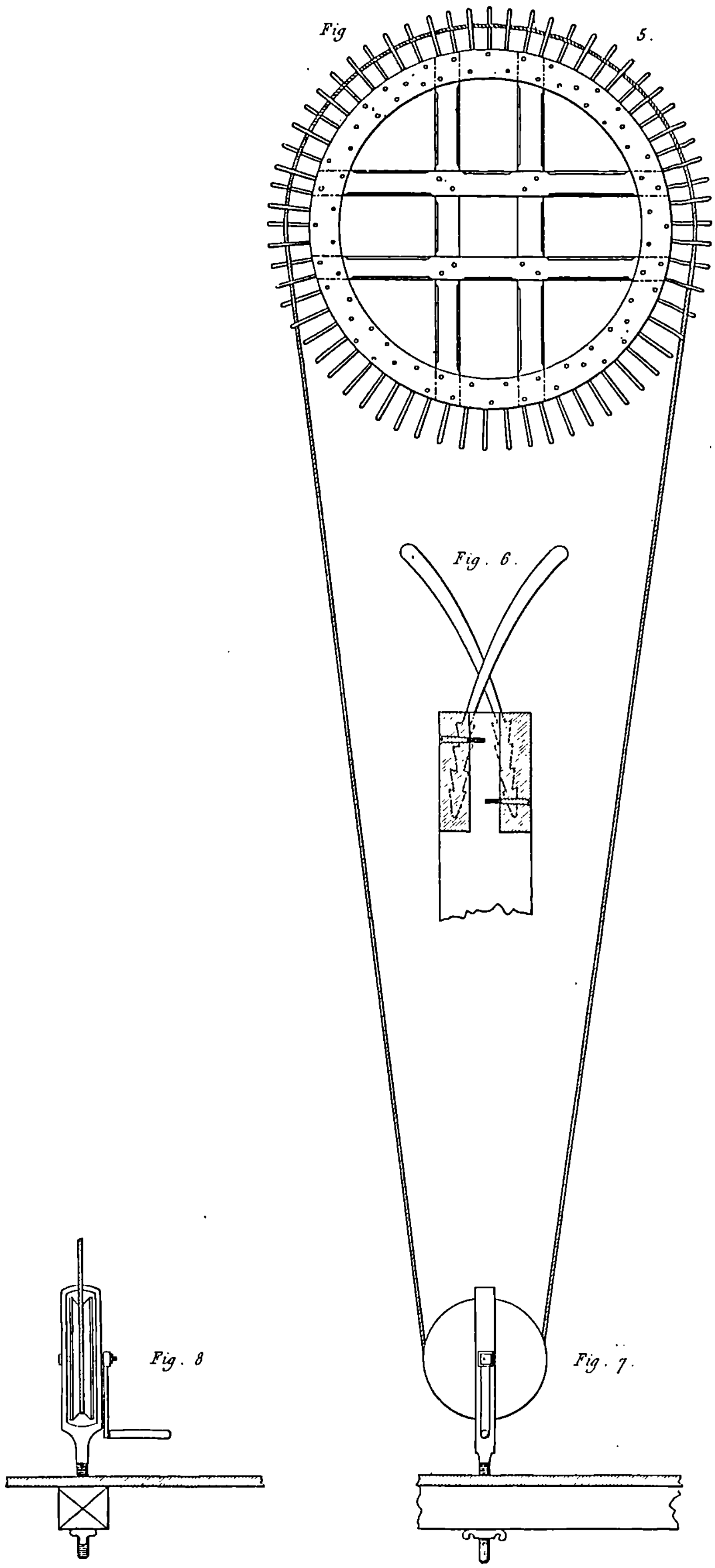
15. Anon., <u>The Bath Chronicle</u>, loc.cit.



Illus.40 Details of construction of drum. Contant, op. cit., pl.29.

virtually any position above the stage. Leacroft suggests that they were

> "used for a variety of purposes which could include the movement of the borders or upper grooves .... the raising and lowering of the backcloths or framed - cloths of various forms, or of any other individual piece of scenery." 16

The five sets of spiked wheels could have been used to raise the adjacent pairs of upper grooves, but it must be remembered that the upper grooves could be easily raised by one man, while it would be very difficult to raise and lower a gas batten, especially when lit, without the aid of such a mechanism. Indeed it is quite easy to imagine five flymen attempting to 'hand haul' a lit batten and causing it to sway back and forth in close proximity to the highly flammable scenery!

It is also worth pointing out that the use of a spiked wheel for the purpose of raising and lowering scenery poses problems. Because the wheel is operated from a continuous rope, it is impossible for the flyman to mark off his 'dead', i.e. the exact point at which the scenery is in the correct position. Moreover, the oblique angle at which the stage is viewed from the fly gallery makes it impossible for the flyman to 'sight' the placement of the scenery. It would therefore appear that spiked wheels were not ideally suited for flying scenery.

However, a single drum and shaft still hung above the stage left fly gallery in 1981, and from the structural framework which supported the machinery it appeared that there were originally two such mechanisms. When Richard Leacroft first surveyed the installation in 1954, one had already been removed, but from the extant evidence he concluded that it had been a continuous shaft running in an upstage/downstage direction, although it was not possible to ascertain exactly where the drum had originally been positioned.

The surviving drum and shaft was 30'2" in length, the shaft having a 2'10" circumference and the drum an 11' circumference. The considerable length of the two drum and shaft mechanisms would have been ideally suited to co-ordinated scene-changing, allowing a complete set of borders or cut-cloths to be changed in a synchronised manner. This was carried out by attaching the three flying lines to the cloth, passing them over the pulley blocks at grid level and

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16. Richard Leacroft, "Nineteenth Century Machinery in the Theatre Royal, Bath", op.cit, p.22.

attaching them to the designated shaft at the required point. Given the length of the shaft, several pieces of scenery could have been attached in this way. Once again it is possible to draw a parallel with the flying machinery at Plymouth, where sets of borders were connected to the same shaft. It would also have been possible at Bath to rig two sets of borders onto the same shaft, thus allowing one set to be flown out as another set was flown in by the simple expedient of winding the flying lines of the borders onto the shaft in opposite directions.

The movement of the scenery was controlled from a single line which was wound around the circumference of the drum. If two sets of borders were attached to the same shaft it would have been essential to ensure that one set was slightly heavier. Herein lies the difference between the operation of the drum and shaft and that of the spiked wheel. The single line attached to the drum is 'paid out' as one set of borders is dropped in and 'hauled in' as the other set is dropped in. If only one set of borders, or a single piece of scenery, was attached to the shaft it could be counterweighted in the usual manner. However, my personal experience has shown that under normal circumstances the mechanical advantage gained is sufficient to 'haul out' a backcloth without the assistance of counterweights.

One of the drum and shaft mechanisms at Bath may have been used to raise the hinged extensions to the upper grooves on either side of the stage, but there was no evidence left in 1981 to indicate the original groove positions, though the newspaper account provides several important pieces of evidence:

> "The beams supporting the fly floors are 22 feet from the stage on the underside, the fly floors being 2 feet higher, and are 10 feet wide. The floors are cradled down to 18 feet, which is the height of the wings and flats." 17

A definite structural and functional inter-relationship is therefore clearly discernible between the grooves, the drum and shafts, the layout of the stage traps, the grid and the flying galleries from which much if not all of the overstage machinery was operated on the English wood stage.

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17. Anon., The Bath Chronicle, loc.cit.

The Flying Galleries.

As has been seen in previous case studies, the dimensions and in particular the height of the fly tower in an English theatre increased during the course of the nineteenth century. As a general rule it may be said that the number of fly galleries provided in a theatre also increased and was directly related to the complexity of the stage machinery to be worked therein. Buckle defined the galleries as,

> "Staging or floorings erected on each side of the stage, at right angle with the proscenium and extending the entire depth of the stage." 18

He also stated that on no account should the edge of the gallery be more than 3 feet from the proscenium opening, and that where practical they should be between 5 and 10 feet wide. It was however important to ensure that the width did not inconveniently reduce the width of the 'hanging cloths'. Buckle also advocated that the joists which formed the floor of the fly galleries be supported at one end on the side walls of the stage and at the other on the bottom plate of a strongly formed truss. The 'upper plate' or 'head-piece of the truss' became the 'fly-rail' made of 'deep scantling'. The cleats, made of wrought iron or hard-wood were then attached at regular intervals.

With reference to the height of the galleries above the stage he recommended a minimum of 20 feet, though 28 to 30 feet would be preferable to avoid them being seen from the auditorium. If the first tier was inadequate on its own a second tier between 7 and 10 feet higher should be constructed. These upper galleries were also to be connected by means of bridges parallel and close to the proscenium wall and suspended by rods from the gridiron.

Although Buckle provides a fairly adequate general description of the requirements of a theatre's fly galleries he fails to mention whether the lower gallery should be level or raked parallel to the stage floor. This basic piece of information is particularly important when considered in conjunction with the operation of the 'flats' and 'grooves'. For instance, if both upper and lower galleries are level, and the stage raked

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18. Buckle, op.cit., p.34.

traditionally at 1 in 24 then the distance between gallery and stage will decrease progressively upstage. Inevitably the upper grooves, usually attached to the lower fly gallery, will follow the same pattern, and as a result the stage will require flats of varying heights all exclusive to their own set of grooves. Edwin Sachs shows this particular arrangement incorporating four sets of grooves [see Illus.29]. In addition he advocates the use of four suspension ropes for scenery in preference to the common nineteenth century practice of three - 'long', 'middle', and 'short' as employed at the Tyne Theatre, which has a proscenium opening of 28 feet 4 inches.

In his longitudinal section of the English wood stage [see Illus.29] Sachs does not actually illustrate a 'hemp set', that is ropes attached to a piece of scenery, suspended from the grid and 'tied off' on the fly-rail. Instead he shows ropes attached to various pieces of scenery, and passed up to several drum and shaft mechanisms, but there is no logic to the rigging depicted which appears to be completely workable. Gas battens, scenery and even upper hinged groove extensions are attached to the same shaft! Writing almost ten years after Buckle, Sachs provided additional information regarding the function of the galleries, recommending that windlasses could be placed on the fly floor to raise heavy weights. This could be further assisted by counterweights placed against the fly tower wall and encased to avoid accidents, perhaps reflecting the general increase in the weight of the flown scenery between 1888 and 1898 and a greater awareness of the need for safety. This type of primitive counterweighting was in fact employed at the Alexandra Palace Theatre (1875), the whole of the stage left wall being completely boxed in to allow the passage of counterweights. However, this method was not always used and quite often the weights were allowed to hang unprotected and unguided, passing through fly floors and roughly cut holes and hanging dangerously above the heads of unsuspecting actors.

Most of the flying work was carried out on one particular side of the stage. This meant that the ropes from the gridiron which suspended the scenery were all brought down onto the fly-rail at the 'prompt side', known as the 'working flies'. At the Tyne Theatre, for instance, the working flies were on the upper stage left gallery, which consists of a main fly rail for securing suspensions used in the current production, and a back fly-rail for permanent non-moving hangings such as borders. The lower stage left fly-gallery housed the thunderun prior to the fire of 1985. At the time of writing (1989) this is still awaiting restoration. [see page 74 for full description]. The upper stage right fly gallery was only partially boarded to allow counterweights to pass through the floor where they could be loaded on the lower gallery. It is also quite probable that the lighting battens (gas or electric) were tied off on the upper stage right fly rail, as cleats were attached to the rail at infrequent intervals.

On the location of flying bridges, Sachs recommends one against the back wall of the stage rather than against the proscenium wall as advocated by Buckle. This could then probably be incorporated as a working platform for a paint frame. Several other flying bridges could be installed as required and although they did not effectively reduce the flying space as they were suspended from the roof trusses of the gridiron, they were not always in exactly the right position. On such occasions, according to a writer in The Strand Magazine,

> "the fly men crawl along the gas batons [sic.] with the dexterity of a monkey - and be it distinctly understood that this is intended as a compliment - and put the rebellious bit of canvas right, returning to his place as though nothing had happened. He was only twenty or thirty feet above the level of the stage, and with absolutely nothing to protect him!" [19]

The fly galleries were therefore multi-purpose platforms positioned on either side of the stage and could be used for access, suspension, operation etc.

The Upper Grooves.

The most complete contemporary information relating to the groove system is provided by Clément Contant in his treatise Parallèle des Principaux

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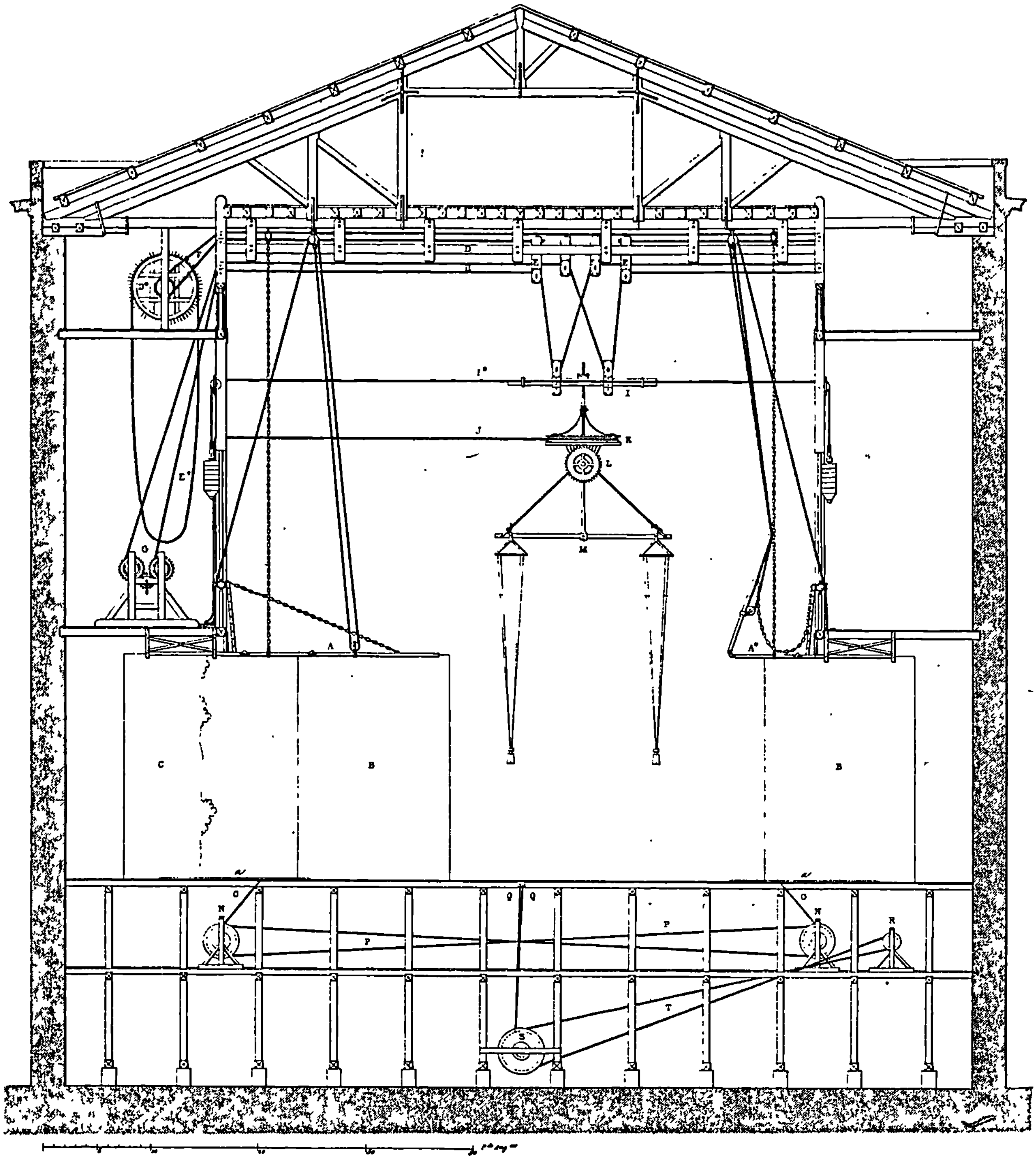
19. Anon., "Transformation Scenes, How They Are Made And Worked", The Strand Magazine, VI, (1893), p.709.



Illus.41 Transverse section of an English stage. Contant, op.cit., pl.27.

Théatres, ironically an example of information about the English stage coming from a French source.

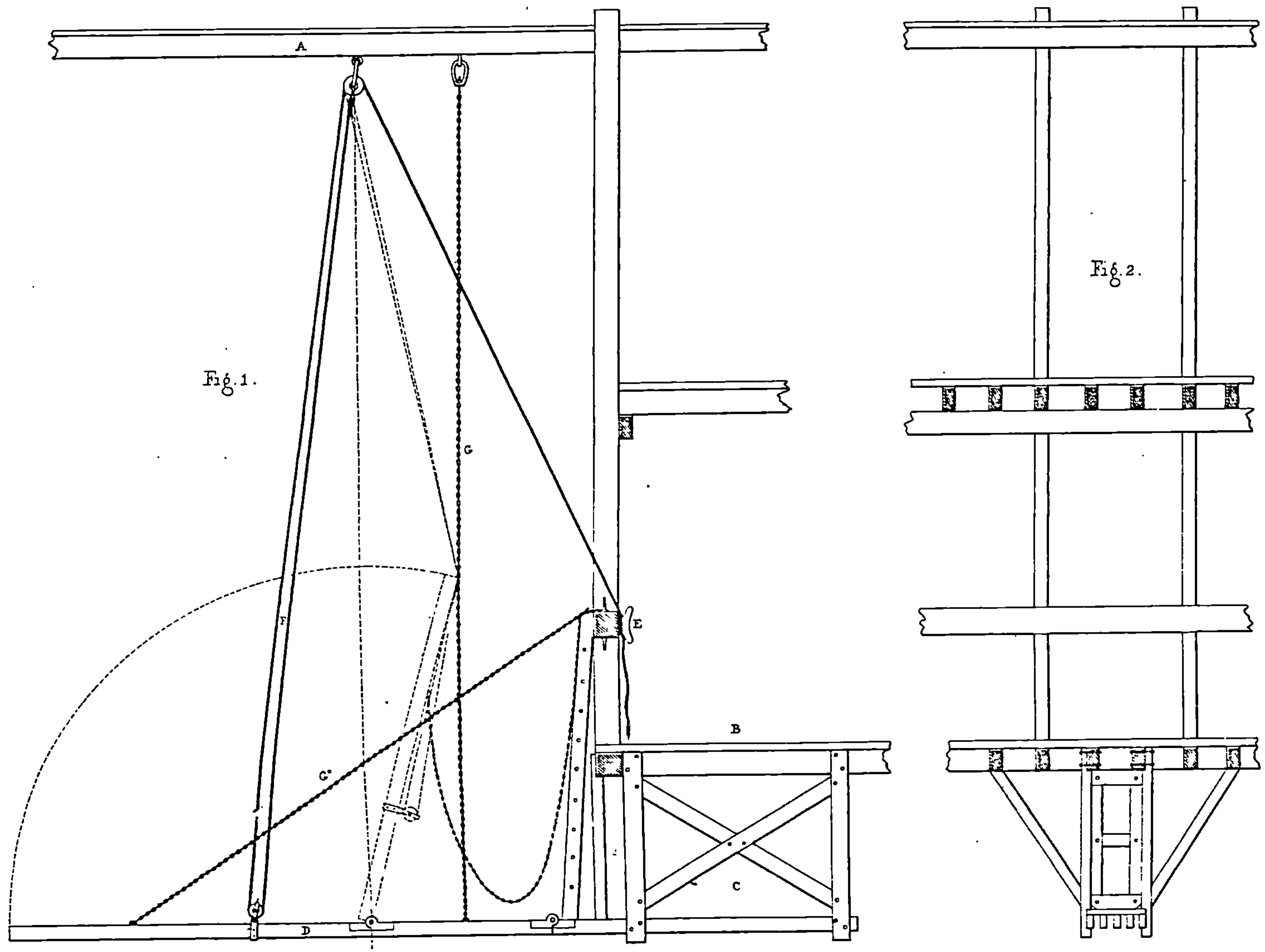
Plate 27, [Illus.41].

Transverse section of an English stage.
as follows:

A. Movable groove, guiding the tops of the wings and the half-flats of the backscene, arranged for a change (of flat scene).
A*. Position of the same groove before coming into position.
a. Raised fillets on the stage floor between which slide the bases of the wings and of the halves of flat scenes.
B. Backscene in two halves, joining in the middle and kept together by alternating joining cleats.
C. Ordinary side scenes or wing-pieces.

These details are made even clearer in his plate 28, [Illus.42], which provides further enlarged drawings of the upper grooves:

A. Grid floor.
B. Lower fly-floor.
C. Stay or distance framework of the movable grooves under the fly-floors.
D. Movable parts of the grooves put in readiness for the sliding-in of a flat. The dotted lines show the position of the groove when it is used only to take a wing-piece.
E. Cleat for fixing the groove.
F. Hand line for lowering or lifting the grooves.
G. Iron chain or check-support.
G*. Moving chain to maintain the level of the extremity of the groove.
Fig.2 Section of the fly-floors and the arrangements of stays beneath them.
Fig.3 General plan of the groove.
Figs.4,5,6 Working details, or side elevation, plan and end elevation of a groove.



Illus.42 Details of upper grooves. Contant, op.cit., pl.28.

The suspension of the upper grooves was effected by an intervening timber framework, positioned between the underside of the fly floor and the grooves. In Contant's diagram the immovable offstage section of the groove measures 9 feet in length, the middle section hinged at either end measures approximately 6 feet 4 inches, and the third onstage section measures some 12 feet, giving a total of 27 feet and 4 inches. It follows therefore that if a pair of grooves were fully extended there would, according to the scale given on Contant's plate 27, be a distance of approximately 15 feet 8 inches between the tips. This means that in order for a pair of flats to meet at the centre line of the stage it would be necessary for the flat at either side to extend 7 feet 10 inches beyond the grooves. The construction of the upper grooves is interesting, for owing to their size they are not made of solid timber; instead the grooves are spaced with blocks, producing an open, lattice-like structure. [20]

Richard Southern in his book Changeable Scenery considers the operation of these grooves and though his account is essentially a piece of imaginative writing rather than a description based on concrete evidence, it seems to capture the backstage atmosphere of a nineteenth century theatre, and is for this reason perhaps worth quoting at length.

> "The working of these mammoth grooves is interesting in the extreme. Of the three sections of each set, the first or fixed section is braced immovably under the fly-floor, the second or intermediate section hinged to the first is slung by a 40ft. chain from the grid. Why a chain? Because a chain can stand a considerable tensile strain - and a jerk - without stretching, while a rope will lengthen not only with strain but with atmospheric changes. And, of course, to allow the upper grooves to drop even half an inch would mean that the scenery must jam in them. The third, or inmost, section is supported by a second chain, but this time a much shorter one, attached to the rail of the first fly-floor. Just at its attachment there is to be seen a perforated strip, presumably of metal, descending from the fly-rail to near the end of the fixed section of grooves. The purpose of this is obscure. It may afford a means of

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20. All dimensions are taken from the 'pied anglais' scale given at the bottom of Contant's plate 27.

adjusting the groove to meet changes in the height of scenery resulting from differences in atmospheric humidity and other causes, or it may be a ladder to give access to the groove in cases of jamming.

But the third section of the grooves has another attachment. This is the working-line. The working-line is here no simple rope going, in company with others from other sets of grooves, to a common operating shaft, but originates in the first place from a block in the grid, whence it runs down to the sheave of a block attached to the grooves; from here it turns aloft again, circles the sheave of the first block, and descends finally to a cleat on the inside of the fly-rail.

Observe the ingenuity of the working. If this line be heaved in from the fly-floor, the third section of the grooves will lift, bringing the pulley with it, so that the line goes progressively from the diagonal to the perpendicular; when the perpendicular is reached, the fly-man jerks his line and then immediately slackens his pull slightly. This has the effect of bringing the reared-up end of the grooves beyond the perpendicular. Now at this stage it strikes the line which pulled it up-and, were this maintained taut, would go no farther; to keep it in this upright position the line would have to be securely tied off to a cleat. But if the momentary slackening is permitted, the rearing groove, upon striking the vertical rope, will not only strike it but push it back. The groove now passes the vertical and its centre of gravity is transferred to the other side; its tendency is to fold back on itself. Now the fly-man gently checks the yielding lines again, and they become a support for the leaning-back groove-arm. Ease them until they and the arm-tip touch the long chain supporting the second section and they will stay in position without further support.

Take the line again and tug it slightly; it will tighten and straighten, kicking the arm across and past the vertical position again. Check the line immediately this occurs and then proceed to ease it out slowly and the groove-arm steadily descends to the horizontal again.

A sufficiently ingenious arrangement as must be admitted. But we have not reached the end of the story.

Lift the groove-arm again. This time, when it reaches the vertical, do not jerk nor slacken the line, but continue to pull on it steadily. You will now begin to exert a lifting pressure upon the second section of the groove. This too will rise until it achieves the vertical and lies in a straight line with its fellow above. You have but to tie off each groove in this position and the whole space is then clear from the fly-rail on one side of the stage to that on the other." 21

A comparison of figures 1 and 2 in Contant's plate 28 and the upper grooves featured in plate 27 reveals that they are not identical. The figures in plate 28 show a second fly floor, not indicated in plate 27, and the intermediate fixings between the underside of the fly-floor and the groove are different.

Contained within the grooves shown on plate 27 are some standard flats, which could have been used in a 'flat-scene', and more importantly a profiled wing-piece. It therefore seems that wings and flats could be used within the long grooves indiscriminately.

The Lower Grooves.

No detailed drawings are given of these grooves and so all the available information is therefore confined to plate 27. The lower grooves, *,[a] are much shorter than the upper ones, being approximately 14 feet in length. The large flats which are shown to be contained within and extending outside the lower grooves appear to rest upon the stage surface. This being the case the lower grooves must simply consist of strips of wood without a 'bed'. Unfortunately the method of attachment to the stage is not indicated. As with the upper grooves, there appears to be no definite distinction between 'wing-grooves' and the longer 'flat-grooves'. The lower grooves are all 14 feet long, which must have given rise to several

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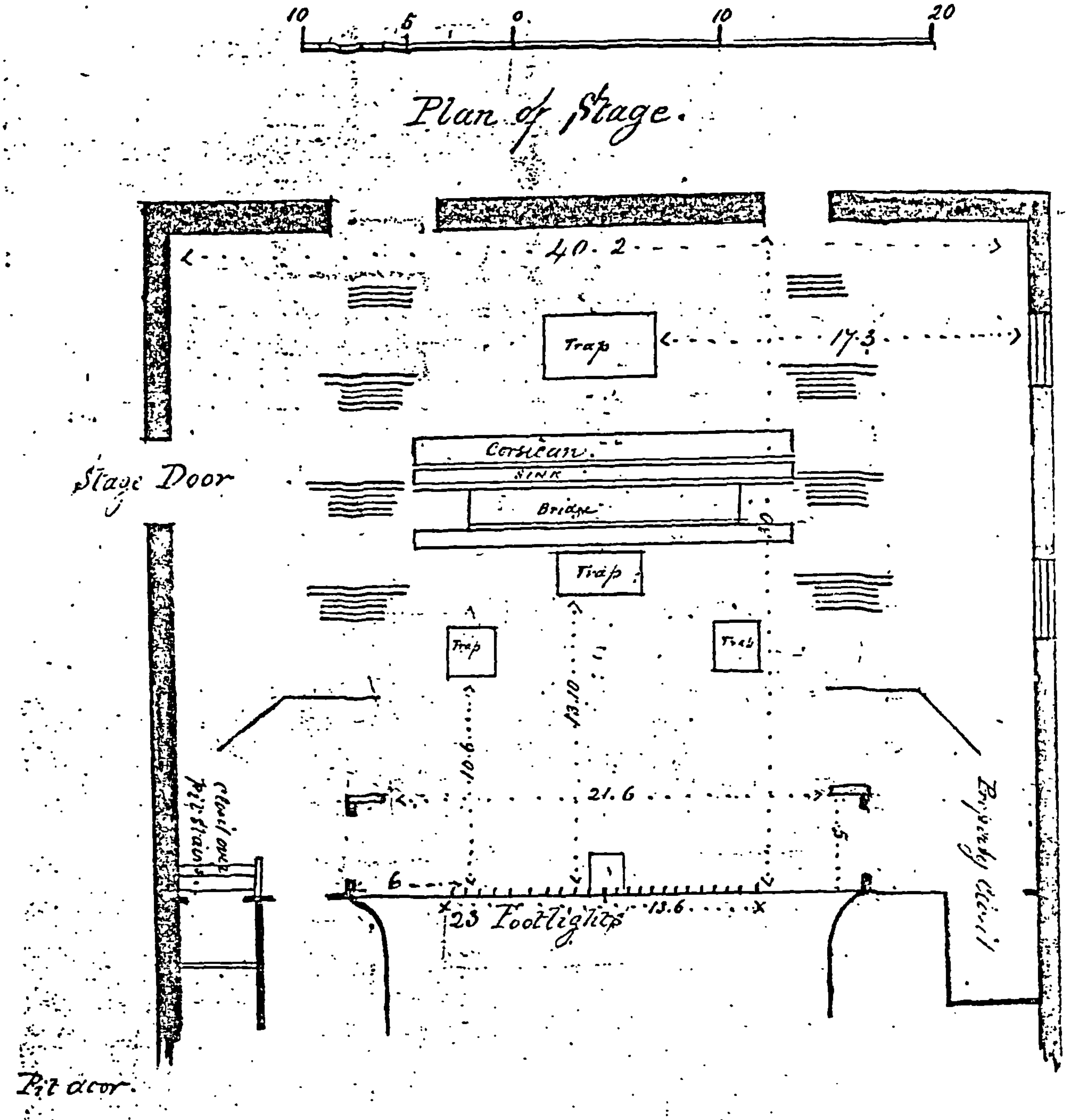
21. Southern, op.cit., pp.332-333.



The small Traps are 1.9 × 1.10½

The next is 2.1 × 4.3 long.

The first sink is 8in wide 17ft long.

The Bridge 1.10 wide 14 long.

The next sink is 8in wide 17ft long.

The Corsican Trap 1.3 wide 17ft long.

The last Trap. 3.3 × 5.5.

Illus.43 Stage plan, Theatre Royal, Ipswich. c.1858. Eyre M.S. op.cit [Courtesy of the Suffolk Record Office].

complications when 'flat-scenes' were used. On such an occasion a flat would have to extend 7 feet 6 inches past the onstage extremity of the upper groove in order to meet the corresponding flat from the other side on the stage centre line. This would mean that 7 feet of the flat would still be retained within the upper groove but that the lower edge of the same flat would have passed completely out of the lower grooves. That being the case, the sliding on and off of the flats must have posed several problems. There would undoubtedly have been a loss of stability at the base of the flats, though with a countervailing advantage not having a lower groove to position by hand before flats could be slid onto the stage. The hardest operation would probably have been when the flats were withdrawn and re-entered into the lower grooves. This would undoubtedly have required careful manipulation which may often have been hampered by low levels of lighting. Although Contant's account is perhaps one of the most extensive documents available it deals almost totally with large, grandiose theatres and opera houses, providing no information about the small provincial theatres which were in operation at the same time. Once again therefore, it is very useful to be able to consult the Eyre manuscript relating to the Theatre Royal, Ipswich.

The detailed stage plan [see Illus.43] dates from around 1858 and is therefore contemporary with Contant. The first set of grooves was positioned far upstage in relation to the proscenium opening, but this gap was adequately masked by a pair of 'booked' proscenium wings which were painted of crimson drapery, and remained in a static position throughout the performance. Half of the 'book' ran parallel with the grooves, while the other half angulated downstage at approximately one hundred and forty degrees. The first three sets of grooves all had 4 wing grooves and 2 long grooves; the fourth set at the rear of the stage only four wing grooves. The back scene was probably provided by a tumbled cloth, thus obviating the necessity of a long groove. The stage plan does not, however, indicate the exact nature of the grooves, nor does it state whether there were lower as well as upper grooves. One piece of text does however provide a valuable insight into the use of a lower groove around 1850.

> "The old stage during the latter part of Smith's time & up to the purchase by Charles Gill of the theatre, was very uneven so a board or grove [sic.] had to be placed across the stage before a flat

> could be run on. The board or grove was made in two so a piece was pushed on from each side & had a pin in each end which dropped into a square hole in the stage to keep the grove steady. This arrangement kept the end of the flat off the stage some 1.5 inches so enabled the hinged part to swing. The each half of the flat being in those days made in two, one half or part being hinged to the other so as to pack for travelling." [22]

Within this short section of text are several important pieces of information which enable us to establish a comparison with Contant's slightly later and Foulston's earlier grooves. Although Contant does not state how the lower grooves were fixed to the floor the fact that the methods used at Ipswich and Plymouth are almost identical to one another would seem to suggest that this may have been standard practice. In addition we can establish that the flats did not run in a guide fixed to the stage, but in a true groove which had a bed, elevating the flats around one and a half inches off the stage surface.

The text which describes how the flats were hinged seems at first to be a little puzzling. However, as there was comparatively little wing space for the removal of flats from, and their insertion into the grooves it was probably necessary to hinge them: as a flat was withdrawn from the groove it could then have been folded to ninety degrees whilst the other half was removed. This would have been extremely easy to do when one remembers that the groove bed was elevated above the stage.

Differences however are discernible between the Plymouth grooves of 1811 and the Ipswich grooves of c.1850. For instance, at both theatres in order to convey the impression of perspective, the grooves enroach progressively further upon the stage in an upstage direction, but the progression is more pronounced at Plymouth (1811), than at Ipswich (c1850). This tapering of the distance between the groove tips is, however really a tradition of the eighteenth and early nineteenth centuries when scenic perspective was regularly practised.
.... At this point in the study of the English groove it

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22. H.R.Eyre, op.cit.

is important to recall a discovery made in 1939 by Richard Southern at the Theatre Royal, Bristol. On a tour of the building accompanied by the theatre manager and the curator of the Bristol Museum he inspected the roof space above the auditorium and discovered hidden away the fragments of a groove, [23] [see photos.5, 6]. It consisted of a series of timber grooves of varying length, width and construction perhaps indicating that it had passed through several phases of modification. At one end were two metal strap hinges now parted from their original timber attachment.

Photograph 5 shows the groove viewed from the side with the longer groove farthest from the camera. These two distinct lengths are battened together, although the shorter member is two inches lower than the longer. The apparent difference in construction between the long and short members suggests that they were made at different times, though it seems virtually impossible to say with any certainty which came first. Southern suggests that the long portion may be older because it is made with hand-made nails while the shorter is screwed together. Yet both existed simultaneously during the nineteenth century, as indeed they do today.

The longer groove has six intervening timber strips of varying size attached to the 'bed'. A similar arrangement is also used for the short groove save that there are only four intervening strips of a regular size, providing a considerably deeper groove in which the flats were guided. This is all quite apparent from photograph 6, which also shows a small remnant of another groove section on the other side of the long groove, perhaps originally forming a mirror image of the short groove.

Finally, Southern tentatively dates the long groove as c.1764 and the short groove as later. The theatre opened after construction in 1766, and it is possible that the remaining portion dates from 1850 when the theatre was substantially refitted backstage.

Clearly this is an example of an upper groove: owing to the uneven nature of its 'back' it could not have been placed in a level position upon the stage floor, and must therefore have been suspended from a fly gallery.

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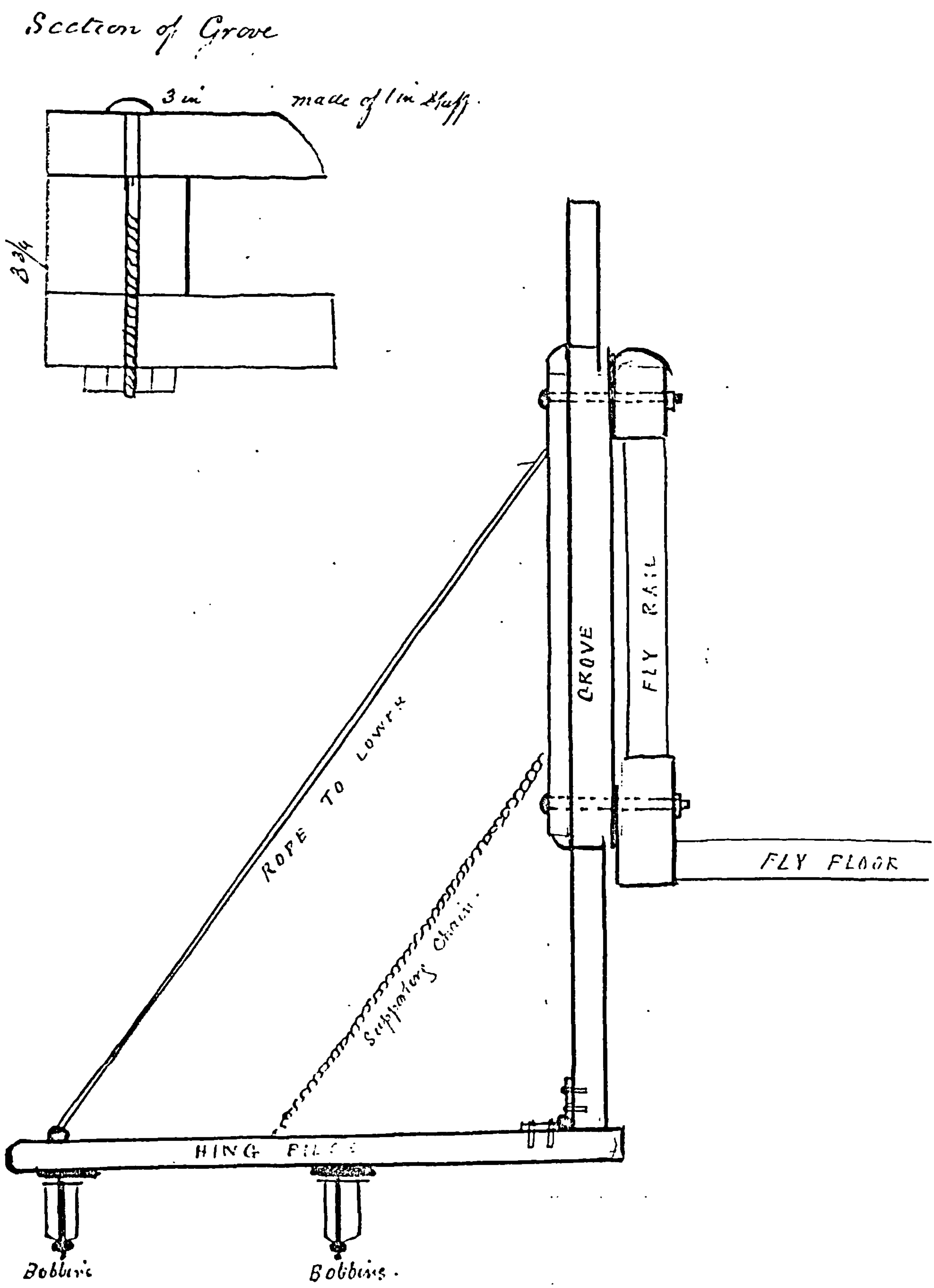
23. Southern, op.cit., pp.229-231.



Illus.44 Details of upper grooves. Theatre Royal, Ipswich. Eyre M.S. op.cit., [Courtesy of the Suffolk Record Office].

In 1948 Richard Southern and Richard Leacroft discovered another set of upper grooves at the Theatre Royal, Leicester. Photographs 7, 8, and 9 show the grooves attached to the stage left fly-gallery, which Southern suggested were not their original position [24]. When the theatre was built in 1836 the fly galleries were in close proximity to the proscenium opening, but in 1880 they were narrowed when the fly tower was raised. If the grooves dated from 1836 a pair would have been five feet six inches apart when fully extended whereas after 1880 the gap would have been increased to 12 feet 6 inches. This would mean that in order for a pair of flats to meet centre stage, each would have to extend 6 feet 3 inches beyond the groove tips. With Contant's groove in mind the possibility is not inconceivable, and it is further supported by the existence of the grooves in 1948. If they had been made in 1836, there seems no reason whatsoever to have re-attached them to the fly-rail after the narrowing of the gallery. The theatre would almost certainly have been still using grooves in 1880 and there would not have been room or time to install obsolete ones. It is therefore my belief that this set of grooves should be examined as dating from 1880.

The grooves, though slightly damaged by the loss of the downstage lath, were positioned 3 feet 6 inches upstage of the proscenium wall, and consisted simply of three long grooves with no provision for wing grooves. Presumably wing pieces were simply inserted into the long groove with the hinged extension withdrawn up against the fly-rail. The groove was fastened to the rail by two metal straps which allowed the height of the grooves to be adjusted. The position was finally secured by a line which passed from the top of the groove to a pulley block on the upper fly floor and back down to the lower floor where it could then be 'tied off'. This margin for adjustment of height was extremely important, especially for a provincial theatre regularly receiving touring companies who provided their own scenery which must have constantly varied in size.

Assuming that this groove does date from 1880 it becomes useful in assessing the changes that were made at the Theatre Royal, Ipswich. Once again however, the dating is a problem. Eyre provides detailed drawings

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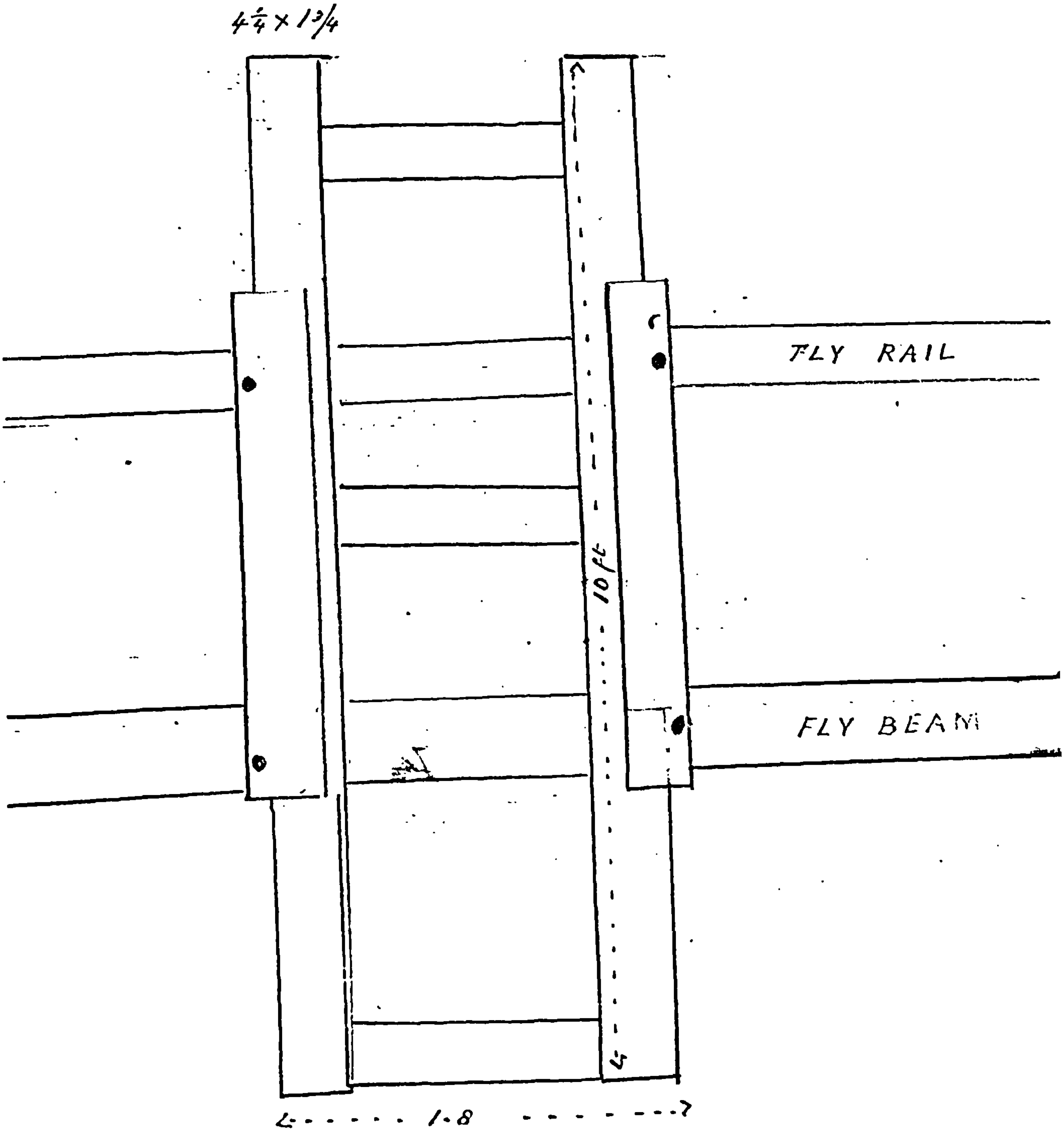
24. Ibid. pp.317-318.



Illus.45 Elevation of groove framework for height adjustment. Theatre Royal, Ipswich. Eyre, M.S. op.cit. [Courtesy of the Suffolk Record Office].

[see Illus.44] and measurements of some upper grooves in the theatre but gives no date. Richard Southern in Changeable Scenery dates them at 1857 when according to Eyre the 'modern style' was introduced, and they would therefore be the grooves previously cited and shown on the stage plan of c1858. However Eyre also states that in 1888

> "The roof was taken off, the walls carried up 10 feet higher and a pitched 'mansard' roof instead of the old 'hip' form put on which with the new 'flies', and 'grid' floor made the stage one of the best in the provinces the scenes being made 16 feet high." [25]

He also provides an elevation [Illus.45] of the framework to which the groove arm was hinged and clearly labelled are both "Fly Rail" and "Fly Beam". If this is compared to another drawing entitled, "Flies of *Theatre* put in 1888" [Illus.34], it is immediately noticeable that the same annotation is used. The grooves are not shown positioned upon the fly gallery, but they are probably excluded simply for clarity.

There is other evidence, too, related to their design which suggests that they are of a later date than 1857. The drawing supplied by Eyre shows that the height of the groove was adjustable to take varying heights of flats. Unlike Foulston's grooves this arrangement contained a permanent groove to which a movable hinged extension could be added. The whole horizontal piece measuring 4ft.x 17 ins. was hinged and suspended by a chain and lowering rope. Two iron plates were attached to the underside of the 'groove arm' and each had 5 'bobbins' as shown in Eyre's diagram [Illus.46]

If this kind of groove had been installed at Ipswich in 1857 one would expect to find contemporary examples from other theatres as well as periodical illustrations, but this is not the case. However, two comparable examples have recently been discovered. One is at the Grand Theatre and Hippodrome, Leigh, (1908), [see photo.10] where, according to Ted Bottle;

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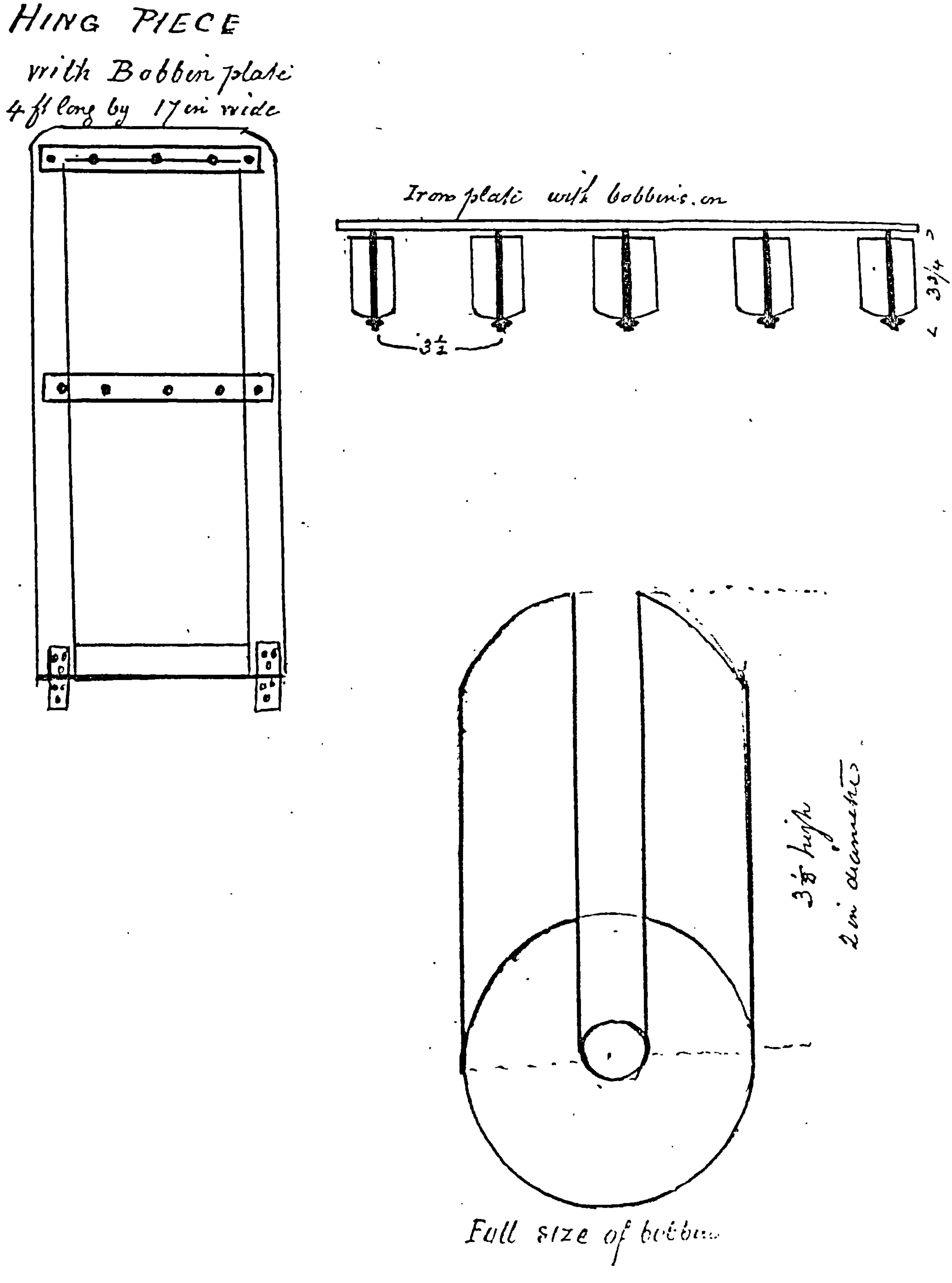
25. H.R.Eyre, op.cit.



Illus.46 Details of groove hinge and groove bobbins. Theatre Royal, Ipswich. Eyre M.S. op.cit., [Courtesy of the Suffolk Record Office].

> "Four wooden bobbins exist, thereby allowing the passage of three flats. If a second row of bobbins existed behind the first they have disappeared." 26

The existing bobbins are attached to adjustable sloat-like timbers hanging down from the edge of the O.P. fly rail. The second example was traced at the Theatre Royal, Merthyr Tydfil, (1891), [see photo.11], where;

> "Two sets of grooves, in good condition, but detached from their mountings were found in a room off the fly gallery. Each frame has two sets of six bobbins (one set acting as a steadier), all of which still revolve, thereby allowing the positioning of up to five flats at a time." 27

The latter example is very similar in construction to the Ipswich version almost contemporaneous with the raising of the Ipswich fly tower in 1888. It seems highly probable that Eyre would have been able to reproduce detail of this kind only if it were extant in his day, whereas if these grooves were installed in 1857, as Southern suggests, they would almost certainly have been disposed of as obsolete when the fly tower was installed and Eyre would not have been able to produce detailed measurements when he came to compile his work in the 1890's.

Moreover, the stage plan of c1858 [Illus.43] shows wing grooves <u>and</u> long grooves, the latter presumably intended for flat scenes. Consequently, if Eyre's groove details dated from 1857, one would expect to find evidence of both kinds, but this is not the case, - perhaps because the raising of the fly tower in 1888 allowed more cloths to be flown, and reduced the necessity for long grooves. Finally, possibly the strongest evidence for dating the 'bobbin grooves' at 1888 is to be found on illustration 45. Eyre clearly shows a "fly rail" and "fly beam" indicating that there was a "fly gallery" in existence at the theatre when the bobbin grooves were in use.

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26. Ted Bottle, "Surviving Theatre Grooves", <u>Theatre Notebook</u>, XXXVII, No.1, (1983), p.25.
27. Ibid.

Yet prior to the raising of the fly tower in 1888 the stage gridiron was very low and cloths had to be tumbled. It is therefore almost certain that there would not have been the room or necessity for a fly gallery in 1857, all the tumbled cloths being operated from stage level.

In consequence it seems more than likely that the 'modern style' referred to by Eyre was in fact the groove system. Previous to this it appears that a rather ingenious system of "book-wings" existed which were "worked by means of a spindle passing through the stage". At the end of the spindle was a grooved wheel around which passed a rope connected with another wheel situated on the prompt side of the stage. By turning this wheel one man could apparently carry out an entire scene change on his own. If this mechanism worked efficiently it is very difficult to see why it was considered necessary to convert to the groove system or 'modern style', though perhaps it was found to be inconvenient for visiting companies.

Yet the evolution of the groove was neither spontaneous nor universal; often new ideas were tried and rejected only to revert back to the old groove system. In the same year as the fly tower was raised at the Theatre Royal, Ipswich, J.G. Buckle wrote:

> "The 'grooves' fixed to the underside of the fly galleries in the older theatres, and used for steadying the 'flats' and 'wings', are now almost entirely dispensed with in modern theatres, as they necessitate all the scenes being set parallel with the proscenium."

He goes on, however, to relate yet another alternative modification:

> "'Grooves' are still used in a modified form, but are attached to the lower rail of the 'fly-truss' and turned upon a pivot, by which means wings, & c., may be set at any desired angle. Another arrangement is to fix iron sockets to the upper and lower plates of the 'fly-truss' in which a long wood bar, about 3 in. square, works up and down, being fixed in any position by means of an iron pin fitting into a series of holes, specially drilled. At the lower end of this bar is attached a contrivance very similar to an enlarged garden rake. This works upon a pivot and between the teeth the upper edge of the 'wing' or 'flat' is secured." [28]

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28. Buckle, op.cit., p.35.

Towards the end of the nineteenth century there was a growing disatisfaction with the traditional groove system. Yet many of the alternatives put forward, such as the "bobbin method" used by Eyre at Ipswich, did not alleviate one of the main objections. Namely, that the wings had to be parallel with the proscenium opening. Not only did this appear somewhat unnatural and regimental but it caused severe masking problems. Percy Fitzgerald commented that,

> "the scene-shifters are occasionally revealed, each with half a castle in his grasp, as he pushes the scene back in its groove." [29]

On another occasion he wrote:

> "With the old system of flats, side scenes and borders, we all realise how a change of scene used to be effected. A shrill whistle was heard, a series of grooves working on hinges were let down for the side scenes to run in, one set was drawn away and another pushed forward, whilst the back scene divided into two portions met in the centre with a sharp report." [30]

Remarks on the inadequacy of the groove system are legion, yet by the 1880's it had become virtually as sophisticated as was feasibly possible. The "fork" as suggested by Buckle was a final attempt to modify the system into an acceptable form. When the Theatre Royal, Blyth, was demolished in 1983 I was able to rescue a very interesting fork [see photos.12, 13] which was attached to the end of a hinged groove-like arm, in turn secured to the underside of the fly gallery. There were in fact five such forks on either side of the stage, almost certainly dating from the construction of the theatre in 1900. The prongs were secured to the timber arm of the fork by a bolt which allowed them to be positioned at any desirable angle, thus overcoming one of the main objections to the groove system. Yet here the story ends: forks similar to this one continued to be manufactured by Hall and Co. until the 1930's [see Illus.47], but the days of the English groove system were over. Though the fork gave a greater flexibility it could not

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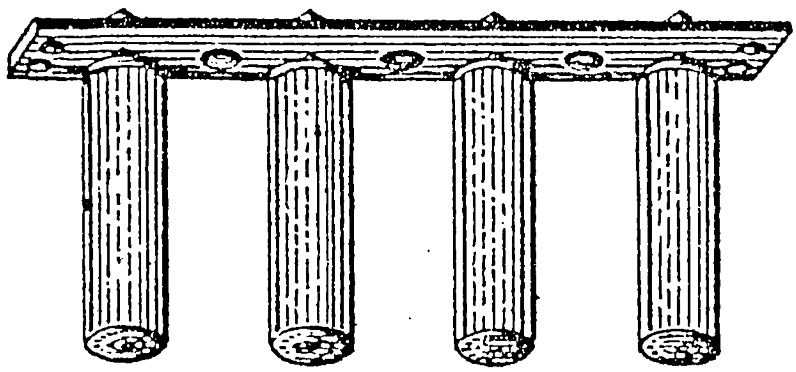
29. Percy Fitzgerald, The World Behind The Scenes, (London:Chatto, 1881), pp.2-3.

30. Percy Fitzgerald, "On Scenic Illusion and Stage Appliances", Journal of the Society of Arts, 18th March, (1887), p.459.

cater for the changing concepts in scenic design which became established during the second half of the nineteenth and the early years of the twentieth century. The erosion of scenic convention with the introduction of 'box-sets' had meant that the grooves were simply inadequate, for parallelism was no longer the norm and a new method of dressing the stage was required:

> "The scenery is strapped together by cleats and cords, and secured to the floor of the stage by means of iron rods or braces, hooked to eyes attached to the framework of the scenery, whilst the other end is secured to the floor with 'stage screws'." [31]

And slowly but surely the groove disappeared, almost without physical trace, to be replaced by the bracing method, outlined by Buckle, and one hundred years later the English theatre still employs upon this somewhat primitive method to support may of its scenic pieces.



Illus.47 Forks for supporting the top of flats. Hall Maufacturing Co. catalogue, 1931.

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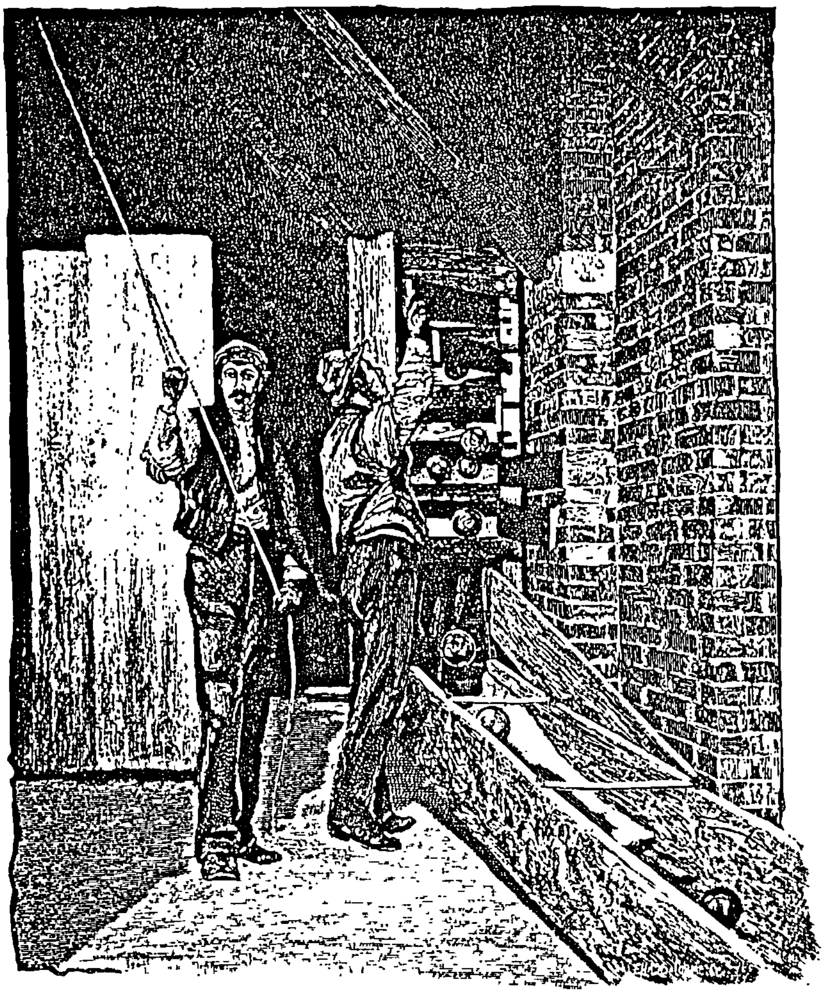
31. Buckle, op.cit., p.35.



Illus.48 The "Rabbit-Hutch" thunder machine. Kobbe, Scribner's Magazine, op.cit., p.452.

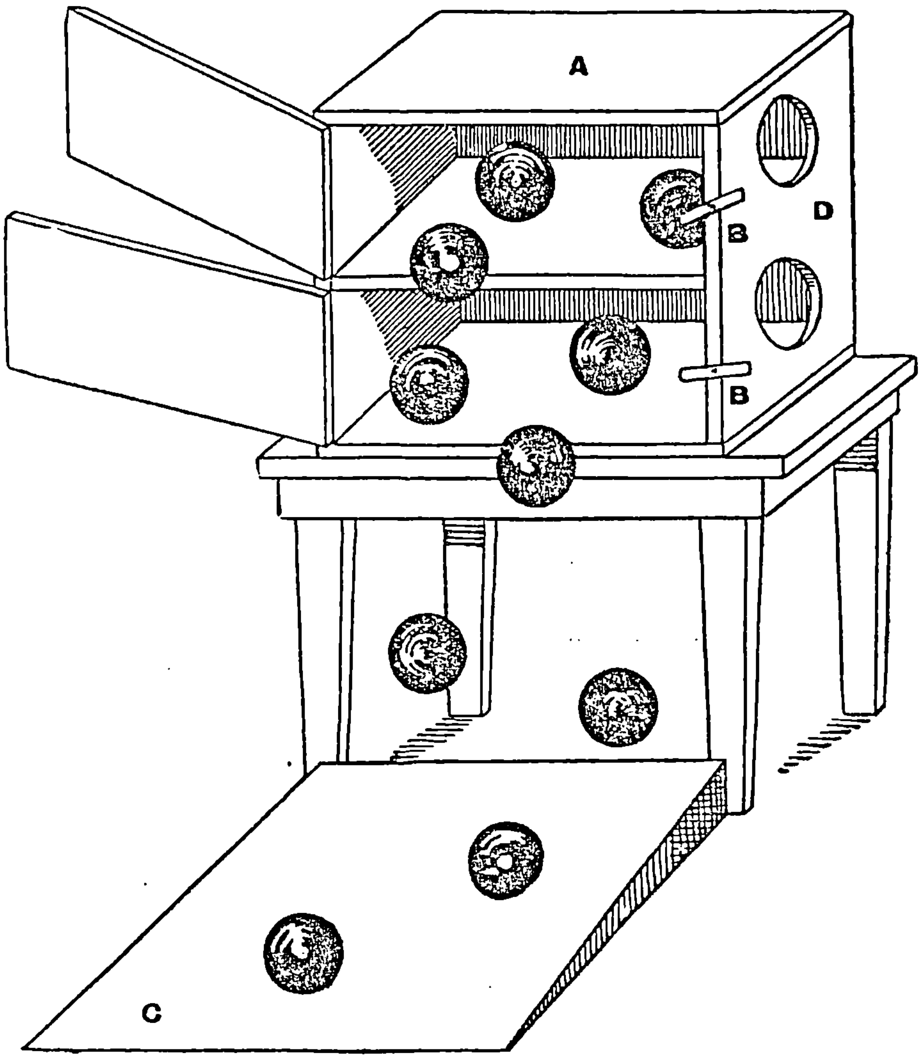
Thunder Machines.

The desire to create an auditory as well as a visual illusion in the Victorian theatre produced various machines, the design and construction of which were usually the stage carpenter's responsibility. Probably the most demanding was that of the thunder machine. Although this sound was quite often simulated by a metal 'thunder-sheet' the more effective and certainly more spectacular method was the use of a 'thunderun'.

The oldest surviving example of this device in Great Britain is to be found at the Theatre Royal, Bristol, dating from perhaps as early as 1800 when the auditorium was constructed. It is installed above the auditorium within the main roof trusses, a natural location directly above the heads of the audience, and consists of two wooden troughs positioned one above the other in opposing inclined planes [see photo.14]. The mode of operation was to place a variable number of metal cannon-balls at the top of the upper trough restrained by small wooden partitions which formed compartments within the trough. This allowed the balls to be released in varying numbers at varying intervals. As the balls reached the lower end of the first trough they cascaded into the second producing an extra hard crash before trundling down to the bottom. Writing in 1943, Richard Southern noted that above the head of the top trough was a board of pulleys where lines could open the wooden partitions as required. By June 1969, however, when the accompanying photograph was taken, these had apparently been removed.

A rather more sophisticated cannon-ball release mechanism was pictured and described in an American journal, Scribner's Magazine' in 1888 [see Illus.48]. This so-called 'rabbit-hutch' was constructed in the following manner:

> "With one side against the wall of the third fly gallery, prompt side, stands a cabinet with six slanting shelves closed by doors which open sideways towards the wall. On each of these shelves are half a dozen cannon-balls prevented from rolling out only by the closed doors. From under the cabinet runs a broad zinc-lined trough which, at a distance of eighteen feet from the cabinet, is led



Illus.49 A "Rabbit-hutch" style thunderun. Rose, op.cit., p.7.

> distance of eighteen feet from the cabinet, is led through the flooring and then in two long slants to the floor below. At short intervals in the trough are little inequalities of surface. A rope places one of the two men who work the apparatus in communication with the stage. Suppose there are to be two long, loud rolls of thunder. The stage manager pulls the rope, the man at its end on the second fly-gallery gives the word to the man at the cabinet. He throws open the doors of the lower three shelves. Eighteen cannon-balls roll thundering down the trough and through the floor to the end of the trough on the floor below. When the second signal is given the balls in the upper three shelves are freed with the same effect. If only one or two balls are used, the sound resembles the rumbling of distant thunder while a short, terrific peal can be produced by freeing the thirty-six balls simultaneously and checking them before they pass through the floor." [32]

The method of cueing described here is worth noting and comparing with that depicted in the illustration of the understage of the Princess's Theatre, London, in 1874 [see Illus.65].

The 'rabbit-hutch' method shown in illustration 48 is also recalled by A. Rose in his Stage Effects (1928) [see Illus.49] which gives practical details of many theatrical techniques of the previous century. His account reads:

> "A is the hutch made up as a stout wooden box with one or more compartments in it and doors to open outwards, each door being kept in its place by the aid of a couple of hinges. Several cannon-balls, made of wood or iron, are placed in each compartment, the doors being then closed and securely fastened by a simple button at B. The floor of each compartment is slightly raised at the back so as to form an incline, which induces the cannon-balls to escape from the hutch and fall with a thud on to the inclined platform C, then rumbling off and along the stage, where they are gathered up and

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32. Gustav Kobbé, "Behind the Scenes of an Opera-House", Scribner's Magazine, IV, (1888), No.45, p.454.

> returned to the hutch through the opening at the side D, the doors having previously been closed." [33]

The lack of a guiding trough in this method gives one some cause for concern and with this in mind it is worth considering the history of the thunderun at the Tyne Theatre, Newcastle-upon-Tyne. It was installed in 1882 and consisted of a single inclined trough extending between the stage left fly-galleries. The cannon-balls were loaded through the floor of the upper gallery, and were restrained by a wooden pole which ran across the top of the trough. When the pole was removed the cannon-balls ran down the trough, which contained various obstacles to increase and irregularise the noise, finally coming to rest at floor level on the lower gallery.

In April 1887 the Carl Rosa Opera Company visited the theatre and on Thursday the 7th the scheduled performance of Il Trovatore had to be cancelled owing to the indisposition of Marie Roze. This was replaced by an additional performance of Nordisa by Frederick Corder, with disastrous results, as The Newcastle Courant reported:

> "Last night, about nine o'clock, a serious accident occurred to a man named Robert Courtnedge, 30 years of age, millwright at the Tyne Theatre, Newcastle. It appears that whilst the avalanche scene was being carried out ... a cannon-ball, a 36 pounder, was rolled along a surface to cause the effect of stage thunder. After the ball had rolled along the required distance it dropped into a box which was placed to receive it, but instead of remaining, it fell out, by some means as yet unknown, on to a rostrum, and from there it dropped a distance of about twelve feet on to Courtnedge's head, fracturing his skull. Dr. l'Anson was at once called in, and on his advice the unfortunate man was removed to the Infirmary in a cab. There the medical gentleman pronounced the injury to be of shocking nature. On making enquiries late we were informed that the injured man's condition was very dangerous." [34]

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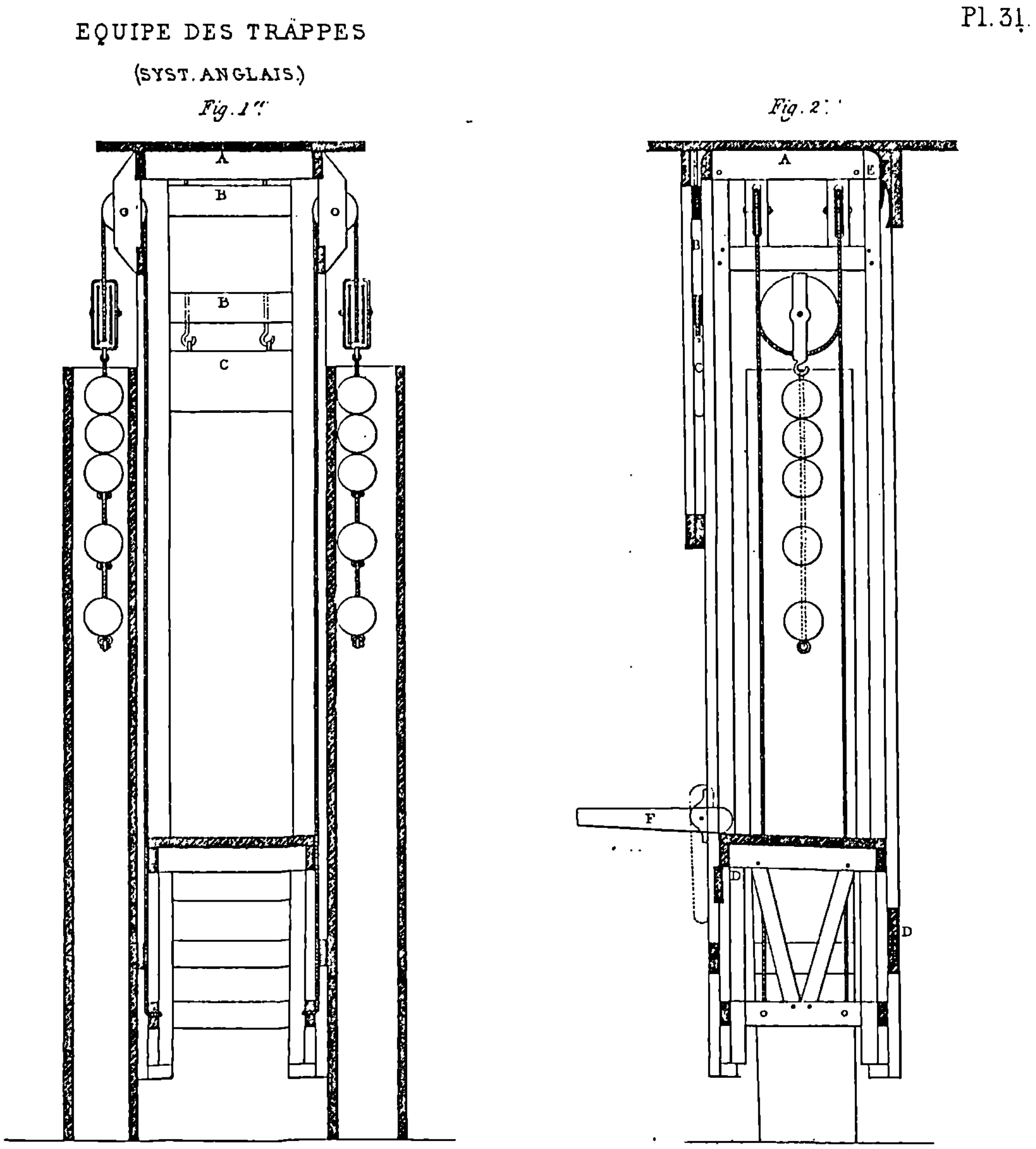
33. A. Rose, Stage Effects, (London: George Routledge and Sons Ltd., 1928), pp.7-8.
34. Anon., "Dreadful Accident at the Tyne Theatre", The Newcastle Courant, 8th April, (1887), p.5.



Illus.66 Sections of an 'ordinary' trap. Contant, op.cit., pl.31. figs.1, 2.

Courtnedge subsequently died from his injuries and at the inquest a witness to the accident said that the 'shoots' had been installed 5 years previously and had been used regularly, especially at all the pantos; the jury, however, decided it was unsafe!

When I first examined the thunderun in 1979 it was heavily encased with metal hoops, with an apparently excessive hinged metal flap complete with hasp and staple for added security [see photo.15]. It may well be that this metalwork was added after the fatality to provide added safety.

A photograph of the fly gallery at the Theatre Royal, New Street, Birmingham [see photo.16], shows a double inclined thunderun, with a cannon-ball balanced precariously on the edge of the fly gallery almost in readiness for a repeat performance of the Nordisa incident. It is interesting to note that these cannon-balls appear to have a hole in the centre, presumably to allow them to be used as counterweights as shown by Contant in one of his corner trap examples [see Illus.66]. Although this piece of equipment disappeared when the theatre was demolished in 1956 a similar example survives at Her Majesty's Theatre, London, presumably dating from its opening in 1897. It is positioned against the stage left wall, above the fly gallery. Photograph 17 was reproduced in Tabs in Autumn 1974 accompanied by the following comment:

> "Loudspeakers and tape can be splendid technical theatre tools but are there not some productions when the style might be better served by a cannon ball in a thunder run or the scraped canvas of a wind machine? Is there perhaps a danger that a desire to reproduce an identical sound (or light) effect from one performance to the next might take the life out of live theatre?." [35]

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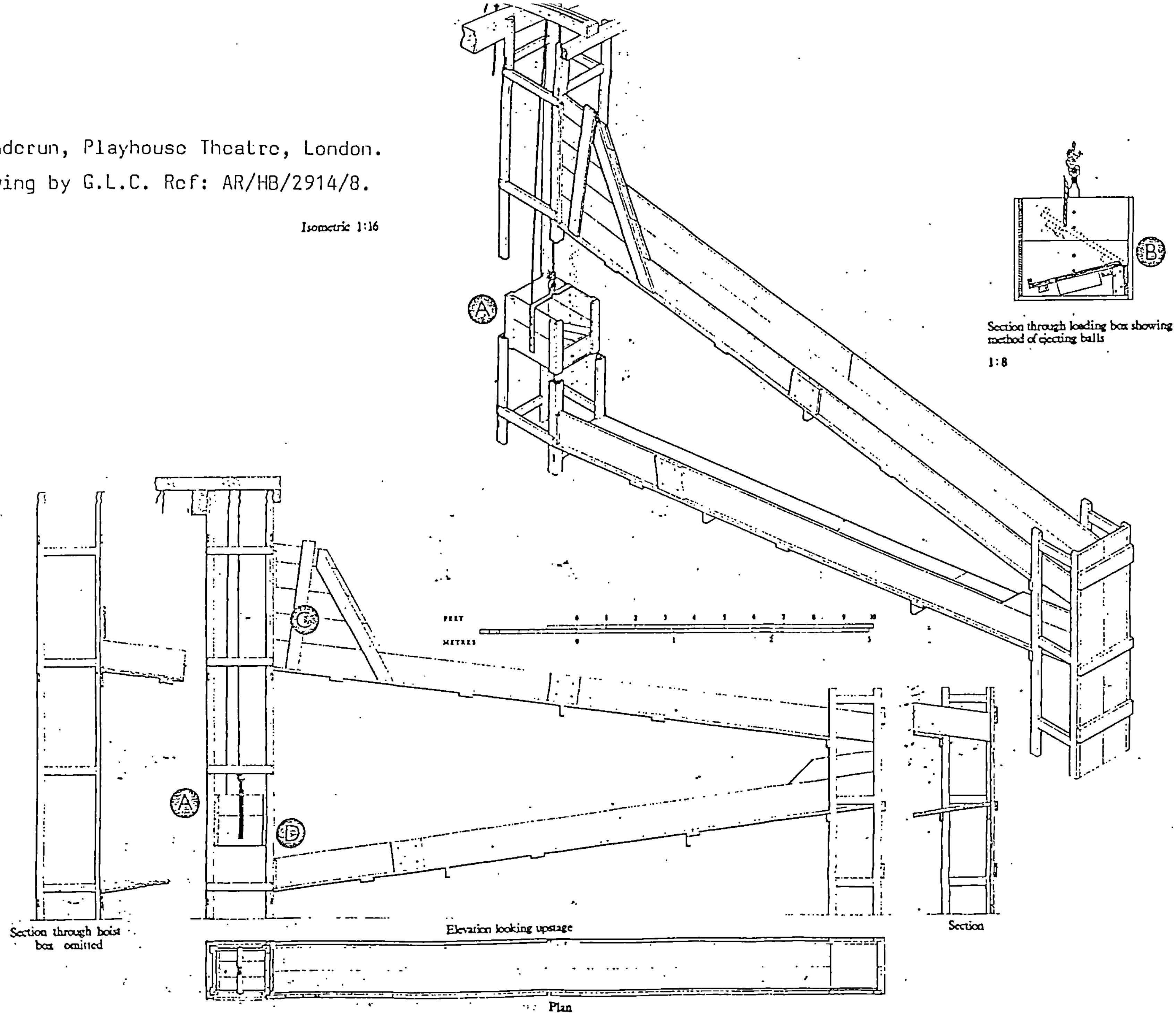
35. Anon., Tabs, XXXII, No.2, (1974), p.23.

Illus.50 Thunderun, Playhouse Theatre, London.
Drawing by G.L.C. Ref: AR/HB/2914/8.



Certainly this type of sound effect machine can be put to great use should the situation demand it. In 1985 E.M.I. International commissioned me to restore for sound recording purposes the thunderun still in situ at the Playhouse Theatre, Charing Cross, London, to enable them to use the effect for a recording of Handel's Alcina. As shown in the accompanying G.L.C. measured drawing [Illus.50], it consists of a double inclined trough positioned quite unusually beneath the stage against the basement back wall. It is operated by loading the requisite number of cannon-balls into the box lift 'A', and hoisting the box from cellar to mezzanine level. At the given moment a rope which is attached to a hinged flap 'B' in the bottom of the box is pulled, causing the cannon-balls to cascade into the trough at 'C'. As they roll down the gradient producing the desired effect the box lift is hurriedly lowered to the cellar to act as a receptacle for the rapidly approaching cannon-balls at 'D'.

In 1904 Harley Vincent, writing for the The Strand Magazine, considered how 'stage sounds' were produced, telling his readers that:

> "For thunder there are four arrangements; the primitive one is the 'thunder-plate', a very long and slender plate which hangs loose on a string and is set working at the lower extremity. The rattling noise which immediately follows a flash of lightning is thus fairly well produced. For rolling, distant thunder there is a gigantic kettle-drum covered with an ass's skin, and worked with two vigorous beaters. In the older theatres a 'thunder-carriage' is still met with; that is, a cart loaded with stones, and drawn this way and that over the floor. The 'thunder-clap', however, is the chef d'oeuvre. This is produced by a rectangular wooden pit reaching from the 'loft-of-the-stage-for-scenic machinery' to the podium.
>
> The inner sides are provided with irregularly constructed cross-laths, over which stones thrown down from above clatter." [36]

Clearly there were and are many ways to simulate the sound of thunder in

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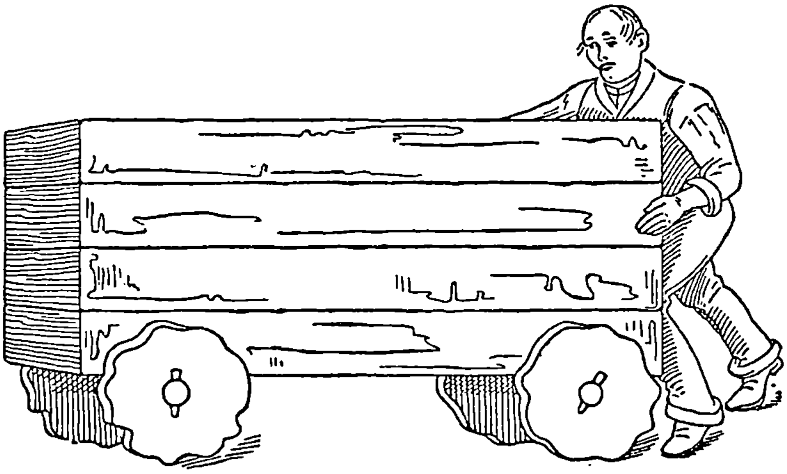
36. Harley Vincent, "Stage Sounds", The Strand Magazine, XXVIII, No.53, (1904), p.421.



Illus.51 A thunder cart. Rose, op.cit., p.6.

the theatre and once again we may usefully consult A.Rose for information about the operation of the "thunder cart", shown in illustration 51.

> "The men controlling it can just move the cart about behind the scenes. It will be undertstood that the thunder cart is a most effective piece of apparatus. The secret lies in the eccentric cam-shaped wheels ." [37]

While I have not personally come across an example of this kind in Britain, I did discover a similar device positioned on the fly floor of the Marie Antoinette Theatre at Versailles [see photo.18]. This consisted of a board with two eccentric wheels mounted at one end with a hand hole cut in the other. The suspended floor of the gallery provided an excellent sounding board, producing an extremely loud and authentic reverberation.

Before bringing this section to a close it is worthwhile recalling Walter Dando's attempts to mechanise the thunderun [see page 188]. However, the days of the thunder machine were numbered, as were all other stage devices, for the simulation of sound. As early as 1904 The Strand Magazine commented that:

> "The latest recruit to stage mechanics is the phonograph, which has recently been introduced in Berlin .... The innovation is likely to spread." [38]

As we now know, this prophecy was well founded, but it is interesting to note that an inventory [39] of the Theatre Royal, Newcastle-upon-Tyne, dated as late as March 8th 1935, lists "1 built Thunder box with 26 large and 26 small balls, sheet iron lining with 3 discharges," possibly another description for the 'bee-hive' mechanism discussed above and very probably at that time still in working order.

FLYING MACHINES.

Since time immemorial man has always been fascinated by flight and his personal inability to overcome the forces of gravity. It is therefore not surprising to learn that attempts to produce the illusion of flight in the

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37. A.Rose, op.cit., p.6.
38. Harley Vincent, op.cit., p.422.
39. Inventory of the Fixtures and fittings at the Theatre Royal Newcastle upon Tyne, Tyne and Wear Archives, 8th March, (1935), Ref.155/10/18.

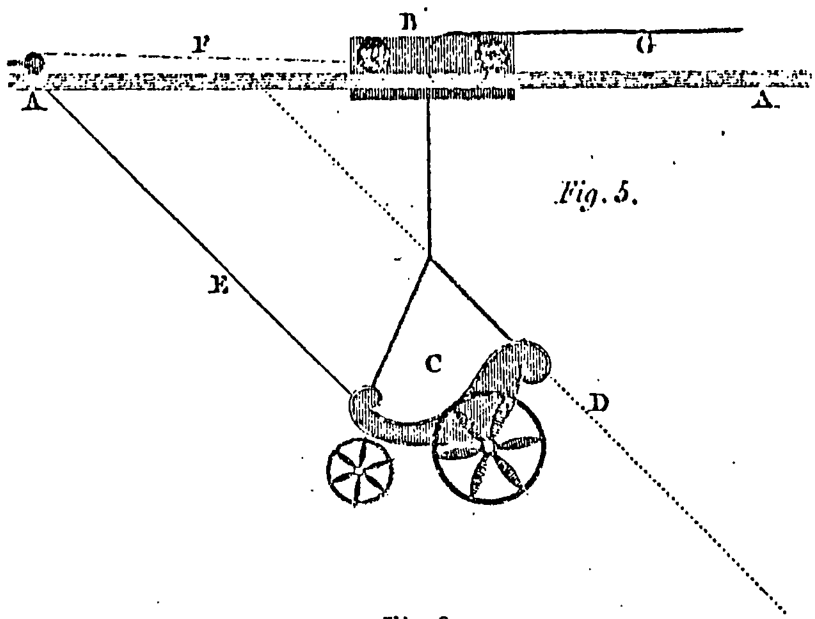

Fig. 8.

Illus.52 Machine to produce oblique ascent or descent. A.Rees, op.cit., pl.XI, n.pag.

theatre have been made for hundreds of years. This thesis deals specifically with the nineteenth century, and it is therefore useful to consult Rees's Cyclopaedia [c.1809] as a useful starting point in this section. The writer reproduces a small engraving [see Illus.52] of a carriage suspended by various ropes which enable its ascent, descent and traverse to be controlled by the stagehand. He describes it thus:

> "Fig.5 is a plan of a machine to produce the oblique ascent or descent of a car, horse, or any other body, above the stage. Upon a cross bar of wood A, A, passing between the platforms, and sufficiently high to be concealed from the spectators, is a box or frame moving upon rollers." [40]

The use of the word platform is interesting for the writer is undoubtedly conversant with theatrical techniques and yet does not use the phrase "fly gallery". However, although the large theatres in London did have such galleries at this time, they were certainly not common in the provinces: any ropes were usually controlled from the stage, for fly galleries and flying had not entered regular usage at the beginning of the nineteenth century. The text continues;

> "A cord F, attached to this frame, is wound upon a barrel upon the platform. Another cord G, attached to any fixture upon the opposite side, and passing over a pulley in the Box B, suspends the car C. When the cord F is wound upon the barrel, the car will ascend in the direction of the dotted line O, and when unwound will descend in the same line by its own gravity. The cord E will keep the car or other body steady. This is merely another application of the principles investigated under the article DIAGONAL motion, and were the descent required to imitate the parabolic curve of a projectile it might be effected by constructing the barrel like the spiral of a watch, the diameters for the convolutions of the cord F being accurately calculated, and another barrel constructed to regulate the descent of the suspending cord G." [41]

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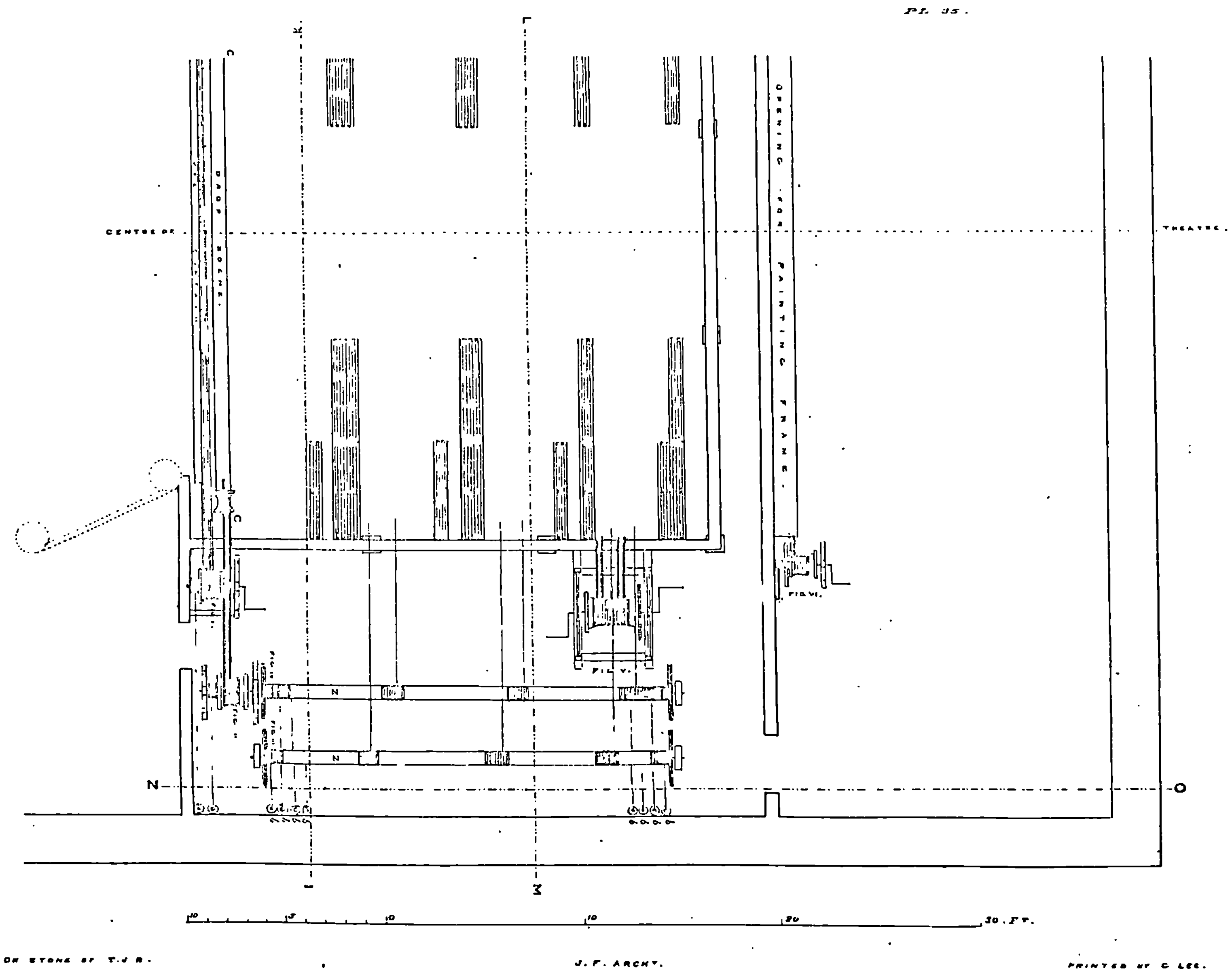
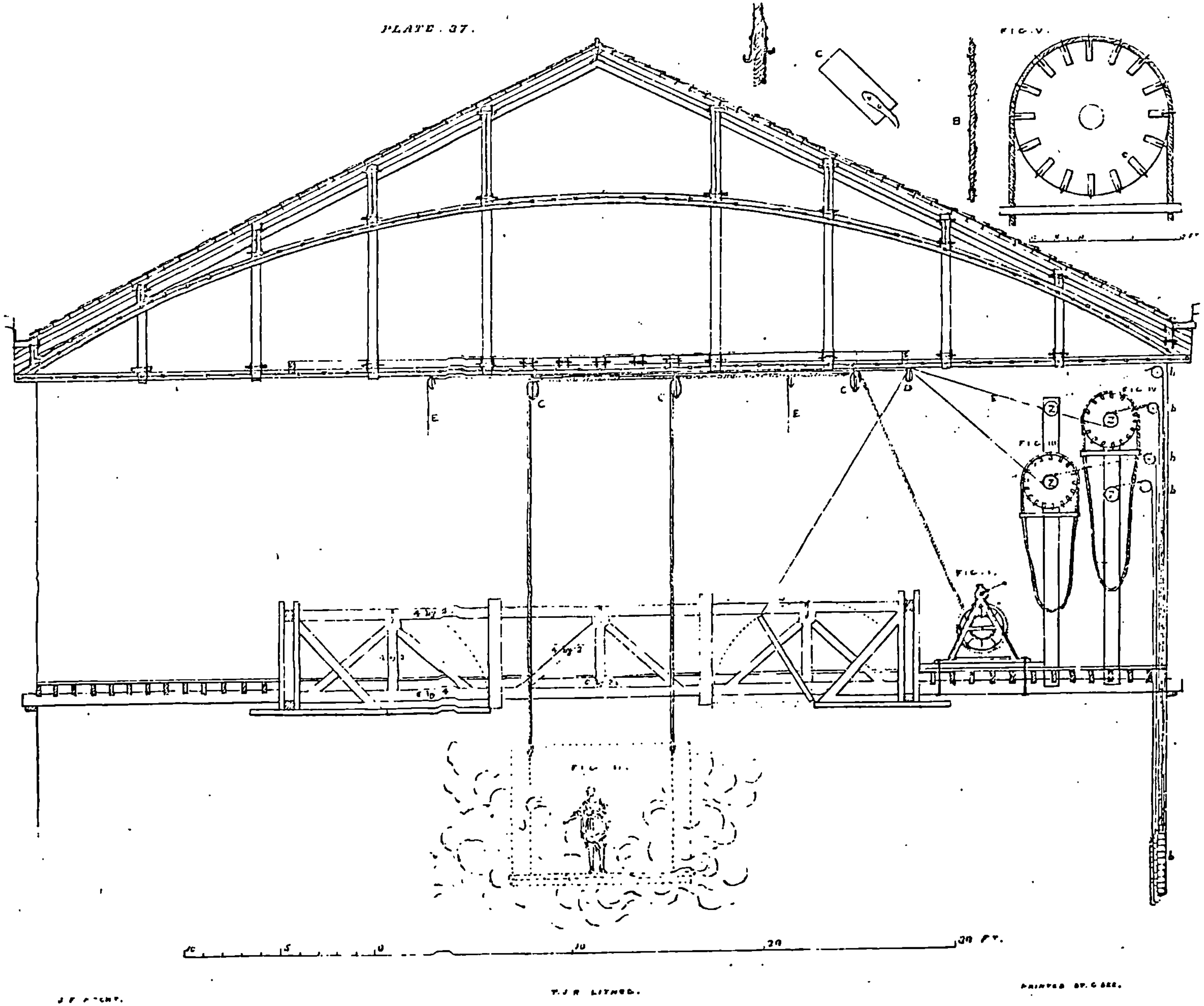
40. Abraham Rees, op.cit., XII, n.pag.
41. Ibid.



Illus.53 Plan of machinery for ascents and descents. Theatre Royal, Plymouth. Foulston, op.cit., pl.35.



Illus.54 Transverse section of Flies, showing flying machine. Theatre Royal, Plymouth. Foulston op.cit., pl.37.

This passage is particularly interesting because it introduces the use of the graded drum and shows that this method of flying was really rather precise as opposed to a hit and miss affair.

> "The cords are very slender and painted black, to elude the eye of the spectator. The lights also are strong in front, and dim behind, to assist the optical deception. To give the cords sufficient strength without increasing their diameter, they are spun of the best hemp, mixed with brass wire well annealed. Those used at Covent Garden for the flying horses in the Pantomime Spectacle of Valentine and Orson, whose flight was effected by an apparatus similar to that in the figure, although less in diameter than a common quill, were said to possess sufficient strength to suspend a ton weight." [42]

This method could also have been used in the small provincial theatres where there were no 'platforms' or true flying space. The track or 'cross-bar' could be suspended with the borders and the object or person made to traverse the stage from one side to the other.

However the introduction of fly galleries, coupled with the increase in the height of fly towers, enabled the stage machinist to redouble the complexity of 'flying machines'. The Theatre Royal, Plymouth, built in 1811 [see page 38] had just such a machine. Three plates from <u>The Public Buildings erected in the West of England as designed by John Foulston, F.R.I.B.A.</u> provide a few details concerning its construction,[see Illus.53-55], and are annotated as follows:

<u>Plate 35</u> - Plan of Machinery on the Flys and Painting Room Floors.

Fig.5 - For the ascents and descents from and to the Stage.

<u>Plate 37</u> - Transverse Section of Flys, taken at L, M, Plate 35, looking towards the Painting Room.

Fig.1 - Machine for performing the ascents and descents from and to the Stage.

Fig.2 - Shews [sic.] the operation; c, c, c, Ropes and Pullies, [sic.] by which the Frame is suspended, there being two front and two at the back.

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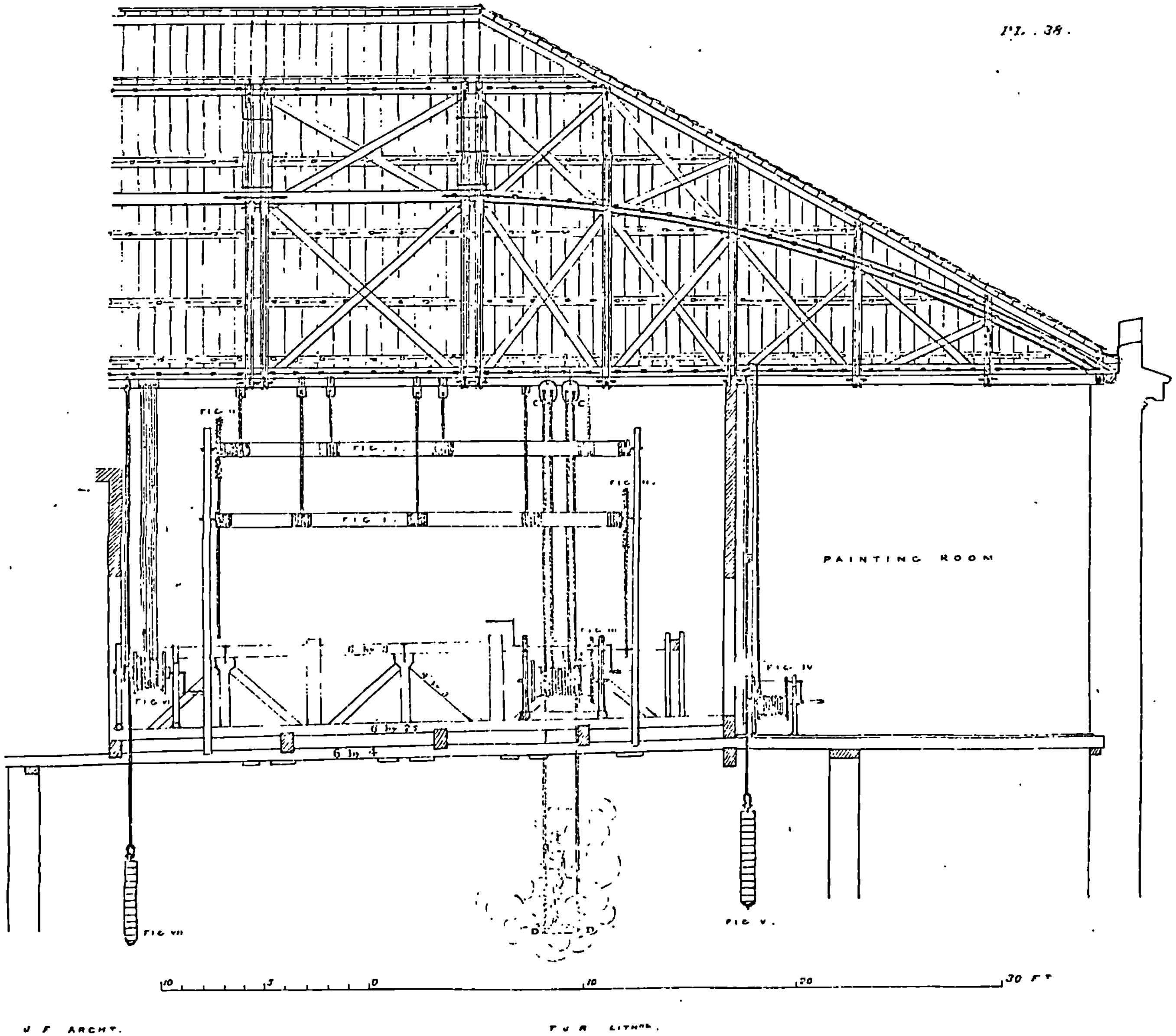
42. Ibid.



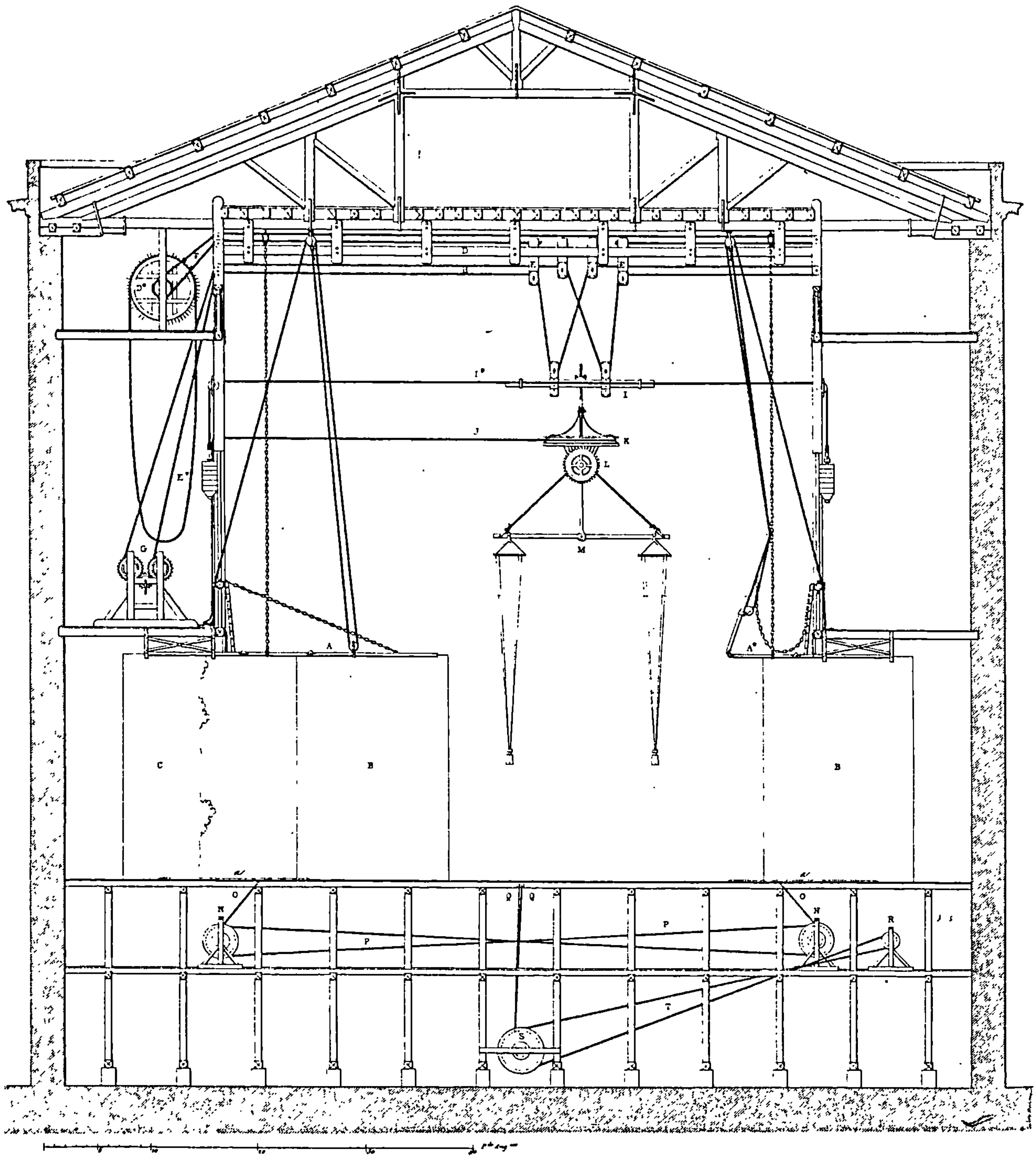
<u>Illus.55</u> Longitudinal section of Flies showing flying machine. Theatre Royal, Plymouth. Foulston, op.cit., pl.38.

Plate 38 - Longitudinal section of Flys, from N to O, on Plate 35.
Fig.3 - Windlass, &c.&c., for lowering or raising objects from the stage.

From the scale given with the plates the platform would appear to measure approximately 9 feet 6 inches by 2 feet, providing at most enough space for three people. The platform is annotated in the plate with the engravers impression of scenic clouds, which were used to mask the realities of the framework. The four suspension ropes pass up to the pulleys C, C, and across to a cast iron geared windlass positioned on the stage left fly gallery. It would appear that no provision was made for the platform to traverse across the stage as with the earlier example quoted from Rees.
It may therefore be considered as rather limited in its usage, and though chronologically later it predates Rees in evolutionary terms.

The next extensive piece of evidence relating to flying machines comes from Contant's treatise Parallèle des Principaux Théatres Modernes de L'Europe of 1860. His plate 27 shows a section of a stage which incorporates a flying machine, accompanied by the following text:

Plate 27, [Illus.56].
Cross/transverse section, apparatus of a revolving flight.
D. Paths of cross-flights etc.
D*. Drum [cog wheel] with iron pins between which passes the endless rope.
E. Mobile float [to carry characters].
E*. Endless rope of the drum.
F. Calling wire of the float round the small diameter of the drum.
G. Cog-wheel winch, and crank handle with double-geared cylinders used to raise or lower the flying apparatus at will.
H. Winch-lines of the float.
I. Horizontal crosspiece or carrier of a new system of revolving flights.
I*. "Retraite" rope held at the ends by counterweights after having been passed through turned eyelets fixed onto the cross-piece, in order to stop the float swinging during the turning of the wheel which is suspended from it. [For details, see his Plate 36, Fig.12 and 13 of this system].
J. Endless line of horizontal wheel.
K. Wooden wheel, with a horizontal groove, under which is fixed a gear-wheel.



Illus.56 Cross-section and apparatus of a revolving flight. Contant, op.cit., pl.27.

L. Small drum for the lines of the carrier with iron wheels with the wheel above and transmitting to the flight a tilting or see-saw movement.

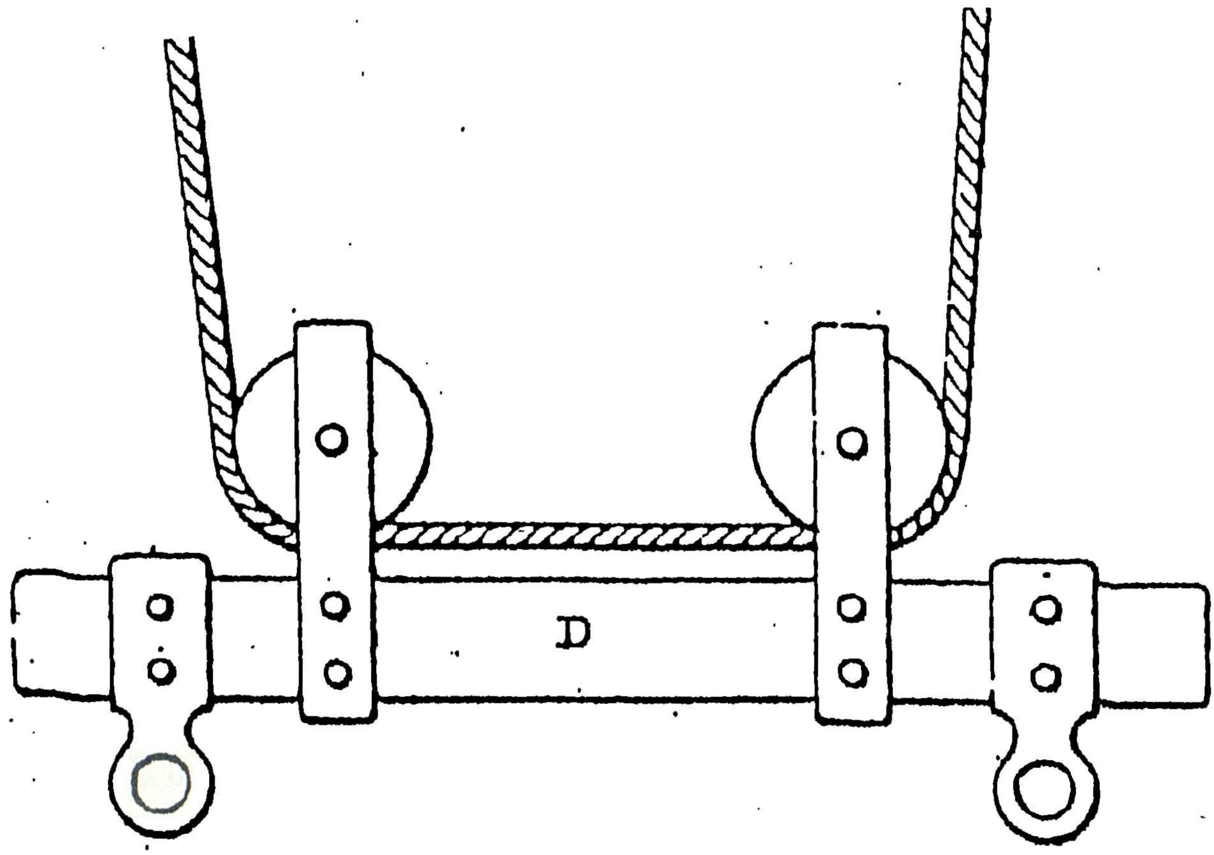
M. Iron frame to which are attached the iron or brass wires.

This example represents unquestionably the most complex 'flying machine' instanced in any authoritative text devoted to the English system. Although Contant does not provide any precise explanatory text relating to the machinery his annotated key provides adequate information to attempt a reconstruction of its working.

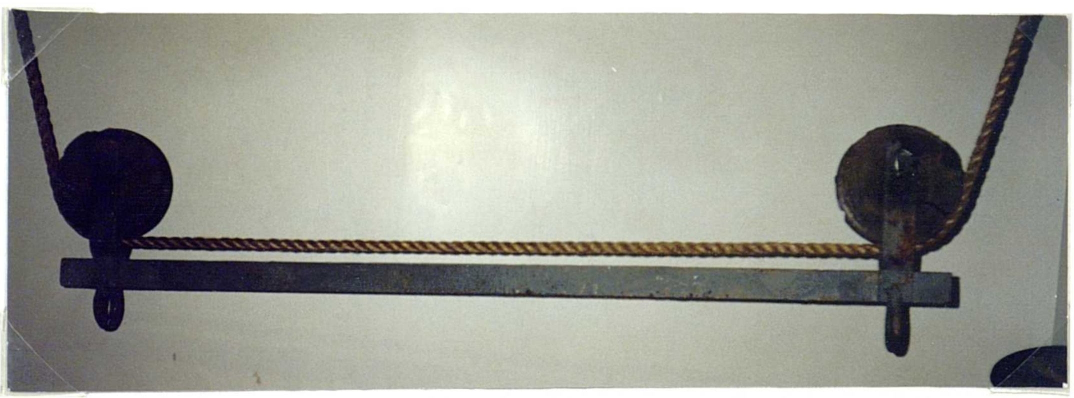
The position of the '~~flat~~ float', E, was determined by a rope, F, attached to the shaft of the spiked drum and shaft mechanism, D*, shown on the top left hand side of his plate 27. This was controlled from the lower fly gallery by an endless line, E*. A double-barrelled geared winch on the same gallery operated the ropes, H, which were threaded through the pulleys of the 'float' interlinking with the horizontal cross-piece for the revolving flights mechanism. The "retraite" rope, I*, passes through eyelets on the horizontal cross-piece and is kept taut by counterweights suspended from either end above the lower fly galleries. This is designed to limit any swinging of the float when the revolving piece of the apparatus is in motion. J is another endless line controlling the horizontal wooden grooved wheel, K, with a smaller geared wheel attached to its underside. This wheel intermeshes with gear wheel L which provides a tilting motion to the suspension bar, M.

The co-ordinated operation of this mechanism could not have been a simple matter and must have required at least three stage-hands; one for the drum controlling the position of the float, one to control the geared winch G, and one for the endless line of the revolving mechanism. All three were located on the same fly gallery, which meant that they could at least be in close contact during any sequence of movements.

Although this equipment appears to work in theory, there is no evidence to suggest that an exact replica was ever installed in a theatre, a problem associated with almost all Contant's information. However, bearing in mind the date when the second edition of this treatise was published, 1860, it is interesting to examine the flying machine installed at the Tyne



Illus.57 Flying-machine carrier. Contant, op.cit., pl.39.



Illus.57 Flying-machine carrier. Contant, op.cit., pl.39. Carrier discovered below P.S. scene dock floor. Tyne Theatre and Opera House, Newcastle-upon-Tyne.

Theatre, Newcastle-upon-Tyne. The theatre was built in 1867, and the machinery installed by William Day, an experienced stage machinist from Liverpool. It is not inconceivable that he was aware of the French publication, but, that aside, the flying machine has several similarities with Contant's drawings. If, however,one wishes to suggest some sort of influence upon the design it is first of all necessary to establish that the flying machine at the Tyne Theatre does in fact date from 1867. It is suspended under the first grid roof truss, some 10 feet upstage from the proscenium opening, the track in which the float runs stretching almost the entire length of the truss. There are four pulley wheels attached to the float, [see photo.19] and the metal housings which contain the wheels are stamped with the name "ABBOT". When the theatre was first built a firm from Gateshead known as John Abbot and Sons Ltd. provided the metalwork (the gasolier was raised and lowered by a cast iron winch bearing their name). It would therefore seem reasonable to suppose that the flying mechanism dates from the original building of the theatre.

If, then, it is likely to be contemporary with Contant's publication, its method of operation becomes worthy of consideration. An endless rope was attached to the float, for traversing, and operated from the upper stage left fly-gallery, and another line threaded through the four lignum vitae pulley wheels in exactly the same manner as shown in Contant and controlled from a timber winch on the same fly gallery. Until recently that was all that remained of the mechanism, but a metal horizontal crosspiece with two large lignum vitae pulleys mounted on brass bushes was discovered beneath an old floor which was once a scene dock. It is almost identical to a 'carrier' shown by Contant in one of the flying machine variants he illustrates [see facing page for comparison]. These variations were designed to perform different functions, including the flights of children and small women, as well as "devils, winged dragons and birds", as shown below.

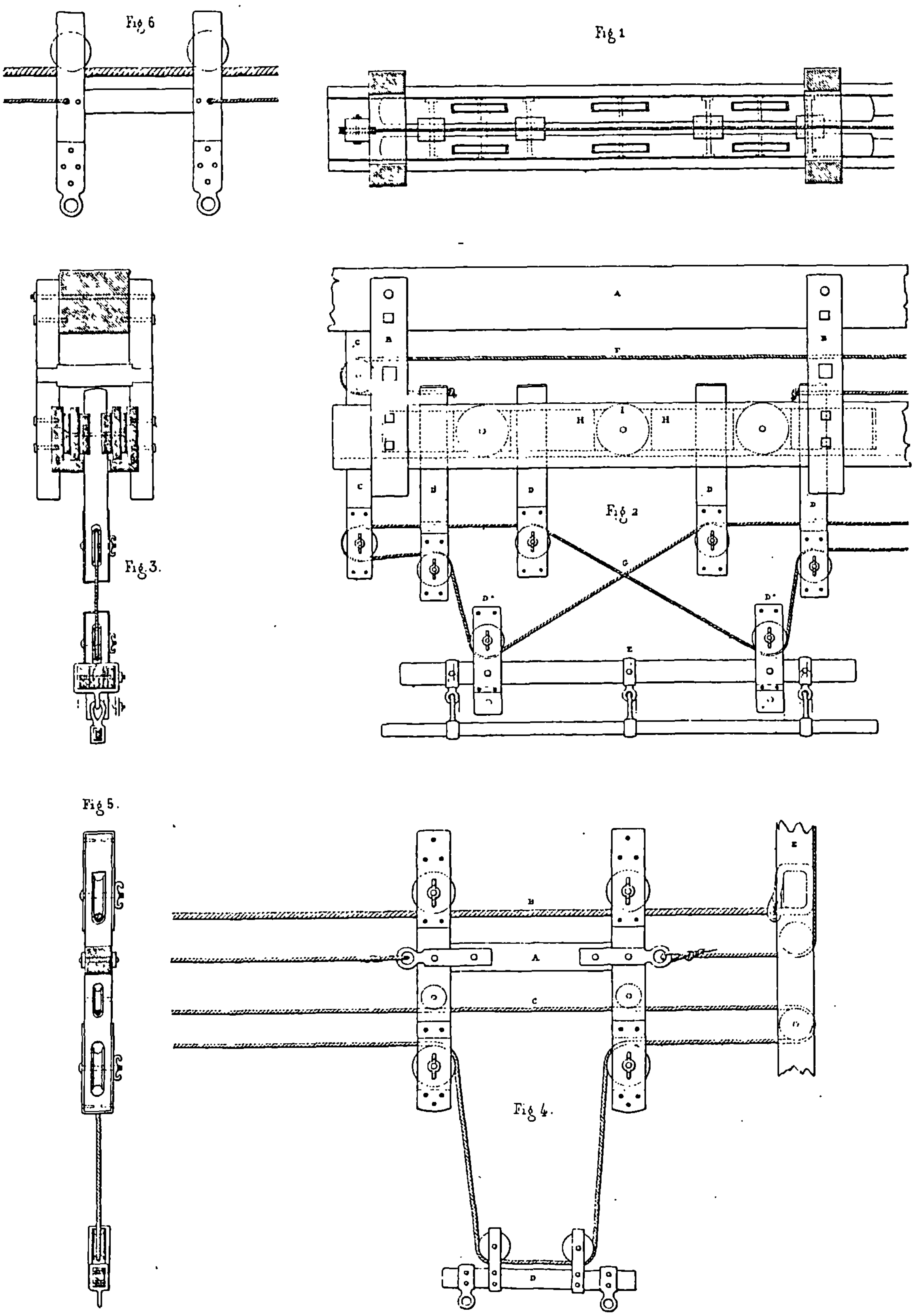
<u>PLATE 39 [Illus.58].</u>

Apparatus for the flights.

Fig.1 Plan of the route of the float, used to lift away one or more persons.

Fig.2 Elevation of the float's route, and of the iron lines-carrier, viz:

A. Tie-beam of the grid floor.



Illus.58 Apparatus for flights, Contant, op.cit., pl.39.

B. Braces or hanging brackets bolted onto the tie-beams.

C. Stopping pole of the carrier.

D. Pole of the float, complete with returning pulleys.

D*. Returning pulleys from the carrier to that of the float.

E. Carrier of the iron line.

F. Manouevring line of the float.

G. Calling line of the float and carrier.

H. Dotted line showing the float itself.

I. Runners moving along the slide which in turn is fixed onto the hanging brackets of the horizontal channel.

Fig.3 General cross-section of the apparatus for cross-flights.

Fig.4 "Brigandins" [?], a carrier sliding in a recess which stretches between the two fly-galleries of the fly-space, for a cross-flight carried out by a child or a woman of small frame.

A. "Brigandin" carrier complete with its calling lines.

B. Channel used as a route for the said carrier.

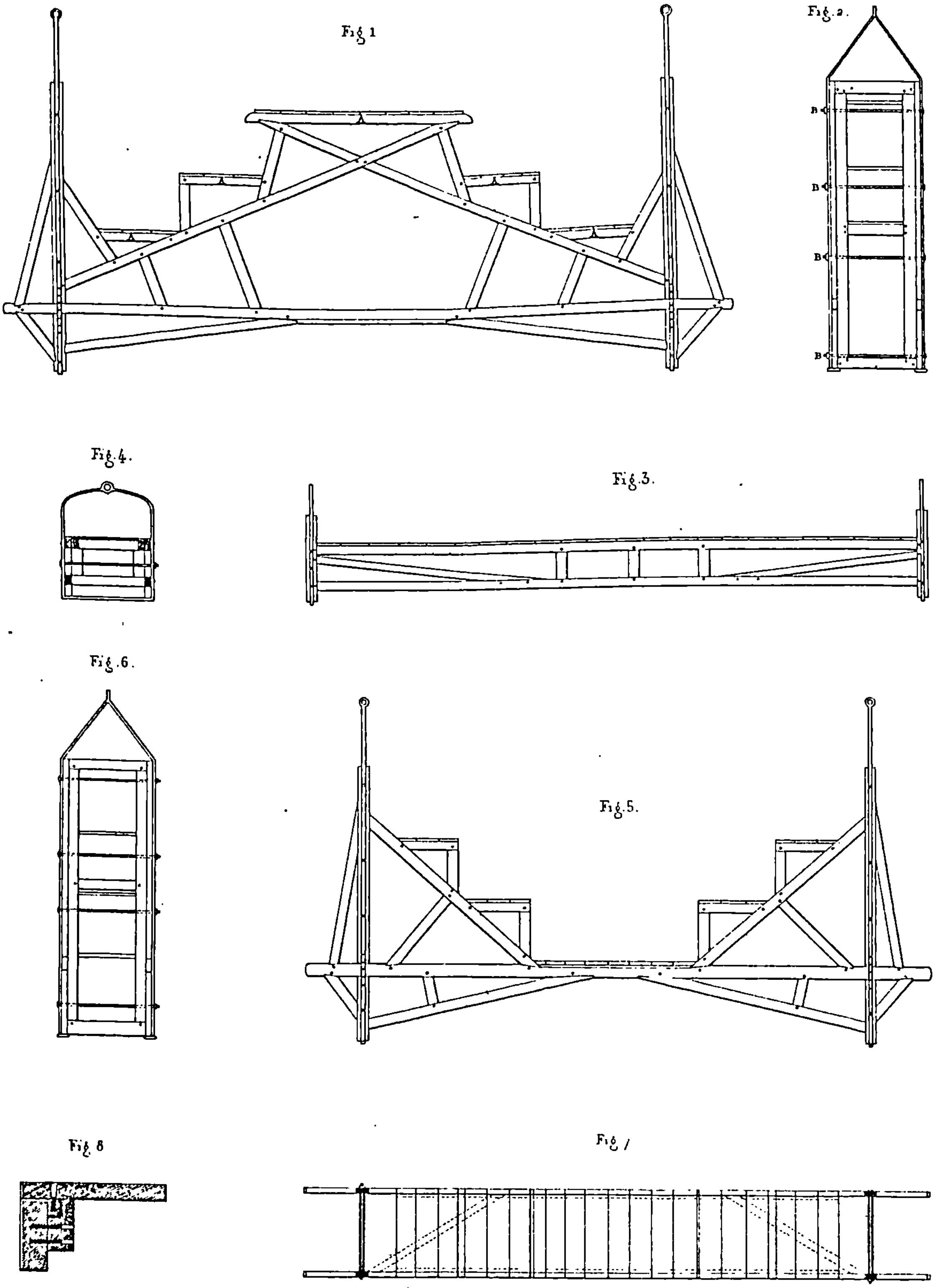
C. Working line.

D. Carriers of the iron lines.

Fig.5 General cross-section of the apparatus of the carrier ("brigandins").

Fig.6 Carrier which is used regularly to enable the crossing of the stage by dummies (devils, winged dragons, birds etc).

The whole of the section on the English system within Contant's treatise does not appear to relate to any particular theatre which he had visited. Yet the inclusion of so many variations of the basic flying machine tends to suggest that he was reproducing specific examples rather than designing a large amount of machinery broadly based upon the techniques of the English stage machinist. The flying machines within the English theatres of the nineteenth century were probably not used on a regular basis, perhaps two or three times a year for the pantomine and speciality acts, and it was not until later in the century that several people began to specialise in this kind of equipment, often patenting it. Notable patentees included George Conquest, George Kirby and Augustus Scudamore. Indeed, the derivative company of George Kirby, "Kirby's Flying Ballet" still survives to this very day and specialises in providing flying equipment for productions such as Peter Pan. Yet flying individual people was only part of the nineteenth century tradition. Quite often tableaux and transformation scenes included an apotheosis or glory which could



Illus.59 Details of 'glories', Contant, op.cit., pl.38.

involve the lowering of fifteen or more girls upon a large platform from the flies. This type of flying is reminiscent of the flying machine at the Theatre Royal, Plymouth, (1811), discussed earlier. In many ways a platform bearing actors stretching the full width of the proscenium opening is very much akin to the substage bridge. It is not impossible to imagine a scene where the floor sections of a bridge were opened and an independent 'glory' platform lowered through the aperture into the substage. Actors could then be positioned for a grand transformation scene where they rose up out of the floor and continued up, finally disappearing into the flies.

Once again Contant is the main source of information concerning 'glories', showing the construction of these flat and tiered platforms which were raised and lowered within the precincts of the flies. His plate 38 shown opposite is accompanied by the following text:

Plate 38, [Illus.59].
'Glories'

Fig.1 Large floor-piece of a glory, with platform and tiers on each side, in order to group, for example, the Gods of Olympus, etc.

A. Construction framework supporting the floors of the podia.

Fig.2 Side view and suspension framework of the said 'glory' platform.

B. Nuts and bolts, to maintain a distance between the joists of the framework.

Fig.3 & 4 Cross-section and elevation of an ordinary 'glory' floor.

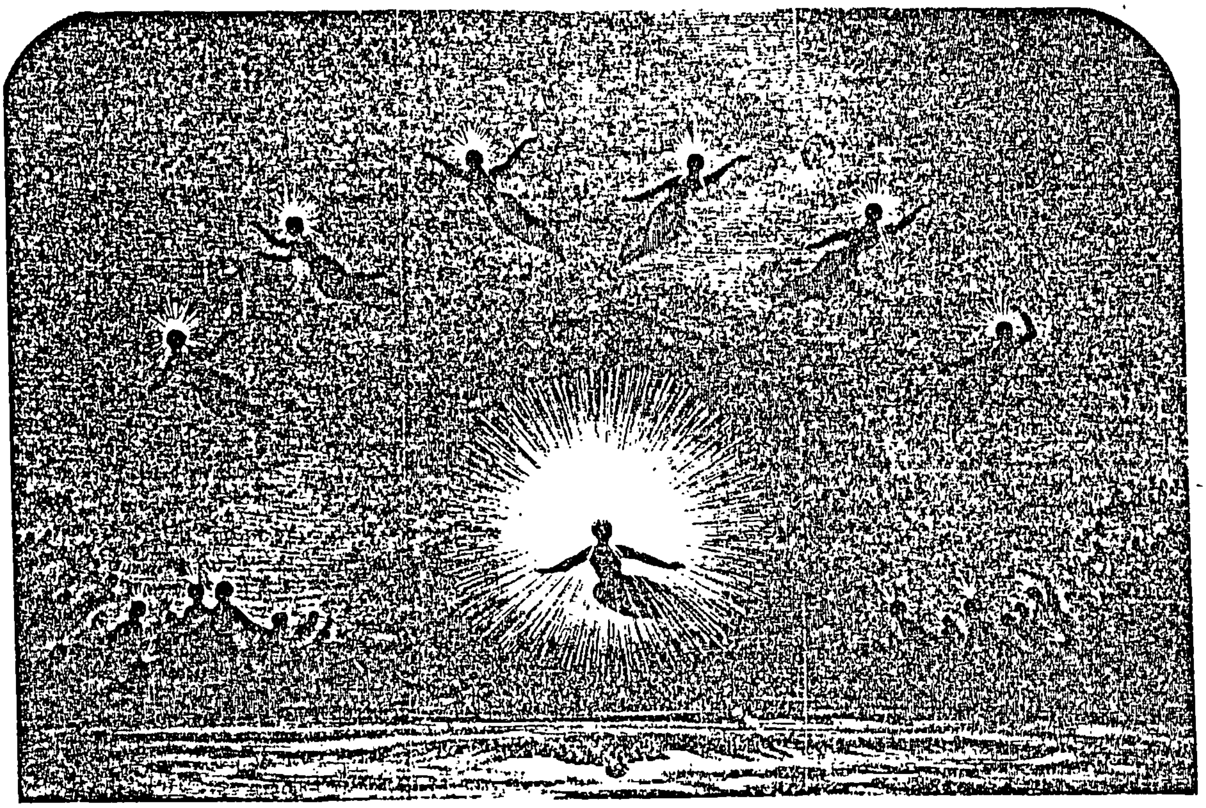
Fig.5 & 6 Elevation and side-view of another glory floor with side-tiers.

Fig.7 General plan of the said floor.

Fig.8 Cross-section showing the construction of the framework with the floor-piece.

An examination of an engraving from The Illustrated London News [see Illus.60], featuring the ballet Electra or, the Lost Pleiade, which opened at Her Majesty's Theatre, London, on April 7th 1849, shows the final scene, when

> "six Pleiades rise amongst the clouds, each with her bright particular light, and the seventh, the forgiven, is seen sailing up



Illus.60 "Electra or the Lost Pleiade." The Illustrated London News, loc.cit.

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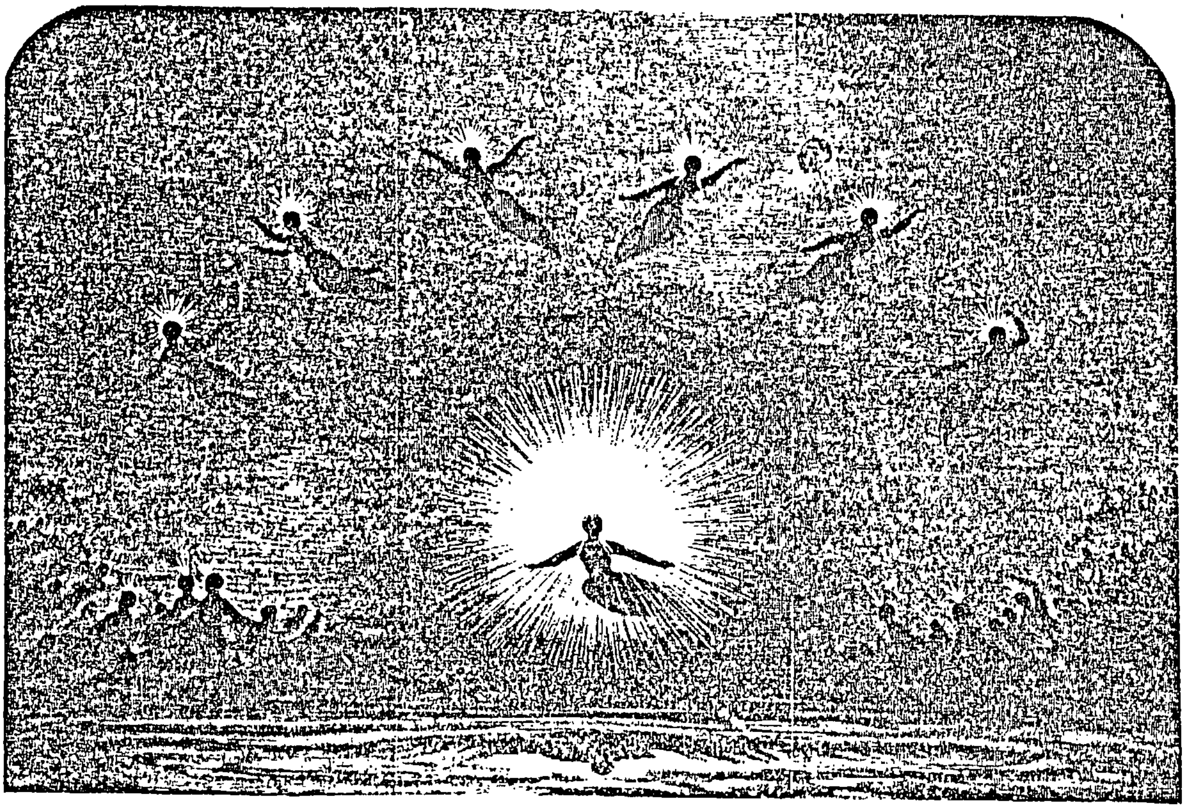
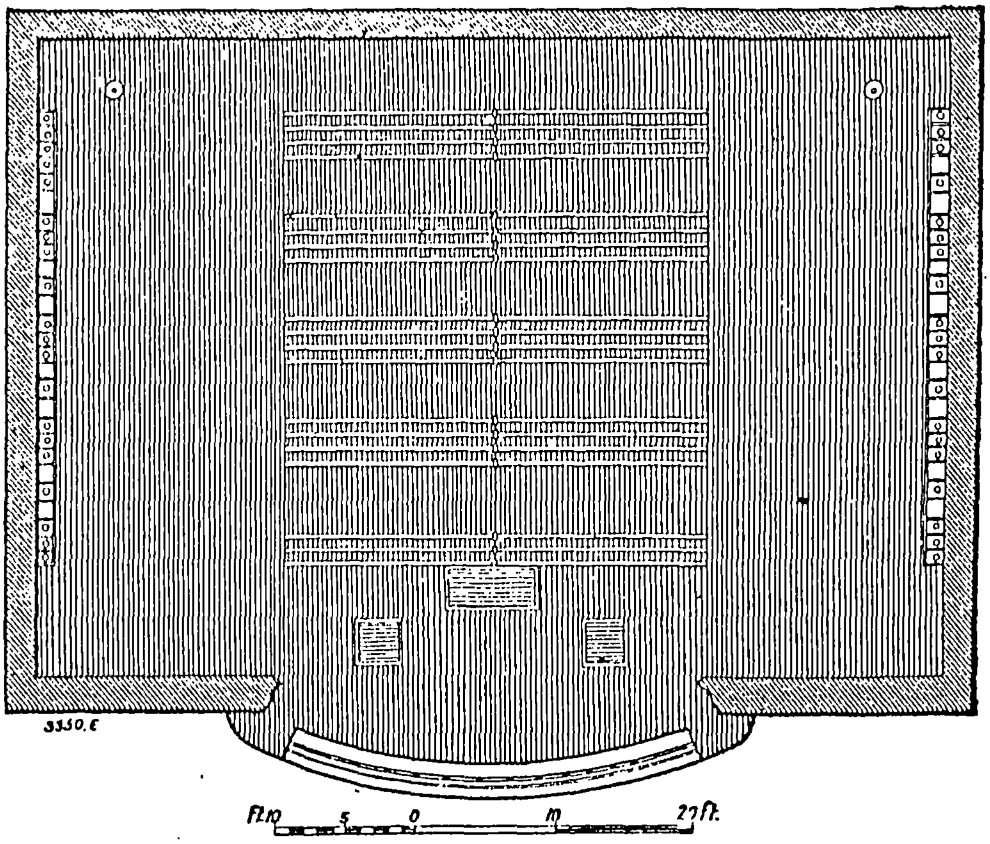


Illus.60 "Electra or the Lost Pleiade." The Illustrated London News, loc.cit.

and forwards to the front of the stage." [43]

It would seem reasonable to suppose that a group of six pleiades may have been mounted upon a glory platform, and the single central pleiade who required more intricate movements was controlled from a cloud or flying machine similar to the kind discussed previously.

Throughout theatrical history the actor has performed upon a platform or stage of one description or another, but has also frequently required the ability to pass above and below it, using it almost as a permeable membrane. The traditions of the theatre and the undoubted connections with religion have established an unwritten law which states that devils and demons are the habitués of the substage whilst angels and good fairies dwell in the sacrosanct realms of the flies. There is seldom any contact between the two except when they meet upon a single plane of combat, namely the stage.



Illus.27 Plan of English wood stage. Sachs, Modern Opera Houses, III, supp.1, p.11.

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43. The Illustrated London News, XIV, (1849), p.293.

The Layout and Construction of the English Wood Stage.

At the turn of the century Edwin Sachs asserted that "the typical English stage of today ..... is practically the old wood stage of the last century." [44] Whilst it cannot be denied that the construction materials had remained almost identical, a large amount of finesse had in the meantime been applied to the basic machinery described by Rees at the beginning of the century. This chapter of the thesis will examine the development and diversification of the English wood stage, which reached its zenith in the 1890's.

The responsibility for the design of a theatre's machinery was usually delegated by the architect to a, 'stage machinist' or 'master theatre carpenter'. As late as 1893 Ernest Woodrow wrote:

> "That it is necessary for the architect of a theatre to understand somewhat of the machinery of a stage is obvious, but I will not go so far as to say that every architect who designs a theatre should be able to supply the detail drawings of the traps and sliders. Stage machinery is a speciality, and as a rule is left in the hands of the stage carpenter or chief machinist, who must be a man of considerable ability, ingenuity, and inventive faculty. The architect must not, however, because of the existence of this individual, ignore the stage entirely, and be satisfied to hand over the four bare walls for the stage carpenter to fill in the stage machinery, irrespective of strength of materials; the architect should acquire sufficient knowledge of the requirements to be able to supervise the work." [45]

This appears to have been the procedure adopted in 1867 for the construction of the stage machinery at the Tyne Theatre and Opera House, Newcastle-upon-Tyne, which may be regarded as a typical mid-century example.

The building was designed by William B.Parnell [see Appendix 3 for biographical details], who was not a specialist theatre architect. The Tyne Theatre was in fact the only theatre that he ever designed and it is

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44. Edwin O.Sachs, "Modern Theatre Stages," <u>Engineering</u>, 28th Feb., (1896), p.271.
45. Ernest A.E.Woodrow, "Theatres - XVII," <u>The Building News</u>, 10th Feb.,(1893), p.188.

highly probable that he sought advice from other persons more experienced in the field. With this in mind, it is interesting to note that during the summer months of 1867 Newcastle's other main theatre, the Theatre Royal,was undergoing extensive interior alterations under the direction of Charles J.Phipps [see Appendix 4 for biographical details] and included the reconstruction of the stage by Mr. Day, of the Prince of Wales Theatre, Liverpool [46]. It would undoubtedly have been necessary for Mr.Day to spend a considerable amount of time in Newcastle during the early months of 1867, and that he used this time to double advantage is borne out by the following account:

> "The stage is also a marvel of completeness and ingenuity, and is furnished with all the latest and most approved stage accessories. The work of this part of the house has been done by Mr.W. Day of Liverpool, and will add greatly to his renown. This gentleman has had great experience in this particular line of business, not the least important of his undertakings having been the laying down of the stage of the Royal Polytechnic, London where he was engaged for five years." [47]

Clearly then, William Day was an experienced stage machinist, well qualified to equip a large provincial theatre with all the facilities normally associated with a typical English wood stage.

Although an architect seldom had the technical expertise to design the stage machinery himself, he still had to be aware of the structural requirements of the backstage area. If the fly tower was too low or the stage too narrow, the machinist could not carry out his work successfully. In this connection Sachs wrote that;

> "A proscenium 30 feet wide requires a measurement of 65 feet between the main walls of the stage, as the width of the stage must be at least somewhat more than double the width of the opening, in order to allow the floor to be 'worked off' to the right and left." [48]

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46. Anon., "Theatre Royal, Newcastle", The Builder, 31st Aug., (1867), p.649.
47. Anon., "Opening of the Tyne Theatre at Newcastle-upon-Tyne", The Era, 29th Sept.,(1867).
48. Sachs, Modern Opera Houses, III, supp.1, p.9.

This would appear to be a basic requirement for any theatre of the period, but it was not always the case in reality. Some theatres were built on awkward sites which did not allow large wing space. A classic example of this is at the Aldwych Theatre in London where the downstage right wing space is almost nil. On such occasions, "where the space is limited 'sliders' may be worked on the revolving - shutter principle, but this arrangement cannot be recommended."[49] One excellent example of this 'revolving shutter' or 'scruto' method still survives at the Victoria Theatre, Salford, built by Bertie Crewe in 1899. The proscenium opening is thirty-three feet wide, yet the wing space is comparatively cramped. The stage machinist therefore installed grooved beams which guided the flexible stage scruto (not tongue and groove boards) down an inclined plane [see photo.20]. The scruto was joined together with strips of canvas nailed onto the underside of the boards, this method being applied to both the cuts and the bridges [see photo.21].

Of course not every theatre required large and elaborate substage machinery, which meant that the wing space could be almost any shape or size, but this was the exception rather than the rule. A table of figures given by Buckle relating to the size of the stages in London and provincial theatres provides an indication of how many stages fulfilled the conditions stipulated by Sachs, i.e. a stage width more than double the proscenium opening [see Appendix 2]. Only 61.5% of the provincial theatres quoted and a mere 43.8% of the London theatres listed measured up to Sachs's figures, demonstrating that stages in England in 1888 were by no means standardised. It would seem reasonable to suppose that by and large these variations in size were occasioned by conscious design, but it is worth recalling once more that Buckle explicitly states that architects did make mistakes when it came to backstage planning:

> "The importance of having the gridiron the requisite height may be estimated from the fact that at a representative London theatre an increased outlay of from £500 to £700 is required on each production, owing to the gridiron being a few feet too low, a fault in construction made by an architect hitherto credited with having an

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49. Buckle, op.cit., p.31.

monopoly of knowledge as regards theatrical requirements." [50]

The depth of the cellar required to house the scenery and machinery was also something which varied enormously from one theatre to the next. Buckle quotes the Theatre Royal, Runcorn, as having a depth of 6 feet from stage to cellar floor, while at the Royalty Theatre, Glasgow, the depth was one of 27 feet. Once again the dimensions were related to function and necessity. Sachs advocated that:

> "In as much as the scenes raised upwards have to be taken out of sight, the scenes lowered under the stage floor have likewise to disappear from the vision of the audience, hence the height from the bottom of the 'cellar' or 'well' under the stage should if possible, be equal to the height of the proscenium opening, or height of the 'cloths'." [51]

There were, however, practical problems associated with this. For instance, in order to allow the audience a quick and easy access to the street from all levels of the theatre, especially the gallery, the pit and stalls were often sunk below ground level. It therefore follows that in such instances the stage cellar would have to be excavated to a greater comparative depth, thus increasing the risk of flooding, etc. The Comedy Theatre, Panton Street, London, built in 1881, is just such an example and as a result the cellar floor is excavated to a depth of only 9 feet below stage level. Owing to the large number of subterranean streams in the area, stage cellars in central London were always susceptible to flooding, which could cause a rapid deterioration in the machinery and scenery, as well as a generally damp and unhealthy atmosphere. Quite often the floor was soil although in the latter part of the century attempts were made to install concrete waterproof courses.

In deep substages an intermediate or mezzanine floor was usually installed from which most of the machinery could be operated. Unlike the cellar floor, it was from my personal experience mostly raked, though Buckle [52]

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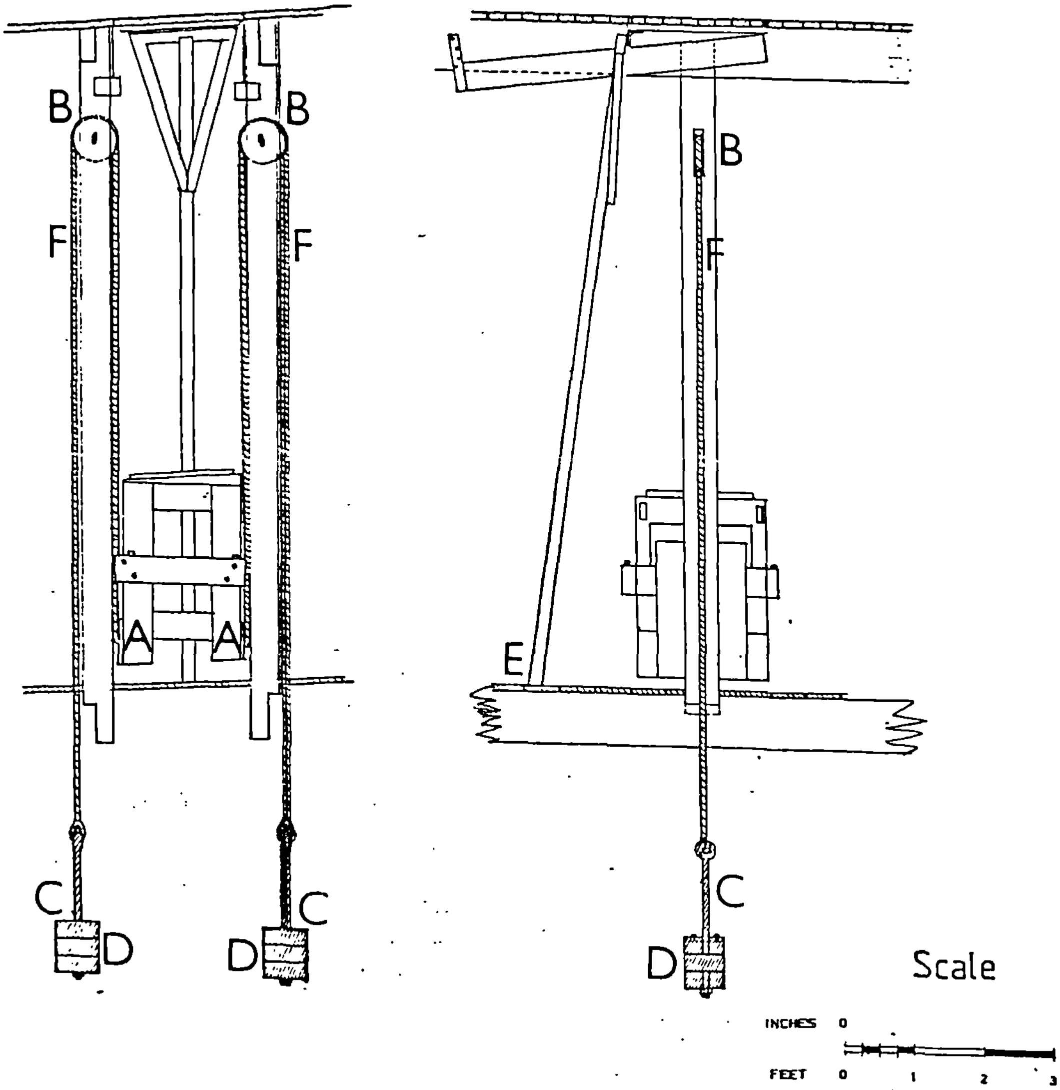
50. Ibid. p.33.
51. Edwin O.Sachs, "Modern Theatre Stages - No.IV", <u>Engineering</u> 28th Feb., (1896), p.271.
52. Buckle, op.cit., p.36.



Illus.61 Corner trap. Tyne Theatre and Opera House, Newcastle-upon-Tyne. Drawing by D.Wilmore.

is of the contrary opinion. Clearly both types were used, and the choice may largely have depended as so many things did, upon the personal preferences of the stage machinist responsible for the installation.

The Stage Floor.

The 'rake' or slope of the stage varied considerably during the nineteenth century. Rees, (1809), advocated 1:36, while Buckle, (1888) suggested a rake of between 1:18 and 1:24. However, by 1896 Sachs stated that "all our stage floors are laid to the same rake, namely falling 1/2 inch to every foot from back to front", [53] or in other words 1:24.

> "The slope of the stage, is of course only necessary for sighting purposes, so as to enable the occupants of the 'area' to see the actor as he retires 'up' the stage. If the lowest seat in the area were on the same level as the stage, and the rows of seats in the area rose steeper, a horizontal stage floor could be used", [54]

and was in fact one year later at Her Majesty's Theatre, London. Once the tradition of the raked stage had thus been challenged, several other flat stages were laid, but they still consisted, as in the past, of tongue and groove softwood. It was not until the introduction of new London County Council regulations in 1906 that it became necessary to use oak for the stage floor. These regulations were introduced because oak has a greater fire resisting quality than softwood. It must also have increased the operational efficiency of the machinery, as seasoned oak does not fluctuate in size as much as softwood under variable atmospheric conditions." [54]

The Corner Trap.

A typical example of an English wood stage corner trap is to be found at the Tyne Theatre and Opera House, Newcastle-upon-Tyne [seeIllus.61]. The two sections show a trap platform with a 1:24 raked top measuring 24 inches by 24 inches. Two ropes are attached to the base of the platform at 'A' and these run vertically to respective pulleys, 'B'. From here they

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53. Sachs, "Modern Theatre Stages - No.IV", Engineering, 28th Feb., (1896), p.272.
54. Ibid.

pass down through the mezzanine floor where hangers, 'C', and a variable quantity of counterweights, 'D', can be attached.

The operation of a corner trap requires an amount of skill and care. There is a popular belief that the corner trap was heavily counterweighted so that on release it sped up to stage level to crash into the stage joists. This method may have been used in some theatres, but it carries with it great danger because from the moment of release until the moment the trap reaches stage level it is out of the control of the operator.

The correct procedure is to secure the trap platform in the down position, allow the performer to stand on the platform while ensuring that the weight of the performer is slightly greater than the counterweights. This enables the operator to remove the safety catch without the trap ascending. The trap is opened by pulling back the supporting handle, 'E', which allows the trap cover to drop down onto a set of inclined timber runners which run off to one side. Once this has been done and the cue given for the ascent, the platform is raised by pulling down on both ropes marked at 'F'. It therefore requires two men, one on each rope to raise the platform, quickly or slowly but always under the control of the operators. As the trap approaches stage level it is preferable to slow down the ascent at the last second to avoid a loud crashing noise as the platform meets the underside of the stage. The corner traps at the Tyne Theatre were in fact fitted with small pieces of india rubber at each corner to attempt to cushion the impact.

During the nineteenth century safety was not always considered important in the theatre and consequently accidents, especially with corner traps, were quite frequent. This is well illustrated by the following passage from the Memoirs of Joseph Grimaldi, concerning a performance of his in Manchester:

> "He arranged and got up a very pretty little pantomime called 'Castles in the Air', in which he of course played Clown. His first appearance was to be from a large bowl, placed in the centre of the stage, and labelled 'Gooseberry fool'; to pass through which it was necessary for him to ascend from beneath the stage through a trap-door which the bowl concealed. On the first night of the piece, he ascended from below at the proper time; but when he gained the level of the stage, the ropes which were attached to the trap broke, and he fell back into the cellar from which he had just risen. He

was terribly shaken and stunned by the fall, but quickly recovering himself, ascended the stairs, went on the stage, and played as though nothing had happened to discompose him."

However this was not the end of the unfortunate episode;

"The Liverpool Theatre belonging to the same managers, and being resorted to by the same company, they all travelled thither for one night for the purpose of playing 'Castles in the Air' as the afterpiece, having the same master-carpenter with them as they had had at Manchester. Grimaldi sought the man out, and explaining to him the nature of the accident which had happended through his negligence on the previous night, entreated him to render all secure for that evening, and to prevent a repetition of the occurrence. This he promised but failed to do notwithstanding, for a precisely similar accident took place here. Grimaldi had ascended to the stage and got his head through the bowl, when, as a shout of laughter and welcome broke from the audience, the ropes gave way and he was left struggling in the trap. For a second or two he did not fall; for, having passed through the trap nearly to his waist, he strove to support himself by his arms. All his endeavours, however, were vain; the weight of his body pulled him downwards and the trap being small, his elbows were caught by the edges and forced together above his head, thereby straining his shoulders to such an extent that he thought his arms were wrested from their sockets. He fell a considerable distance, and when he rose from the ground was in excessive pain." [55]

It is difficult to decipher exactly what happened, though it may have been associated with the impact of the trap against the underside of the stage. A rapid ascent can cause the counterweight ropes to produce a whiplash effect as the trap comes to rest. It follows that if the ropes used by Grimaldi's carpenter were only just strong enough to suspend the weights, they would not withstand the additional strain of the whiplash, and snapping would be the inevitable (and painful) result.

There was also a variant of the corner trap known as the star trap, and

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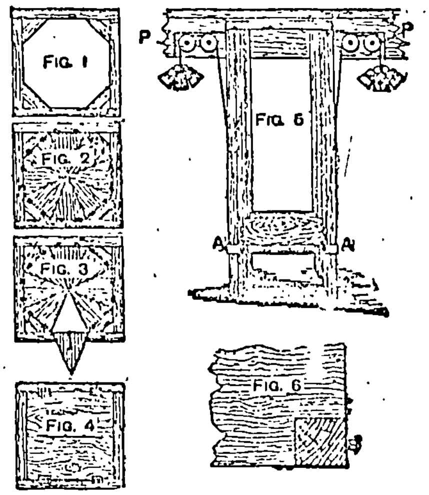
55. Ed.Boz.,(Charles Dickens), Memoirs of Joseph Grimaldi, (New York: William H.Colyer, 1838), pp.153-54.



Illus.62 "How to make a star trap for the stage."
Corbould, op.cit., p.104.

named after a different type of cover which could be inserted into the existing trap aperture. It is a sad fact that descriptions relating to the construction of stage machinery and written by people with first-hand experience are very rare. Luckily, however, a very interesting article entitled, "How to make a Star Trap for the Stage" [see Illus.62], was published in a periodical called, Work in 1895:

> "SIR - a correspondent wants to know how to make a star trap. A depth of at least 8 ft. will be required under the stage. The star trap is usually made to fit into a square trap in the stage - that is, the trap that is always in the stage except when the star trap is being used. This is made in a square frame so that when the trap is taken out it shall fit the hole exactly.
>
> To make the star trap which must be very strong to withstand the shock of at least 4 cwt or 5 cwt, some practical knowledge of stage carpentering is essential or the amateur may come to grief. First make the square frame, which should be quartering of 3.5 inches by 2 inches dovetailed together; then put a piece across each corner (see Fig.1) forming an exact octagon. Eight pieces are now cut to fit this octagonal hole nicely (see Fig.2); these are hinged on to the frame. It is best to have two hinges for each piece; this will ensure their falling into their proper place. Each flap must have a stout indiarubber spring, one end fastened to the frame, the other end to the centre of the flap (Fig.3). A simpler way of making this trap is to have only two flaps (see Fig.4)." [56]

Variations did of course occur. Leopold Wagner, in Pantomimes and All About Them, (1881), advocated that a star-trap should be "circular in form and usually constructed of sixteen angular pieces, with their bases hinged to the circumference, and their points meeting in the centre." [57]

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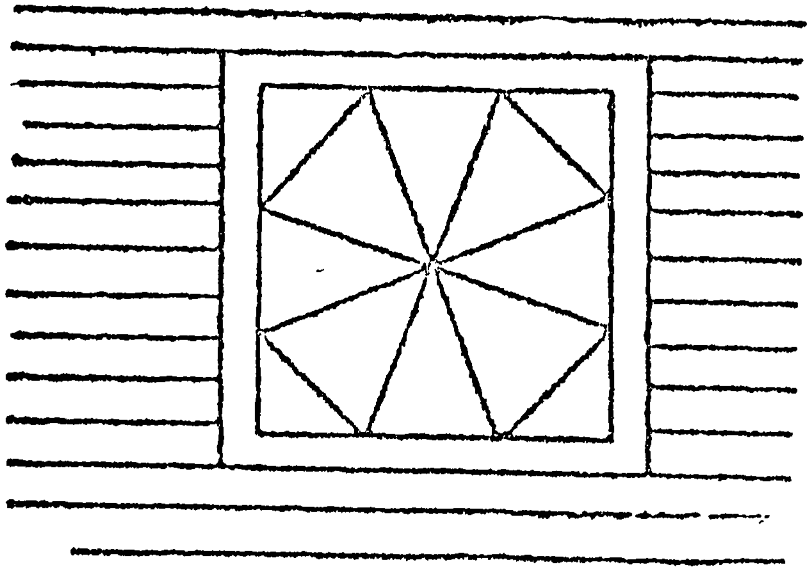
56. Wm. Corbould, "How to make a Star Trap for the Stage", Work, 31st Aug., (1895), p.104.
57. Leopold Wagner, The Pantomimes and All About Them, (London: Heywood, 1881), p.55.



Illus.63 A star trap cover. Sachs *Modern Opera Houses*, III, supp.1, p.11.

Georges Moynet in Trucs et Décors recommended the use of "12 juxtaposed triangles", [58] while Modern Opera Houses and Theatres [59] contains a diagram with eight such triangles [see Illus.63] . Clearly the number varied and was not crucial to the operation of the trap. I personally know of only two star trap covers still in existence in Great Britain. One, preserved at the Museum of London, came originally from the Theatre Royal, Drury Lane [see photos.22,23,24] and has eight segments, while a star cover recently discovered at the Grand Theatre, Llandudno, [see photo.25], has twelve segments. It could perhaps be argued that a greater number of segments would assist the illusion of the performer passing through solid ground, but this was seldom the main objective in using a star. In any case, as Sachs points out:

> "Where it is desirable for a figure to rise through the stage without the hole or opening being seen, bristles are sometimes put over the floor; these cling to the body and return to the level when the actor is clear of the trap." [60]

He then notes that a "tight-skin of india rubber with a slit in it" could also be used for the same purpose. To return to the article in Work, the writer, Mr. William Corbould [61] goes on to discuss the construction of the trap mechanism:

> "The apparatus underneath [the star trap cover] consists of four upright pieces of quartering 3 in. square planed up smooth. These are fixed firmly to the floor and to the underpart of the stage forming the square of the trap.
>
> The platform is now made, each corner cut out to fit the four uprights (see Fig.5). A corner angle of iron is put round each upright (see A, A, Fig.5). Fig.6 shows the corner of platform showing iron band at B, which should run easily on the uprights.

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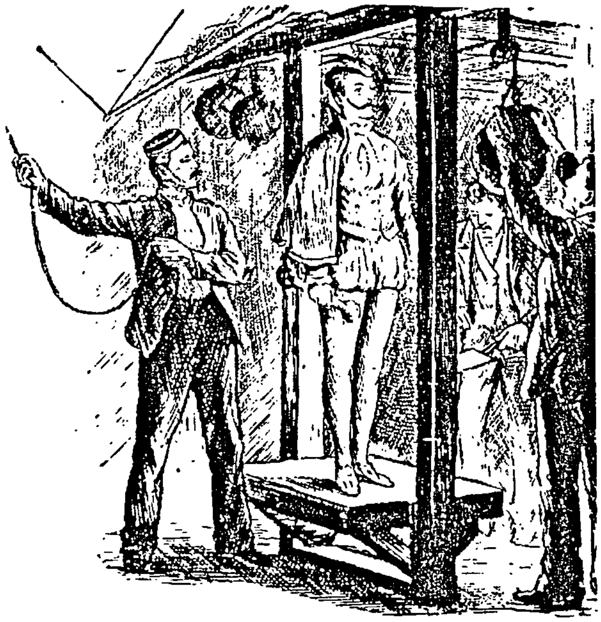
58. Georges Moynet, Trucs et Décors, (Paris: La Libraire Illustrée, 1885), p.120.
59. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.11.
60. Ibid. pp.11-12.
61. Corbould, loc.cit.



Illus.64 Star trap at the Royal Artillery Theatre, Woolwich 1877. Salberg, Once Upon A Pantomime, [London: 1981] (Original source unstated).

> This platform should be made of 1-in.floor-board double, the top boards running one way, the bottom the opposite. Soap or grease may be rubbed on the uprights to facilitate the rising of the platform."

The uprights on the two corner traps at the Tyne Theatre did in fact show evidence of being lubricated with a substance resembling graphite and grease mixed together into a paste. M.J. Moynet indicates that this was also common practice in France: "The trap framework, by means of two small tongues of wood, slides in the two grooved beams that are well rubbed with graphite." [62]

Corbould's description then continues:

> "Two strong pulleys are fixed to the stage (P_1, P Fig.5). A rope running through these is fixed to the platform, the fall end carrying the weights, which must vary according to the weight of the person and the height to which he wishes to go.
>
> In standing on the platform the head should touch the trap. The weights are held up by two persons or by lever until the signal is given. When the performer is coming down the legs should be opened so as not to land on the trap." [63]

This final paragraph provides an interesting insight into the techniques actually employed in the operation of a star trap. The splayed legs of the performer were an obvious precaution, and the head presumably had to touch the underside of the 'star' in order to avoid the risk of concussion.

The description and illustrations given by Corbould suggest a rather primitive kind of corner trap when compared to surviving examples extant today. It is however quite certain that this type of trap was in regular use especially in some of the smaller provincial theatres. Illustration 64 shows a basic corner trap which was in use at the Royal Artillery Theatre, Woolwich, in 1877. It is interesting to note that only one stage-hand is controlling the trap, while the man on the left holds the 'cue-line'. This

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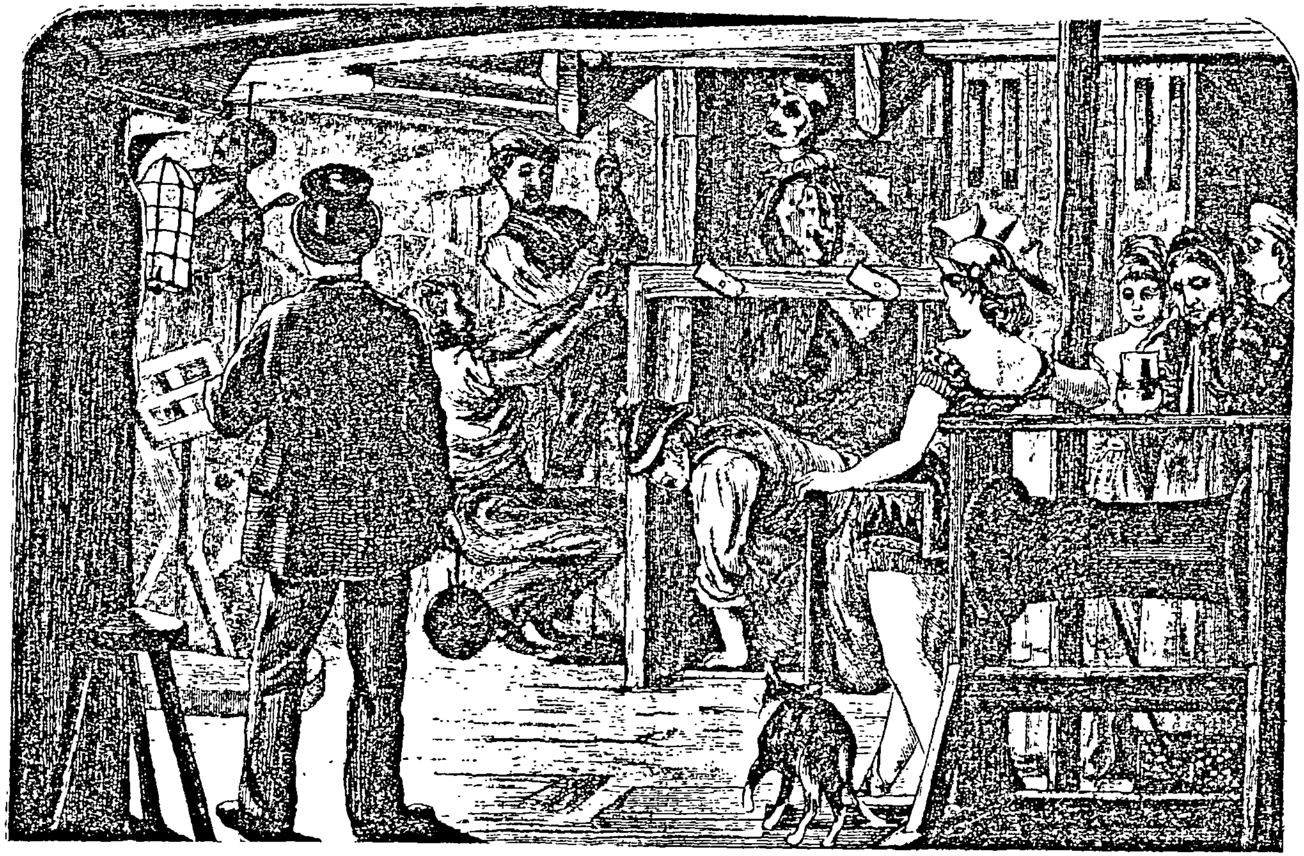
62. M.J.Moynet, L'Envers du Théatre, (1874, 2nd edn., rpt.New York: Benjamin Blom, Inc., 1972), p.55.
63. Corbould loc.cit.



Illus.65 The substage at the Princess's Theatre, London. Illustrated Sporting and Dramatic News rpt. in Rowell, The Victorian Theatre [London: 1956], Fig.12.

was quite simply a piece of rope which ran from the stage-hand to the stage manager, who tugged on the rope when he wanted the trap to ascend. Another example of this method is very well illustrated in an engraving of the Princess's Theatre made in 1874, [see Illus.65]. The top-hatted stage-hand holds the cue-line while two other stage-hands pull down on the operating rope. It would appear that the man kneeling down is applying his weight to the trap platform to counterbalance the force exerted by his two colleagues and the counterweights attached to the operating line. This would seem to suggest that as the cue was given the kneeling man rolled off the trap, allowing the platform to ascend very quickly to stage level. This being the case, it is not difficult to imagine how accidents frequently occurred.

Unfortunately the construction of the corner trap platform is not shown either in John Foulston's drawings of the Theatre Royal, Plymouth, or in the Eyre manuscript. However, several detailed drawings of "English" corner traps are reproduced by Contant in his treatise, Parallèle des Principaux Théatres, and it is interesting to consider them all in detail. 64

Plate 31, Figs.1 and 2 show a corner trap, which is accompanied by the following annotations:

Fig.1 and 2: Section of an ordinary trap frame.

A.	Movable floor of the stage.
B, C.	Framework with a flat counterweight fixed to the stage.
D.	Stop mechanisms on which the trap frame rests.
E.	Brackets or chime brackets forming the groove or rabbet.
F.	Lever by which the upwards movement is achieved.

The above is also accompanied by the following explanatory text.

> "As soon as the lever is in the vertical position (shown by the dotted lines) the frame moves upwards. The actor lifts the movable stage floor which is pulled aside by the counterweighted

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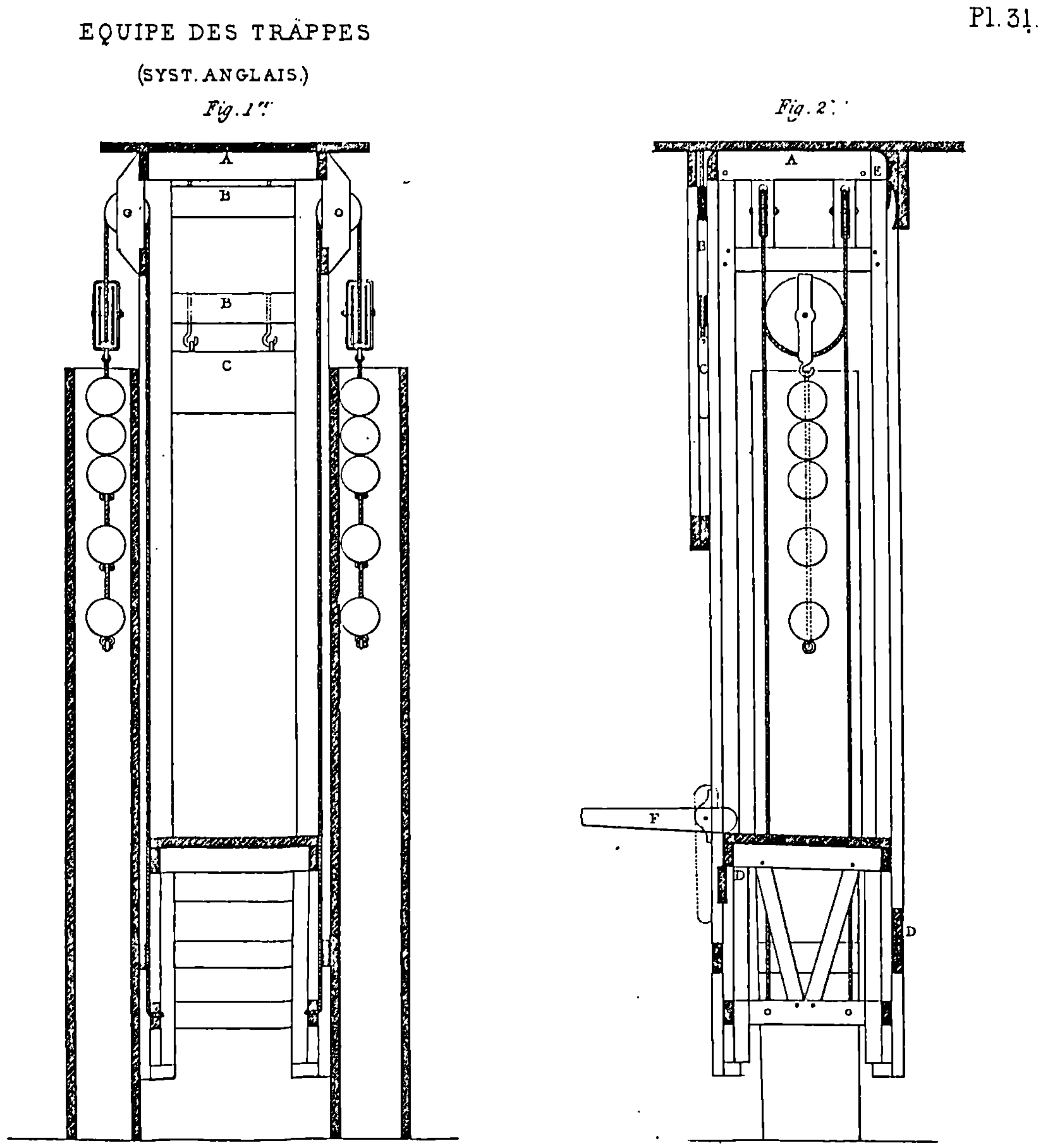
64. Contant, op.cit., pl.31 and p.149.



Illus.66 Sections of an 'ordinary' trap. Contant, op.cit., pl.31. figs.1, 2.

framework into a vertical groove, and the structure completes its course without a jerk, since the iron balls which pull it, hitting the ground one after the other, avoid the possibility of any impact."
65

Illustrations 66 [Plate 31, Figs.1 and 2] show a corner trap which is highly sophisticated when compared to extant English examples from the 1860's, e.g. at the Tyne Theatre. The counterweights are enclosed inside boxes as a safety precaution, and hang at intervals on the suspension line causing the trap to slow down just before it reaches stage level. This would make it possible for only one stage-hand to hold onto the brake, F, and release it at the given moment, allowing the trap to ascend (once weighted for the actor) without any further assistance.

It is interesting to compare this trap with the corner traps which were installed at the Theatre Royal, Bristol, around 1850. [see photo 26]. Although the latter do not show the same degree of sophistication they do incorporate the same kind of 'cannonball' counterweights. The photograph in question was taken in October 1969, by which time the trap was used only occasionally and the art of the stage machinist was all but forgotten. It is therefore reasonable to suppose that during the nineteenth century the trap's counterweights were staggered in a similar manner to the one shown by Contant. It is also worthy of note that the Bristol trap was 'restrained' with a small metal bar inserted through the upright support, though this may be a later modification.

Another variation of the corner trap is given by Contant in figures 3 and 4 of plate 31. The accompanying text reads as follows:

Fig.3 Section of another trap-frame, namely:

A. Lines acting on the levers which open the floor of the stage in two parts from underneath.

B. Hinged lever.

C. Counterweight of the lines which keep the two parts of the floor open.

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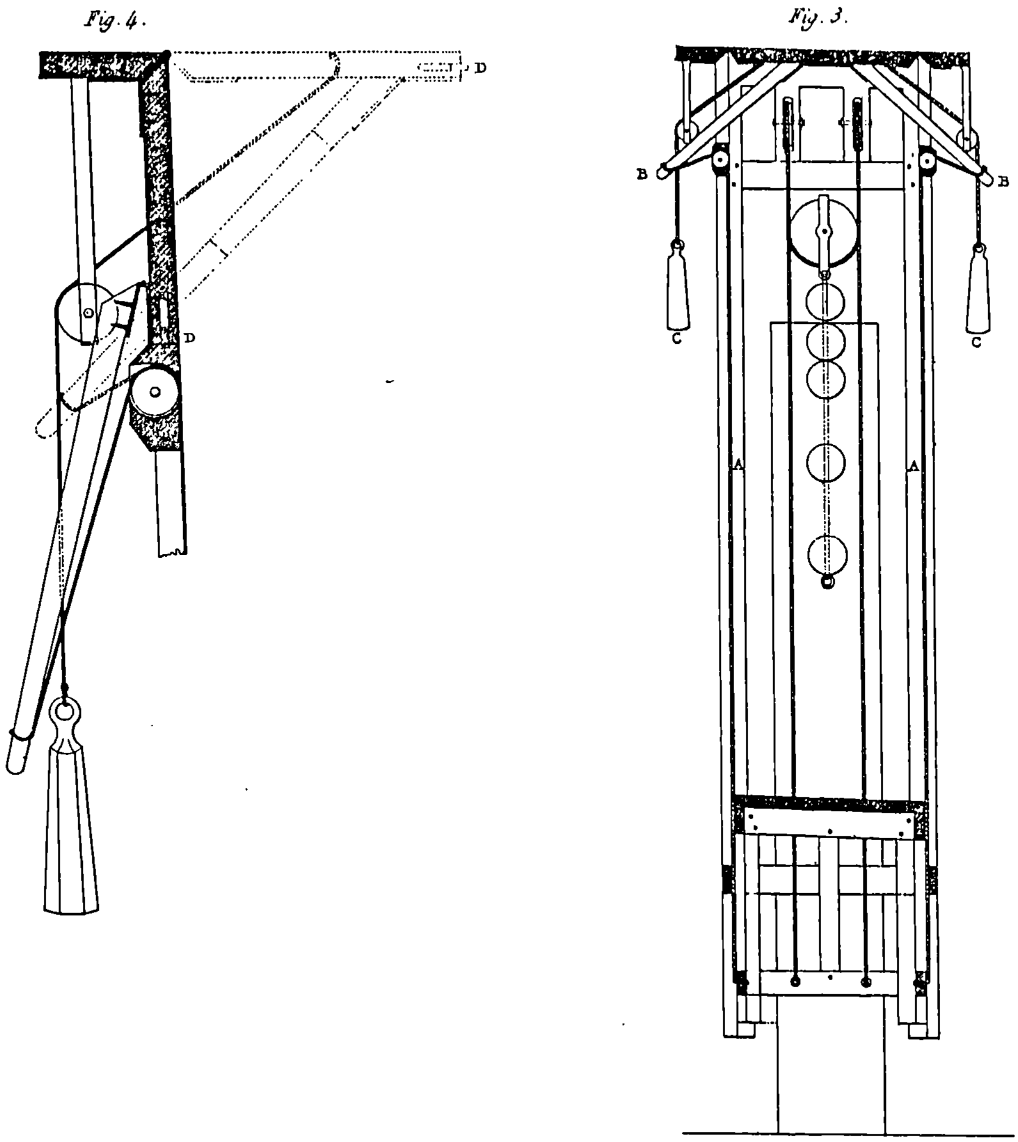
65. Ibid.



Illus.67 Section of another trap-frame. Contant, op.cit., pl.31. figs. 3, 4.

Fig.4 Details showing the position of the lever and the open floor making way for the trap frame.

D. Catch or stop mechanism which holds the two parts of the stage floor together when they are open or closed.

This demonstrates the subtleties and variations which could be incorporated into the construction of a corner trap. Although basically the same as the previous one, this example shows another method of opening the trap cover. The actor stands upon the trap platform, and as it ascends two ropes, AA, attached to the base, allow the two levers B, B, to drop down under the force exerted by the two small counterweights C, C. This arrangement dispenses with the necessity of opening the trap door before the trap is raised, the whole operation being carried out almost simultaneously. This has a great advantage over the ordinary trap cover, because the premature opening of a trap forewarns members of the audience seated in the first circle and above that something is about to happen. Owing to sightline considerations the audience in the 'pit' or 'stalls' rarely saw the stage surface. I have not, at the time of writing, come across this type of cover, though there is no reason to suppose that it would not work.

Figures 5-7 in Contant's plate 31 shows another variant of the corner trap which displays additional subtleties of the stage machinist's art:

Fig.5c Double frames or transformation traps.

A. Disappearance frame.

B. Appearance frame.

The actor who has to disappear being placed on trap A, and the one who must replace him being placed on trap B, at the signal, the upright I (shown by dotted lines) is removed. The quickly descending trap raises the other one with the actor, who, by striking against the pivoting floor section C, moves it into the empty space left by the descending trap.

D, E, F, G. Spherical counterweights accelerating the disappearance, and arranged so that F and G are on the ground when the frame A is one metre below the stage level, and the counterweights D and E similarly on the ground when the movement of these traps is completed.

H.line, at the end of which one can hang a counterweight, which acts only at the moment when platform B is about 15cm. from the stage-floor and prevents it from being carried above the level of the stage floor by the momentum of such a rapid movement.

Fig.6 Plan view of the fixed frame.
Fig.7 Plan view of the movable section of the stage.

This "double" or "transformation" trap, allowing for the substitution of one actor for another in the course of a scene may well have been used in a play such as The Corsican Brothers. First produced in France in 1850 and in England in 1852, it concerns the fortunes of twin brothers, both played by the same actor. On several occasions in the course of the action it is necessary for both brothers to be on stage at the same time. For instance in act III, Fabien fights a duel with Château Renaud, the man who killed his brother, Louis. As Fabien kills Renaud he passes behind a tree on the stage and a substitution is made. The principal actor could pass down on the trap into the substage while the substitute rose to take his place, reappearing from behind the tree. The text of the play states that the substitute "then advances with face covered by his hand". In the meantime the actor now in the substage has mounted the Corsican trap, which is then operated to reveal him as the dead Louis, who makes one final speech before the curtain falls.

Although there is no definite evidence to suggest that this type of "double" or "transformation trap" was used in The Corsican Brothers, the play clearly provides a useful hypothetical example of how it might have been employed. Contant must have been aware of the play, which was performed regularly, when he published his work in 1860, although he does not reproduce any drawings specifically relating to the mechanism of the Corsican trap as such, which I shall discuss, in greater detail later. [66]

Contant describes a further variant of the corner trap in plate 32 and its associated notes:

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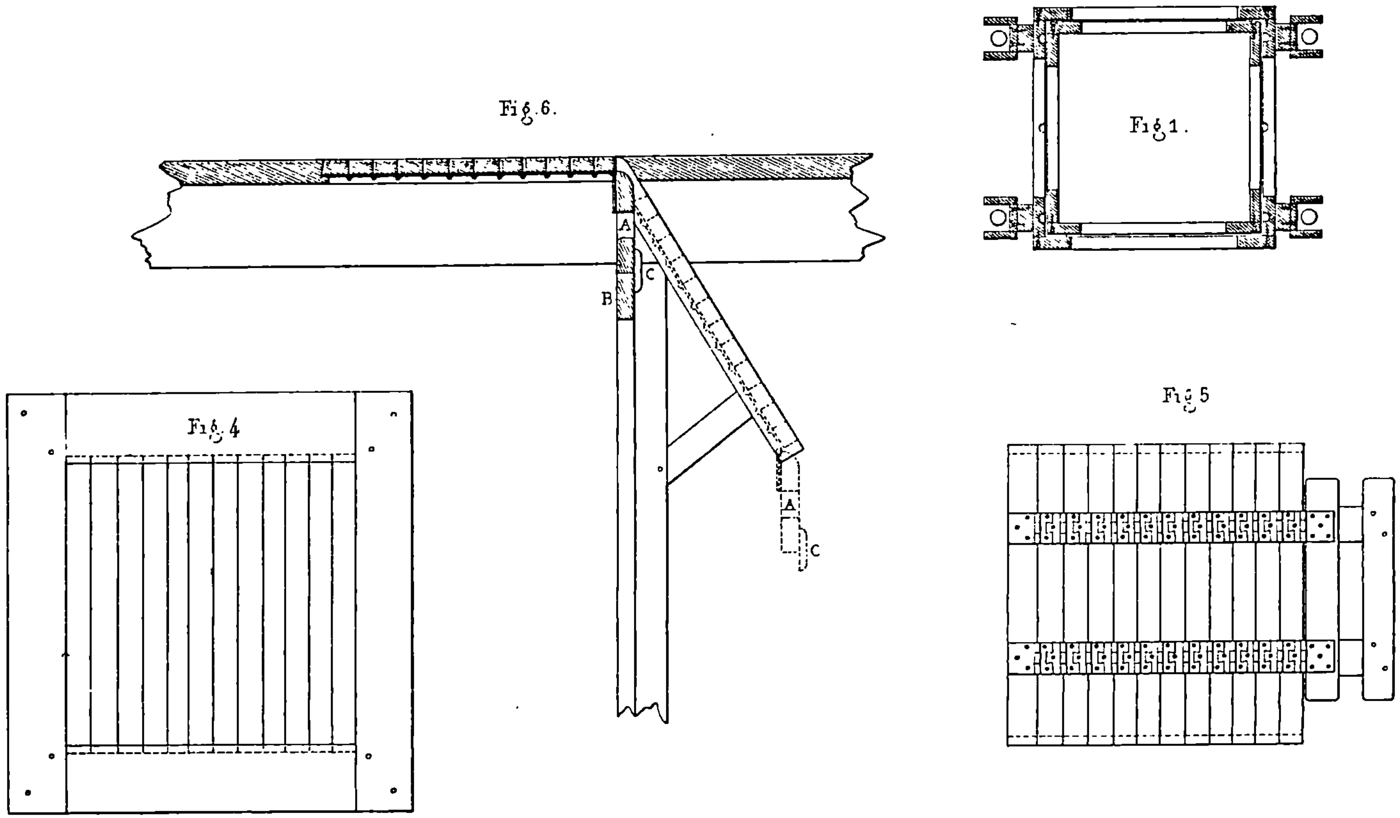
66. See pp.114 - 123



Illus.69 Dctails of traps. Contant, op.cit., pl.32, figs. 1, 4, 5, 6.

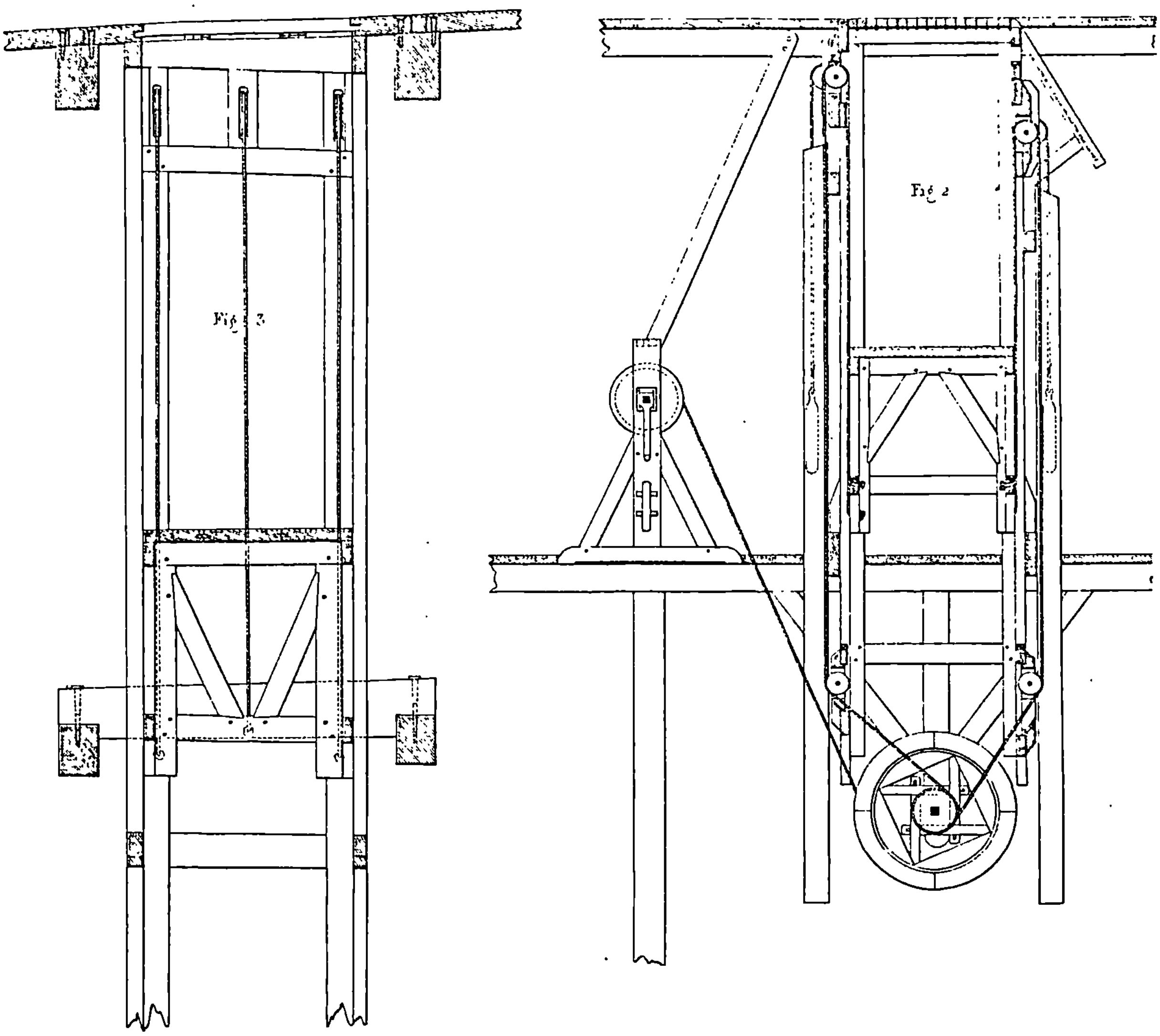
Plate 32 [Illus.69-70].
Apparatus of the Traps.

Fig.1	Plan-view of a trap frame with counterweights at the corners.
Fig.2 and 3	Section from both sides of the trap frame, drums etc.
Fig.4	View of the underneath of the scruto wood.
Fig.5	View of the underneath of the same portion complete with hinges.
Fig.6	Cross-section showing by dotted lines the position taken up by the scruto, to allow passage of the trap-frame.
A.	Movable handle for opening and closing the floor of the stage.
B.	Cross-piece used to fix the aforesaid handle in position.
C.	Bolted stop catch.

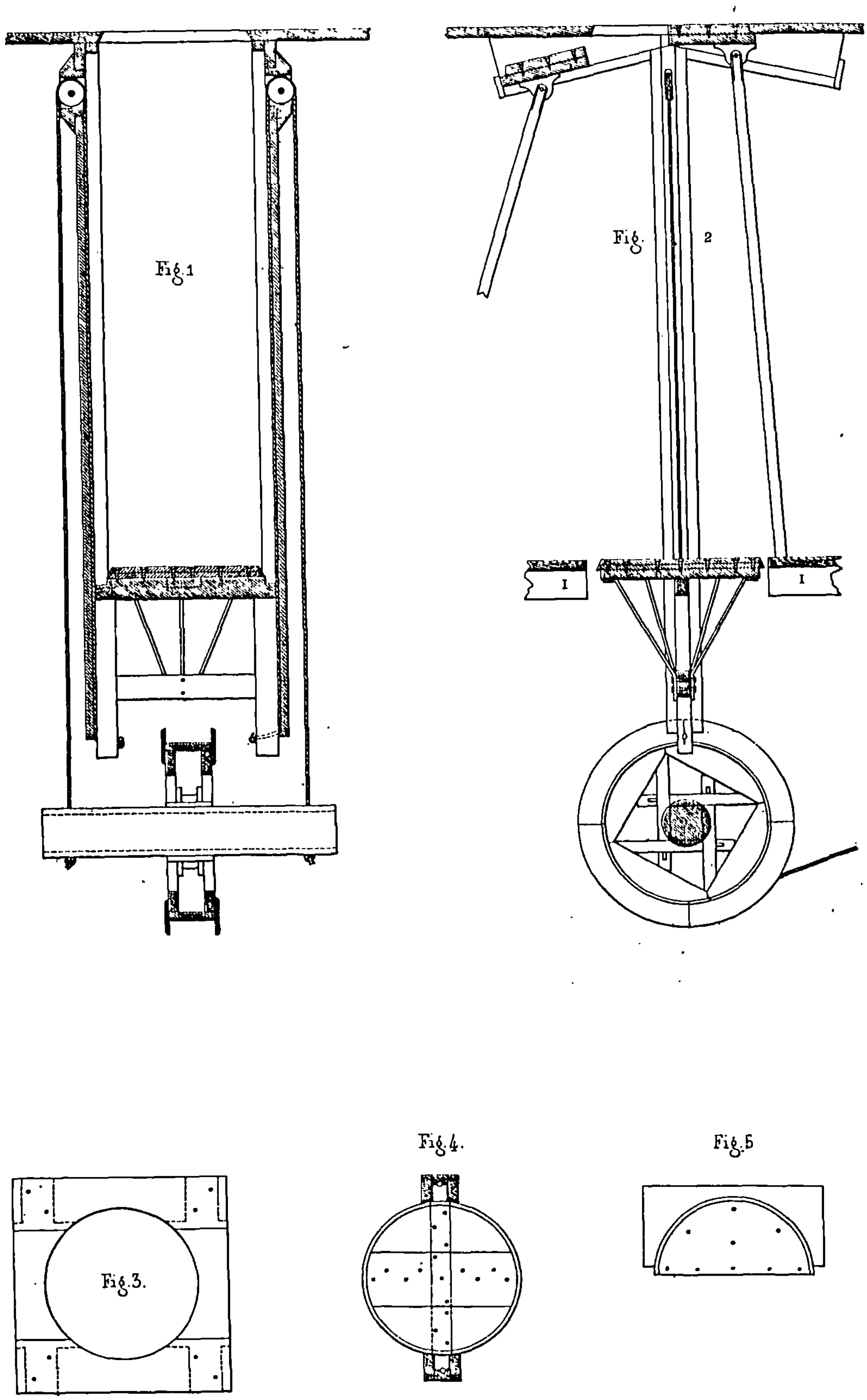
The movements of this structure are carried out by means of the small drum turned by means of a crank handle, and fastened down by two uprights bolted to the joists of the stage floor.

This trap has counterweights, which are boxed in for safety, though much smaller than the spherical cannonball type shown in previous plates. With this design the importance of counterweighting is reduced by the introduction of a drum and shaft mechanism controlled from a winch on the mezzanine floor. This has the added implication of slowing down the rate of ascent of the trap, suggesting that this type of trap would have been suitable for "apparitions" rather than "demons".

Figures 4-6 show the details of the trap cover which consists of strips of timber hinged together on the underside. This type of construction, for which the french term was 'plancher à lames brisées' was known to the English stage machinist as scruto. More commonly in England the wooden laths were joined by strips of canvas rather than hinges and formed an integral part of the sliding floor sections for the Corsican trap [see page 117].Quite clearly there was a different type of corner trap available to suit every occasion.



Illus.70 Details of traps. Contant, op.cit., pl.32. figs.2, 3.



Illus.71 Details of traps. Contant, op.cit., pl.33.

Contant quotes yet another example with further subtle variations:

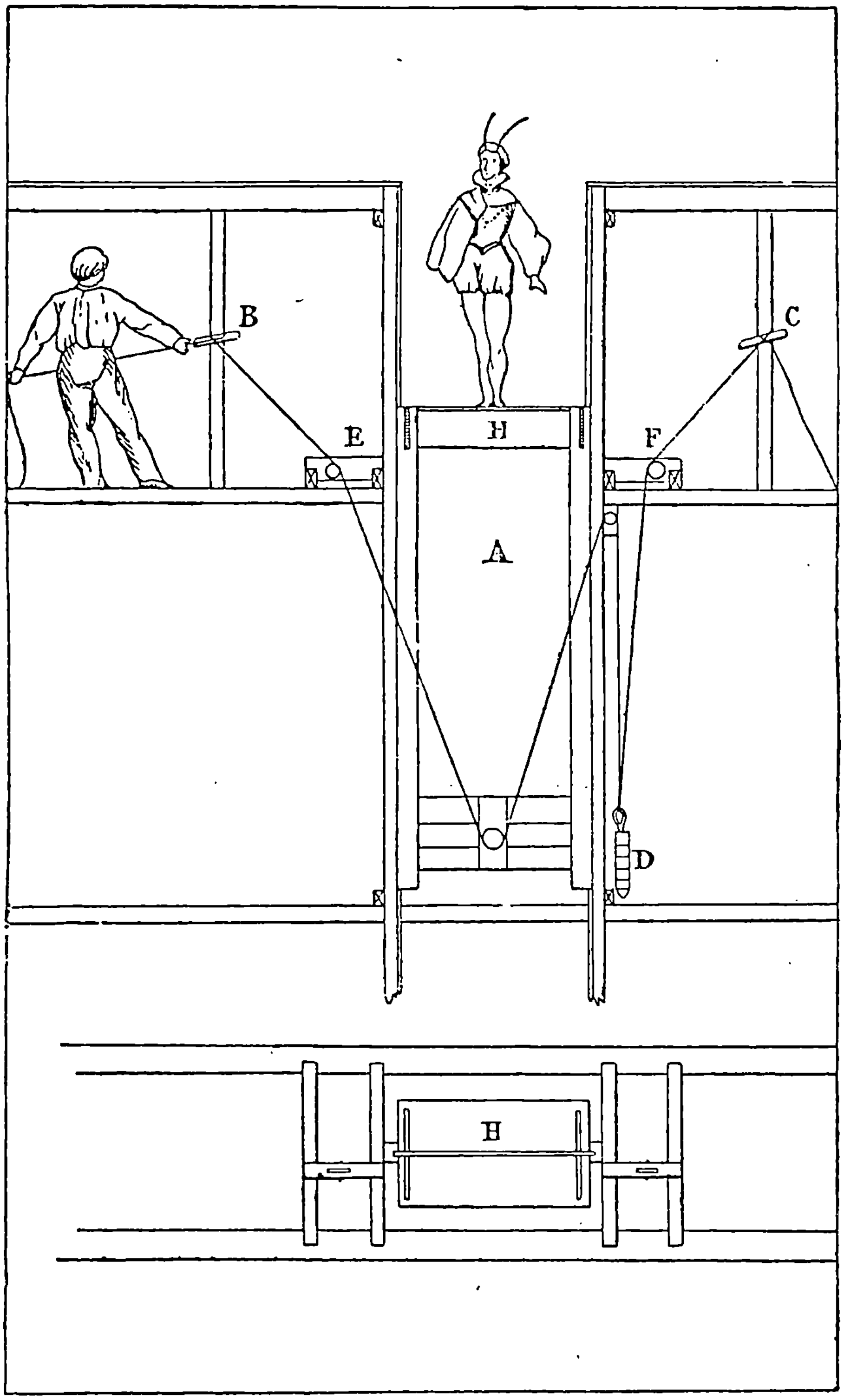
Plate 33, [Illus.71].
Apparatus of the Traps.

Fig.1 and 2. View from both sides of a circular trap frame.
Fig.3 Plan of the fixed portion of the stage.
Fig.4 Plan of half of the circular frame.
Fig.5 Plan of half of the circular platforms sliding under the stage floor by means of the upright which holds it together (see Fig.2).

As in the previous example this variant also relies upon mechanical advantage gained from a drum and shaft positioned below the trap, though it employs no counterweights at all. The trap platform is circular and runs in two grooved vertical posts which are in effect sloats. (For a full description of the sloat see page 133). The use of a drum and shaft, which, although not shown was probably operated by a windlass, and the complete absence of counterweights suggests that this too was probably a slow-rise trap.

In Moynet's L'Envers du Théatre there is a very interesting illustration of a French corner trap, [see Illus.72]. Although not identical to the examples given by Contant it provides a valuable insight into the operation of this kind of trap, be it French or English. Moynet comments:

> "Two upright pieces placed to the right of the grooved beams are equipped with some transverse pegs or pins as means of stopping and controlling the action. Two ropes pass through the pulley at the bottom of the trap frame (A) and through two others (E and F), that are placed at each side of the grooved beams. Then the rope is fastened to the counterweight (D).
>
> The drawing explains the action. The actor is in position on the trap at a point on the stage precisely indicated by a chalk mark. The stage hand placed in the substage at the left of the trap keeps



Illus.72 Workings of a trap. M.J.Moynct, op.cit., p.57.

himself in readiness. He unfastens a line that was tied off on the pin fixed at post (B), snubbing it with one turn around the pin in order to hold up the framework, trap, and actor so that their combined weights can set it in motion at the agreed signal.

As soon as this cue is given, the stage-hand lets the rope run more or less freely, according to what has been determined in rehearsal, snubbing it a little at the moment when the chassis arrives at its desired position, so that it does not give a jolt to the person on the platform.

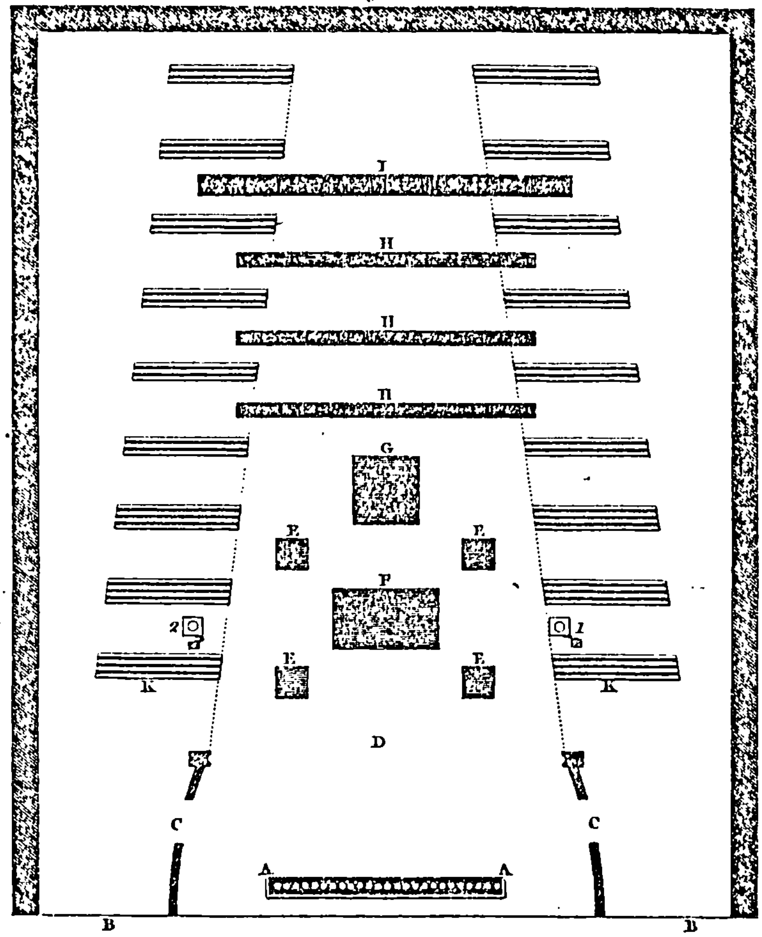
To execute the opposite action, a stage-hand places himself at the right post and unfastens the rope which is on the pin (C). He raises the counterweight by hand to position (F). The left rope goes slack and must be shortened in order to allow the operation of the raised counterweight. The stage-hand at the left takes up the slack, then he lashes it solidly on the pin of the left post (B). The trap prepared, the actor has only to place himself on it. At the given signal, the stage-hand at the right has only to release the counterweight, this in falling pulls on the left rope; thus making the framework return to its first position and the character on the trap is made to appear out of the floor.

While these two manoeuvres are being accomplished, there is another which demands introduction of a third stage-hand. The opening that the actor leaves above him when the trap descends must be closed. This is a very simple operation. Two grooved boards are fastened below the floor, and in these grooves slides the trap cover that is moved into the exact place in the floor left open by the lowered trap section. This trap cover is itself fixed on another slightly larger platform, forming two layers. The whole apparatus is brought to the level of the floor by means of a lever similar to the one which raised back the large sliding covers that go under the floor space of the wings."

He then proceeds to describe a type of corner trap more akin to the kind found in the English substage.

"In raising or lowering large weights, which often happens, square

Fig. 1.



Illus.73 Stage plan. A.Rees, op.cit., pl.X.

frames rising on sliders in grooved beams are used. Four counterweights are placed at each corner and the ropes are fastened to a tambour [drum] instead of being held by hand." [67]

The position of a corner trap on the stage floor in relation to all the other machinery, and the proscenium arch is a matter of particular interest. During the early part of the nineteenth century when the form of the Georgian playhouse was still dominant the forestage extended beyond the line of the proscenium arch into the auditorium. Corner traps could therefore be inserted into the forestage, though an examination of the available evidence does not reveal a consistent tradition. Foulston's Theatre Royal, Plymouth (1811), does in fact show two corner traps in the forestage, although he gives no information regarding their mechanism. Henry Holland's Theatre Royal Drury Lane of 1794 had four cornertraps; two in the forestage, two just upstage of the proscenium arch parallel with the centre stage grave trap [68]. When the theatre was rebuilt by Benjamin Wyatt in 1811 the forestage remained, (in a revised form), but its two corner traps were relocated alongside the other two upstage of the proscenium arch. It is also instructive to compare the stage plan of Covent Garden shown by Rees [see Illus.73]in his Cyclopaedia (dated c1809) with the rebuilding of the theatre by Sir Robert Smirke in 1808-9 [see Illus.5]. Rees [69] shows four corner traps positioned upstage of the proscenium arch, while Smirke, or his stage machinist, preferred three corner traps in the forestage, and three upstage of the proscenium, - the central one being slightly larger. This inconsistency in location is not surprising when one considers that the whole shape and form of the Georgian playhouse was in a very important phase of architectural transition during the early years of the nineteenth century. The actor/audience relationship and the position of the forestage were gradually changing until at the end of the process,

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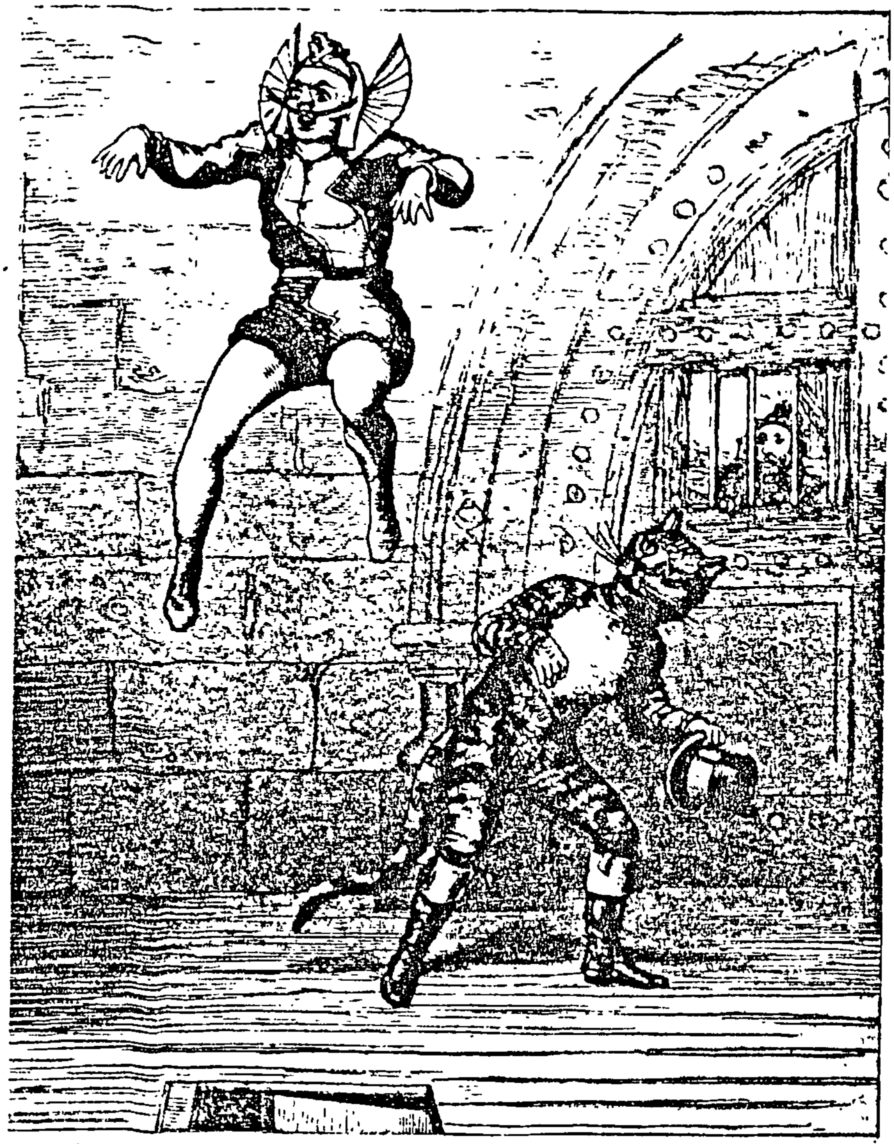
67. M.J.Moynet, op.cit., pp.56-59.
68. The stage machinery for this building was designed by Rudolph Cabanel; Holland wrote in a letter to him that, "the inclination of the stage shall be half an inch to the foot, that the floor traps, placing the Barrels, working the wings and scenes, shall be according to your model." From a M.S. in the possession of a Mr.Robert Eddison. Quoted in, Survey of London, XXXV, p.54.
69. Abraham Rees, op.cit., XII, n.pag.



The Ogre (George Conquest). Puss (Master Conquest).

Illus.74 George Conquest performing a trap ascent, *Puss in Boots*, Crystal Palace. *The Penny Illustrated Paper*, XXVI, 3rd Jan. 1874.

the forestage had retreated and the action was contained within the picture-frame of the proscenium arch. When Sachs wrote Modern Opera Houses and Theatres (Vol.3) in 1898, the retreat of the forestage and the 'traditional' position of the corner trap had been established for many years. His stage plan of a typical English wood stage [see Ilus.27] shows the two traps located symmetrically downstage of the grave trap. In some theatres, such as the Alexandra Palace Theatre, 1875, they were located parallel to the line of the grave trap, but such small variations in location should be considered as personal preference rather than significant differences in the evolution of trap location.

Similarly the many different designs of the corner trap which have been discussed may well be partially explained by the personal preferences of the stage machinists who installed them. Nevertheless, the variations were also related to function, for corner traps had to fulfil many different demands, often associated with the variable speed of appearance. The pantomime tricks of the Conquest family, for instance, usually relied upon fast rise traps enabling them to perform acrobatic leaps and somersaults [see Illus.74]. This type of trap work is probably best illustrated by a film entitled Joyland made by Lupino Lane in 1925 [70] but belonging to an earlier style of theatre which he had inherited from his famous theatrical forebears. Although the film sequence (which forms part of the video cassette accompanying this thesis) was probably shot in a film studio rather than a theatre, and relies heavily on 'cutting' for its timing, it represents a fascinating insight into the skill and dexterity of the acrobats who performed with such amazing agility.

The more slowly rising corner traps, which used sloats and/or drum and shaft mechanisms rather than heavy counterweights, were better suited to the more gradual scenic presentation of the pantomime transformation scene. It should not, however, be assumed that only one type of corner trap was ever used in a particular theatre. The relatively small size of these traps, coupled with the ingenuity and easy adaptability of timber construction meant that a stage carpenter could probably convert the corner trap from a fast rise to a slow rise in a comparatively short time. The many variants which have been quoted simply serve to illustrate the

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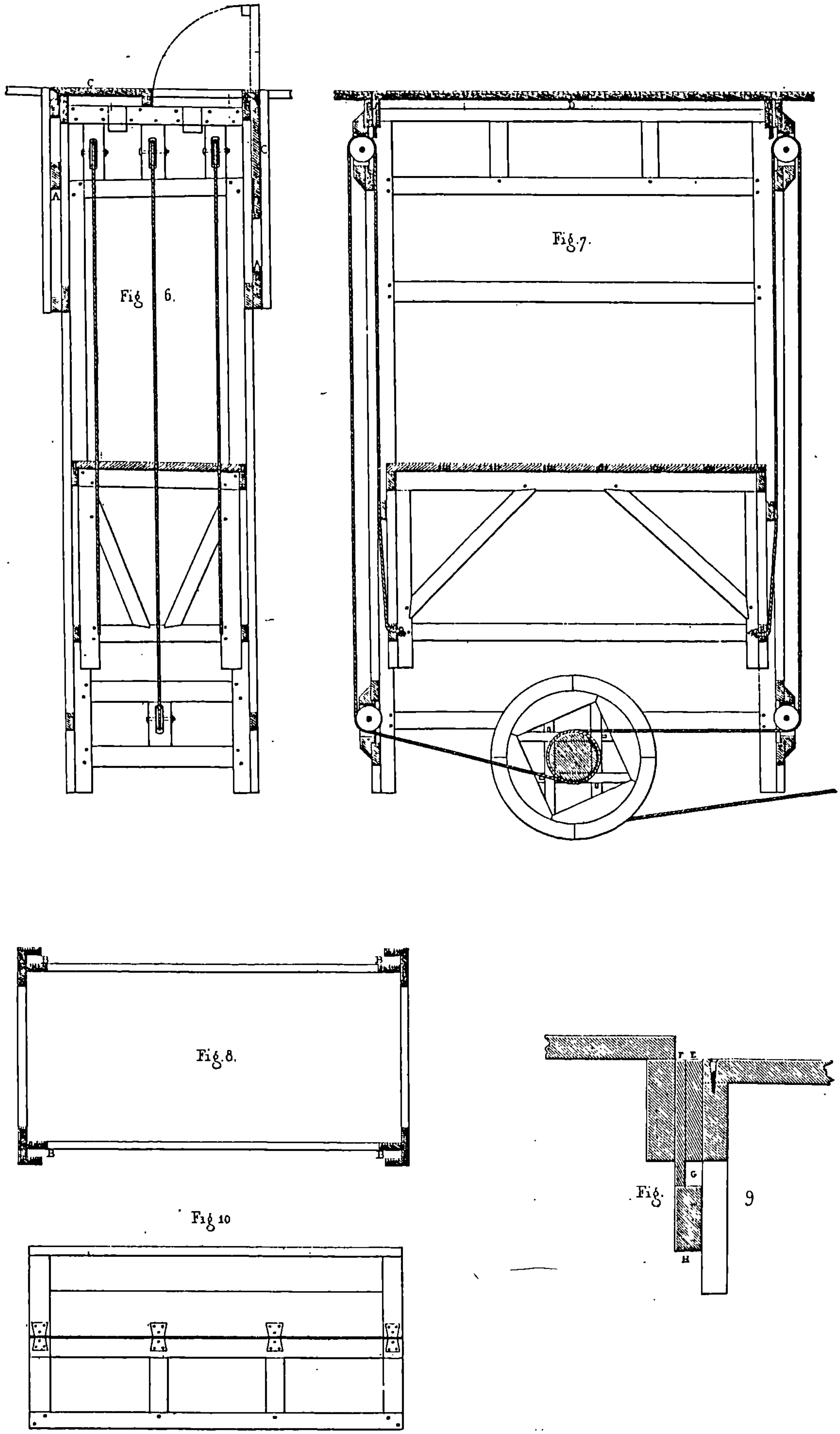
70. Joyland was made in 1925 and released in 1926 by Educational Film Studios, Hollywood, U.S.A.



<u>Illus.75</u> 'Grave' style trap. Contant, op.cit., pl.33.

enormous flexibility of the English wood stage, especially in comparison with the difficulties encountered in modifying traps made of an iron or steel construction.

The Grave Trap.

The name of this trap was derived from the proportions of the trap's aperture, which approximated, to the size of a coffin, and from its use in the Churchyard scene in Shakespeare's Hamlet. It was traditionally positioned centre stage as in Henry Holland's Theatre Royal, Drury Lane (1794). Rees, in his Cyclopaedia also shows a centre stage grave trap, [see Illus.73] and refers to it as "of an oblong form from six to seven feet in length, and from three to four feet in breadth. It is most frequently used for the grave scene in Shakespeare's tragedy of Hamlet." [71]

The mechanism which operated the trap varied very little from that of the corner trap. Contant [72] illustrates only one example although he does not specifically refer to it as a "grave" trap, and it does contain one or two surprising features.

Plate 33, [Illus.75].

Fig.6 and 7	View from both sides of a large trap frame.
A.	Handle of the movable frame, by means of which the two parts of the stage-floor are opened and closed at will.
B.	Grooves of the fixed frame receiving this platform. [See Fig.8]
C.	Sections of floor, one open, the other shut.
Fig.8	Plan of the fixed frame and grooves.
Fig.9	Details of section D.
E.	Oak bracket on which the stage floor rests when it is open.
F.	Movable stop-mechanism forming a rabbet with the bracket.
G.	Fixed cross-piece in which slide the tenons of the stop mechanism.
H.	Pine cross-piece bolted below the platform of the frame, used to bring up to stage-level the oak bracket and stop

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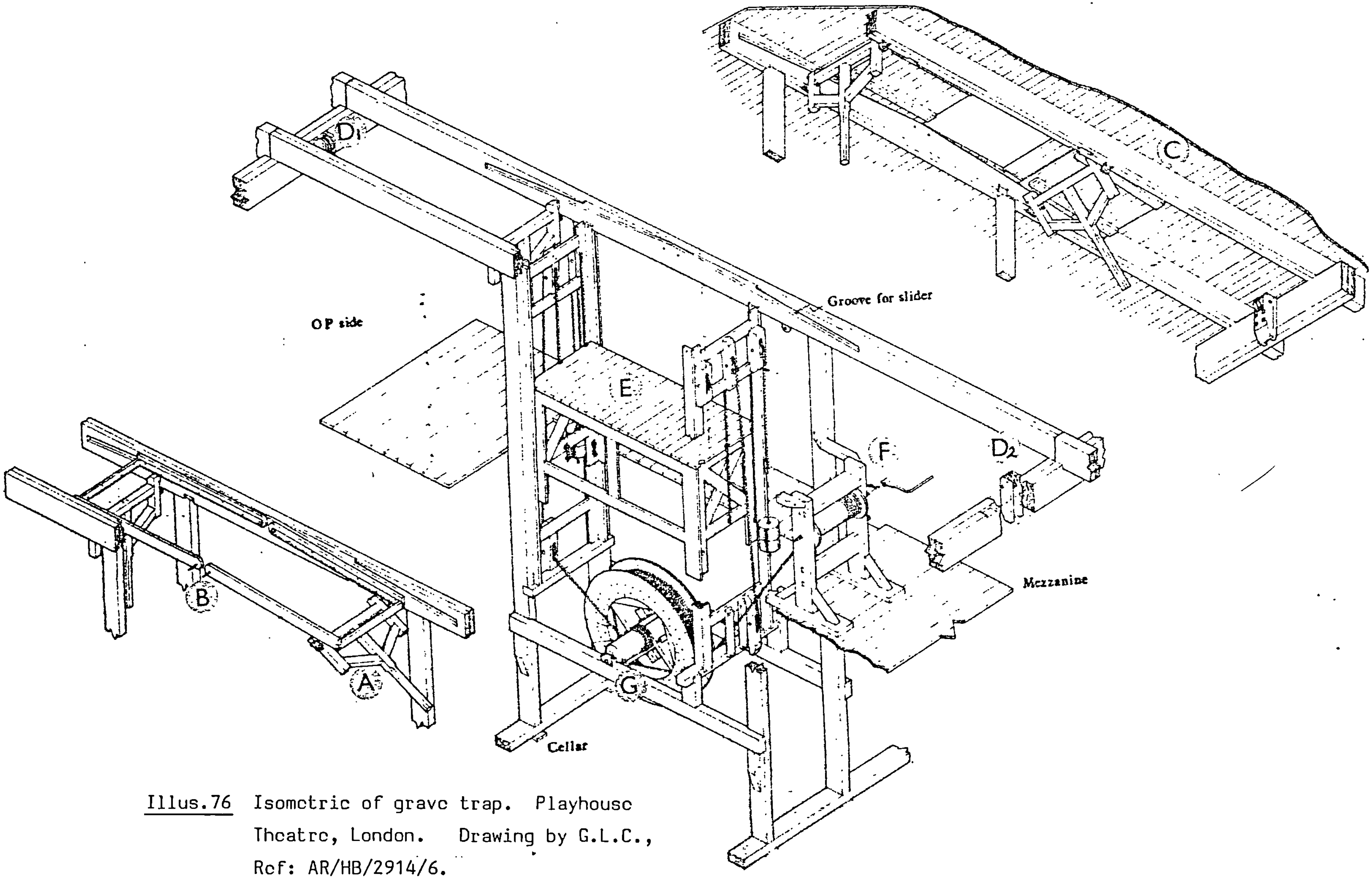
71. Abraham Rees, op.cit., XII, n.pag.

72. Contant, op.cit., pl.33 and p.149.



Illus.76 Isometric of grave trap. Playhouse Theatre, London. Drawing by G.L.C., Ref: AR/HB/2914/6.

mechanism which descend again simultaneously with the disappearance of the frame.

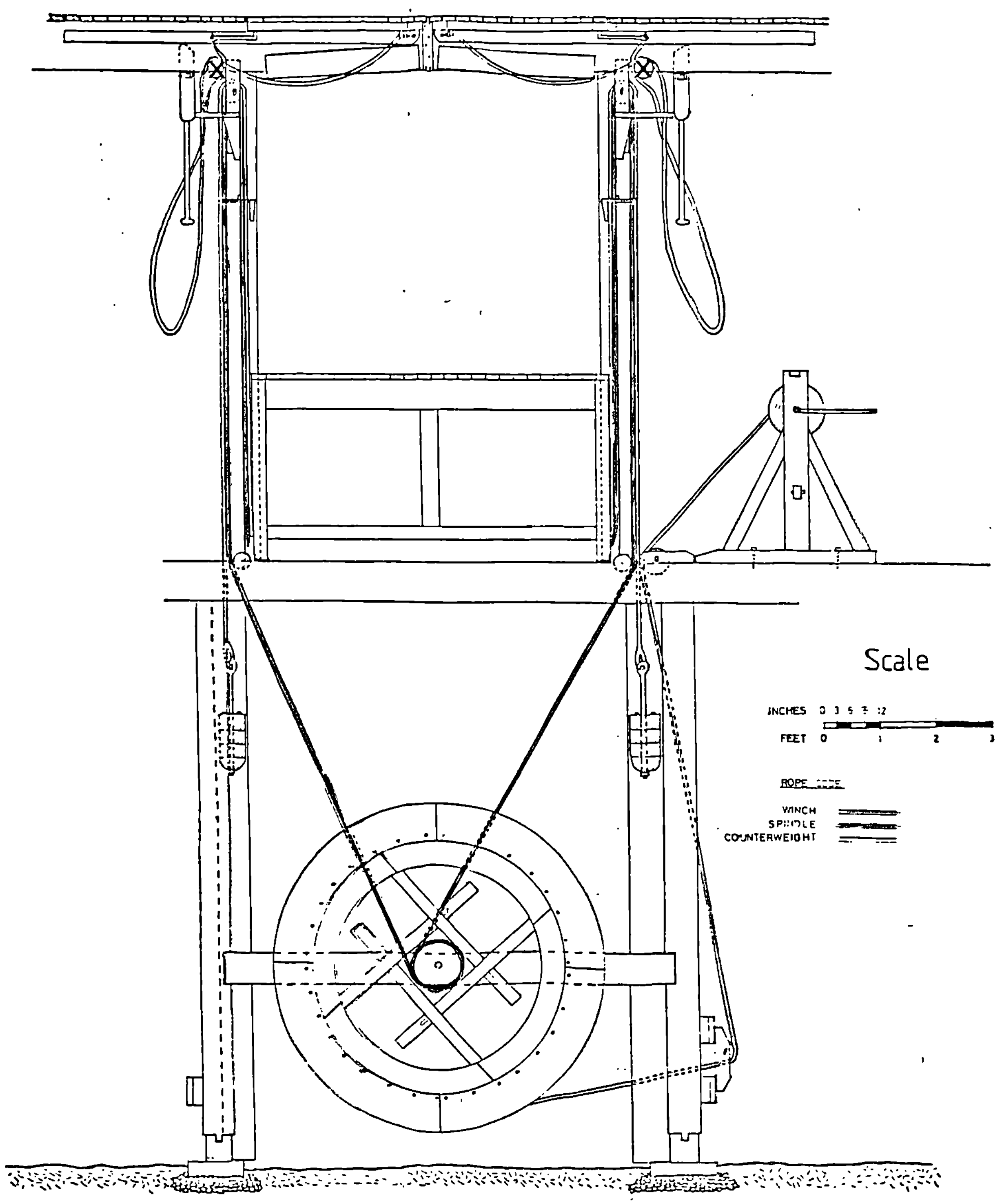
Fig.10 Half of the movable stage floor of the stage complete with hinges.

The method of opening and closing the movable floor sections shown in figures 6-10 is interesting because it appears to be very unusual. Herein, it could be argued, lies the danger of relying on evidence of English stage machinery written and drawn by foreign practitioners. However, the amount of evidence available today is very small in comparison to the number of grave traps which must have existed in England in the course of the nineteenth century. It therefore seems important to examine all available information.

According to Contant, the floor sections, C, are hinged and pivot as shown by the dotted line in Figure 6. When the floor sections become vertical they slide downward into a groove, B, shown in Figure 8. Although there seems to be no reason to suppose that this method would not work, it must have appeared unsightly to an audience compared with the more conventional method whereby the trap covers slid out of view under the permanent stage. Moreover, the rigging for the trap, as shown in Figure 6, must surely be inaccurate, for the two outer ropes appear to be attached only at one end. It would seem reasonable to suppose that counterweights were hung from these lines, four in all, which could be adjusted as required. The central lines are attached to the grave trap platform, one at either end, and run over various deflection pulleys to be finally attached to the shaft of a drum and shaft mechanism positioned directly below the platform. The line which is fed around the drum was presumably controlled from a windlass, although this is not shown on the plate.

More 'typical' grave traps of the nineteenth century English wood stage are to be found at the Tyne Theatre, Newcastle-upon-Tyne (1867), and the Playhouse Theatre, Charing Cross, London, (1907).

The latter example measures 6 feet by 2 feet 8 inches and is located in the traditional centre stage position. The lever or 'paddle' at 'A' [see Illus.76], supports a 'fillet' which pivots at 'B'. When the paddle is drawn back, as the right hand one is in the diagram, the fillet drops down



Illus.77 Transverse section of grave trap. Tyne Theatre and Opera House, Newcastle-upon-Tyne. Drawing by D.Wilmore.

along with the floor section which rests upon it. This then allows each floor section to be drawn off to its respective side underneath the permanent section of the stage, shown at 'C'. It has to be said, however, that the actual means of removing the 2 floor sections is not entirely clear from the diagram. The drawing shows two sets of double pulley blocks, D_1 and D_2, and there is an annotation in the margin stating "Blocks for sliders probably never used". The reason for this is related to the position of the blocks. Each floor section, when complete, should have two metal brackets, one at either end, to which is attached a single piece of rope passing through the double pulley block. The basic requirement of this method of opening the trap is that the pulley pivoting point (i.e. the double pulley block) be situated midway between the 'open' and 'closed' positions of the sliding floor sections. The Tyne Theatre grave trap [see Illus.77], for instance, has a roller x, which acts as a double pulley block to ensure the smooth operation of the sliding floor sections. Consequently, when I was engaged to restore this machinery at the Playhouse Theatre in 1987, a small modification had to be made to fulfil this basic requirement.

The grave trap platform at the Playhouse Theatre is raised and lowered by turning the handle of the timber winch, 'F'. The rope wound onto this winch is attached to a drum in the cellar mounted on a wooden shaft, 'G', to which two ropes are attached, one on either side of the drum. These pass through a series of deflection pulleys to be attached to both ends of the trap platform. The operation of the trap is also assisted by four sets of adjustable counterweights, which hang from ropes attached to each corner of the trap platform. It is particularly important to give careful consideration to the number of weights to be used. For instance if the trap has to ascend to stage level carrying a heavy load and then remain in this position until the end of the production, a large number of weights can be used. If, however, the trap is required to ascend and after off-loading descend unladen, a small number of weights must be used, otherwise the trap will not descend under its own weight. On such an occasion the effort required to operate the winch is increased, though usually still within the capabilities of one man.

Although forty years separate the installation of the Tyne Theatre grave trap and that of the Playhouse Theatre, their method of construction and operation is virtually identical, the only major difference being that the former is made of pitch pine, the latter of oak, owing to the introduction of tighter fire regulations by the London County Council in 1906. The design of the grave trap was almost standard during the latter part of the nineteenth century and few variations occurred. One such variation was however, used at the Alexandra Palace Theatre, 1875, where the drum and shaft was dispensed with to rely completely on counterweighting for assistance in operating the trap. Not only was the design of the grave trap fairly standard but so was its position upon the stage, although when I examined the Theatre Royal, Bath, prior to the demolition of the stage in 1982, there was evidence to suggest that several grave traps had been installed further upstage. These traps were, however, superimposed upon the original design of the substage machinery, indicating that they were probably incorporated for a particular production - further testimony to the flexibility of the English wood stage.

The Vampire Trap and Trappe Anglaise.

Reputedly the vampire trap was originally developed for J.R. Planché's adaptation of Le Vampire , which was first performed at the English Opera House (The Lyceum Theatre), London, on August 9th 1820. In the final scene, Ruthven the vampire is struck to the ground by a thunderbolt, requiring the actor to vanish immediately via a "vampire trap" positioned in the stage floor. For other productions, however, it would appear that it was frequently incorporated within the framework of a scenery flat and in L'Envers du Théatre Moynet provides a detailed account of its construction in this form. When it was first introduced to Paris in 1826 [73] in a production of Le Magicien et le Monstre, "what especially excited curiosity", he says, "was to see this singular character pass through walls and the earth without one being able to discover any opening there." [74]

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73. Six years after its first use in England.

74. M.J. Moynet, op.cit., p.60.

The trap consisted of:

"A solid frame of flat with two shutters or double doors, that is the entire machine .... but the details merit all our attention.

Each of the shutters is divided according to its width into a certain number of strips bound together by a cloth glued to the backstage side; on this cloth is applied a series of very flexible steel bands, the ends of which are solidly attached to the frame. The two shutters are thus kept flush with the surface of the flat. If a heavy body coming with speed, a running man for example, throws itself against the middle, the two shutters easily give way, then quickly spring back to their original position as soon as the man has passed through. The steel bands that will have given way by bending, will spring back immediately while bringing the shutters of the trap back to their position. If the actor has passed through very quickly, the opening will not be seen. This is what always happens when this passage is effected through the floor, the weight of the actor precipitating his fall." [75]

This must have been the case in the aforementioned production of The Vampire. It is interesting to note that Moynet's description given above is extremely similar to one given by Percy Fitzgerald:

"A number of elastic belts of steel, like two combs placed with their teeth together. These are covered with canvas, like any scenic door. The genie flings himself against it - it lets him through and flies back to its original state. Sometimes twigs are used." [76]

Moynet adds that, "The bands of steel in these traps have recently been replaced by whalebone which makes it still more difficult to notice a gap the whalebone springing back more rapidly." [77] Unfortunately this description is not elaborated upon and he closes the paragraph with the comment:

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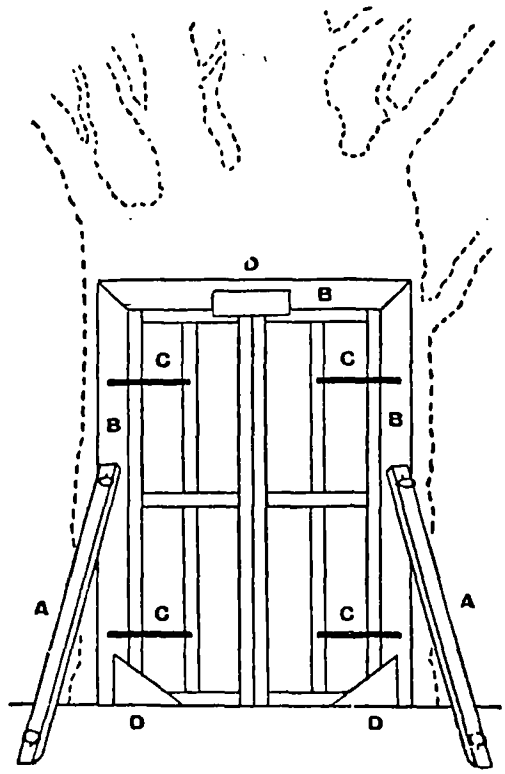
75. Ibid., pp.60-61.
76. Percy Fitzgerald, The World Behind the Scenes, p.55.
77. M.J.Moynet, op.cit., p.63.



Illus.78 "Details of trap in scenery flat." [A vampire trap]. Rose, op.cit., p.48.

> "The construction of this new apparatus is very different from the old; the shutters have disappeared from it. This new trap is still little known and has not yet [1874] functioned on a French stage." 77

Leopold Wagner, writing in 1881, describes the vampire trap as a "pair of doors coming together in the centre and worked upon springs, which whether the actor steps forwards or backwards afford him a speedy passage through, and in an instant return to their former place owing to the action of these springs." [78] He then notes two 'tricks of the trade' which assisted the operation of the illusion. Firstly, when the trap was inserted into a flat it was harder to see the outline of the doors if the scene was painted in dark colours. Secondly, if the gas was turned down behind the scenery, "the possibility of discerning the chinks of the matchboard doors"[78] was entirely removed.

A propos the vampire trap, it is worthwhile quoting an unnamed trap given by A.Rose in his book Stage Effects, [see Illus.78]. Although published as late as 1928 it recalls largely the techniques of the nineteenth century which were considered applicable for amateur theatricals around this time. It is interesting to note that the name 'vampire' is no longer used, its origin and significance having disappeared from living memory, but the modus operandi has remained the same. Rose describes it thus:

> "A very useful trap for sudden appearances may be arranged as shown in Fig.37. This is an upright pair of doors fixed to the back of a scene and firmly held in its place by a wooden batten at each side of the doors, the battens being held in position by four glorified screw-eyes, as used at most theatres for a like purpose, or stout and strong gimlets would answer. The dotted lines here shown are the outline of a tree that is painted upon the front of the scene, part of the trunk of the tree is being painted on the doors, so as to disguise them as much as possible. Of course, the design of the front scene may not, according to the plot of the play, be a tree, but perhaps a brick wall, a fountain or an interior wall, and so on. The battens, A, are secured to the door framework, B. The doors are

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77. M.J.Moynet, op.cit., p.63.
78. Leopold Wagner, op.cit., p.56.

built up of light wooden battens, and covered with canvas in front. Attached to the framework, B, and the door battens is a rubber spring, C, shown by the solid black lines. There are four springs, two for each door. Pieces of wood, D, are screwed to the door framework to act as buffers, so that the doors will not open inwards. These buffers must be well padded with pieces of thick felt or indiarubber, that the door when closing upon them is silent. When fixing the rubber springs they should be stretched somewhat, so that when in action they will have a fairly good tension. All being ready the actor awaits his cue, then, very quickly, pushes the doors open, passes through when the doors immediately close behind him. Well rehearsed, and quickly done, this should give an instantaneous and surprising effect. There is another trap for disappearances, which is arranged in the floor of the stage. It has two doors or flaps, through which the performer dives on to a mattress or other convenient receptacle below the stage, the flaps closing up immediately level with the stage." 79

Wagner offers useful advice to the would-be 'entortilationist'.

"The trick panels in the comic-scenes, through which Messrs Clown and Harlequin are wont to jump are managed on the same principle, a number of men standing ready behind to catch them as they pass through. For our own part, experience has proved that it is most advisable in order to ensure personal safety to distribute beer-money amongst these men from time to time alas!" 80

At the time of writing I do not know of any surviving examples of the vampire trap. This is undoubtedly due to the temporary nature of this kind of trap, as it was inserted into a scenic flat or into the stage floor to answer the needs of a particular production. The grave trap could be easily modified to serve this purpose. Perhaps this was what happened at the Theatre Royal, Ipswich, in 1874, when, Eyre tells us, 'The entire

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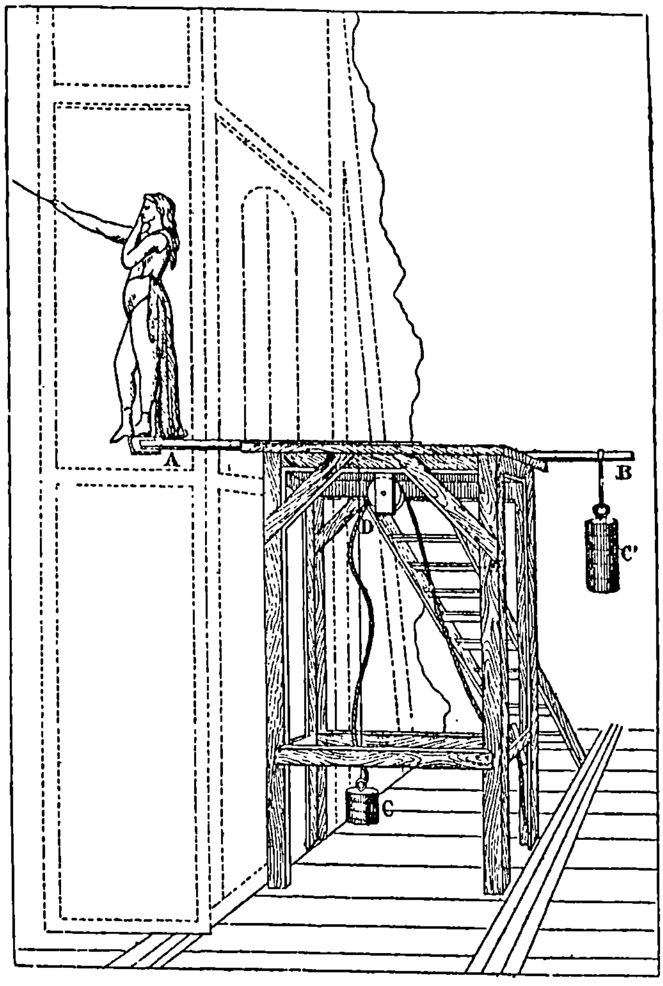
79. A.Rose, op.cit., pp.47-49.
80. Leopold Wagner, op.cit., pp.56-57.



Illus.79 "Trappc Anglaisc." M.J.Moynct, op.cit., p.205.

lot [traps] were put in working order with new sliders, tables, ropes & cranks & also 2 'star' & 1 'vampire' traps added." [81] In another, conflicting passage he states that, "the stage remained in a very bad condition until 1871 when William Addis carpenter of the proprietors fitted in a new stage, but the new traps which had been for some long time out of order, were not put into working order until 1876 at the Christmas, when two star & a vampire trap were added by John Baxter the Carpenter to Messrs. Richardson and Turner the then lessees." [82] As the text specifies the "addition" of a vampire trap, the implication on this occasion would seem to be of a semi-permanent feature incorporated into the stage floor, rather than a temporary type built into a scenic flat.

The film sequence from Joyland shows the vampire trap being used as an acrobatic device, rather than as an aid to illusion. It is quite obvious to the observer that Lane does not "pass through walls", nor was it intended that he should appear to do so. It nevertheless provides an excellent demonstration of the uses to which this kind of trap could be put.

In L'Envers du Théatre, Moynet provides an illustration of another piece of equipment which could be used in conjunction with a vampire trap or, as he calls it, the "trappe anglaise" [see Illus.79]

> "We are before a little scaffolding to which one gains access by a miller's ladder. A bar of iron (A), slides in a groove on another larger bar (B), pulled by a strong linen rope on which is suspended a counterweight (C). Iron bar (A) is bent at a right angle at the forward end, making the rigid upright shaft on which will be supported the fairy, belted by a heavy strap with her feet resting on a little pedal on (A). The pulley (D) seen under the floor of the scaffold is used to raise back the counterweight (C) at the end of the scene, which will return the fairy to the floor of the scaffold. The line will be tied off on a peg, indicated in the lower part of the framework. It is clear that, as the counterweight (C) is let out

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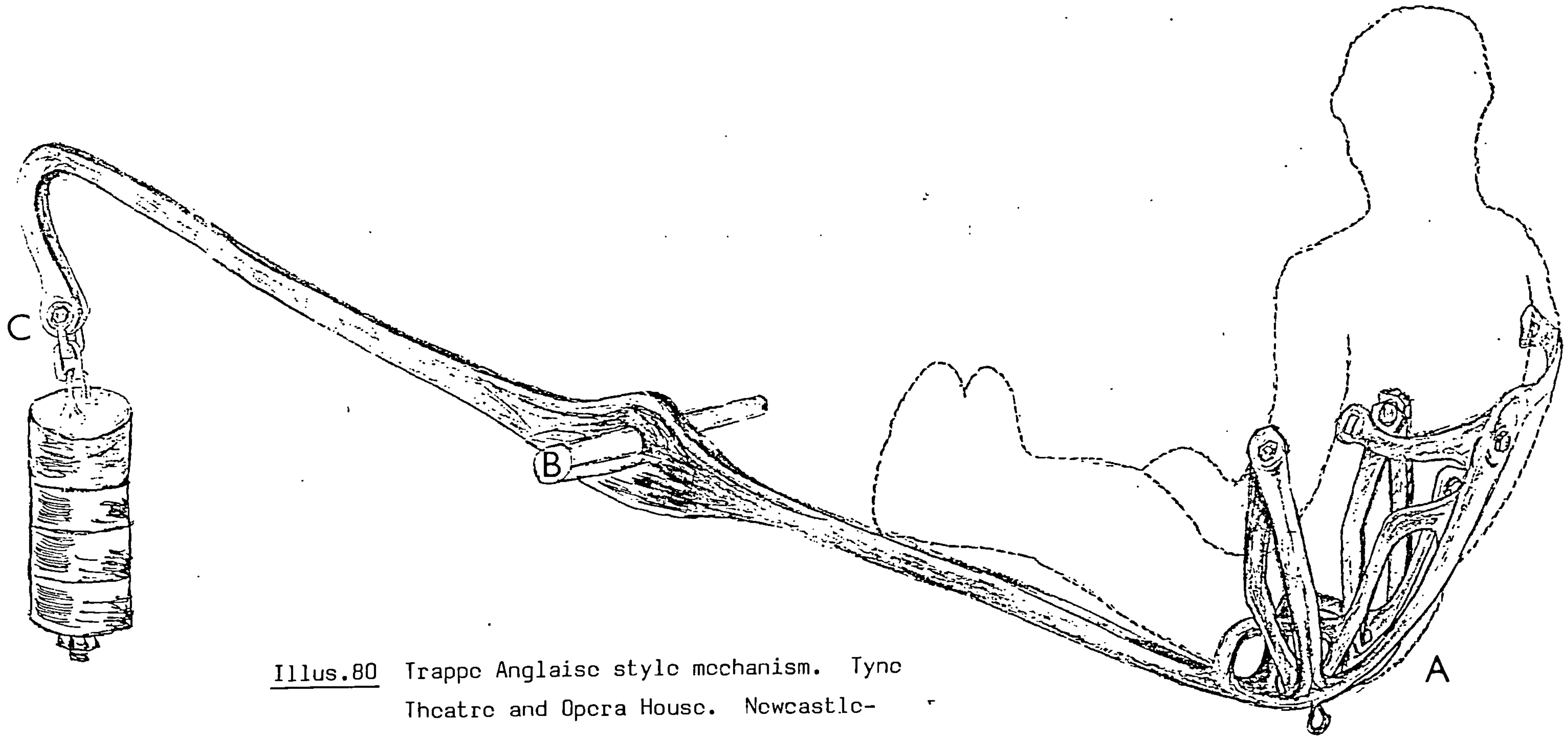
81. H.R.Eyre, op.cit. p.20.
82. Ibid., p.82.



Illus.80 Trappe Anglaise style mechanism. Tyne Theatre and Opera House. Newcastle-upon-Tyne.
Drawing by D.Wilmore.

quickly by hand, the moving iron bar, its perpendicular shaft, the pedal, and the person on it will slide rapidly along the fixed iron bar fastened to the scaffold framework. Two strong clips or staples keep the moving iron bar on top of the other and prevent it from toppling over. A heavy counterweight (C') suspended on the outside of the structure, will maintain the stability and balance of the contraption when all the weight is overhanging forward." [83]

This particular piece of apparatus was designed by Eugène Godin for the Gaîté Théatre in Paris, although the original idea came from England, hence the name 'trappe anglaise'. It does, however, highlight two considerations which are worth mentioning at this point.

Firstly, it is based upon the vampire trap, which indicates that continental stage machinists could be influenced by practices in this country. More importantly, the design of this piece of apparatus illustrates how a so called new trap or technique was simply an adaptation of an old idea. For instance, the sliding iron bars bear a striking resemblance to a sloat, and the supporting brace for the fairy is reminiscent of the brace which will be discussed in connection with sloat corner traps [see page 136]. Although Moynet states that this apparatus was designed for use in a French theatre, it is very interesting to compare it with a large metal brace discovered at the Tyne Theatre. Illustration 80 shows a long iron bar, with at 'A' a small primitive seat, at 'B' a hole suggesting a possible axis or pivoting point, while the hooked end 'C' contains another hole, from which a counterweight was hung. Admittedly, the bar does not have a sliding mechanism, as in the Moynet example, but in the right position it would be possible to pivot the chair through a set of vampire trap doors to produce a similar effect.

The English stage machinist seems to have been particularly adept at developing a new type of effect or trap, albeit with existing forms of mechanism and technology. Indeed this very inventiveness, it could be argued, may have been one of the reasons why newer and more sophisticated forms of technology were seldom introduced into stage machinery. In view

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83. M.J.Moynet, op.cit., pp.200-203.

of the fact that the vampire trap was specially devised for the English adaptation of a French play, it is perhaps not surprising to learn that when an adaptation of Eugène Grange and Xavier de Montepin's Les Frères Corses was produced in London, an English stage machinist designed a particular piece of machinery which was to have a great influence on the layout of the English wood stage for almost fifty years.

The Corsican Trap.

The Corsican Brothers was first performed in England on 24th February 1852 at the Princess's Theatre under the direction of Charles Kean. During his eight and a half years tenancy at the theatre it was produced two hundred and thirty six times, providing an indication of its popularity with the mid-Victorian audiences. The story concerns two brothers who were born in Corsica. One still lives on his native island, while the other lives in Paris. The Parisian brother becomes involved in a duel and is subsequently murdered. He then reappears to his brother in Corsica imploring him to avenge his death, which he eventually succeeds in doing. The play is divided into three acts, the first two taking place simultaneously in time.

On several occasions during the course of the production it is necessary for the dead man to appear as a ghost to his brother. For this purpose a piece of stage mechanism was devised which made the ghost appear to glide across the stage while apparently rising through the ground; hence the trap's alternative name, the "ghost glide". In The World Behind the Scenes, Percy Fitzgerald provides a description of the mechanism:

> "Below the stage on the mezzanine floor - the dessous, as the French call it - we see around us a bewildering miscellany of ropes and wheels; it is like the tween decks of a vessel. At the extreme end on the left side begins an inclined plane of two ledges or rails, starting from the ground and stretching at a gentle slope to the opposite side. A level circular stand is inserted at the bottom between the ledges, and on this the Corsican brother, or his double, when they go below the actual stage, take their stand. Overhead there is an oval opening sufficient to let a figure pass through, the edges of which are lined with black bristles or brushes, which makes the

opening, as it were, fit close to the figure. This opening, however, is fixed in a sort of travelling plank or strip duly jointed on the principle of those wooden shutters which roll up and down in front of shop windows. This flexible strip, for the time appearing to be port of the stage, is wound on the same windlass or drum to which the rope that draws the stand up the inclined plane is attached, so that both the aperture and the stand advance together, and by the time the journey is completed, both have been wound round the drum." [84]

Although this appears to be a comparatively detailed description of the Corsican trap any attempted reconstruction comes up against one basic problem. Fitzgerald clearly states that the flexible flooring, known as scruto, and the moving platform which ran on inclined rails, were controlled by the same windlass. However, because the floor moves horizontally and the platform travels in a diagonal line, the distances travelled are different. This variation must therefore be compensated for, but unfortunately Fitzgerald gives no indication as to how it was done. Although many Corsican traps were installed into many theatres in Great Britain very little evidence survives to this day. The popularity of The Corsican Brothers had virtually been exhausted by the end of the nineteenth century, although, according to The Builder , [85] a Corsican trap was installed into the newly built Her Majesty's Theatre, London, in 1897. Because of the decline in the popularity of the play many theatres removed the mechanism to replace it with more conventional and standard timber machinery. This factor alone would seem to account for the lack of evidence still extant. It has been suggested that the secret of the Corsican trap mechanism was jealously guarded, but the play was performed at hundreds of theatres all over the world, and many thousands of people must have seen and worked one. Indeed it is probably because the workings of the Corsican trap were common knowledge to many stage machinists that no-one appears to have documented it in detail.

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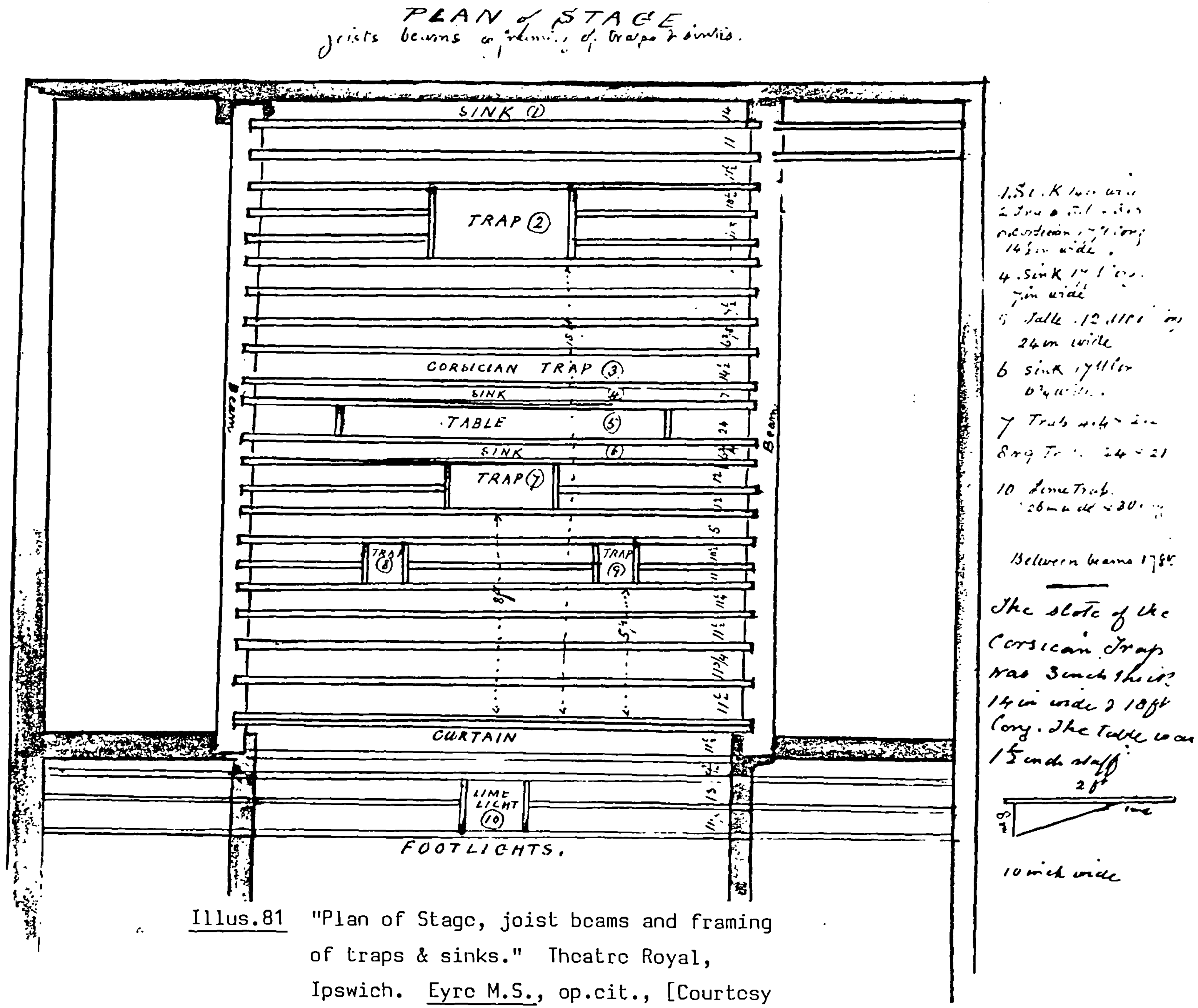
84. Percy Fitzgerald, The World Behind the Scenes, pp.46-47.

85. Anon., "Visit to Her Majesty's Theatre, Haymarket", The Builder, 13th March, (1897), p.251.



Illus.81 "Plan of Stage, joist beams and framing of traps & sinks." Theatre Royal, Ipswich. Eyre M.S., op.cit., [Courtesy of Suffolk Record Office].

One piece of information concerning the mechanism can, however, be extracted from the Eyre manuscript. He relates that,

> "Under an opening 17 feet long and 14.5 inches wide, a small 2 foot platform ran on a sloping rail. On this the player stood, entirely hidden under the stage at the beginning of its travel. As it was drawn across it rose on its rails, until when it reached the far side of the stage the 'ghost' was fully in view. Attached to either side of the trap opening, so as to move with it, were two lengths of jointed flooring which slid along the aperture covering the gap, except where the trap happened to be at a given moment. Furthermore, the circular opening of the trap itself was lined with a fringe of bristles which pressed against the figure as it rose and so prevented any aperture being visible between the player's body and the stage through which it was passing." 86

Unfortunately this does not add a great deal to Fitzgerald's description. However, also included in the Eyre manuscript is a small drawing of the platform on which the actor stood, [see Illus.81] and this is supplemented by a very important annotation which reads "The slote of the Corsican Trap was 3 inches thick 14 inches wide and 18 feet long. The table was 1.5 inch stuff." 87

The descriptions given by Fitzgerald and Eyre seem highly similar, though there is one small difference which may be of some significance. Fitzgerald describes the track on which the platform ran as "an inclined plane of two ledges or rails", whereas Eyre states that it also ran on rails, but adds that a slote was incorporated into the mechanism. Given this, it is feasible to suppose that the trap platform was attached to the tongue of the slote and that two rails were positioned on the "sleeve" or immovable section of the slote to assist in the guidance of the platform.
This does not, however, explain how the sliding "scruto" floor sections and the trap platform were operated in a synchronised manner. Because the effect usually required the apparition to traverse almost the full width of the proscenium opening, it meant that a large quantity of scruto had to be

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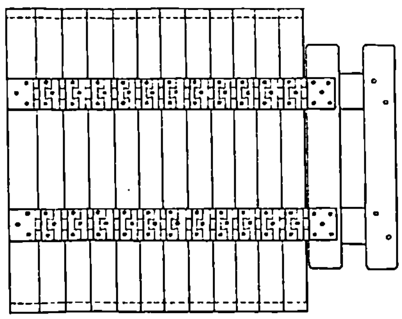
86. H.R.Eyre, op.cit.
87. Ibid.

Illus.82 Diagramatic representation of scruto travel for Corsican Trap. Drawing by D.Wilmore.

(Not to scale).



Illus.83 Details of scruto style trap cover. Contant, op.cit., pl.32. fig.5.

available. For instance, [see Illus.82] the hole 'A' through which the actor must pass has to travel to 'B'. This means that a length of scruto equal to the distance between A and B must be attached to the offstage side of A at 1. However, in order to carry this out it would be necessary for the wing space at either side of the stage to be at least equal to the proscenium opening. Clearly, there were very few theatres in the country which could fulfil this condition, and it must therefore be assumed that an alternative method was used.

The 'scruto' consisted of small planks of wood, which were nailed together on their underside by two strips of canvas. A similar method was in fact illustrated by Clément Contant in connection with the construction of a corner trap cover [see Illus.83]. It is, however, possible to draw on evidence found during an examination of the substage of the Theatre Royal, Bath, prior to its demolition in 1981 for, although the sloping rails and mechanism had been removed, the trap cover and a small amount of associated scruto was discovered lying in runners beneath the stage right wing space. [see photos.27,28].

This evidence would appear to represent the only portion of an original Corsican trap still extant anywhere in the world, and it must therefore be considered carefully. According to the newspaper accounts relating to the theatre's opening in 1863 [88], a Corsican trap was installed in the substage as a permanent fixture and as the substage when examined in 1981 appeared to be largely original, it seems reasonable to suppose that this Corsican trap remnant dates from 1863. As can be seen from photos.27, 28, the trap aperture is oval in shape, the diameter varying between 1 foot 2 inches and 1 foot 7 inches. However, the edges of the timbers forming the aperture do no display any evidence of ever having had bristles attached as related by Fitzgerald. Perhaps the greatest problem presented by the evidence extant at Bath was the operation of the sliding scruto. As discussed previously, the wing space was hardly ever wide enough to accommodate an adequate length of scruto. It would therefore seem reasonable to suppose that the scruto was wound onto a windlass as described by Eyre. However, in order to make this possible the stage

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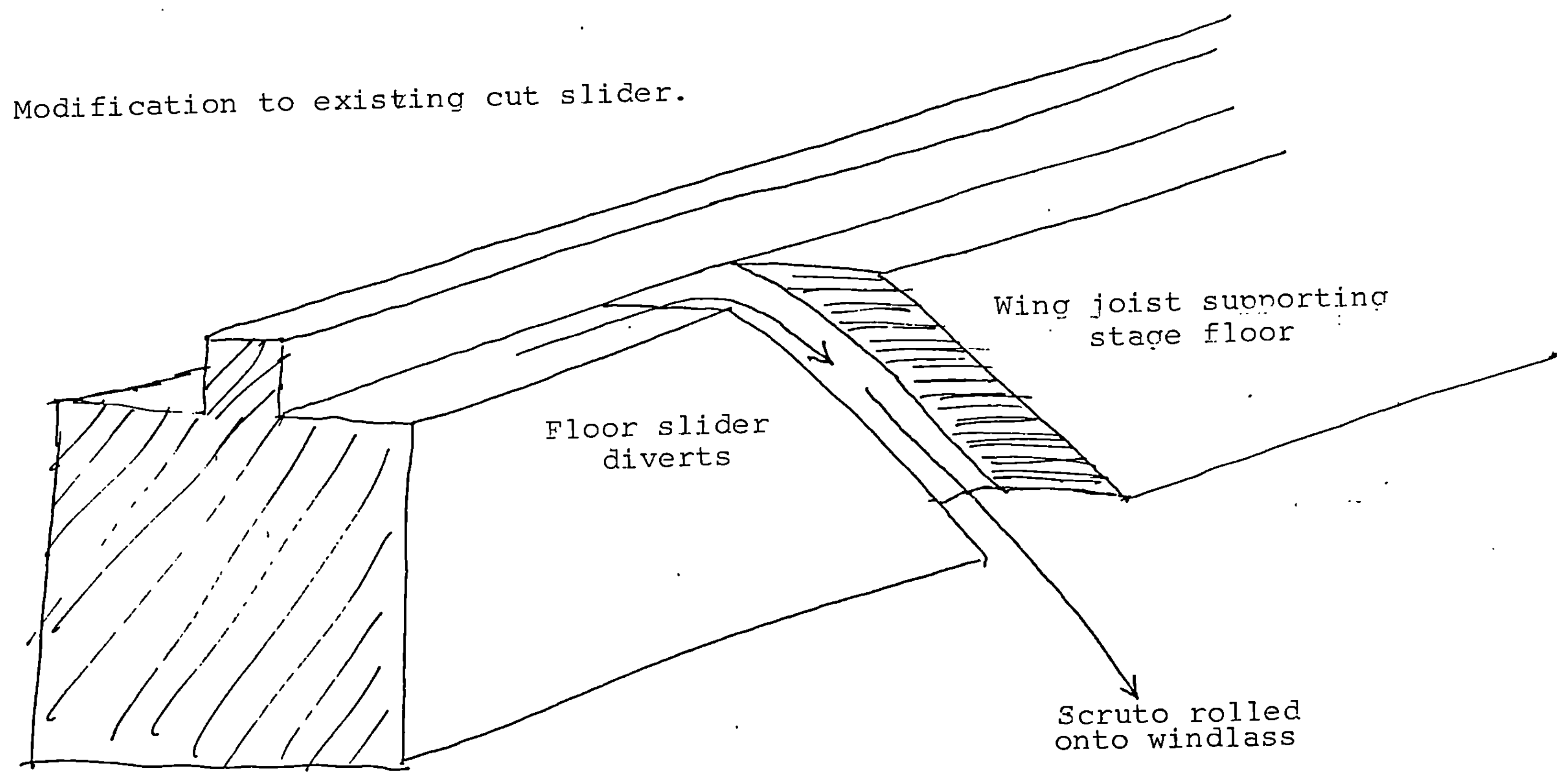
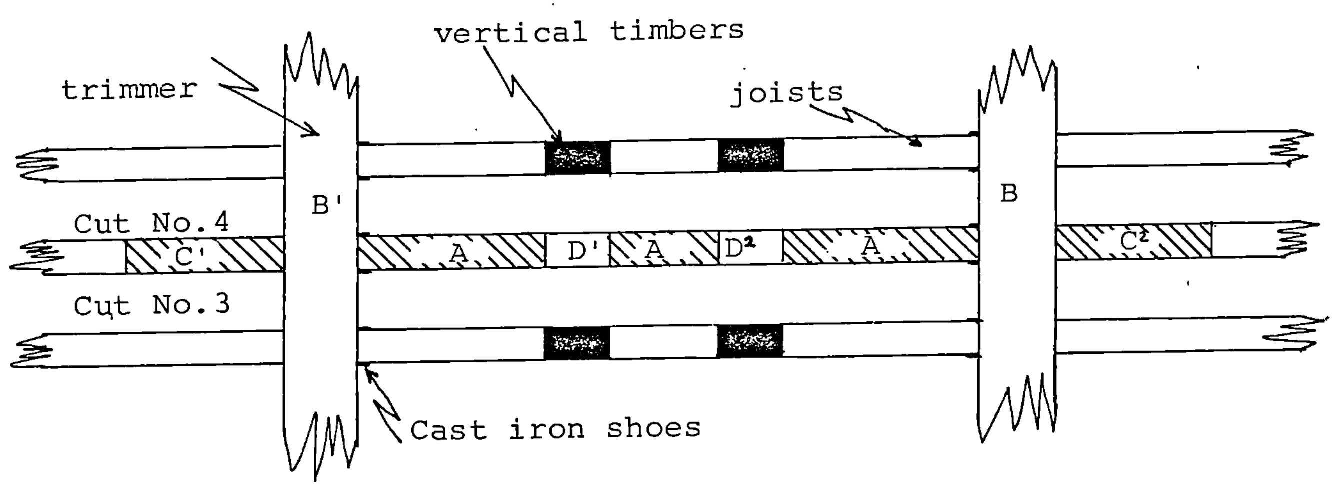
88. Anon., <u>The Bath Chronicle</u>, 5th March, (1863), p.7.



<u>Illus.84</u> Corsican Trap Scruto Operation. Tyne Theatre and Opera House, Newcastle-upon-Tyne. Drawing by D.Wilmore.

joists would have to have had a special set of runners to guide the scruto on to the windlass, but a detailed examination of the joists revealed nothing. Nevertheless, the presence of the scruto indicated that the Corsican trap floor sections must have been rolled onto a large drum. Although the evidence was not to be found at Bath, an examination of the stage joists at the Tyne Theatre revealed an important modification which had been made to stage cuts three and four [see Illus.84]. The joists as shown on the drawing had had an additional curved runner chiselled out to allow scruto to be passed down presumably to a windlass located on the mezzanine floor. Additional corroborative evidence suggesting that these runners were cut for a Corsican trap can be drawn from their relative position on the stage. The apparition is designed to be located far enough away to look realistic, and yet near enough to ensure no loss of effect. It therefore follows that the trap would be ideally positioned at a point approximately equidistant between the front and the rear of the stage, allowing space behind for the tableau scenes at the end of acts one and two. It therefore seems certain that the number three and four cuts [see Illus.85] were modified into a Corsican trap by removing the tranverse joist, A, which was mounted on cast iron 'shoes' set into the main trimmer joists, B^1, B^2. In addition, a portion of the joists C^1, C^2, was removed to accommodate the scruto as it passed down onto the mezzanine windlass. Two vertical timbers were also removed, D^1, D^2, which had originally acted as intermediate bearers for the transverse joist, A, thus providing room for the installation of the moving platform on a sloping rail/slote. With the removal of C^1, C^2, the paddle mechanisms for the cuts were also removed.

When the machinery was examined in 1979, the structural timbers A, D^1, D^2, had been replaced, though the timbers C^1, C^2 and paddle mechanisms were missing. This would seem to indicate that, although it was necessary to make the stage structurally secure after the performance of The Corsican Brothers, it was not considered essential to replace the paddles, either because the 'cuts' were no longer operated on a regular basis or perhaps because the stage machinist anticipated using the trap again in the near future. This incidentally shows that with the incorporation of cast iron shoes the standard English wood stage could be modified quickly and easily, providing greater flexibility than is usually attributed to this system. This was, in fact, common practice, Ernest Woodrow commenting in 1893 that iron shoes were incorporated to "provide an opening in the stage



Illus.85 Diagram of removable joists for Corsican Trap. Tyne Theatre and Opera House. Newcastle-upon-Tyne. Drawing by D.Wilmore.

of a width greater than the slider or the bridges." [89]

Unfortunately, all the available evidence does not explain how the movements of the scruto and the trap platform were co-ordinated. It seem clear from the descriptions quoted that the operation of both of these items was controlled by one single windlass. There must therefore have been some kind of compensating mechanism to allow for the variation in distance travelled by the scruto and the platform. One possible solution is to construct a windlass with a barrel divided into two, each half having a different circumference. This would then mean that with one revolution of the windlass the amount of rope taken up and therefore the distance travelled by the scruto and the trap platform would be proportionally correct. The use of a variable circumference or "graduated" windlass was common in the nineteenth century theatre, although its application in this particular case poses several problems. If the apparition traversed the full width of the proscenium opening, say twenty-eight feet, there would be twenty-eight feet of rope to wind onto the windlass. This would mean that it would be necessary to 'layer' the rope onto the barrel, causing the effective circumference to increase. It would therefore be very difficult to account for this change in circumference and still maintain perfect alignment between the scruto and the platform.

Another possible method of operation has been suggested by David Anderson [90]. This assumes that the trap platform and scruto were physically attached to one another. Although a model which he constructed works very well, its construction is not apparently based upon any definite historical evidence. An examination of the underside of the scruto and aperture from the Theatre Royal, Bath, reveals nothing to suggest a point of attachment for the platform. The two small metal hooks [see photo.28] do, however,

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89. Ernest A.E.Woodrow, "Theatres XVII", The Building News, 10th Feb., (1893), p.189.
90. David Anderson, "Forgotten Theatre Machinery:The Corsican Effect or Ghost Glide", Theatrephile, I, No.4, Sept.(1984), pp.76-77.

suggest that this scruto section could be connected to standard lengths of scruto, allowing the aperture to be positioned as required. Perhaps in the course of time more information will be discovered to solve this curious problem.

At the end of the first act of the play the Corsican trap is seen for the first time. The text reads:

SAV: (R.C.) Yes, you are right - it is a very strange thing - I remarked it myself - the clock stopped this morning without any apparent cause.

FAB: (L.C. much agitated) This morning! - but - it has not been regularly wound up - mother?

SAV: Yes - and that is what I cannot understand; for it was wound up the day before yesterday.

FAB: Oh! -Louis! -Louis!

SAV: Dear child! what is the matter?

FAB: Nothing - mother - nothing. Good night, dear mother!

SAV: Good night, Fabien. (near L.H. door) (aside) Oh! I am sure there is something unknown and terrible hanging over us.

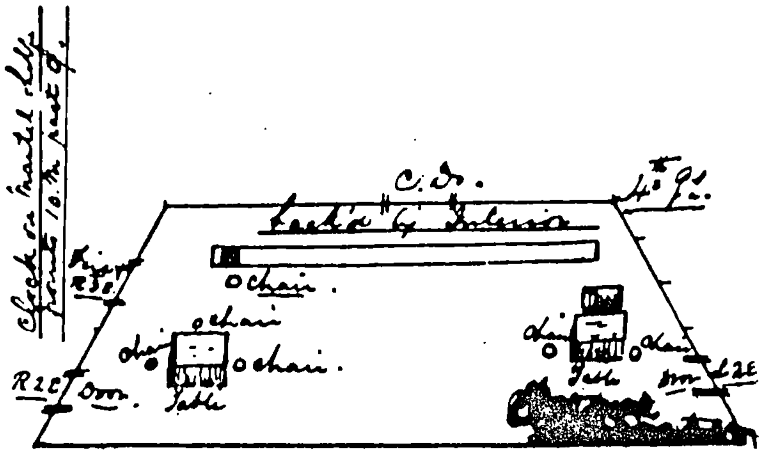
Exit R.D.

FAB: To horse - to horse - Griffo! not an instant's delay. For me, I will write at a venture to my brother; you must put the letter in the post as soon as you arrive, so that it may go by the steam-boat to-morrow; get ready, and return in five minutes for it.

Exit Griffo, C and L.

FAB: This pain in my side - this coincidence between my watch and the clock. (throwing off his jacket) Nothing - nothing - not-withstanding - (he remains in his shirt sleeves, and sits at the table on R. writing) "My brother, my dear Louis, if this letter finds you still alive, write to me instantly, if only two words to satisfy me. I have had a terrible warning - write to me! - write to me".

He folds his letter and seals it, at the same time Louis dei Franchi appears, rising from R.C. without his coat or waistcoat, as his brother is, but with a blood stain upon his breast, he glides across the stage - ascending gradually at the same time.



Illus. 86 Stage plan sketch for The Corsican Brothers, by John Proctor, prompter at the Pittsburgh Theatre, 1852. [Courtesy of the Folger Shakespeare Library].

LOUIS: (laying his hand on FABIEN'S left shoulder, and heaving a sigh) Ah!

FAB: (turning round) My brother! - dead!

SAVILIA appears at the door, R.H.

SAV: Fabien (going over to him) who is dead? (terrified at his emotion, she sinks on her knees by his side, L.)

LOUIS: (with his finger on his lips and addressing FABIEN) Silence! -look!

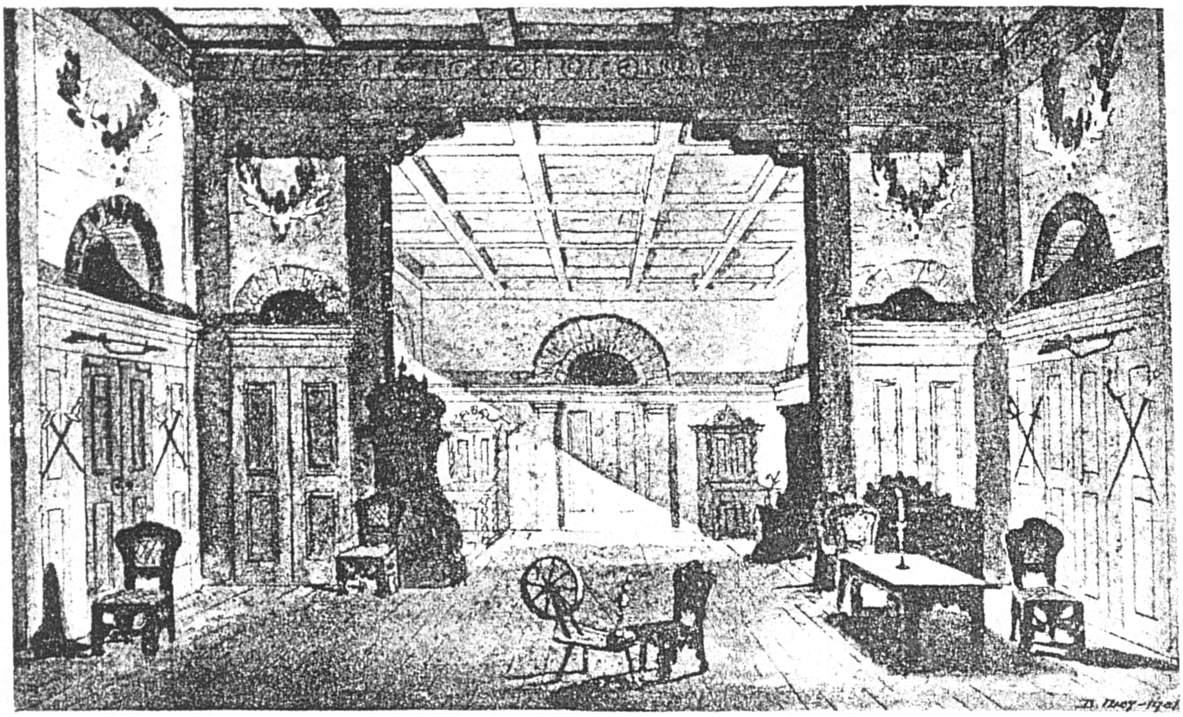
He disappears - at the same moment the scene at the back opens and discloses an open clearing in the forest of Fontainbleau, at C. is CHATEAU-RENAUD who is wiping his sword, and on the other, LOUIS DEI FRANCHI, upon the ground, R.C. supported by a SURGEON and his SECOND, who are rendering him assistance - two other GENTLEMAN in position R., realising the group from the picture of "THE DUEL".

TABLEAU

End of Act the First

A prompt book made by John Proctor for an 1852 production at the Pittsburgh Theatre, U.S.A., also illustrates this scene [see Illus.86]. The desk and chairs where Fabien writes his letter are positioned almost directly downstage of the trap aperture, (presumably the shaded block), providing adequate masking. Once the effect is complete the 'ghost' brother steps off the Corsican trap to speak the line, "Silence! - look!", and then the stage direction requires him to disappear, presumably via the trap marked on the prompt copy stage plan, positioned just upstage of another table, stage left. Finally, there is the tableau scene depicting the duel in Paris, viewed from the house in Corsica [see Illus.87]. Similarly, at the end of act two, there is a tableau scene showing the house in Corsica, viewed from the Forest of Fontainebleau [see Illus.88]. It would seem reasonable to suppose that these two scenes could be executed with a gauze which when lit from the front produced a 'solid' scene and when 'bled' revealed the tableau behind. Fitzgerald remarked that:

"The use of so intense a light as the limelight has favoured the



Illus.87 The interior of the house in Corsica.

Reveal of the duel in Fontainebleau Forest.

Reproduced in: Southern, The Victorian Theatre, op.cit., p.44.

> introduction of a new effect in the shape of transparent scenery; that is, of a scene that looks like any ordinary one, but is painted on a thick gauzy material. Thus, in the first act the back scene in the Corsican palace is of this material, through which the tableau of the Paris duel is shown, a fierce light being cast upon it." 91

He then adds:

> "In the original representation half of the wall descended, the other portion ascending, and revealed the scene."

This suggests that the lower portion was attached to a series of sloats which descended into the substage, while the upper half was flown. However, the stage directions for both acts read:

ACT ONE:- "at the same moment the scene at the back opens and discloses an open clearing in the forest of Fontainebleau".
ACT TWO:- "the bottom of the stage opens slowly - the Chamber of the First Act is discovered".

These directions suggest an alternative method whereby a pair of flats, possibly running in long grooves, "opened" or parted centre stage. At the given moment the stage carpenters slid the scenery off into the wing space, revealing the preset tableau behind. This meant that at the end of act one Louis, or in effect "the double", observed by his brother, had to traverse on the Corsican trap and exit by a corner trap. However, almost immediately Louis was revealed to the audience in the tableau scene, which raises the interesting question of the possible use of two doubles.

In the second act the main actor played the part of Louis, while the double played Fabien in the tableau scene which closes the act.

At the end of the third act the text reads as follows:

FAB: (rising) My Mother! I have kept my word with you! - Louis! Louis - I can weep for him now! (passes behind a tree, L., upstage; then advances, with face covered by his hands, and sinks, weeping, upon the fallen tree, L.C. - (a pause)

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91. Percy Fitzgerald, The World Behind the Scenes, op.cit., p.48.

Illus.88 The Forest of Fontainebleau.

Reveal of the interior of
the house in Corsica

Reproduced in: Southern, The Victorian Theatre, op.cit., p.45.

LOUIS: (rising from R.C., and gliding to L.C., placing his hand on the shoulder of FABIEN).

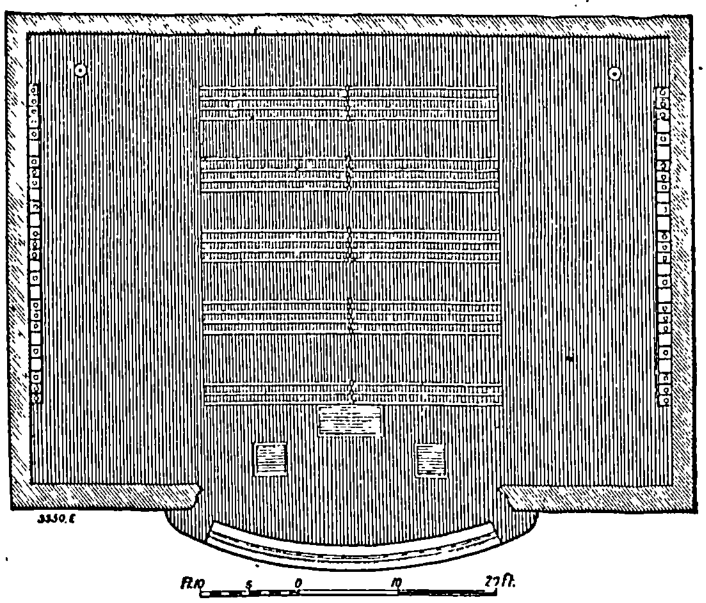
Why weep for me, my brother? - shall we not meet above?

FABIEN falls on his knees, with his face to the Figure.

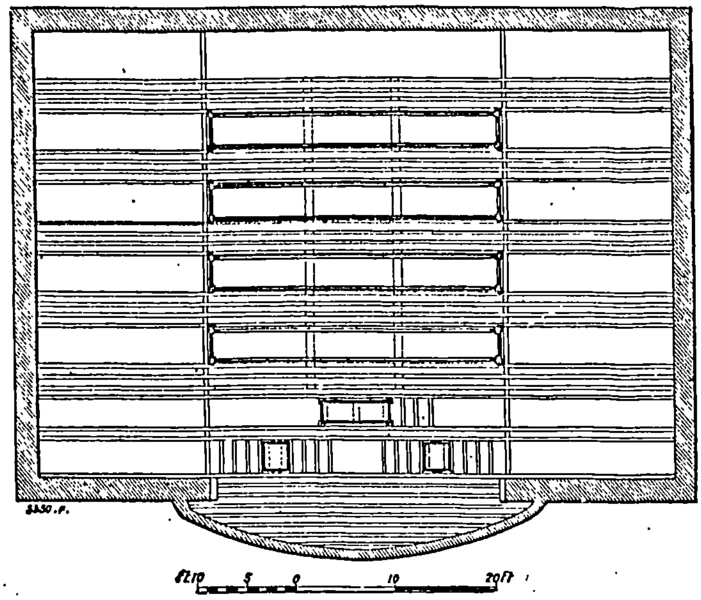
Curtain descends.

After Fabien has spoken the line, "I can weep for him now," the main actor passed behind a tree from which reappeared the double. This substitution may have been made with the "transformation trap" discussed on page 99, or simply by an ordinary corner trap. The real actor, once in the substage, had rapidly to mount the Corsican trap platform, and make some simple costume change, before the trap was operated. As the apparition reached stage level he spoke the final line while the double stood with his back to the audience as the curtain descended.

Although the Corsican trap was originally conceived for a specific effect in a particular play the mechanism must have been used throughout the latter half of the nineteenth century for many purposes. However, it was never in constant use within a theatre and this may well explain why so little archaeological evidence is extant today. When the inclined track, platform and associated equipment was not in use it may well have been put into storage to allow the Corsican Cut, that is the floor sliders, to serve some other purpose. For instance, it would be quite possible to install a few sloats and use it as a standard cut. Yet again this demonstrates the flexibility of the English wood stage and underlines the fact that any nineteenth century theatre had a stage which was being constantly altered, modified, improved, and rebuilt to cater for the scenic demands of the next production.



Illus.27 Plan of English wood stage. Sachs, Modern Opera Houses, III, supp.1, p.11.



Illus.28 Plan of English wood stage at mezzanine level. Sachs, Modern Opera Houses, III, supp.1, p.11.

THE STRUCTURAL CONSTRUCTION OF THE ENGLISH WOOD STAGE AND ITS RELATIONSHIP TO THE DISTRIBUTION OF TRAPS.

Sachs's stage plan of a typical 'English wood stage', [see Illus.27] shows, upstage of the grave trap, a series of traps which stretch the full width of the proscenium arch. The layout of these traps therefore dictates to a very large extent the layout of the structural timbers as shown in his plan [see Illus.28] of the mezzanine floor. This indicates that nearly all the joists run parallel to the proscenium opening, with the exception of two 'trimmers' which flank the offstage ends of the apertures. It is therefore almost inevitable that there was a considerable amount of instability inherent in the design of this kind of machinery. French nineteenth century stage machinery also relied on a similar timber framework, with an identical problem of which M.J.Moynet was well aware. He describes it thus:

> "The whole of the substage is a series of parallel frames, composed of uprights or posts and lengthwise beams. The bottom posts rest on stone or cast concrete foundations solidly set in the ground. The upper stringers serve to support, as I have said, the traps. This system of wooden framework does not make a very stable whole since its elements cannot be connected by permanent bracing because of the necessity of letting large objects pass through without encountering obstacles. This inconvenience has been remedied by means of a great number of movable iron hooks [92] that are unhooked when such a manoeuvre is made. These maintain, after a fashion, the spacing between the frames. I say after a fashion, because the masses of people who move on the floor all the time, the scenery mounted in the substage that temporarily prevents the use of the hooks, and a great many other things always cause the whole arrangement to lean toward the auditorium. This often pulls things out of line which causes a piece of scenery to jam in the middle of a change. From this cant in the direction of the auditorium comes the fact that wing flats often gradually lean forward so as to prevent their fitting neatly with their borders etc.

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92. Moynet calls them 'crochets'.

> Attempts have been made and are being made still to find a better system. The solution has not yet been found. The floor of the theatre being an essentially mobile thing, stability can be obtained only at the expense of the principal characteristic, its flexibility." [93]

The flexibility to which Moynet refers was of great importance in the design of an English wood stage as well. The transverse joists which formed the framing for the 'cuts' and 'bridges' were quite often mounted, as at the Tyne Theatre, on cast iron shoes. This enabled the stage carpenters to remove the joists for a particularly spectacular effect, say the sinking of a ship. However, the removal of additional transverse joists simply added to the overall instability. Sachs commented:

> "The want of some bracing together or connection between the uprights from back to front of stage makes the whole stage have a tendency to move forward. If, however, such a movement were allowed, there would be a great danger of the 'cuts' becoming wider than the movable portions of the floor which are made to cover these openings, and there would be the risk of the floor falling in between the joists. To avoid the movement in the old wooden stage the uprights are fastened together from back to front on the hook-and-eye principle, with old-fashioned iron shutter-bars. I would here remark that since the authorities have insisted upon the stage being divided from the auditorium and orchestra by a solid brick wall, much greater rigidity has been given to the stage floor than under the old form of construction, when the front of the stage was only a wooden partition." [94]

The Tyne Theatre (1867) has just such a brick wall, but although it provides some stability it does not solve the problem. If the "tie-bars" were not in position during a production at the theatre, it must have been very easy for the stage to begin to oscillate especially if a large

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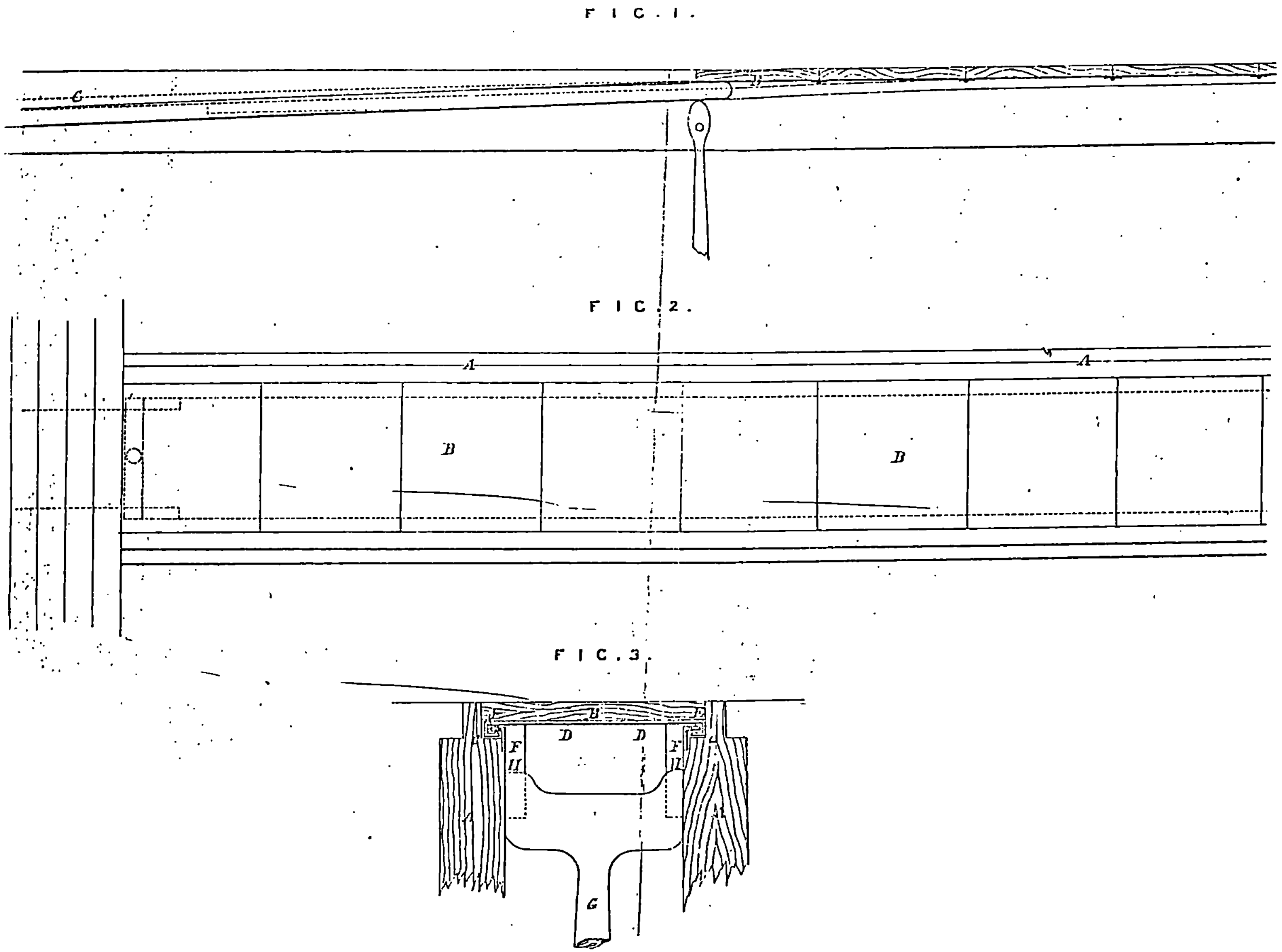
93. M.J.Moynet, op.cit., p.51-52.
94. Edwin O.Sachs, "Modern Theatre Stages. No.IV", Engineering, 28th Feb., (1896), p.275.



Illus.89 "Locking stage joists." T.W. Grieve, U.K. patent No.294, 1873.

number of people were dancing rhythmically upon it. If this ever happened, it would only have been a matter of time before the sliding sections of the stage "caved in".

In 1873, Tom Walford Grieve produced a patent entitled, Locking Stage Joists [95], which attempted to solve the problem of structural instability. A patent is not of course proof that an invention works. However, when the Alexandra Palace Theatre stage was fitted out, "under the immediate supervision of Messrs. Grieve and Son" [96] in 1875, they incorporated the patent into the design, which still survives in the theatre today. Unfortunately, because the machinery and theatre have been disused for many years, it is now impossible to say whether the mechanism worked effectively. Within the text of the patent Grieve provides an interesting insight into this instability as seen from the viewpoint of the stage carpenter:

> "The joists of a theatre are usually locked together by lock irons bolted to one joist or its support, and hooking into a staple on the next joist or its support. This arrangement is open to the great objection that the locking is not self-acting, and that in case of any neglect on the part of the cellarmen in charge of this duty, on the opening of a 'slider' the adjoining joists on either side may play, and any performer on that part of the stage may fall through to the cellar or be thrown down and injured."

He goes on to describe his method of providing structural stability to the substage framework:

> "I form a groove or guide running longitudinally along each joist, and place across each 'slider' at such intervals as I may deem most desirable cramp irons, the flanges of which ride in the grooves or guides on the joists, so that the simple closing of the 'slider' of necessity locks the joists.
>
> In order that the 'sliders' may pass under the fixed flooring in the usual manner, the grooves or guides on the joists are inclined

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95. Tom Walford Grieve, Locking Stage Joists , U.K. Patent No.294, (London: H.M.S.O., 1873).
96. Anon., "The Alexandra Palace", The Era, 2nd May, (1875).

immediately in front of the fixed flooring, and when the 'slider' is on, that is to say closed, the ends are forced up by a lever as now practised.

To prevent any lateral motion of the flanges of the cramp irons in the grooves, and to make them run easily, I may fit them with a friction roller." 97

The three drawings which accompany the patent [see Illus.89] show the stage joist, A, while B is the "slider" running in the "grooves" C, C. The "cramp irons" are attached to the underside of the "slider" and are fitted with small friction rollers, E. These help the 'slider' to run along and against the "guides", F. G is the lever which raises the slider flush with the stage in combination with the "rods" (fillet), H. Grieve also comments that short cramp irons could be used which would not extend the full width of the slider, and that they were placed at any suitable distance apart. Alternatively, the arrangement could be reversed so that the catches or cramp irons were on the joists and the grooves or guides upon the sliders.

From my personal experiences at the Tyne Theatre there would appear to be one major problem associated with this patent. When several sliders, be it "cuts", "bridges" or a combination of both, are opened simultaneously the structural framework tends to move or open up, causing slight variations in the sizes of the trap apertures. Given this, it is difficult to imagine the cramp irons attached to the sliders being capable of pulling the framework back together. It would seem more likely to suppose that enormous strain would be exerted at the point of contact between the guide rollers and the guides resulting in the slider jamming. This theory can only be proved or disproved if the machinery at the Alexandra Palace Theatre is restored. It was not, however, as far as I am aware, incorporated into any other stages. Almost without exception the English wood stage relied upon the hook and eye principle for its lateral stability, one set being installed upon the joists which supported and

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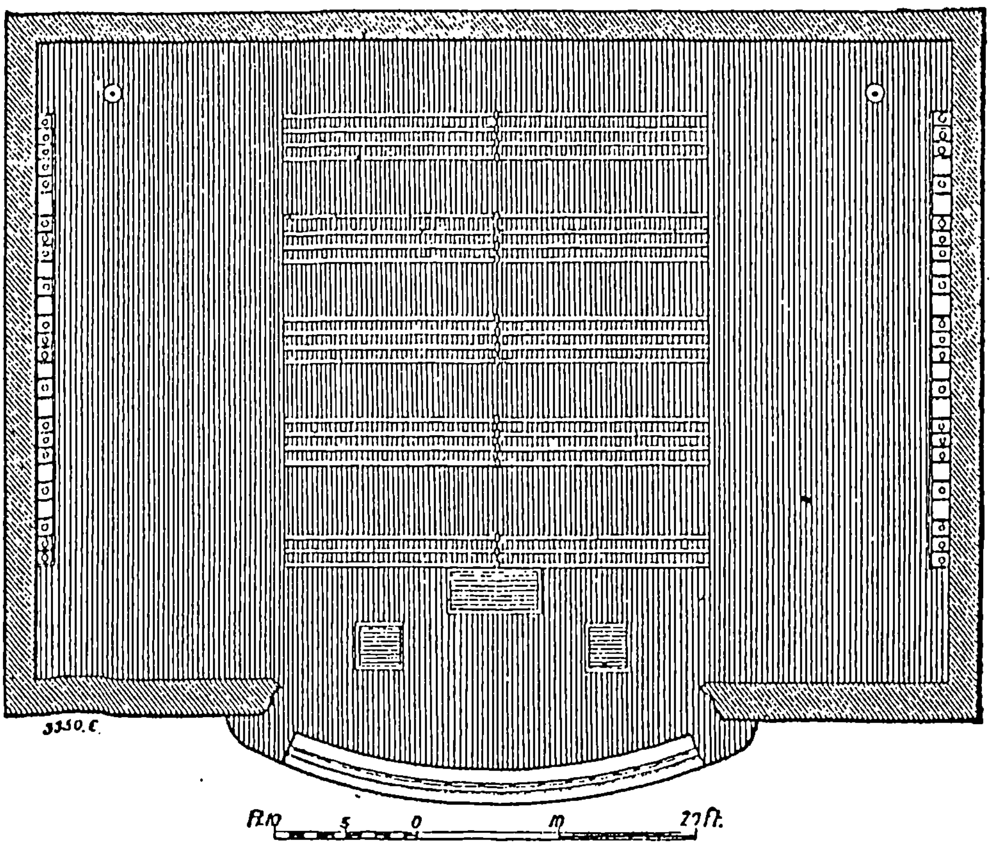
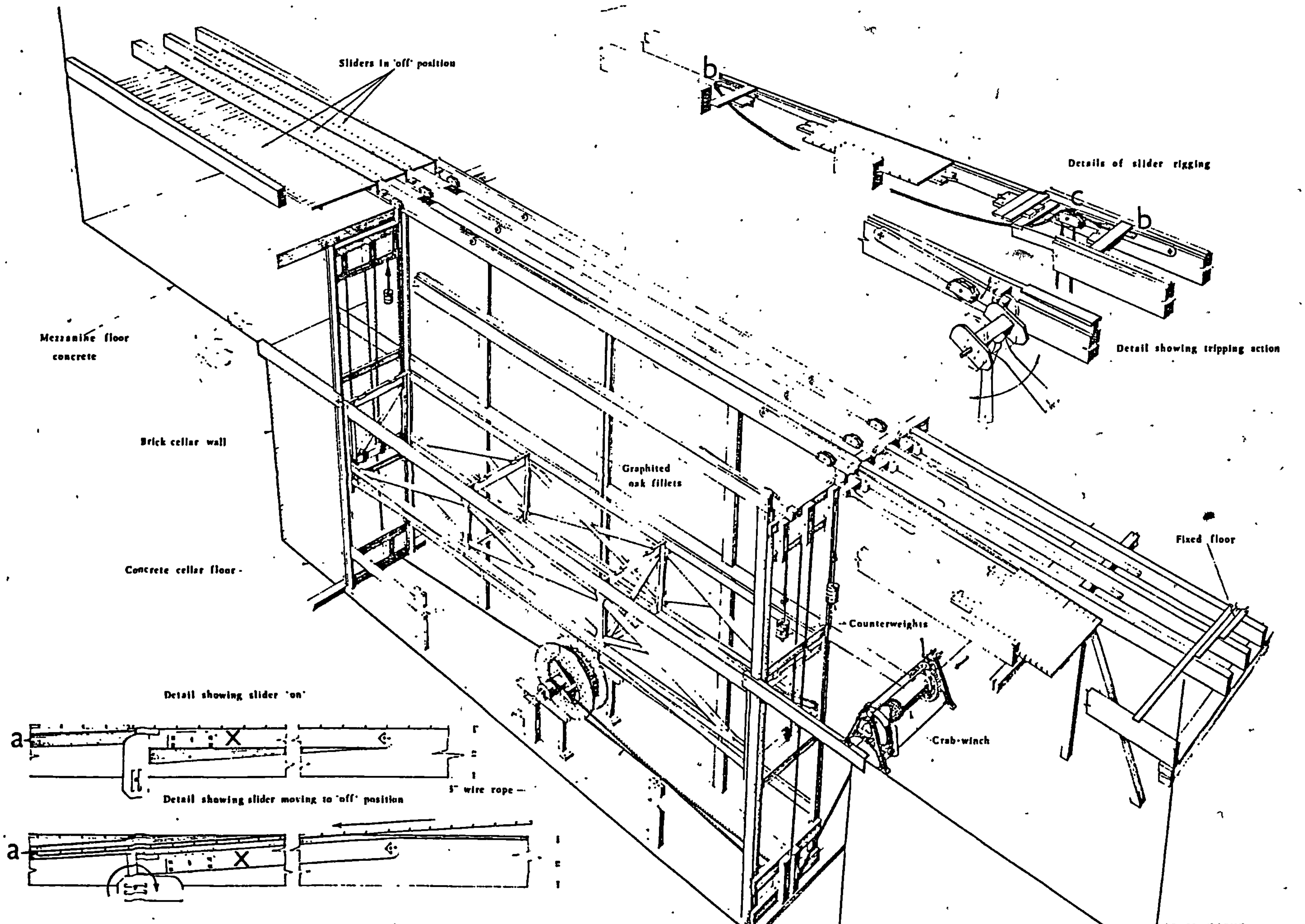
97. Grieve, loc.cit.

framed the trap apertures at stage level, and another set positioned at mezzanine level. It was therefore desirable to operate the machinery in a particular aperture with the lower set in place if at all possible, though in reality it was often necessary to remove both upper and lower sets.

The position and overall distribution of timber supports in the substage was of course a direct result of the trap layout. Sachs's stage plan, [Illus.27], shows the following sequence of full width traps, reading downstage to upstage: two cuts, one bridge, three cuts, one bridge, three cuts, one bridge, three cuts, one bridge, three cuts. There was in practice some variation in the layout of apertures during the latter half of the nineteenth century. The table given below shows how the complexity of stage machinery increased rapidly in the 1860's, reaching its zenith just before the turn of the century, followed by a rapid decline.



Illus.27 Plan of English wood stage. Sachs, Modern Opera Houses, III, supp.1, p.11.



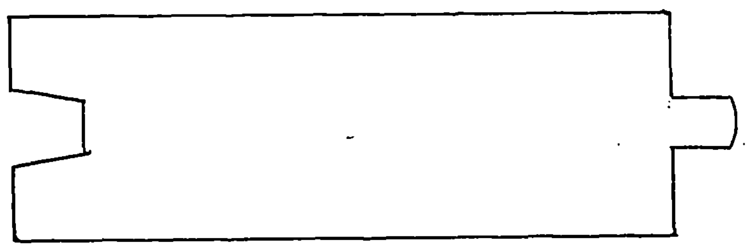
Illus.90 Isometric view of bridge mechanism.
Her Majesty's Theatre, London.
Drawing by G.L.C. Ref: AR/HB/995/15.

Distribution Of Traps Stretching Full Width Of Proscenium Arch.

Theatre	Date	Trap Sequence
Theatre Royal, Ipswich	1858	1C,1B,1C,1CT,1 large trap
Theatre Royal, Bath	1863	2C,1B,2C,1B,1CT,2C,1B,2C,1B,1C
Tyne Theatre, Newcastle	1867	2C,1B,2C,1B,2C,1B,2C,1B
Theatre Royal, Leicester	1873	2C, Grave Trap, 1B,3C,1B,2C,1B,1C
Alexandra Palace Theatre	1875	2C,1B,2C,1B,2C,1B,2C,1B,2C,1B,1C
Theatre Royal, Bristol	1870's	2C,1B,2C,1B,2C,1B,1C
Grand Theatre, Wolverhampton	1894	2C,1B,3C,1B,3C,1B,3C
Her Majesty's Theatre, London	1897	2C,1DB,3C,1B,2C,1B, 2C,1B
Sachs's Wood Stage	1898	2C,1B,3C,1B,3C,1B,3C,1B,3C
Playhouse Theatre, London	1907	1B,1B,1TB

KEY: C: Cut
B: Bridge
CT: Corsican Trap
DB: Double Bridge
TB: Triple Bridge

Although there are variations in the distribution of the traps, one basic rule is in almost every case observed, a regular alternation of "cuts" and "bridges". This next section of the thesis examines how these two basic types of machinery worked, and the variations which they exhibited. Although they performed different functions , the sliding floor sections were operated in the same way, parting at the centre line of the stage to be 'drawn off' under the wing space at the respective sides of the stage. The offstage ends of these sliders were supported by a 'fillet' and tripping lever (also known as a handle or paddle, see Illus.90). When the lever was in the vertical position the slider was flush with the stage, but when the stage carpenter pulled it towards himself, the 'fillet', x, dropped under the weight of the sliding floor section to align itself with a groove 'a' cut into the joists under the wing space. A rope was attached to either end of the slider 'b b' and threaded through a double pulley sheave 'c'. As a general rule the cut sliders could be opened and closed comfortably by one man, although the bridge sliders usually required a winch to operate them. Illustration 90 relates to the substage machinery at Her Majesty's Theatre, London, which was built in 1897. Writing in the



Scale:1:1

Illus.91 Cross-section of tongue and groove flooring for stage. Tyne Theatre and Opera House. Newcastle-upon-Tyne. Drawing by D.Wilmore.

previous year, Sachs stated that:

"The construction of the 'slider' consists of a slab of narrow grooved and tongued boards fixed to a backing or fillet of hard wood. By this means a certain flexibility is obtained." 98

An examination of the "cut sliders" at the Tyne Theatre prior to restoration in 1979 revealed that many had been fragmented into several pieces through years of use, though some remained in a single piece. This meant that, if a fragmented piece jammed, it was susceptible to jumping out of its runners in a concertina fashion, caused by the excessive tension exerted by the operating rope. However, the sections remaining in one piece, and measuring approximately fourteen feet in length, slid in a manner akin to the operation of a roll-top desk. This was due to the comparative thinness of the backing batten, which was made of English oak, and the way in which each tongue and groove board was machined. This cross-section of a board [see Illus.91] shows that the tongue was in actual fact a loose fit within a tapered groove. This allows each board, whilst still attached to the backing batten, to articulate, thus allowing the floor or slider to 'flow'. The French wood stage of the nineteenth century also relied upon this method of slider operation and it is therefore relevant to adduce M.J.Moynet's comments from L'Envers du Théatre:

"The tops of the frames have along the top and on each side a kind of groove in which the trap covers slide. The groove slopes gently down toward the storage area in order that the piece of flooring will move off to the side. It falls by its own weight the depth necessary for its passage under the permanent part of the floor of the stage. The trap covers, being arranged in sections, drop down one by one into the storage area." 99

This comment seems to suggest that the trap covers were segmented as were the bridge sliders at the Tyne Theatre. He continues:

"When they are returned to stage level, the cover in the groove is put back and raised up into the opening level with the stage floor by means of a very simple lever that has been lowered before the change."99

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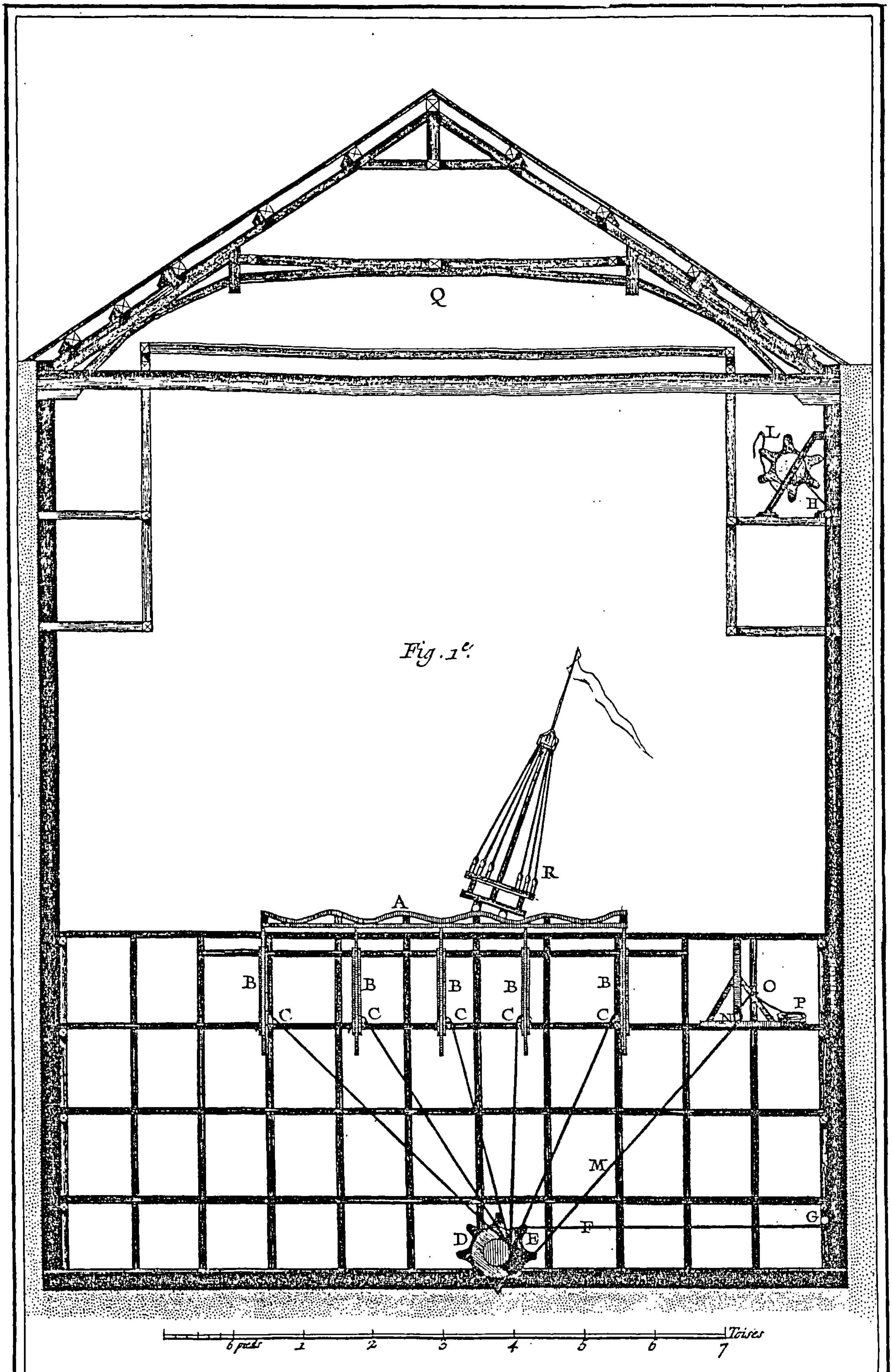
98. Edwin O.Sachs, "Modern Theatre Stages, No.IV", Engineering, 28th Feb. (1896), p.275.

99. M.J.Moynet, op.cit., p.52.



Illus.92 Dctails rclating to cassctlc and
amc machincry. Didcrot, op.cit., p.61.

This method of opening the stage floor to allow the passage of actors and scenery was therefore common to both Great Britain and the Continent during the nineteenth century. Each and every English wood stage had its own individual characteristics, but almost all worked upon the same basic principle. This sliding floor section technique was employed in the operation of both the 'bridge' and the 'sloat' (or slote) mechanisms discussed below.

The Sloat Mechanism.

There is no doubt that the sloat mechanism was developed for use in the Continental theatre prior to the present period of study. In 1777, Denis Diderot published his Encyclopédie showing the French equivalent of the sloat, known as the "cassette and âme" [see Illus.92]. In Great Britain this type of mechanism was certainly in use by the time Rees's Cyclopaedia was written c.1809, though it is important to point out that the writer does not refer to the mechanism as a "sloat" but uses the more general term of "crane".

> "No machinery whatever is permanently attached to the flaps or sliders for as these apertures serve generally for the passage of the flat scenes through the stage, the machinery must depend upon the particular effect which it is necessary to produce. The flat scenery is generally raised by a crane, unless a very rapid ascent or descent be required, when it may be done by the application of a counterpoise."[100]

Unfortunately the writer gives no illustration or further information relating to the "crane". It may even be something completely different from a sloat, for instance an overhead mechanism in the "flies". The sloat and its associated mechanism common to the latter part of the nineteenth century could, however, be likened to a crane. For instance, the controlling windlass gathers in the rope which is attached to the tongue or

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100. Abraham Rees, Cyclopaedia, XII, n.pag.

"jib" of the crane, while the whole thing lifts a piece of scenery from a lower to a higher level and vice versa.

The use of the sloat in the Georgian playhouse was often impossible because of the lack of depth in the substage. However, when Benjamin and John Green designed the Theatre Royal, Newcastle-upon-Tyne, in 1837, considerable provision was made for stage machinery;

> "THE STAGE - This important part of the Theatre has an incline, from back to front of upwards of half an inch to a foot. It is very considerably deeper and wider than that in the late Theatre, with an arrangement for adding nineteen feet additional to produce scenic effect, when required. It has also the advantage of more height above it and the sink under the Stage is twenty-two feet, for what is technically called 'flats', giving greater facility for transformations and those parts worked by machinery in Pantomimes, and other delusive scenes. The arrangements in the Stage for effecting transformations also include an entire set of 'traps' or openings, six in number, the whole back part of the Stage being movable -this being highly important in the performance of scenic illusions. In four portions of the Stage there are also cuts formed, technically termed 'scrutors', or slotes. By opening these, fairy and other scenes can be made to disappear." 101

The terminology used by the writer of this article is somewhat confused, but worthy of consideration. Perhaps the four cuts to which he refers had sliding floor sections constructed of scruto, [see page 88 for description] and contained within these cuts were the "slotes". The writer points out that the cellar was twenty-two feet deep, which would provide more than adequate space for the operation of this kind of machinery. He concludes this section of his article by stating that this arrangement of scrutors and slotes was "enjoyed by no Provincial Theatre, and only by two Metropolitan Houses" . Although it is always dangerous to accept exclusive claims of theatrical design made in newspaper accounts, this one

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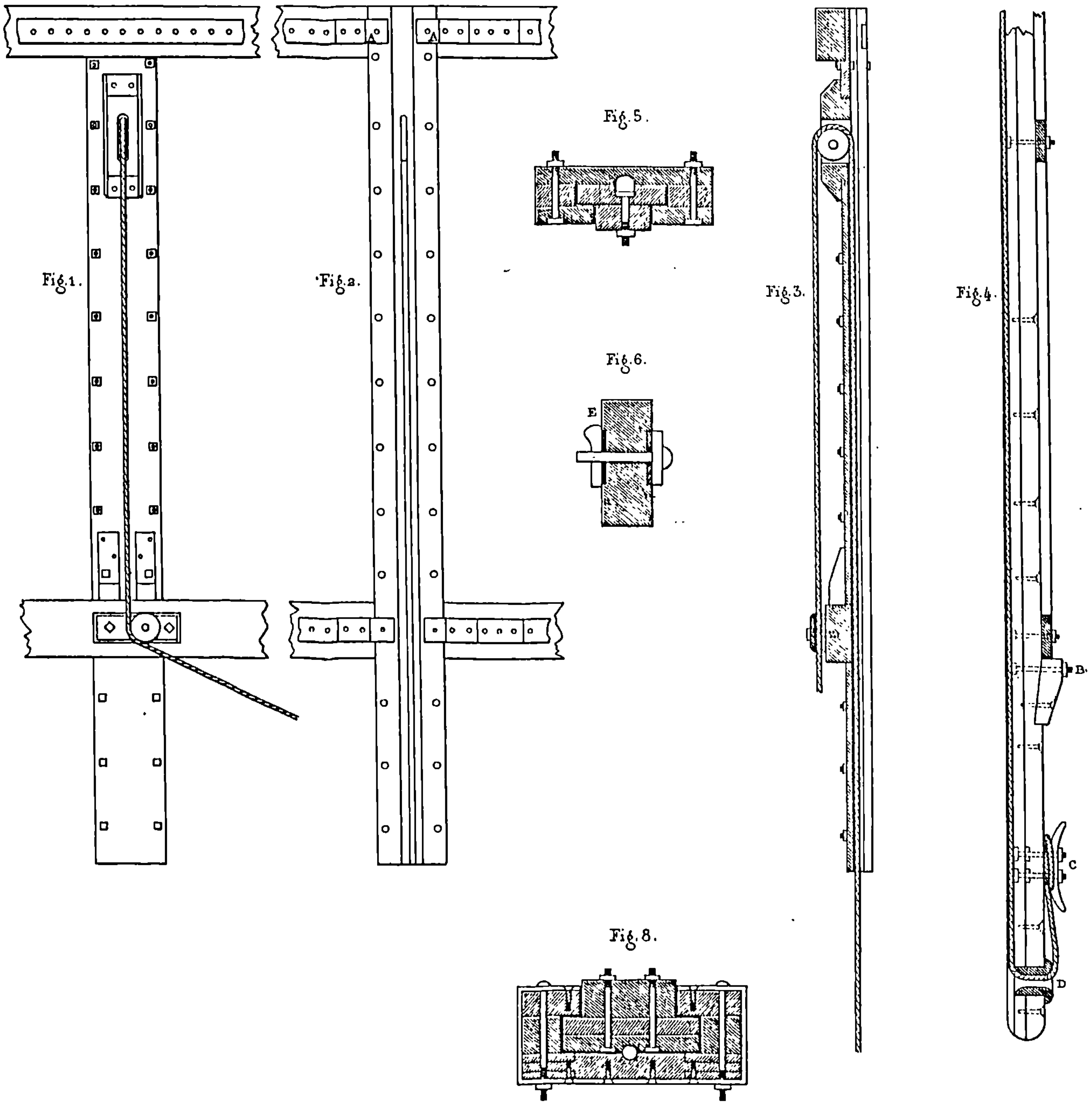
101. Anon., "The Theatre Royal", <u>The Newcastle Journal</u>, 18th Feb.,(1837), p.3.



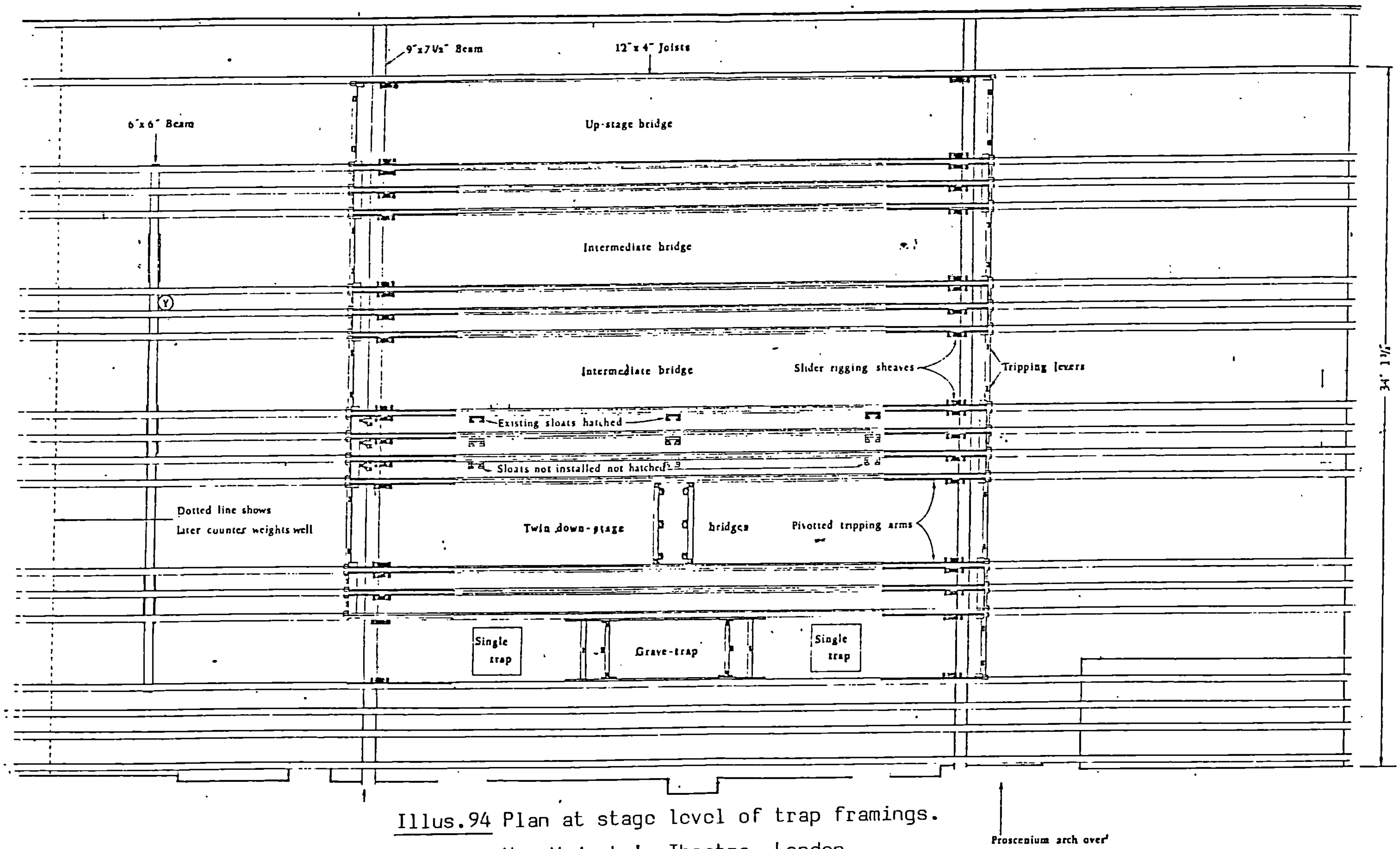
Illus.93 Details of "cassettes" [sloats].
Contant, op.cit., pl.36. figs.1-6, 8.

has a certain amount of supportive, albeit circumstantial, evidence. When the Newcastle theatre opened in 1837, it was almost certainly one of the largest, if not the largest, of provincial playhouses and was therefore furnished with a deep cellar, deeper than that at the Theatres Royal at Plymouth, Bury St.Edmunds, and Ipswich.

The cellars of the French and Italian theatres had been consistently deeper during the eighteenth century and it was therefore only natural that they would develop and utilise the sloat much earlier than the British theatre. By 1850 the sloat, or as it was termed in France the cassette and âme, had been developed on the Continent to a fine degree, while in Britain, judging from late nineteenth century examples extant today, it was still in its infancy. Consequently, when Contant published in 1860 his treatise, Parallèle des Principaux Théatres Modernes de L'Europe, he reproduced diagrams of sloats from the English system, but it is important to bear in mind that he was writing from the Continental viewpoint, and though his quoted examples may have existed at Drury Lane and Covent Garden, the provincial theatres still had comparatively primitive sloats. Nevertheless the text and engraving are highly informative, providing the earliest comprehensive account of this type of machinery:

> Plate 36 [Illus.93].
> "Cassettes" [Sloats].
>
> Fig.1 and 2. Sloats mounted on the back substage joists, viewed from behind and from the front viz:
>
> A. Iron mountings used to fix the sloat to the joists of the stage and first substage. These mountings, bent in opposite directions, are pierced with a bolt-hole of 15mm diameter, corresponding to those of iron, flat mouldings, grooved on each side of their entire length, five centimetres apart, by the joists - so that the placing and removal of a sloat is carried out with great ease.

This particular design incorporates a fairly high proportion of ironwork, especially when compared to later examples from many provincial theatres in Great Britain. The use of iron brackets to mount the sloats upon the joists of the substage, afforded flexibility of location, and was therefore a movable item which was regularly repositioned to transfer two dimensional scenery from substage to stage level and vice versa.



Illus.94 Plan at stage level of trap framings.
Her Majesty's Theatre, London.
Drawing by G.L.C., Ref: AR/HB/195/11.

Fig.3 Cross-section of a sloat and of the returning pulley from the "âme" [tongue] to the drum.

Fig.4 Tongue of the sloat equipped with its line, and bolted to the substage joist.

B. Bracket or batten on which rest the ground-rows in the substage or the base of the substage joist.

C. Cleat to tie up the line from the tongue.

D. Eyelet in hardwood, through which passes the aforesaid line.

Fig.5 Plan of the sloat complete with bolts.

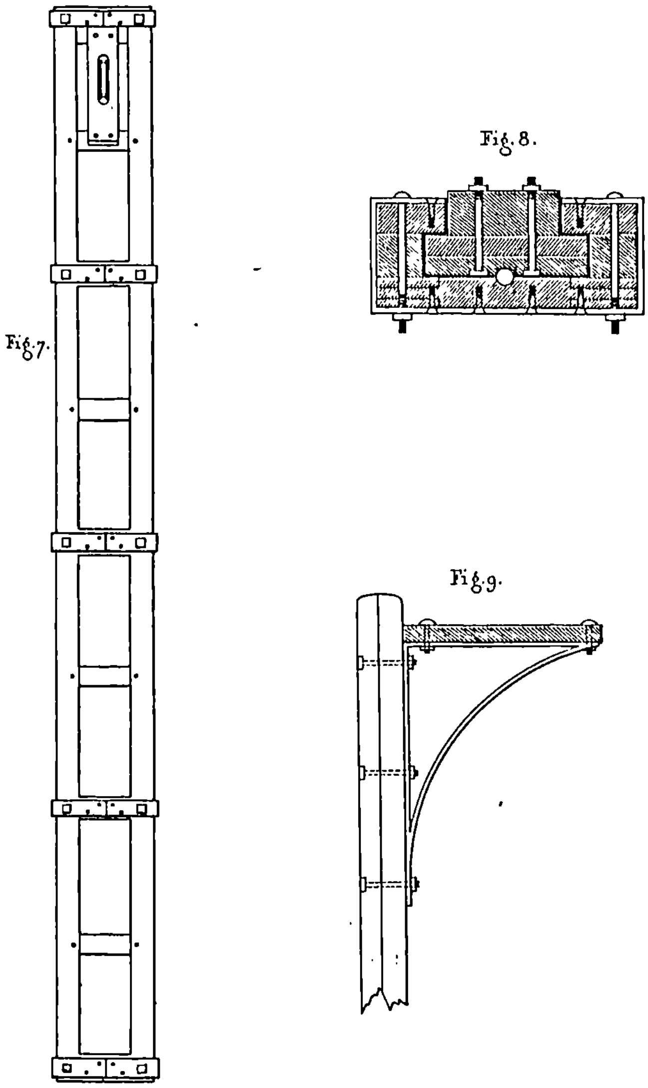
Fig.6 Cross-section of the transverse frames and bolts and collars E, by means of which the sloats are fixed into the substage of the theatre.

Fig.8 Plan of the sloat complete with iron mountings.

The sloat is rigged by attaching a line to the cleat, C, shown in figure 4, which then passes through an eyelet in the base of the tongue at D. This allows the line into a circular groove shown in Figure 8. It then passes up and over a head pulley and back down to a deflection block attached to the substage joist on which the sloat is mounted. The line then passes to a winch, presumably positioned on the mezzanine floor.

The number of sloats positioned within a cut varied from production to production, and from theatre to theatre. This can, however, be qualified by stating that the wider the proscenium opening was,the more sloats were generally positioned within a single cut to provide additional support for the scenery. Two sloats were located within each cut at the Tyne Theatre and the operating lines were attached to a windlass positioned on the stage right side of the mezzanine floor [see photo.29]. The weight of the attached scenery and the resulting friction produced by the ropes passing over deflection pulleys made it difficult, but possible, for two men to raise the scenery smoothly. The friction produced by the wooden tongue rubbing against the wooden box of the sloat was reduced by applying a graphite compound to act as a lubricant, but without counterweighting or any mechanical advantage which might have been obtained from a drum and shaft, they were hard to operate.

However, the continental cassette and âme system usually did employ a "tambour" or drum and shaft to produce a co-ordinated and smooth



Illus.95 Details of large sloats for raising actors. Contant, op.cit., pl.36, figs.7-9.

scene-change. A few theatres in Great Britain also employed this kind of mechanism to operate their sloat system, i.e. Grand Theatre, Leeds, 1878 [see page152], Royal English Opera House, 1890 [see page185], and Her Majesty's Theatre, London, 1897, where three drum and shaft mechanisms [see photo.30] were installed to operate three cuts positioned between the first and second bridges. [see Illus.94]. Three sloats were positioned within each cut and were constructed as shown on the accompanying drawing. The tongue was made of a hardwood, presumably to help it withstand the wear and tear caused by constantly attaching and removing pieces of scenery. This must, however, have increased the weight quite considerably although compensated for by the mechanical advantage gained from the drum and shaft. The rigging of the sloat, too, was slightly different from that of the traditional English sloat, for the lifting line attached to the tongue passes back down to the cellar floor through a metal sheave [see photo.31] guiding it along to the drum and shaft mechanism located on the stage right side of the cellar [see photo.30]. Within the Her Majesty's installation there are another six cuts but none of them were furnished with a drum and shaft mechanism and all were traditional winch-hauled sloats. Perhaps this is a reflection of the stage machinery designer's belief that the cuts between the first two bridges were likely to be used on a more regular basis than the rest.

The sloat had a manifold function within the nineteenth century theatre. Although it was usually positioned within the timber framework of the substage to raise pieces of two dimensional scenery it could also be modified to raise people as illustrated by Contant.

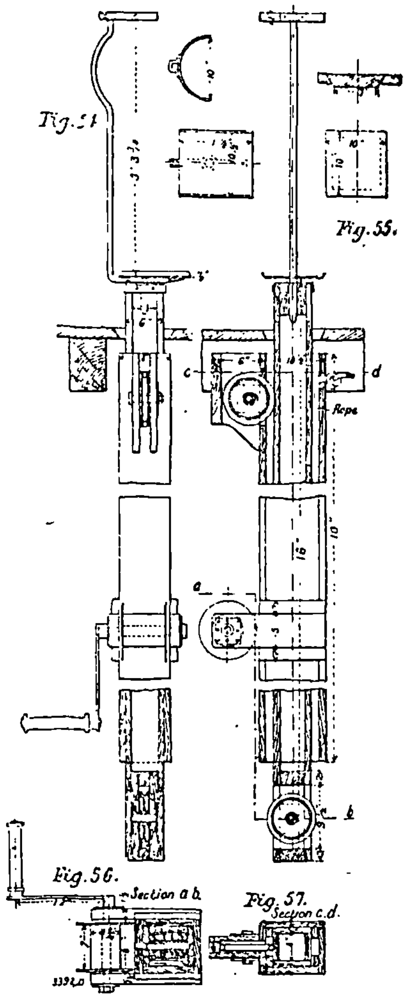
<u>Plate 36, [Illus.95].</u>

Fig.7 Large sloat constructed in open lattice work, complete with bridles and iron bolts, used to raise several actors up to the set, as for example in the ballet <u>Faust</u>.

Fig.8 Plan of the sloat complete with iron mountings.

Fig.9 Cross-section of a projecting platform, supported by an iron bracket bolted onto the tongue of the sloat.

The addition of a small platform here to the tongue of the sloat allows an



Illus.96 Special sloat to Angels around 'Jacob's Ladder.' Sachs, Engineering, 13th March, (1896), p.334.

actor to be raised up to stage level. Although the ascent would almost certainly be slower than that performed by a corner trap, the sloat could not only raise the actor to stage level but, more importantly, continue upwards to a position perhaps several feet above stage level. The actual height would be governed by the length of the tongue, which was limited to the depth of the cellar. When fully extended the base of the tongue was almost level with the top deflection pulley set into the box of the sloat.

It is interesting to note that Contant mentions the use of this type of sloat in connection with the ballet Faust, as Sachs [102] also quotes the use of a specialised sloat for another ballet production of the same name. This was performed at the Empire Theatre of Varieties, Leicester Square, London, in March 1896. The scenery was designed by "Wilhelm" and the mechanics were largely the work of Herr Lautenschlaeger of Munich. The sloat which raised angels around "Jacob's Ladder" was operated from a hand winch incorporated into the mechanism [see Illus.96]. The tongue was boxed in on all sides, with a small platform mounted on the top. The operating line was attached at one side to the top of the sloat, then passed down to a deflection pulley at its base and back up to another deflection pulley on the other side before finally passing down to the hand winch. Mounted upon the platform was a securing harness, almost identical to one which was found at the Tyne Theatre, and yet another one was recently discovered at the Citizens' Theatre, Glasgow, incorporating a sloat [see Illus.97]. The trap platform is attached to the top of the tongue and the actor is supported by the metal brace which has an adjustable height waistband for added security. The absence of any counterweighting tends to suggest that it was intended for slow ascents. The Glasgow example may well date from 1878 when the theatre was originally opened, while the 1896 example quoted by Sachs shows how the development of this mechanism occurred, the latter facilitating the use of a hand winch and a small amount of purchase. It must be said, however, that these modifications were introduced by Lautenschlaeger and not by a stage engineer from this country.

Although the sloat is essentially a piece of machinery contained within the timber framework of the substage, it also performs another function. When

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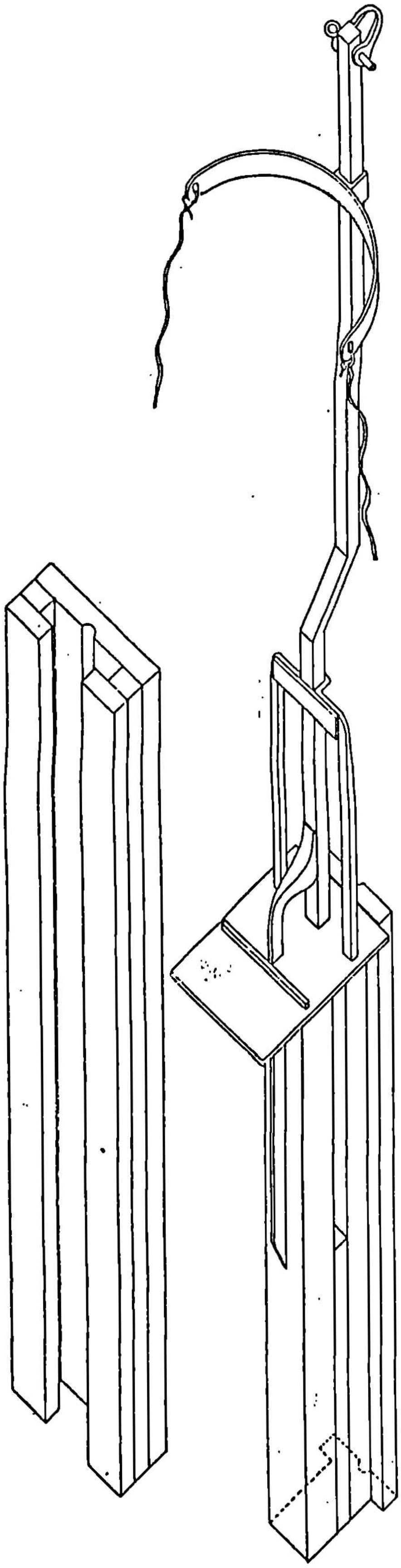
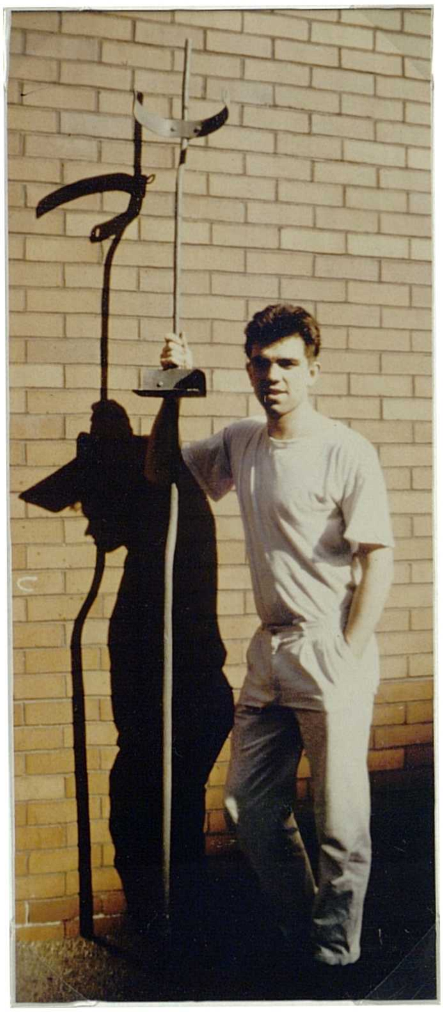
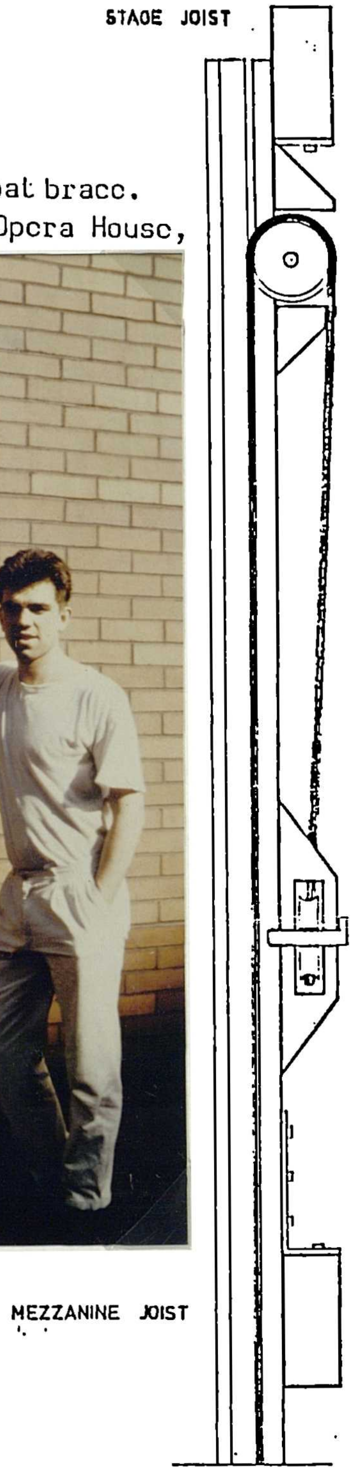
102. Edwin O.Sachs "Modern Theatre Stages - No.V", Engineering, 13th March, (1896), p.334.



Details of sloat brace.
Tyne Theatre and Opera House,





Illus.97 Details of sloat and brace. Citizen's Theatre, Glasgow. Drawing by Rennie Mackintosh School of Architecture.

I first examined the Tyne Theatre machinery in the 1970's, almost all of the sloats had been removed from their positions to be stored in the cellar. It was not until we began to reinstall them in their correct positions that I realised that they also served a structural purpose, connecting the transverse joists at mezzanine and stage level. As previously discussed, the nineteenth century timber stage was by definition laterally unstable, though the instability could be reduced by the sloats which acted in effect as secondary vertical structural supports.

The Bridge.

The bridge was not generally incorporated into the traditional English wood stage until after the beginning of the nineteenth century. Rees makes no specific mention of a platform trap stretching almost the full width of the proscenium arch. As previously noted, bridges were not in use at the Theatre Royal, Plymouth, in 1811, nor are they mentioned in connection with the opening of the Theatre Royal, Newcastle, in 1837. Even Contant as late as 1860 does not specifically illustrate the construction of a bridge mechanism, though it is apparent from the details given relating to grave traps that the 'bridge method' was well known. When the Tyne Theatre opened in 1867 the stage was fitted with "three bridges on the stage," [103] later increased to four by the addition of one in an upstage position.

Sachs's illustration of a bridge mechanism [see Illus.32], shows the typical standard wooden bridge which became so common in the large theatres of the late nineteenth century. The bridge platform was controlled from a windlass located on the mezzanine floor. A rope attached to this windlass passed down into the cellar where it ran around a deflection pulley before being wound around the circumference of a large timber drum, often measuring six feet in diameter. Two more ropes were wound onto the shaft, one on either side of the drum. These passed to respective deflection pulleys mounted at either end of the bridge guides, then passed up and over

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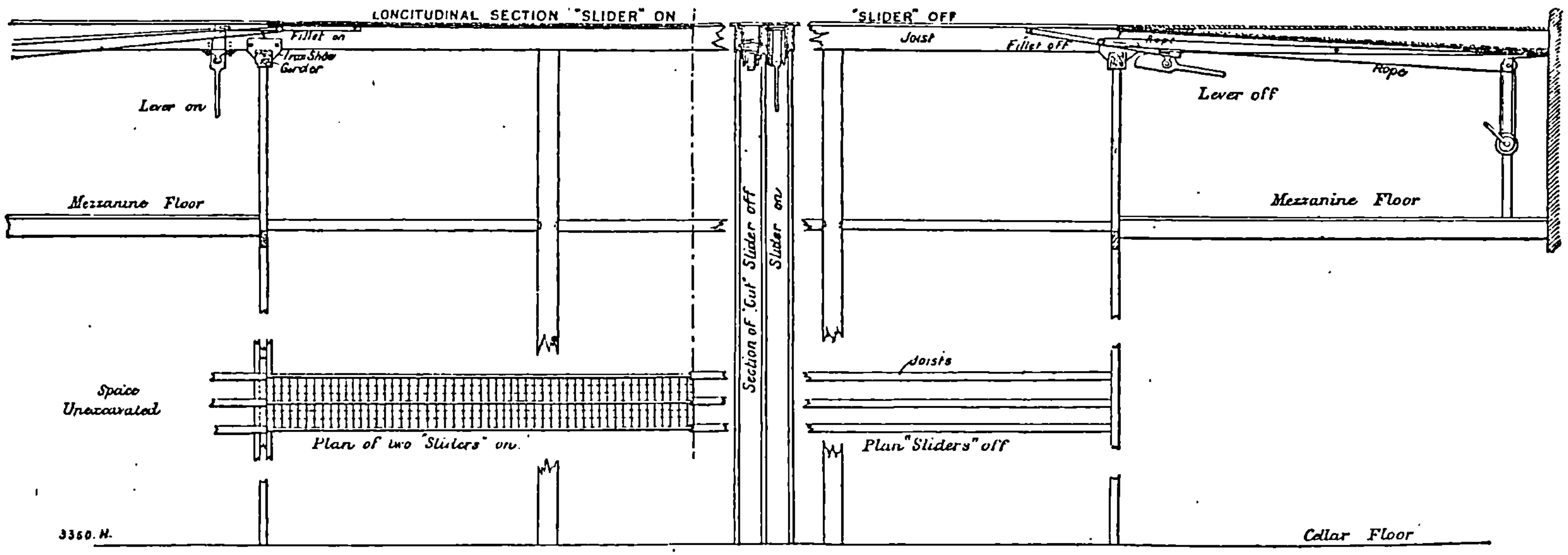
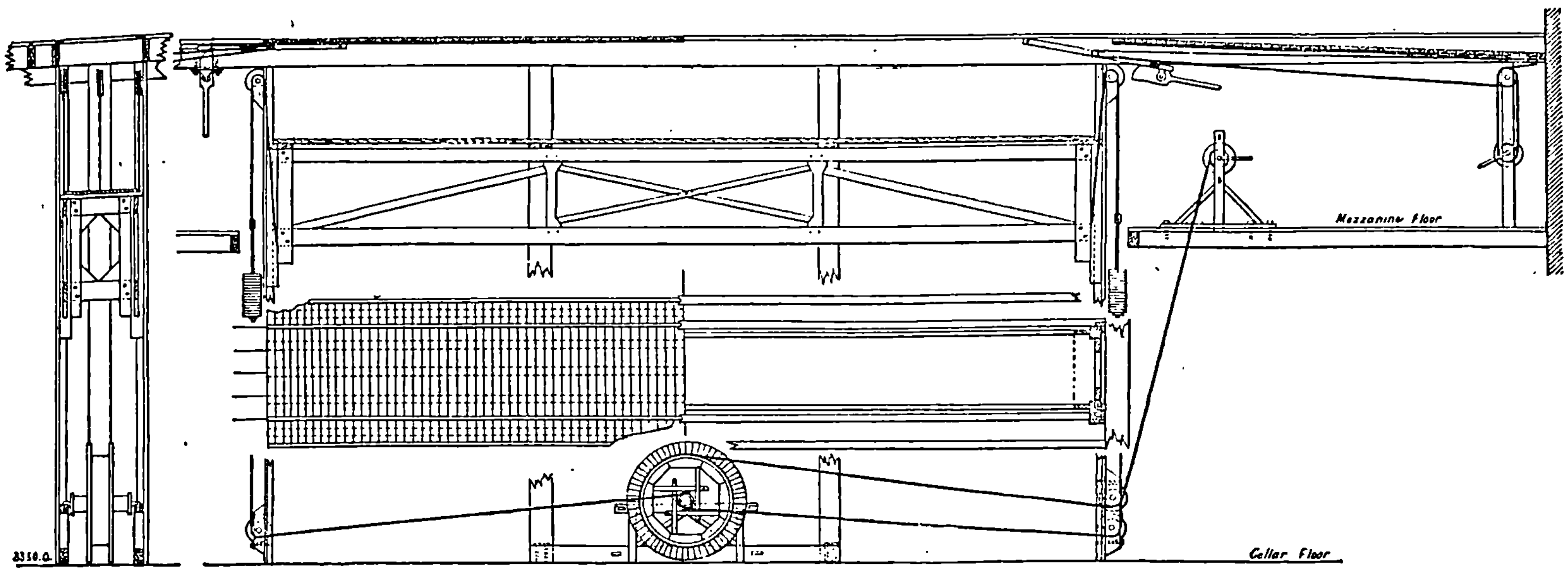
103. Anon., "The New Tyne Theatre and Opera House", The Newcastle Daily Chronicle, 18th Sept.,(1867), p.4.



Illus.31 Details of the sliders of an English wood stage.
Sachs, Modern Opera Houses, III, supp.1, p.14.



Illus.32 Details of a bridge from an English wood stage.
Sachs, Modern Opera Houses, III, supp.1, p.14.

another set of deflection pulleys just below stage level, before being attached to the base of the bridge platform. This rigging system produced a certain amount of mechanical advantage equal to the ratio of the circumferences of the drum and the shaft, but the operation of the bridge was also assisted by counterweights attached by ropes to either end of the bridges. This allowed the stage carpenters to compensate for any particularly heavy scenery or large numbers of people which had to be raised to stage level. Problems could, however, occur if the actors had to step off the bridge once it had arrived at stage level, for the additional counterweighting was often heavier than the bridge platform on its own. This meant that it would not sink to allow the sliding floor sections to be closed. On such occasions it was usually necessary for cellarmen to be stationed in the "well" who, as the platform reached stage level and the counterweights were in the cellar, could remove as many weights as necessary to allow the bridge to sink under its own weight.

Sachs defines the function of the bridge as "to raise bodily any heavy 'scene' furniture, or a group of figures as in spectacle". However, he goes on to say that a bridge "only raises its load level with the stage, whilst some of the new hydraulic 'bridges' can be lifted to any height." [104] Here he is mistaken, for many of the English wood stage bridges travelled above stage level. This was effected by constructing the bridge platforms with long legs, so that the top of the bridge rose up above stage level before the base of the platform, where the ropes were attached, came level with the aforementioned deflection pulleys located just beneath stage level. Of course, this did impose restrictions on the height of scenery which could be contained within the substage as the base of the bridge platform grounded on the cellar floor. Nevertheless it did mean that the bridges could be used as rostra, making unnecessary the time-consuming operation of erecting portable rostra while a downstage front cloth scene took place. The four bridges at the Tyne Theatre were all designed to elevate above stage level: the number one downstage bridge comes eighteen inches above stage level, and there is a tiered progression until the fourth upstage bridge travels almost five feet above the level of the stage. This allows the downstage bridge to travel a distance of sixteen

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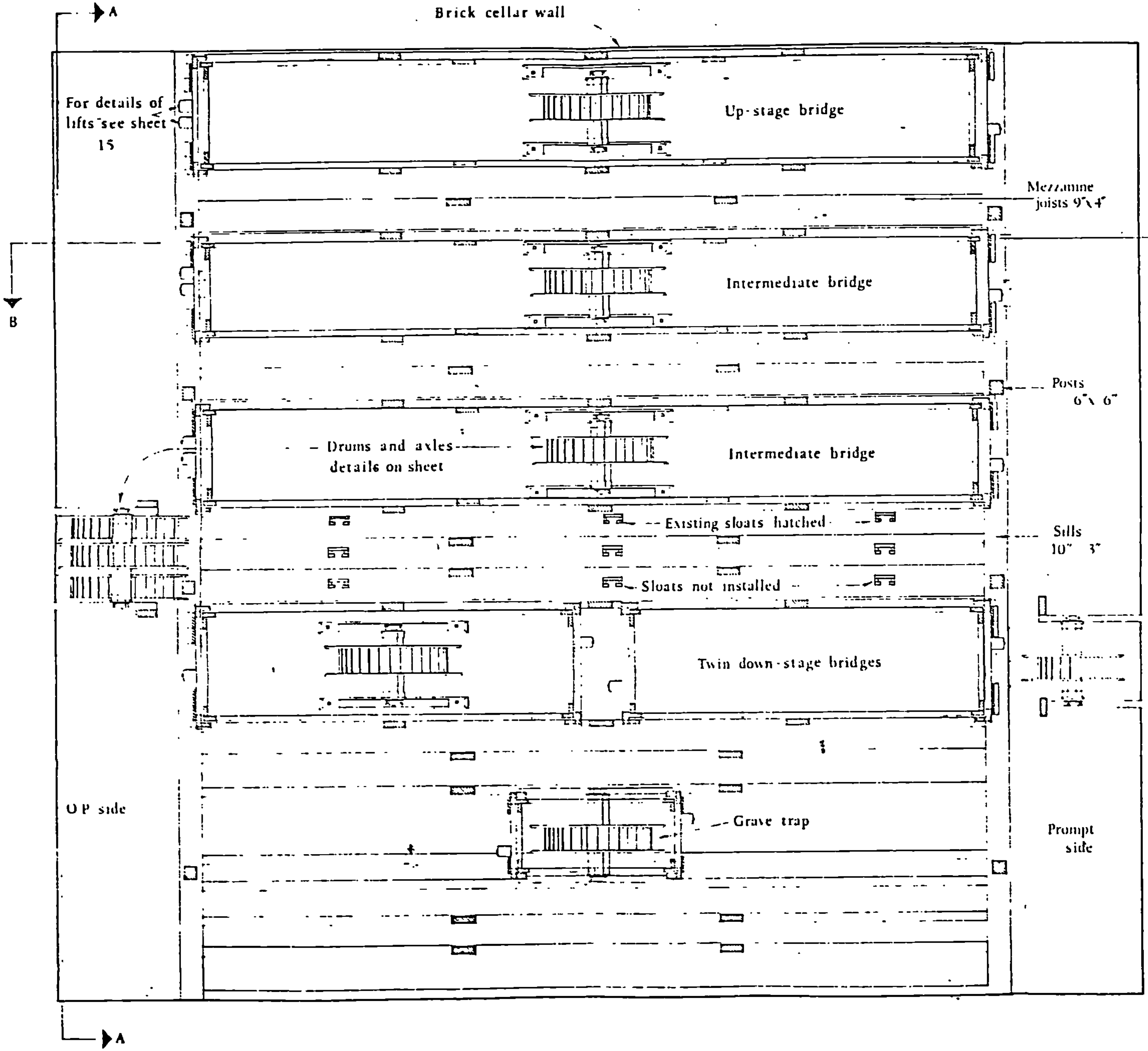
104. Edwin O.Sachs, "Modern Theatre Stages - No.IV" <u>Engineering</u> 28th Feb.,(1896), p.275.



Illus.98

Plan at cellar level. Her Majesty's Theatre, London. Drawing by G.L.C., Ref: AR/HB/995/10.

feet three inches and conceal beneath the stage a scene fourteen feet high and twenty-eight feet wide.

The layout of the English wood stage as shown by Sachs and cited on page 42, does not really represent the system at its zenith. For although many theatres did not possess any substage machinery whatsoever, many had more intricate and ingenious systems, especially those dating from the 1890's and 1900's. The suite of machinery installed at Her Majesty's Theatre, London, in 1897 is particularly interesting for it was the first flat stage in Great Britain and considered to be highly innovative, yet it still relied on the traditions and techniques of the nineteenth century stage carpenter. Sachs was highly complimentary about the innovation remarking that it "simplified everything in connection with stage mechanism. The sloping stage has always been a hindrance to those who desired to adopt some mechanical power for the working or the handling of scenery." [105] While praising the level stage he chose to ignore the fact that a traditional suite of timber stage machinery had also been installed. Its design was based upon the basic English wood stage, though several modifications were introduced to increase its flexibility and operation. As previously mentioned, some of the sloats were operated with the assistance of drum and shaft mechanisms. Perhaps of more importance was the division of the traditional No.1 downstage bridge into two separate bridges [see Illus.98]. The operating crab winches, manufactured by Bullivant and Company of London, were positioned on the respective sides of the mezzanine floor, while the remaining three bridges were all operated from the stage right side [see photo.32]. The winches also had a coupling bar facility which allowed all of them to be operated together, ensuring that a transformation scene was effected in a smooth, regular and co-ordinated manner.

This installation represented perhaps the final phase of development before its comparatively rapid decline, although the timber bridge did show signs of further development when a suite of substage machinery was installed at the Playhouse Theatre, Charing Cross, London, in 1907. It was built in hardwood in deference to licencing regulations brought in by the London County Council in 1906. The stage was equipped with a grave trap, two

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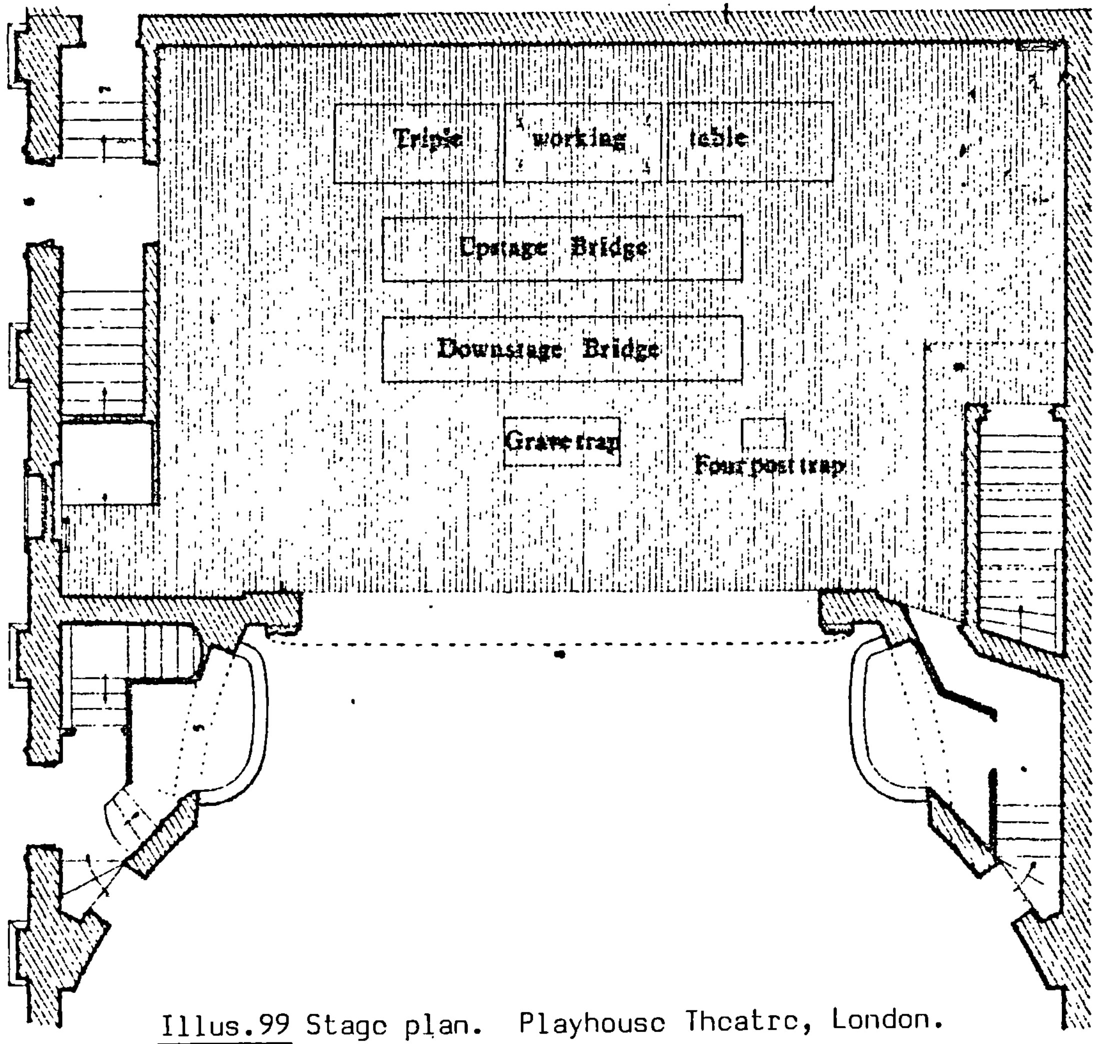
105. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.82.

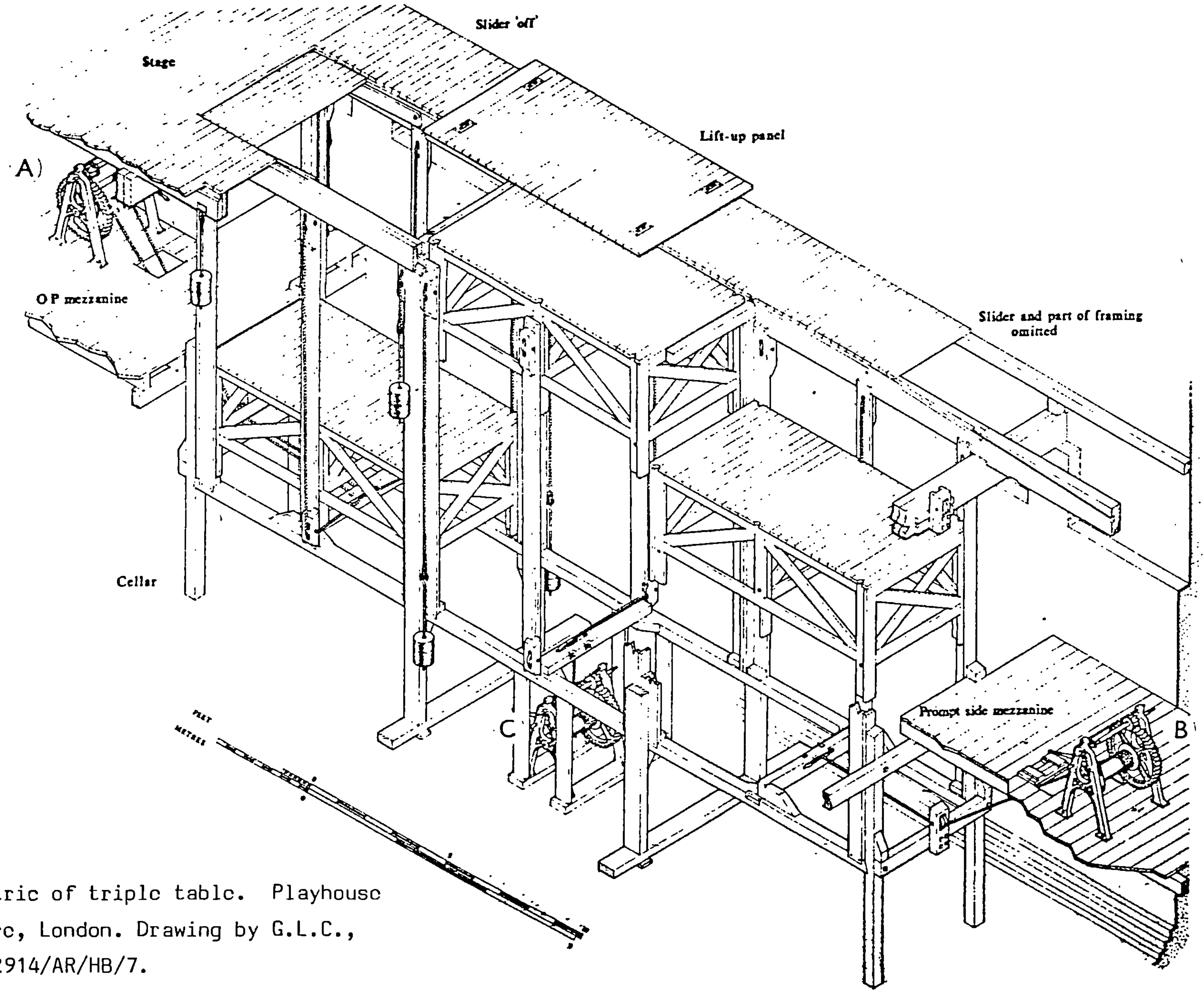


Illus.99 Stage plan. Playhouse Theatre, London.
Drawing by G.L.C., Ref: AR/HB/2914/2.

conventional bridges and a triple bridge as shown on the accompanying stage plan [see Illus.99]. There were no cuts or sloats, and initially no corner traps, though a small one was installed in the stage left position at a later date. This installation is therefore symptomatic of the demise of the cut and sloat system and the final diversification of the bridge. The triple bridge or table is located in an upstage position and consists of three independently operated tables measuring eight feet by four feet. They do not incorporate any drum and shaft mechanisms, each relying upon the gearing of the operating crab winch and four sets of counterweights. Winches 'A' and 'B' [see Illus.100] operate the offstage bridges at their respective sides while the centre table is operated by winch 'C' located in the cellar. The floor sections for the offstage tables are removed in the conventional manner previously described. However, because the centre stage table is flanked on either side by the other two tables, the floor section has to be lifted out manually by stage staff at stage level.

In retrospect, the bridge mechanism is perhaps remembered best for its use in transformation scenes, when scenery and actors were raised from the comparative darkness of the substage to form part of a glittering spectacle at stage level, as described by a correspondent for The Strand Magazine in 1893:

> "Some moments before the cluster of pretty people is required the fairies are busily arranging themselves - under the direction of the stage manager - beneath the stage, on what is known as a bridge. This is a substantial length of board connected with weights, pulleys and cords, which, at the proper moment, is raised to a level with the stage by means of a windlass. Down the stairs the fairies come tripping and take up their position on the bridge. Some will lie down, others recline against supports to help them to remain without moving, whilst others who are to pose in a sitting position are provided with comfortable seats and strapped on for safety.
>
> All at once the bell sounds - it comes from the prompter's box. The trap, which provides the opening above, silently slides away, the men in their shirt sleeves at the windlass clap their hands to the



Illus.100 Isometric of triple table. Playhouse Theatre, London. Drawing by G.L.C., Ref: 2914/AR/HB/7.

handlcs, and noisclcssly thc bridgc with its bcautiful burdcn asccnds, and wc hcar a burst of applausc." [106]

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106. Anon., "Transformation Sccncs, How Thcy Arc Madc and Workcd". Thc Strand Magazinc, VI, (1893), No.6, pp.709-710.

The Nineteenth Century English Wood Stage.

Summary.

With the advent of the enlarged fly tower and substage, the techniques formulated by the machinists and stage carpenters of the previous two hundred years were developed and enhanced to cater for the scenic spectaculars and pantomimes of the second half of the nineteenth century. Although the English wood stage relied heavily upon a large number of stage staff to operate it, wages were comparitively low and it was, incredible as it may seem, economically viable for a theatre manager to employ as many as one hundred stage staff for a pantomime.

The great advantage of working with wood in the theatre is that it is eminently well suited to quick, cheap and easy modification, which can be carried out on site. Admittedly the stages were constructed of large timbers, often measuring thirty feet in length, but with a large staff available they were in truth portable, allowing the relocation of traps not only between but actually during performances. This enviable flexibility was almost certainly the main reason for the perpetuation of the English wood stage. Yet it was unquestionably a great fire hazard especially when the backstage areas were lit by gas. This is demonstrated only too well by the frequency with which theatres burnt down. It was therefore only natural for architects and designers to endeavour to reduce the amount of combustible material used in the construction of a theatre, particularly in the backstage areas. Obviously the overriding need was to replace wood itself and with this in mind attempts were made to construct stages partially or wholly of metal.

In 1840, for instance, a civil engineer by the name of Rowland Macdonald Stephenson, designed and patented [107] a, Method of Adjusting, Shifting and Working Theatrical Scenery and Apparatus. It was installed at the Royalty Theatre, Dean Street, London, in 1840 for Miss Fanny Kelly's production of Summer and Winter by Morris Barnett and a description of the

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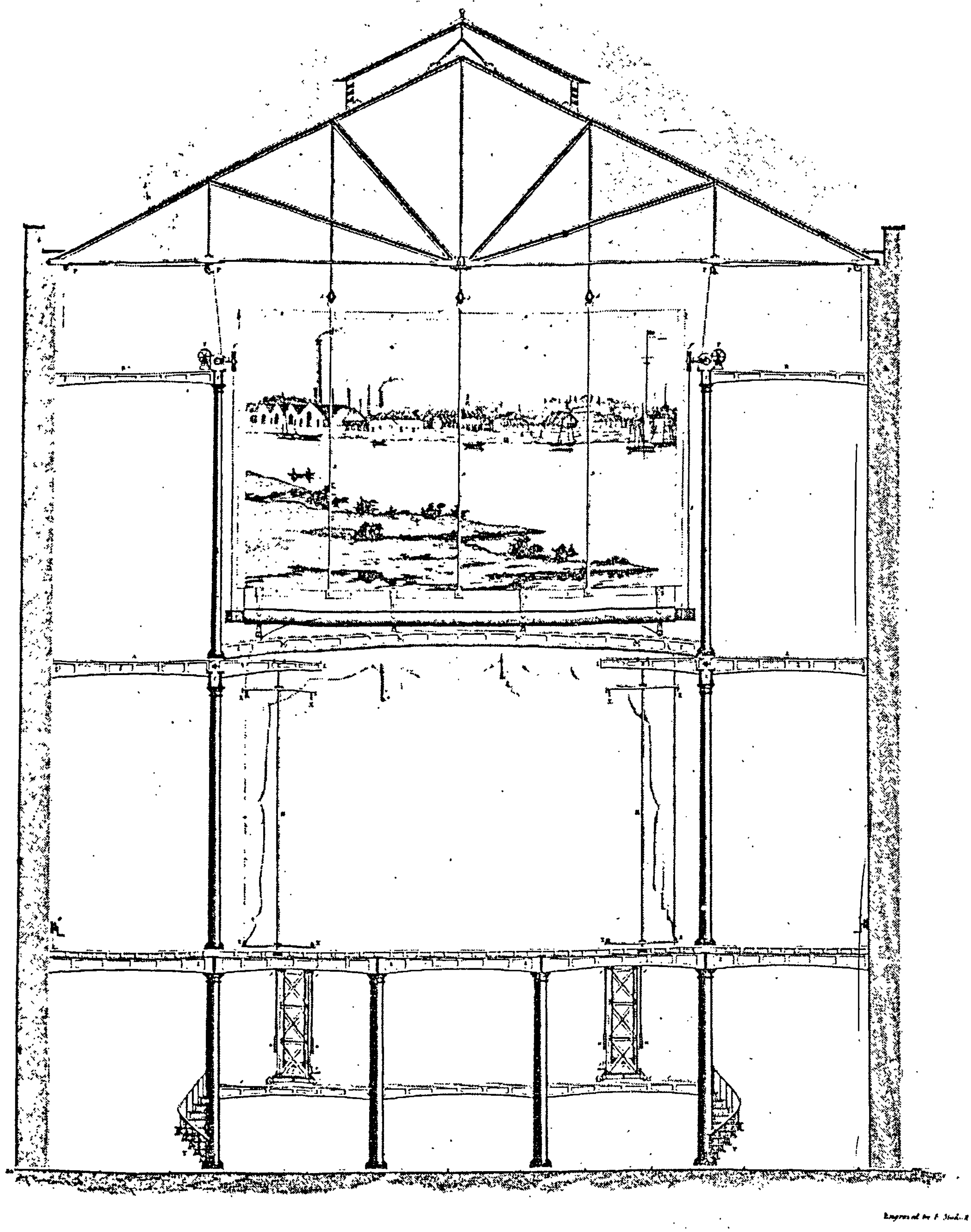
107. Rowland Macdonald Stephenson, Shifting Stage Scenes and other Theatrical Machinery, U.K.Patent No.8404, (London: H.M.S.O., 1840).

PLATE I.



Illus.101 Transverse section of Rowland Macdonald Stephenson's patent theatre machinery. U.K.patent No.8404, 1840.

machinery was presented to the Institution of Civil Engineers in 1841 by J.B.Birch, Grad.Inst.C.E.:

"The apparatus provides means for shifting simultaneously and without noise, any number of distinct pieces of scenery, bringing at the same time into view other scenes to replace them ....

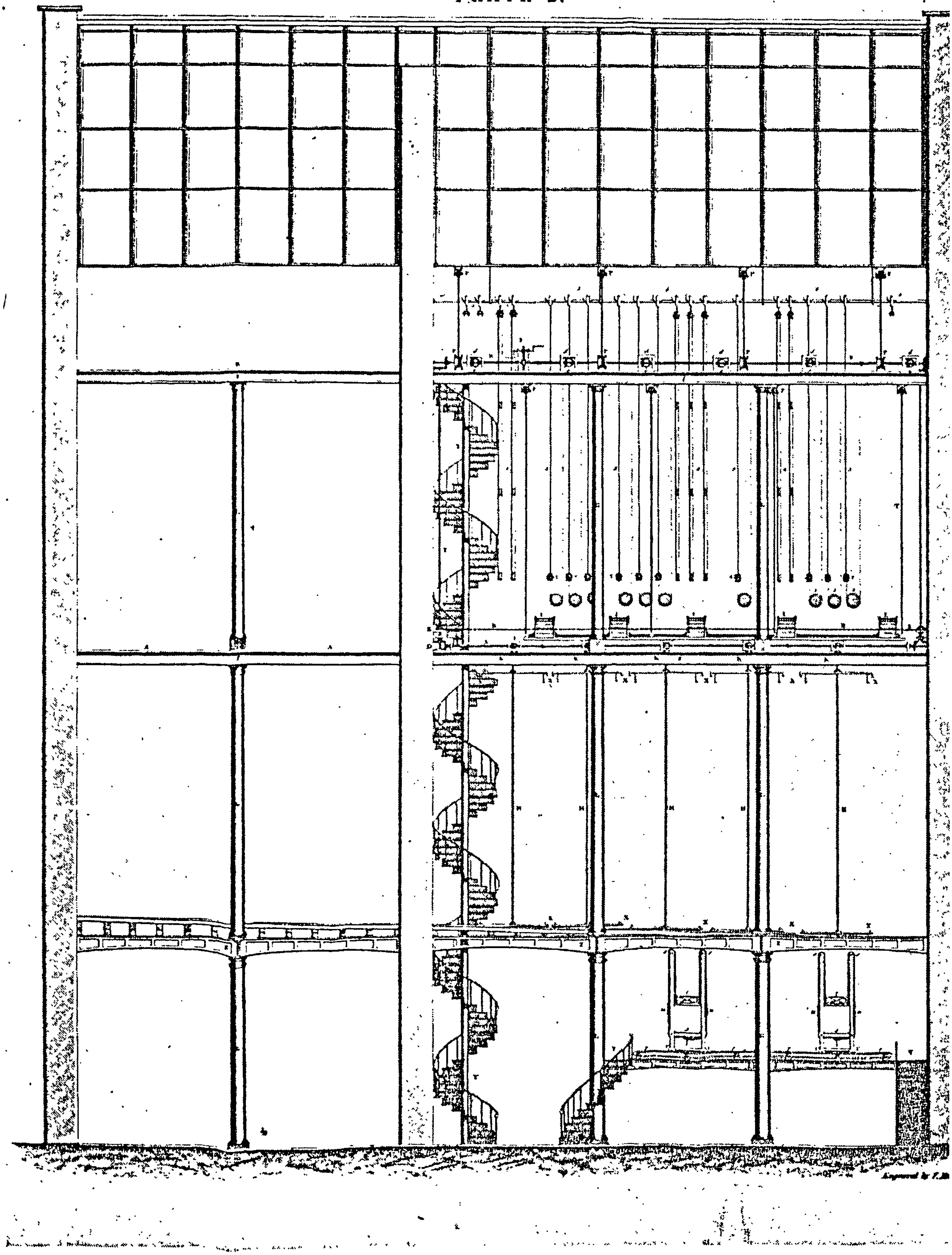
The interior of the house between the basement and the roof is divided into four compartments, viz: [see Illus.101,102]

1. A raised platform on which the gearing for working the stage traps is placed. The trap frames are mounted upon rollers; they traverse on the lower platform in every direction; and when brought under the appertures in the stage, allow the traps to sink or rise steadily at any required speed.
2. The stage, with its traps of various dimensions, including a considerable portion formed to raise or fall by suitable machinery, and called the sinking stage.
3. The lower flies or corridor, between which and the stage are placed the wings or side scenes, and the border frames are suspended.
4. The upper flies, upon which is placed the machinery to communicate motion to the whole, from the upper horizontal shaft, by means of bevel gear, provided with double clutches to reverse the motion and shafts, on the lower ends of which are the slow-motion wheels and drums, an endless chain is driven horizontally in either direction; to this are attached the borders representing clouds, foliage, arches, & c.

The side scenes or wing frames, the number of which is determined by the depth of the stage, may be either flat, circular, or triangular, and receive a rotary motion, combined with or apart from a forward and backward movement at pleasure, and can be placed at any desired angle to the audience. At every change of the scene they revolve through 120° or one third of a circle, and the scenes when removed from sight are replaced by those which are to succeed them.

The transversing frames revolve on a centre, and are suspended from the border frames or from the upper part of the theatre, for crossing

PLATE 2.



Illus.102 Longitudinal section of Rowland Macdonald Stephenson's patent theatre machinery. loc.cit.

the stage in any direction, and at any given inclination." [108]

Though Stephenson intended to design a modern and effective piece of scene-changing equipment the project proved to be a fiasco. It was constructed, "for the purpose of avoiding the confusion, mistakes, and noise, consequent upon the number of men usually employed in the stage department of a theatre, and with a reduced number of men to effect more perfectly all the operations required there", but this worthy ambition remained unattainable. The Times, reporting the opening night, commented that:

> "The scenic department wants improving, large gaps being left between the wings through which the sceneshifters can be seen on both sides of the stage by a person remaining in one position. The pauses between the acts should likewise be lessened as last night they were the means of protracting a performance that might have been short to a great length." [109]

Yet another complaint concerned the disproportionate amount of noise made by the machinery, audible from all parts of the theatre, and, to make matters worse, it had not proved possible for a single man, nor indeed several, to operate it. Instead, a horse had to be brought in to provide the motive power by walking on a treadmill. Given that Stephenson's patent showed a stage based upon the dimensions of the then Theatre Royal, Drury Lane, with a seating capacity of around three thousand and that the machinery was in fact installed at a theatre with a capacity of around two hundred, it would seem reasonable to conclude that the whole system was impracticable. This is supported by the fact that the theatre was closed after five nights, and the machinery totally removed. It seems ironic, almost bizarre, that the Institute of Civil Engineers should still have published the previously quoted paper, given in June 1841, over a year after the dismantling of the actual machinery.

While Stephenson's patent cannot be regarded as having made a useful or practical contribution to the development of stage machinery in the nineteenth century, it does serve as a positive reminder that as early as

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108. J.B. Birch, Description of Stephenson's Theatre Machinery. Proceedings of the Institution of Civil Engineers, I, (1837-41), pp.153-154.

109. Anon., "Miss Kelly's Theatre", The Times, 26th May, (1840), p.5.

1840 efforts were being made to replace the English wood stage with 'modern' techniques and materials. In 1878 a further attempt was made to construct a stage from iron, but this time it drew its inspiration from the techniques and principles of the wood stage itself and proved to be a far more successful and therefore important step in the evolution of a 'mechanical stage'. It has been said, however, that for all the attempts made to replace it the methods and techniques of the English wood stage endured well into the twentieth century.

THE GRAND THEATRE AND OPERA HOUSE, LEEDS, 1878.

The Grand Theatre and Opera House opened on 18th November 1878 [1] and was the work of two local architects, George Corson and his chief assistant James Robinson Watson. It was part of a development which also contained a concert-hall, an assembly room, offices and shops. The erection of 'the block' took some thirteen months, reputedly at a cost of £60,000. During the building of the theatre an actor-manager, Wilson Barrett, applied to the directors of the Grand Theatre Company for a lease. He was well known in Leeds, having previously leased the Amphitheatre with his wife Caroline Heath, an actress eleven years his senior. They were particularly noted for their high standards of performance and an ability to stage new plays from London. The directors therefore offerred Barrett a five-year lease commencing with the opening of the theatre [2].

Edwin Sachs discussed the Grand Theatre in his treatise, Modern Opera Houses and Theatres, and commented that "the intention of those responsible for the 'Grand' Theatre was to provide Leeds with a large and well-equipped playhouse and after making allowance for the date of erection, and the little attention which was paid at the time to protection against fire, I hold that the original purpose has, to a great extent, been attained in the design of this structure." [3]

In April 1979 I made a visit to the theatre to investigate the backstage areas and in particular the substage machinery. This was exceptionally urgent as the machinery was scheduled for demolition during the summer. I had anticipated examining a derelict, decaying and fragmented wooden substage installation.

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1. Not 1876, as stated by Edwin Sachs in Modern Opera Houses and Theatres, II, p.44.
2. It is therefore quite possible that Barrett was able to exert a certain amount of influence upon the design and building of the theatre. Several years later, in 1888, J.G. Buckle dedicated his standard text, Theatre Construction and Maintenance, to "Wilson Barrett, Esq., a manager who has displayed an earnest desire to adopt reforms conducive to the public safety and convenience."
3. Edwin O.Sachs, Modern Opera Houses, II, p.44.

Instead I discovered a totally complete and intact suite of iron substage machinery, the design of which was based upon the traditional English wood stage. Although a new stage surface had been laid, which did not accommodate the trap apertures, the machinery appeared to have been well maintained. It was painted a deep maroon colour, was comparatively clean and appeared to be in a workable condition.

The examination of the installation was made exceptionally interesting by an undated stage plan signed by 'J.R.Watson' [4] [see Illus.103 bound at the back of this vol.], and an inventory of the backstage equipment supposedly made in 1895. [5]

The Substage.

The substage area was particularly spacious, with two mezzanine floors and a concrete cellar floor, all of which were kept in a tidy and clean state,allowing easy access to examine the machinery.

The Corner Traps.

The introduction of five corner traps is extremely interesting and clearly indicates that the theatre was built for pantomime, spectacle and opera. They were made of wood and showed no great innovations in design, relying simply on counterweights and muscle power to operate them. Although five are shown on the stage plan, only four remained in 1979, the centre stage trap having been removed. This may have been to ease the access to the grave trap, which, was located immediately upstage.

The Grave Trap.

The grave trap was located in a centre stage position and had an aperture measuring 5'8" by 1'10". It was constructed of timber and employed both counterweights and a drum and shaft (stamped with the words "Leeds Theatre Company"), which was controlled from a windlass located on the first mezzanine floor.

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4. Grand Theatre, Leeds, Stage Plan drawn by J.R.Watson. West Yorkshire Archive, Leeds.
5. Grand Theatre, Leeds, Inventory, West Yorkshire Archive, Leeds. Item 17.

The Distribution Of The Large Traps.

The layout of the 'cuts' and 'bridges' is particularly interesting, for the traditional pattern of '2 cuts, 1 bridge' repeated several times over is here abandoned. It is replaced by the following sequence, commencing on the upstage side of the grave trap:

No.1 Cut,	9"	Wide	
No.2 Cut,	19"	Wide	
No.3 Cut,	9"	Wide	Unit No.1
No.1 Gas Cut,	5"	Wide	
No.1 Bridge,	2'9.5"	Wide	
No.4 Cut,	9"	Wide	
No.5 Cut,	19"	Wide	
No.6 Cut,	9"	Wide	Unit No.2
No.2 Gas Cut,	5"	Wide	
No.2 Bridge,	2'9.5"	Wide	
No.7 Cut,	9"	Wide	
No.8 Cut,	19"	Wide	
No.9 Cut,	9"	Wide	Unit No.3
No.3 Gas Cut,	5"	Wide	
No.3 Bridge,	2'9.5"	Wide	
No.10 Cut,	19"	Wide	
No.11 Cut,	9"	Wide	Unit No.4
No.4 Gas Cut,	5"	Wide	
No.4 Bridge,	2'9.5"	Wide	
No.12 Cut,	9"	Wide	
No.5 Gas Cut,	5"	Wide	Unit No.5
No.5 Bridge,	2'9.5"	Wide	

Summary Table.

TRAPS / UNITS	9" Cuts	19" Cuts	5" Gas Cuts	Bridges
No.1 Unit	2	1	1	1
No.2 Unit	2	1	1	1
No.3 Unit	2	1	1	1
No.4 Unit	1	1	1	1
No.5 Unit	1	0	1	1
TOTALS	8	4	5	5

An analysis of the distrbution of traps shows that the number of 9" and 19" cuts within each unit decreases progressively in an upstage direction. This is clearly a specific intention of the designer and must therefore be related to use and function. Although the 9" cuts are used in every unit the 19" cut is absent from the fifth unit. However, despite the varying number and order of the 9" and 19" cuts, the 'gas cut' is retained in every unit and is always positioned immediately downstage of the bridge. The provision of a 'gas cut' is, as far as I am aware, a unique occurrence in the annals of stage machinery in the British Isles [6].

To identify any relationships between the various cuts it is necessary to attempt to understand from the evidence available how they worked.

The 9" Cuts.

On the stage plan the No.1 cut bears the annotation, "From Stage down to Cellar at this Cut 27'0". From stage at this point to Gridiron 63'0" ", a total of 90 feet. At other points upon the stage these measurements would vary because the stage was raked at 1:24 and the gridiron was level. It was therefore theoretically feasible to raise up from the substage a piece of scenery marginally less than 27' in height. This figure would increase progressively

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6. Terence Rees, author of Theatre Lighting in the Age of Gas, has no knowledge of another example.

upstage, for unlike the stage surface, the concrete floor of the cellar was flat.

The sliding floor sections of the cuts were operated in the traditional manner but incorporated some minor modifications with regard to materials. The 'fillets' were constructed of timber - the offstage end of several are visible in photographs 33 and 34 - as were the upper portions of the paddles. However, the handle section was made of iron, and had a hollow bone finger-grip which rotated upon a spindle. The floor sections were opened and closed by means of a rope passed over a metal pulley wheel, with either end attached to the onstage and offstage ends of the sliding floor sections. The wheels, 'a' [see photos.33, 34], were located on the onstage side of the paddles in a central position. It was therefore almost identical to the traditional method of the English wood stage [see page 129].

Sloat attachment blocks were still evident in 1979 on many of the iron joists, suggesting that three sloats had originally been mounted within each 9" cut. Although no complete set of sloats was intact within any particular cut, several single examples were left. Photograph 35, which was taken looking in an upstage direction, shows four sloats, each from a different cut. The downstage one, in the foreground, had become detached from the joists of the substage but it was probably still approximately in its original position. Although a large proportion of the substage framework was iron, the sloats were made of timber, and showed several constructional variants. The two sloats in the foreground of photograph 35 were both positioned in 9" cuts, but it is interesting to note that the iron deflection pulleys, 'a', are positioned at opposite sides, suggesting that they were operated from opposite sides of the mezzanine. These deflection pulleys are considerably larger than the ones normally used for sloats, and were probably specifically employed to reduce frictional resistance and therefore the number of stage crew required. This type of sloat had another large iron pulley fitted to the base of each tongue [see photo.36] to facilitate the raising and lowering. One end of a rope was attached to the sloat box at 1st mezzanine level, and was passed down and through the pulley at the base of the tongue. It then passed back up to the large iron pulley at the top of the sloat to be deflected across to a suitable winch on one of the mezzanine floors. However, the exact position of these winches was not immediately apparent as they no longer existed.

The floored areas of the 1st mezzanine did not show any bolt holes which might have indicated the original position of any winches, and there seemed no reason to suppose that the floor boards were not contemporary with the machinery installation.

The angled timber bearer for the upper iron pulley of the sloat also allowed the containing fixture bracket of the wheel to be attached in an angular manner and consequently any rope which passed through the wheel would have to be deflected downwards to avoid rubbing or chafing on the iron bracket. If the rope was attached to a winch on the stage right 1st mezzanine floor and the sloat was positioned on the stage left side, the angle of deflection would not have been great, but probably sufficient to avoid any rubbing. The angle would of course be increased the nearer the sloat was to the crab winch. However, the angular attitude of the wooden bearer would afford a considerable amount of strength to a rope deflected at an even greater angle. Such would be the case if the sloats were operated from the 2nd mezzanine floor and there would need to have been adequate space to operate the sloats from either side (bearing in mind the previous evidence). An inspection of the 2nd mezzanine floor revealed a series of ratchet winches on the stage left side, specifically labelled for operating the bridges. In addition there was a wooden drum and shaft mechanism on either side of the mezzanine floor, which ran in an upstage/downstage direction [see photos.37, 38, 39, 40]. The drums were located on the extreme downstage ends of the shafts, the stage left one having suffered some damage. Owing to the great length of the shafts they were supported by intermediate bearers to avoid any distortion over a long period of time. Although there were no directly obvious markings to indicate their function, the stage right drum had "G.M." painted on it, which might imply in theatrical terminology "Grand Master". The inventory describes them as "2 Do. (Working drums) for sinks, with long shafts, fixed on 2nd Mezzanine and with end standards, intermediate bearers &c."

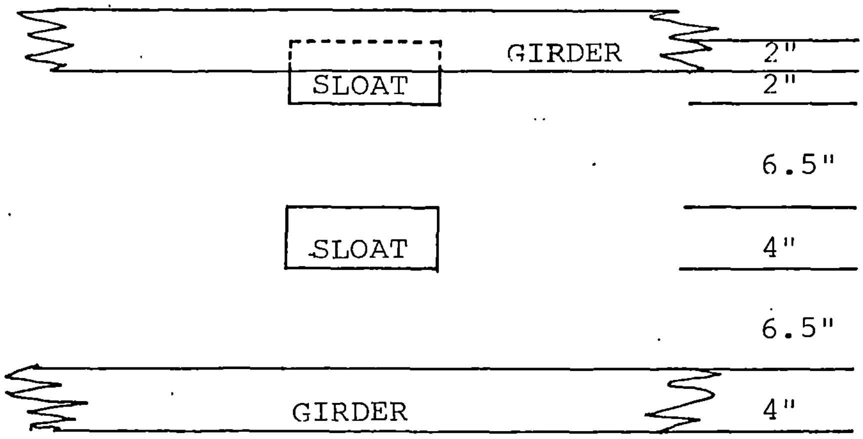
If one accepts that the drum and shaft mechanisms examined in 1979 are the same as those described in the inventory, no question can arise concerning their function. They were specifically installed to control the co-ordinated scene-changing of the 'cuts' or 'sinks'. This co-ordination of the sloat mechanism is something which Walter Dando was to introduce at the Royal English Opera House some thirteen years later. For 1878, however, this method was advanced in its thinking and must have obviated the 'jerky' and uneven movement so criticised in the English wood stage system. From the evidence extant in

1979, it was not possible to ascertain whether any counterweighting had been used in conjunction with the two drum shafts. It would, however, have been feasible to attach a line to one end of the shaft and wind it in a contrary direction to the ropes from the sloats. The counterweights could then have passed down into the cellar, and been fitted with a double purchased counterweight hanger if necessary. No winch, or evidence of one, was found adjacent to either of the drums. It is therefore probable that the master line, which was wound around the drum, was simply 'paid' on and off by the stage-hands.

The spatial distribution of the 9" cuts is particularly important, as it gives an indication of their relationship with other items of machinery. In each of the five 'units' a 9" cut is always positioned on the downstage side of a gas cut, which is in turn always positioned on the downstage side of a bridge. The actual operation of a 'gas cut' is discussed below and here it is sufficient to say that it was probably used for lighting scenery and people on the bridges. This being the case, any 'gas ground row battens' would have to be masked from the audience. This could have been effected by a scenery ground row attached to the sloats of a 9" cut, which would have also provided masking for any lattice ironwork of the bridges that rose above stage level.

The remaining 9" cuts are positioned on the downstage side of the 19" cuts, and therefore, excepting the 1st, on the upstage side of the bridges. Consequently they were able to provide a backing ground row for the bridges, which would presumably match the ground row on the downstage side of the bridge. There is, however, no 9" cut on the upstage side of the fifth bridge, simply because a backcloth would be hung in this position to complement the other pieces of scenery.

On occasions when the bridges were used in conjunction with the 9" cuts, i.e. for 'transformation scenes', the whole visual effect would have been greatly enhanced by the co-ordinated changing of the scene. This was no doubt facilitated by the two drum and shaft mechanisms previously discussed.
As the five bridges rose up, the cuts, Nos.3,4,6,7,9,11,12 attached to a single drum and shaft, could be smoothly raised up to stage level. Moreover, it would be possible to 'strike' the ground rows of the previous scene, using the other drum and shaft in conjunction with the 19" cuts.



<u>Illus.104</u> Sloat arrangement in the 19" cut. Grand Theatre, Leeds. Drawing by D.Wilmore.

(Not to Scale.)

The 19" Cuts.

The four 19" cuts, one in each of the first four units, carry a very interesting annotation in the stage plan. "It is not considered advisable to work two Sinks in the 19 inch Cuts [Nos.2,5,8 and 10] but in case of necessity they may however be used." [7]

The wording does not make it exactly clear whether one set of 'sinks' (sloats) was situated upstage of the other set, or whether two sets were mounted upon the same line. If the former method was used, it is evident from illustration 104 that there would be only 6.5" per set of sloats in which to place the scenery, whereas within a 9" there would be 7" for scenery. Although this represents a difference of only 0.5" the scenery would actually have to occupy a smaller space to allow a reasonable clearance on the joists, and the additional confusion arising from a double set of ropes and pulleys would undoubtedly have caused further clearance and 'snagging' problems. If this method was employed, it would also have been necessary to install intermediate supporting joists for the sloats to rest upon at the various levels. Clearly such modifications to the substage structure would take time, and for this reason alone it may have been considered inadvisable. This being the case, it is probable that the 19" cuts were designed to house a single set of sloats, which could raise highly developed three-dimensional scenery.

If, on the other hand, two sets of sinks were worked upon the same stage line, in a 19" cut it would have been necessary to detach pieces of scenery on every sloat, making it impossible for two continuous ground rows to be operated. This seems highly impractical. One may infer therefore that the annotation upon the stage plan relates to the former method. The use of a 19" cut with or without a double set of 'sinks' is a highly unusual feature, which would have enabled the scenic designers to introduce heavy mouldings and cornices into interior scenes and elaborate trees and foliage into exteriors. None of the 19" cuts had two sets of sinks positioned in them in 1979 and most of the remaining sloats were exactly the same as those positioned in the 9" cuts. The inventory does not differentiate between sloats for the 9" cut and sloats for the 19" cut. It simply notes: "24 Bot slots with irons, pullies, tongues, ropes &c" and a later

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7. Grand Theatre, Leeds. Stage plan drawn by J.R.Watson, op.cit.

annotation adds; "4 extra, 12 in use, 16 not". If three sloats were operated in each 9" cut, 24 would be required, but if three were also operated in each 19" cut, the number would rise to 36. This would appear to indicate that the sloats were movable items, regularly relocated as each production dictated. Further support for this idea is provided by the later annotation, indicating as it does that it was not necessary to have the sloats working in every cut and that only twelve were in regular use at this later unspecified time. It is equally possible of course that this was due to the decline in usage of the sloat as the end of the nineteenth century approached.

Photograph 35 also shows a different type of sloat which was positioned in a 19" cut. A rope was threaded through a hole at 'b', passed down inside the sloat to the base of the tongue, where it was threaded through another hole. It then passed back up inside the sloat to the pulley block at 'c', where it was fed over to the side of the mezzanine floor. It is also interesting to note the two metal brackets attached to the face of the tongue, at 'd' and 'e' which were used to attach pieces of scenery to the tongue of the sloat. The specialised construction of this sloat suggests that it may have been used to raise single items, e.g. a tree, a pillar ,etc., which were positively three dimensional. Thus the 19" cuts and sloats allowed Victorian theatre managers, scenic designers and audiences to indulge their appetite for realism and spectacle which was so much a feature of the latter years of the nineteenth century. A major criticism associated with the movement towards realism was that it required long breaks and intervals to allow the sets to be changed. Clearly the use of the sloat was greatly diversified by widening the cut, allowing three dimensional, heavily detailed and realistic sets to be introduced, without using bridges, in a quick and efficient manner. The 19" cut was therefore a piece of intermediate stage machinery between the bridge and the 9" cut, possessing some of the capabilities of both and several of its own.

The Bridges.

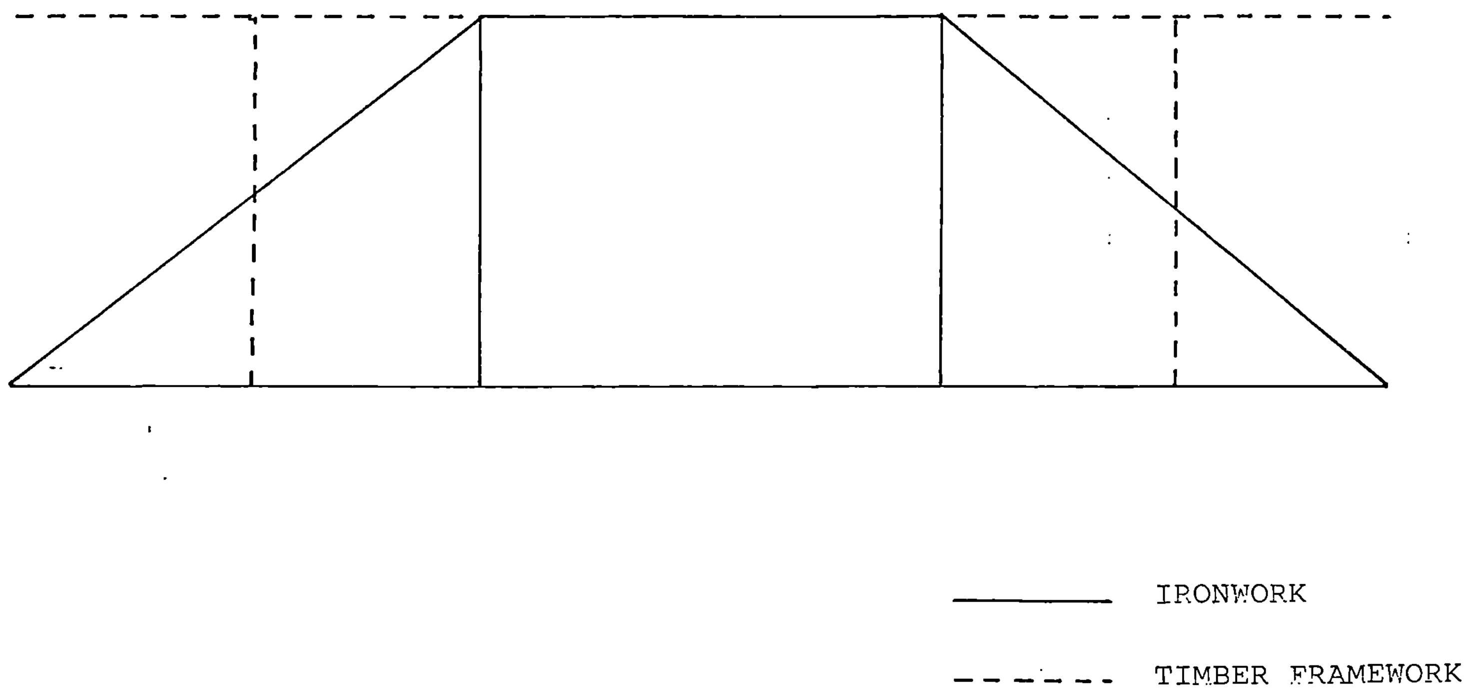
The five bridges were 33' long and 2'9.5" wide and, according to the stage plan, would rise 12'0" above the stage and sink 8'5" clear below the stage. Each bridge was operated by a winch located on the stage left side of the mezzanine floor, [see photos.41, 39]. The five bridge winches were offset in two lines to allow sufficient operating space, being clearly labelled "First

Bridge", "2nd Bridge", and so on. The end plates, 'f', also acted as a ratchet wheel, and either end had teeth running in opposite directions to ensure that the winch could be locked whether raising or lowering its bridge. The overall construction of the winch was exceptionally simple, quite unlike the elaborately jointed winches at the Tyne Theatre, but it was nevertheless extremely functional. It is somewhat suprising, however, to find that there was no gearing between the handle and the barrel, considering the advanced design of the machinery as a whole. This may of course have been unnecessary if the bridges required very little effort to raise and lower them.

Wound around the barrel of the winch was a steel cable which passed through the second mezzanine floor down to the drum and shaft in the cellar [see photo.36]. The latter was constructed of timber in the usual manner but incorporated two interesting features. Iron plates were fixed to the ends of the wooden shafts at 'g', ensuring that it was not possible for the rope to run off the end of the shaft and entrap itself in the associated spindle and bearing. The bearing, 'h', is interesting simply because it it easily removable and would therefore not be time-consuming to replace. Two steel cables were wound around either side of the shaft and passed to the respective offstage ends of the bridge framework, where each was deflected over a pulley 'i' [photo.42], and passed up to the central pulley, 'j' [photo.33], located just beneath the stage. From there they descended, passing through a channel specially cast in the counterweights, 'k' [photo.43], to a point of attachment at the base of the bridge platform, 'l' [photo.42].

The cast-iron counterweights were attached by two steel cables, 'm' [photo.44], which were deflected over two pulleys and passed down to be attached to the same iron cross member as the previous cable at 'n' [photo.42]. This arrangement is particularly unusual as it does not provide for the addition and removal of supplementary weights. Consequently the large cast-iron counterweights had to be slightly lighter than the iron framework of the bridges to ensure that they would always sink into the cellar. This meant that if a particularly heavy set, or large number of people, were, to be carried upon a bridge a considerable amount of effort would have been required by the winchmen.

The sliding floor sections were operated in the traditional 'paddle and fillet' manner, although iron was introduced into the construction of the paddles as shown in photograph 34.



(Not to Scale.)

Illus.105 Diagram of two-tier bridge arrangement. Grand Theatre, Leeds. Drawing by D.Wilmore.

The design of the bridges was therefore very similar to that used in the traditional English wood stage, but there was one notable departure. All five of the bridges had two platforms, one mounted on top of the other [see photo.45 and Illus. 105], a feature confirmed by the inventory:

> "No.5 Bridges, formed of wrought iron framework, two platforms of wood, Top platform formed with movable flap pieces and wood framed legs or supports also movable-guides and working pullies."

This flexible bridge system must have been of great assistance to the designer of transformation scenes. The concept of sub-platforms within a single bridge platform is something which was to be developed to a high degree in Vienna by the Asphaelia Syndicate during the early 1880's and indeed by Sachs in 1901.

A note on the stage plan states that all the bridges would rise 12 feet above the stage. Those at the Tyne Theatre were also designed to rise above the level of the stage, but they were not provided with two platforms. This is what makes the machinery at Leeds particularly interesting. A double platform would provide additional support for three-dimensional scenery or simply further space for actors to stand upon. It appears to be something which was totally unique in Great Britain at this period and could perhaps be compared to the 'Glories' described by Contant in his Parallèle treatise of 1860 [see page 84].

The Gas Cuts.

All five 5" gas cuts are positioned immediately on the downstage side of the five bridges. The name 'gas cut', inscribed on the stage plan, implies that they were associated with gas lighting equipment for the stage, and as previously noted, I am unaware of any other examples.

Photograph 33 shows the stage right paddle of number 1 bridge being withdrawn. On the downstage side of this paddle the small gap visible between two joists is the number 1 gas cut. None of the five gas cuts had been fitted with fillets and paddles, nor were the joists rebated to receive the sliding floor sections. It is therefore unclear how the floor was opened, if at all, for the stage had been relaid in recent times. A newspaper article of 1878 says that, "in front of each bridge there is a narrow gas cut by which the stage is strengthened so as to prevent it racking forward."[8] The use of iron in the structure of the substage would undoubtedly have mitigated this familiar problem and the introduction of a permanent section of staging would quite possibly have totally overcome it.

Below the stage contained within each gas cut was a gas supply pipe which terminated at a main supply running down the stage left wall of the 1st mezzanine floor. Some of the gas cut pipes had been replaced with electrical conduits in recent years. However, the remaining pipes had supply taps mounted at varying points to allow rubber tubing to be attached to ground row gas battens and the like. Photograph 35 shows two gas pipes: the one in the foreground, 'p', had slipped off its mounting brackets, while the one in the background, 'q', had totally collapsed at one end. It is interesting to note that the top half of the gas pipes had been carefully coated with white paint, presumably to allow the gasmen to see the pipes at stage level in a 'blackout'. This may suggest that the gas cut floor sections did open up at various points across the stage.

The gas cuts may have been designed and positioned specifically to light the bridges, while being masked by a ground row in one of the downstage cuts. Alternatively they may simply have been positioned at arbitrary but regular intervals upon the stage. They must almost certainly have been used to supply gas to portable lights on stands or gas ground row battens. All the gas lights were apparently controlled from one of two positions, clearly labelled on the stage plan. This raises the interesting possibility that there were two gas plates, each controlling half of the stage lighting.

The Groove System.

The stage plan shows six sets of grooves, all of which are annotated with various pieces of information. The downstage pair were designated "No.1 Grooves" and were positioned upstage of a "Proscenium Wing", which could be moved apart to any distance between 31'6" and 37'6". Each set of grooves is

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8. Anon., Review of the newly built Grand Theatre Leeds. The Yorkshire Post and Leeds Intelligencer, 19th Nov., (1878), p.5.

annotated as follows, perhaps suggesting the distribution of long and short grooves:

	No.of Cuts	No. for Flats	Gas Groove	No.for Wing Pieces
No.1 Grooves	5	0 (5)	1	4 (3)
No.2 Grooves	11	5 (4)	1	5 (3)
No.3 Grooves	11	5 (3)	1	5 (3)
No.4 Grooves	9	4 (3)	1	4 (2)
No.5 Grooves	8	0	1	7
No.6 Grooves	6	0	1	5

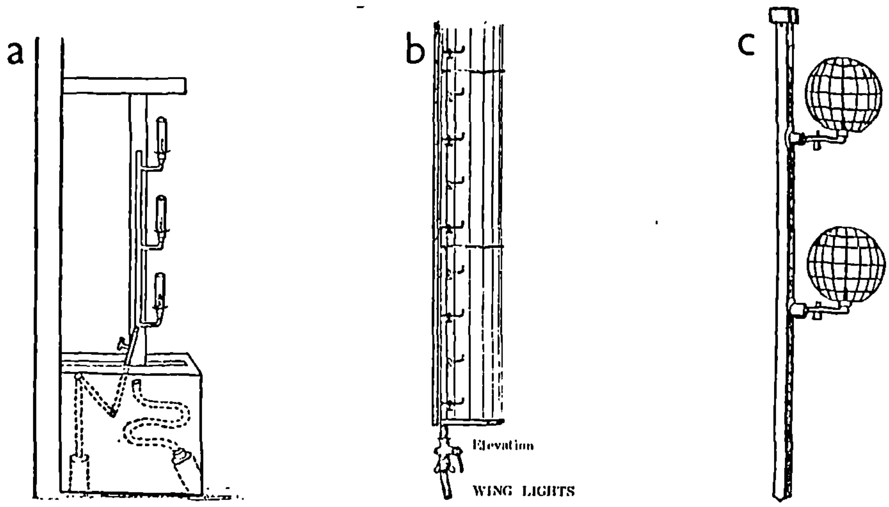
(Nos. in brackets indicate comparative figures for Theatre Royal, Plymouth)

It could be construed from this arrangement that the cuts which were specifically set aside for 'flats' were long grooves, the remainder being short grooves for wing pieces. If this was the case, the long grooves, used for the traditional 'flat-scenes', were only located in sets 2 to 4 inclusive. No sets of long grooves were included in the No.1 set, simply because there would have been insufficient acting space if a 'flat-scene' had been used in such an extreme downstage position. It is very interesting to note this change of long groove distribution when compared to the layout previously studied at the Theatre Royal, Plymouth. Although only 67 years separate the two theatres the evolutionary retreat of the forestage, and the resultant change in long groove distribution, is complete.

With the development of more sophisticated flying systems and higher grids, it was no longer necessary to have long grooves for 'flat-scenes' in the upstage sets. Undoubtedly more realism could be gained by incorporating small mouldings and panellings onto the flats used in the long grooves. However, the same degree of realism could also be achieved by a backcloth, providing that it was sufficiently far away from the audience, i.e. around Nos.4 and 5 groove sets.

The Gas Wing.

The stage plan provides some illuminating information in the 'Notes' at the



Illus.106 a. Gas wing (schematic) at the King's Theatre, Haymarket. G.Aldini, Memoria sulla illuminazione .... (Milan: 1820).

b. Gas wing, elevation. The Building News, (1894), p.569.

c. Gas wing, elevation (Hasluck, 1900). [Reproduced in T.Rees, Theatre Lighting op.cit, p.32].

bottom: "The number of Groove Cuts given includes the one occupied by the gas wings". In this connection Terence Rees comments:

> "A variety of gas burners have been employed as wing lights, [see Illus. 106], the Argand giving the most steady light because of its protective glass chimney, though it was also the most expensive in terms of consumption. The lowest light often came within twelve inches of stage level until in the 1860's the Lord Chamberlain and various local authorities began to set minimum heights of about four feet." [9]

The wing light was not intended to light the scenery contained within the wing grooves but to cast light onto the stage. It therefore seems highly probable that the gas wings were located in the upstage groove of each set. This implies that the long grooves were sandwiched between the wing grooves on the downstage side, and the gas wing on the upstage side. The inventory includes, "12 Framed woodwing ladders, with iron gas battens on same, connections to pipes, mediums of red and green", thus supporting the supposition that there was a wing light associated with every set of grooves.

Another interesting annotation states that, "The Grooves are removed as a rule during Pantomime production", giving an interesting insight into backstage practice for the pantomime season. Unfortunately no explanation is given, but it probably relates to the fact that a great number of people were on the stage during a pantomime, making lower long groove projections exceptionally prone to damage and in turn creating additional obstacles for the performers. If grooves were not used, they must have been replaced by extra backcloths, cut cloths, and substage scenery.

The actual extensions of the upper and lower grooves are not indicated on the stage plan, making it difficult to assess how far they encroached upon the trap apertures. However, the inventory does give some interesting additional details:

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9. Terence Rees, op.cit., p.32.

"Grooves &c.

No.2 Proscenium wing grooves, 1 joint to each, and 3 cuts, working ropes, bearing chains, adjusting screws, swivels &c.

No.8 Wing and flat grooves, 2 joints, do.do.do

No.2 Wing grooves, 1 joint do.do.do."

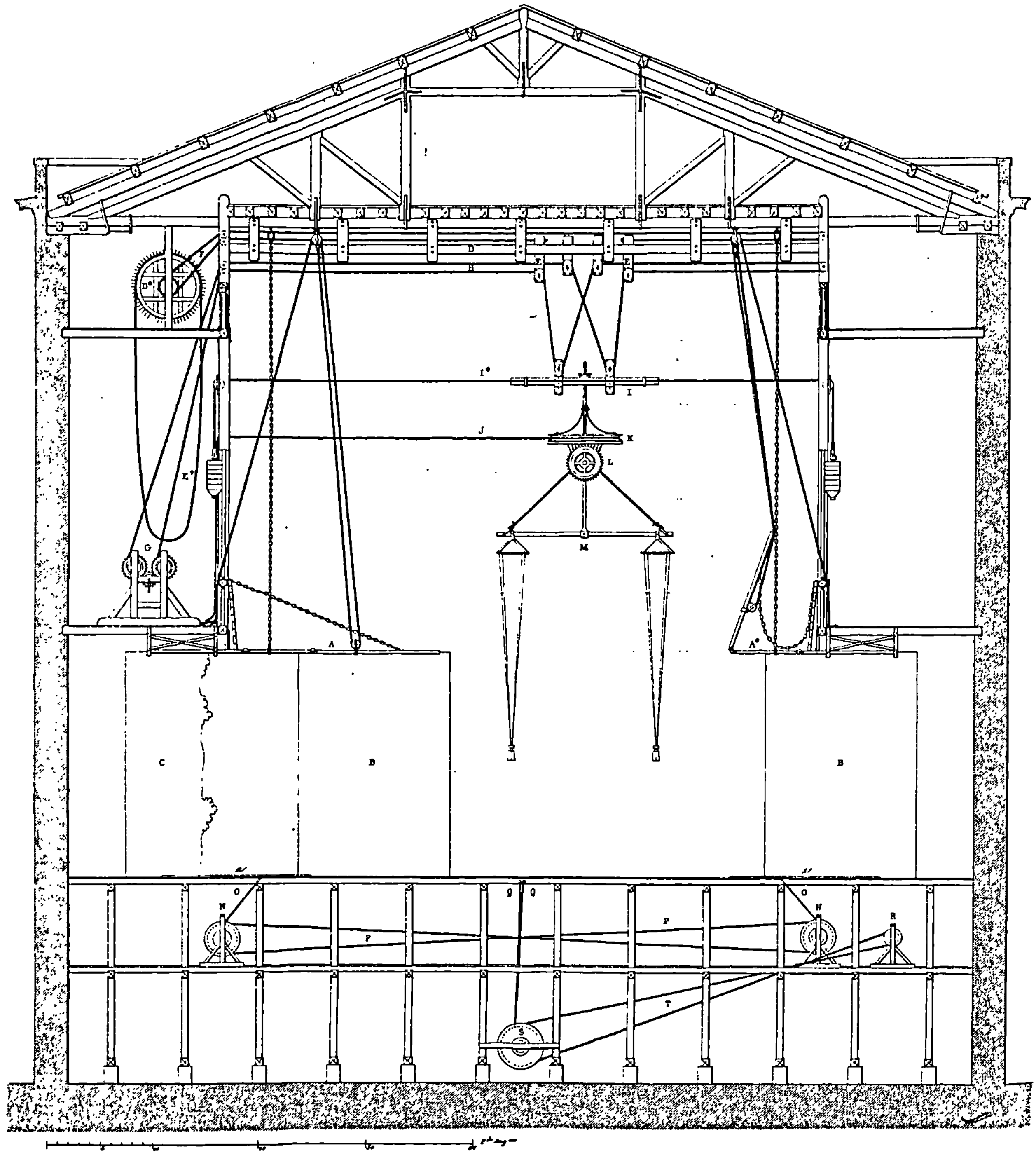
A further and presumably later annotation in a different hand reads "Taken down and stored in cellar."

The quantification of grooves has always been difficult to determine, and typically here it is uncertain whether "2 wing grooves" refers to two grooves or to two pairs, i.e. each pair consisting of a matching upper and lower groove. If one assumes the former and relates it to the stage plan, there are a few inconsistencies, but these could perhaps be explained by later modifications.

It would seem reasonable to assume that the "No.1 Grooves" of the stage plan and the "Proscenium wing grooves" of the inventory are one and the same thing. There is, however, a discrepancy in the number of cuts cited in the two documents, 5 and 3 respectively. Also Nos.2-4 grooves are noted as composite grooves upon the stage plan whereas "8 wing and flat grooves" are cited in the inventory. This being the case, it could be that a decision was made to introduce long grooves to the No.5 set, for only one set remains to be accounted for in the inventory. This is presumably the No.6 set, described as "2 wing grooves" in the inventory, which thus agrees with the stage plan. The annotation, "Taken down and stored in cellar", suggests that the upper grooves were removed from the underside of the fly gallery and that almost certainly the lower grooves were also removed, although there is no direct evidence to prove unequivocally that lower grooves were ever used.

The stage plan specifies "at No.3 Cut Grooves 18'0" high", suggesting the standard flat size. However, the position of the grooves could probably have been altered, as the inventory states that the grooves had "adjusting screws", presumably to adjust the height. There is also a mention of "swivels", possibly intended to angle the grooves to point upstage, which would require precise alignment of upper and lower grooves to allow the flats to run up the rake of the stage.

The most important piece of information provided by the inventory notes on the grooves is that the "8 wing and flat grooves" had "2 joints". Although no



Illus.107 Transverse section of an English stage. Contant, op.cit., pl.27.

drawings accompany the text of the inventory, it is helpful to draw upon Contant's Parallèle treatise once more for some highly detailed drawings of upper grooves with two joints. Illustration 107 shows a transverse section of an English stage according to Contant. The text relating to the grooves is given below. [For a more detailed discussion see page 58].

A. Movable groove, guiding the tops of the wings and the half-flats of the backscene, arranged for a change (of flat scene).
A*. Position of the same groove before coming into position.
a. Raised fillets on the stage floor between which slide the bases of the wings and of the halves of flat scenes.
B. Backscene in two halves, joining in the middle and kept together by alternating joining cleats.
C. Ordinary side scenes or wing-pieces. [10]

It is important to correlate the dimensions of Contant's 'English' theatre of about 1860 with those of the Grand Theatre, Leeds, 1878, to ensure that a genuine comparison can be made.

	LEEDS	CONTANT*
Stage to Fly-floor	20'	23'6"
Height of Grooves	18'	21'
Proscenium Opening	32'6"	Not shown
Stage to Grid	63'	60'
Width of Stage	69'	85'

* (according to the 'pied anglais' scale given with the plate)

The dimensions of the Leeds theatre are only slightly smaller than those shown in Contant's drawing. It is therefore a definite possibility that the type of groove illustrated by Contant and previously examined on page 58 was similar to that which was installed at Leeds.

Against the groove entry in the inventory is the annotation "Taken down and

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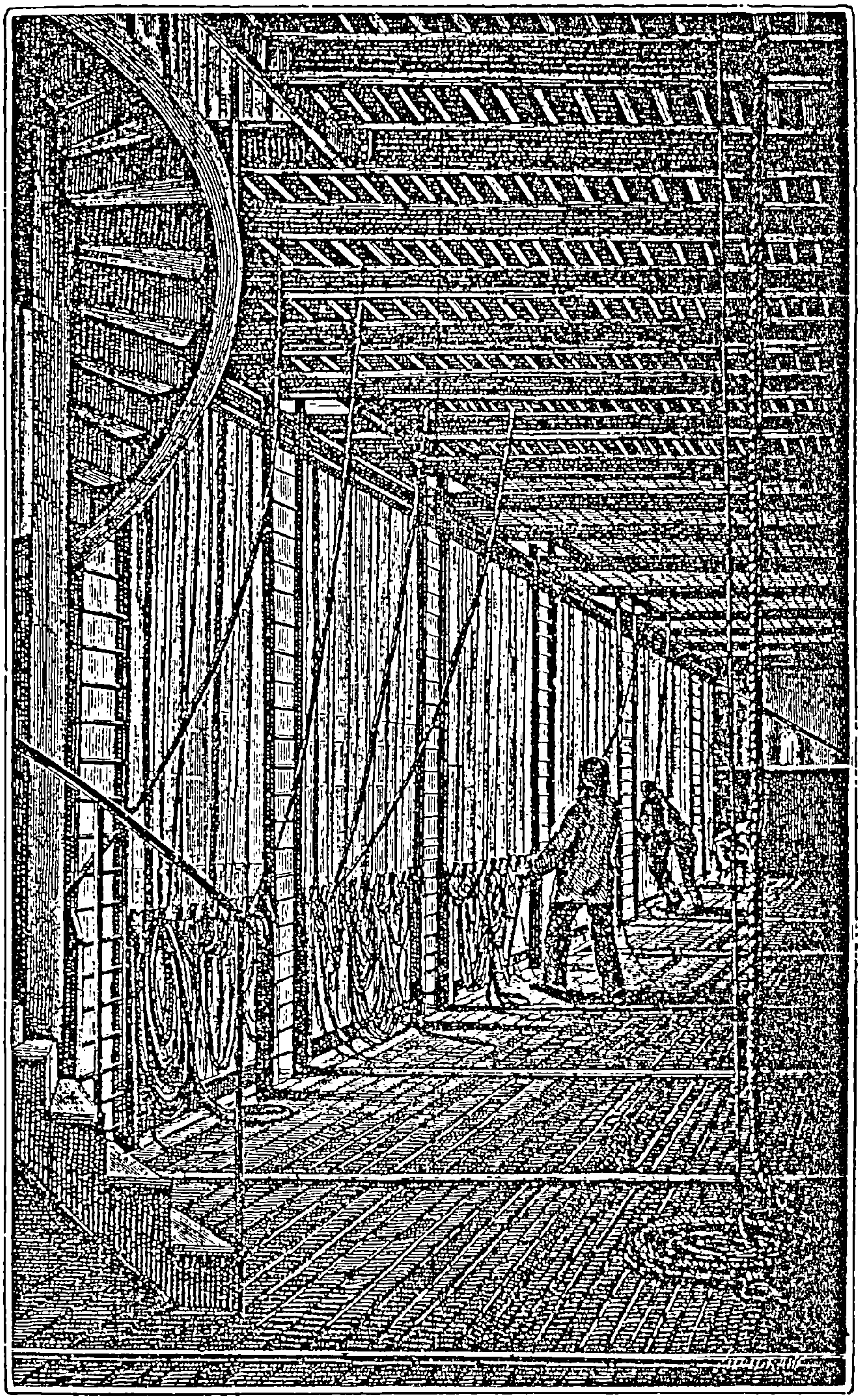
10. Contant, op.cit., pl.27 and p.148



Illus.108 "Premier corridor du cintre pendant la representation." M.J.Moynet, op.cit., p.69.

stored in cellar". This would appear to relate to the permanent removal of the groove system from the theatre and not to a temporary removal for pantomime, mentioned on the stage plan. It is unfortunate that this comment is undated, but it nevertheless offers further evidence for the demise of the groove system around the end of the nineteenth century, brought about by changing ideas in scenic presentation and production. An examination of the cellar in 1979 did not reveal the remnants of any grooves, which had presumably been destroyed many years before.

Overstage.

Originally there were three fly-floors at either side of the stage, all having the fly-rail positioned along the same line, as shown on the stage plan. Unfortunately the overstage area had undergone many modifications by 1979, including the installation of a new steel grid. It was therefore impossible to find any evidence relating to flying mechanisms in the original installation. The description of the "Flies &c." in the inventory is therefore of great importance in building up a picture of the technical facilities at the theatre in 1878:

> "Flies &c.
> Working flies, three at each side, and constructed with wrought iron lattice girders and wooden joists - the lower flies with solid grooved and tongued boards, the upper two flies with open spar floor.
>
> Limelight flies, one tier at each side formed with wood beams and joists, hung with iron from flies above. Gangway of 1" boards, handrail and posts at each side. Grid iron floor. Formed with beams, joists and open spar floor, and suspended from roof with wrought iron hangers."

The use of multiple fly galleries, with "open spar floors", is not typical of an English opera house, although other examples do exist (notably at the Alexandra Palace Theatre, 1875). M.J.Moynet [11] shows a French example [see Illus.108] of

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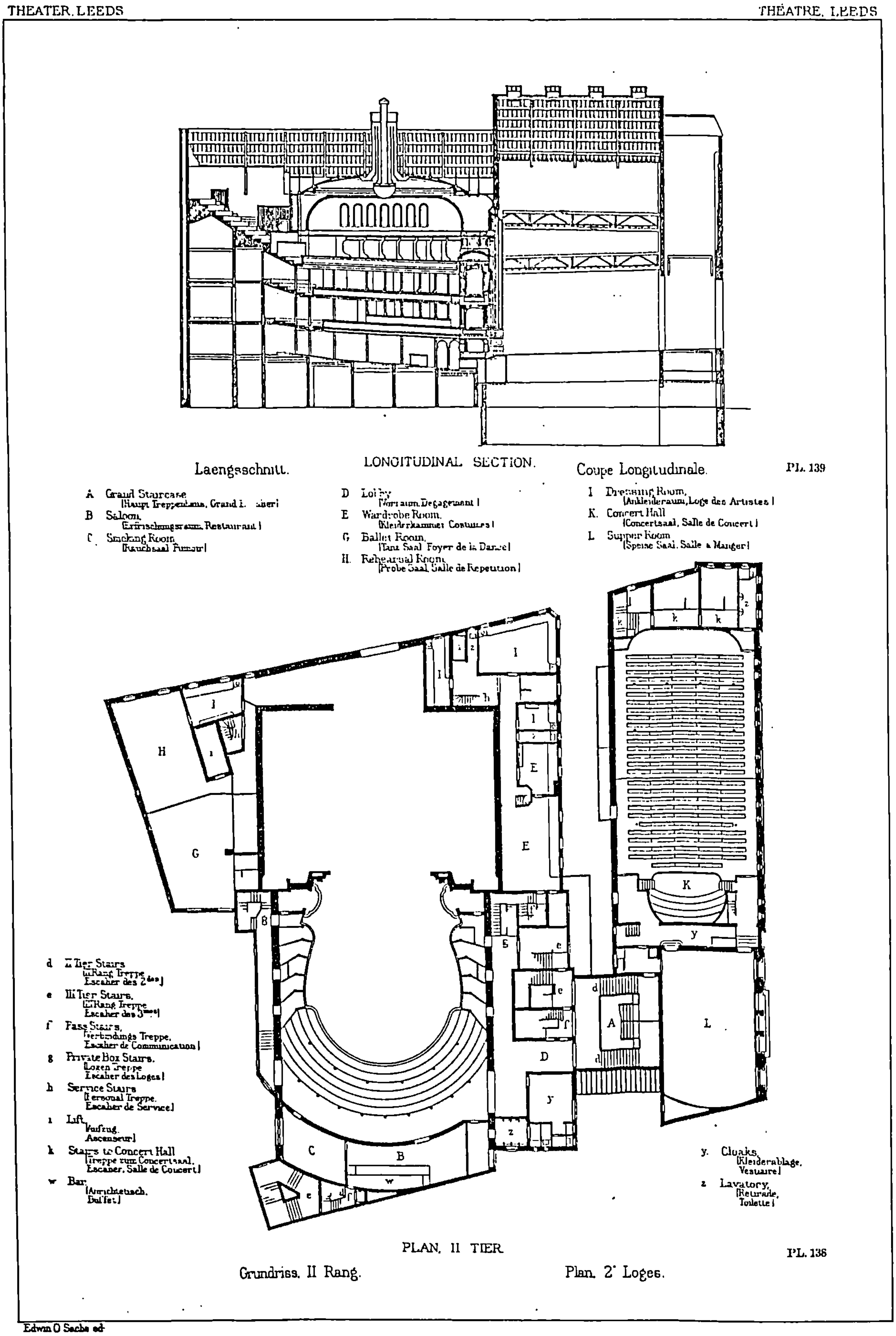
11. M.J.Moynet, op.cit., p.69.



Illus.109 Longitudinal section and plan, Grand Theatre, Leeds. Sachs, Modern Opera Houses, II, pl.138-139, n.pag.

two fly galleries, the upper having an open spar floor, thus allowing ropes to pass down to the fly rail on the lower fly floor which is a solid floor. Although three fly galleries are mentioned in the Leeds inventory and in the newspaper accounts, Sachs's drawings show only two, the lower being raked and the upper level, [see Illus.109]. The only possible explanation appears to be that alterations were made after the opening of the theatre and before Sachs's account was written in about 1898. On the other hand, his source of information about the Grand Theatre seems unreliable at times and it would not be unreasonable to suggest that this was simply an error on his part.

Under the heading "Counter Weight &c.", the inventory gives the following list:

"57 Large cast iron counter weights.
50 Small, do, do, do.
40 Half round bottom do. with the hole through centre.
40 Wrot. iron hangers for counter weights."

Although some of these weights would be required for the corner traps and the grave trap, there would be a considerable number available for use in the 'flies'. This is borne out by the fact that 40 hangers are listed, only 14 of which would be required for the substage traps (2 per corner trap, 4 for the grave trap).

In the inventory under the heading of "Stage Machinery" is a long list of artefacts relating to both above and below the stage. Unfortunately it is not clear in every instance where the items were located and what their function was. Nevertheless the list is highly informative, and gives a very useful insight into the overstage machinery which had been removed prior to 1979:

"No.25 Single purchase crabs cast iron frames, wood barrels, wrot.iron handles.
No.10 Double purchase do.do.do.
No.1 Large crab do.do. with iron teeth."

Within the limited descriptive format of the inventory it is quite possible that several identical items, positioned at various points in the backstage area would have been accounted for under one numerical entry. Given this, the 25 single purchase crabs may have been positoned on several fly galleries, and on the upper mezzanine floor to operate the sloats.

In terms of friction, more is involved in operating a set of sloats than in manually hauling 'out' a backcloth. This is largely due to the number of deflection pulleys used and the angles through which the ropes have to be deflected. If this was the case at Leeds, the "10 double purchase crabs" would have been of greater use in operating the sloats in the substage. It therefore seems probable that a large proportion of these winches were positioned there. However, it must be remembered that an 'iron crab' is a flexible item which could be moved around to suit the requirements of a specific production.

> "336 Single blocks-iron pullies with wood sheaves.
> 47 double do.do.do."

This entry would appear to relate to the pulley blocks located on the gridiron. If there were three single blocks to each line, the gridiron would have accommodated 112 lines, or with 4 single blocks 84 lines, the latter seeming the more probable.

> "5 working drums to the gas battens, on wood frames, with short shafts, axle pins, gudgeons, endless working lines and counterweight lines."

This entry is particularly enlightening as it specifically relates to the function of the machinery, which was to suspend, raise and lower the gas battens. The stage plan is annotated with the following information:

Gas Battens	30'0" long		
	Ordinary hanging height		25 feet
	Lowest do.	do.	20 feet
	Highest do.	do.	32 feet

while the inventory lists "6 iron battens, 30 feet long with chains, ropes, gaspipes and burners, leather connections &c."

It follows that once the battens were hung they had to be rigged to allow an overall alteration in height of 12 feet. At their lowest hanging height of 20' the battens would have been suspended 2' above the upper grooves at the No.3 cut. This immediately raises a problem with regard to the positional relationship between the gas battens and the hinged extensions of the upper grooves. All six battens were positioned either directly underneath the connecting 'fly bridges' or in close proximity to them, and in every case adjacent to the groove positions. Consequently, when it became necessary to lower an upper groove extension into position, it would also have been necessary to raise the adjacent gas batten out of the way. It is unfortunate that no height is given for the fly bridges, but they must have been sufficiently high to avoid the arc made by the lowering of the grooves.

The first (downstage) gas batten was hung over the Proscenium wings, the second and third in front of their respective fly bridges, the fourth, fifth and sixth under their respective fly bridges. From this it is possible to infer that the bridges must have been suspended more than 32' above the stage, this being the maximum hanging height of a batten. It is not immediately clear how a batten could be suspended directly below a fly bridge and still be adjustable in terms of height. However, if one also considers the evidence previously discussed relating to the overstage mechanism from the Theatre Royal, Bath, several similarities begin to emerge. The connecting fly bridges at Bath, which were apparently not directly related to the gas battens, had several holes drilled in them, on the stage right and left ends, and in the centre stage area. This, taken together with the evidence given on the Leeds stage plan, suggests that the holes were drilled to allow the passage of suspension ropes through the fly bridge floor. It is not possible positively to identify them as holes made specifically for ropes attached to battens, but at least one can perhaps discern how the batten height might have been altered at Leeds. The space available for flying cloths in any theatre was always very precious. It must therefore have seemed an ideal solution to use one area for two functions. However, many theatres did not have fly bridges, so the gas battens were "frequently used by the stage hands as a means of access from the flies on the one side to the flies on the other." [12] To carry this comparison of the two theatres further, it may be added that the machinery which was used to operate the gas battens at Leeds was very similar to that installed at the Theatre Royal, Bath, in 1863. Indeed it was suggested in the section relating to the latter installation that the machinery may have been used for controlling the height of the gas battens. The description given in the Leeds inventory could be directly applied to the

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12. Ernest A.E.Woodrow, "Theatres-XLIII", The Building News, LXVI, (1894), p.567.

machinery at Bath. In particular, the use of the phrase "endless working lines" suggests that the drums had a spiked circumference to entrap the endless line, and that only a "short shaft" was required to accommodate the comparatively small amount of cordage received from the batten. The use of counterweights, in conjunction with an endless line and short shaft, seems to have been the standard arrangement for an efficient gas batten suspension system. The information derived from the inventory consequently increases the likelihood that the machinery at the Theatre Royal, Bath, was specifically designed to operate the gas battens.

Although six gas battens are shown on the Leeds stage plan, only "5 Working drums" are accounted for in the inventory, but a later annotation adds "1 Extra". The apparent anomaly of only five working drums compared with the "6 Iron battens 30 ft. long with chains, ropes, gaspipes, leather connectors &c" also listed in the inventory may therefore have been simply a clerical error, or additional equipment may have been installed after the inventory was originally made.

> "3 Working drums for scenery with long shafts, fixed on Gridiron, with end standards, intermediate bearers."

These appear to be standard drum and shaft mechanisms used to gain mechanical advantage for raising heavy pieces of scenery. The word "long" suggests that they were also designed to operate several pieces of scenery, such as 'cut cloths', in a regular and co-ordinated manner. No specific mention is made of the materials employed in their manufacture. However, the inventory appears to specify when iron was used, implying that all other items were made of wood.

The importance of this installation cannot be over emphasised, for it represents an important evolutionary phase in the development of stage machinery particularly in its use of iron. The replacement of timber with iron is something which Walter Dando was to attempt some years later and with limited success at the Royal English Opera House, London, in 1890-91. Because Sachs does not mention the substage installation at Leeds, it would seem logical to assume that the Leeds machinery post-dates Sachs's publication of Modern Opera Houses and Theatres, which was completed in 1898. However, there is much evidence which tends to invalidate such an assumption.

Firstly, the inventory (which has been dated 1896 by the Leeds City Archive) appears to be largely consistent with the machinery which remained in the theatre in 1979. Secondly, the stage plan, signed by J.R.Watson, carries below the signature an address, "5 Blundell Place, Leeds", which according to Leeds street directories was his place of work between 1875 and 1886. These two factors alone suggest that the machinery extant in 1979 could date from the opening of the theatre in 1878. Moreover, the local newspaper accounts of 1878 provide some very useful descriptions of the backstage areas of the theatre as they then were:

> "The height from the cellar to the level of the stage will be 30ft. From the stage-level to the gridiron, or floor over the stage, there is a height of 70ft., and from the gridiron to the apex of the roof over a further height of 18ft: the total height from the cellar floor to the apex of the stage roof being 118ft. From the footlights to the back walls of the stage a width of 72ft; but as the main walls of the stage are pierced with openings opposite the stage entrances, and as the stage itself is surrounded by a corridor 6ft.6" in width, the full 72ft. of the stage can be occupied with a set-scene, and the stage entrances and access be still preserved .....
>
> There are three tiers of working flies on each side, and in addition, under the first tier of flies, there are lime-light flies in which the gas arrangements are placed for the battens. The gridiron extends over the whole stage. In the cellar there are two mezzanine floors, and the cellar occupies the entire width of the stage. In order to obtain a thoroughly strong and satisfactory stage iron has been used for the under construction. There are 23 cuts in all, five of them being bridges, each of which is 37ft. long and 3 ft.6" wide; in front of each bridge there is a narrow gas cut by which the stage is strengthened, so as to prevent it racking forward. The drawings for the stage were made by Mr.J.R.Watson, and the work was carried out by Messrs.Cooper and Dawson. Mr.Robert Wade has superintended the laying of the stage skin and also the fitting of the scenery." [13]

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13. Anon., Review of the newly built Grand Theatre, Leeds. <u>The Yorkshire Post and Leeds Intelligencer</u>, 19th Nov., (1878), p.5.

This account agrees almost exactly with the installation examined in 1979. The only discrepancy appears to be in the number of cuts, cited as 23. An examination of the stage plan and of the machinery itself revealed eight 9" cuts, four 19" cuts, five gas cuts, and five bridges, giving a total of 22. However, if one includes the float, even this minor discrepancy evaporates.

The importance of the theatre, and especially of the stage machinery, was something which was fully appreciated by the writer of an article in The Leeds Times, who observed:

> "It is not, perhaps, on the grounds of the gorgeousness of the decoration that such high rank may be claimed for our new Leeds theatre, though the decorations are exceedingly rich and tasteful - neither is it for the seating capacity of the auditorium, but for completeness of detail, for convenience both before and behind the proscenium, for depth of stage and elaborateness of stage machinery, we imagine it to be unsurpassed even in Germany. To Mr.Corson and Mr.Watson, (the architects) belong the credit of producing so great a work. Mr.Watson, it is said, has made construction of theatres his study for many years. He is familiar with all the great theatres of the European capitals, and this knowledge he has used very judiciously, and perhaps it is in great measure to his skill and knowledge of even the smallest necessary detail that we now possess so fine a theatre in Leeds." 14

This places the theatre well in perspective and provides an interesting insight into the background of James Robinson Watson. Yet, although he appears to have had considerable theoretical knowledge of theatre design, he was not involved in building any more theatres and did not, it would seem, publish any papers on the subject. With regard to his familiarity with "all the great theatres of the European capitals" it is not possible to say if he visited any of them personally. Interestingly, a cash book in the West Yorkshire archive does show the following entry:

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14. Anon., The Grand Theatre Leeds, The Leeds Times, 23rd Nov.,(1878), p.2.

"1878 Sept.10th J.R.Watson pd.his expenses for journies on a/c of Stage & scenery £28 11s."

Presumably these expenses were incurred in connection with visits to other theatres, but it seems very unlikely that he could have toured all the large European theatres for so small an outlay! It is also of interest to note the following entry:

"1877 Aug. 7th pd. Barr Nelson & Barr for Directors expenses to M'chtr to view the Theatres £8 19s 9d."

The theatres which would have been open in Manchester in 1877 include the Prince's Theatre, built in 1864 and designed by Edward Salomons, the Tivoli Theatre, built in 1845, and the Theatre Royal, built in 1845 by Irwin and Chester and whose interior was reconstructed by Edward Salomons in 1875, two years before the visit of the Leeds directors. It is not clear whether Watson made the journey with the directors to Manchester, but if he did he would probably have noted at the Prince's that:

"the scenery was arranged to be worked according to the latest mechanical improvements; what were known as grooves being removed from the stage, and the carpenter's shop, being placed fifty feet above the stage level, it was made possible to draw all the scenery up and save much time in the setting of scenes, improvements introduced into the Theatre Royal in due course." 15

The cost in the late nineteenth century of installing 'modern' and elaborate stage machinery is a matter which is extremely difficult to assess owing to the lack of extant historical documentation. The paucity of development in stage machinery design was, according to Sachs,

"due to the fact that our actor-managers have to rely on their own purses or on those of some speculative financier, instead of having a certain

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15. Anon., "The Prince's Theatre: An Historical Sketch," Manchester Programme, 4th Jan., (1897), p.5.

> proportion of public funds placed at their disposal. Our managers cannot afford expensive experiments. Too much risk is involved in the sudden departure from traditions and conventional usages, and the most that can be undertaken is a gradual improvement of the scenery on the old lines." [16]

Notwithstanding this statement, radical improvements were made in the design of the stage machinery at Leeds. Undoubtedly, Watson was the man responsible for these improvements, but there were also several other factors which influenced this departure from tradition. Watson, the theatre directors and local officials must have been aware of the fire hazard caused by the excessive use of timber in a theatre, for the previous Theatre Royal, Leeds burnt down on May 28th 1875, followed by the Leeds Amphitheatre on March 2nd 1876. These events must have still been fresh in everyone's memory and probably helped to justify the added expenditure incurred by using a high proportion of iron in the theatre, such a theory is supported by several entries in the theatre cash book, which show a high regard for fire prevention:

PAGE NO.	DATE	ENTRY	AMOUNT
19.	1878, March 16th	Cooper & Dawson, pd them on account of Fire proof Flooring to as per Architects Cert.No.1.	£ 700
20.	1878, April 9th	Cooper & Dawson, pd them on a/c for Beams & concrete as per Architects certificate No.2	£ 300
23.	1878, June 26th	Cooper & Dawson pd them on a/c for Fire proof Flooring to as per Architects certfc No.3	£ 500
24.	1878, Aug.27th	Cooper and Dawson pd them on a/c for Iron and Concrete floor as per Architects certfc No.4	£600

This concern for fire proofing seems highly incongruous when correlated with Sachs's statement that, "little attention .... was paid at the time to

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16. Edwin O.Sachs, Modern Opera Houses, III, supp.I, p.2.

protection against fire." [17] Once again his information appears to have been incomplete and it serves to reinforce the notion that this theatre was not examined personally by Sachs. In 1878, Cooper and Dawson were listed in the Leeds Directory as "metal brokers and iron merchants, 7 Park Row", and were responsible for supplying the vast majority of ironworks used in the construction of the theatre, including the stage machinery.

The theatre had originally been scheduled to open on 11th November, 1878, but the date had to be deferred until 18th November because the building was not ready. Indeed an examination of the cash book shows that bills for construction work such as concreting were still being paid in January 1882, implying that building continued for some time after the theatre had opened, although the majority of the work must have been complete for the 1879 pantomime, Dick Whittington and his Cat, for The Yorkshire Post and Leeds Intelligencer reported that:

> "The sixth scene, 'The Storm and Wreck', in spite of the announcement on the programme, came upon me with surprise. It is so full of vigour and motion -the sea lashing against a spurning rock as the ship, with wonderful fidelity to marine motion, rocks to and fro and gradually sinks amid increasing thunder and lightning." [18]

This supposition is further supported by an undated typed manuscript in the West Yorkshire Archive, written by John Beaumont, which reads: "The theatre closed for a short time in July [1879] to put in machinery beneath the stage; cut the traps, put in the bridges and make other provisions for the proper production of a great spectacular piece. It had been impossible to install all this machinery in time for the first pantomime." [19]

The costs involved in constructing a theatre of this size, and especially details relating to the costs of constructing stage machinery, are usually very difficult to discover. However, in this instance individual payments and financial summaries still exist, providing invaluable information about the

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17. Ibid., p.44.
18. Anon., Pantomime review of "Dick Whittington and his Cat". The Yorkshire Post and Leeds Intelligencer, 26th Dec.,(1879), p.4.
19. John Beaumont,M.S. in West Yorkshire Archive, Ref.G.T.

construction of a nineteenth century theatre [20].

The final total of £30,311 3s 3.5d for the building of the theatre suggests that, even with the additional costs incurred in connection with the Assembly Rooms and other buildings in the complex, the final total would be something well below the figure of £60,000 quoted by Sachs.[21] Adding the costs of scenery, gearing, stage, act drop, and rope together gives a sub-total of £3,553 16s 11d, which provides a useful indication of the cost of a large, well equipped stage.

Summary.

The detailed information given in contemporary newspaper accounts is entirely consistent with the machinery extant in the theatre in 1979. Certainly the inventory dated 1896 proves conclusively that the machinery was installed prior to this date and makes it all the more regrettable than no original inventory dating from the opening of the theatre appears to exist. An inventory was certainly made, as the cash book reveals:

> "1881 July 12th J.R.Watson pd his a/c for inventory £75"

Yet even though the extant inventory has been dated 1896, the foot of every page is initialled 'W.B.' (presumably Wilson Barrett), which is at odds with the fact that the theatre reopened under the new management of John Hart on 6th May 1895. Several of the entries in the inventory have been amended in a different hand and often mention "Mr.Hart". It would therefore seem reasonable to suppose that the inventory is in reality Watson's original, amended for Hart by Thomas Winn and Charles Appleton (the signatories) in 1895. This is further supported by the fact that the financial summaries of costs relating to the construction of the theatre dated January 31st 1879 [22], are undoubtedly in the same hand as

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20. Summary of building costs relating to the Grand Theatre, Leeds, 31.1.1879. West Yorkshire Archive, Leeds. Item G.T.210 (orange folder) [see Appendix 5].
21. Edwin O.Sachs, Modern Opera Houses, II, p.44.
22. Summary of building costs relating to the Grand Theatre Leeds, West Yorkshire Archive, Leeds. G.T.210 (orange folder), op.cit.

the inventory. Given this, several things fall into place. First, the amendment to the entry relating to the grooves seems to make greater chronological and evolutionary sense. Undoubtedly the theatre would have relied heavily upon the use of grooves in 1878, but by 1895 they would probably have been considered obsolete. Moreover, if this inventory does date from 1881, it follows conclusively that the stage machinery examined in 1979, was the same as that designed for the theatre in 1878-9. In this case the following statement, which appeared in The Leeds Times on 16th November 1878, takes on an immense significance:

> "The stage is simply a marvel of construction, and of capacity for the presentation of great spectacular effects. It is of iron and is the first stage ever built of iron."

One is forced to conclude that, in 1979, not only was the stage machinery at the Grand Theatre removed, but the first iron stage constructed in Great Britain was destroyed, without an adequate record being made. As Iain Mackintosh has said without mentioning a specific theatre, though clearly he has the Grand Theatre, Leeds in mind, a "unique set of mid-Victorian steel machinery, which could easily have been used for the effects appropriate to nineteenth century opera or to pantomime, was junked to make a cheap orchestra room in one of Britain's greatest theatres." [23]

Watson's design was approximately twelve years in advance of Dando's attempts at the Royal English Opera House [see page175]and also approximately three years in advance of the Asphalcia Syndicate of Vienna. It is therefore extremely mystifying to find that Sachs does not mention the Leeds stage machinery in any of his works. This, coupled with the fact that some of the measurements he quotes relating to the Leeds Grand are inaccurate, inclines one to the view that Sachs was acting on information supplied by other people. For instance:

	Watson	Sachs
Proscenium Opening	32'6"	30'3"
Height of Proscenium	40'6"	40'

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23. Mackintosh, Iain and Sell, Michael et al. Curtains!!! or a New Life for Old Theatres. (Eastbourne: John Offord (Publications) Limited, 1982.) p.11.

Had he examined the theatre, it would undoubtedly have featured very prominently in volume III of his Modern Opera Houses and Theatres. Sadly it did not, and the advances made by Watson were not recognised at a national level. If they had been, the bridge and cut system of the wood stage, might have received new impetus to extend its evolutionary life well into the twentieth century.

Had the importance of this installation been apparent before its removal, it could have been saved. A discussion with the stage-door keeper in 1979 revealed that he had been the stage manager in the 1940's and that, although he did not recall using it, he remembered cleaning it once a month, and painting it once a year. Had the possibility of re-using the machinery in 1979 been examined, it would have been apparent that it simply required a minor overhaul and a new stage surface to accommodate all the traps. Paradoxically it was removed to provide a new band room and rehearsal facilities for 'Opera North', the very people to whom its use could have been a revelation.

Yet although Watson had created an iron stage operated by muscle power and based upon the English wood stage, it was apparently not adopted in any other locality, and in later years omitted from Sachs's treatise. Not for twenty years or more were plans made for another iron stage in England, still relying on muscle power and introducing not for the first time in Great Britain the traditions of the French stage.

THE ROYAL ENGLISH OPERA HOUSE, 1890/91, LONDON.

In 1891 the Royal English Opera House in Cambridge Circus was completed under the direction of its owner Richard D'Oyly Carte. It was particularly noted for the attention given to safety, which was effected on the advice of J.G. Buckle, who had three years previously published his Theatre Construction and Maintenance.

Even more notable, however, was its stage machinery, designed by Walter Pfeffer Dando [see photo.46], who, according to Sachs, was "an engineer who had considerable experience in the designing of French stage machinery"[1] ; an article in The Sketch [2] confirmed that Dando had worked at the Châtelet Théatre in Paris before coming to London. The designs for the Royal English Opera House stage machinery were in fact patented [3] by Dando in 1890 and constitute the main body of information available, as the machinery has been almost completely removed from the theatre. It is, however, necessary to make a distinction between the original design, given in the patent, and the actual installation, which underwent several modifications during the planning and execution stages. Ernest Woodrow made this comment upon the discrepancy:

> "When the Royal English Opera was first started, I remember hearing of the great improvements that were to be made in stage machinery, and that nearly everything but the boards of the stage was to be of iron. True, there are some minor improvements in the details, but the broad principles on which this stage is built is the same as used generations ago." [4]

Conversely, Sachs commented that it was "practically the only stage in the

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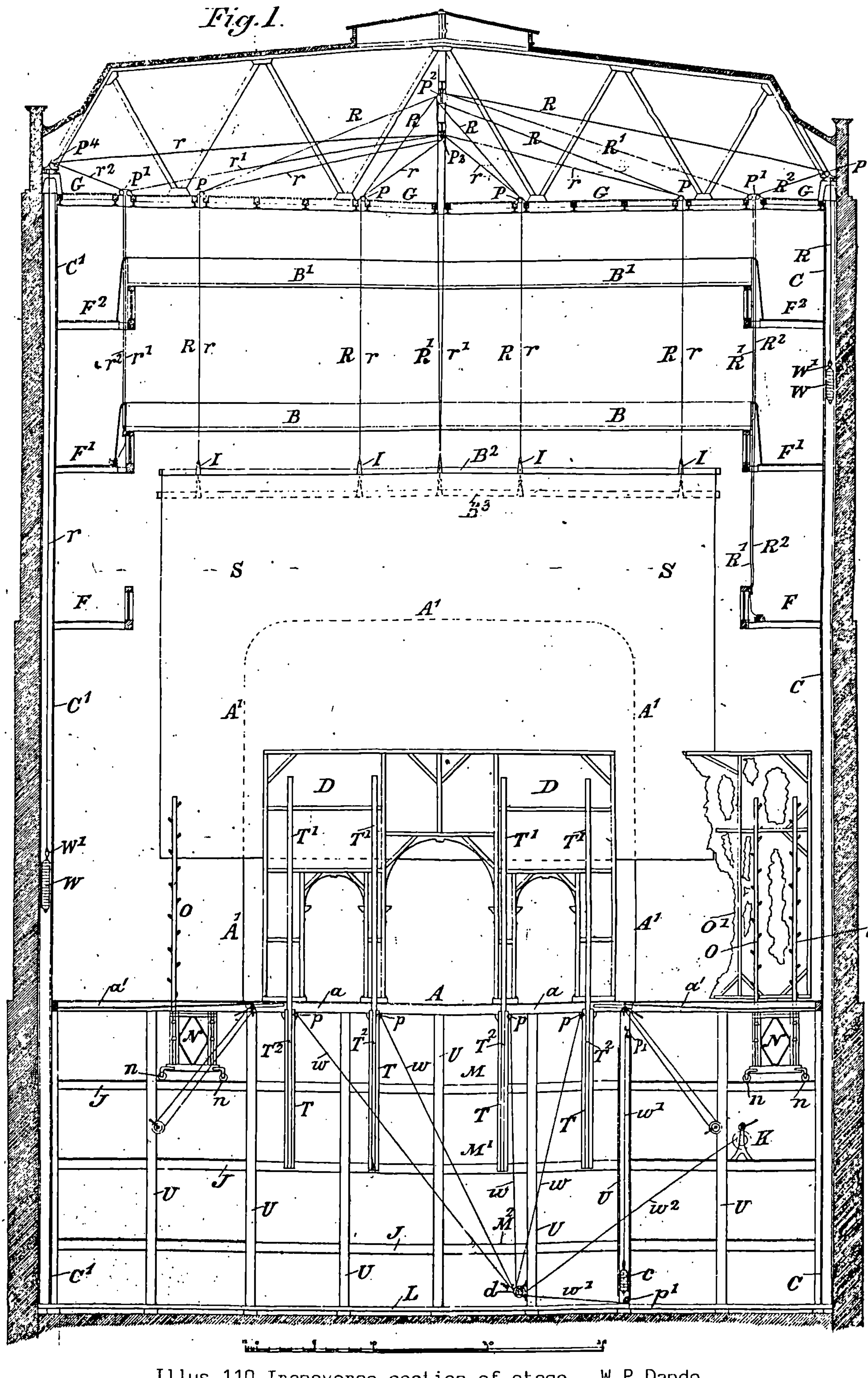
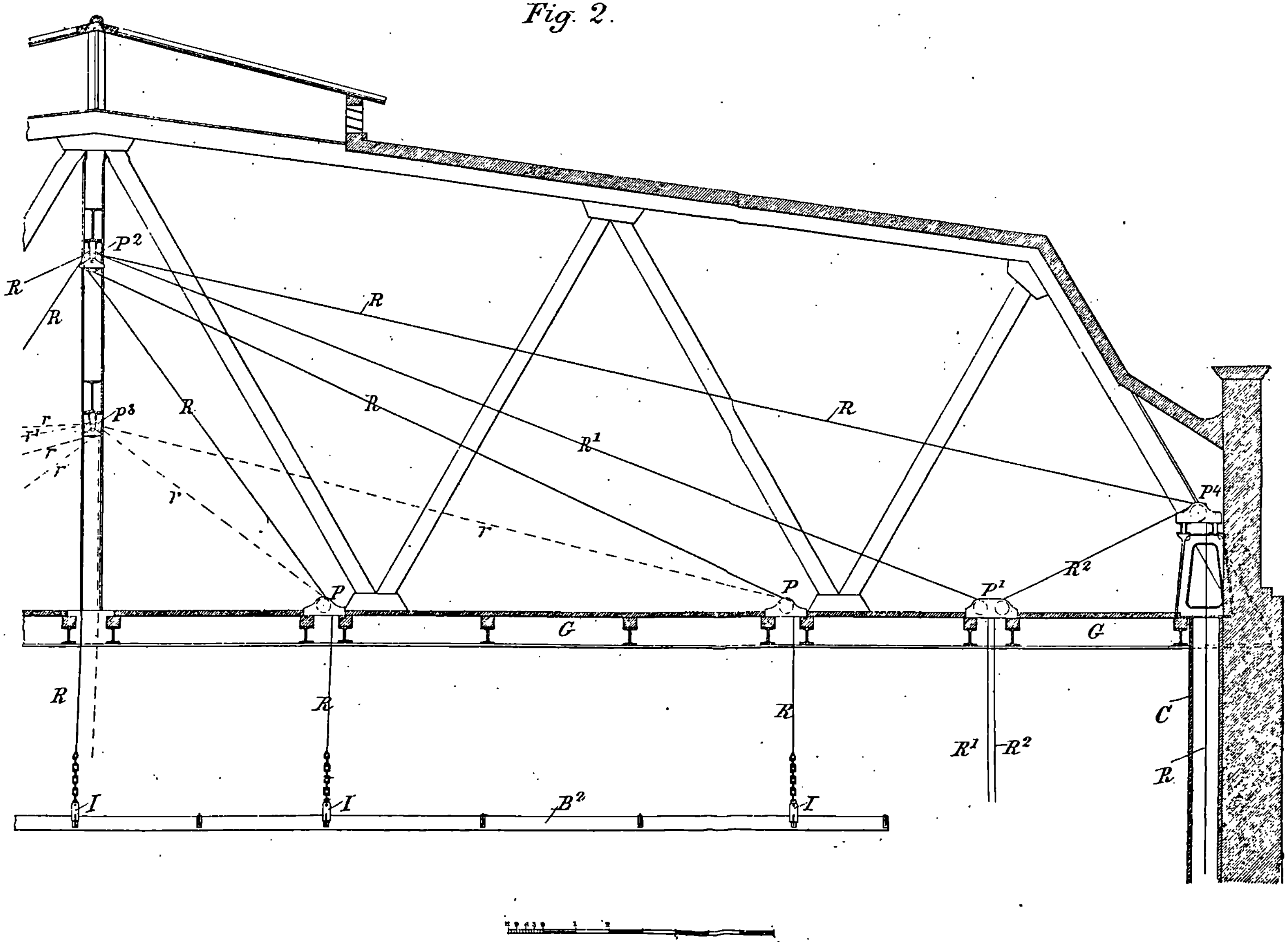
1. Edwin O.Sachs, "Modern Theatre Stages - No.XI", Engineering, 3rd July, 1896, p.3.
2. Anon., "How the Palace Tableaux are lighted: A chat with Mr.W.P.Dando". The Sketch, 14th March, (1894), p.373.
3. Walter P.Dando, Improvements in the Mechanism of Theatrical Stages and Means for Operating the Scenery and Producing Scenic and Stage Effects. U.K. Patent No.16,699, (London: H.M.S.O., 1890). [Illustrations bound on facing page, full text given in Appendix 6].
4. Ernest A.E.Woodrow, The Building News, 25th March, (1892), pp.427-30.



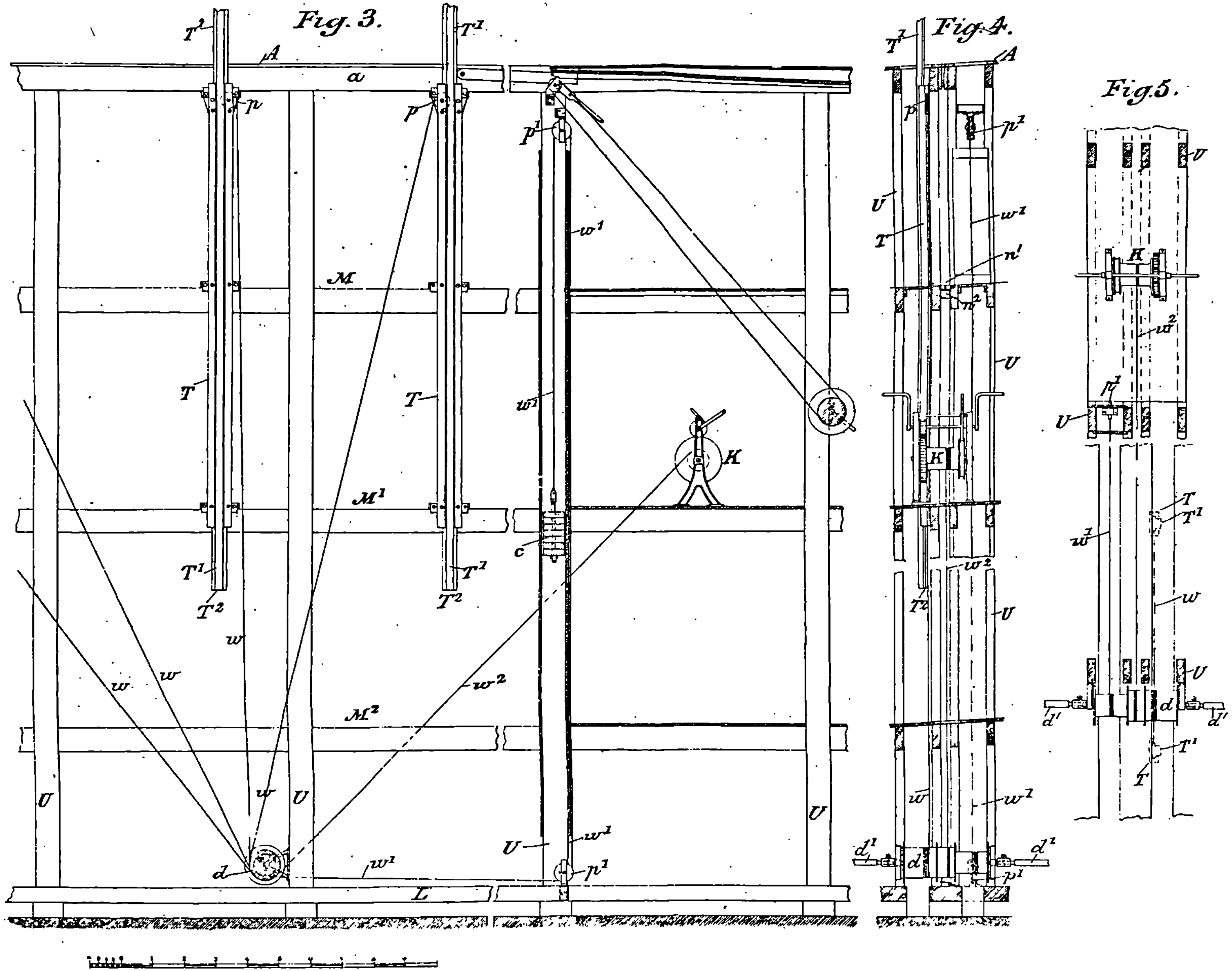
Illus.110 Transverse section of stage. W.P.Dando, U.K. patent No.16,699, 1890, Fig.1.

Fig. 2.

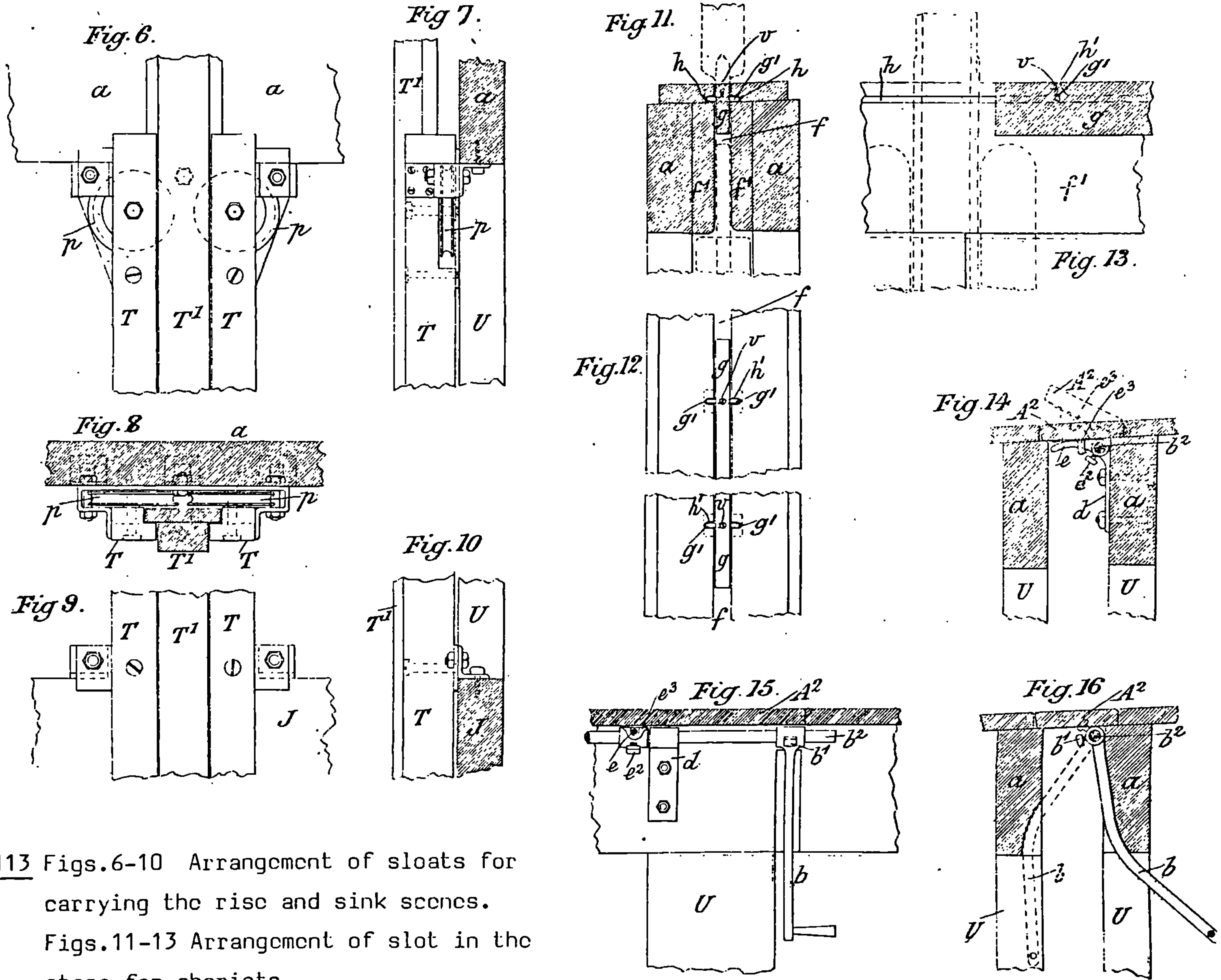


Illus.111 Transverse section of half of the grid.

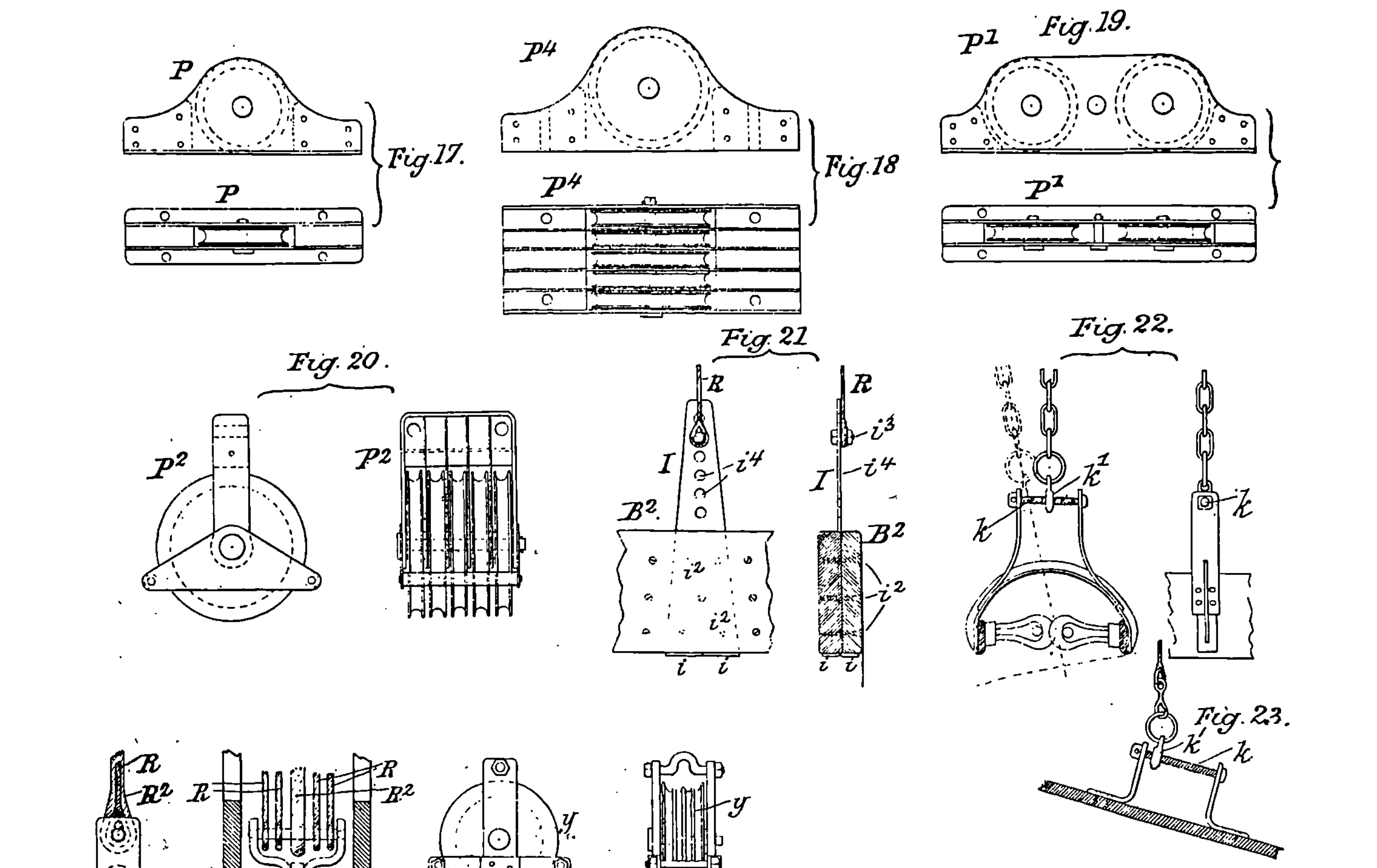
W.P.Dando, loc.cit., Fig.2.

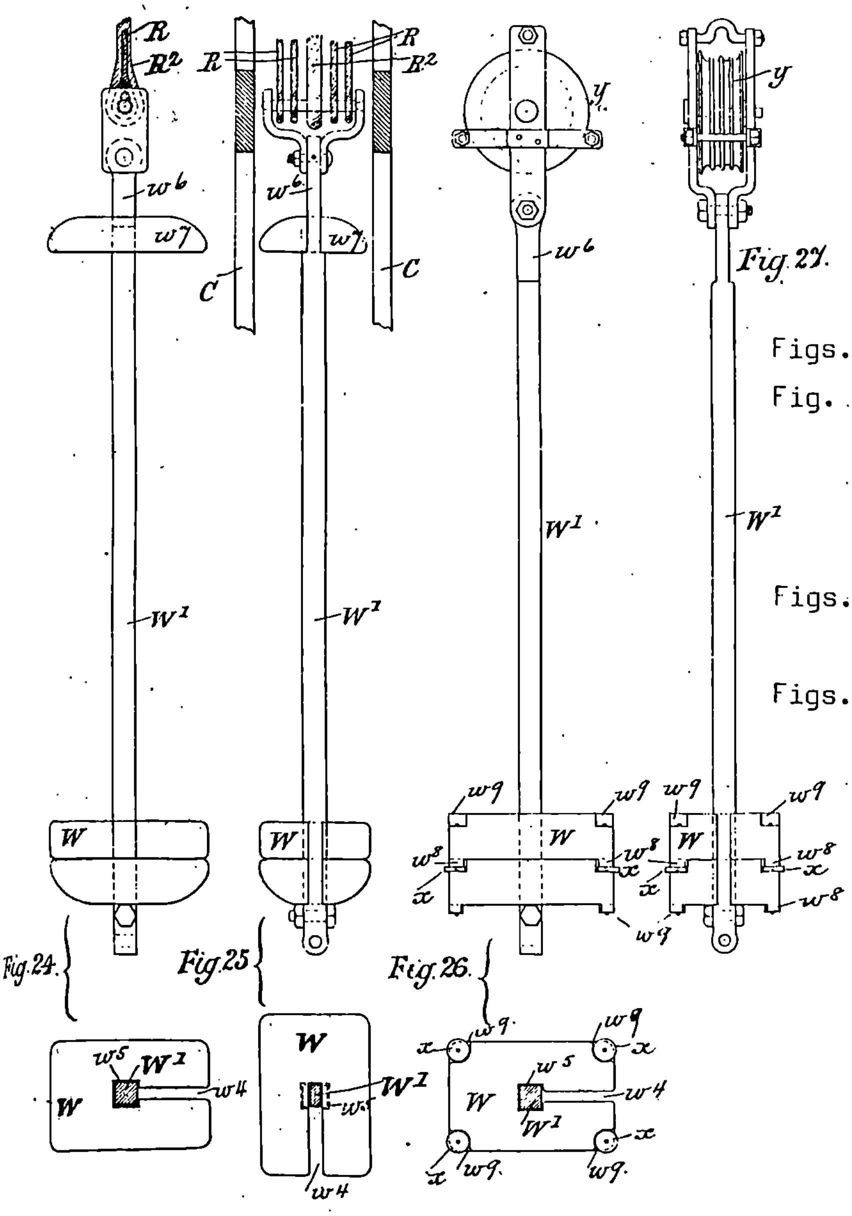


<u>Illus.112</u> Dctails of sloats in substagc. W.P.Dando, loc.cit., Figs.3-5.



Illus.113 Figs.6-10 Arrangement of sloats for carrying the rise and sink scenes.
Figs.11-13 Arrangement of slot in the stage for chariots.
Figs.14-16 Arrangement of carpet cut.
W.P.Dando, loc.cit.





Illus.114

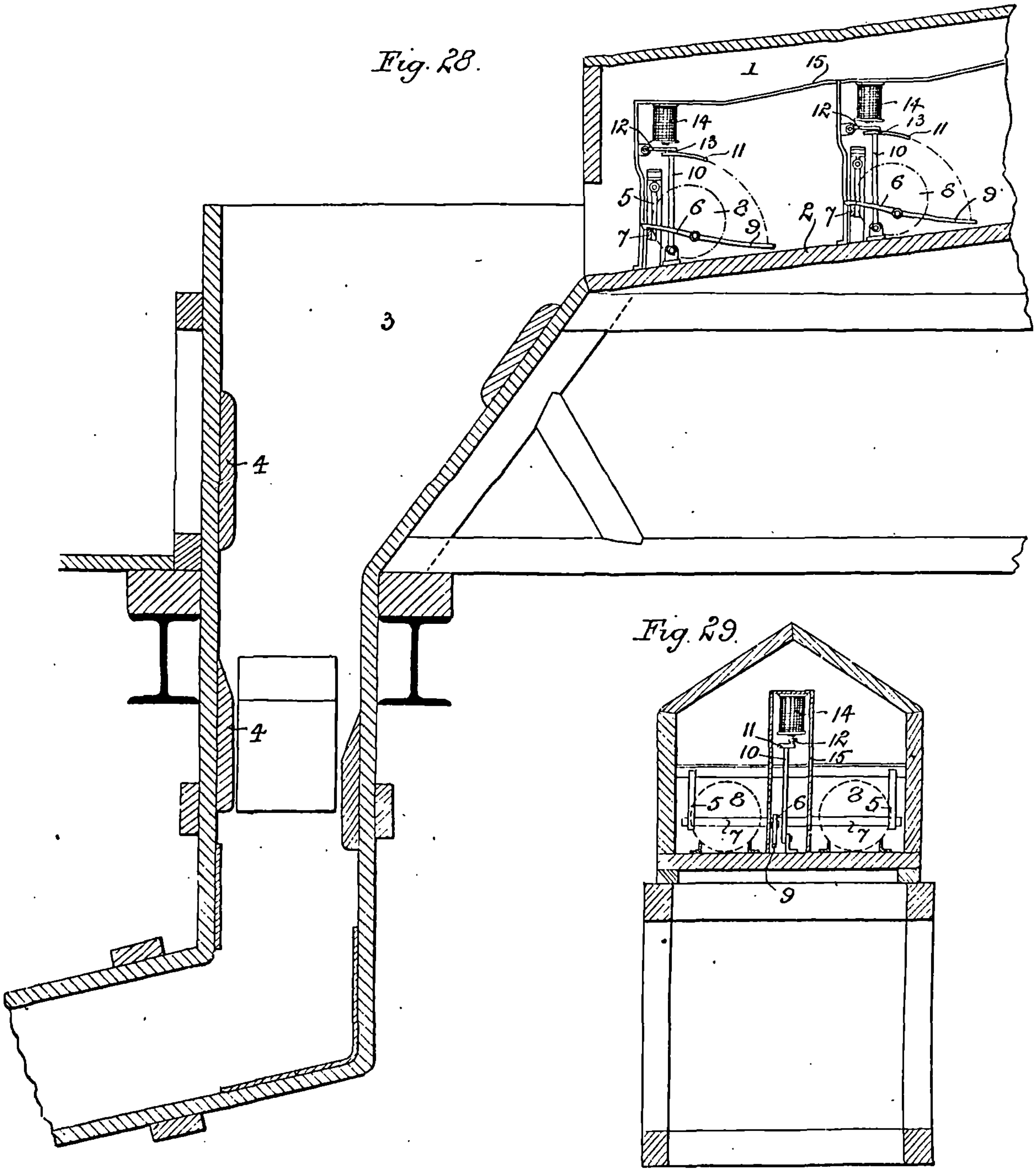
Figs.17-20 Details of pulleys.

Fig. 21 Elevation and cross-section of an adjustable arrangement for attaching the wire ropes to scenery battens.

Figs.22-23 Means for suspending a batten or ceiling piece at any angle.

Figs.24-27 Arrangements for counterweights and their carriers.

W.P.Dando, loc.cit.



Illus.115 Figs.28-29 Vertical section and front elevation of apparatus for "stage crashes." W.P.Dando, loc.cit.

Metropolis where the ante-diluvian methods of the stage carpenter have been improved upon." [5] In reality, the specifications given in the patent were not implemented in an exact manner, but nevertheless represent a very important evolutionary phase in the development of stage machinery. The text of the patent therefore demands careful consideration in its own right.

In the opening paragraphs of the patent Dando identified the basic problems common to stage machinery of the period and then proceeded to explain how his new system would overcome these problems:

> "My invention relates to mechanism used in connection with theatrical stages and means for operating the scenery and producing scenic and stage effects so that scenery may be changed with great facility and precision and freedom from 'jerks' and with but a small expenditure of manual labour and whereby scenic effects can be produced which are impracticable with the appliances as hitherto used in theatres. According to my invention I provide systems of wire ropes pulleys and counterweights so arranged that the scenes can be manipulated with great ease, facility and steadiness so that if desired the whole of the back scene and set scenes can be operated together to give the effect of the scene as a whole rising or falling together.
>
> Moreover I supercede the system technically known as 'bracing' or 'gimbleting', that is supporting set scenes by braces or struts which are screwed into the stage, which is objectionable and a source of danger to the persons engaged on the stage." [6]

By attempting to remove the "jerks" in any scene changes and "give the effect of the scene as a whole rising or falling together", Dando greatly improved the overall scenic presentation and produced almost ideal conditions for a transformation scene. The introduction of a counterweight system incorporating wire cables is particularly notable, for many theatre architects, managers and carpenters believed that hemp ropes were preferable simply because they could be easily severed in the event of fire. However, such thoughts were formulated in the days of gas lighting, and the Royal English Opera House was lit by

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5. Edwin O.Sachs, Modern Opera Houses, I, p.36.
6. Dando, op.cit., p.1.

electricity.(Richard D'Oyly Carte was the first theatre manager to introduce electricity into a theatre, at the Savoy, in 1881).

Other attempts were, however, made to improve the quality of the cordage specifically available for use in theatres. One significant contribution was patented by Crowe, Phillips, and Betts in 1890 [7]. It is particularly interesting because unlike many theatrical patents it was actually mass produced by the patentees, "Manufacturers & Merchants of Scene Canvas, Stage Ropes and Theatrical Sundries." Their catalogue for 1892-3 stated that the "patent safety rope" had various advantages over ordinary rope:

> "In case of FIRE, after the Hemp or outside Fibre has been consumed, a cord remains, composed of Wire and Asbestos, which will carry weight corresponding with the original strain put upon the rope, thus preventing PANIC and DANGER to Life and Property: There is no fear of it suddenly snapping from friction or dry rot, and is guaranteed to stand a greater strain than ordinary rope." [8]

The introduction of composite and wire cordage certainly meant that scenery could no longer be 'cut down' with great ease. With the advent of specific fire regulations relating to theatres, the emphasis was placed upon sealing off any fire which originated in the backstage area. It is therefore incongruous to discover that the Royal English Opera House did not have a proper safety curtain installed until 1903. The L.C.C. Theatres and Music Hall Committee then stipulated: (i) that the proscenium wall should be made good to the underside of the stage flooring and the portion of the stage floor between the back of the proscenium wall and the back of the curtain to be made fire-resisting; and that (ii) the curtain should be provided with an arrangement for pouring water on its surface [9].

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7. Willliam J.Crowe, Herbert T.Phillips, William J.Betts, Improvements in the Manufacture of Rope. U.K. Patent No.19,642, (London: H.M.S.O. 1890), [Full specification reproduced in Appendix 7].
8. Crowe, Phillips, and Betts Trade Catalogue, (London: 1892).
9. Letter from the L.C.C. Theatres and Music Halls Committee, 19th March 1903. G.L.C. Archive.

The Counterweight System.

In Fig.1 C and C' represent the 'prompt' and 'opposite prompt' counterweight boxes, running from the grid to the cellar. Within the boxes are contained the counterweights, details of which are given in Figs.24-27. The weights had a slot, W_4, leading to a square aperture, W_5, which allowed them to be slipped upon the narrow part of the hanger, W_6, and passed down to the point where the wider part of the hanger coincided with W_5. Chamfered 'capping weights' were used in order to guide the counterweight's course within the box. The ordinary weights, shown in Figs.26-27, had 'leg pieces', W_8, which interlinked and were prevented from rattling by the insertion of a rubber disc, x. The counterweight hangers could if required have purchase pulleys attached to them, thus reducing the distance travelled (Figs.26-27, y).

Fig.1 shows two scenes, S, attached to battens B_2, B_3, and operated by wires, R, r. The wire ropes, R, were attached to the batten, B_2, and passed over a pulley, P, on the grid (Fig.17). From there the rope passed around the sheaves of pulley P_2 (Fig.20), around the sheaves of pulley P_4 (Fig.18), and down into the counterweight box, c, where it was attached to the hanger. The 'power rope' R_1, was attached to the centre of the batten, B_2, and passed over a sheave of pulley P_2, over a pulley at P_1, passing down to the fly gallery at F. When this rope was pulled the counterweights moved downwards, and the scene was raised. The rope, R_2, passed from the fly gallery, F, over a pulley, P_1, over a pulley, P_4, and was then attached to the counterweights. By pulling on this rope the counterweights were raised and the scene was lowered. The various pulleys referred to could in fact be placed at any suitable height, if there was insufficient room for them side by side. An examination of photo.47 taken in 1972 reveals two tiers of five pulley sheaves, attached to a 'meccano-like' girder, which presumably allowed them to be moved around as required (though these pulleys were later made redundant by the installation of a new counterweight system). The scenery could be raised or lowered from either of the fly galleries on either side of the stage, and the traditional 'long, middle and short' system of flying was dispensed with. The two outer wires and the two inner wires were the same length respectively and there was therefore an equal strain exerted upon the batten. The wires were attached to the batten by an adjustable bracket shown in Fig.21. The bracket, I, was set between the two halves of the batten and its bottom edge was bent over to either side to provide additional support. A bolt was passed through the wire eye and the bracket, and its position could be altered by placing the bolt through any of the five holes on the suspension bracket. This arrangement replaced the old method of nailing the cloth to the batten and passing the ropes through holes in the top of the cloth, which caused a great deal of damage and reduced the life expectancy of the cloths. With Dando's method the batten was always left hanging; it was therefore one of the first counterweight systems to adopt in principle the method still in use today.

An interesting feature of Dando's flying equipment was the inclusion of a ceiling suspension bracket, which became increasingly important with the introduction of the 'box set'. It consisted of a screw, K, attached to a bracket, which was in turn attached to the ceiling piece. When the screw, K, was turned, the nut K_1 moved along the thread of the screw, causing the angle of the ceiling piece to alter. This suspension bracket could be attached to the flying lines by either a chain, (Fig.22), or by a spring hook Fig.23.

Neither Dando's patent nor Sachs's drawings indicate the presence of a drum and shaft mechanism on the grid. However, two exceptionally large ones are extant today, [see photo.47] and would undoubtedly have assisted Dando's aim to produce smooth, co-ordinated scene changes. The question must therefore be raised: was a later modification made to obviate the inadequacies of Dando's original equipment? Writing in 1896, five years after the opening of the theatre, Sachs pointed out that a special feature of the design of the machinery at the Royal English Opera House was the "abolition of the heavy and cumbersome drums, used in all other English stages, and the substitution of pulleys and counterweights." [10]

The Chariot and Pole System.

Dando included within the specifications of his patent the chariot and pole system of scene-changing which had existed on the Continent for many years. Yet he was certainly not the first person to attempt to incorporate it into a British theatre. As previously noted, Rees [11] described and illustrated

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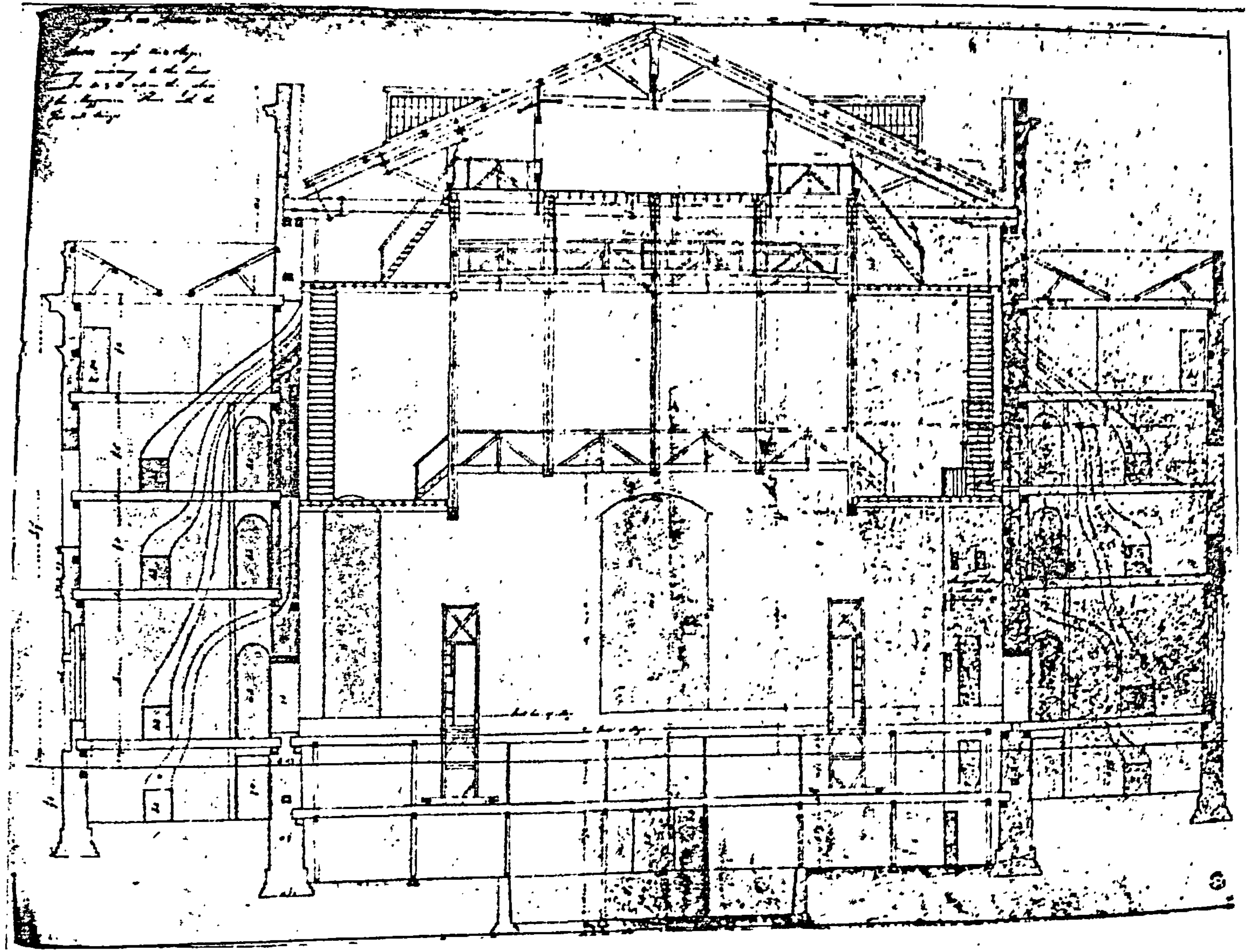
10. Edwin O.Sachs, "Modern Theatre Stages - XI", Engineering, 3rd July, (1896), p6.
11. Abraham Rees, op.cit., XII, n.pag.



Illus.116 Transverse section of stage, Theatre Royal, Drury Lane, London, by Benjamin Wyatt. Drawer 38, set 1, pl.32. [Courtesy of the Trustees of Sir John Soane's Museum].

a method of co-ordinated wing scene-changing apparatus which was very similar in design to the continental wing chariot and pole system. This description was apparently written in 1809 [see p.4 for evaluation] and the drawings reproduced based upon the "Covent Garden Theatre", which was presumably Sir Robert Smirke's Theatre of 1809, the previous building having burnt down on 20th September 1808. On 24th February 1809 the Theatre Royal, Drury Lane, suffered the same fate. By September 1809 the Covent Garden Theatre had been completely rebuilt, though it was not until October 1811 that the designs of Benjamin Dean Wyatt had been selected to rebuild Drury Lane. Wyatt must therefore have been aware of the chariots at Covent Garden and it may well have influenced his decision to include them in the stage at Drury Lane. They ran on tracks, 18 feet 6 inches long, mounted at mezzanine level some 7 feet 6 inches below stage level. There were six pairs of carriages on either side of the stage, though there is no information on his drawing relating to a co-ordinating mechanism such as a drum and shaft [see Illus.116].

It therefore seems rather surprising that, although at least two of London's main theatres employed the so-called "continental system" of wing carriages in the early part of the nineteenth century, the system does not appear to have been adopted by many other houses in London or the provinces. Further references to the use of the carriage and pole system during the mid-nineteenth century are scarce. In March 1856 the Covent Garden Theatre was once again destroyed by fire and subsequently redesigned by the architect E.M.Barry and reopened in 1858. Concerning the backstage arrangements he wrote:

> "Mr.Beverley, the distinguished artist, was consulted as to its general arrangement [the stage] and mode of working, and the practical realization [sic.] of his views was confided to the experienced hands of Mr.Sloman [12]. The proscenium columns are arranged to slide on wheels, so as to expand or contract the opening when desired. The grooves commonly used for the support of the scenes are entirely dispensed with, it being considered that their undoubted convenience is more than counterbalanced by attendant disadvantages, and more particularly by the obstacles they offer to the formation of a grand open scene embracing the whole extent of the stage. The back scenes are of single sheets of canvas, lowered from the top, and secured to rollers resting ultimately upon the main beams of the roof.

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12. This may well have been the same man who assisted in the installation of the stage machinery at the Theatre Royal, Bath in 1863, [see p.51].

The side scenes and set pieces are fixed to the wing ladders, behind which the side gaslights for lighting the stage are placed. The wing ladders being unattached to anything above, the artist is enabled to place large set-pieces such as trees, rocks, houses, &c., against them, and still preserve the total height of the stage, while they are so constructed that they may be moved completely across the stage." 13

The tradition of the carriage and pole system was therefore continued at Covent Garden and was almost certainly still in operation in 1863, when Charles Fechter decided to adopt this system at the Lyceum Theatre, London. A description of this machinery appeared in a periodical entitled All Year Round, which was "conducted by Charles Dickens", and provides a useful insight into the basic layout of the equipment:

"We must keep at present to the main-deck - the stage that is visible to the public when a play is acted. The first thing that strikes you in examining this is that it is traversed completely from side to side by certain narrow slits, through which you can see down into the second stage below. There are two dozen of these slits in parallel lines. Having observed them, and wondered what they are for, you notice a number of strong upright poles rising out of the stage, where the wings are ordinarily placed; going up to one of them you see, on examination, that, though it is a pole above the stage, it has a broader lower member - part and parcel of it - which descends through one of those slits already described, into the 'between decks' below. Descending a companion-ladder, you post off to see what becomes of it after it has passed through the slit, and then one glance reveals the simple plan by which the scenes are pushed backwards or forwards to their positions on the stage. That broad flat piece is received in a travelling crane below, which runs on wheels along an iron tramway, and moves so easily that a child might move it with but little exertion. These iron tramways are laid along the floor of the second stage, exactly underneath the slits above; it will be obvious that the pole which descends through the slit may, by means of the travelling crane which runs along the tramway, be pushed to any part of the stage where it [the pole] is wanted." 14

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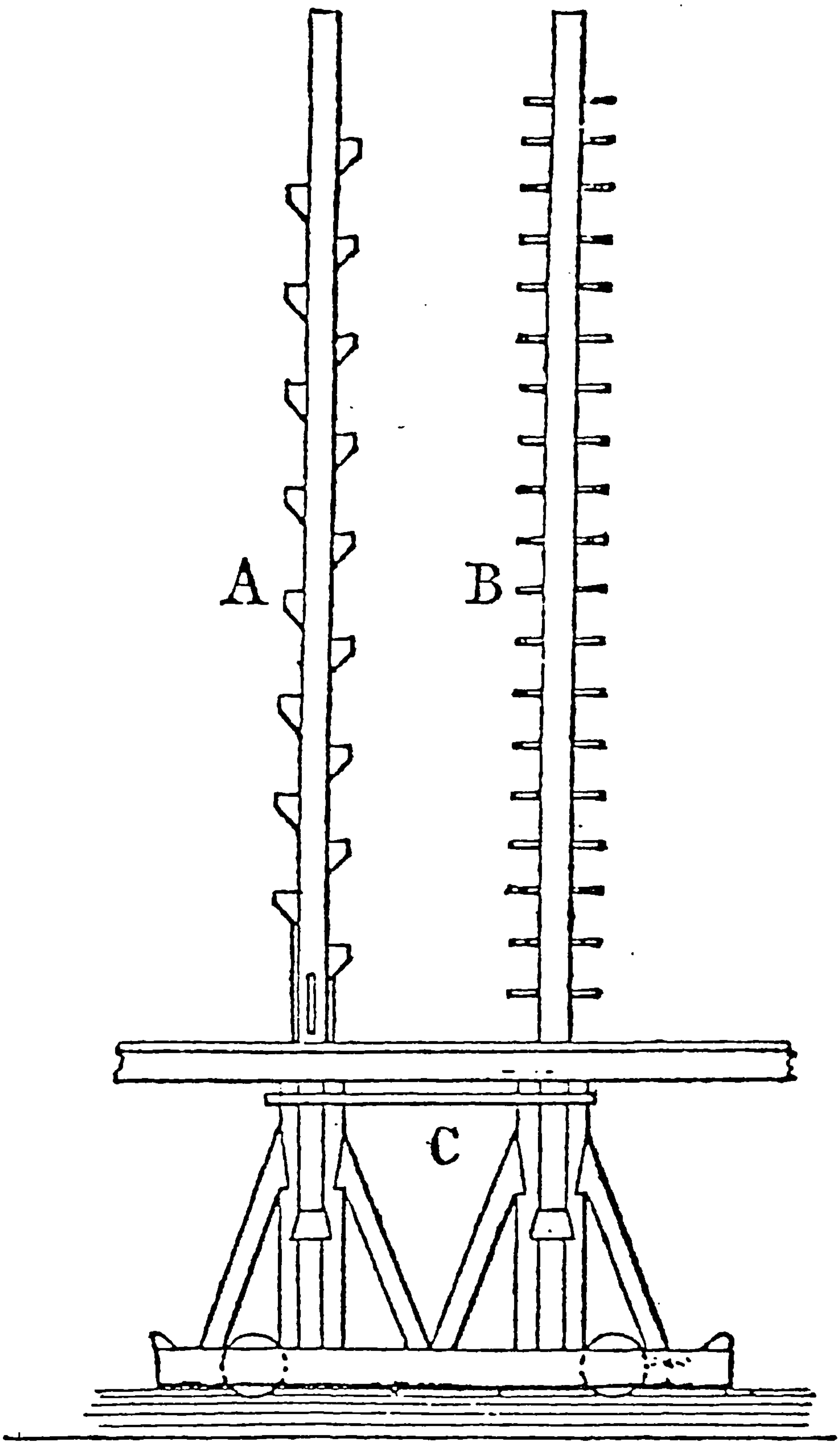
13. E.M.Barry, "On the Construction and Rebuilding of the Royal Italian Opera House, Covent Garden, R.I.B.A. Transactions, X, 1859-60, pp.62-63.
14. Charles Dickens, "A New Stage Stride", All Year Round, X, 31st Dec., (1863), pp.230-231.



Illus.117 Dctails of wing chariots. M.J.Moynct, op.cit., p.45.

Charles Fechter took over the management of the Lyceum Theatre in 1863, having first appeared in Paris at the Salle Molière in 1840 and making his debut at the Comédie Française in the same year. It is reasonable therefore to assume that his years spent working in the French theatre influenced his decision to install a wing carriage system at the Lyceum. From the description given above the installation certainly appears to be based upon the traditional wing carriage system of the French theatre. A useful reference can therefore be made to the wing carriages illustrated by M.J.Moynet in <u>L'Envers du Théatre</u>[see Illus.117]:

"The flats [châssis] to fulfil the function required of them on the stage, must be placed on one of two apparatuses called masts [mâts], wing ladders or false flats [faux châssis], the description of which is useful because they are indispensable for the placement and strengthening of scenery, for which they are the means of support.

A mât is a strip of fir timber of seven, eight or nine metres in height, equipped at the bottom with a kind of base [tenon] covered with iron or even solid iron, as M.E. Godin stage manager at the Gaîté Théatre recently has made them. This tenon, of iron or of wood covered with iron, passes through the slit in the floor [costière] and interlocks in a form, a kind of mortice, that is in a movable trolley manoeuvring in the substage. The mât, then, keeps its position vertical to the floor; moreover it is furnished with iron rungs for its entire height to permit a man to climb to the top. At its bottom, one centimetre above the stage floor, an iron bracket holds the flat, that, being clear of the floor, moves to its proper place when the trolley bearing the whole apparatus is manoeuvred. The iron crosspieces on the mâts are tending to disappear to be replaced by cleats. [see Illus.117A]. An accident occurring recently at the Opéra has brought into disrepute the use of the iron rungs [Illus.117B], that tend to weaken the body of the mât.

It is well to add that the flat is not only fixed on a bracket but it is fastened, or to speak more accurately, hoisted, by one or two of the top crosspieces, to the mât that supports it." [15]

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15. M.J.Moynet, op.cit., pp.44-45.

There can therefore be no doubt that this system of scene-changing equipment was a tried and tested method in the French theatre of the nineteenth century. This raises the question of why it was apparently never adopted on a permanent basis in Britain. That the machinery installed at the Lyceum was built in the traditional manner of the French theatre seems almost certain, especially when one recalls Charles Fechter's French origins. Given this, it is interesting to note Clement Scott's reminiscence that "Mr.Fechter's wonderful French stage which cost a mint of money was subsequently found to be utterly impracticable." [16] This impracticability may, however, have been more attributable to the resistance to a new and alternative method of scene-changing on the part of the stage carpenter rather than the inadequate design of the machinery itself. In addition, scenery designed to be operated in conjunction with wing carriages may not have been compatible with the English groove, which would cause problems for any productions which were required to "tour".

There were of course problems in operating either system and it is worth recalling comments made in Walter Dando's patent relating to the traditional French system and the improvements he proposed to make:

> "In the system known as the chariot and pole system a wide opening across the stage is required and this is frequently left open and is then obviously a source of danger to dancers or others engaged on the stage and its closure is effected by strips of wood with L iron clips on top projecting above the stage level and so not only being dangerous to dancers and others but causing a clattering noise when jumped upon and often springing from their position and so leaving an opening in the stage. Moreover these 'cuts' have to be prized open by means of a lever which is very inconvenient in practice. These defects I have overcome and I have also improved the form and construction of the 'chariots' 'poles' and 'runners' and reduced the width of the opening in the stage for the pole. I have also provided means for perfectly closing the opening without any L iron or other projection above the stage." [17]

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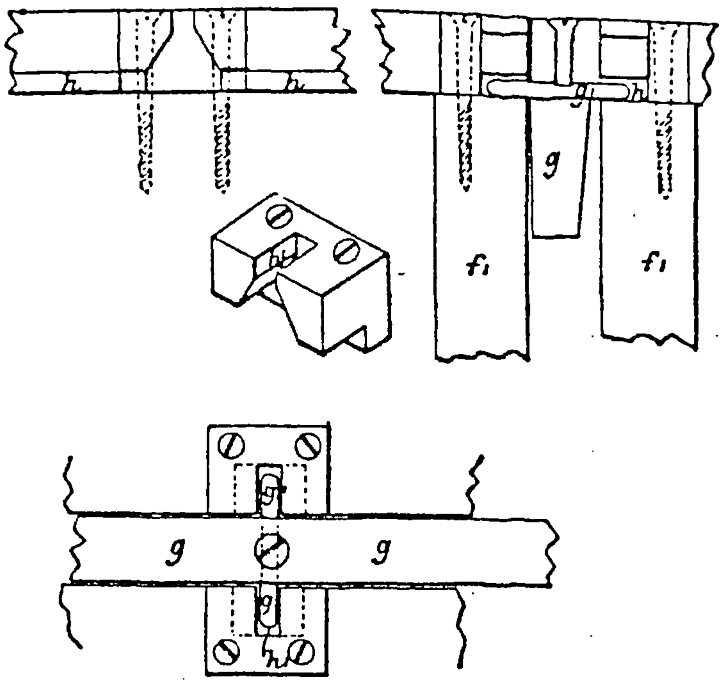
16. A.E.Wilson, <u>The Lyceum</u>, (London: Dennis Yates, 1952), p.126.
17. Dando, op.cit., p.1.



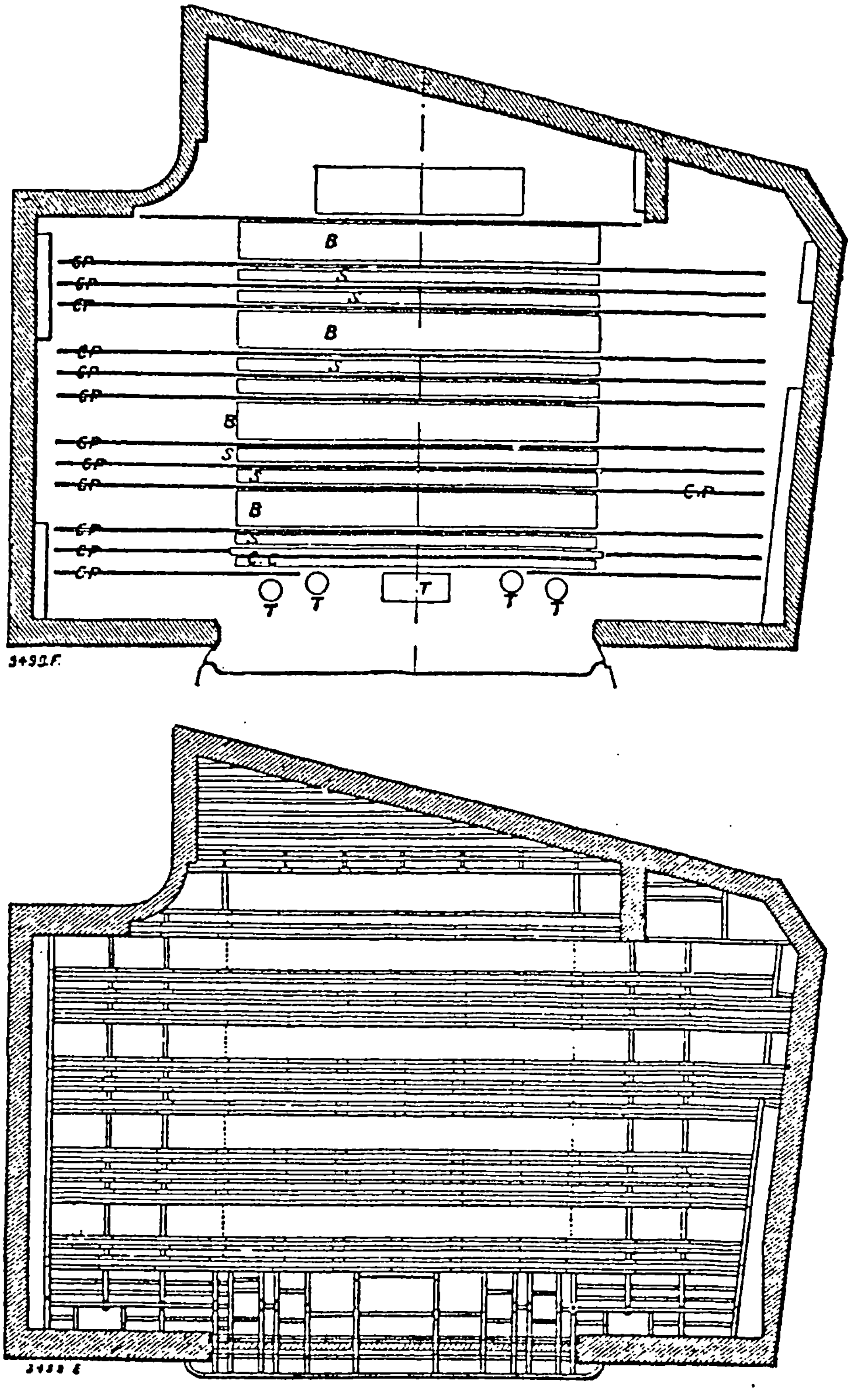
Illus.118 Details of oak fillers. Sachs, *Modern Opera Houses*, III, supp.1, p.31.

The basic problems appear to have been overcome in the patent. In particular, he introduced "oak fillers" to bridge the intervening spaces which were inherent in the traditional design. Dando's explanation of his method, however, is somewhat confusing. In discussing this particular item Sachs simplified the language used in the patent and provided four drawings [see Illus.118] of his own which are certainly much clearer than the originals, but the shape and proportions of these drawings vary from those of the patent, suggesting that Sachs may have examined the mechanism personally, after installation.

The oak fillers are denoted by the letter 'g', each containing two adjacent steel pins, 'g^1', which run in the continuous slots 'h'. These are formed at the top of 'f^1', by rebating the underside of the stage surface. The fillers, 'g', could be traversed across the stage in front of and behind the chariot, leaving no visible gap in the stage surface. They were constructed in several lengths which allowed sections to be added or removed by means of small vertical slots, 'h^1', through which the steel pins passed.

Unfortunately the stage surface has been replaced and no traces of the mechanism remain. Still, the theory of this method seems very plausible and it would certainly have improved the safety of the stage. Nevertheless, the clearance between the fillers and the stage surface appears to be very small, and I would therefore suggest that problems may have arisen with the twisting and warping of the fillers or with jamming, if large quantities of dust became lodged in the runners. Dando does state that the filler can be easily and quickly lifted out or put into its place and pushed along, but it is difficult to see how any jamming could have been easily rectified in the course of a performance.

The chariots, N, had grooved wheels which ran on rails. Today the only vestiges of the installation at the theatre are the rails, which run on the first mezzanine floor. It is however worth noting that it could not have been possible to synchronise the changing of adjacent chariots, as it had been with Rees's earlier design which incorporated a winch [see page10] co-ordinating mechanism. In Dando's design, poles were supported upon the chariots and hinged at the base with a metal shoe. They were placed with their greatest width parallel to the proscenium opening, and therefore allowed as narrow a slit as was feasible in the stage. The stage plan reproduced by Sachs [Illus.119] shows twelve cuts for chariots and poles arranged in groups of three, spaced between the sloat cuts and the bridges.



Illus.119 Stage plan Royal English Opera House, London.
Mezzanine plan Royal English Opera House, London. Sachs, *Modern Opera Houses*, III supp.1, p.30.

The first downstage chariot and pole cut does not (unlike the rest) traverse right across the stage. Instead it consists of two short cuts which were designed to support the 'curtain wings'. A comparison may be made here with the 'book wings' which were present in the Georgian theatres, where a pair of permanent wings were positioned in between the proscenium and the first set of wings proper. Throughout the performance they remained in the same position and were not directly associated with any scene changes which took place upon the stage. Even today some theatres still use this kind of wing, although it is now more commonly referred to as a tormentor.

Although these examples of the chariot and pole system at the Lyceum and Royal English Opera House were comparatively short-lived, they were an attempt to overcome the restrictions, inadequacies and in many ways the frustrations of the English groove system. Yet they both had one basic similarity which was to be considered unacceptable in the years to come: they both required the scenery and wing pieces to be set parallel to the proscenium arch. Nevertheless, the relationship between this continental system and the English theatre was not quite at an end.

When Edwin Sachs toured Europe before compiling his treatise, Modern Opera Houses and Theatres, in the 1890's, he examined many continental stage machinery installations which incorporated the chariot and pole system. It is therefore perhaps not surprising to learn that when he redesigned the stage at the Royal Opera House, Covent Garden, in 1901 he included metal chariots designed to support wing lights [see photo.67 and p.228 for further details].

Although the wing carriage or chariot and pole system was introduced intermittently into the English theatre of the nineteenth century, it never appears to have been a serious challenge to the English groove system, despite the latter's shortcomings. The traditions of the stage carpenter and of the theatre as a whole were so rigid that from the outset a revolutionary change from groove to chariot was never truly a realistic proposition.

The Sloat System.

The stage plan of the Royal English Opera House [Illus.119], which is given in Sachs but not in the patent, shows seven 'cuts' for housing sloats. Figs.1 & 3 of the patent show four sloats mounted in each cut. The sliding floor sections were operated in the traditional wood stage manner, although the paddles were iron, and the floor sections were drawn to either side with the assistance of wire ropes and a windlass. The scenery, D, was fixed to the tongues of the sloats, T1. A wire cable, w, was attached to the base of the tongue at T2, passing through a channel up to pulley wheel, p, and then down into the cellar, where it was attached to one segment of a tripartite drum, d. The weight of the scenery and of the tongue of the sloat was offset by counterweights, c, which ran in a shaft, as shown in Fig.3. The cable, w1, attached to the weights, passed over a pulley, p1, located near the paddle of the cut, and down into the cellar, deflecting through another pulley, p1, to be attached to another portion of the same drum, d. The circumference of this portion was slightly less than the rest in order to reduce the distance which the weights had to travel. The third central portion of the drum, the narrowest, was taken up by the power rope, w2, which was controlled by a geared iron crab winch, k, located on the mezzanine. Fig.3 shows the counterweights rigged to assist the raising of scenery, though in this case by passing the cable, w1, around the drum in an opposite direction. Manual power would then be necessary to raise the scenery and the counterweights, but the crab winch could be thrown out of gear and the scene lowered rapidly, being braked by the manual brake on the iron crab.

To ensure that sets of sloats were operated in a co-ordinated manner Dando introduced coupling-bars, d1 (Figs.4 & 5), which fitted onto the spindles of the drums, d. It was therefore possible for one operative to control several sets of sloats from one iron crab winch. The use of a drum in the cellar to collect all the 'sloat ropes', and a power rope attached to a winch on a higher mezzanine floor was not, however, a new idea. As early as 1777 Denis Diderot [18] published an engraving showing the operation of five sloats, from a 'master' drum or 'tambour'. Once again Dando had drawn upon his knowledge of the French system. M.J.Moynet, writing in about 1870, described the French system (which is closely comparable to Dando's patent) in these terms:

> "A large ferme, extending across the entire stage, is ordinarily attached to five âmes, each of which goes into a cassette. A rope proportionate in size to the weight to be supported is passed through the pulley at the right or left. This rope is passed through a ring placed at the bottom of the âme and then hitched to a snap hook screwed on the âme. The other ends

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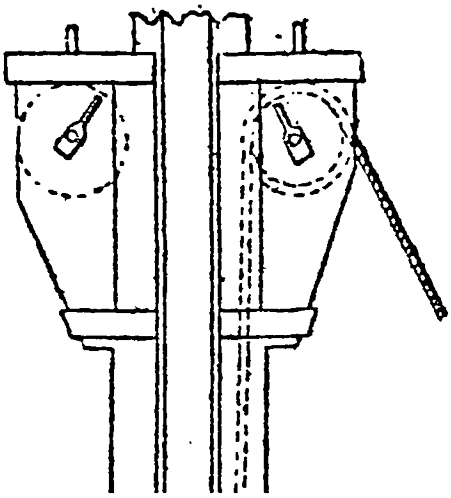
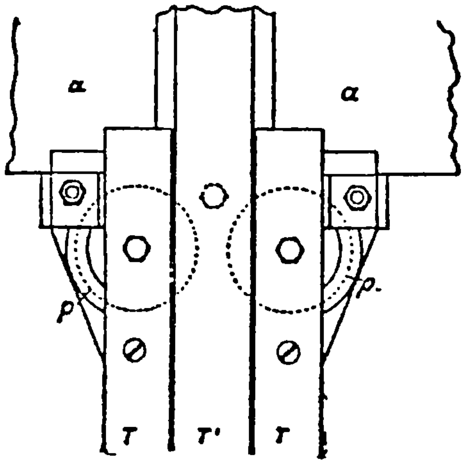
18. Denis Diderot, op.cit, p.61.



M.J.Moynet,



Edwin O.Sachs

Illus.120 Comparison of top pulley arrangements on sloats. M.J.Moynet, op.cit., p.64. Sachs, Modern Opera Houses, III, supp.1., p.33.

> of the five ropes are brought together on a windlass [tambour]. This drum, turning in one direction or the other, raises or lowers the ferme. Another rope, attached to the drum and winding in the opposite direction, goes through several pulleys, then fastens to a counterweight that descends when the ferme rises and ascends when it lowers, thus easing the turning of the drum." 19

It is also interesting to note the similarity in the construction of the top pulleys of the sloat [see Illus.120]. The British sloat did not have the double pulley at the top, because this was essential only when all the sloats were to be controlled centrally from a drum in the cellar. Fig.3 of the patent shows the stage left sloat using the stage right pulley, and the stage left centre sloat using the stage left pulley. It was, however, necessary to equip the sloats with two pulleys for they were often moved around and if a particular piece of scenery required additional support five or more sloats might be operated within one cut.

The Bridges.

For some inexplicable reason Dando does not describe or illustrate the workings of the substage bridges. Fortunately Sachs does illustrate them in his stage plan [Illus.119] and his transverse/longitudinal sections [Illus.121, 122]. He shows four large bridges stretching the full width of the proscenium opening, and a fifth shorter bridge at the rear of the stage, though no details of any drum and shaft or counterweight mechanism are given. With regard to the construction materials Sachs says:

> "Speaking generally of the 'under machinery' of this stage, I would observe that wood has again been used for the principal part, though iron has been introduced in much of the detail, including such appliances as the 'bridges'." 20

As Dando does not refer to them within his specification, one infers that Sachs was writing about the installation after examining it in situ.

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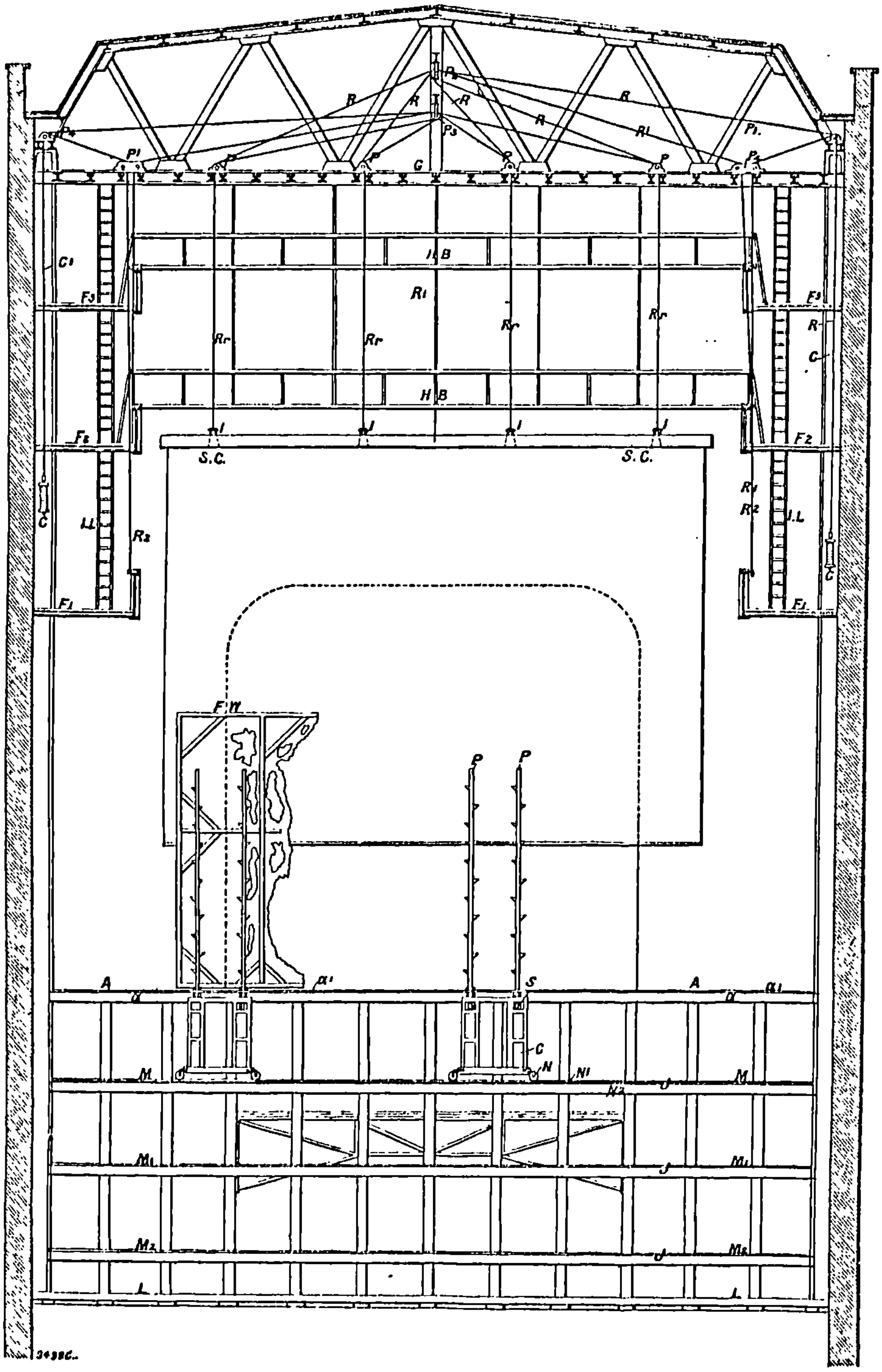
19. M.J.Moynet, op.cit., p.64.
20. Edwin O.Sachs, Modern Opera Houses, III, supp.1,p.31.



Illus.121 Transverse section of stage. Royal English Opera House, London. Sachs, Modern Opera Houses, III, supp.1., p.32.

The Small Downstage Traps.

The details of the corner traps and the grave trap are not given in the patent, although Sachs shows two corner traps on either side of a centre stage grave trap. The grave trap is shown in his longitudinal section but the mechanism details are not disclosed. There is, however, no reason to suspect that they deviated in any way from the traditional design of the English wood stage.

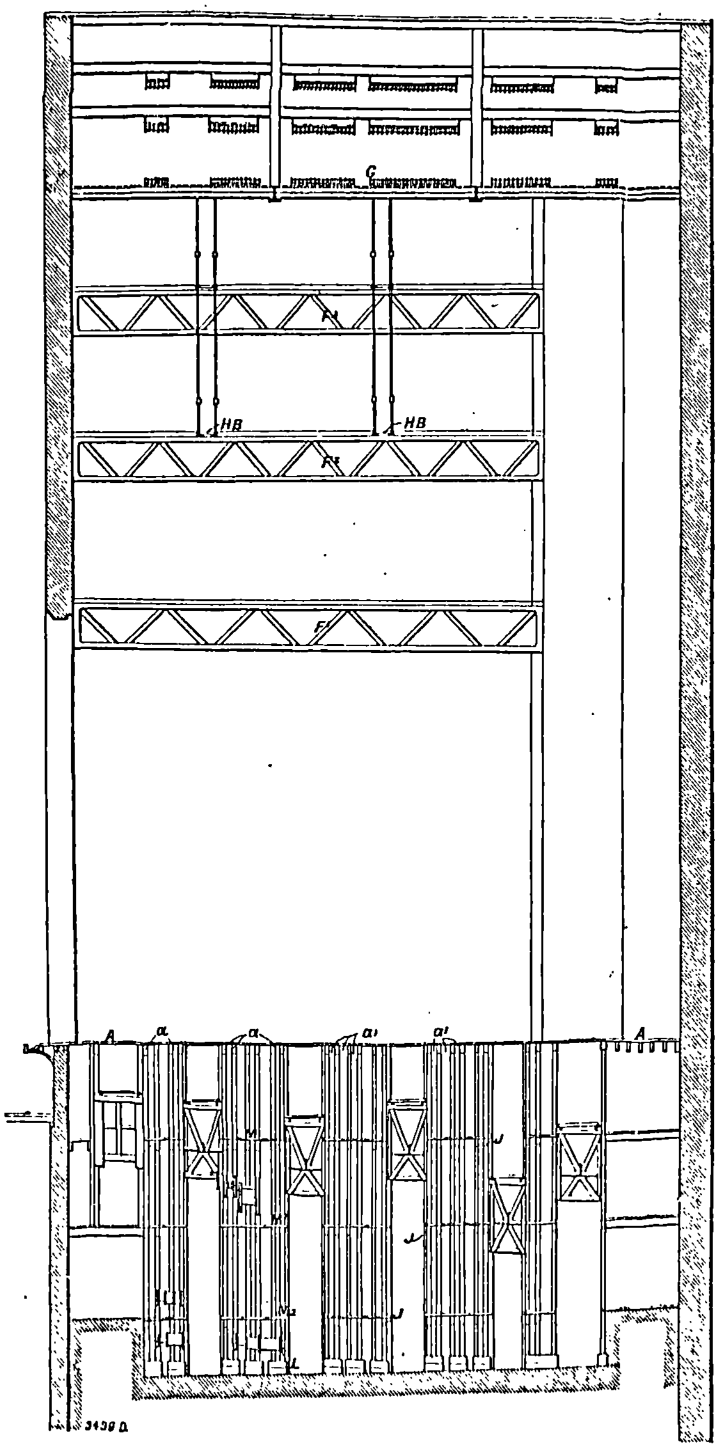
The Carpet Cut. (Figs.14-16), [Illus.113].

The function of this mechanism was to allow a carpet or stage cloth to be removed without any stage-hands appearing before the audience. A lever, b, is fixed by a set screw, b1, to the shaft, b2, which revolves in the shaft, b2. The cut is opened by pushing the lever from the 'solid line position' to the 'dotted line position', thus raising the hinged flap, A2, as shown. The carpet can then be wound onto a roller concealed on the mezzanine floor below.

Thunderun. (Figs.28,29), [Illus.115].

The device was designed to be operated by the 'promptor' [sic.] without leaving his box. Dando claimed that it was sufficiently versatile to produce thunder, reports of artillery firing, the falling of structures and other noise known as 'stage crashes'. Unfortunately nothing remains of the mechanism (if it was installed), although it was supposed to be located near the roof or on the gridiron. Within the inclined box, at suitable distances apart, were hinged flaps, 5, which could be opened at the lower end and retained in position by catches. The balls or wooden blocks which effected the noise were restrained behind the flaps, and could be released either by a cord attached to the flaps or alternatively by electrical or pneumatic means. Dando expressed a preference for the electrical method, which used an electro-magnet, 14, protected by a casing, 15. The flaps had to be released in successive order from the lowest to the top, as all the balls had to pass through the same route.

This method of producing thunder seems a little too complex for something which is really quite simple. It does, however, show that new technology could be applied to methods which had been in use for over a hundred years.



Illus.122 Longitudinal section of stage. Royal English Opera House, London. Sachs, Modern Opera Houses, III, supp.1., p.32.

Summary.

The Royal English Opera House was originally built by D'Oyly Carte with the specific intention of producing operas by English composers. For the opening production Sir Arthur Sullivan collaborated with Julian Sturgis to write Ivanhoe, a 'Romantic Opera' in 3 acts adapted from Sir Walter Scott's novel. The scenes required by the plot were:

ACT 1

SCENE I The Hall of Rotherwood
SCENE II An Ante-room in Rotherwood
SCENE III The Lists at Ashby

ACT II

SCENE I The Forest, Copmanhurst
SCENE II A Passage-way in Torquilstone
SCENE III A Turret-Chamber in Torquilstone

ACT III

SCENE I A Room in Torquilstone
SCENE II In the Forest
SCENE III At Templestone

There were therefore nine different scenes, and six scene changes during the actual performance. (The other changes being made during intervals). The technical facilities provided by Dando must have been tested to the full, although he was not himself the stage manager of the production; this role was filled by a Mr.H.Moss [21]. At the early performances, the audience was made to wait during the scene changes, for The Times correspondent in his second review commented that:

> "The Performance is now, as it ought to be after eleven weeks, altogether perfect, and the waits between the scenes have been greatly curtailed, so that the end is reached much sooner than was the case at first." [22]

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21. Anon., The Times, 2nd Feb.,(1891), p.4.
22. Anon., The Times, 24th April, (1891), p.14.

Unfortunately, after the closure of Ivanhoe, D'Oyly Carte was unable to find a suitable English replacement and it was followed by a production of La Basoche with music by Andrew Messager, translated from the French of Albert Carré by Sir Augustus Harris with English lyrics by Eugène Oudin. Clearly there was not enough high quality English opera available to sustain Carte's original production policy. Opera was usually performed in repertory, so that one theatre was producing perhaps as many as six different operas in any one week. Because D'Oyly Carte had envisaged comparatively long runs of English operas he had not instructed the architects to provide large storage areas for scenery which could not be constructed, painted or stored in the theatre. This meant that repertory opera would have been very expensive, given the cost of constantly transporting scenery to and from a warehouse (which would also have to be bought or rented). If a warehouse had been used close to the theatre, i.e. in central London, the rent would have been high, but the time required for transportation low, and vice versa. As a result D'Oyly Carte sold the theatre to Augustus Harris on 28th November 1892 and its name was subsequently changed to the 'Palace Theatre of Varieties'. Walter Dando was still connected with the theatre however, for he produced another patent, (No.24,064) in 1893, relating to tableaux vivants and in its specification he gives his occupation as "Stage Manager Palace Theatre, Shaftesbury Avenue, London, W."

As far as Dando's original design concept is concerned, Sachs says that, "the original intention was to provide a stage built entirely of iron, and the drawings which were passed in the first instance by the authorities indicated an iron stage." [23] However, a report by the L.C.C. Theatres and Music Halls Committee of 25th June 1890 stated: "The stage machinery is shown entirely of wood on revised drawings. In the specifications accompanying the drawing approved by the late Metropolitan Board of Works, it is provided that ... the slider frames be of iron joists supported only at the ends, and sufficiently trussed." [24] The whole of the ironwork for the theatre was manufactured by the Horseley Iron Works, in Tipton, near Wolverhampton. In 1894 Ernest Woodrow reproduced a drawing in The Building News relating to the 'iron joists'

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23. Edwin O.Sachs, Modern Opera Houses, III, suppl.1, p.30.
24. L.C.C. Theatres and Music Halls Committee Presented Papers, 25th June 1890. G.L.C. Archive.

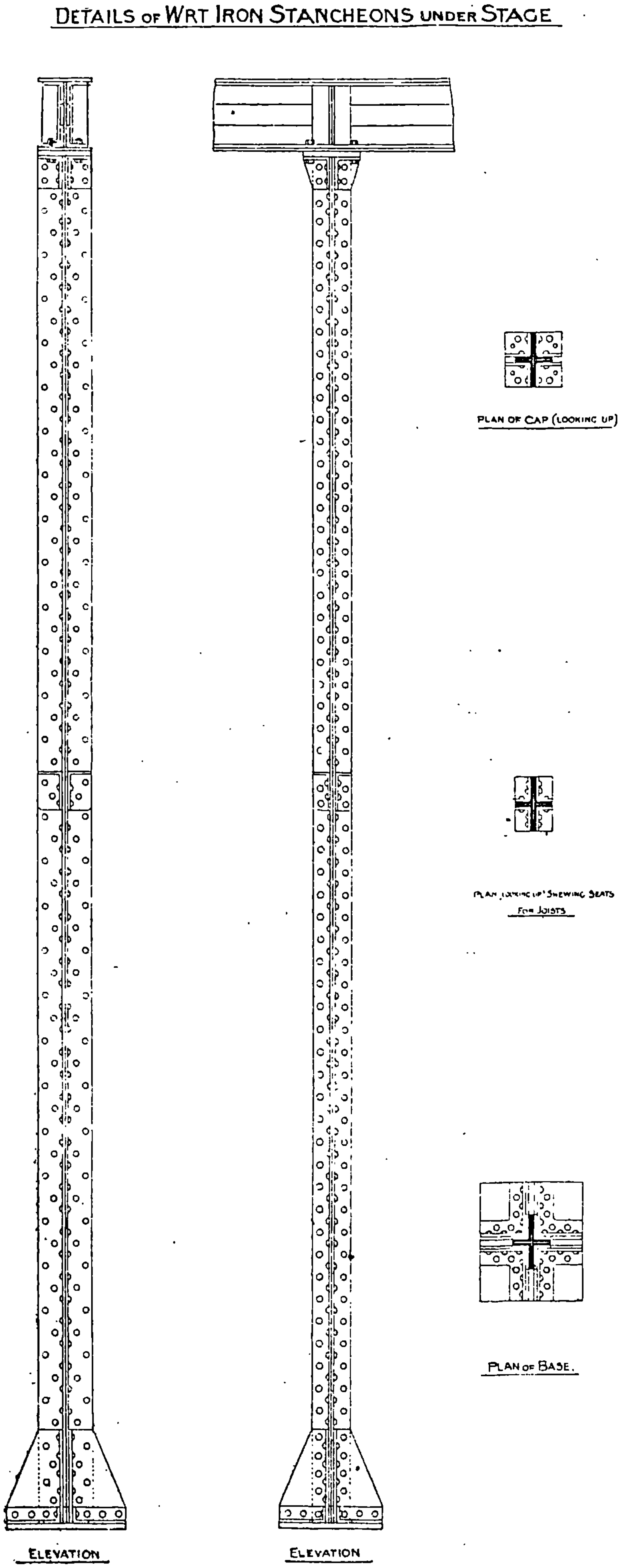

FIG. 6.

Illus.123 Details of wrought iron stanchions under the stage. Woodrow, The Building News, 24th March, (1894), p.394.

referred to above [see Illus.123]. Here he gives the measurement of the stanchions as "7in by 10in. by 21ft. in length, with a base 1ft. 7 in. by 1ft. 10 in., and built up of four angles 5 in. by 3.5 in, with 0.75 rivets at a 4 in. pitch." [25]

Owing to the change in the design of the substage, the publication of the patent prior to the completion of the theatre and the almost total removal of the substage machinery, it is very difficult to establish what the final design of the machinery actually was. Dando's patent and his intentions undoubtedly influenced the thoughts of Sachs and other people responsible for the design of backstage facilities. It was not, however, until Sachs redesigned the substages at Drury Lane and Covent Garden that some of his ideas and concepts came to fruition.

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25. Ernest A.E. Woodrow, "Theatres - XXXIV", The Building News, 23rd March, (1894), p.393.

THE WEST END THEATRE, EDINBURGH, 1875.

In 1875 Andrew Betts Brown registered a patent entitled Hydraulic Machinery for Actuating Stage Effects &c.[1], which is of particular importance as it represents the first attempt to apply hydraulic power to stage machinery in Great Britain. Unlike many theatrical patents it was not a fanciful dream but a practical proposition and was incorporated into the new Edinburgh or West End Theatre. This theatre was built in 1875 and, like the Grand Theatre, Leeds, was designed as only one building in a multi-purpose complex.

The site chosen was in Castle Terrace, between Cornwall Street and Cambridge Street, and measured approximately 300 feet by 160 feet. The choice of site is noteworthy for it backed onto Grindlay Street, where C.J.Phipps's Royal Lyceum Theatre was to be built in 1883. The company which was set up to build the new theatre had a capital of £65,000 a considerable portion of which was expended upon the elevation, designed by the original owner of the site, Sir James Gowans, as part of the sale contract. The interior, however, was undertaken by Frederick Thomas Pilkington and his associate Mr.Bell of Hill Street, Edinburgh, who, according to The Builder, "in order to make the place one of the most convenient and suitable that could be contrived, visited the principal theatres and opera houses in England and the Continent, and endeavoured to combine what they considered the excellent features of each in their designs." [2] It is not clear whether Andrew Brown himself was able to visit and observe hydraulic stage installations on the Continent, but he must have been influenced to a certain extent by the findings of the architects. Comparitively little is known about Brown [3]: his firm of Brown Brothers, established in 1871, still exists and operates under the name of Vickers Marine, in Edinburgh but many of the company records were unfortunately destroyed by fire in April 1964, and nothing remains relating to the West End Theatre and its machinery.

It seems certain that Brown was commissioned by the architects to devise a 'modern' hydraulic stage because of his experience in general hydraulics rather

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1. Andrew B.Brown, Hydraulic Machinery for Actuating Stage Effects, &c., U.K. Patent No.3593, (London: H.M.S.O. 1875), pp.1-12. [All figures are reproduced in Illus.124-129, and the full text in Appendix 8].
2. "West-end Theatre and Winter Gardens for Edinburgh", The Builder, 8th May, (1875), p.420.
3. Please see following page for Footnote 3.

than a specific interest in stage mechanics. Nevertheless before undertaking the project he must have studied the inherent problems associated with stage machinery and theatre auditoria of the 1870's for his patent discussed the use of hydraulic stage machinery, ventilation, heating and fire extinguishing. He also outlined the reasons why it was necessary to change from the 'traditional wooden stage' to 'the hydraulic stage':

> "Up to the present time theatrical scenery and stage apparatus has been worked by manual labour, and the number of men which it is requisite to employ in these operations is frequently very large. The employment of these men involves great expense; they require close supervision and even then mistakes constantly occur, besides which there is often difficulty in obtaining the services of the men at the times when they are required." [4]

Because many theatre managers and theatre architects relied heavily upon the services of the stage carpenter, the science of stage mechanics had stood still for many years: indeed Sachs commented that this lack of modern technological application was for once untrue to our national reputation for practical adaptations; and this, moreover, in a case where there is unlimited scope for young energetic engineers." [5] Considered in this light, it is arguably rather less surprising that Brown had no previous theatrical experience, but his

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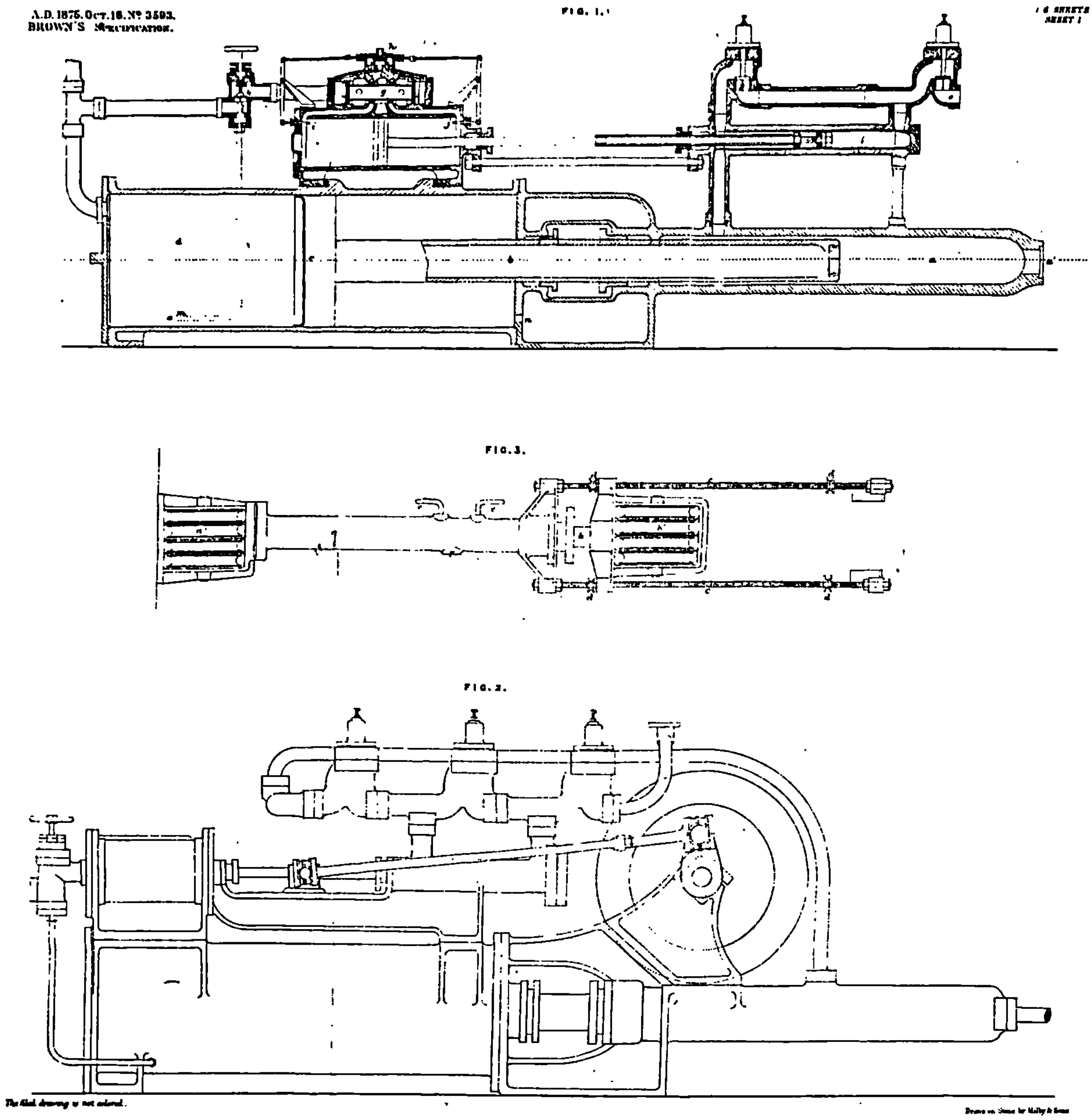
3. (From a letter addressed to the writer from Brown Brothers and Co.Ltd., dated 21.4.83.)
"Andrew Betts Brown was born in Edinburgh on 4th May 1841. After his schooldays he served his apprenticeship with the North British Railway at St.Margarets and possibly with Hawthorns of Leith, builders of steam locomotives and general engineers. He studied in the evenings at the Watt Institution and School of Art in Adams Square, the subjects then available being mathematics, chemistry, mechanical or natural philosophy and mechanical drawing, at which College he gained several prizes. He then went to Manchester, and studied chemistry and kindred subjects at a Technical College and it is stated that he took various degrees, but these are not specified. While in Manchester he prepared the illustrations of a large volume in Engineering by Robert Scott Burnett. Andrew Betts Brown died in 1906."
4. Andrew B.Brown, op.cit, p.5.
5. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.2.



<u>Illus.124</u> Fig.1. Vertical section of pumping engine.

Fig.3. Hydraulic hoist.

Fig.2. Engine with rotating shaft and fly wheel.

A.B.Brown, U.K. patent No.3593, 1875.

practical engineering ability and lack of experience in the theatre must have made an interesting combination, one which is perhaps evident at various points in the text of the patent, as for example his naive remark that "As many as 30 cloths may be required to be hung in a theatre." [6] Provision was admittedly made to concentrate the distribution of cloths in a particular area, using hydraulic hoists which were not immediately adjacent, but it would not be difficult to imagine a spectacular Victorian pantomime which required more than thirty cloths in total.

The hydraulic power which fed the Edinburgh theatre's hoists was supplied via a large main designed to convey water at a high pressure (by preference 800 lbs per square inch) by means of a boiler and pumping engine which was placed in a fireproof building outside the theatre. The 800 lbs/square inch is a similar pressure to the 700 lbs/square inch supplied by the London Hydraulic Power Company to the London theatres around the turn of the century [7]. The pumping machinery which Brown recommended was based upon a previous patent of his, No.2805 dated 14th August, 1874, and entitled <u>Hydraulic Bolt-making Machinery, &c.</u>, which he subsequently improved in the stage machinery patent. The introduction of a comprehensive circuit of hydraulic pressure pipes into the theatre allowed the positioning of fire hydrants "in each side of the basement floor, the stage floor, and in the flies, also on each gallery of the front of house." [6] Brown seems to have had a great awareness of fire hazards and safety precautions, which may perhaps be related to his non-theatrical background. Although the technology to introduce new safety standards and new forms of motive power had been available and in use by industry for several years, the theatrical profession had been slow to take advantage. Brown, on the other hand, was not inhibited by any superannuated traditions and was able to initiate a fresh approach to theatre building and stage mechanics, particularly by the use of hydraulics.

The power required to operate the machinery was generated within the building by an engine which was also designed by Brown. Figures one and two in his patent relate to two alternative engine designs which may well have been manufactured

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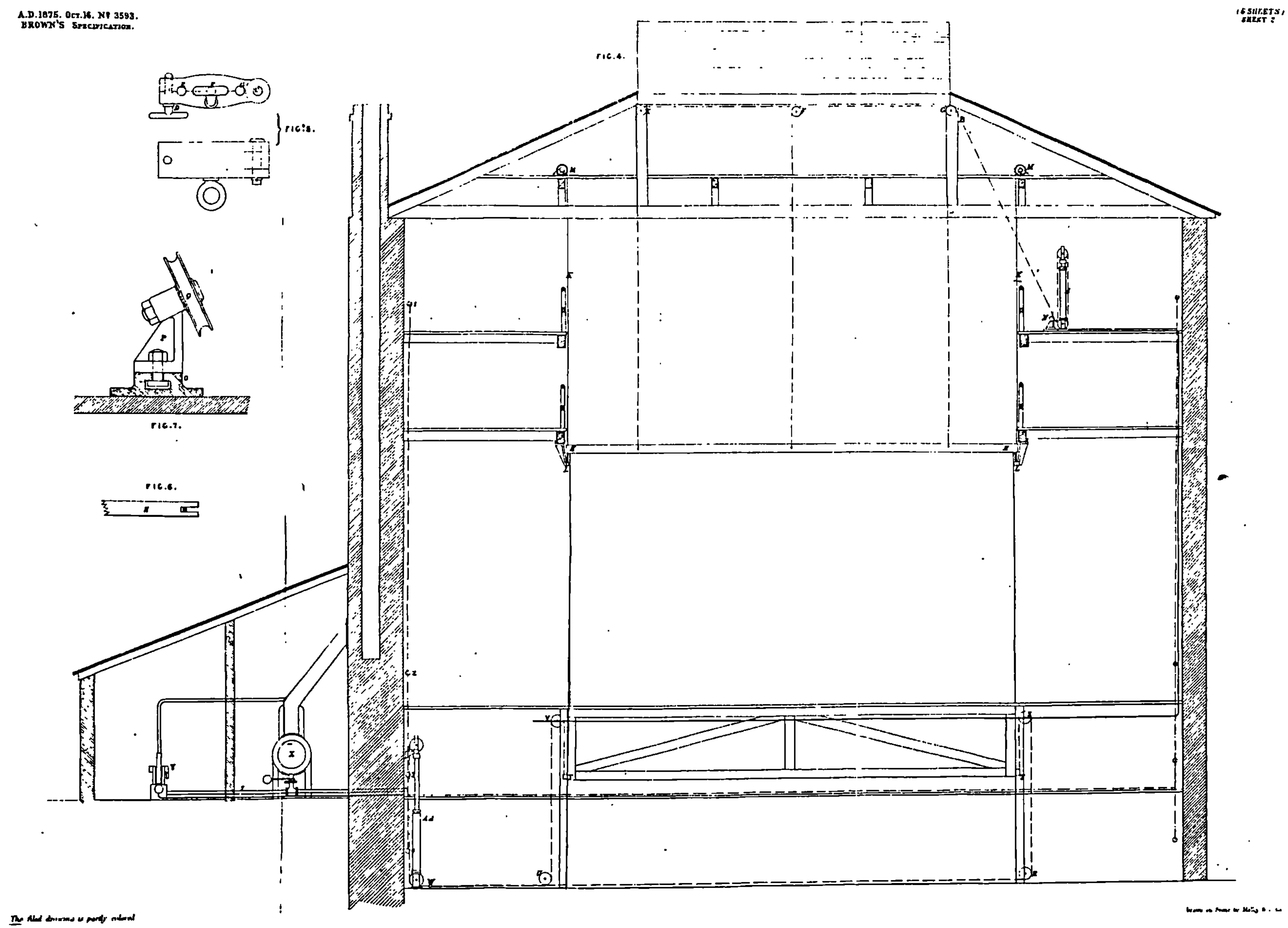
6. Andrew B.Brown, op.cit., p.4.
7. By comparison the Asphaleia Syndicate of Vienna used 120 lbs/square inch.



<u>Illus.125</u> Figs.4-7 Transverse section of stage.

Brown, loc.cit.

by his company for many different purposes. The details of the hydraulic hoists are given in figure three: 'a' represents the hydraulic cylinder, and 'a1' the pulleys which revolve upon an axis carried by the frame attached to the end of the cylinder, while 'b' is the ram with pulleys 'b1' carried by a frame mounted on its head. According to the patent the hoist was adapted "to suit the use of ropes which make no noise"[8], though exactly what these adaptations were is not stated. Obviously Brown was aware of the necessity for silent operation and a further important design feature was the provision of stops which limited the action of the hoist in either direction. This was effected by guide rods c, c, in figure three which were threaded and provided with locking nuts. It was therefore possible for scenery to be raised and lowered exactly to the same positions time after time, a very important and useful feature providing a much more reliable 'dead' than the rather hit-and-miss method of the traditional hemp set. The operational rope is attached to the hoist by means of belaying pins (e, e, in figure three), passed around the pulley sets to gain the necessary purchase and then off to be attached eventually to the scenery suspension bar. The scenery was operated entirely by this kind of indirect or suspended hydraulic hoist, as opposed to the direct ram design advocated by the Asphaleia Syndicate and employed at the Theatre Royal Drury Lane, London.

In figure four of the patent Brown reproduces a transverse vertical section of the theatre showing two hydraulic hoists of varying size, A and AA. A rope is shown by a dotted line attached at one end by belaying pins and at the other to a metal ring, B. He comments, however, that the ring could be replaced by a clamp (shown in figure five), which enables the ropes to be taken up more quickly. The clamp has a joint at C and a tightening screw, D, whilst the holes (designated E, F, G), which receive the ropes relate to the pulleys marked E, F, G, in figure four. The ropes run over deflection pulleys and are attached to a wooden batten, H, to which is attached the scenery. This batten has a groove cut at both ends as shown in figure six. In order to prevent the cloths fouling one another, wire or rope guides, K, K, run in these grooves attached by spiral springs at L, L, to keep the guides taut. All of these guides are tensioned by one long roller, M, M, with ratchet teeth and a square end. The spiral tension springs, L, L, compensate a difference in the stretch of the ropes. This system seems somewhat impractical, for when it became necessary to

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8. Ibid.p.7.

A.D.1875. Oct.16. Nº 3593.
BROWN'S SPECIFICATION.

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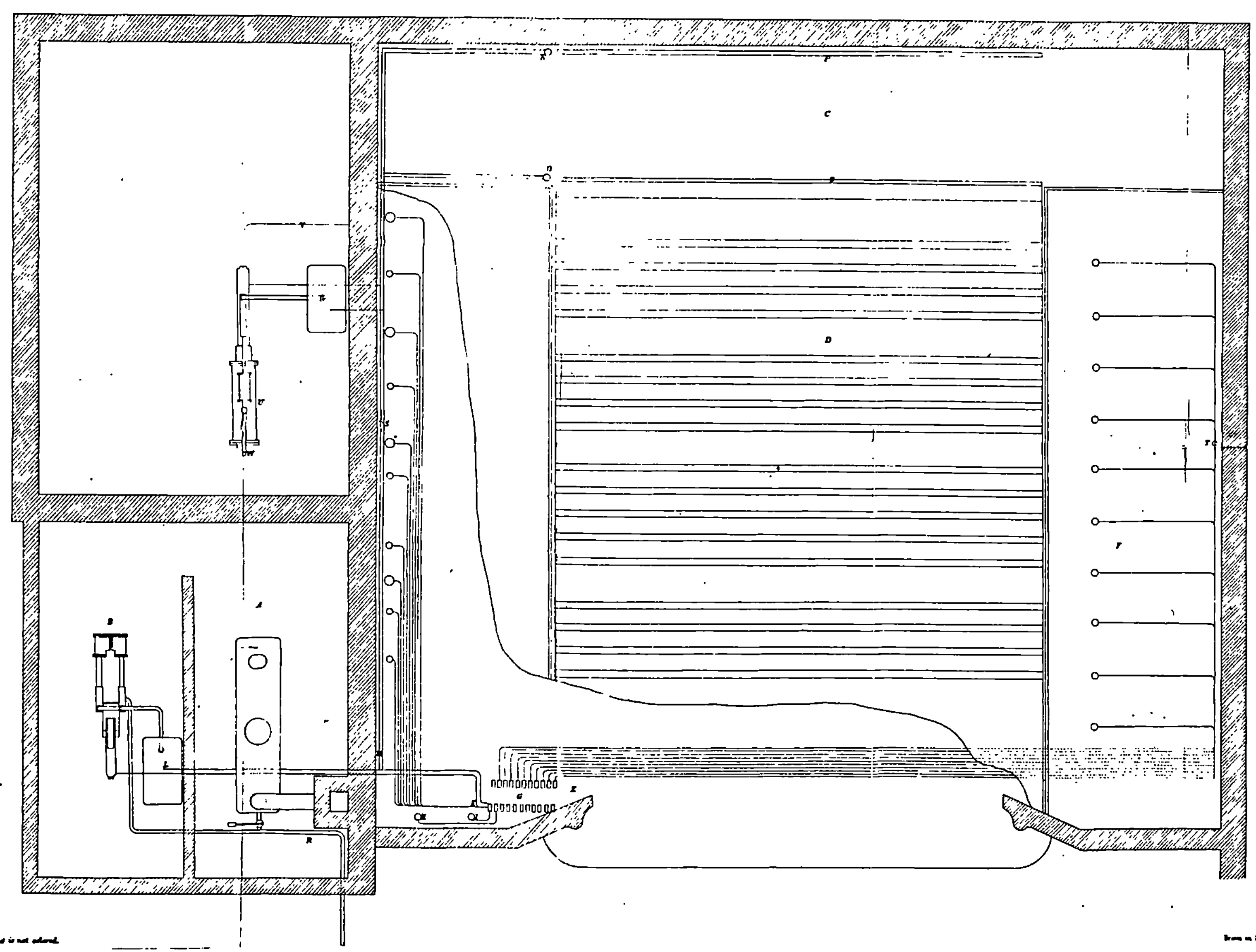


The tinted drawing is not coloured.

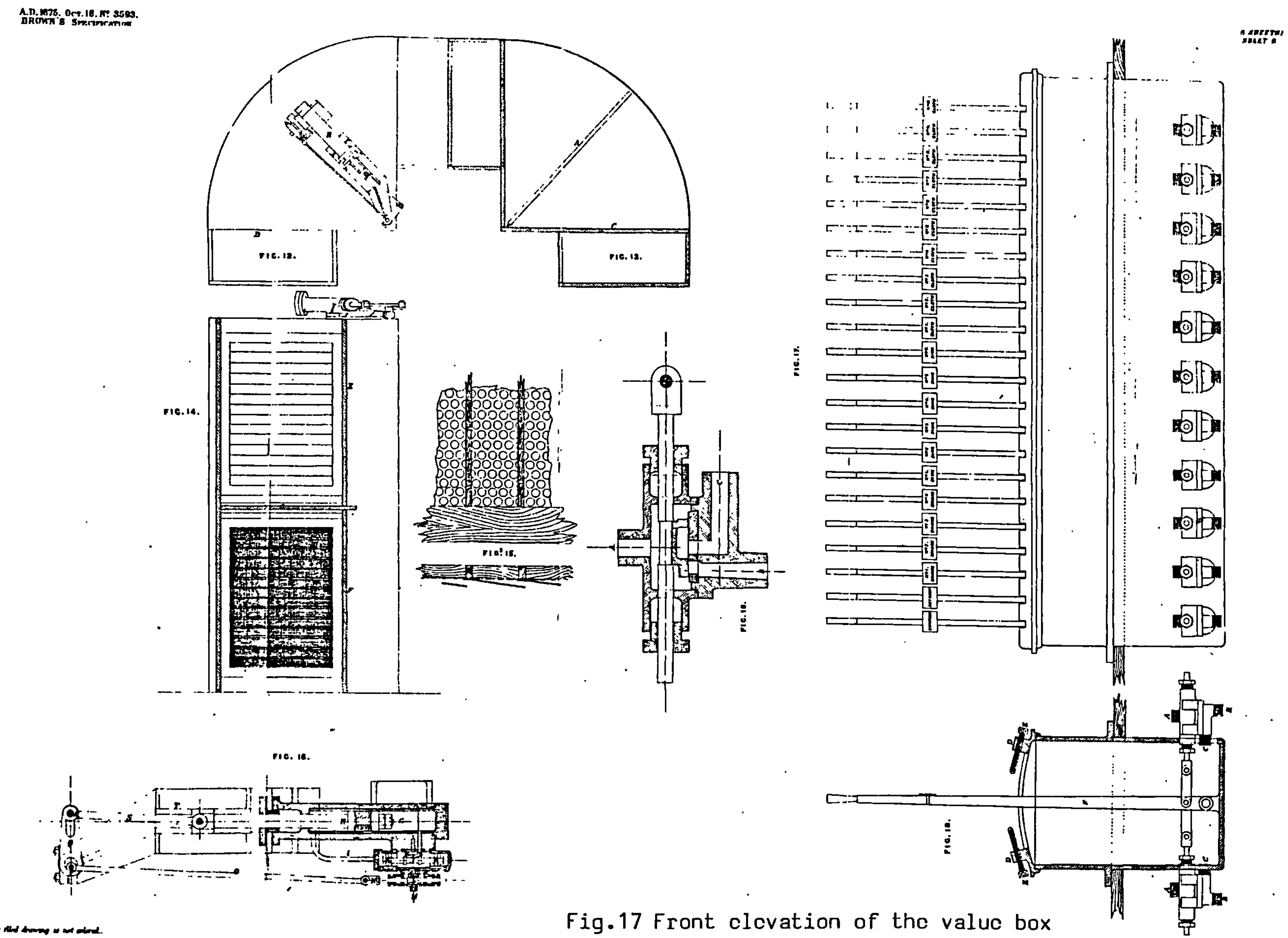
Illus.126 Fig.8 Stage plan
Brown, loc.cit.

change some of the scenery the whole barrel had to be unwound to allow the guide ropes, K, K, to become slack. They would also be in the way when tensioned, creating some severe obstructions in the wing areas. The hoists in the flies, A, are placed as close together as possible, as deflection pulleys can be arranged to operate a piece of scenery positioned anywhere on the stage. Sliding pulleys shown in figure seven at N are used for this purpose. The grooved casting at O is led along the floor in front of the hoists, and another quantity of castings, P, with T-headed bolts are placed upon it. These castings have an angle pulley, Q, which is inclined towards the cloth pulley shown at G, allowing any hoist to operate any piece of scenery as required.

The hydraulic hoists which control the bridges are located in the cellar beneath the stage at A, A. The ropes, or alternatively chains, are attached to both ends of the bridge by passing over pulleys R, S, and U, V, before being secured to the bridge at T. The chains are gathered into a ring at W, to which the hoist chain is attached. Brown states in his patent that "the sink scenes, ... are worked in the same manner". Unfortunately he provides no details, though he probably utilised a similar hydraulic hoist to operate a type of sloat mechanism contained within the sinks or cuts, thirteen of which are shown on the stage plan in figure eight.

Figure eight represents the general layout of the stage area. A is the boiler house, B the engine room, C the painters' room, D the stage, and E the prompt corner. Ten sets of pipes are led from valves underneath the stage floor located by the prompt corner. A corresponding number of hoists is positioned in the cellar, comprising four heavy bridge hoists and six light sink hoists. Two hoists, H and I, work the main curtain and act drop respectively. In order to show the pipes, figure eight has a broken line indicating part of the stage but also revealing the cellar. The pressure pipe from the accummulator, J, enters the building and connects with the row of valves at K, while the exhaust main returns back to the tank at L. Another branch pipe, M, leads to the paint room hoists N and O, which operate the frame. However, unlike all the other hoists, which are controlled from the prompt corner, the paint frame hoist is controlled from the paint room itself.

This system of 'centralisation' was in later years also adopted by the Asphaleia Syndicate, but there are several problems associated with such an arrangement. The main objection is that the operator in the prompt corner is not always in a



Illus.129 Figs.12-14. Hydraulic ventilator or punkah.
Fig.15 Valve detail of ventilator.
Fig.16 Sectional plan of engine.

Fig.17 Front elevation of the valve box controlling the hoists.
Fig.18 Cross-section of valve box showing side elevation of valves.
Brown, loc.cit.

position to observe the movement of the machinery under his control. Accidents could therefore occur whilst the operator was totally oblivious of any mishap. Sachs was adamant on this point:

> "I must repeat that I do not believe that the 'upper machinery' of a stage can be safely worked from only one point, no matter what the power employed may be to move the 'cloths'." [9]

In a general criticism of stage hydraulics, Sachs quoted Julius Rudolph's view that "accidents occurred to actors using steam 'traps' through catching some part of their body, as for instance, the foot, in the fixed framing of the stage when the trap was ascending." [10] He goes on to make the valid complaint that if a trap is raised by hydraulics an actor has no power to ease or stop its movement, whereas, with the old system of counterweights some effort exerted by the actor would often enable him to disentangle himself.

The layout of the prompter's control panel, from which the hoists were operated, is shown in figures seventeen to nineteen. Figure 17 shows a front elevation of the 'valve box', containing all the slide valves which lead to the respective hoists. Figure 18 is a cross-section of the same box, and figure 19 a section of the slide valve. The control handles, (figure 17) are positioned side by side and labelled according to their function. The speed at which the scenery will rise or fall is controlled by 'snugs', D, D, positioned on top of the box (and shown in figure 18 but omitted from 17). The snugs have screw stops, E, E, which limit the travel of the control handle, F. It therefore follows that a transformation scene can be plotted to take exactly the same amount of time on every occasion.

Within Brown's patent provision was also made for apparatus to produce aquatic effects such as waterfalls. Figure nine represents a sectional elevation of the equipment, A is the stage line, B the water injector, C the upper overflow tank, and D the lower receptacle. The water is pumped from D in the direction of the arrow into the injector, B. It then rises into the tank, C, and flows eventually back to D in a continuous motion. The pipe, E, conveys the jet water back into the engine tank. Brown realised that a stage effect such as this was

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9. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.50.
10. Ibid p.49.

A.D.1875. Oct.16. No 3593.
BROWN'S Specification.

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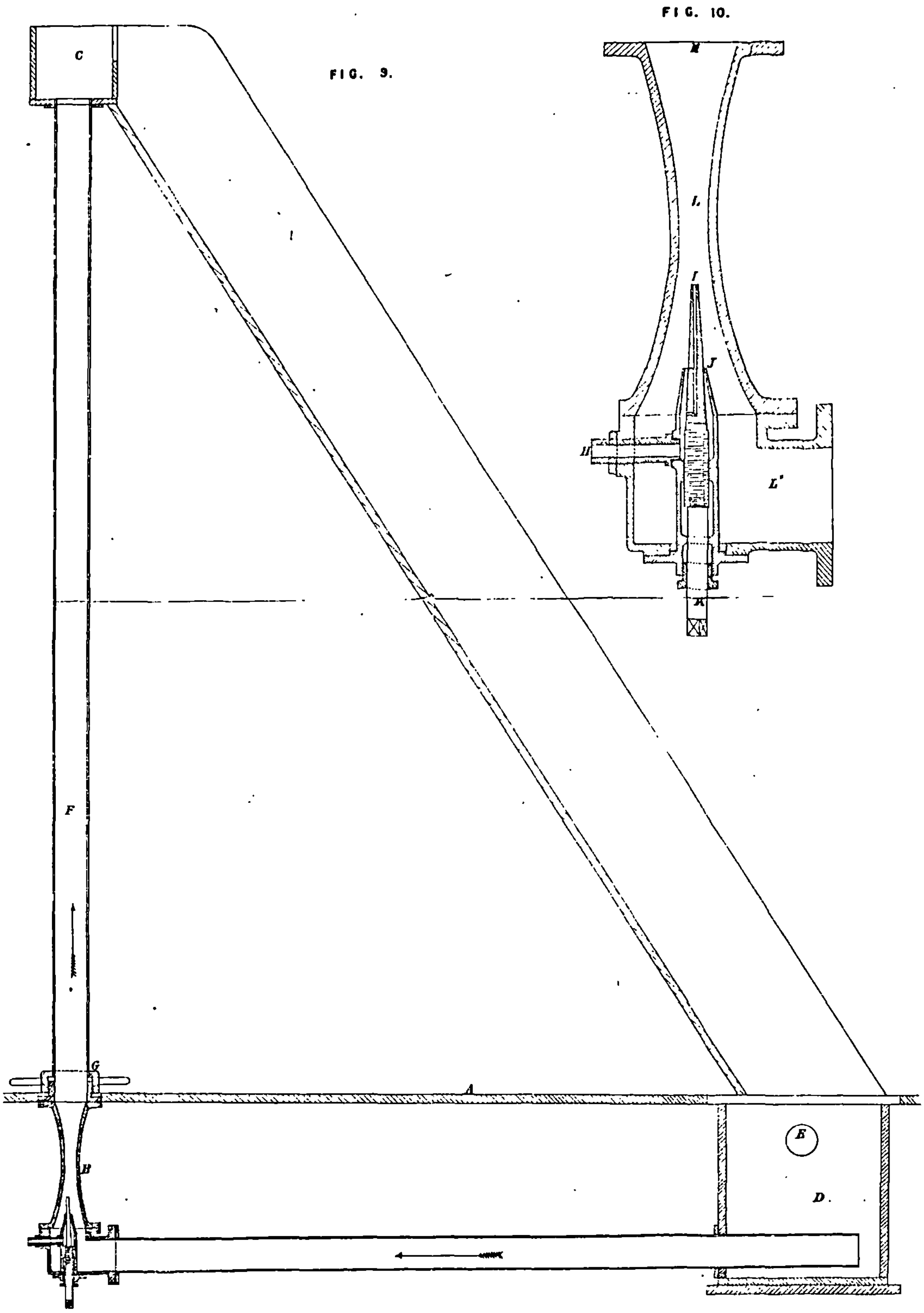

The filed drawing is not colored.

Drawn on Stone by Malby & Sons

Illus.127 Figs.9, 10 Apparatus for producing artificial waterfalls. Brown, loc.cit.

essentially a temporary, portable piece of equipment which had to be removed during the course of a production. The rising main pipe, F, was therefore made of india-rubber, so that it could easily be positioned and removed quickly. A large scale section of the water injector is shown in figure ten. The water enters at H and squirts out at I and, annular space, J, which can be regulated by a screwed spindle, K. It exits through the 'throat' at L, which is 1.5 inches in diameter the nozzle, I, having a diameter of 0.15 of an inch and the nozzle, J, of one inch. Suction water enters at L^x and the delivery rises by M. The flow of water is therefore constant and regular. Even though it was demountable, time would have been required to remove it, any residual water would have been heavy and the tanks bulky.

Nevertheless the use of water, and machinery for theatrical water effects, was by no means a new idea. Sadler's Wells Theatre for instance produced a spectacular series of 'aqua-dramas' between 1804 and 1824. These were made possible by installing an irregular shaped tank, the measurements of which were given by Dibdin [11] as 90 feet in length by 24 feet in breadth at its widest point at the front of the stage and 10 feet in breadth at its narrowest point at the rear of the stage. Water storage tanks for aquatic effects were also a feature of the Tyne Theatre when it was built 1867. However, when the Edinburgh Theatre opened in 1875 many theatres were still without any special equipment of this kind, so the incorporation of such machinery suggests that Brown and the building's owners were determined to have a highly versatile theatre capable of staging the best and most spectacular productions. As originally designed, the so-called Edinburgh Winter Garden and West End Theatre was intended to include an aquarium, but this idea was abandoned for lack of adequate funds. If it had been executed it is quite conceivable that Brown would have designed the necessary aquatic machinery.

Although Brown's patent advocated the use of hydraulic power, it still relied upon timber to constitute the basic structural framework of the stage. The text of the patent does not specifically state what the 'bridges' and 'sinks' were made of, but it appears that Brown was more concerned with the motive power employed than with the traps and machinery which it worked. The use of timber

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11. Charles Dibdin, ed. by George Speaight. Memoirs of Dibdin the Younger, (London: The Society for Theatre Research, 1956), p.60.

A.D. 1875. Oct. 16. Nº 3593.
BROWN'S Specification.

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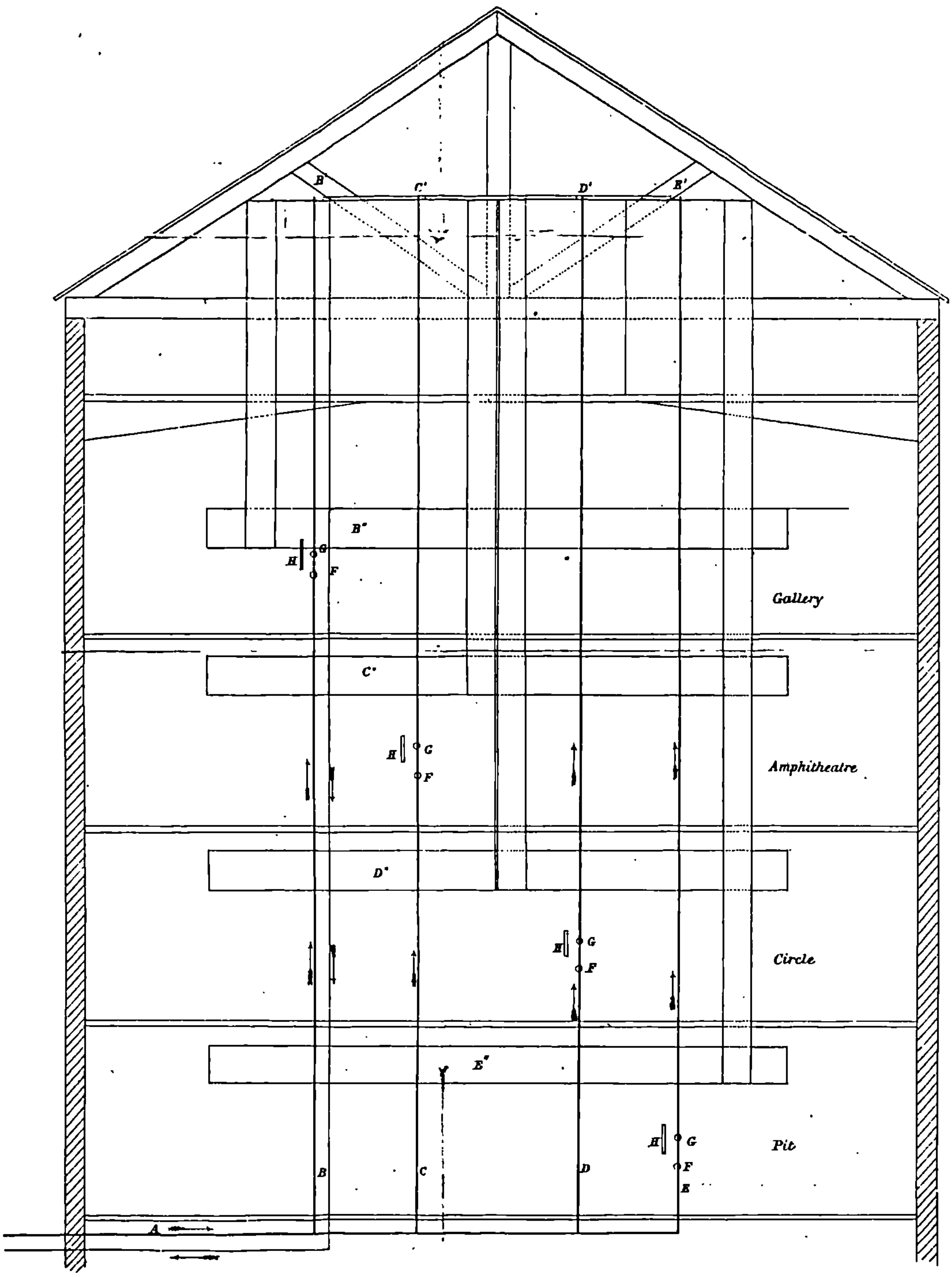
FIG. 11.



The filed drawing is partly colored.

Drawn on Stone by Malby & Sons.

Illus.128 Transverse section showing ventilation details. Fig.11. Brown, loc.cit.

within the substage undoubtedly increased the fire risk but also had distinct advantages. First, the construction of a stage made completely of iron would have increased the cost of heating, especially during the winter months. Secondly, with a stage structure made of timber it would still have been comparatively easy for the stage carpenters to modify the traps for a particular production, an adaptability that would almost certainly have been lost with an iron stage.

Sachs commented in 1898: "No independent opinion has been obtainable as to the actual working of these appliances at Edinburgh, but the specification contains no reason why the installations may not have been of considerable service." [12] Indeed, there seem to be no grounds for doubting their effectiveness, as the patent specifications were the work of a reputable engineer. Admittedly, the fact that Ramsay Macdonald Stephenson was also an engineer did not prevent the machinery he had installed at the Royalty Theatre in 1840 being found impractical and removed after little more than a week, but the failure of the West End Theatre was not attributable to the machinery: the scheme was simply not a viable financial proposition. As Sachs remarked, "it is to be regretted that a system on which so much labour was bestowed should have had but a brief life owing to circumstances quite beyond the inventor's control." [13]

Although the design of the stage machinery and ancillary services at the West End Theatre was unique, Brown's patent did not quite introduce a revolutionary or unprecedented piece of equipment as such. As he stated in the provisional specification of the patent, "I make no claim to the hoist, water injector, or fire hydrants individually, but my Invention consists of the combined arrangement of hydraulic apparatus for doing the varied work of a theatre at present effected by manual labour." [14] This aim to curtail manual labour and thus reduce the cost of running a theatre was something to which many theatre managers aspired, but the capital outlay was usually thought to be too great for the financial rewards it generated. Exactly what financial rewards were forthcoming at the West End Theatre are difficult to imagine, although the cost of operating equipment of this sort will be assessed in a later chapter.

Unfortunately the West End Theatre was fairly short-lived. In 1877 when the management company went bankrupt the building was sold for £26,700 to the Synod

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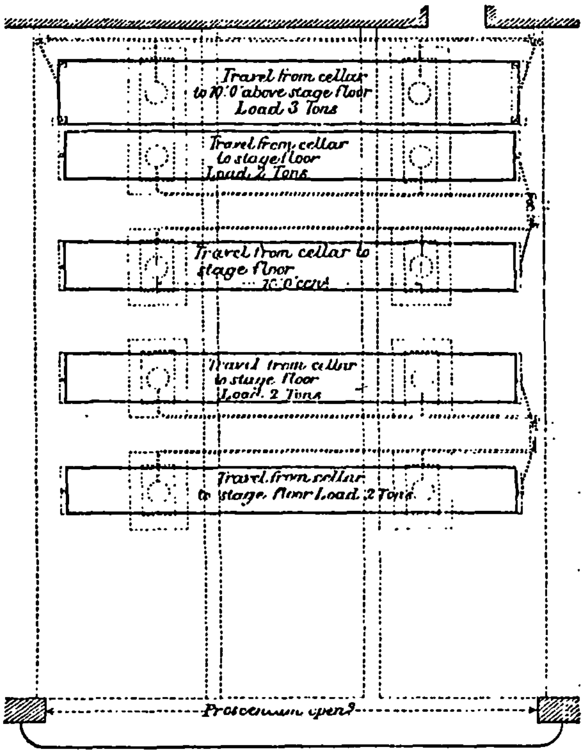
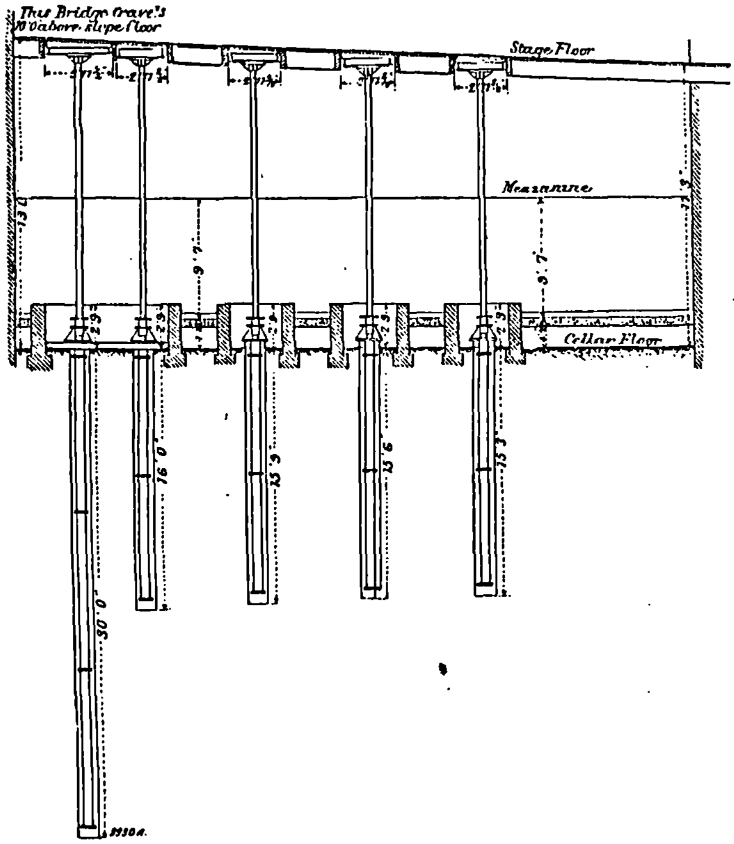
12. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.76.
13. Ibid. p.75.
14. Andrew B.Brown, op.cit., p.4.

of the United Presbyterian Church and in May a competition was held for designs to convert it into a new Synod Hall.

It subsequently became a cinema and was finally demolished in 1966 to make way for a brand new opera house, which was never built. Today the site which backs onto the Royal Lyceum Theatre is a large wasteland which has been used, ironically, as a performance venue for the Edinburgh Festival Fringe under the title of 'The Hole in the Ground'. Nevertheless, whatever the fate of the building, Andrew Brown's machinery marked the beginning of the use of hydraulics in the British theatre, and was conceived some seven years before the formation of the Austrian Asphaleia Syndicate and thirteen years before a second attempt to install comprehensive hydraulic substage machinery in a British theatre, at the Lyric Theatre, London, in 1888-9.



Illus.130 Stage plan showing hydraulic bridges.
Lyric Theatre, London.



Longitudinal section of hydraulic
bridges. Lyric Theatre, London.
Sachs, Modern Opera Houses, III, supp.1.,
p.77.

THE LYRIC THEATRE, SHAFTESBURY AVENUE, LONDON, 1888/9.

The Lyric Theatre was built for Mr.Henry J.Leslie from designs by C.J.Phipps, and opened on the 17th December 1888, with the 817th consecutive performance of Dorothy, a comedy opera by B.C.Stephenson and Alfred Cellier. But although the theatre was ready for December 1888, the installation of the hydraulic stage machinery by Clark, Bunnett and Company, who were specialists in lifts and cranes, took fifteen months and was not completed until sometime after the opening.

The stage machinery comprised five bridges [see Illus.130], each supported by two direct hydraulic rams, at either end. Sachs described them (presumably after inspection) as "a set of five ordinary hydraulic lifts which chance to have been added to a stage" [1] and saw nothing calling for special comment. Indeed, two of the main objections relating to the installation of elaborate stage machinery appear to have been obviated in this case. The five bridges were comparatively cheap, costing £867 and the theatre did not have to undergo a period of closure to allow for the installation of the machinery into the substage.

In describing the bridges Sachs remarks that: "Four of the 'bridges' may be termed 'bridges' proper for they only rise to stage floor level, but a fifth and larger 'bridge' can be taken 10ft above this level." [2] It is interesting to note the criterion which Sachs uses to identify what is truly a bridge. By implication this means that any platform rising above stage level is not a bridge, and in terms of this classification the Tyne Theatre 'bridges' should not strictly be called 'bridges'. Such criteria seem to me quite arbitrary and I would prefer to regard all the five hydraulic platforms at the Lyric Theatre 'bridges'.

The four smaller downstage bridges were capable of carrying a load of 2 tons, each having two hydraulic rams measuring 3.75" in diameter. The fifth upstage bridge had a 3 ton capacity, and was fitted with two rams which measured 4" in

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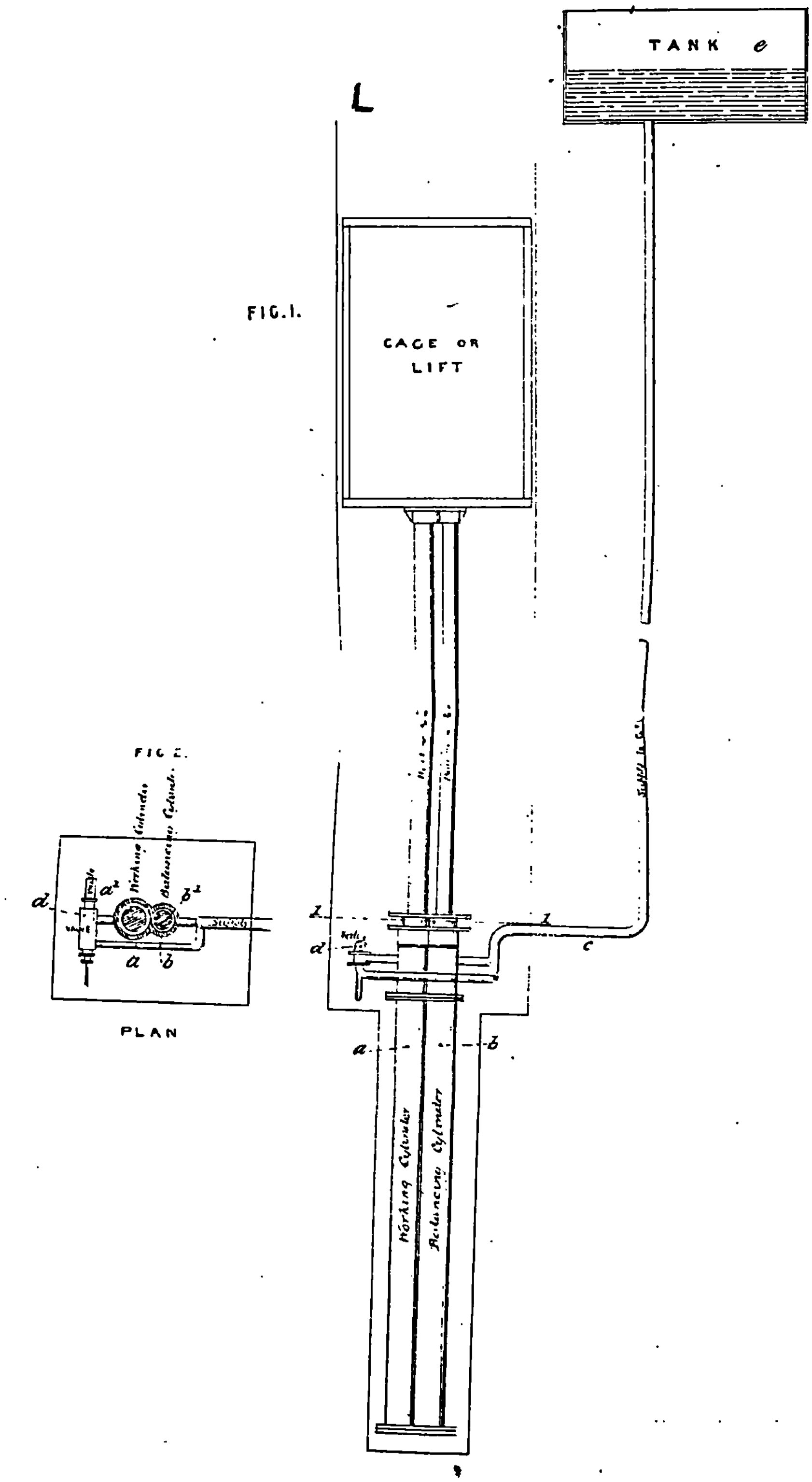
1. Edwin O.Sachs, Modern Opera Houses, III, supp.1., p.77.
2. Ibid.



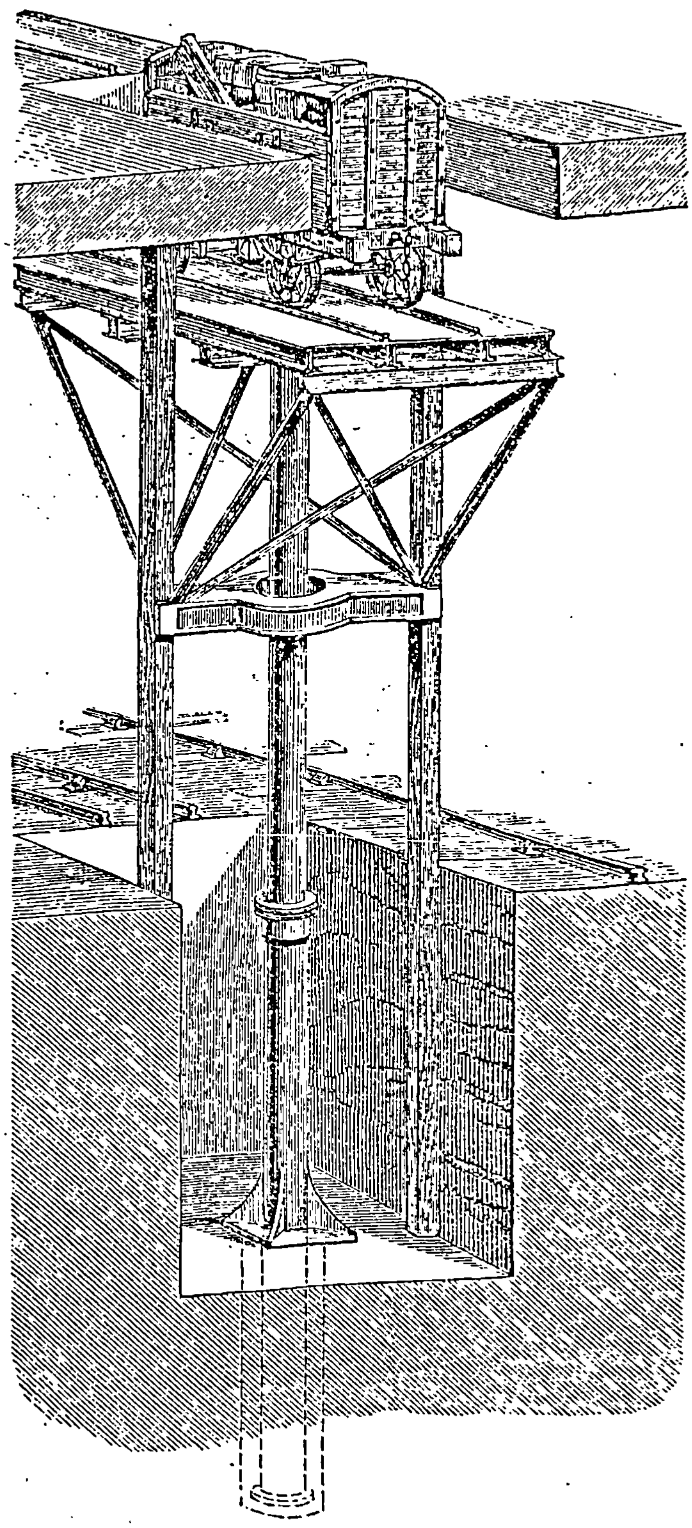
Illus.131 Hydraulic lift. A.Clark, U.K. patent No.125, 1884.

diameter. Twelve gallons of water were required to raise the smaller bridges from cellar to stage level, and 29 gallons were required to raise the large bridge from cellar level to 10 feet above the stage, a total distance of 27 feet.

Although no patent was specifically taken out for the Lyric Theatre machinery, Alexander Clark did take out a patent in 1884, No.125, entitled Improvements in Hydraulic Lifts, and related to a direct double ram lift, which had a working ram and a counterbalance ram, [see Illus.131]. Although there would not appear to be any direct connection between the patent and the Lyric installation it is worthy of note that Clark's company was actively involved in making technological advances, and improvements to their products. So much can be inferred from an article which subsequently appeared in a Supplement to the Illustrated Carpenter and Builder.

MODERN TYPES OF LIFTS

It has sometimes been advanced that all improvements in lifts, especially those for passenger use, are of American origin. This is not so, however, the lift and hoist is distinctly English in its early introduction as well as in its later developments. In our selection from the catalogue of an eminent English firm (Messrs.Clarke[sic.] Bunnett, and Co., of 22 Queen-street, Cheapside), we shall see that for all purposes lifts of the most improved patterns are made in England. This firm is known for the variety and extent of its engineering work, and from its large fitting shops at New Cross. The company is in a position to produce the whole of its work without external assistance, and to guarantee quick delivery, with perfect workmanship, at lowest possible prices. It should be remembered that hoists, lifts, and cranes are but one department of general engineering work carried on by the company, nearly every class of engineering, hydraulic, and foundry work being turned out by them. In the way of lifts some varied types are shown, and it is pre-supposed that all hand-power and suspended hydraulic lifts should be fitted with the company's safety apparatus or sustaining gear. This gear can be fitted to all types of hand-power lifts. It provides that if from any cause when raising a load the hauling rope is left, the cage with its load is at once arrested.



Illus.132 Clark and Bunnell's direct-acting hydraulic hoist for railways. Anon., Supplement to the Illustrated Carpenter and Builder, 20th July, 1900, p.4.

We present a sketch [see Illus.132] from the company's own catalogue of the patent direct-acting hydraulic hoist for railways. The great advantage of this lift consists of the omission of the deadweight counter-balance for cabin and ram, dispensing with all overhead gear, chains, & c., and effecting an economy in the consumption of water. Another selection is the suspended lift, the cylinder being fixed in the lift shaft. No well-sinking is required for these lifts; they therefore make a cheaper and effective type of lift. The cylinders are strongly constructed, the cabins or goods cages are carried on steel wire ropes of the best manufacture, and fitted with safety apparatus. Every kind of lift is made by this well-known firm, from the smallest hand dinner lift to the very largest passenger lift. Two main systems are advocated. The lifts either work by low or high pressure water. By low pressure, ranging from 30lb to 120lb to the square inch, obtained from the various water companies or town mains direct; or where the building is of sufficient height iron cisterns can be placed in the roof, and the lift arranged to work from them, a bottom tank being fitted in basement with small engine and pump. The water, after serving the lift, can be pumped up and used over again, thus effecting an economy in consumption of water which would in a short time repay the outlay in engine and pumps. In the other case high pressure is used. Here water, ranging from 150lb to 800lb to the square inch, can be obtained either from laying down hydraulic plant, consisting of engine (either gas or steam), pump, and accumulator, or from the public hydraulic power company's mains. In the event of a number of lifts being fitted in one building, a set of hydraulic plant will be found most economical. Whatever may be the requirements, however, Messrs.Clark, Bunnett and Co. are equal to the occasion and will supply every detail, and their wide knowledge and experience in this class of work enables them to advise on the class of lifts and the power to be used, so as to ensure full efficiency with the truest economy." [3]

Although this article appeared about eleven years after the installation of the machinery at the Lyric Theatre, the illustration relating to the 'patent

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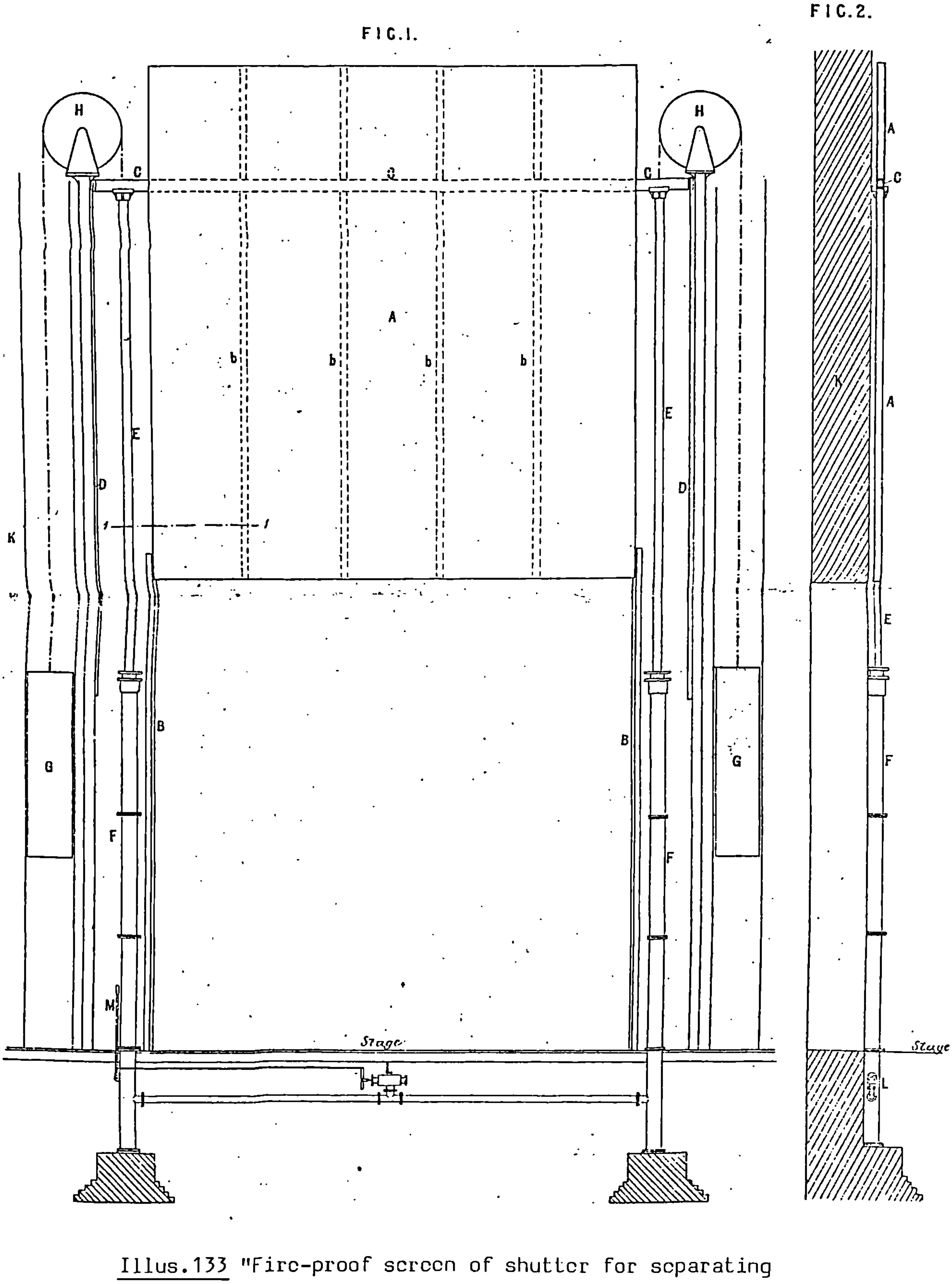
3. "Modern Types of Lifts", Supplement to the Illustrated Carpenter and Builder, 20th July, (1900), pp.3-4.



Illus.133 "Fire-proof screen of shutter for separating the stage from the Auditorium of Theatres." A.Clark, U.K. patent No.2601, 1883.

direct-acting hydraulic hoist for railways' is extremely similar to the drawings and information supplied by Sachs. This point is amplified by Sachs's statement, that,

> "The installation should be considered simply in the light of a set of five ordinary hydraulic lifts which chance to have been added to a stage. There is nothing essentially different from similar hoists or elevators, or anything calling for special comment. And yet this application of water power at the 'Lyric' Theatre, with the view of assisting theatrical effects, marks an important step in the improvement of stage mechanism in this country. The 'Lyric' installation was the first of its kind in this metropolis." [4]

The theatre was also supplied with a safety curtain, made by the same company. In 1883, Alexander Clark took out a patent, No.2601, entitled Fire-proof Screen or Shutter for Separating the Stage from the Auditorium of Theatres.[5] It advocated the use of a curtain comprising iron or steel plates rivetted to the opposite sides of suitable channel and angle iron framing, thus forming a double skin with a sufficient air space between the two skins to prevent the rapid transmission of heat. Alternatively the safety curtain's intervening cavity could be filled with water or packed with an unspecified fire resisting or non conducting material.

At a point near the top of the curtain a horizontal girder, C, was placed to project past the curtain's edges, where the two hydraulic rams and cylinders E, F were mounted [see Illus.133]. This method also required the assistance of counterweights, to enable the curtain to be raised and lowered with the minimum of power consumption. Alternatively, the mechanism could be arranged so that the hydraulic rams also acted as counterbalances for the weight of the curtain. In the provisional specification, though not in the full specification, Clark suggests that the curtain could be made in two separate sections, one rising from below the stage and the other descending from above, thus meeting at a predetermined mid-point [Full specification given in Appendix 9].

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4. Edwin O.Sachs, loc.cit.
5. Clark also patented another safety curtain in 1882, No.2,935.

The fire-curtain installed at the Lyric Theatre in 1888 was undoubtedly based upon this patent and appears to have been a great success.

> "The curtain at that theatre [the Lyric] measures 31 feet 11 inches in width, to cover an opening of 29 feet 11 inches and has a height of 28 feet. The arch of the proscenium opening is shown in the diagram, but the upper part is closed by brickwork, and the lower part of the arch has a fixed curtain 4 feet in height. The actual proscenium opening has a height of 27 feet, so that the movable curtain overlaps the opening by a foot all round. This curtain (as will be seen from the diagram) is worked by hydraulic power, and the rams do not appear to be in any way assisted by counterweights. The rams take a 10 inch by 5 inch rolled iron joist, from which the curtain practically hangs, the curtain itself being a wrought iron framework braced in two principal sections, and cut up into a number of minor sections, with light iron sheets used to form the covering. The mechanism is worked by one lever which controls both the rams. I certainly consider Max Clark's design to be a most suitable one for this country, wherever hydraulic power is available, and I ascribe the success of his appliance mainly to the fact that this gentleman has had a considerable experience of theatre requirements as an architect and surveyor, and has not treated the matter simply as an engineer's theme, without knowing the necessities of the case in every detail." [6]

Welcoming the theatre's opening in 1888, The Builder reported that, "The Iron Curtain dividing the Stage from the Auditorium has been painted by Mr.E.G.Banks, the painting representing the Old Iron Gates leading to the Avenue of Chestnuts at Bushey Park." [7]

The London Hydraulic Power Company, supplied the power for the operation of the safety curtain and a 'Preliminary Inspection' report from their archives reveals that the two rams measured 3 $^{7}/_{16}$" x 26'11", that all parts subjected to pressure were tested to 2,500 lbs per square inch, and that a relief valve was

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6. Edwin O.Sachs, "Modern Theatre Stages - No.XXVIII, Engineering, 26th March, (1897), p.394.
7. Anon., The Builder, 22nd Dec., (1888), pp.453-54.

fitted, which was designed to blow off at 800lbs. per square inch, as a safety measure. Thereafter the theatre continued to be served by the London Hydraulic Power Company until 22nd February, 1977, when the supply was sealed off, owing to the fact that the company sold its distribution network of tunnels. In 1972 the GLC photographed a pump [see photo.48], manufactured by Clark and Bunnett in 1888, which served as a manual stand-by pump for the fire curtain, situated in the substage area.

The overall success of the hydraulic equipment at the Lyric Theatre is difficult to assess with accuracy. There seems no reason to suppose that it did not work satisfactorily, yet it was subsequently removed years later leaving little or no trace. Even though it was the first major hydraulic stage machinery in London it did not cause a major reassessment of backstage practice either by the theatre managers or by the stage carpenters. It was not until the installation of such equipment at the Theatre Royal, Drury Lane, in 1896-7 that the advantages of hydraulic power for the theatre began to be appreciated.

THE THEATRE ROYAL, DRURY LANE, LONDON.
THE HYDRAULIC STAGE MACHINERY 1896/7.

Until the introduction of two hydraulic bridges at the Theatre Royal, Drury Lane in 1896, its stage was worked according to the traditions of the English wood stage. It had apparently been Sir Augustus Harris's intention to install modern stage machinery for some years, but owing to the considerable financial outlay required the machinery was not commissoned until shortly before his death on 22nd June 1896. The responsibility for the installation itself then passed to Harris's successor and protégé, Arthur Collins.

The machinery designs were based upon those of the Asphaleia Syndicate (an Austrian organisation which registered a U.K. patent for hydraulic stage machinery in 1882), and was controlled by four men, Robert Gwinner, Johann Kautsky, Carl Dengg, and Franz Roth, who resided in Vienna. The Drury Lane machinery, which was manufactured by Carl Dengg's company, comprised two hydraulic platforms or bridges, each possessing two direct 18.5" x 21'6" hydraulic rams, one at either end of the bridge. They were positioned 6" out of centre to the right of the stage and measured 39'3" x 7'6". The direct rams were designed to allow the bridges to be raised 11 feet above the stage and lowered 8 feet below it.

The hydraulic power required to operate the machinery was supplied by the London Hydraulic Power Company. However, before the supply could be connected several modifications had to be made. The machinery had originally been designed to operate at a low hydraulic pressure, but the standard operating pressure in London was much higher, at 700 lbs/square inch. It was therefore necessary to fit reducing values to compensate for this pressure variation, and this work, along with the overall installation was carried out by Messrs Archibald Smith and Stevens, an established firm of lift engineers.

It seems very strange that Harris and Collins should have decided to import machinery from Austria, when comparable equipment could have been supplied from this country. This was felt a the time by the <u>Engineering</u> correspondent who commented: "There is no doubt that if English engineers were to undertake similar work they would be able to make something lighter and more suitable for the purpose ." [1]

The Asphalcia hydraulic machinery did, however, have several advantages over the bridges of the English wood stage, one of which Sachs identified in his remark that, "these appliances [the bridges] were primarily intended to facilitate the presentation of a large shipwreck scene," [2] a feature attributable to their ability to tilt from one end to the other. This motion was effected by independently controlling the hydraulic rams at either end of each bridge, and by the inclusion of a pivoting joint between the top of the ram and the bridge table top. The process is illustrated by two photographs which were taken during a 'fit-up' for a production of The White Heather [see photos.49, 50].

Sachs, writing his serialisation for Engineering on 'Modern Theatre Stages' [3] noted that the bridges "had been adapted for the so-called 'see-saw' movement under the direction of Mr. Brown, who is in charge of this appliance at Drury Lane". This comment, which was omitted from Modern Opera Houses and Theatres, suggests that the machinery may not have had a tilting mechanism when it was originally manufactured in Austria.

In 1899 a production of The Price of Peace was mounted at Drury Lane and included a shipwreck scene. Two illustrations from this production give not only an insight into the use of the machinery, but also an interesting comparison between the reality of a photograph and the artistic licence of a theatrical illustrator [see photos.51, 52].

The hydraulic bridges were at all times controlled from a platform located on the stage left side of the mezzanine floor. This was a departure from the location advocated by the Asphaleia Syndicate, for they recommended that all the machinery should be controlled by the stage mananger at stage level i.e. 'centralisation'. This does, however, have the great disadvantage that the operator cannot see the machinery when it is moving

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1. "Hydraulic 'Bridges' at Drury Lane", Engineering, 17th June, (1898), p.754.
2. Edwin O.Sachs, Modern Opera Houses, III supp.1, p.77.
3. Edwin O.Sachs, "Modern Theatre Stages No.XXIX", Engineering, 9th April,(1897), p.464.

in the substage, at a time when it is potentially at its most dangerous, since actors could become trapped between the structural framework and the bridge platforms. The person who operated the bridge was assisted by a positional indicator [see photo.53] which showed the exact position of each end of the hydraulic table. This ensured that the bridges could always be positioned in exactly the same place for every performance. The control handles which operated the control valves regulating the amount of water admitted into the hydraulic rams can be seen in operation on the accompanying photographs 54, 55. It is also interesting to note that when these photographs were taken in 1910 there still appears to have been a wooden bridge in the background on the downstage side of the hydraulic bridges.

Within a year of the connection of the hydraulic supply on 30th November 1896 there was a mishap: on 18th September 1897, during a run of The White Heather, the hydraulic bridges used in Act III, Scene III, 'Boulters Lock', were found to be defective just before the evening performance. Arthur Collins had to cancel the show and wrote the following apology to The Times:

> "SIR - Owing to a temporary failure tonight in the working of the hydraulic lift on the stage, which placed it out of power to proceed with the setting of the scenes, the performance of The White Heather could not be proceeded with. As this unfortunate occurrence only became apparent five minutes prior to the advertised hour for raising the curtain, no notice could be given, before the enormous audience assembled. The management deeply regret the inconvenience caused, and beg to thank all present for their generous consideration and sympathy under the circumstances.
>
> Ever since the lift has been in use, about 12 months, such a mishap has never occurred; the necessary repairs are being proceeded with to-night, and the theatre will re-open as usual on Monday.
>
> Yours obediently,
> ARTHUR COLLINS, MANAGING DIRECTOR
> (For Theatre Royal, Drury Lane (Limited)).
> September 18." [4]

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4. Arthur Collins, The Times, 20th Sept.,(1897), p.5.

Arthur Collins subsequently approached Edwin Sachs to investigate the occurrence, who after consideration declared that it was due, "to either wilful damage or culpable negligence." [5] He later commented, in volume three of Modern Opera Houses and Theatres, that the mishap had been "unique in the annals of modern Stage construction, ... the iron stage worked by hydraulic power has always been considered reliable. I had an opportunity of examining the appliances directly after the establishment had been closed, and, to my mind, there was nothing to show that the appliances themselves, though, as indicated, constructed on the earliest 'Asphaleia' lines, had any defects. There were, in fact, indications that the cause of the collapse of the 'bridges' was either due to malicious damage or wilful negligence, and, as far as the movement of 'Stage Reform' is concerned, it is well that it could be attributed to this, for the charge unreliability would be fatal to the development of modern stage mechanism if put forward by its opponents, among whom should be counted many of the stage carpenters of old. Nevertheless, the failure at Drury Lane afforded a warning to this extent, that the vital parts of modern mechanism should be protected from accidental or intentional damage, and that an installation of this description should always be in the hands of skilled engineers and trustworthy mechanics." [6]

Collins, understandably concerned, asked Sachs to circulate to the editors of many publications a letter explaining how the accident had occurred.

> "The accident in question took the shape of a collapse of these lifts whilst in a sloping position with the result that certain parts of the mechanism were strained or broken.....
>
> As to the repairs, which are being executed under my supervision, I am glad to say that, thanks to the indefatigable efforts of Messrs.A.Smith and Stevens the hydraulic engineers, the first of the two 'bridges' is already in working order, and the second will soon be

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5. Edwin O.Sachs, "The Stage Accident at Drury Lane", The Builder, 2nd Oct.,(1897), p.255.
6. Edwin O.Sachs, Modern Opera Houses, III, supp.1,p.78.

> ready, so that what has had to be temporarily done by manual labour can again be worked by water power. That the play could be presented with provisional aids as early as the Monday following the accident is mainly due to Mr.Taylor, the stage machinist, and his staff of carpenters." [7]

It is very clear from Sachs's comments on the incident that he was very concerned about the possible lasting effects of such an occurrence upon the 'Stage Reform' movement. Whether the incident was caused deliberately to attempt to halt such reform will probably never be known, but clearly any bad publicity concerning the machinery would not have aided the reformation Sachs was attempting to implement. However, with the advantage of historical perspective, it now seems highly unlikely that this single occurrence had any direct influence on stage machinery in general. It is nonetheless interesting to note that Sachs filed his provisional patent specification for electric stage lifts in December 1898, 15 months after the accident at Drury Lane. This patent was accepted by the patent office on the 21st October 1899, and he subsequently used this design as the basis for four new lifts at Drury Lane.

On several occasions Sachs's opinions on the suitability of hydraulics for stage mechanism do indeed appear to conflict. For instance in the third volume of his treatise, dated 1898, he commented that, "the iron stage worked by hydraulic power has always been considered reliable" [8], whereas in 1901 he remarked, "I had long been impressed with the unreliability of the hydraulic lift as applied to stage purposes." [9]

Although he defended the hydraulic machinery immediately after The White Heather incident, this was almost certainly in order to ensure that the 'Stage Reform' movement did not receive a major setback. In the same Sketch article his reservations became very apparent:

> "the run of 'White Heather' - on which occasion I was called in to advise - served only to strengthen my conviction. I had seen many of

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7. Edwin O.Sachs, "The Accident to the Drury Lane Stage", The Engineer, LXXXIV, 1st Oct.,(1897), p.322.
8. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.78.
9. T.H.L., "Reconstruction of the Opera Stage: A chat with Mr.Edwin O.Sachs." The Sketch, 3rd April, (1901), p.426.

these lifts at work during repeated visits to the principal opera-houses and theatres on the Continent, where they were in use pretty generally, but they frequently proved unsatisfactory. After devoting a good deal of attention to the subject, I became convinced that ELECTRICITY WAS THE FORCE that would be most advantageously employed." 10

Yet there were advantages and disadvantages associated with both electricity and hydraulic power, and for many years the argument over their application to stage machinery continued. The use of hydraulic stage machinery on a large scale appears to have been pioneered in Great Britain as previously discussed [see p.192] by Andrew Betts Brown at the Edinburgh Theatre in 1875, while the first hydraulic installation of such machinery at a London theatre occurred at the Lyric Theatre, Shaftesbury Avenue in 1881 [see page 201]. It was not however until the expansion of the London Hydraulic Power Company in the 1880's and 90's that theatre managements began seriously to consider the practicality of alternative motive powers.

The formation of the Asphaleia Syndicate in 1881 did not lead to the immediate installation of hydraulic stage machinery into British theatres, but it did make a large number of eminent theatre managers and architects aware of its possibilities. Walter Emden, [11] a theatrical architect of some repute, originally studied mechanical engineering in the workshops of Maudsley, Sons and Field of Lambeth, and later became a civil engineer in the firm of Thomas Brassey. He was therefore eminently qualified to assess the suitability of hydraulic power for use in the theatre when he attended a meeting of the Institute of Civil Engineers in 1887. The minutes of the proceedings record a comment made by Emden.

"The main reason against the use of machinery on the stage, was cost of working. If, however," he went on ,"the power could be transmitted all over London, and used easily and cheaply by theatrical managers,

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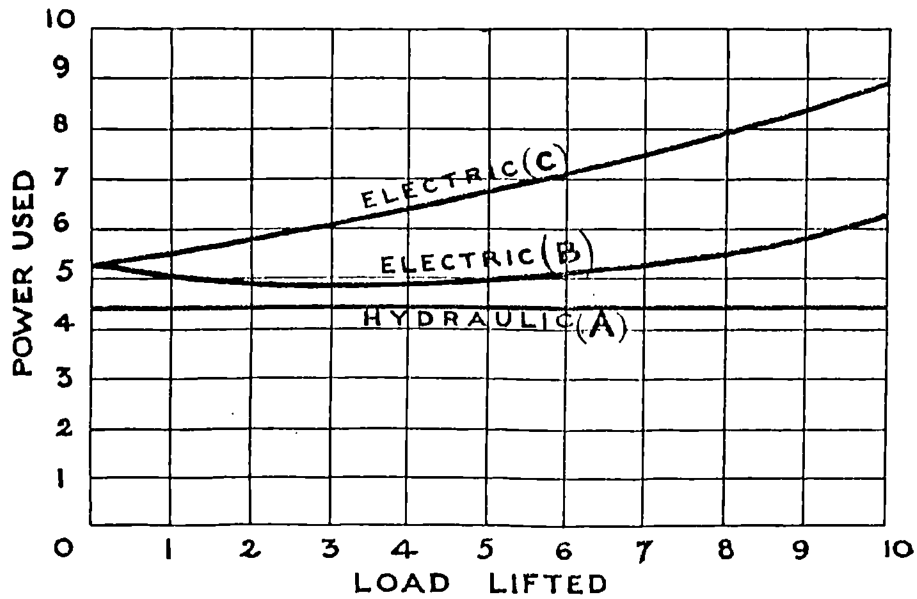
10. Ibid.

11. A short biography is given in Appendix 10.



Line A—Hydraulic Power used in SINGLE Power Lifts (the same at all loads).

" B—Electric Power used with equal loads up and down.

" C—Electric Power used taking loads up and coming down empty, or vice versa.

NOTE.—Intermediate stops will raise the curves B and C, but do not affect A.

Illus.134 Diagram showing proportional consumption of power for all round trips in Hydraulic and Electric Lifts.

Lifts, Hydraulic Power V Electric Power op.cit., n.pag.

he had no doubt that the Author's method of transmitting power would cause an entire revolution in such matters. The present system was as bad as it could be; any improvement would be an advantage; but an improvement which brought water at high pressure on to the stage, would be of great importance, not only for working the machinery but also for extinguishing the fire." [12]

Even by 1887, the hydraulic power distribution network was still inadequate, measuring some twenty-five miles in all. This had grown by 1900 to fifty-three miles, stretching from West India Docks to Hyde Park Corner in one direction, and from Mint Street south of the river to beyond Old Street on the north side.

During the 1890's there was great competition between the manufacturers of hydraulically and electrically operated equipment, each claiming theirs to be the best and most economical. The London Hydraulic Power Company asserted that,

"At the same load factor there is an economy in production in favour of hydraulic power, and the lower the load factor the greater the comparative economy. The cost is not however the cost of production, but the relative economy in the use of the power. Hydraulic Lifts at full load are the most economical owing to the direct action and simple movement of the working parts, but in Electric Lifts the amount of electricity used is more or less in proportion to the varying loads. At the same time when the machinery used is properly proportioned the economy of Hydraulic Lifts at full load is so great that at all loads, less hydraulic than electric power is used to do the same work." [13]

This claim was supported by a table [see Illus.134], showing the proportional consumption of power for "all round" (i.e. up and down) trips in Hydraulic and Electric Lifts. In complete opposition to this was a

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12. Edward Bayzand Ellington, "The Distribution of Hydraulic Power in London." <u>Pro.Inst.Civ.Eng.</u>,XCIV, (1887-8), p.64. [Comments made by Emden after the above paper had been given].
13. Anon., <u>Lifts, Hydraulic Power v. Electric Power</u>, pamphlet, (London: The London Hydraulic Power Company, 1906), p.11.

TABLE I.

COMPARATIVE COST OF WORKING HYDRAULIC AND ELECTRIC LIFTS.

Type of Lift.	Load.	Source of Power.	Travel in Feet.	Cost of Average Round Trip Up & Down in Pence.	Number of Trips per penny.	Remarks.
Electric	7 cwt.	Birmingham Corporation ...	50	·072	13·6	Observed. Conditions ordinary. Current at 2½d. Test covered 40 round trips with full load.
Hyd. Suspended H.P. ...	7 cwt.	Manchester Corporation ...	50	·29	3·45	Calculated from Published Scale.
Hyd. Suspended L.P. ..	7 cwt.	Town Supply	50	·445	2·2	Calcu'ated at 6d. per 1000 Gallons. Pressure, 50 lbs.
Electric	9 cwt.	Private Supply	50	·066	15·	Observed. Conditions ordinary. Current at 2½d.
Hyd. Suspended H.P. ..	9 cwt.	London Hyd. Power Co. ...	50	·237	4·22	Calculated from Published Scale.
Electric	9 cwt.	Glasgow Corporation ...	50	·066	16·4	Observed. Current 2½d.
Hyd. Suspended H.P. ..	9 cwt	Glasgow Corporation ..	50	·212	4·7	Calculated from Published Scale.
Hyd. Suspended H.P. ..	12 cwt.	London Hyd. Power Co. ...	50	·287	3·48	Observed.
Hyd. Suspended H.P. ..	9 cwt.	London Hyd. Power Co. ...	50	235	4 25	Observed.
Hydraulic Ram. H.P. ..	12 cwt.	London Hyd. Power Co. ...	50	·344	2·9	Observed.

N.B.—Corrected by L. H. P. Co., 1904 Scale.

Illus.135 Comparative cost of working hydraulic and electric lifts.

Notes on Electric Lifts, op.cit., p.9.

table published in 1904 [see Illus.135], by Archibald Smith and Stevens, [14] manufacturers of electric lifts, who, it may be recalled, installed the hydraulic machinery at Drury Lane! The disparity amply illustrates the problems involved in assessing the operating costs of the two types of lifts. The first table [Illus.134] does, however, show that the cost of operating a hydraulic lift is constant irrespective of the load, and perhaps, more importantly, irrespective of the number of stops made in one trip, whereas, the number of stops made by an electric lift increases the amount of current used. The cost of operating a hydraulic lift seems also to have been dependent upon the type of installation. The 'ram lift', such as the substage machinery at the Theatre Royal, Drury Lane, was generally more expensive to operate than the 'suspended lift' which was utilised at the West End Theatre in Edinburgh. To quote the London Hydraulic Power Company pamphlet, "A Hydraulic Ram Lift can with a simple ram, 3 inches in diameter, 30 feet high and with a load of 10 cwt. would consume nearly 10 gallons per journey. Now a Hydraulic Suspended Lift to raise the same load the same height would take say 3 gallons or less than a third of the power." [15]

The cost of hydraulic power in London around the turn of the century was calibrated on a sliding scale, with the minimum charge for 3,000 gallons or less per quarter being £1 5s 0d [15]. It would therefore seem probable that the Theatre Royal, Drury Lane lifts with their large 18.5" x 21'6" direct hydraulic rams, were comparatively expensive to operate, but it must be remembered that they would not have been used with any great frequency and that actual running costs would have been restricted accordingly. However, the relative economy of hydraulic and electric lifts was not merely a question of running costs, for the initial capital expenditure had to be considered, and here conclusive evidence can be cited. In their 1904 pamphlet the firm of Archibald Smith and Stevens, advocates of the electric lift, could not dispute the fact that, "With respect to first

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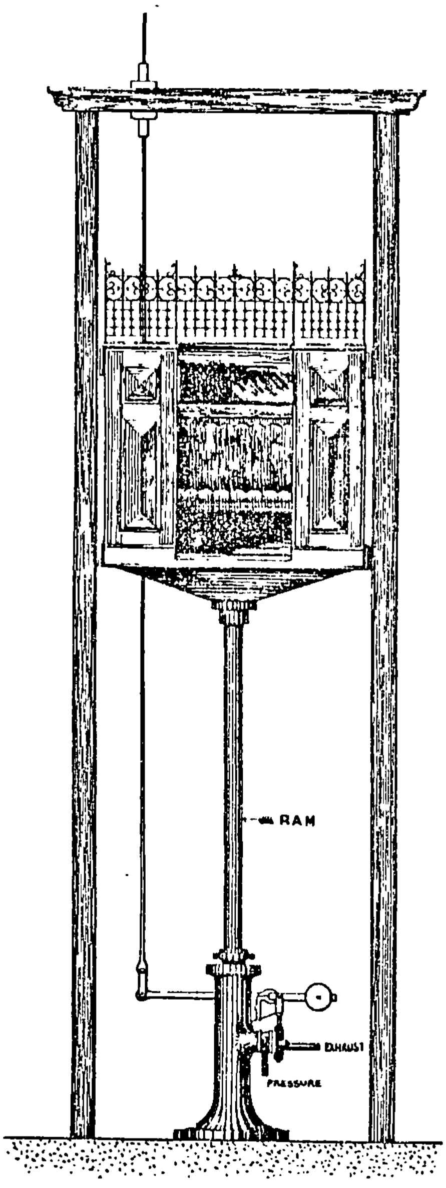
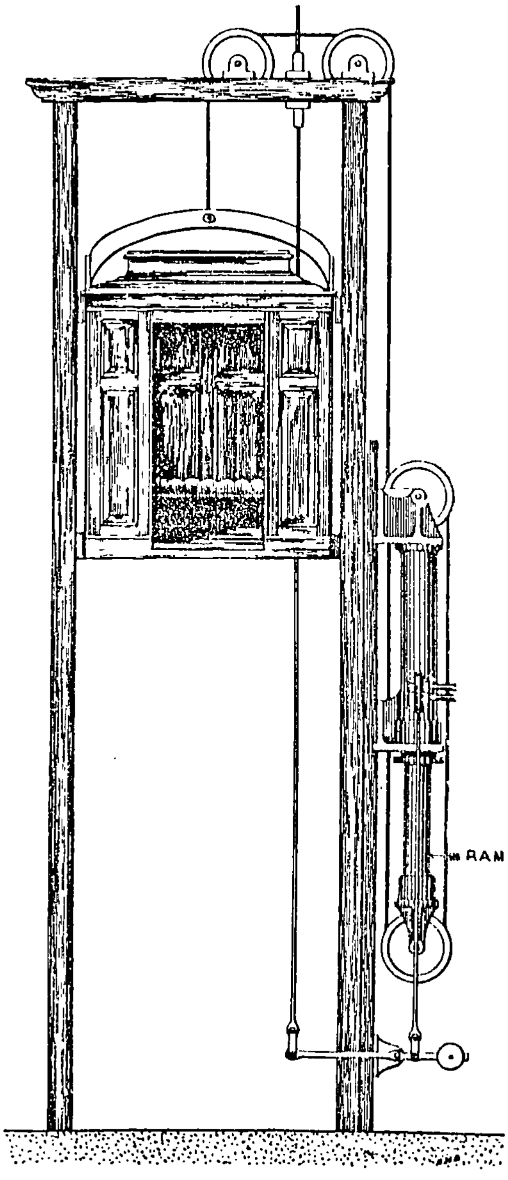
14. Anon., Notes on Electric Lifts, pamphlet, (London: Smith and Stevens, (1904), p.9.
15. Lifts, Hydraulic Power v. Electric Power, op.cit., pp.13-14.



HYDRAULIC RAM LIFT.



HYDRAULIC SUSPENDED LIFT.

Illus.136 Two types of hydraulic lift. Lifts, Hydraulic Power v Electric Power, op.cit., n.pag.

cost, the advantage ..... lies with the Hydraulic Lift, the average proportionate prices working out at the present time approximately thus:-

Hydraulic High Pressure	75
Hydraulic Low Pressure	87.5
Electric	100 ...." [16]

Smith and Stevens also admitted that, "in point of simplicity, and of directness of action, the advantage must be conceded to the Hydraulic Lift." [17] Also, thanks to this "simplicity and directness of action", hydraulic lifts were usually considered to be safer than their electric counterparts. Undoubtedly safest of all was the direct ram lift [see.Illus.136] since the ram acted as a supporting column, which rose and fell with the lift platform. This type did, however, have its limitations because it was necessary to sink a well into the ground to accommodate the ram when fully retracted. This problem is well demonstrated by the cross-section of the stage of the Lyric Theatre, London, [see Illus.130] where the five rams had to be sunk 15'3", 15'6", 15'9", 16'0" and 30'0" below the level of the cellar floor. The diameter of the ram must be increased proportionally according to the distance which the lift must travel. There therefore comes a point beyond which the cost of a large ram in terms of *installation, and consumption of water, makes it a financial* liability. In such circumstances the suspended hydraulic lift [see Illus.136] was a more practical and economic proposition. It consisted of a shorter hydraulic ram, usually of a larger diameter than the direct ram, and incorporating as shorter 'stroke' which was multiplied by a series of purchase pulleys. The main disadvantage associated with this type of lift was the increased risk of accident inherent in any suspended lift system.

As there were two basic types of hydraulic lift, the direct ram and the suspended, so there were variations in the type of electrical power available which can be split into four basic categories:

(1) Continuous or Direct.

(2) Single Phase Alternating.

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16. Notes on Electric Lifts, op.cit., p.4.
17. Ibid.

(3) Two Phase Alternating.

(4) Three Phase Alternating.

As a rule it was the first of these that was associated with operating lifts and it was in fact utilised for the electric stage lifts at the Royal Opera House, Covent Garden, The Theatre Royal, Drury Lane; and the motors for the triple concentric revolve at the Coliseum Theatre. All electric lifts, however, operate on the suspended lift principle and all require one important feature which is not needed in hydraulic lifts - a mechanical or electromagnetic brake. Moreover, since the lift cage is counterbalanced to assist the journey up, while the electric motor is used for lowering, it was claimed that the cage could be overbalanced in an attempt to minimise the current required. Another danger associated with electric lifts was overwinding. Quite surprisingly Smith and Stevens published the following passage in their 1904 pamphlet advocating the use of electric lifts: "Thirteen accidents to drum machines by over-winding have been recorded during the last eighteen months. No accident either by over-winding or slipping has ever occurred with our vee drive." [18]

These risks are not found in hydraulic lifts because the control is maintained by a valve attached to the cylinder. When it is closed the water is contained within the cylinder and the lift remains in the same position. When opened to mains pressure, the water begins to flow and the lift ascends. It is only when the valve is opened to exhaust that the water can flow out of the cylinder, thus allowing the lift to descend. As most of the lifts under consideration, whether hydraulic or electric, would have been installed in the substage and cellar regions of a theatre, it is important to consider their susceptibility to failure after flooding. The presence of water near live electrical machinery is obviously a very dangerous and potentially fatal hazard. Notwithstanding this the electric motors which operate the substage machinery at the Royal Opera House, Covent Garden, have been flooded on several occasions and after careful drying out have been found to be in perfect working order. On the other hand, electric motors exposed to water whilst in operation will most certainly break down. When hydraulic lifts come into contact with water

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18. Ibid. p.28.

either from leakage or cellar seepage, corrosion will begin to occur. However, this can easily be avoided by ensuring that the equipment is regularly serviced and maintained - a proposition supported by the excellent condition of the hydraulic stage machinery at the Theatre Royal, Drury Lane in the 1980's.

There are undoubtedly advantages associated with both hydraulic and electric lifts. Although the London Hydraulic Power Company no longer supplies power in Greater London it is quite possible to generate hydraulic power on site. Given this, the debate, "hydraulic power v. electric power" still continues along the same lines. How easy it would be to suggest that the following passage, which actually dates from 1977, was written in 1897:

> "Demands from both producers and audiences for increased scenic realism together with increasing costs of both labour and materials, has meant that theatre managements have become more prepared to use the potential of modern technology. The theatrical spheres of operation where fluid power can assist to the best advantage are scenery flying, stage elevation and roation and special scenic effects equipment." [19]

Apparently the argument continues! This dispute, hydraulics v electricity was, however afforded, an opportunity for direct comparison and competition when the next phase of development was undertaken at the Theatre Royal, Drury Lane.

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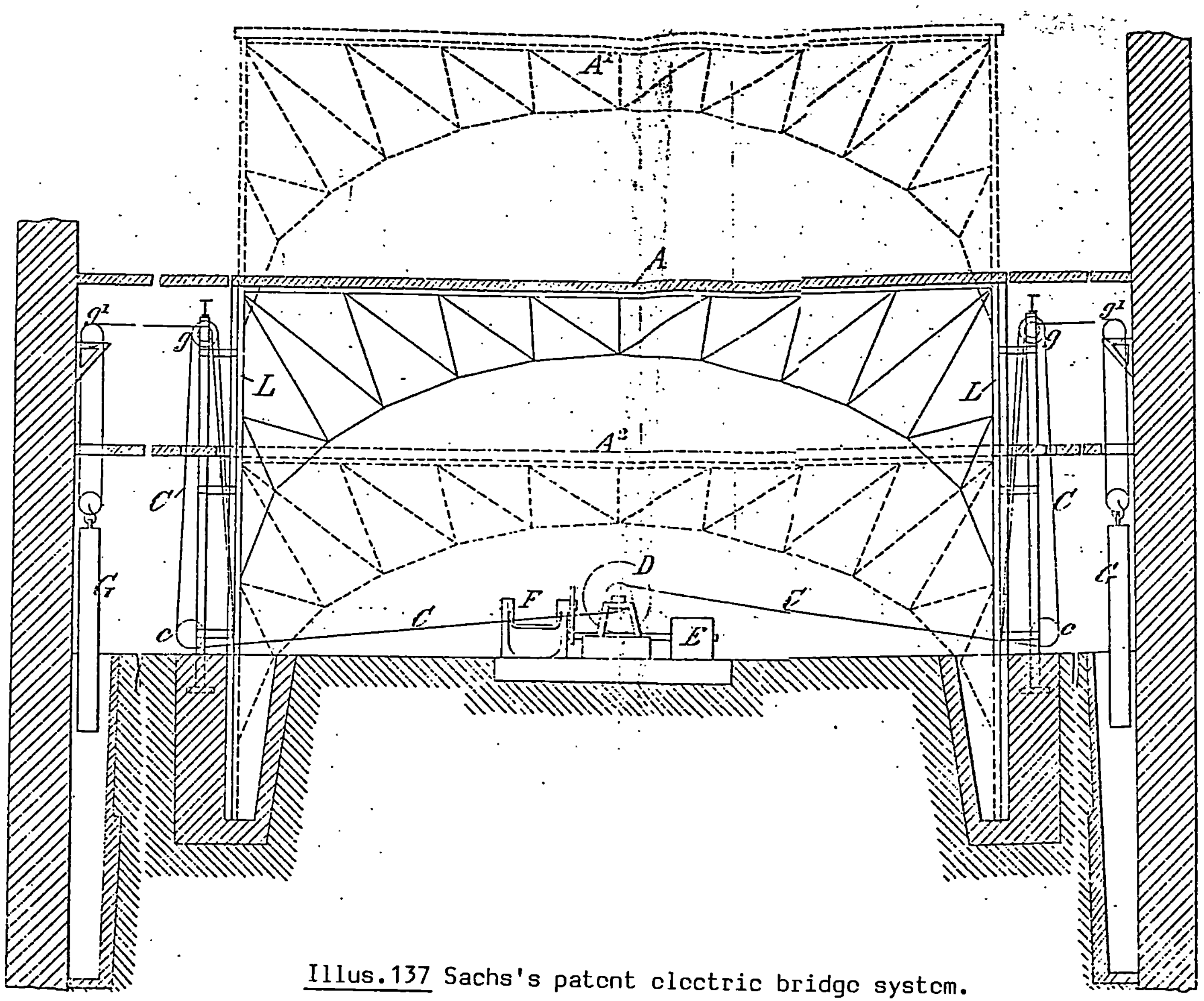
19. M.Waddington, M.Barnett. "The Wonder of our Stage", Chartered Mechanical Engineer, Sept., (1977).



__Illus.137__ Sachs's patent electric bridge system.
Sachs, U.K. patent No.27,000, 1898.

THE THEATRE ROYAL, DRURY LANE, LONDON.
THE ELECTRICAL STAGE MACHINERY, 1899.

When Edwin Sachs published his treatise, Modern Opera Houses and Theatres, between 1896 and 1899, he became the undisputed authority on stage mechanics in Great Britain. It was therefore only natural that Arthur Collins should have approached him to investigate The White Heather incident, and design some new machinery to supplement the two hydraulic bridges. This new machinery was based upon a Sachs patent, entitled An Improvement in Stage Floors the text of which is unusually short in comparison with other stage machinery patents and is accompanied by a single drawing only [see Illus.137].

The complete specification reads as follows:

> "My invention relates to the construction of a stage floor in compartments which can be raised above or sunk below the general level, as I shall describe referring to the drawing accompanying my Provisional Specification, which is a section of a compartment of a stage floor according to my invention.
>
> The floor A is supported by a trussed arch terminating at each side in vertical legs L which run in guides, and have wire ropes attached to their lower ends. Some of the ropes run over guide pulleys gg^1 and carry counterbalance weights G. Others of the ropes C pass over pulleys g and under pulleys c to the barrel of a winch D which can be worked by an electric or other motor E or by hand gear F. Pits are provided for the legs L and the counterweights G.
>
> As shown [sic.] in the drawing the floor compartment can be raised above the general stage level as indicated at A or lowered as indicated at A^2. The floor compartments are secured in any position into which they are moved by means of any suitable locking gear such as draw bolts and the motion of the compartments may be controlled by safety brake mechanism of any known kind."[1]

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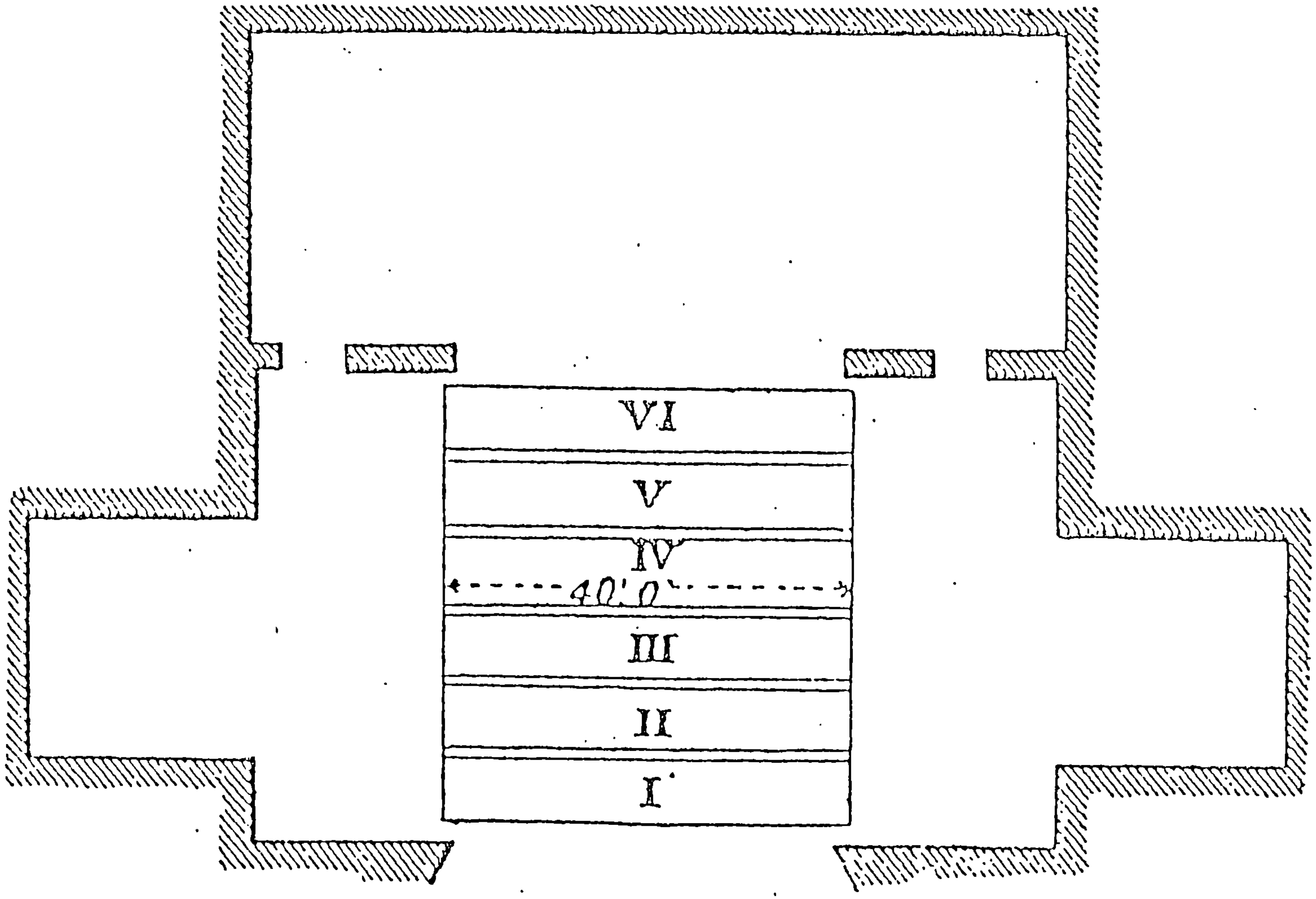
1. Edwin O.Sachs, An Improvemenct in Stage Floors, U.K.Patent No. 27,000, (London: H.M.S.O., 1898).



I & II. Proposed 'Bridges' subdivided into numerous minor sections & traps. III & IV. Bridges work^g vertic^y or slant^g V & VI. Bridges working vertically.
(4736.E)

Illus.138 Sachs's proposal for the layout of the stage at the Theatre Royal, Drury Lane, London. Engineering, 23rd Dec., (1898), p.834.

Although Sachs produced a practical patent for a stage mechanism powered by electricity, there were those who thought it would not work. "It was declared", he said, "that electricity was a force that could not be made adaptable to the slow raising of the stage required during certain scenes, say, in the so-called 'transformations', and that, were electricity employed, the stage would shoot up suddenly and so on." [2]

Nevertheless in the early months of 1898 Collins commissioned Sachs to construct intially two bridges, as laid down in his patent, with the option of another two at a later date.

Essentially the drawing which accompanies the patent shows a 'bridge' system owing much in design to the 'bridge' of the English wood stage. Sachs did, however, overcome the two main objections to the old system: he replaced muscle power with electric motors, and the highly combustible timber with iron. Even so the design did fall short in one respect, in that it did not allow the bridges to be tilted in the same manner as with the hydraulic lifts at Drury Lane.

Sachs's scheme to improve the Drury Lane stage involved dividing it into six movable sections [see Illus.138]. The hydraulic lifts were retained as sections III and IV, sections I and II were to be constructed according to the patent at a later date, and the work was to begin by installing two electric bridges in sections V and VI on the upstage side of the hydraulic lifts. The whole reconstruction scheme was carefully scheduled by Collins and Sachs to ensure that the theatre did not have to close its doors to the public. During the installation period performances of The Great Ruby were given nightly at Drury Lane, while a shift system was operated by the workmen 24 hours a day. Indeed, on occasions the four-in-hand coaches [see photo.56] and cavalry in the production had to pass over a stage which was practically supported only by temporary trestles.

This was essential to ensure that the management suffered no loss of income which would have effectively increased the cost of the installation. The reconstruction contract was undertaken by the Thames Ironworks Co., with

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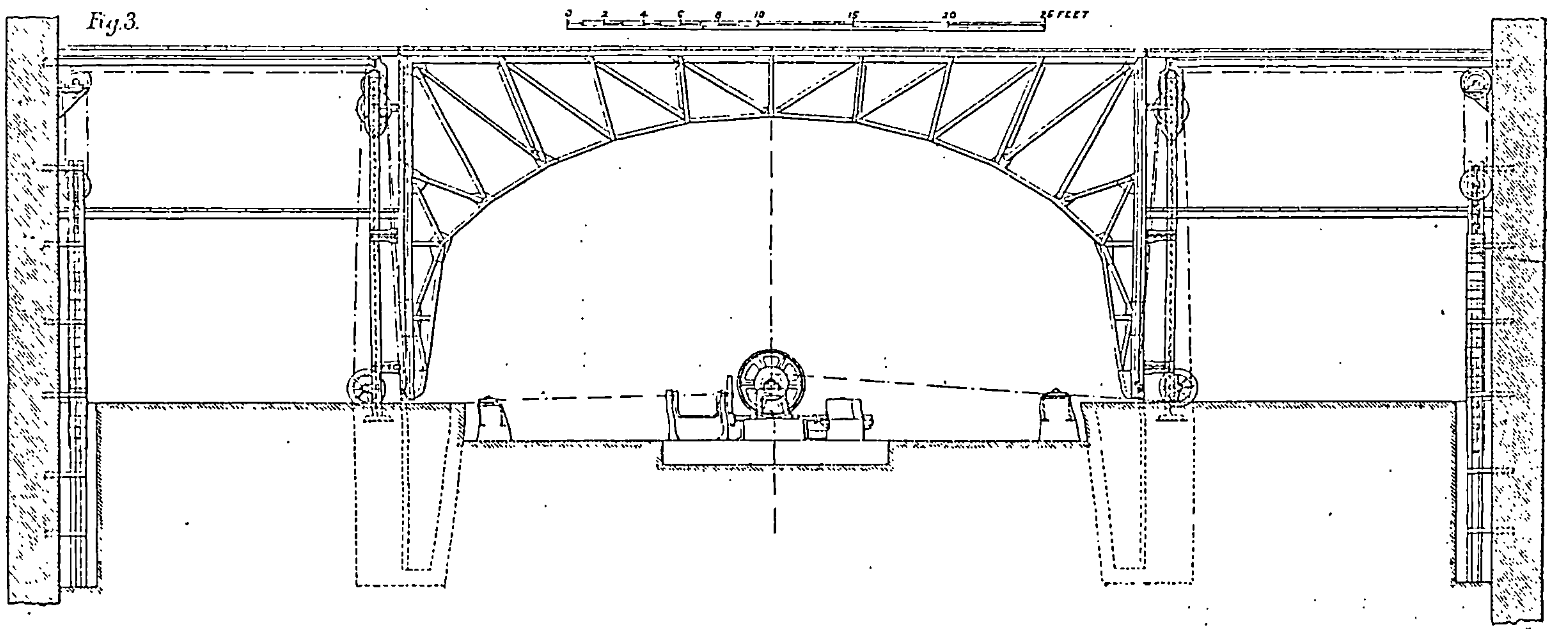
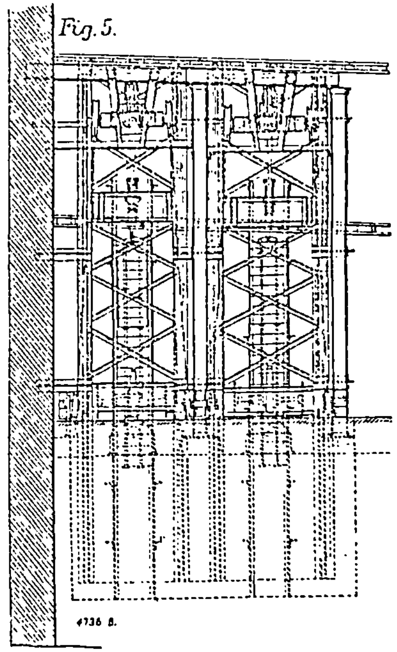
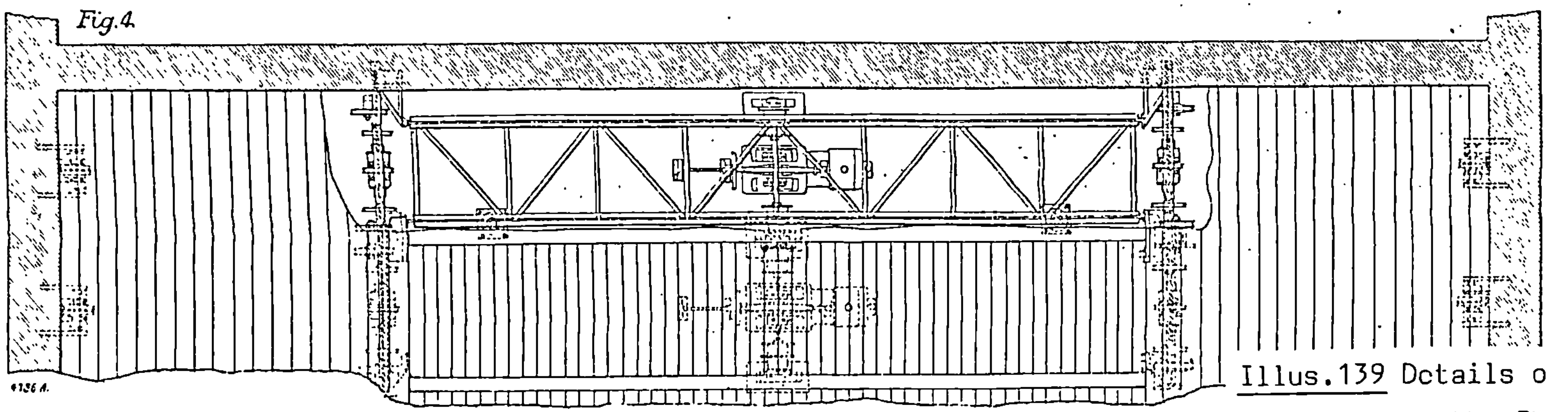
2. T.H.L., op.cit., p.426.

ELECTRICAL STAGE MECHANISM AT DRURY LANE THEATRE.

CONSTRUCTED BY THE THAMES IRON WORKS AND SHIPBUILDING COMPANY, LIMITED, ENGINEERS, LONDON.







Illus.139 Details of the electrical stage mechanism at the Theatre Royal, Drury Lane, London.
Fig.3. Transverse section.
Fig.4. Plan view.
Fig.5. Longitudinal section.
Engineering, 23rd Dec., (1898), p.835.

Mr.Alexander Stuart superintending the construction work and Mr. Grove taking responsibility for the electrical installation, which included designing the electric motors used to operate the bridges, [see Illus.139]. The installation of sections V and VI was completed in time for their inclusion in the Boxing Night performance of The Great Ruby, and they operated during pre-show trials, "with unwanted smoothness, without any jar, or shock on starting and stopping, and quite noiselessly, only 25 amperes being used." [3] Sections V and VI measured 7'3.5" x 39'3" and 7'0" x 39'3" respectively. There were no intervening cuts, as in the traditional English wood stage system, but the sections were separated by an 8" strip, (known on the Continent as a Cassettenklappen) which was attached to one of the bridges. The bridge platforms comprised a light steel arch-lattice girder structure, topped with flooring which matched the stage surface as a whole. There were no sliding floor sections to be drawn off to either side, as in the old English wood stage system.

The steelwork of each of the two sections weighed a little in excess of 4.75 tons and the joists and staging which were mounted on the top provided an additional 1.5 tons, giving an overall total weight of 6.25 tons. The bridges were of course counterweighted up to a maximum of 4.5 tons. They were originally designed to travel 8'6" below the stage and 10'6" above, but subsequent modifications reduced these figures. The smooth travelling of the platforms was assisted by the long legs which slid in right-angled guides. To accommodate the legs of the bridge when it was lowered into the substage, special pits were excavated as shown on the patent cross-section.

Each bridge was equipped with an electric-four-pole enclosed shunt-wound motor. [see photo.57] which developed 7.5 H.P. at 520 revolutions per minute, although they were capable of working at a higher rate in emergencies. The actual speed of the motor was reduced by the ratio of 104 to 1 by means of a large worm gear, the worm-wheel being geared to a shaft which carried the two requisite winding drums each capable of five revolutions per minute. Around the drums were wound steel ropes, which in turn passed over deflection pulleys to be attached to the legs at four

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3. Anon., "Electrical Stage Appliances At Drury Lane Theatre", Engineering, 23rd Dec., (1898), p.836.

individual points near each corner. The actual rate of lifting could be varied between 16' and 6' per minute by adjusting the resistances connected into the motor circuit. A compensating mechanism was also included in the design, allowing the tension on either rope to be of equal force,and therefore obviating the problem of one end of the bridge rising more rapidly than the other. The control panel for each individual mechanism was positioned on the stage left mezzanine floor, in close proximity to the operational equipment for the hydraulic lifts. The electric bridges could therefore be controlled by one person located in a good position to observe the movement of the machinery. The control panels were fitted with a combined starting/reversing switch, which has in recent times been replaced with an equivalent but more advanced control box. If there was ever a power failure (and there quite often was in 1898), the bridges could be operated by a manual winch incorporated into the electric motor.

To ensure that the bridges could not collapse as in The White Heather incident, Sachs incorporated a locking-device which would hold the bridge in position if one of the cables broke. In addition, automatic cut-off switches were provided to limit the distance which the bridge could travel, just in case the operator was "derelict in his duties."[4] This also meant that the bridges could be guaranteed to stop in the same place on every occasion, clearly an improvement on the visual gauge used with the hydraulic lifts.

Sachs intended initially to retain the hydraulic lifts, but at a later unspecified date he considered removing them, for he found that they were more expensive to maintain than his electrical bridge system. However, owing probably to a lack of funds this proposal was never carried out. The sections I and II were not installed for some years, but when eventually they did materialise they were almost indentical to sections V and VI.

The fact that all six sections are still in place and in working order today [1989] is certainly a tribute both to the Asphaleia Syndicate and to Edwin Sachs. The installation of this stage machinery in the 1890's was a great advancement for the 'Stage Reform' movement, and undoubtedly

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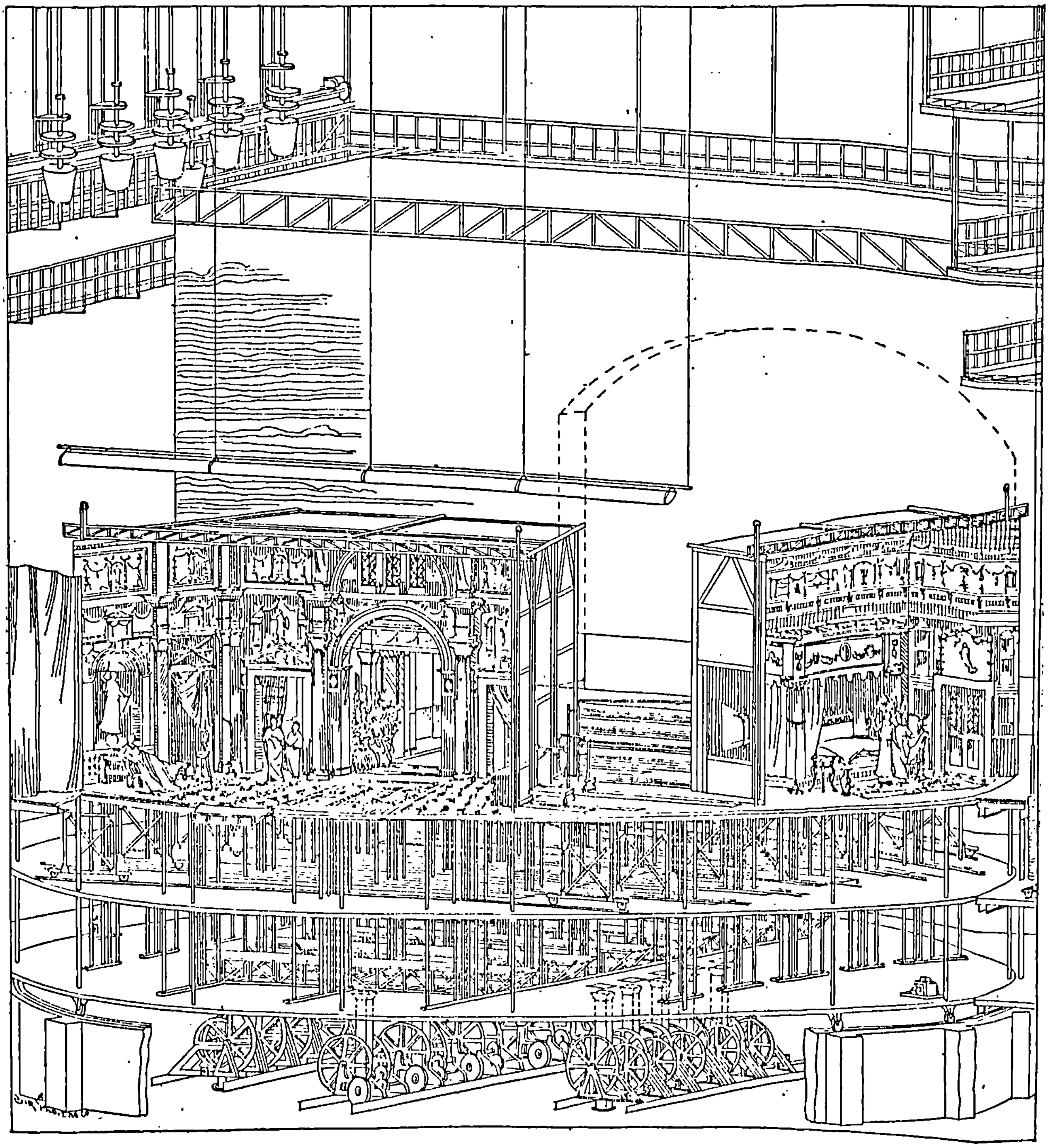
4. Anon., "Modern Stage Mechanism", Scientific American, 7th Oct., (1899), p.233.



Illus.140 Electric 'turntable' stage. Sachs, Modern Opera Houses, III, supp.1., p.68.

influenced the installation of the Royal Opera House, Covent Garden, stage machinery in 1901.

In conclusion, it is worthy of note that Sachs considered modifying the six sections into an electric turntable stage, similar to the one designed by Karl Lautenschlaeger for the Munich Court Theatre [see Illus.140]. In 1898 he wrote that, "the six sections will practically only have to be lowered a few feet to take the necessary tramlines for the rolling-way, and the 'turntable' will also be installed by sections with its centre pivot between the third and fourth sections." [5] Such a conversion was never attempted, but it is very interesting especially when one considers that a revolving stage was to be installed at the Coliseum Theatre, London in 1904.

Although the installation of this specialised stage machinery reduced the number of staff required to operate the substage, it probably did little in real terms to reduce the number of backstage staff at the theatre. This is due to the fact that large numbers of stage-hands were still required to make complicated scene-changes involving large practicables and the like. In effect the same number of staff, give or take a few, simply had a little less work to do during the course of a performance. This theory is borne out by Weedon Grossmith, recalling a 1903 production of The Flood Tide in which he appeared at Drury Lane:

> "Scene III, Act III was what is termed a front scene. It was very dark, and a couple of dozen men dressed as workmen, with lanterns in their hands and pickaxes, were discussing the seriousness of the continuance of wet weather. It was difficult to hear all they said, for dozens of men were knocking and hammering behind getting ready the big sensational scene. After this, Lady Tree was heard bribing Norman McKinnell, an Italian scoundrel, to murder the lunatic millionaire, played by Charles Somerset, to slow music.
>
> When they had departed the workmen re-entered; some had struck work fearing a great accident and the chief of the gang who shouted, and

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5. Anon., "Electrical Stage Appliances at Drury Lane Theatre". Engineering, op.cit., p.835.

he had to shout loudly to give the 'music cue', informed his mates at the top of his voice, 'Things can't go on much longer, lads. The masonry is giving already. We have had three months continuous rain, and with another night of this cursed deluge the great dam which-has-taken-seven-years-to-build-will be in Blackmere Lake by - the morning!!!.'

The stage suddenly 'blackened out'. We are all in total darkness, black gauzes are lowered. There are shouts from the stage manager 'Strike!! Lower your borders!!' Stage hands rush in every direction, carrying something, or pushing something.

'Mind your backs!' they shout. 'You jump aside!' The safest place is close to the curtain down by the footlights ... 'Get on your blues! Down with the borders! Take care! Who's working the lifts? Then why the devil don't you do it? Come on! Look out! Get your cloth down above there. Now then boys' etc. No.3 is too low! Do you hear? Get your props. D--n it, mind the batten! why the tum, tum, fum, rum don't you do what you're told? etc. The front row of the stalls frequently complains of the loudness of the band, particularly the brass, and wonder why it is not remedied, but James Glover, the conductor, knows why!

'Look out for your calls!' Then a boy with an electric torch leads you through rocks, rivers, spars of iron, and cautions you against an open trap, and conducts you to your place. The land is still crashing and booming, an electric sign to the orchestra and the music changes to the tremolo and mysterious. The gauzes rise slowly, opening on the big sensational scene. The gallery is noisy with shouts of 'Down in front! Order please! Take of your 'at', 'Lay down!' etc.

I shall never forget the first night, when the flood commences. Tons of rice and spangles poured from the side to indicate the bursting of the dam. Children floated by, clinging to barriers and floating trees, screaming and yelling, especially as some of them got frightened and tipping sideways fell down the trap, to be caught underneath. Then the boat-house with myself hanging outside from the roof, commenced

> to wobble, and then the whole structure toppled over, and a huge floating tree - with a well-concealed mattress, passed by, and Somerset and myself jumped on to it and were supposed to be saved as the curtain descended slowly." [6]

Such was the success of Sachs's electrical stage machinery that when the Royal Opera House, Covent Garden decided to undertake major rennovation work he was called in as consultant.

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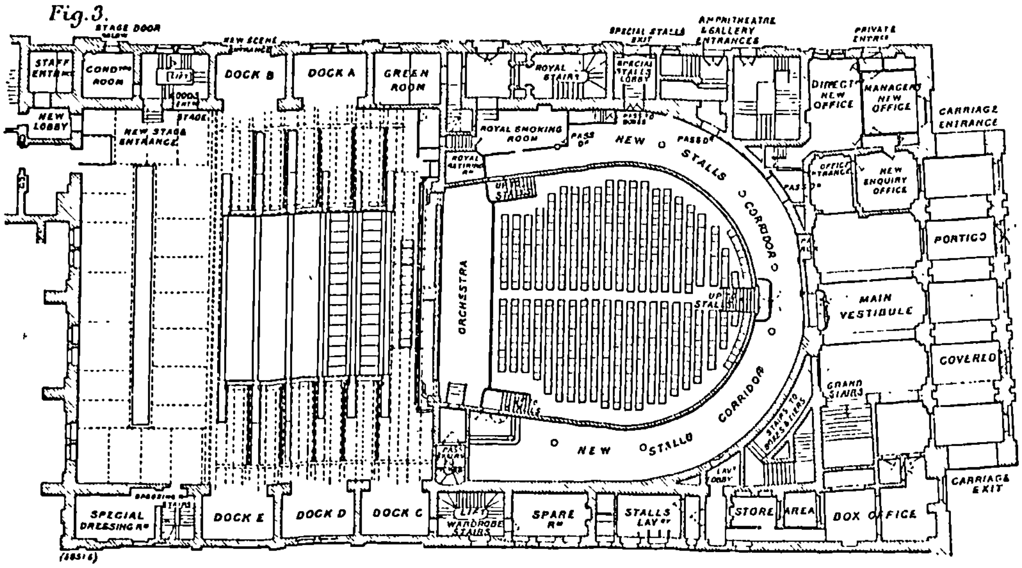
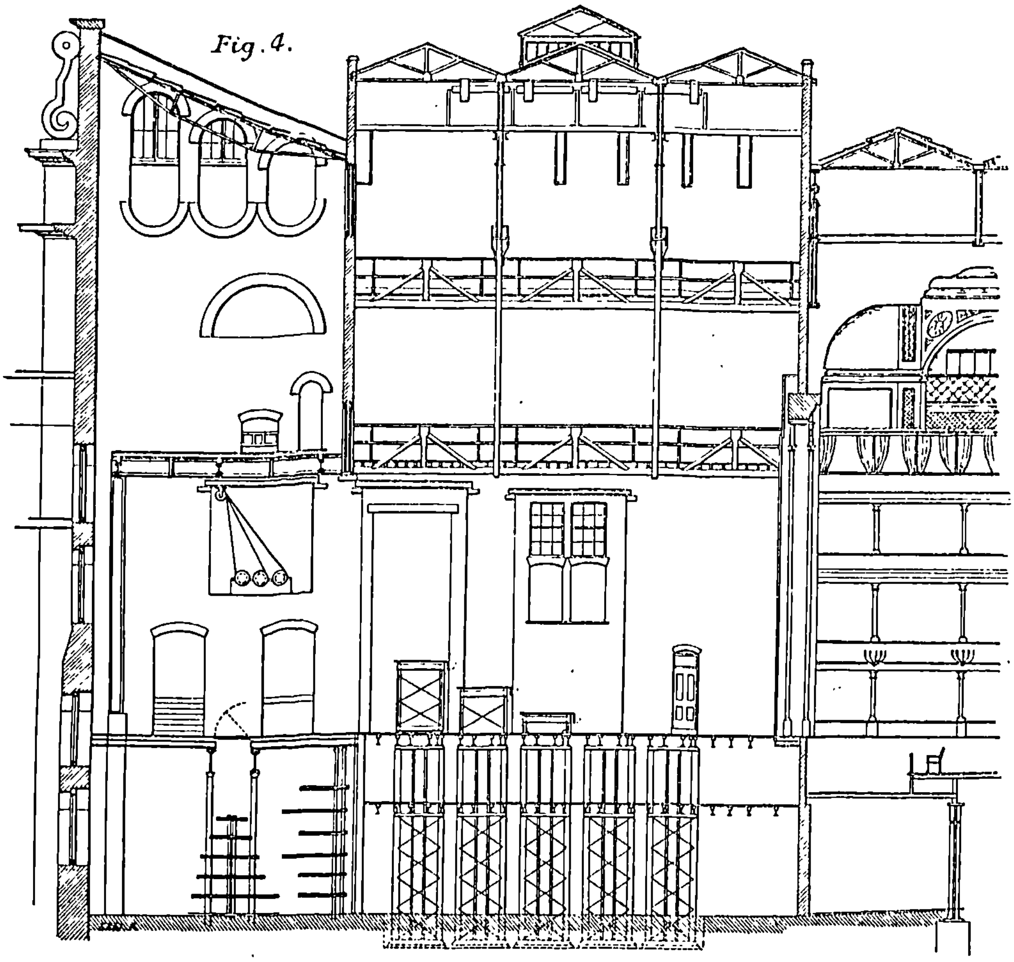
6. Weedon Grossmith, Studio to Stage, 2nd edn., (1913), pp.286-88.





Illus.141 Fig.3. General plan of the stage.
Royal Opera House, Covent Garden.
London.

Fig.4. Longitudinal section of the stage.
Royal Opera House, Covent Garden,
London.

Engineering, 24th May (1901), p.659.

THE ROYAL OPERA HOUSE, COVENT GARDEN, LONDON, 1901.

The present building in Bow Street, Westminster, was designed by Edward M.Barry, and opened on the 15th May 1858 under the management of Frederick Gye. The backstage equipment was installed under the direction of Mr.H.Sloman, who was described as a 'stage machinist'. This installation remained substantially intact until 1900 when the lessees, known as 'The Grand Opera Syndicate', decided to carry out major alterations. This Syndicate was made up largely of Sir Augustus Harris and his Drury Lane backers, and it is therefore not surprising to learn that they appointed Edwin Sachs as the project architect [see photo.58]. The experience gained by working on the Drury Lane stage machinery was undoubtedly of great assistance, and, as before, the scheduling of all the works was to be critical.

The opera season of 1900 finished on August 3rd, and during the ensuing three or four weeks all the scenery was cleared away. A fire-resisting curtain, built by Messrs.Merryweather and Sons Ltd., was fitted to the proscenium opening, the work being completed on the 15th October to enable Mr.Rendle to take up tenancy of the auditorium for his ball season which opened on 26th October. This fire-curtain temporarily served a dual purpose, for it provided an excellent seal between the stage and auditorium to ensure that no dust and dirt passed from the former to the latter during alterations. During September and October a large scene store was constructed at the rear of the stage. Completed by 1st November, it provided a storage area for the stock scenery normally stored around the peripheral areas of the stage.

Later the back of the theatre was remodelled, including the installation of several hydraulic lifts. These modifications, which were completed by the 1st January 1901, facilitated the transfer of many stores and props and enabled the stage area to be totally cleared by 4th January. This in turn allowed the old substage, which dated from 1858, to be gutted. According to The Builder, "the gutting of this lower portion of the stage comprised by itself a wreckage of nearly 1,000 cartloads of timber."[1] Once the debris had been cleared it was necessary to excavate the cellar to a greater depth in order to

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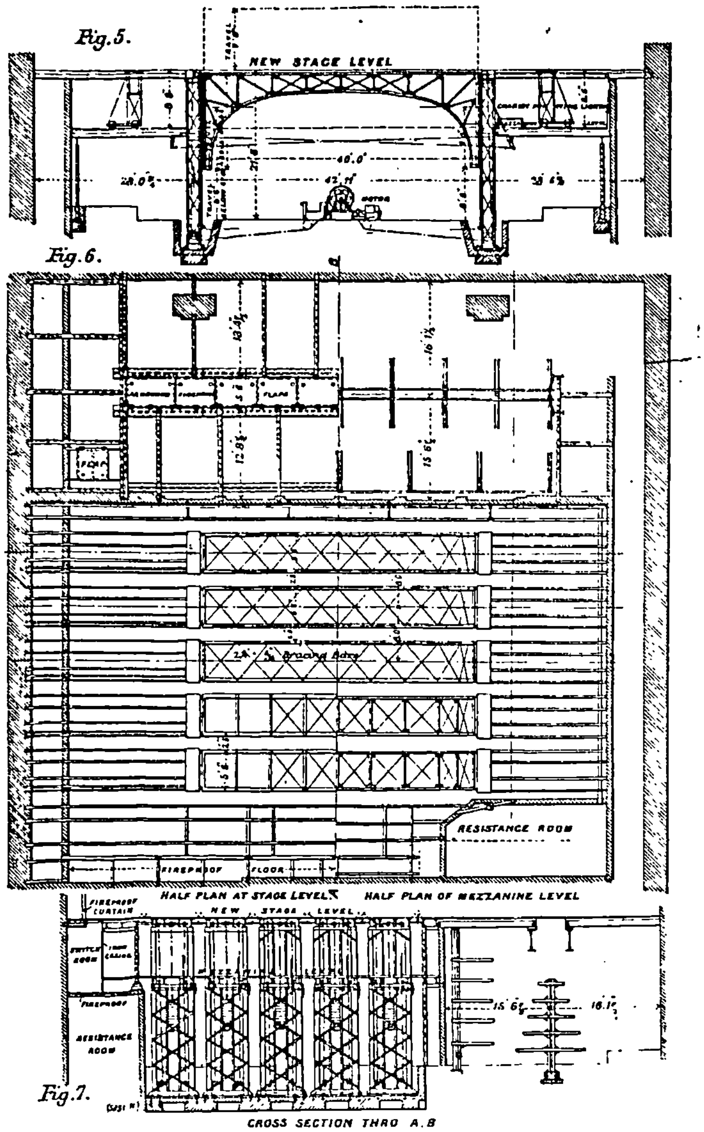
1. Anon., "Improvements at the Covent Garden Opera House", The Builder, 1st June, (1901), p.540.



Illus.142 Plan and section of electrical stage machinery. Royal Opera House, Covent Garden, London. Engineering, op.cit., plan n.pag.

accommodate the new machinery.

The upperstage, too, underwent change. In September/October 1900 the old 1858 grid had been removed, for which the "roof alteration comprised a span of 90ft to a width of 70ft, at a height of 90ft above the ground." [2] While these alterations were being carried out the aforementioned construction work was in progress below, which meant that the building had to be kept waterproof. By the end of January 1901 all that remained of the 1858 backstage interior were the wooden fly galleries which were incorporated, somewhat surprisingly into Sachs's new scheme.

Sachs based the substage machinery installation upon his electrical bridge patent and the experience gained at the Theatre Royal, Drury Lane. He divided the area designated for machinery into six sections which ran parallel to the proscenium opening, each section measuring 5 feet 6 inches wide and 40 feet long [see Illus.141, 142]. The first downstage section was not a bridge, but an area allocated for small traps in the traditional manner. It originally contained a carpet cut, and openings to allow for the installation of a grave-trap and corner-traps. The second and third sections consisted of electrically operated two-tier bridges, constructed of lattice ironwork. This two-tier design (which was an addition to the patent specification and the Drury Lane installation) is reminiscent of the bridges previously described at the Grand Theatre, Leeds. Figures 13-16,[Illus.144], show the details of the bridges, and demonstrate the spatial relationship between the two tiers designed to facilitate the installation of smaller traps as described below. The bridges were originally intended to rise 6 feet above the stage and sink 8 feet below, although these limits were altered in later years [3].

Unlike the bridges at Drury Lane, the counterweights were contained in tracks which ran in close proximity at either end of each bridge [see Illus.144], a return to the method usually used for the wooden bridges of the English wood stage. The central steel hawser attached to the ends of each bridge passed up

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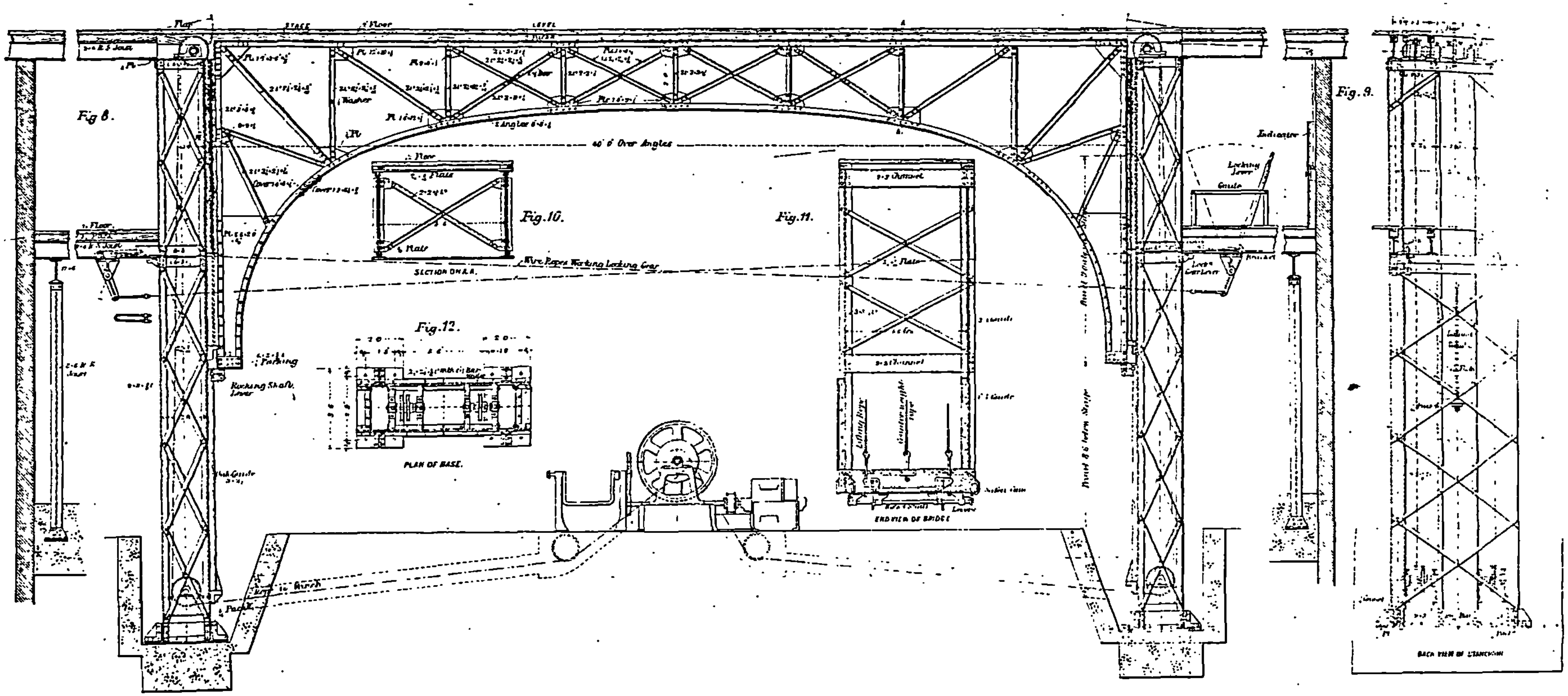
2. Ibid., p.539.
3. Scientific American Supp., L, No.1342, 21st Sept.,(1901), p.21511, however, quoted a travel of nine feet above the stage.



<u>Illus.143</u> Transverse section and details of single tier bridge. Royal Opera House, Covent Garden, London. <u>Engineering</u>, loc.cit.

to a central pulley located just underneath the stage, and from there passed back down to be attached to the travelling counterweight carrier. The end stanchions acted both as supports and as guides for the bridges. Each one comprised four vertical channels measuring 9 inches x 3 inches x 0.5 inches, and braced together with flat bars across the diagonals measuring 2.25 inches x five sixteenths of a inch. A vertical lattice box was therefore produced inside which the steel cables were located for suspending and counterweighting the bridges. Oak planks were bolted to the inner channels of the ironwork to act as guides for the ends of the bridges. Between each section or bridge a longitudinal 2 foot flap whose upstage side was attached to the downstage edge of each bridge. These flaps could be used to increase the width of the bridge or alternatively they could be angled down to mask the iron lattice work, and at the same time provide a gap in the stage for scenery to pass through "for transformation scenes and the like." [4]

Photograph 59 shows the lower downstage bridge with its flap angled, while the other two are horizontal. The flaps are moved by a continuous horizontal shaft, [photos. 59.1 and 60.1] which in turn operated from the stage left end of the bridge by a worm screw mechanism [photos. 61.4, 62.4].

The bridges were all independently operated by 7 B.H.P. shunt-wound motors [photo 63, Fig.8], all located under their respective bridges in the cellar. They were almost identical to those used at Drury Lane, and therefore incorporated a manual operation handle in case of power failure. The winches built into the motors consisted of a single barrel split into two sections, each accommodating a single cable from either end of the bridge. This single cable then divided into two during its passage through a small underground tunnel, emerging at the base of the stanchions [photo.64], passing up to respective pulleys located just under the stage [Fig.14] and from there passing downwards to be attached to the base of the bridge [photo 65.5, Fig.15].

Each bridge could be locked into position with a lever located on the stage left side of the mezzanine floor, [photo. 65.3, Figs.8, 9, 13] which moved a locking joist at each end of the bridge, as shown in Figure 13.

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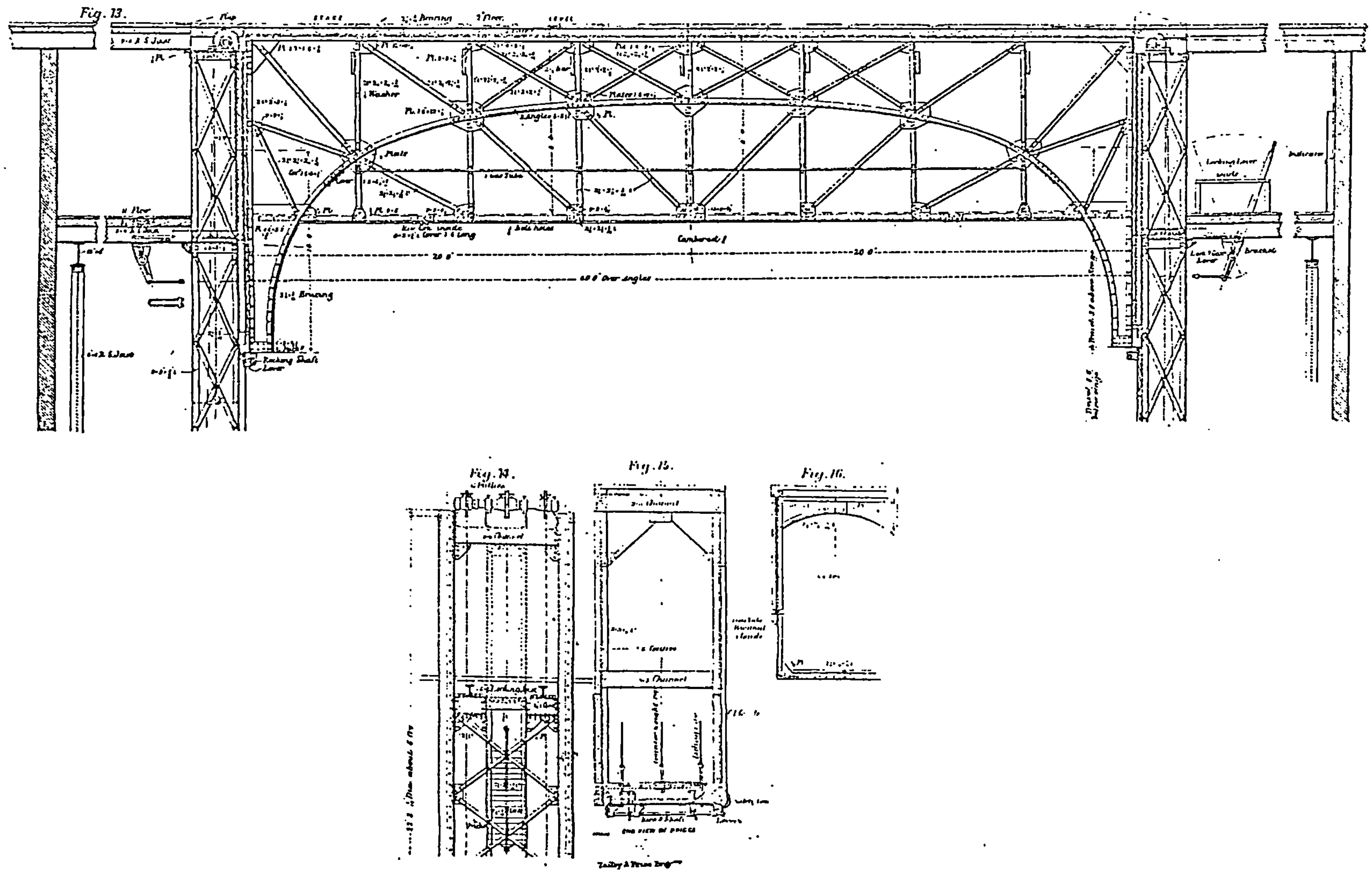
4. Anon., "Stage Alterations at Covent Garden Theatre, London". Engineering, 24th May, 1901, p.659.



Illus.144 Transverse section and details of two-tier bridge. Royal Opera House, Covent Garden, London. *Engineering*, loc.cit.

The fourth, fifth and sixth sections of the stage were made up of three single tier electric bridges, as shown in Figures 8-12. Although they were all installed for the opening of the 1901 opera season only three were made operational, the remaining two being completed during the summer of 1901. It was confidently reported in the technical press that each bridge was capable of raising a load of 2 tons, the power for such a manoeuvre costing around a farthing. The only additional costs quoted were those for the weekly attendance of a mechanic, amounting to about 30 shillings, and the replacement of brushes inside the motors.

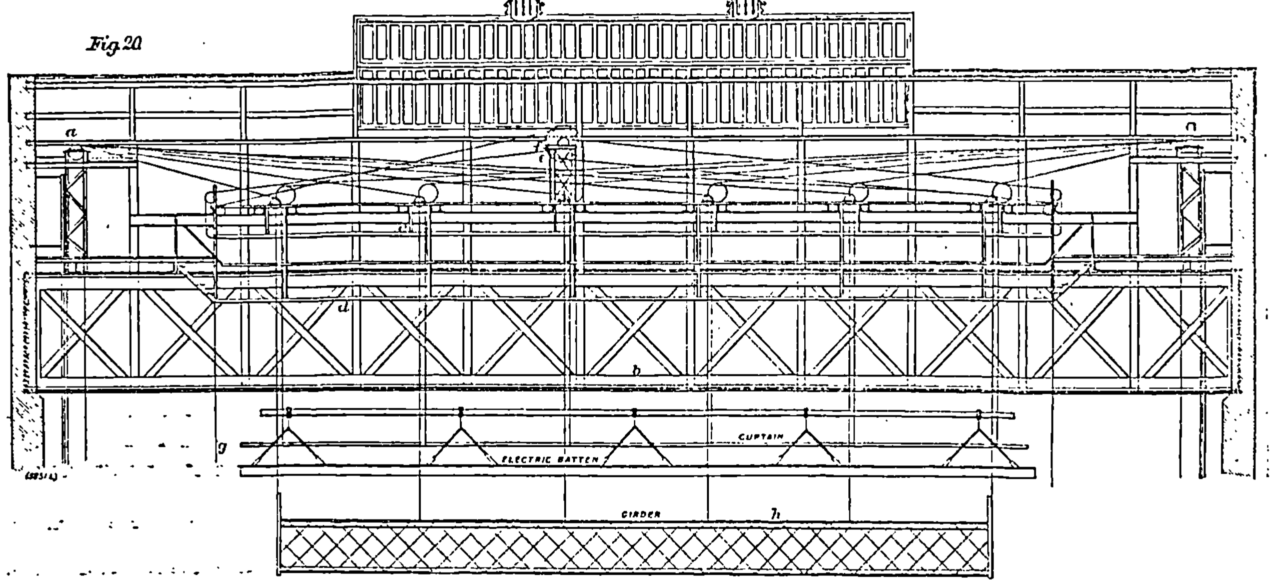
Photograph 67 gives a general view of the mezzanine floor, showing in particular the "chariots" which were designed to support wing lights at stage level. They were mounted on rails which ran on the mezzanine floor, adjacent to the downstage edges of the five bridges [see Fig. 5 and 6]. Unlike many of the chariots used in continental theatres they could not traverse the whole of the stage, as the rails only ran as far as the offstage ends of the bridges. Nevertheless, this design must have been influenced by Sachs's visits to the theatres of Europe, and possibly even by observations he made at the Royal English Opera House.

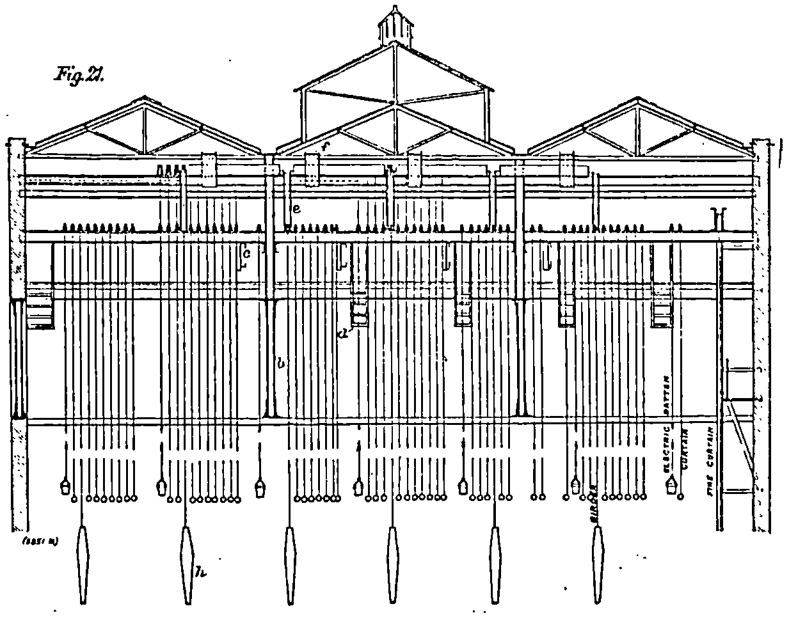
Figures 3 and 4 show the theatre after Sachs had completed the alterations to the stage areas and the auditorium. It is interesting to note that the stage is completely flat, whereas the Theatre Royal, Drury Lane has a rake. Although Sachs was never given the opportunity to carry out such drastic alterations at Drury Lane as he made at Covent Garden, it should be recalled that the first flat stage to be installed at a large theatre in Great Britain was at Her Majesty's Theatre in 1897 under the direction of Beerbohm Tree. This may have influenced Sachs in his decision to install a flat stage at Covent Garden.

The new flying equipment for the enlarged fly tower was not designed by Sachs, but by an acquaintance of his, Herr Felix Brandt, who made several contributions to the 'Stage Reform Movement' on the Continent. The Brandt patent counterweight system (which was in fact never patented in Great Britain) was designed to compliment the sectionalisation of the stage. Figures 20 and 21, [Illus.145] show how the fly tower was arranged into six sections corresponding to the six sections of the stage. Each section possessed one wooden girder, an electric batten, and on average ten lines for ordinary battens. The wooden girder was designed for attaching particularly heavy or flexible pieces of scenery and was suspended directly over the flaps on the stage, so that should the situation

STAGE ALTERATIONS AT COVENT GARDEN THEATRE, LONDON.

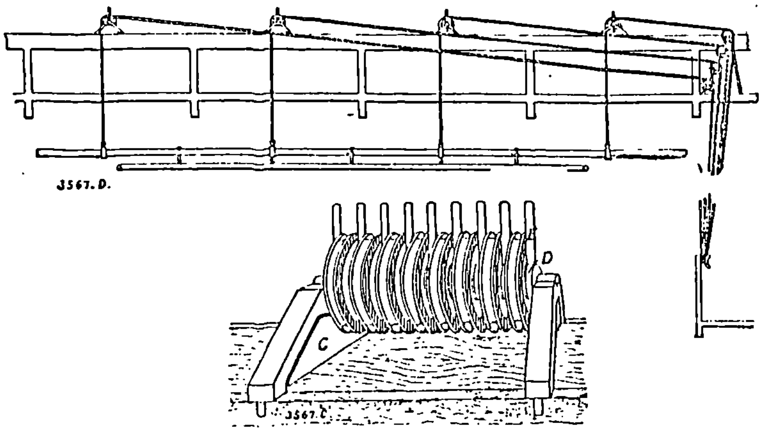
MR. EDWIN O. SACHS, ARCHITECT, LONDON.





Illus.145 Fig.20. Transverse section of grid. Royal Opera House, Covent Garden, London.

Fig.21. Longitudinal section of grid. Royal Opera House, Covent Garden, London. Engineering, loc.cit.



Illus.146 Details of Robert Afflecks pulley. Sachs, Modern Opera Houses, III, suppl.1, p.78.

demand it, the scenery could pass down into the substage.

The lines which were attached to the ordinary battens rise vertically to the pulleys on the grid [photos 68, 69, 70]. From there they are deflected to either side of the grid where they pass over another set of pulleys positioned within the iron stanchions a, a. in Figure 20. The lines are then wound on and off these pulleys by means of an endless rope which passes downwards inside the stanchion to stage level, around another pulley and up again to the pulley above. The counterweights, which can be altered according to the load to be carried, are attached to the wall side or offstage side of the aforementioned rope. Because the stanchion was constructed of open lattice iron the lines could be operated from any level. However, the comparative bulkiness of this system made it impossible to locate all the counterweight lines on one side of the stage.

The pulleys on the grid are all mounted on rolled steel channels and joists, which in turn rest upon the girders, b, [Figs. 20 and 21]. In 1896 Robert Affleck, the chief machinist at the theatre, had filed a provisional specification for a patent entitled, Working Theatrical Scenery [No.6176, May 19th, 1896]. Unfortunately the patent was abandoned and the full specification never published. However, according to Sachs,

> "it 'claims to do away with blocks entirely' and to substitute in their place a series of 'pulleys' running on steel shafts, in adjustable lengths of 18 inches (45 centimetres) or longer, each of which is supported at its respective end in a metal bearing. These bearings are fixed to the joists of the 'gridiron' by a 'stud' at each end, which drops into holes drilled into the joists at suitable intervals. Guides are provided for each of the 'pulleys' in the shape of 'arms' screwed into and through dividing 'collars' onto the 'shaft' to keep them in position. The leading pulleys are mounted on similarly adjustable bearings, made in the form of steps one above the other [Illus.146], and by this system the 'pulleys' are quickly adjusted." [5]

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5. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.78.

Illus.147 Das Rheingold swimming machinery. Royal Opera House, Covent Garden, London. The Tatler, 1936.

Although this patent was never given full status Sachs was clearly aware of it when writing Modern Opera Houses and Theatres, and it may well have influenced his discussions with Felix Brandt prior to the installation of the overstage machinery.

Figures 20 and 21 show a series of brackets denoted by 'c' which were located directly under the grid. They were used in connection with the equipment for flying angels, fairies etc. Access to these brackets was gained by the connecting galleries, d, which join the fly galleries on either side of the stage. It is also interesting to note that the lines used for suspending the electric battens pass through the floor of the connecting bridges, as they did at the Theatre Royal, Bath. The flying wires were wound onto the drum and shaft mechanisms, f, mounted on stanchions, e. Ropes were coiled around the drums [photos. 68, 69] which then passed over deflection pulleys to fall vertically at g. This formed the main working line of the equipment. Steel wires were then wound onto the shaft, one from the top and one from the bottom, to be led to either side of the grid where they passed over pulleys to meet, forming in effect a continuous line. It therefore followed that when the working line, g, was operated the flying line attached to the shaft could be tightened or slackened. To this line a running pulley was attached and to this an angel! A line was then taken from the running pulley to either side of the stage. Consequently any object or person could be raised or lowered and traversed simultaneously. According to Engineering:

> "The sagging of the fly wire tends to give a more realistic effect to the motion of any figure attached to it, as a more or less swooping movement can be given, according to the slackness of the fly wire." [6]

The accompanying illustration, 147, was drawn in 1936 by a Tatler artist for the Royal Opera House production of Das Rheingold by Wagner. It may well be that this incorporated the aforementioned scenery and that the stage-hand seen in the illustration is operating a counterweighted line attached to the drum, f, in Figures 20 and 21. Immediately before the opening of the new opera season on Monday 13th May, 1901, Sachs acknowledged the assistance given to him by the

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6. Anon., "Stage Alterations at Covent Garden Theatre, London", Engineering, 7th June, (1901), p.725.

contractors, their representatives and the stage machinist Mr.Robert Affleck [7]. Similarly The Builder commented that,

"the results, both in time and in lack of accident must be attributed to a great extent to the co-operation of all parties concerned, not forgetting artisans and labourers, who were, to a great extent, new to the class of work required, and Mr.Sachs, who acted as architect for the work throughout is particularly anxious to acknowledge the assistance rendered him by the contractors and their representatives, [see Appendix 11], and the cordial manner in which the various firms worked hand in hand under very trying conditions." [8]

It cannot, however, be denied that problems did arise with the installation before the opening of the new opera season, and indeed after it. So much may be inferred by the fact that "Mr.Edwin O.Sachs was taken seriously ill on Friday upon leaving the final machinery rehearsal at Covent Garden. He is now progressing favourably, but will still have to keep to his room for a considerable time, and hence be unable to attend the opening of the Opera House, which has seen such changes at his hands." [9] The strain which Sachs must have undergone during the months prior to the re-opening of the theatre had apparently taken its toll. Moreover, the new opera season was not the great success that everyone had hoped for.

"As is only natural with so large a new installation of stage mechanism, the scenic arrangements at the opera in London were the subject of considerable discussion and criticism during the current season, and many of the visitors to the opera were disappointed that the scenic effects were not up to the standard they had anticipated. This however was mainly due first, to the fact of the stage having been handed over to its owners a few days before the commencement of the season, and, secondly, to its having become necessary to dismiss the entire Covent Garden stage staff just before the opening of the season, the conservative British workman having apparently not taken to the modern appliances.

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7. Anon., "Chit Chat", The Stage, 9th May, (1901), p.16.
8. Anon., "Improvement at the Covent Garden Opera House", The Builder, op.cit., p.540.
9. Anon., "Chit Chat", op.cit., p.13.

It will be easily understood what it means in an opera house with a repertoire of some thirty numbers played over a short season of some seventy nights to suddenly have an entirely new staff to deal with, quite irrespective of the question of entirely new equipment of mechanism, so it naturally occurred that much was wanting so far as the niceties of scenic effort was concerned. Added to this, the scenic inventory of the opera had been allowed to run down to a very bad state during the last ten years, with the unfortunate result that when it came to moving and rapidly handling these vast packs of material in order to make room for the new stage much that would have otherwise seen a little longer life went absolutely to pieces and the management found themselves short of many of the component parts for the scenic effects they required. It is, however, generally understood that the management are now seriously contemplating a very large renewal of their scenic stock, that the staff are to be systematically drilled and the scenery systematically stored, so that if all is well Mr.Sachs should in the next season see the ample fulfilment of his ideals in scenic management, i.e. a practical modern stage equipment with an artistic modern stage outfit worked by a modern staff." [10]

Similar views were expressed by several other leading journals. The Builder commented that,

"At present, to judge from the performances of the first couple of weeks, one would think that the captain of a fishing smack was trying to manage a torpedo-catcher. Of course, there has been little or no time for rehearsal, but given mechanics rather than stage-hands, and stage-engineers rather than stage-carpenters, things will, no doubt, gradually right themselves." [11]

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10. Anon., "Stage Bridges At The Covent Garden Opera House, London, England". Scientific American Supplement, L, 21st Sept,(1901), pp.21511-12.
11. Anon., "Improvement At the Covent Garden Opera House", The Builder, op.cit., p.540.

These difficulties, coming as they did after a long period of stress for Sachs - the gutting of the stage and the raising of the roof had taken two and three months respectively - must have preyed on his mind and contributed to his sudden illness.

The unforeseen problems of the opening season were, however, resolved in the fullness of time and the remaining electric motors were installed into the substage to bring the final two bridges into full operation. Once the staff began to learn about and understand how the machinery worked there was a definite improvement in the technical production standards. These improvements were in fact brought about under the direction of Francis Neilson, the stage manager, and Robert Affleck, the chief machinist. By 1903 Affleck had not only organised the smooth day-to-day running of the machinery but introduced some additions and refinements, primarily for Wagner's "Ring". These were the subject of a lengthy article by Kathleen Schlesinger in The World's Work.

> "The traps, so constantly needed in all stage business, have often proved a source of vexation; formerly five men were required to work each. Mr.Affleck's new patent trap [see photo.71.5] thanks to the application of the system of counter-weighting and to other ingenious mechanism, is easily operated by one man; the singer, in fact, could work it for himself as he stands in it; for obvious reasons this would be undesirable. This trap rises and falls as smoothly and noiselessly as the large electric bridges. Another of these traps is seen in one of the electric bridges raised above stage level; a horse stands on it ready to be taken off the stage when his turn comes [see photo.71.6].....
>
> The most sensational novelties of the season are unquestionably the swimming-machines. Mr. Neilson's new device, worked out and patented by Mr.Affleck, is simple but ingenious. In view of the great interest excited not only in England but in Germany by the extreme beauty of this effect, and of the ride of the Valkyries seen last year, I propose to lift the veil of mystery and by special permission to describe the working.
>
> Three different kinds of machines are rendered necessary by the changing conditions of the scenery. In Scene 1 of Das Rheingold the machines consist of a high trolley on specially made castors which allow of the most delicate evolutions being made by ponderous machines noiselessly and with perfect ease in any direction. The iron rod bearing the kind of saddle in

which the Rhine Maiden reclines at a height of about fourteen feet above the stage is counterweighted and works up and down in a slote cut in the rectangular post [see photo 71.7]; a pretty hood of pale green chiffon ornamented with graceful weeds conceals the working pole during the performance, and passes unperceived in the depths of the water. For the first time it is now possible for the maidens to dive down and rise up again, to circle, frolic, and chase each other. Formerly the movements were so restricted that Wagner's directions could not be followed accurately. The evolutions of each machine are superintended by co-repetiteurs, each provided with a copy of the prompt book, who direct the men if necessary and give them the musical cues. The men, after a few rehearsals, knew their parts by heart.

In Act III of Die Götterdämmerung the maidens are seen on the surface instead of the depths of the Rhine. This second machine consists of a revolving railed-in disc, on which the maidens kneel or stand with their bodies passed through radiating slits in a rubber top painted to represent water [see photo.71.8]. The machine stands on an electric bridge which rises and falls as desired to enable the maidens to appear and disappear in the river; the whole machine is, besides, wheeled about on the bridge from side to side, or made to revolve as the maidens circle in the dance. The third machine, used in the closing scene of the same drama, is also placed on an electric bridge, and here the maidens sit on seats suspended by strong rubber cords to give them elasticity of movement as they swim forward and drag Hagen with them into the depths of the water." [12]

It is impossible to say whether Affleck's patent trap was included in the technical specifications of his aforementioned patent, as no full patent was ever granted for the apparatus. But it is clear how hard he was working at the Covent Garden Theatre to improve and develop the art of the twentieth century stage machinist, who now required engineering skills which had hitherto been unnecessary. Yet although Affleck must have exerted some influence upon the design and development of the stage machinery at Covent Garden, Edwin Sachs was the man responsible for the overall installation which at the time of writing in 1989 is still in working order though scheduled for removal within the next

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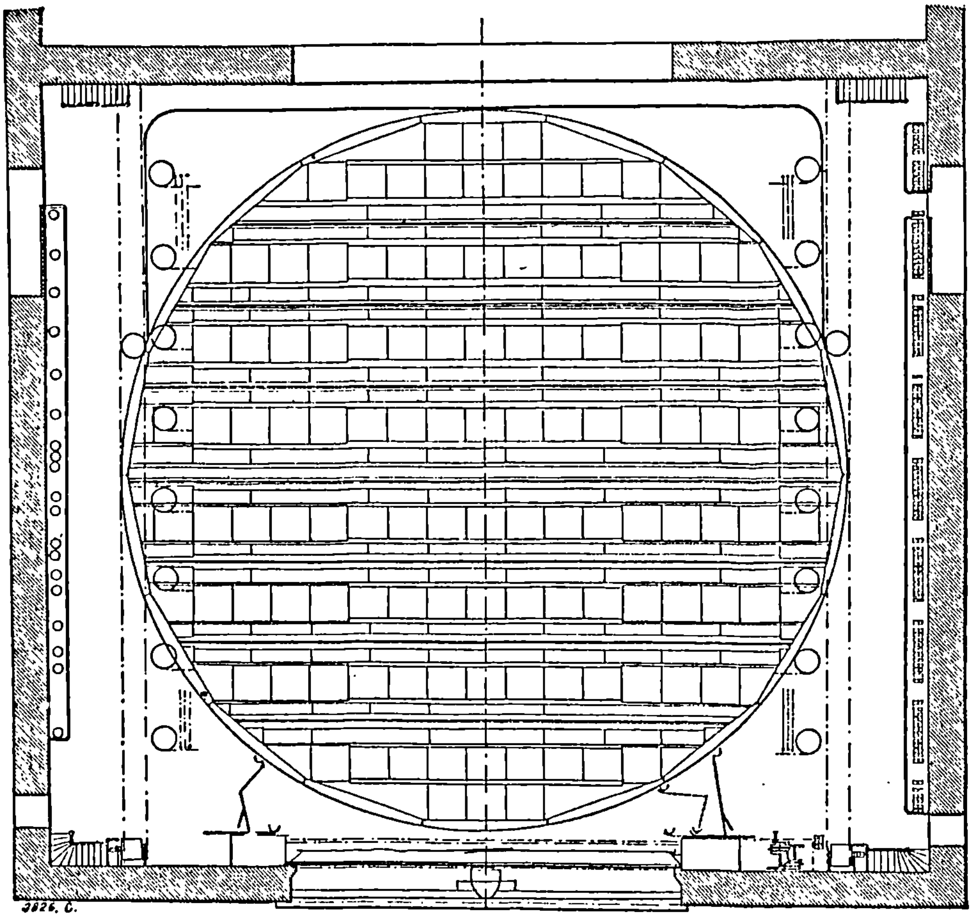
12. Kathleen Schlesinger, "The Machinery of Grand Opera", The World's Work, II, June-Nov.,(1903), p.25-33.

few years. Sachs it was who had extrapolated from the basic principles of the English wood stage, i.e. traps distributed in parallel lines adjacent to the proscenium opening and applied them to a new system.

At the same time there were other forms of stage machinery which could be utilised to great effect, as was the case at the Coliseum Theatre, London.



Illus.148 Electric turntable stage. Sachs, Modern Opera Houses, III, supp.1., p.69.

THE COLISEUM THEATRE, LONDON, 1902/4.

The installation of a revolving stage at the Coliseum Theatre, personally instigated by the owner, Oswald Stoll, in 1902-4, was the first of its kind in Great Britain. Previously Stoll had not shown a particular interest in stage machinery, and it is therefore important to attempt to identify the influences which brought about the design and installation of this revolving stage.

In 1896 the stage engineer, Karl Lautenschlaeger, installed a temporary turntable stage at the 'Residenz' Theatre, Munich, for a production of the opera Don Juan. Although it was only operated manually it enabled him to develop his ideas for an electrically powered turntable stage at the Court Theatre in Munich. Unfortunately, although the designs were completed, this turntable was never installed. Several of the design drawings were, however, reproduced by Sachs in his treatise and accompanied by the following description:

> "On looking at the plan [see Illus.148], we find that the plane of the stage has practically only one enormous opening, i.e. the circular well, which takes the 'turntable', in this case measuring, to repeat, nearly 80 feet in diameter." [1]

A similar circular well was excavated to house the revolving stage at the Coliseum Theatre, as can be seen in photographs 72, 73, 74.

Lautenschlaeger had advocated the use of electric motors to operate the turntable on the grounds that hydraulics were expensive to install, and that electricity could be fed to any point comparatively quickly. Likewise Stoll's revolving stage used electric motors as its main source of motive power, although hydraulics were introduced into the braking mechanism. On the other hand, whereas Lautenschlaeger's electric turntable was designed to accommodate bridges and chariots, Stoll's turntable was simply a triple concentric. Nevertheless, the published information regarding the proposed electric turntable at Munich may well have given Stoll the idea of installing a revolving stage at the Coliseum Theatre. This is further supported by the fact that "Oswald Stoll Esq., Empire Theatre, Cardiff", is named as one of the original

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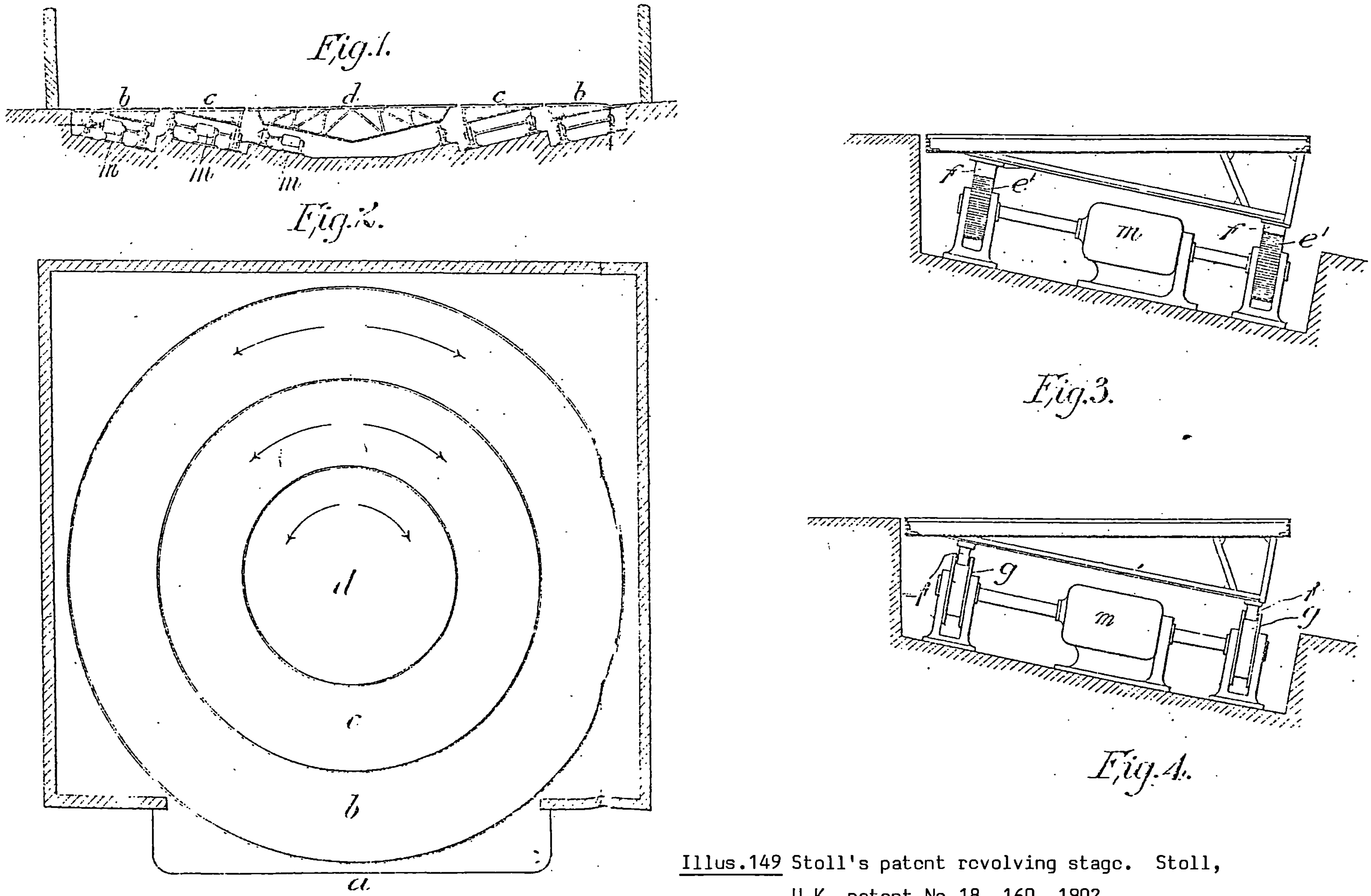
1. Edwin O.Sachs, Modern Opera Houses, III, supp.1, p.70.



Illus.149 Stoll's patent revolving stage. Stoll, U.K. patent No.18, 160, 1902.

subscribers to Sachs's Modern Opera Houses and Theatres. The final volume containing the information relating to the Munich turntable appeared in 1898, only four years before Stoll registered his patent for his own triple concentric revolving stage.

In closing the section on Lautenschlaeger's electric turntable Sachs commented that,

> "Its application should be limited to opera houses, where spectacular effects are more common than in the home of drama; and to the Variety theatre, where ballets and transformation scenes demand every facility for rapid changes in the displays." [2]

Given the fact that the Coliseum was built primarily for variety it seems likely that Sachs's words provided the initial impulse for Stoll's decision to install an electrically driven revolving stage.

On 18th August, 1902, Oswald Stoll applied for his patent relating to a triple concentric revolving stage; the complete specification was "left" on 18th May 1903, and accepted on 18th November of the same year. It was entitled Improvements in connection with Stage and Platform Appliances for Producing Scenic and other Displays. [3] [see Illus. 149].

Figure 1 shows the three concentric tables, b, c, d, in cross-section, each driven apparently by a single motor, m. The substage floor is not level, as might be expected, but set at various inclined levels to accommodate the motors and races. The stage surface is however level, continuing the precedent set at Her Majesty's Theatre, and later by Sachs at the Covent Garden Theatre. Figure 2 shows a basic stage plan and the relative sizes of the three concentric tables. Figures 3 and 4 show the alternative methods of driving the tables, as discussed in the patent specification.

After Frank Matcham had rebuilt the Empire Theatre, Cardiff, for Oswald Stoll in 1900, Stoll commissioned Matcham to design the Coliseum Theatre, in St.Martin's Lane, London. This venture afforded Stoll the opportunity of installing a large

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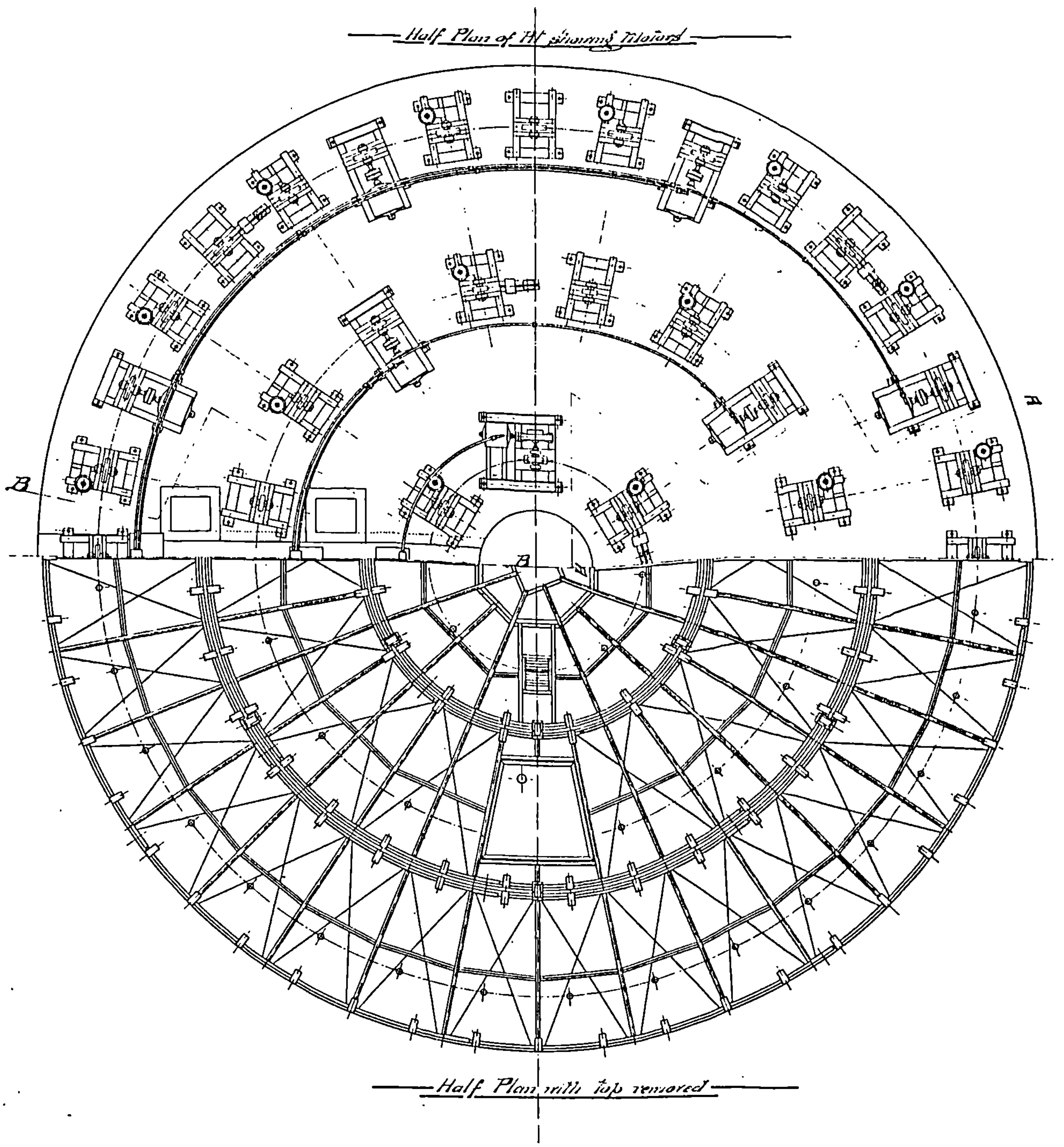
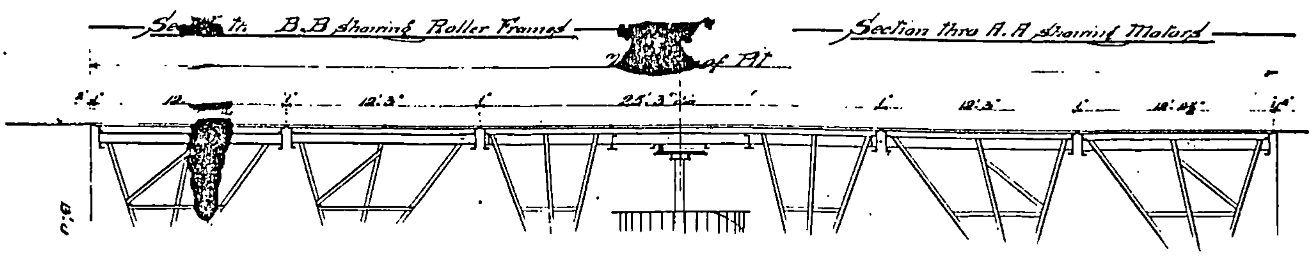
2. Ibid.
3. The full specification is given in Appendix 12.



Illus.150 Plan and cross-section of revolving stage constructed for the Coliseum Theatre, London. [Courtesy of Ransomes and Rapier Ltd., Ipswich].



revolving stage based upon his patent. The contract for the construction of the revolving or turntable stage was given to Ransomes and Rapier Limited of Ipswich, who took Stoll's basic design concept and developed it under the direction of the projects consulting engineer, Mr.E.Wingfield Bowles, into a piece of practical engineering. The basic triple concentric ring layout was retained, although the substage was excavated to a greater depth, with a flat floor. As built, each 'table' consisted of a steel framework, attached at the base to a concentric girder which carried two rails, one on the underside, and the other acting as a guiding rail, on the external circumference of each table. Rollers were positioned at regular intervals along the rails to hold the table in position [see Illus.150, 151], by bearing against guide rails. The lower rails rested upon 'idle rollers', between which were rollers powered by the electric motors which were kept at a constant pressure by helical springs. All three of the concentric tables were powered by individual electric motors, two on the inner, four on the middle, and eight on the outer. They all remained stationary when the tables revolved, and could be driven independently to allow any table to move in either direction from 2 m.p.h. to approximately 20 m.p.h. Alternatively all three could be linked together to produce a single rotating table with a 74 feet 2 inch diameter.

The central table, shown in photograph 75 after assembly at the manufacturers in Ipswich, had a diameter of 25 feet 3 inches. It contained a central spiral staircase which led from the substage to a trap door located in the middle of the revolve. This allowed actors to gain access onto the stage from below even when the revolve was in motion. The intermediate table was 12 feet 3 inches wide and contained two water tanks, which could each hold one thousand gallons of water, for use in aquatic ballets and spectacle. One of the tanks is shown in illustration 150; "Half Plan with top removed", as a trapezium shape [see photo.76.1].

The tops of the revolving tables were covered radially with 3 inch teak while the outer and middle tables were provided with sockets, into which could be slotted masts to support pieces of scenery. However, by 1911, according to The Electrician [4], their use had been discontinued, probably because they were too cumbersome.

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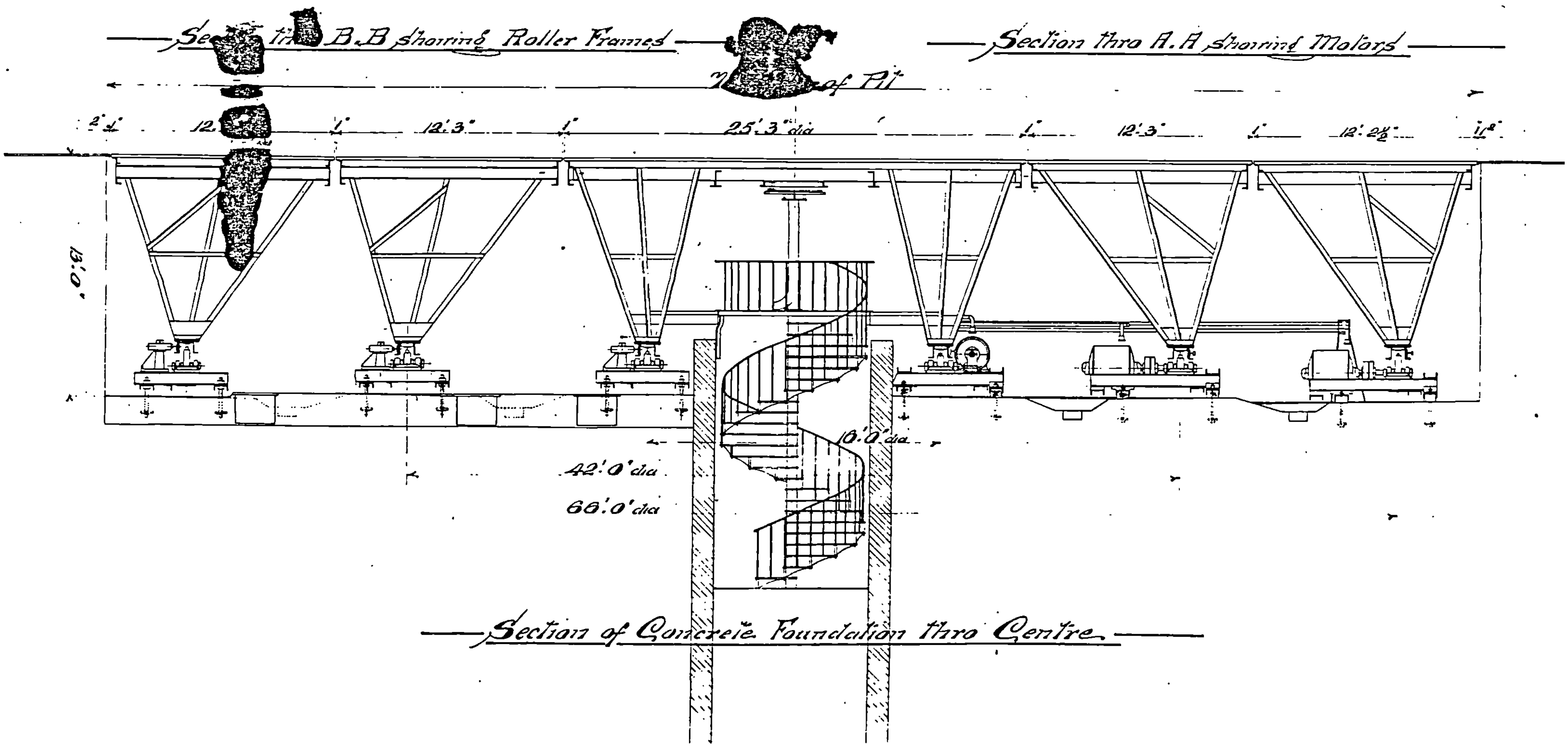
4. D.C.M.Hume, "The Eletrical Equipment of Modern Theatre", The Electrician, 19th May, (1911), p.207.



Illus.151 Section through revolving stage constructed for the Coliseum Theatre, London. [Courtesy of Ransomes and Rapier Ltd., Ipswich].

The electricity for the theatre was supplied in 1904 by the Charing Cross and Strand Electricity Supply Co., who in order to accommodate the demands of the revolve made a special supply installation which consisted of double-pole main switches. After leaving the changeover switch the supply branched into three separate boxes [see photo.77]. The largest box, shown on the left in photograph 77, supplied the eight motors of the outer table, while the central box supplied the four motors of the intermediate table, and the right hand box the two motors of the inner table. Directly above the three switches were positioned six fuse boxes, two for each two-pole supply.

The switchboard controlling the revolve consisted of panels of enamelled slate mounted upon a steel framework. There were four automatic circuit breakers (manufactured and patented br Messrs.J.E.Spagnoletti), one for the centre table, one for the intermediate table, and two for the outer table. Four ammeters were connected to the circuit breakers in series, with four switch fuses for each motor. The speed of the tables was regulated by controllers, manufactured by the Sturtevant Engineering Co. There were four of these in all, three controlling four motors each and the fourth two. Because the outer table required a large quantity of power it was considered inadvisable to control all its motors from a single controller. They were therefore divided into two groups of four, each having a separate controller, although these were linked together by a gearing system to ensure that the supply was always equal.

The control of the motors was made by series parallel combinations, and the intermediate speeds were obtained by inserting resistances in series with the motors. The making and breaking of the circuit on contacts inside the controller was avoided by using solenoid-controlled main switches, which were equipped with carbon making and breaking contacts and magnetic blow-outs.

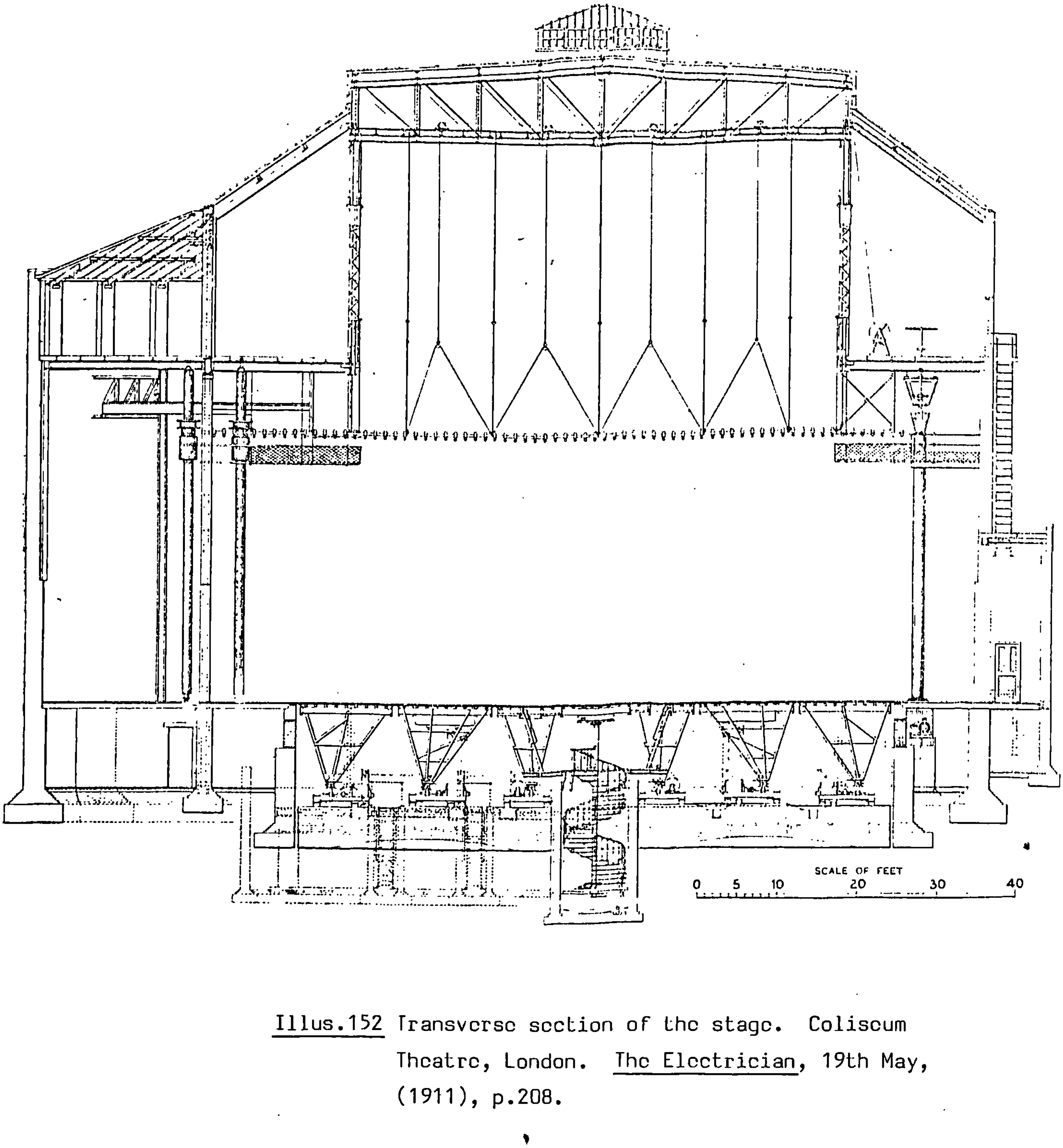
These electrical controllers were operated by three mechanical controllers one for each table, shown in photograph 78. Each mechanical controller had a handle, connected in turn to a worm gear system. All three were positioned upon an elevated platform stage right, affording the operators a reasonable view of the stage. It was almost certainly the most practical place to position the controls, but it was inevitable that the operators could not see every part of the revolve at any one time, especially when tall scenery was erected upon it.

Each handle attached to the worm-gear controller was fitted with an adjacent gauge which told the operator exactly which 'step' of the controller was in use at that particular time. If the controlling handle was turned backwards to the 'off position' it had the effect of short-circuiting the motor armatures through a variable resistance, allowing the motors to be stopped quickly in the event of an emergency. Emergency stop switches were also provided within easy reach on the operators' gallery.

The revolve weighed 160 tons when it was completed and could be operated between 2 m.p.h. and 20 m.p.h. with intermediate gradations of 2 m.p.h. The Sturtevant controllers fed 40 cables, varying from 61/15 to 19/16, down to the resistance room [see photo.79] via a specially constructed trench. A similar idea was also used for the motor cabling, 'draw-in boxes' being positioned underneath the stage for each table. A hollow cast-iron pillar was erected at every 'draw-in box', thus allowing all the cabling to travel up into a steel tube which extended to all the motors, approximately four feet off the cellar floor.

The eight outer table motors produced ten horsepower when running at 216 revolutions per minute, the four intermediate table motors were of a similar rating while the two inner motors produced four and a half horse power when running at 450 r.p.m. All the motors were manufactured by Messrs.J.P.Hall and Co. of Oldham. Although it was possible to brake the tables with the motors, the former were also provided with hydraulic brakes capable of bringing the tables to a stop from top speed in twenty-six seconds. The hydraulic power was supplied by the London Hydraulic Power Company, and, according to a preliminary inspection report from the company archive, three sets of brakes (presumably one set per table) were provided. Each set had a hydraulic ram $2^1/8$ inches in diameter with a 1.5 inch stroke. The report states that these were also manufactured by Ransomes and Rapier and had been tested to two and a half thousand pounds per square inch. Hydraulic pressure indicators and ammeters were fitted to the control platform of the revolve, while the brakes were operated by foot pedals shown in photographs 80 and 81.

Underneath the inner table was a fixed metallic brush, connected to a series of contacts spread equidistantly along the track. This was in turn connected to a lamp indicator board on the control platform which informed the operator of the exact position of the inner table, should the view be obscured by scenery on the intermediate and outer tables.



Illus.152 Transverse section of the stage. Coliseum Theatre, London. The Electrician, 19th May, (1911), p.208.

In order to enhance the scenic potential of the triple concentric, especially during 'spectacle' performances such as horse racing, a moving panorama was installed [see Illus.152]. When used in conjunction with the revolve, it allowed some very convincing races to take place, and represented a sophisticated development of the many 19th century patents relating to treadwheel floors and moving panoramas.

This particular design of panorama apparatus, which was also installed at Earl's Court, consisted of a large canvas onto which was sewn a rope of 0.75 inch diameter, [see photo.81]. The latter was fed between pairs of vertical rollers some 9 inches deep and 6 inches in diameter which were machined with a 1 inch shoulder and spaced $^3/_8$ inch apart. It was therefore impossible for the rope attached to the canvas to slip from between these rollers. According to The Electrician there were "five panorama rolls driven by 5 H.P. motors supplied by the Lancashire Dynamo and Motor Co. Each panorama motor has in connection with it a special motor panel enclosed in a cast-iron case, and containing an ammeter, double-pole switch and enclosed fuse, and a maximum and no voltage circuit-breaker." [5]

A more detailed description of the overstage arrangements appeared in The Illustrated Carpenter and Builder and is given in Appendix 13.

For the inauguration of the theatre it was intended that a re-creation of the siege of Port Arthur in China would be presented. However, during the rehearsals prior to the opening a large piece of scenery fell over and four 'scene-shifters' were injured [6]. As a result it was decided to change the production to a representation of 'The Derby' horse race. This was designed to take place in front of a moving panorama, with the horses galloping upon the revolving stage. On several occasions during the early performances the imitation turf which had been laid upon the stage rucked up and it nearly felled several horses. On the thirteenth day of the production, when the race was at its height and the stage revolving at full speed, one of the horses stepped off the edge of the revolving stage with devastating results. The horse

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5. Anon., "The London Coliseum", The Electrician, 27th Jan.,(1905), p.579.
6. Anon., "Accident at the Coliseum", The Times, 14th Dec.,(1904), p.11.

lost its balance, fell and tumbled over the footlights into the orchestra pit. The jockey, Fred Dent, was thrown head first against the side of the proscenium arch and died shortly afterwards. As a result the theatre was closed for eighteen months before re-opening as a variety theatre.

The video cassette which accompanies this thesis contains archive film shot around 1920 of the revolve in operation.

CONCLUSION.

After the specialised stage machinery installations at the Theatre Royal, Drury Lane, the Royal Opera House, Covent Garden, and the Coliseum Theatre the development of substage machinery in Great Britain came to an abrupt halt. These three installations, in three of the largest theatres in London, were carried out by managements committed to the various forms of spectacular presentation. This termination of its development was not attributable to any single factor, and it is therefore important to examine the various considerations which brought about this radical change in the evolution of staging.

At the end of the nineteenth and the beginning of the twentieth century, Great Britain was undergoing an enormous social change which was naturally enough reflected in the theatre. The public's seemingly insatiable appetitie for spectacle had produced a form of drama which many critics and observers held in abhorrence. Productions often paid more attention to the visual presentation than to the spoken word. Yet this was no new phenomenon. One has only to recall the arguments between Inigo Jones and Ben Jonson to realise how history has a habit of repeating itself.[1] This continuing debate was also well expressed by Henry James in 1889 when he pointed out that,

> "there is evidently a corrosive principle in the large command of machinery and decorations - a germ of perversion and corruption. It gets the upper hand - it becomes the master. It is so much less easy to get good actors than good scenery and to represent a situation by the delicacy of personal art than by 'building it' and having everything real."[2]

Yet the sensation dramas and the spectacle of pantomime continued into the 1920's. One might even argue that today's pantomime is simply a diluted piece of theatre archaeology handed down from a previous age. Perhaps 1928 may be identifed as a significant date, the year in which Bruce Smith, or 'Sensation Smith of Drury Lane', retired. As his grandson and biographer relates, "Bruce Smith was almost the last of his race. Gone from programmes now were the names of Harker, Perkins, Caney, Emden, Hann and other giants of Macklin Street."[3]

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1. See Southern, op.cit., ch.6.
2. Henry James, "After the Play", New Review, I, June, (1889), pp.34-35.
3. Dennis Castle, Sensation Smith of Drury Lane, (London: Charles Skilton Ltd., 1984), p.234.

The men who created the scenes and machines were old and tired, passing into retirement as did their machinery, still housed within the theatres. Although the knowledge these people had acquired over the years was passed on to younger men, many went to fight in the first World War never to return. By the end of the War widespread disillusionment with the past meant that the desire for spectacle was waning and times were hard in the theatre as they were everywhere. Money was no longer readily available for lavish luxurious productions on the scale seen in the 1880's and 90's.

The final phase in the development of the English wood stage also provides significant indications about the changing style of production. As previously observed, perhaps one of the most comprehensive suites of timber stage machinery was built at Her Majesty's Theatre London in 1897. Yet although it possessed all the typical features of a nineteenth century substage machinery installation, it also had one unique feature: the stage surface was flat. The traditional one in twenty-four (half-inch to the foot) rake was discarded in favour of a level acting surface, which naturally enough had sightline implications demanding careful consideration from the architect Charles Phipps, even though the basic layout of the English wood stage was retained.

However in 1902 the London County Council introduced a new set of regulations which made it much harder to obtain a theatre licence. Although no specific reference is made to the stage machinery within these rules it is almost certain that the inspecting officers would have required some improved fire precautions in a theatre substage area. When, for instance, Cyril Maude decided to rebuild the Avenue Theatre, Charing Cross, London in 1905 there was an existing suite of substage machinery which did not come under the jurisdiction of these new rules, but the situation was completely altered when part of the adjoining Charing Cross Station collapsed onto the theatre causing severe damage to the stage left wall and inevitably to the stage and basement areas. The Times reported that,

> "A portion of the ironwork, and the upper western wall, which was thrust out by the collapse of the roof, tumbled almost bodily upon the Avenue Theatre. It crashed through the roof of that building and fell with a deafening noise on to the stage, which was partially destroyed. There were over 100 workmen engaged in the alterations and decorations which were being carried out in preparation for the reopening of the theatre in January by Cyril Maude and it is regarded as little short of miraculous that so many escaped either instant death or serious injury. During the

progress of the work it has been the practice of the architect, Mr.Detmar Blow, and his assistants to hold a consultation on the stage each Tuesday afternoon. It so happened that one of these weekly meetings was being held at the time of the accident. Mr.T.E.Bare, surveyor to Cyril Maude, who was one of the company, gave a graphic description of the exciting and dangerous experience of himself and his colleagues. He said:- We were engaged in conversation when we heard a prolonged roar. This was followed by what sounded like an explosion. Immediately we were plunged into darkness. Something had dashed against the electric light and extinguished it. We moved to the side of the stage, where there was some shelter, and had scarcely done so when a great mass of bricks, mortar and other rubbish fell almost the exact spot on which we had been standing and carried that portion of the stage into the basement below, a distance of 16ft. Our clerk of the works was carried down with the mass and was seriously injured, but no one else who was on the stage at the time suffered any hurt."[4]

The damage sustained to the stage and substage areas must almost certainly have destroyed the machinery. As a result new equipment had to be designed to replace the old, and this time it was required to adhere to the new London County Council rules. It was therefore built almost entirely of oak and designed consistent with the requirements of a small London theatre in 1907. The new installation, according to the submitted drawings, consisted of a grave trap, two bridges, and a wide rear bridge which was actually three independently operated platforms measuring four feet by eight feet. The cut and sloat mechanism which was traditionally located in between the bridges was totally discarded. Furthermore, the trend, set at Her Majesty's Theatre, towards a flat stage was also incorporated. Some have in fact suggested that this machinery at the Playhouse actually dates from before 1906, but the evidence seems strongly opposed to this view. Firstly, no theatre manager would have built substage machinery out of oak, which was comparatively expensive, unless there was a legal requirement to this effect. Secondly, the trap platforms show no evidence of ever having been modified from the raked stage which existed at the Avenue Theatre, before 1906. If the machinery had dated from the original construction of the Playhouse, or Avenue Theatre as it was first known,

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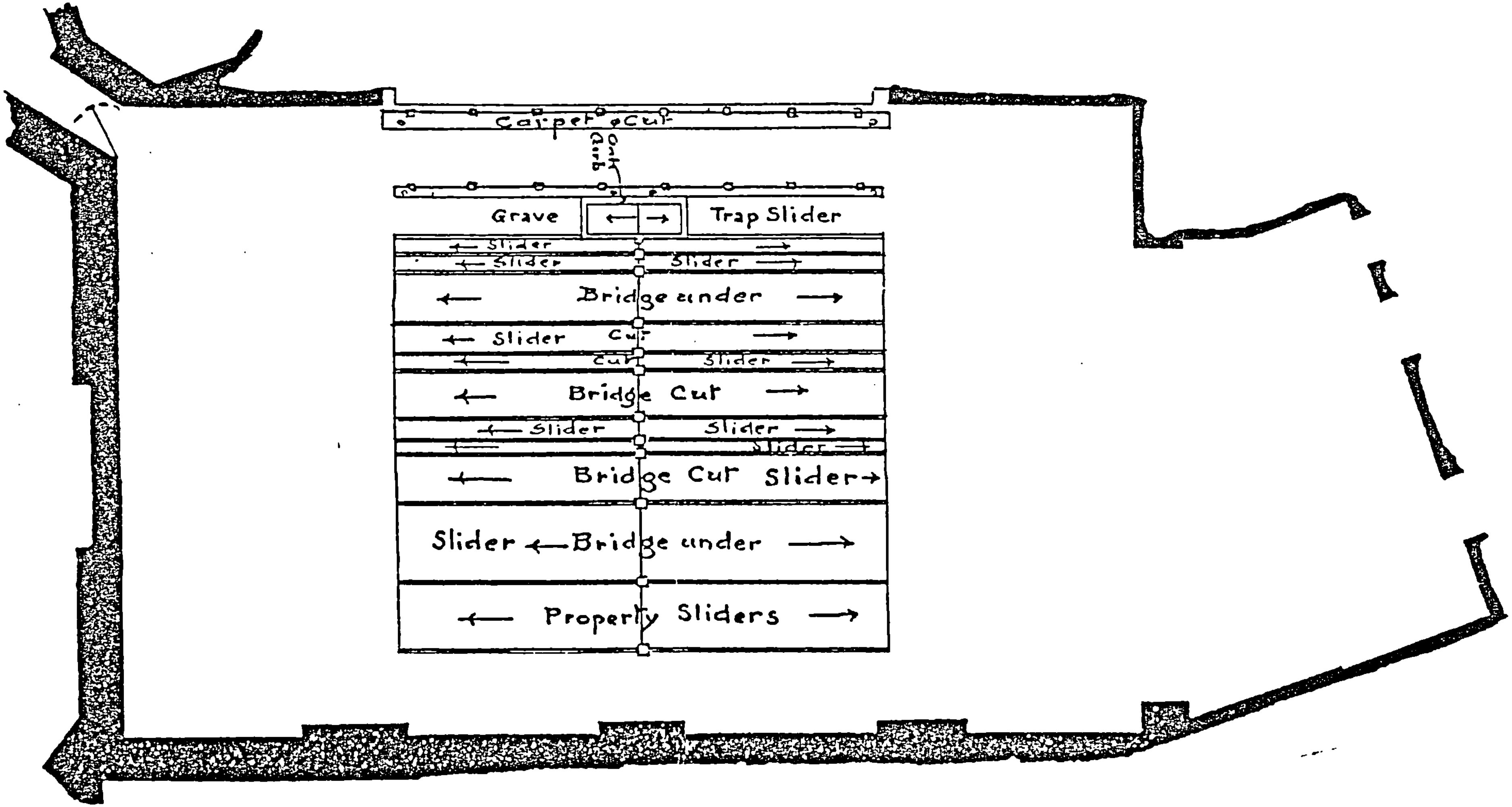
4. Anon., "The Playhouse Theatre Disaster", The Times, 6th Dec., (1905).



Illus.153 Plan showing traps in the stage. Gaiety Theatre, London. P.L.Marks, op.cit., p.82.

it would almost certainly have had cuts and sloats consistent with the normal theatrical practice of the period. Yet evolution is seldom clear - cut, and in 1916 the St.Martin's Theatre, London opened complete with a traditional English wood stage, which is still substantially intact today. The date, 1916, is however particularly important because it marks virtually the end of what has been called the 'theatre building boom'. It follows that this was also the end of the stage machinery building boom. No longer could stage machinists travel the country installing brand new machinery into brand new theatres. Any work which was carried out in existing theatres was done by the 'in-house carpenter', often patching or repairing temporarily rather than renewing.

As the frequency of stage machinery installations decreased so relevant knowledge was slowly but surely dissipated. Yet perhaps the final chapter in the evolution of the English wood stage was written at the Savoy Theatre, London, at the time of its remodelling in 1929. Beneath the stage is still to be found a basement containing vertical timber beams supporting a stage with no trap apertures. The timber, now of hardwood, is still arranged so that the beams run parallel to the proscenium opening, and metal tie-bars run in an upstage/ downstage direction. There seems no reason to have observed these traditions when no stage machinery was ever installed, yet there it is, the final part of the story - not dissimilar in evolutionary terms to the ostrich with wings, which no longer possess the power of flight.

The rapid decline in the use of the English wood stage system is perhaps best illustrated by two articles written in closer succession by the theatre architect, Ernest Runtz. The earlier one advocated the traditional layout of an English wood stage as shown in illustration 153. This relates specifically to the construction of the new Gaiety Theatre, London, designed by Runtz and Ford and opened in 1907. The text can therefore be dated as post-1907 and no later than 1911, when the third edition of The Principles of Planning Buildings [5] in which it appeared, was published. The later article by Runtz, printed in The Stage Year Book, 1913[6], stated that:

> "What is known as a working stage is now hardly ever erected in the first instance, it is left for the resident stage carpenter or engineer to provide such developments as occasion may require."

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5. Percy L.Marks, Ernest Runtz, et.al. The Principles of Planning Buildings, (London: B.T. Batsford), 1911, p.81. [pp.81-83].
6. Ernest Runtz, "Theatre Design and Construction", The Stage Year Book, 1913, (London: The Stage), pp.70 [pp.67 - 73].

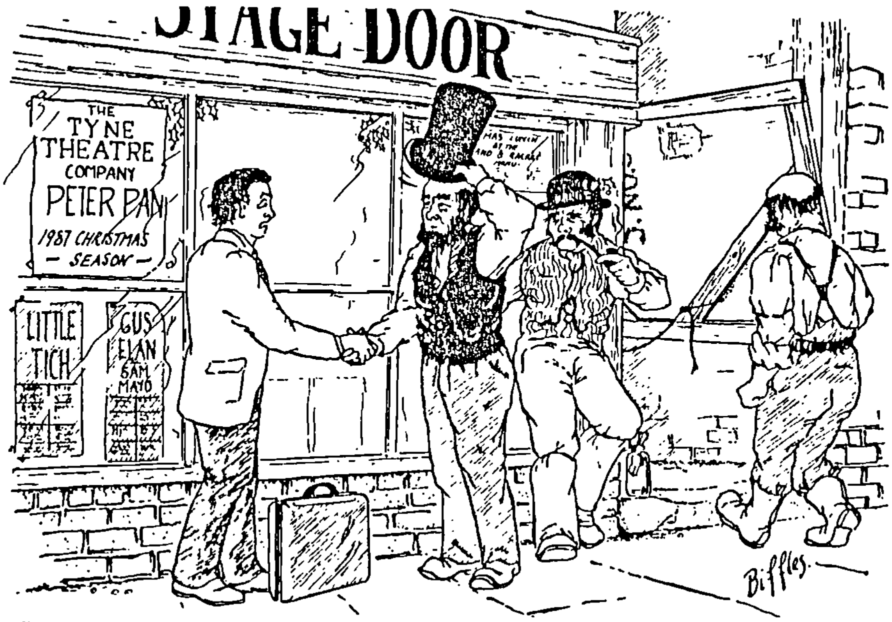
Clearly a change in attitude and approach to stage machinery seems to have taken place within a very small space of time.

There were of course other factors which contributed to the decline of substage machinery, notable amongst which was the question of finance. The wages of stage carpenters towards the end of the nineteenth century were fairly low, but with the formation of the theatrical trades unions the backstage staff were able to negotiate for a 'fair wage', a development which, though it did not bring about an immediate reduction in the numbers working backstage, undoubtedly contributed to the decline in the number of spectacular presentations. A manager was inclined to think twice before embarking upon a spectacular production which required large numbers of stage staff if there was a cheaper and easier alternative.

It is also necessary to consider the much discussed question of stage carpenters having resisted the introduction of new methods and techniques. Whilst it cannot be denied that this contributed to the persistence of the traditions of the English wood stage, it was by no means the single factor responsible. If a theatre manager had wanted to introduce new methods into his theatre in the nineteenth century, he would most certainly have done so, irrespective of the wishes of his stage carpenters. Any real resistance would almost certainly have been answered with 'the sack'. Perhaps a more plausible explanation for the persistence of the old scenic traditions is to be found in the high costs involved in installing iron stage equipment operated by electricity or hydraulic power. Quite often a theatre manager leased the building from the real owner. The managers were intent on realising a large profit as quickly as possible while the owners were simply interested in a regular income from their building. There was therefore no real incentive to embark upon a large programme of capital expenditure which could take years to recoup. Opportunities for the installation of modern technology were usually brought about by the erection of new buildings, as in the cases cited at Leeds and Edinburgh. Yet with such modernisation incorporating iron, irrespective of motive power, came inflexibility. No longer could a stage carpenter modify machinery in the normal course of his duties; it required the services of skilled engineers whose time and expertise were comparatively expensive, another argument against the introduction of new technology.

There was therefore an accummulation of negative factors the continuation of the traditions of the English wood stage and a separate set of factors inhibiting the further thorough going development of the modern style of substage machinery. The outcome was an overall decline in the use of the substage. Where once scenic convention dictated not only that angels and fairies ascended on high but that devils and demons descended below, scenic effects became limited to overstage flying.

However, times once more are changing and the conventions of the substage are being revived. Today not only are hydraulic and electric lifts being installed into substages to rekindle the argument of their suitability, but nineteenth century wooden stage machinery is being restored, not simply because it is of historical importance, but because it actually works in a theatrical context. If over the last seventy years the substage area can be said to have dwindled into scenic insignificance, an examination of theatre history over the past four hundred years suggests that this recent disavowel of substage equipment has been but a temporary aberration. The current awareness of conservation issues and the re-examination of fundamental principles in many professional disciplines, not least in architecture, must surely assist in the rediscovery of the full scenic potential of our beloved English Stage...... The pulley, the wheel, the drum and shaft may once more have turned full circle.



"Blimey! . . . I'd heard some of your stage machinery was Victorian, but . . .!

<u>Illus.154</u> <u>Lighting and Sound International</u>, Jan., (1988), p.5.

INDEX TO APPENDICES.

Appendix 1

The text from Rees's Cyclopaedia; 'Dramatic Machinery'

DRAMATIC *Machinery*. In the earlier ages, although dramatic entertainments were very popular, eſpecially among the Grecians and Romans, more attention ſeems to have been paid to the genius and labour of the poet, than to that of the mechaniſt or decorator. The names of Æſchylus, Ariſtophanes, Terence, Plautus, and many others, have reached us, while thoſe of the mechanics employed (if there were ſuch) have ſunk into oblivion. Whether the mechanical and decorative taſte of the ancients was equal to the genius of their poets, it is wholly foreign from the deſign of this article to inquire. In the preſent ſtate of dramatic repreſentation we find, by experience, that Cinderella, and Mother Gooſe generally faſcinate the ſpectators more than even the moſt eminent works of Shakſpeare. If this be a proof of decay or perverſion of literary taſte, it is alſo at leaſt a very ſtrong one of the progreſs of the mechanical arts, and of the effect which they produce upon the public mind even in matters of amuſement. Of all the branches of architecture, few (if any) have been eſteemed more difficult or uncertain, than the conſtruction of the interior part of a theatre. The architect, beſides the general knowledge incidental to his own immediate profeſſion, would require at leaſt a conſiderable acquaintance with the principles of optics and acouſtics to enſure his ſucceſs; and unfortunately this taſk has been too frequently committed to perſons who, although perhaps good architects and mechanics, were totally ignorant of both these sciences. The latter science is still so imperfectly understood, that great difficulty must remain in this part of the business; the optical part is not so arduous, and a degree of theoretical knowledge, combined with attention to its practical application, will enable the architect who constructs the interior of a theatre to avoid defects, too common in most of those which have been hitherto executed.

The interior of a theatre is generally, and apparently with justice, divided into two departments. That which is before the curtain, and which contains the audience or spectators, and that which is behind, and which ought to be so constructed as to place the whole performance in the most favourable point of view, and to afford to the performers and artists employed the greatest facilities of executing their respective professional duties with correctness and effect. To the latter of these departments this article is confined.

Before entering into any description of the moving parts of the machinery, it may be proper to notice those parts of the architectural work, which must be adapted to receive and support them. Of these the first, and perhaps most important, is the

Construction of the Stage.

The stage of a theatre is of an oblong or rectangular form, and is constructed as an inclined plane, the back part being more elevated than the front. It is usual to allow one inch of perpendicular ascent for every 36 inches of length from the front to the back of the stage. Thus the acute angle formed between the flooring or inclined plane, and a line drawn from the front to the back part, and parallel to the horizon, will be $1^{\circ}\ 24'\ 29''$. This inclination is considered to be of advantage to the vision lines, supposed to come from the eye of a spectator in the front of the house, to any given point in the stage. It particularly places it in the power of the architect, to keep the back part of the pit lower, than could be done without injuring the vision, were the flooring of the stage horizontal. This must be a considerable object, especially in large theatres, where there are many tiers or rows of boxes, and where the galleries must of necessity be constructed at a great altitude, above the level of the front of the stage. As it is also found, that cloth of every description (especially woollen) has a considerable effect in diminishing the transmission of sound, it is considered proper to keep the whole audience in the pit as low as possible without impeding the vision, that their cloaths may produce less of this effect upon the sounds which issue from the stage and the orchestra. A greater declivity might perhaps be of use in this respect, but here the architect must limit himself to so much as will not prove injurious to the action of the performers upon the stage, especially the dancers.

The stage of a theatre, like other wooden floors, consists of plank laid upon cross joists, and where the dimentions of the stage are large, these joists must be supported by cross beams and upright posts to prevent the flooring from springing or yielding too much, as in the common operations of practical carpentry applied to flooring, and entirely depending on the same geometrical laws. In constructing the joists and framing, the architect must in the first place consider the number of apertures which ought to be made for the purpose of conducting the business of the stage with propriety; the dimensions and disposition of these apertures; and the easiest and most economical way of forming others to suit that succession of novelty which seems to be the prevalent taste of the present day. In adapting his joisting and frame-work to answer these purposes, will consist his chief difficulty. The constant changes and improvements

ments which take place, render it impoffible to afcertain any precife mode of doing this, but the general way will be confidered under the fection of this article; *Apertures of the ftage*, comprifiing the foot-lights, traps, flaps, and fliders —to thefe we now proceed.

Apertures of the Stage.

The firft aperture in the ftage immediately behind the orcheftra, and in front of the profcenium and curtain, is that for raifing and lowering the foot lights, both for the purpofes of trimming the lamps, and of darkening the ftage when required. It is marked by the letters A, A, *fig.* 1, *Plate* IX. *Mifcellany*, which is a horizontal plan of a ftage 60 feet in length, and 25 feet in breadth at the curtain line. In this plan, the lines which reprefent the fide walls of the theatre are too much contracted, for it is neceffary to give at leaft eight or ten feet of additional room for the performers and fcene-fhifters, behind each wing. The letters B, B, denote the line which forms the front of the ftage behind the orcheftra:

The next apertures are the fide traps, of which any convenient number may be conftructed. Four of thefe are exhibited in the plan, and are diftinguifhed by the letters E, E, E, E. In the middle are two larger traps. The firft, at F, is of an oblong form from fix to feven feet in length, and from three to four feet in breadth. It is moft frequently ufed for the grave fcene in Shakfpeare's tragedy of Hamlet.

The trap marked by the letter G is generally fquare, and is chiefly ufed for the finking of the cauldron in the tragedy of Macbeth. Behind thefe, in large theatres, where many changes of the fcenery are frequently required, there are a number of longitudinal apertures acrofs the ftage, which are covered by planks moveable upon hinges, fo that by throwing them back, the ftage may be opened in a moment. The ufe of thefe is to allow the flat fcenes to fink through the ftage, when required. Three of thefe will be found in the plan, at the letters H, H, H, and are known by the name of *flaps*.

In the late Theatre Royal of Covent Garden, much of the fcenery, not in immediate ufe, was kept in the cellar under the ftage. For the purpofe of raifing and lowering thefe fcenes with facility, other apertures were made, and clofed with fquare or rectangular pieces of wood, which could be placed or difplaced in a few minutes: thefe were called fliders, and a plan of one is given at the letter I.

Framing of the Traps.

It was ufual to produce the afcent and defcent of the foot lights by the agency of a perfon placed in the cellar under the ftage. This might have anfwered the purpofe of lowering the lamps for trimming fufficiently well, but the partial darkening of the ftage required a more minute attention. For this reafon, it was found proper to convey the mechanical power to the place where the prompter ftands that the lamps might be raifed or funk, either by himfelf, or by a perfon immediately under his infpection. A framing of this kind, conftructed, with a flight variation, from a plan of Mr. George Sloper, of Covent Garden, and fimilar to what was ufed there, is reprefented in *fig.* 2.

This figure is a tranfverfe elevated fection of the ftage, as it would be viewed by a fpectator feated about the middle of the pit. The two fide walls of the theatre, under the ftage, are reprefented by the letters L, L; the aperture, where the horizontal frame which fupports the lamps rifes, is marked A A, as in *fig.* 1. The horizontal frame M M flides upon two upright pofts, under the fides of the aperture

A A, and from both ends cords, paſſing over two pullies O, O, are fixed to a large wheel N, placed in a ſtout framing, which is omitted to prevent confuſion in the figure. The weight of the frame M M, and the lamps, is counterpoiſed by a weight, ſuſpended by a cord paſſing over the pulley R. Upon the ſame axis with the large wheel N, is a ſmall wheel, and what is called by mechanics an endleſs line, paſſing round this, is guided over the directing pullies P, P, P, to the ſmall barrel or cylinder Q, which being turned by the prompter, or an aſſiſtant, the lights are elevated or depreſſed at pleaſure, without entering the cellar under the ſtage, except when trimming the lamps may be neceſſary. The difference of the diameters of the wheel N, and the ſmall wheel on the ſame axis, ſerves merely to increaſe the power, and diminiſh the velocity of the aſcent and deſcent of the lights, upon the common mechanical principle of the wheel and axle.

The traps are worked under the ſtage, by an apparatus attached to each, and ſimilar in all, according to the dimenſions of the reſpective apertures. That correſponding to the aperture F, in *fig.* 1, is repreſented by *figs.* 3 and 4. *Fig.* 3, has a tranſverſe elevation, like *fig.* 2. At the ends of the aperture are two upright poſts V, V, upon which the trap ſlides. The trap conſiſts of a horizontal board fitted to the aperture above, and under this is another, with grooves to fit the poſts V, V, ſo that the horizontal poſition of the trap may be preſerved while riſing and ſinking. Theſe are repreſented at S. In front of the poſts V, V, are two others U, U, to carry a cylinder T, turned by a winch to raiſe or ſink the trap, and ſecured by a catch and ratchet wheel. The trap, if neceſſary, may alſo be counterpoiſed, but this is ſeldom, if ever, done.

Fig. 4, is a profile elevation of the ſame machinery, which will further illuſtrate the relative poſitions of the poſts V and U and the way in which the cords by which the motion is communicated, paſs from the trap to the band. The reference letters are the ſame in both figures. The cords are generally made faſt to the beams or joiſts, at the roof of the ſtage cellar, and paſs over a pulley at each end of the trap, to double the power of the perſon who turns the winch. Beſides the moving traps, each aperture is cloſed by a board ſupported by an upright piece of wood, or ſimilar contrivance, when the traps are not at work.

No machinery whatever is permanently attached to the flaps or ſliders, for as theſe apertures ſerve generally for the paſſage of the flat ſcenes through the ſtage, the machinery muſt depend upon the particular effect which it is neceſſary to produce. The flat ſcenery is generally raiſed by a crane, unleſs a very rapid aſcent or deſcent be required, when it may be done by the application of a counterpoiſe.

Diſpoſition of the Stage Lights.

There is, perhaps, no department of a theatre where ſo much pains ought to be taken, as in the diſpoſition of the lights, for upon this, in a very great degree, depends the effect of the ſcenery, however nicely the perſpective may have been executed by the painter, and every optical illuſion calculated to aſtoniſh or amuſe the ſpectator. It was formerly the cuſtom to light the ſtage by a large chandelier, or frame of lamps, ſuſpended in the middle of the proſcenium, and elevated or depreſſed at pleaſure. This ſtill prevails in many parts of the continent, and even in Britain, is very generally uſed to illuminate the ring, or area of thoſe theatres, where feats of horſemanſhip, and other athletic exerciſes, are exhibited.

It ſeems obvious, that the ſuſpenſion of a chandelier directly in the view of the ſpectator, muſt materially deteriorate the

the effect of an exhibition, which can only be considered as excellent in the degree in which it is a faithful copy of nature. When suspended over the proscenium of a large theatre, it must also greatly impede the vision of all spectators seated in the upper parts of the house. These inconveniences induced the late Mr Garrick, when patentee of the old Theatre Royal of Drury-lane, to remove the chandelier and substitute the frame of lamps now distinguished by the appellation of *foot lights*, and this improvement has been adopted in all other regular theatres in the British islands.

But although the adoption of the foot lights removes the objections to the chandelier, they are still very far from producing that disposition of light and shade, which would be very desireable to increase the effect both of the scenery and of the countenances of the performers. The glare of light in the front, and parallel to the stage, besides the smoke which the lamps, however clean and nicely trimmed, always produce, inverts every shadow, and throws the shade upwards instead of downwards upon the performers' face. The most experienced professional men assign this as the reason, that the face of a performer must be so highly coloured to produce an effect in the front of the house, as to appear absolutely ridiculous to a stranger unconversant with the business, if admitted into the green-room, or behind the scenes. The limits of this article will not admit of going farther into detail upon this subject, nor indeed have we any established facts to proceed upon. All mechanical experiments necessarily involve a certain expence, while their success is merely speculative, and it is much better, in every case, to ascertain the extent of the improvement practically than theoretically. The disposition of the lights of a theatre, however, still seems to afford very ample scope for the exercise of the talents of an expert and skilful optician.

To give a sufficient light to the stage side lights are used, as well as foot lights: these are generally placed between the wings, to turn upon a hinge, for the purpose of darkening the stage when necessary. A plan of these, which is very simple, will be found in *fig.* 5. The apparatus consists merely of an upright post, to which is attached a piece of tinned iron, forming two sides of a square, and moveable upon joints or hinges, and furnished with shelves to receive the lamps or candles. That which gives light to the stage is represented by 1, and the position in which the side lights are placed, when the stage is partially darkened, by 2. Side lights are placed between every set of wings, on both sides of the stage.

Besides the foot and side lights, which are permanent, a number of occasional lights are disposed at times on different parts of the stage, to give effect to transparencies, and for other causes, of which, as they must be varied according to circumstances, no particular account can be given. They must be left entirely to the genius and taste of the persons who conduct the business of the stage.

Disposition of the Scenery.

The scenery of a theatre consists of the flat scenes which form the termination of the perspective across the stage, and the side scenes, or wings, which are disposed upon each side of the stage so as to be shifted as often as may be necessary, and to afford opportunities for the actors to come upon the stage, or quit it, at any of the intervals between the respective sets. Besides these, there are scenes which may be occasionally placed and displaced, such as the fronts of cottages, cascades, rocks, bridges, and other appendages, requisite in the representation of particular dramas. These are generally called pieces.

The flat scenes are of three kinds: the first of these are drops, or curtains, where the canvas is furled or unfurled upon a roller, placed either at the top or bottom of the scene. A difference of opinion exists as to the placing of the roller, which, as it is a mere matter of taste, may probably never be determined—both ways are used in the London theatres. The rollers, in either case, are made to revolve by means of cords tightened or slackened as may be necessary; and when the scenes are large it is usual to wind them up by means of a cylinder and a winch, as in the trap machinery.

Although the drop scenes are the most simple, it is necessary sometimes to have recourse to those scenes which are called flats. In these the canvas is stretched upon wooden frames, which are generally constructed in two pieces, so as to meet in the middle of the stage, the junction being in a perpendicular direction. The side frames are moved in grooves, composed of parallel pieces of wood fixed upon the stage, and so constructed that they may be removed with facility from one place to another. The upper part of the framing is also confined by a groove, to retain the perpendicular position of the flat scene. These are sometimes constructed, to save room, upon joints, by which they may either be lowered to the horizontal position, or drawn up to the side walls. In this respect their construction is pretty similar to that of a common draw-bridge. This plan was used in the late Theatre Royal, Covent Garden, where they were called flys. The principal use of the flats is where apertures, such as doors, windows, chimney-pieces, &c. are wanted in the scene, which may be opened and shut as required; these are called, in the technology of a theatre, *practicable* doors, &c., because, when not to be used, they may be painted upon a drop scene. A third kind of scene is the profiled or open *flat*. This is used for woods, gateways of castles, and such purposes: it is framed exactly like the other, and the only difference consists in parts of the scene being left open to shew another behind, which terminates the view.

A very important part of the scenery of a theatre is the wings. These also are stretched upon wooden frames, and slide in grooves fixed to the stage. In some large theatres they are moved by machinery, in others by manual labour. The disposition of the grooves will be seen at the letters K, K, in *fig.* 1. In this figure are nine sets of wings, the front only of which are marked by the reference letter. The wings, like the flats, whether moved by the hand or by the aid of machinery, usually stand upon the stage. The plan of moving the wings of the late theatre of Covent Garden, and that of the Theatre Royal of Glasgow, invented by the writer of this article, are represented in *Plate* X.

Fig. 1, is a transverse elevated section of the stage cellar, and stage of a theatre, where the wings are moved by a cylinder, or barrel under the stage, as was done at Covent Garden. D, D, are the side walls of the house; at A is a strong horizontal beam of wood, such as builders generally call *sleepers*, laid upon the floor of the cellar under the stage. Of these there must be a sufficient number to serve as railways for the frames of all the wings to run upon: four of these frames are represented and distinguished by the letters B B, C C. The frames B, B, are in front of those marked C, C. Each frame runs upon two small wheels, to diminish the friction, and all passing through longitudinal apertures in the stage, which serve as guides, rise to a sufficient height above the stage to support the wings which are attached to them in front, so as to be quickly removed, and others substituted. The line of the stage is represented at E. Two frames at each side of the stage only were used for each set of wings. At F is a long cylinder, or barrel of wood, revolving upon

upon iron axles, and extending from the front to nearly the back of the ſtage, ſo as to move all the wings at once. It will appear, by inſpecting the plate, that the cords, or endleſs lines, paſſing from each frame round the barrel F, and over the directing pulley H back to the ſame frame, are ſo diſpoſed that when the upper part of the barrel is moved towards the right, the front frames B, B, will move forward upon the ſtage, and the back frames C, C, will be withdrawn. In this ſtate they are repreſented in the figure. When the motion of the barrel is reverſed, that of the frames will alſo be inverted; the back frames will advance, and the front ones will recede. When a change of ſcenery is requiſite, the wings are taken off the frames which are out of the view of the ſpectators, and thoſe fixed on which are to be next diſplayed. Upon the barrel F is a wheel, moved by a pinion G, by means of the handle I, to give motion to the barrel, and increaſe the power. A horizontal fly wheel, like that of a jack, was alſo added, but in ſo ſhort a motion it is not probable that it could be of great advantage.

Fig. 2, is an elevation of the machinery by means of which the wings of the new ſubſcription Theatre Royal of Glaſgow are moved, and is the only plan of the kind hitherto attempted. It may be thought ſtrange that any deviation ſhould have been made in this theatre, from the plans adopted in the Theatres Royal in London: the reaſons are the following. Before plans for moving the machinery had been procured, the architectural part of the houſe was finiſhed, and three apartments upon each ſide under the ſtage having been fitted up for dreſſing-rooms, there did not remain ſufficient room to conſtruct the barrel and apparatus to advantage in the ſtage cellar, which was ſufficiently occupied by the footlights and trap framings already deſcribed. It became neceſſary, therefore, either to alter the houſe, or to abandon the idea of working the wings by machinery, unleſs another place could be found where the machinery might be placed to advantage, without interfering with that ſpace behind the ſcenes allotted to the performers and ſervants of the theatre. In every theatre it is neceſſary to have platforms at each ſide above the ſtage, and between theſe a temporary flooring, for the purpoſe of hanging up, taking down, or moving the flat ſcenery. Theſe ſide platforms are diſtinguiſhed by the letters K, K, and the intermediate moveable flooring by L in *fig.* 2. This ſuggeſted the idea that the barrels might be placed upon one of theſe platforms, and the wings moved above inſtead of below. But had the moving lines been attached to the upper parts of wings reſting on their baſes, every motion of the barrel muſt have overturned thoſe wings, or at leaſt have made them totter, and impeded their motion. To obviate this it was thought expedient that the wings, inſtead of reſting upon the ſtage, ſhould be hung from above, the baſis being ſo near to the ſtage as to appear to every ſpectator to reſt upon it, although really ſuſpended over it. Upon this general principle ariſing, as moſt inventions do, from a caſe of immediate neceſſity, the machinery which ſhall now be deſcribed was planned and executed.

Under the platform K were placed horizontal boards upon their edges, $\frac{3}{4}$ of an inch in thickneſs and ſeven inches deep; theſe correſponding to the number of the wings to be uſed, were ſeparated at each end by ſquare pieces of board, of the ſame thickneſs, to keep them aſunder; at each end the whole were bound together by a claſp of iron, O, which paſſing upwards through the platform, was ſecured by wedges paſſing through the arms of the claſp; by means of theſe wedges the claſp, and all the wings ſuſpended from it, could be raiſed, ſhould the platform yield in any part. The claſps, horizontal boards, and intermediate pieces, were ſecured by a ſcrew-bolt paſſing through the whole. The horizontal pieces of board ſerved as rail-ways for the ſuſpended wings to move upon, and were ſeven feet in length within the claſps; from theſe the wings were ſuſpended by ſheers of iron, in each of which was placed a ſmall friction roller reſting upon the board, and the lower part of the ſheers was ſcrewed to the wing, ſo that its baſe might be nearly an inch clear of the ſtage. Between the pieces of wood which ſeparate the rail-ways in front were pullies of about ſix inches diameter, two of which are repreſented at P P; a cord attached to a ſtaple in the top of the ſheers of each wing, and paſſing over each of theſe pullies, connected the wing with one of the barrels above at F. When the barrel was turned theſe cords neceſſarily pulled forward the wing to which each was attached, and thus the wings were brought forward. To allow the wings to recede, another cord, attached to the ſheers, was conducted over the directing pullies H, H; and from the other end a weight was ſuſpended ſufficient to overcome the friction and pull the wing back whenever the cords attached to the barrel were ſlackened. The frame M, which carried the barrels, conſiſted of upright poſts of wood about four inches ſquare, and the horizontal rails for carrying the barrels were of caſt iron with braſs buſhes for receiving the axles or journals of the barrels. The barrels were ſolid pieces of fir, ſix inches diameter, and hooped with iron at each end; the longeſt, which moved ſix wings on each ſide of the ſtage, was divided into three pieces, and the journals connected by coupling boxes. Eight barrels were uſed, four of which were placed as repreſented in the figure, and the other four above upon the rail at M; becauſe the barrel, when pulling forward the wings, was obliged to raiſe all the weights for making them recede; a counterpoiſe, equal to the ſum of all theſe weights, was placed upon the barrel in an oppoſite direction. To increaſe the power each barrel had a wheel and pinion on one end, exactly ſimilar to what is repreſented at F and G in *fig* 1; the pinion containing one-third part of the teeth in the wheel of courſe trebled the power, and thus one man was able to work 12 wings at the ſame time with ſufficient velocity, for the wings always advanced or receded more quickly than the drop ſcenes could be raiſed or ſunk. The direction of the cords will be very obvious by inſpecting the figure, two barrels with the counterpoiſes being corded.

For raiſing and lowering the drop-ſcenes another framing was conſtructed carrying 12 ſhort barrels, a profile ſection of which, with one barrel, is repreſented at N. When the drop-ſcenes were pulled up the barrel was ſecured by a ratchet-wheel and catch.

Although this machinery was conſtructed rather to correct an error in the general conſtruction of the theatre than for any other reaſon; it appears, after four years trial, to poſſeſs ſome important advantages over the plans of the London theatres, whilſt it is fair to ſtate that it is equally liable to ſome objections. As it was conſtructed in a hurried manner, the practical part was not executed ſo perfectly as might have been wiſhed; all the directing pullies were made of wood, and the grooves to receive the cords by no means ſufficiently deep to prevent them from ſlipping occaſionally, which muſt have frequently interrupted the motion of the wings. For this reaſon the counterpoiſe weights were ſubſtituted for the double or endleſs line; and this was more neceſſary, becauſe the cordage being new, it was perfectly evident that the natural ſtretch would in a few days render it quite unſerviceable in this reſpect, unleſs greater care had been taken than is generally to be expected. This machinery, with very little attention, has been found to anſwer the purpoſe remarkably well. Its advantages over that uſed in Covent Garden ſeem to be the following:

The

The frames which carry the fcenes by the plan *fig*. 1, refting upon the floor of the ftage cellar, require a ftrength of framing to keep them fteady, which both renders them heavy to move and involves a very great expence for the timber and workmanfhip; befides this, many people muft be employed to change the wings upon the frames when drawn back, and in this refpect no faving of labour can arife, and the only advantage gained by the machinery is regularity of motion. The hanging wings of the Glafgow theatre are greatly lighter, and might be much more fo than they are, for the whole frame-work was finifhed upon the prefumption that they muft reft upon their bafes, as in the cafe of other wings. But it will at once occur, that a much greater ftrength of frame-work will be neceffary for a fcene upwards of 20 feet high, and refting upon its bafe, than for one fufpended from above, where the force of gravitation acts in a contrary way, and which requires no other power than what is neceffary to diftend the canvas. Add to this, the weight of a framing paffing through grooves in the ftage and running upon a rail-way nearly 20 feet below, and without exactly meafuring the dimenfions of the wood, which muft always depend upon thofe of the theatre, the difproportion of the one plan to the other will appear enormous. In the working of the wings according to either of thefe plans the fuperiority alfo evidently refts with the latter. A perfon or perfons under the ftage are fituated in a moft inconvenient place for obferving the conduct of the drama, and regulating operations to forward its effect. On a platform above every thing is eafily vifible, and common attention to what paffes below is all that is neceffary. In the London theatres, as alfo in moft refpectable provincial ones, a whifpering tube is placed, to convey founds from the prompter to thofe employed above, for their occafional government; this tube is entirely fimilar to a common fpeaking trumpet.

The defects of the hanging machinery, as conftructed at Glafgow, ought alfo to be noticed. The rail-ways, upon which the wings move, were found fometimes apt to warp, and had of courfe fome tendency to interrupt the motion of the wing; this might be eafily remedied by making the rail ways of caft-iron, and if the upper edge fhould be well polifhed the friction would be very fmall indeed.

In a provincial theatre, where a certain fet of wings are almoft conftantly ufed, the plan of fcrewing the fheers which carry the pullies to the wings may anfwer very well; it is, however, certainly more defirable that means fhould be devifed for altering the wings with greater fpeed than can be done by the drawing of fcrew-nails. Many plans may be contrived to anfwer this purpofe; one, which may do fufficiently well, is reprefented in *figs*. 1 and 2, *Plate* XI.

Fig. 1, is a profile elevation of the fufpending apparatus and upper part of the wings as in *fig*. 2, *Plate* X. B is the platform above; A.A, the hanging fupporters, with wedges to raife or fink the whole as may be proper. C is the railway which in this inftance is fuppofed to be of caft iron. E is a pair of fheers or clutch of malleable iron, through which is an axle to carry a fmall friction wheel on each fide. F, F, are fractions of the wings, fufpended by fcrews or bolts and cutters, fo as to be eafily changed. The cordage and barrels may be either as in the former plate, or the endlefs line may be fubftituted, if precautions are taken to prevent the cords from flipping off the directing pullies.

Fig. 2, is a tranfverfe elevation of the fame apparatus, taken directly behind the wings as they advance or recede, and the various parts are diftinguifhed by the fame letters of reference as in *fig*. 1.

The object of this apparatus is, in the firft place, to enfure the regularity of the motion of the wings; and in the fecond to effect this motion by as few fervants as poffible. The hanging part of all the divifions between the five wings reprefented may be of caft iron, and the projecting parts under the friction rollers may be either caft as *feathers*, or in feparate pieces, and joined by counter-funk fcrews. The intermediate pieces to preferve the diftances, where the bolt D paffes through, may be of well-feafoned plank.

By thefe means, and the application of the double rollers, an interval is left by which any wing may be fpeedily removed, without unfixing a fingle fcrew or bolt; and the moving cords, being merely hooked to the wing, may be inftantly unfixed and placed upon hooks in the fufpending apparatus, as reprefented in *fig.* 1, until a new wing is placed on the railway. At the fame time, by ufing caft iron, the whole may be compreffed into fo fmall a fpace, as to have all the wings, neceffary for an evening reprefentation, fitted in their places before the exhibition commences, unlefs in very extraordinary cafes.

Befides the permanent machinery, which is always in ufe, many occafional engines muft be ufed to fuit particular pieces. The limits of this article will not admit of going much into detail refpecting thefe; nor is it neceffary.

The mechanift, whofe chief aim is to produce continual novelty, muft depend much more upon the fertility of his own genius, than upon antecedent plans. We fhall therefore clofe the article, with fhort defcriptions of a few mifcellaneous fpecimens, which will be found in the remaining figures of *Plate* XI.

Fig. 3, reprefents the common method of executing a fea fcene. A certain number of horizontal axes being placed acrofs the ftage, with crofs boards properly painted and cut or profiled, when turned upon their refpective centres, produce the appearance of water, which may be reprefented either as tranquil or ftormy as the occafion requires.

To give the appearance of fhips or boats, a very fimple apparatus will fuffice. A plan of a fmall boat is given in *fig.* 4.

A frame of wood, moving upon friction wheels, is reprefented by the letters A, A, upon this the boat is placed upon an axis at B. From the aftermoft part of the boat, a cord, paffing over the pulley C, is conducted behind the fcenes. The bow or fore part of the boat being made heavier than the after-part or ftern, the cord, by being tightened and flackened alternately, will move the boat upon the axle B, and give it a motion very fimilar to that produced by the natural undulation of the waves. If the friction wheels are covered with cloth or lift, and the axles fmoothly turned and well oiled, the noife from friction will be avoided, which often deftroys the illufion when boards without wheels are pufhed acrofs the ftage. The frame A is drawn acrofs between the axles in *fig.* 3, and all that is under the furface of the water (reprefented at D.) is concealed by a painted board. Two ftops may be placed upon the carriage to regulate the vibration of the boat, as reprefented in the figure.

Fig. 5, is a plan of a machine to produce the oblique afcent or defcent of a car, horfe, or any other body, above the ftage. Upon a crofs bar of wood A, A, paffing between the platforms, and fufficiently high to be concealed from the fpectators, is a box or frame B moving upon rollers. A cord F, attached to this frame, is wound upon a barrel upon the platform. Another cord G, attached to any fixture upon the oppofite fide, and paffing over a pulley in the box B, fufpends the car C. When the cord F is wound upon the barrel, the car will afcend in the direction of the dotted line D, and when unwound will defcend in the fame line by its own gravity. The cord E will keep the car or other body fteady.

ready. This is merely another application of the principles, investigated under the article DIAGONAL *motion*, and were the descent required to imitate the parabolic curve of a projectile, it might be effected by constructing the barrel like the spiral of a watch, the diameters for the convolutions of the cord F being accurately calculated, and another barrel constructed to regulate the descent of the suspending cord G. The cords are very slender and painted black, to elude the eye of the spectator. The lights also are strong in front, and dim behind, to assist the optical deception. To give the cords sufficient strength without increasing their diameter, they are spun of the best hemp, mixed with brass wire well annealed. Those used at Covent Garden for the flying horses in the *Pantomimic Spectacle* of Valentine and Orson, whose flight was effected by an apparatus similar to that in the figure, although less in diameter than a common quill, were said to possess sufficient strength to suspend a ton weight.

Fig. 6, is an apparatus, rather optical than mechanical. It is designed to give the effect of a full moon, and was used with great success at Drury Lane. The front view is distinguished by the numeral 1; the profile by 2. It is a conical case of tin, the lesser diameter of which is a concave reflector at A. The greater diameter, at B, is covered with taffeta, or any transparent coloured cloth, to give the shade required, and a lamp is suspended within the case, which is perforated in many places to admit the air. Simple as this apparatus is, it gives a very striking resemblance of a full moon when suspended by three cords, and when the back part of the stage is darkened.

Fig. 7, is a plan of one of those quick transitions of scenery, which are used in pantomimes or other pieces, where an assimilation to the agency of magic is attempted. Any number of perpendicular cylinders being placed upon the stage to revolve easily; let these be covered with canvas of sufficient length to reach from each cylinder to that nearest to it. When the canvas is rolled upon the cylinders and painted, they will assume the appearance of pillars placed in a room or hall, and a scene placed behind will be seen through the intervals. By pulling the cords at A, the canvas unwinding from each cylinder and reaching to the next, will almost instantaneously change the appearance of the pillars into that of a flat scene, and the former appearance may be as instantaneously restored, either by the action of weights, as in the figure, or by a power acting in a contrary direction. Cords, similar to those at A, must be placed at the bottom in the direction of the dotted line B, to unroll the canvas equally, and the pivots at top and bottom must be concealed.

Fig. 8, is a section of those double flat scenes, which are also used to produce instantaneous changes. The whole scene being covered with pieces of canvas, framed and moving upon hinges, one side is painted to represent a certain scene, and the other to represent one totally different. The section marked 1 shews these pieces when elevated above the joints; that marked 2 shews them when suspended below. The contrivances for moving them are very various. In general, however, they are kept in the elevated situation by catches, which being suddenly relieved, they fall by their own weight.

LONDON THEATRES.

TABLE OF THE PRINCIPAL DIMENSIONS, SHOWING THE COMPARATIVE SIZES.

Name.	Curtain to Back Wall of Pit.	Curtain to Front of 1st Circle.	Curtain to Front of 2nd Circle.	Curtain to Front of 3rd Circle.	Height from Pit Floor to Ceiling.	Number of Persons Accommodated	Curtain to Back Wall of Stage.	Width between Walls of Stage.	Width of Proscenium Opening.	Height of Proscenium Opening.	Height from Stage Floor to Gridiron.	Depth from Stage Floor to Cellar.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Adelphi	74 0	39 6	45 0	44 0	42 6	2300	53 0	65 6	34 0	37 0	55 0	12 6
Alhambra	82 0	60 0	60 0	68 0	80 0	3500	42 0	66 0	36 0	40 0	60 0	24 0
Astley's	91 6	56 0	60 0	...	46 0	3000	51 6	96 0	47 0	36 0	43 0	16 0
Avenue	63 9	41 9	45 9	...	40 0	1200	28 6	50 0	26 0	28 9	50 9	16 4
Britannia	70 0	51 0	51 0	51 0	47 0	3500	58 0	76 0	37 0	38 0	50 0	21 0
Comedy	62 0	30 6	34 0	37 0	45 0	1185	28 0	49 0	25 0	28 0	43 0	9 0
Covent Garden ...	80 0	80 0	80 0	80 0	64 0	3000	86 0	90 0	44 0	38 0	66 0	21 0
Criterion	50 0	31 6	38 0	...	26 0	750	24 0	45 0	22 0	20 0	22 0	8 0
Drury Lane ...	74 0	60 6	60 6	68 0	55 0	3500	79 0	76 0	37 0	41 0	58 0	18 0
Elephant and Castle	67 0	37 0	39 0	...	38 0	2600	40 0	68 0	29 0	28 0	47 0	15 0
Empire	84 6	57 0	57 0	67 0	60 0	3000	47 0	76 0	37 0	36 6	46 0	20 0
Gaiety	53 6	36 0	45 0	47 6	52 6	1150	41 0	61 6	30 0	29 0	49 0	19 6
Globe	47 6	30 9	30 9	...	34 0	1100	31 6	66 3	20 9	26 9	42 0	9 0
*Grand	76 0	38 6	41 0	...	44 0	3000	47 6	51 9	30 6	32 0	52 0	18 0
Greenwich... ...	43 0	31 0	31 0	...	28 0	900	27 0	41 0	20 6	24 0	30 0	8 6
Haymarket ...	No Pit	41 6	44 0	51 0	41 0	1100	41 0	57 6	28 0	24 0	52 0	7 0
Her Majesty's ...	69 0	69 0	69 0	69 0	63 6	2444	53 0	95 0	39 0	35 8	65 0	25 0
Imperial	65 0	48 0	51 0	...	43 0	1450	40 6	58 8	30 6	27 0	42 0	12 6
†Lancaster's ...	58 4	35 0	40 8	44 6	47 0	1800	45 0	65 0	30 0	27 0	54 0	19 0
Lyceum	63 0	47 0	47 0	47 0	49 0	1850	40 0	72 0	34 0	38 0	46 0	14 0
†Lyric	60 9	38 0	44 9	48 3	40 6	...	41 0	70 0	35 0	27 0	...	...
Marylebone ...	75 0	46 0	46 0	...	32 0	1400	40 0	45 0	22 6	29 0	36 0	8 0
Novelty	49 6	28 6	28 6	30 6	40 0	1000	23 0	41 6	26 0	25 0	40 0	9 0
Olympic	59 0	41 6	41 6	...	33 6	900	31 6	40 0	27 0	29 0	No Gridiron.	10 0
Opera Comique ...	51 6	38 6	38 6	38 6	36 0	1000	21 6	60 6	32 0	26 0	42 6	10 0
Paragon	100 0	58 0	...	...	60 0	2500	64 0	100 0	34 0	34 0	60 0	20 0
Pavilion	74 0	52 0	52 0	...	37 0	2200	62 0	64 0	32 0	26 0	42 0	12 0
Prince of Wales's ...	58 6	34 0	40 6	44 2	45 6	1200	30 0	75 0	30 0	27 0	36 0	20 0
Princess's	60 10	32 0	39 0	41 6	56 0	1900	40 5	62 3	32 0	33 0	49 0	18 6
Royalty	50 0	28 0	34 0	...	36 0	800	27 0	40 0	25 0	24 0	30 0	12 0
Sadler's Wells ...	65 0	41 0	46 0	...	37 0	1800	50 0	48 6	26 0	31 0	50 6	8 6
Savoy	51 0	34 6	43 10	48 6	48 0	1150	47 6	59 0	30 0	35 0	56 0	15 0
St. James's.. ...	57 0	40 0	43 0	44 6	36 0	1000	55 0	53 0	25 0	28 0	44 0	12 6
Standard	75 0	57 0	59 0	63 0	55 0	3300	55 0	60 0	32 0	41 0	69 0	14 0
Strand	57 0	31 6	39 0	...	36 0	1000	25 0	60 0	26 0	26 0	37 0	20 0
Stratford, E. ...	43 9	23 9	26 6	...	33 0	850	18 0	40 0	23 0	24 0	31 0	8 6
Surrey	69 0	56 6	56 6	56 6	50 0	2500	60 0	70 0	32 0	38 0	50 0	25 0
Terry's	55 0	28 0	31 0	...	40 0	800	26 0	39 0	22 6	26 0	40 0	9 0
Toole's	55 0	31 9	31 9	...	27 0	900	20 0	36 0	20 9	20 0	36 0	9 0
Variety (Hoxton) ...	48 0	31 6	31 6	...	38 6	1000	15 0	34 0	21 0	26 6	30 0	8 0
Vaudeville... ...	58 9	30 6	36 6	...	34 0	1000	24 0	40 0	21 6	21 6	37 0	8 0

* Destroyed by fire December 29th, 1887. † In course of construction.

Appendix 2

Dimensions of theatres from J.G. Buckle's, Theatre Construction and Maintenance.

The following dimensions of Provincial Theatres have been kindly forwarded to the Author by the respective Managers:—

Name.	Curtain to Back Wall of Pit.	Curtain to Front of 1st Circle.	Curtain to Front of 2nd Circle.	Curtain to Front of 3rd Circle.	Height from Pit Floor to Ceiling.	Number of Persons Accommodated	Curtain to Back Wall of Stage	Width between Walls of Stage.	Width of Proscenium Opening.	Height of Proscenium Opening.	Height from Stage Floor to Gridiron.	Depth from Stage Floor to Cellar.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Aberdeen (H. M. T.)...	42 0	33 6	42 0	40 6	41 0	1750	29 0	54 0	27 0	29 0	38 0	14 0
Belfast (T. R.) ...	68 0	34 0	37 0	42 0	45 0	2500	33 0	55 0	28 0	33 0	55 0	12 0
Birmingham (T. R.)...	55 6	55 6	55 6	62 3	47 0	2500	68 9	65 0	31 3	33 0	57 0	18 0
„ (Queens)	68 0	42 0	44 0	...	42 0	2500	30 0	63 0	30 0	30 0	62 0	20 0
Cambridge (T. R.) ...	80 0	50 0	... behind 1st Circle.	...	...	800	35 0	40 0	21 0	18 0	25 0	9 0
Cardiff (T. R.) ...	59 0	31 0	47 0	31 0	55 0	2000	42 0	56 0	24 0	27 0	40 0	16 0
Cork (T. and O. H.)...	65 0	40 0	50 0	50 0	50 0	2000	40 0	54 6	29 0	40 0	50 0	13 0
Darlington (T. R.) ...	55 0	30 0	39 0	42 6	37 6	1850	39 3	49 0	24 0	27 0	43 0	11 6
Derby (Grand) ...	70 6	45 0	46 0	...	45 0	2500	35 0	67 0	30 0	30 0	64 0	23 0
Edinburgh (Lyceum)	65 0	38 0	42 6	48 6	47 6	2500	44 0	78 0	28 0	33 0	60 0	20 0
Glasgow (Royalty) ...	56 0	30 0	30 0	40 0	50 0	2000	40 0	56 0	29 0	31 0	47 0	27 0
„ (T. R.) ...	68 6	41 3	49 3	51 0	59 0	3062	50 0	72 6	30 10	36 0	60 0	20 0
Gravesend (New) ...	41 0	27 0	...	...	30 0	800	19 0	46 6	23 0	21 0	26 0	9 0
Hanley (T. R.) ...	54 0	37 6	38 0	38 6	49 0	...	46 0	83 0	29 0	30 0	45 0	18 6
Huddersfield (T. R. & O. H.)	57 0	39 0	42 0	46 0	54 0	1900	37 0	55 0	27 0	32 0	45 0	20 0
Ipswich (T. R.) ...	36 0	36 0	34 0	33 0	26 0	1000	26 0	40 0	22 0	16 0	23 0	7 0
Leeds (Grand) ...	73 0	54 0	48 0	44 0	54 6	2600	48 0	72 6	32 6	40 0	62 0	21 0
Leicester (O. H.) ...	68 0	43 0	56 0	56 0	50 0	3000	44 0	60 6	34 0	38 0	56 0	21 0
Northampton (O. H.)	55 0	31 0	38 6	38 6	36 0	1500	35 0	46 0	21 0	29 0	50 0	9 0
Oxford (New Theatre)	54 0	37 0	37 0	...	35 0	950	30 0	50 0	24 0	24 0	43 0	12 0
Runcorn (T. R.) ...	60 0	26 0	Gallery at the	back of Pit.	26 0	1500	25 0	50 0	24 0	17 0	20 0	6 0
Sheffield (T. R.) ...	62 6	36 6	39 6	41 6	51 0	2500	40 6	50 0	26 0	30 0	49 6	9 0
South Shields (T. R.)	52 0	34 0	36 0	...	56 0	1500	40 0	52 0	24 0	36 0	32 0	18 0
Sunderland (T. R.) ...	49 0	38 0	41 0	...	44 0	1900	30 0	60 0	30 0	32 0	52 0	18 0
West Bromwich (T. R.)	60 0	34 8	37 8	...	29 0	1800	18 0	44 0	18 3	20 0	28 0	16 6
West Hartlepool (T. R.)	80 0	45 0	50 0	...	50 0	1700	26 0	42 0	22 0	26 0	40 0	10 0

Appendix 3 - William B.Parnell, Biography.

William B.Parnell came to Newcastle from London to design the Quayside buildings for Mr.Tallantyre Gibson. During his time in the city he established a practice in Collingwood Street and apart from designing the Tyne Theatre was also responsible for the following buildings in Newcastle: St.Nicholas Buildings, New Tyne Brewery, Chronicle Buildings, Norwich Union Assurance Branch Offices, Chas Tennants & Co's, New Chemical Works, Hebburn; Sunderland Engine Works, Sunderland; and Warrior-square Estate Buildings, St.Leonards-on-Sea.

According to a newspaper cutting in the Newcastle Central Library:
"There was a good deal of novelty in Mr.Parnell's construction, such as the weight of the floors being borne distinct from the walls &c., which attracted attention at the time. Mr.Parnell returned to the South, having fallen into ill health."

Local Biography, II, Ref.L920, p.315, Newcastle Central Library.

Appendix 4

Phipps, Charles John, FSA, FRIBA: 1835-1987.

Son of John Rashleigh Phipps of Lansdowne near Bath: born Landsowne: articled to Wilcox & Fuller, architects, of Bath, till June 1857: after a year's travel commenced on his own at Bath 1858, at Cornhill, London 1863-7 and at Mecklenburgh Sq. 1867 to death, FSA 19 June 1862: FRIBA 1866, member of Council 1875-6: advising architect to Theatre Royal, Drury Lane 15 years: exhibited 7 designs at R.A. 1863-97: besides theatres designed various business premises, blocks of flats, the Devonshire club, St.James's St. and the Carlton Hotel, part of the same design as Her Majesty's Theatre, which was carried out and modified after his death by his partner and son-in-law. A.Blomfield Jackson (1868-1951), who continued the practice. Phipps's early designs for buildings and furniture were Gothic and ecclesiastical in the style of Godwin and Burges, but after his first theatre he adopted "a more appropriate classic manner".

The first of the great Victorian theatre specialists, Phipps was for over thirty years the acknowledged doyen in the field; the only theatre architect of the period to be found in the DNB, and one of the few in the standard biographical dictionaries of architects. Fortunately, many of these theatres remain more or less as he designed them. Phipps's most prolific years preceded the flowering of the music hall in the 1890's and his were primarily straight foward theatres. Stylistically, his work was much influenced by the great Continental (particularly, French) theatres of the eighteenth and mid-nineteenth centuries, with a solemn, seemingly solid dignity, quite different from the slender gimcrack feel of earlier English theatre interiors. The line of his balconies runs horizontally through to stage boxes, which often themselves form the proscenium opening, without the intrusion of an elaborate frame surrounding the stage. Decoration in a Phipps theatre is always applied in low relief and restrained, unlike the integrated high key rumbustiousness of the later Matcham or Crewe theatres at their vibrant best. Externally too, Phipps had an assured dignified touch, using the customary producing civic buildings with undeniable theatrical character which made an important contribution to the Victorian street scene. Those that remain, such as the Theatres Royal, Nottingham and Glasgow; Lyceum, Edinburgh and Her Majesty's, still retain their viability in often very altered circumstances.

From: Curtains!!! or A New Life For Old Theatres. op.cit., p.215.

Theatre

General Summary of Theatre Block

			£	s	d
A	Construction	a/c	22382	18	11½
B	Furnishing	a/c	1979	18	8
C	Scenery	a/c	914	6	11½
D	Gearing	a/c	708	4	2
E	Stage	a/c	1642	13	3½
F	Fire apparatus	a/c	235	8	6
G	Gasfitting	a/c	989	7	2
H	Heating apparatus	a/c	699	19	0
I	Decoration	a/c	940	15	0
J	Act drop &c	a/c	157	7	11
K	Rope	a/c	135	4	7
L	Charges	a/c	232	18	11
		Total £	31019	3	1½
			21075	1	3½
			30311	3	3½

31019 - 3 - 1½   31015 - [illegible]
6656 - 3 - 5½   6656 - 3 - 5½
37675 - 6 - [illegible]   37671 - 5 - 9
[illegible]   849 - 9 - 0
36825 [illegible]   36821 - 16 - 9

Appendix 5

Summary of building costs of the Grand Theatre and Opera House, Leeds, West Yorkshire Archive, Leeds. G.T.210

Appendix 6

W.P.Dando patent relating to the stage machinery at the Royal English Opera House, London.

N° 16,699 A.D. 1890

Date of Application, 20th Oct., 1890—Accepted, 22nd Nov., 1890

COMPLETE SPECIFICATION.

Improvements in the Mechanism of Theatrical Stages and Means for Operating the Scenery and Producing Scenic and Stage Effects.

I WALTER PFEFFER DANDO, Theatrical Engineer, of R. D'Oyly Carte's New Theatre, Cambridge Circus, Shaftesbury Avenue, in the County of Middlesex, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

My invention relates to mechanism used in connection with theatrical stages and means for operating the scenery and producing scenic and stage effects so that scenery may be changed with great facility and precision and freedom from "jerks" and with but small expenditure of manual labour and whereby scenic effects can be produced which are impracticable with the appliances as hitherto used in theatres.

According to my invention I provide systems of wire ropes pulleys and counterweights so arranged that the scenes can be manipulated with great ease facility and steadiness so that if desired the whole of the back scene and set scenes can be operated together to give the effect of the scene as a whole rising or falling together.

Moreover I supersede the system technically known as "bracing" or "gimbleting" that is supporting set scenes by braces or struts which are screwed into the stage which is objectionable and a source of danger to the persons engaged on the stage.

In the system known as the chariot and pole system a wide opening across the stage is required and this is frequently left open and is then obviously a source of danger to dancers or others, engaged on the stage and its closure is effected by strips of wood with L iron clips on top projecting above the stage level and so not only being dangerous to dancers and others but also causing a clattering noise when jumped upon and often springing from their position and so leaving an opening in the stage. Moreover these "cuts" have to be prized open by means of a lever which is very inconvenient in practice. These defects I have overcome and I have also improved the form and construction of the "chariots" "poles" and "runners," and reduced the width of the opening in the stage for the pole. I have also provided means for perfectly closing the opening without any L iron or other projection above the stage.

I have also greatly improved the construction and arrangements for working "sloats" and set scenes.

The metal rope which I employ is preferably flexible steel wire rope which being practically free from any stretch or shrinkage enables me to set and regulate the "sloats" and scenes with an accuracy impossible with the old system of "sloats" and scenes worked by hempen ropes.

My invention also includes means for producing rumbling sound to resemble thunder, the fall of structures and other noises known as stage crashes and the like.

And in order that my said invention may be fully understood I shall now proceed more particularly to describe the same, and for that purpose shall refer to the several figures on the annexed sheets of drawings, the same letters of reference indicating corresponding parts in all the figures.

Figure 1 represents a transverse section of the working arrangements of the entire stage from cellar to "gridiron" looking towards the auditorium. The other figures show various parts and details drawn to larger scales. Figure 2 shows one half of the "gridiron" or top part of the stage from which is suspended the scenery "batten" and the like. Figure 3 shows one half of the part beneath the stage known

[*Price* 1*s*. 1*d*.]

as the mezzanine. Figure 4 is a side sectional view thereof, and Figure 5 is a sectional plan. Figures 6 to 10 shew the arrangement of one of the "sloats" and tongues for carrying the "rise and sink scene" (D Figure 1). Figure 6 being a front view. Figure 7 a side view. Figure 8 a sectional plan of the upper part and Figures 9 and 10 front and side views of the lower part. Figures 11, 12 and 13, show the arrangement of slot in the stage (for the pole supporting the side wings to project through or for other purpose) and the means for closing it. Figure 11 being a cross section. Figure 12 a plan, and Figure 13 a longitudinal section. Figures 14 and 16 are cross sections and Figure 15 a longitudinal section shewing means for opening and closing what are known as "carpet cuts" in the stage. Figures 17 to 20 shew detailed views of the pulleys shewn in the main figures, and they are marked with corresponding letters of reference. Figure 21 shows a front view and cross section of an adjustable arrangement for attaching the wire ropes to the scene battens or for like purposes. Figures 22 and 23 shew means for suspending a batten or ceiling piece at any angle. Figures 24 to 27 shew arrangements of the counterweights and their carriers.

Figure 1 represents a general view in section of the entire stage from "cellar" to "gridiron" looking towards the auditorium showing every working portion of the stage, A being the stage level, and a the main joists in which the "sliders" work in the grooves a^1. These parts may be of the ordinary construction and require no particular description here. A^1 represents the proscenium opening. The stage is supported on upright standards U with the joists J which may be either of metal, such as steel or iron, or of wood, M is the first mezzanine, M^1 the second mezzanine, M^2 the third mezzanine. L the cellar level, F the first "flies," F^1 the second "flies," F^2 the third "flies." B and B^1 are bridges communicating from the flies on the one side of the stage to the flies on the opposite side of stage, G is the "gridiron." C and C^1 are the "prompt" and O P counterweight boxes leading from the "gridiron" to the cellar below, in which work the counterweights W resting on the counterweights iron W^1 and connected to the scenes by the wires R r for counterweighting or partly counterweighting the scenes and so assisting in the raising of them. I have shown two scenes S attached to the battens B^2 B^3 and operated by the wires marked R and r but it is to be understood that the same arrangements may be repeated to accommodate any number of scenes. The wire ropes R are attached to the batten B^2 and each pass over a pulley P (shewn separately in Figure 17) and then around the sheaves of a pulley P^3 (shewn separately in Figure 20) and thence over the sheaves of a pulley P^4 (shewn separately in Figure 18) and down into the shaft C where they are attached to the counterweight carrier W^1 carrying adjustable counterweights W. The power rope R^1 is attached to the centre of the batten B^2 and is led over a sheave of the pulley P^2 and then over one of the pulleys at P^1 down to the fly F. By pulling upon this rope the counterweights W run down and by means of the wire ropes R the scene is evenly raised. The rope R^2 also leads from the fly F and passes over the other of the pulleys P^1 over the pulley P^4 and thence is attached to the counterweight so that by pulling on this rope the counterweights are raised and the ropes R R^1 run out and the scene is evenly lowered. The arrangement is shewn repeated with regard to the other scene shewn the pulleys being similarly lettered and the respective ropes being lettered r r^1 r^2. For clearness of illustration the pulley for these wires corresponding to that marked P^2 is shewn in a lower position than the pulley P^2 and is marked P^3. The various pulleys may be arranged at any suitable level if there be not room for them side by side.

To distinguish the rope by which the raising is effected from the rope by which the lowering is effected one of the ropes may have a coloured strand woven into it or be otherwise distinctively marked to indicate its particular purpose.

The scenes or any desired number of them can be operated from either of the flies on either side as may be most convenient. It will be readily understood that each scene can be so accurately counterbalanced by the counterweights W that one man can with great ease and regularity of movement raise and lower any of the scenes by working the rope R^1 or R^2. By carrying all the counterweight wires and working lines to the centre of the gridiron over the centre pulleys (P^2 or P^3). I obviate the use of the "long line and short line" system hitherto employed. The two counterweight wires farthest from the centre pulley (P^2 or P^3) are of the same length and the two other counterweight wires are also of the same length. It will therefore be evident that the two counterweight lines at the two ends of the batten will exert an equal strain. To fully explain and illustrate the principle of this important part of my invention I have given in Figure 2 the sectional view drawn to a larger scale of half the gridiron the parts shewn being marked with the same letters of reference as are those employed for Figure 1. I do not limit myself to the number of pulleys shewn which will be in accordance with the width of the scenery or stage property it is desired to raise or lower. Referring again to Sheet 1 of the accompanying drawings D is the framed "rise and sink" scene fixed to the tongues T^1 of the "sloats" working in the "sloats" T. The tongues T^1 with the scene D fixed thereto, are raised or lowered by the action of the flexible wire ropes *w* attached at one end to the ends of the tongues at T^2 and at the other ends to the drum *d*. The parts T^1 and D are balanced or partly balanced by the counterweights *c* running in the shaft as shewn and attached to one end of the wire rope w^1 which passes over the pulleys p^1 p^1 and is connected at its other end to the drum *d*. The drum *d* is revolved by the power wire w^2 attached to the said drum and to the crab K by revolving which the tongues T^1 of the "sloats" T with the scene D attached are raised or lowered as required. The counterweights *c* will be regulated by the weight of the scene D. It is shewn as being assisted in being raised by the said counterweights but they may, by passing the wire w^1 over the drum in the reverse direction, be used to assist in rapidly lowering the scene D the manual power being exerted to raise both the counterweights and the scene D after which the handle of the "crab" K will be thrown out of gear and the scene can be very rapidly lowered and governed in its lowering by the brake with which the crab is provided. It is only necessary to provide a coupling bar d^1 (see Figures 4 or 5) which will fit on the squares of the spindle of the drums *d*, to raise or sink a number of scenes simultaneously in a parallel line. Figures 3, 4 and 5 are larger views of these parts marked with the letters of reference used to denote the same parts in Figure 1 and Figures 6 to 10 shew details of the working and construction of these counterweighted "sloats." The parts being marked with the same letters as those used in Figures 1, 3, 4 and 5 require no further description.

The "chariots" N have grooved wheels *n* (Figure 1) running on rails n^1 fixed to a timber n^2 bolted between the "sloat" joists J (see Figure 4). The said chariots carry the poles O which support in a hinged shoe fitted at the bottom of the pole or otherwise the "chassis" or "wings" as shewn at O^1. The stage is provided with a transverse slot as shewn at *f* in Figures 11 and 12 the part of the poles O which passes through these slots having their width arranged at right angle to the width at their upper part so that the slots *f* may be narrow. The wing O^1 mounted as described can be readily and easily pushed across the stage as far as required and will stop and remain in any position to which it has been brought.

The method by which I close the opening *f* is shewn in detail in Figures 11, 12 and 13. f^1 are cheeks preferably of oak against which the top of the chariot and side of the pole works. The opening *f* when not in use I fill in by means of fillers *g* made of lengths preferably of oak and having two steel pins g^1 running on top of the cheeks f^1 and travelling in the continuous slots *h* formed by the undercuts in the adjacent portions of the stage flooring. The oak fillers *g* can be moved or put in place very readily as the said adjacent portions of the stage flooring are provided with vertical openings h^1 opening into the slot *h* and corresponding with the pins g^1 on the fillers *g* which pins g^1 are each kept in position by a screw *v*. The two openings h^1 and two pins g^1 being the same distance apart by getting the two screws *v* opposite the openings h^1 the filler can be easily and quickly lifted out or put into its place and pushed along, thus allowing of another similar filler being inserted and pushed along and so on. The slot *f* is by this means readily filled up, as the piece of scenery, or "stage property" travels noiselessly across the stage on the chariot in the first "mezzanine" and without the audience being able to see any opening in the stage.

Figures 14, 15 and 16 shew details of a novel contrivance by which I open and close what is theatrically known as a "carpet cut." The usual method is to push up the hinged piece A^2 with a stick or rod. I obtain better results and perfect regularity as follows. The hinged flap when closed, is shewn in full lines and its position when open, is shewn in dotted lines in Figure 14. The lever b is fixed by a set screw b^1 to the shaft b^2 which works in the bracket d fixed to the joist a by bolts as shewn, a crank e fixed to the shaft b^2 by a set screw e^2 works through a staple piece e^3. By bringing the lever b from its normal position as shewn in full lines in Figure 16 to the position shewn in dotted lines it is obvious that the lever b will actuate the shaft b^2 and work the crank e so that the hinged flap A^2 will be raised the required height to allow a carpet or "stage cloth" to be drawn off the stage down the opening, or the stage cloth can be wound upon a roller, fixed sufficiently low to clear the handle of the lever. The shaft b^2 may be of any length, and have any number of cranks e and brackets d which will be regulated by the length of the "carpet cut."

Figure 21 shews in front view and transverse section the detailed construction of the attachments I by which the ropes R are secured to the scene batten B^2. The attachment I is placed between the two pieces constituting the batten and its under edge is turned under in both directions at i to give additional support to each piece. Screws i^2 pass through the said pieces of the batten and attachment I. The rope R has a loop or eye at the end through which passes a bolt i^3 secured by nuts in either of the holes i^4 to adjust the rope.

Figures 22 and 23 shew details of construction of an adjustable apparatus for suspending a batten or "ceiling piece" at any angle required. The screw k is carried in a frame attached to the ceiling piece and upon this screw a nut k^1 is mounted to which the suspending chain is attached there may be any number of these frames and attachments along the length of the ceiling piece. By turning the screw k the nut k^1 is caused to travel therealong and cause the ceiling piece to hang at any angle as shewn in dotted line in Figure 22. A chain may be used at the end of the wire rope for suspending the ceiling piece as shewn in Figure 22 or a spring hook may be used as in Figure 23.

Figures 25, 26 and 27 shew details of the counterweight iron W and the shape of the weights which may be used although I do not confine myself to the particular shape of weights. I have shewn them as having a slot w^4 entering the hole w^5 so that they can be slipped sideways upon the narrow part w^6 of the iron and then be passed down when the larger part of the iron comes in line with the hole w^5. I prefer to use a weight as at w^7 at top to act as a guide to keep the weight iron I in a vertical position when passing up and down in the box C. I also use a weight cast as shewn in Figures 26 and 27 with leg pieces w^8 on one weight taking into recesses w^9 in the other weight. Any rattling noise may be prevented by the rubber disc x inserted between the weights and kept in position by the weight immediately over it keeping it engaged with the studs as shewn.

If I cannot arrange for counterweight boxes C the whole distance from the gridiron to cellar level as shewn in Figure 1 I may use a counterweight iron with a single purchase pulley Y arranged as shewn in Figures 26 and 27 by which means I gain on the counterweight wires say half the distance travelled by the counterweights W.

The means generally employed for producing what is technically known as stage thunder consists in shaking by manual labour sheets of iron which are suspended against a wall, or in rolling iron spheres over a floor situated above the proscenium. The effects produced by these means are very unreal and as the effects to be produced by these means depend on manual labour there can be no reliance that the noise will be produced at the required moment.

According to my invention the noise producing device is under the control of the promptor and can be operated by him without leaving his box and several peals can be produced in succession. Figure 28 represents in vertical section and Figure 29 in front elevation an arrangement of apparatus according to my invention for producing rumbling sound resembling thunder reports of artillery firing, the falling of structures and other noises known as "stage crashes."

In carrying out this part of my invention I provide in any suitable part of the building preferably near the roof or on the gridiron a box or receptacle 1 having a sloping or inclined bottom or platform 2 the lower end of which communicates with any suitable sound producing device such for example as a shoot trough or trunk 3 arranged vertically or at any suitable angle and provided in the interior with abutments 4 or with a zig-zag passage or both.

In the inclined box or receptacle 1 I provide at suitable distances apart and in advance of one another hinged flaps or frames 5 capable of opening towards the lower or outlet end of the box but retained in their closed position by means of hooked levers or catches 6 engaging bars or projections 7. Behind each of the flaps or frames (5) is placed one or more balls or other suitably shaped blocks (8) of metal wood or other suitable material.

In order to release the balls or the like so that they may enter the trough or trunk 3 the retaining catch 6 must be disengaged from the bar or projection 7 and in order that this may be effected from the promptors box or other place situated at a distance from the receptacle 1 I provide each of the hinged catches 6 with a tail 9 and in proximity thereto is an arm 10 hinged at its lower end to the box 1 and carrying at its upper end a weighted head 11. This arm 10 is maintained in its vertical or approximately vertical position by a hinged or spring detent 12 engaging a projection 13 on the arm 10 so that a very small amount only of power is required to disengage the said arm and may if desired be effected by a cord or wire connected to the detent 12 and conducted over or around suitable guide pulleys to the promptors box or other desired part of the building, or it may be operated by any suitable pneumatic arrangement. I prefer however to release the arms 10 by means of electricity for which purpose an electro-magnet 14 is provided in proximity to each arm and may be excited as required by the promptor or other person in charge, by push buttons or contacts in the usual manner. When either of the magnets are excited the detent 12 in proximity thereto will be attracted and brought out of engagement with the projection 13 whereupon the arm 10 will overbalance and cause its head 11 to strike the tail 9 of the lever catch 6 and thereby raise the hooked end of the lever out of engagement with the flap or frame 5. The flap then being unrestrained, the balls previously retained thereby will roll past it down the inclined platform 2 into the shoot or trunk 3 and in their passage through the said trunk produce the desired rumbling sound.

According to the arrangement shewn, it is necessary to release the flaps or frames 5 in successive order from the lower one to the top one, as all of the balls have to pass to the entrance to the trunk by the same passage; it is obvious however that there may be provided if desired a separate passage for each ball retaining device so that either may be operated at will without regard to order. The releasing mechanism and magnets are preferably enclosed in a casing 15 as shewn.

I do not confine myself to the particular shapes of the several parts shewn in the drawings nor to any particular sizes or placement of the parts which will be regulated by the proportions of the theatre and the weight of the scenery and the like to be moved. The material from which the various parts are made will also vary according to circumstances.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is :—

1. For operating the scenes or equivalent moveable devices of theatrical stages the use of wire ropes pulleys and counterweights substantially as hereinbefore described.

2. For operating the scenes on theatrical stages the ropes (R *r*) attached to the scenes and passing over pulleys P and thence over pulleys P^2 and P^4 to a counter-

weighting device in combination with ropes R^1 r^1 R^2 r^2 arranged for raising and lowering the scenes substantially as hereinbefore described and illustrated in Figures 1 and 2 of the accompanying drawings.

3. For raising and lowering scenes from a theatrical stage, the combination with the sloats T and their sliding tongues T^1 carrying the scenes, of counterbalance weights C connected to the tongues by wire ropes w w^1 passing round drums d, and a wire rope w^2 for connecting the drum to a crab or equivalent hauling device or devices substantially as hereinbefore described with reference to the accompanying drawings.

4. For simultaneously raising and lowering two or more scenes from a theatrical stage, the combination of the sloats T and their tongues T^1 carrying the scenes, counterbalance weights c connected to the tongues by wire ropes w w^1 passing round drums d and a wire rope or wire ropes w^2 connected to one or more of the drums d and to a crab K or equivalent hauling device or devices and rods d^1 or equivalent coupling device for connecting the drums d together substantially as hereinbefore described.

5. The arrangement of fillers g provided with pins g^1 and engaging in grooves h^1 and h substantially as and for the purpose hereinbefore described and shewn in Figures 11, 12 and 13 of the accompanying drawings.

6. The arrangement constituting a device for opening and closing a "carpet cut" substantially as hereinbefore described and shewn in Figures 15 and 16 of the accompanying drawings.

7. The arrangement for adjusting ceiling pieces or battens to any desired angle substantially as hereinbefore described and shewn in Figures 22 and 23 of the accompanying drawings.

8. The arrangement of counterweights to prevent rattling substantially as hereinbefore described and shewn in Figures 26 and 27 of the accompanying drawings.

9. For producing rumbling sounds such as hereinbefore described a chamber or receptacle for containing balls or other suitable forms of wood iron or other suitable material in combination with means for releasing or discharging at a distance from the receptacle the said balls or the like as required into a shoot or trunk provided with projections or into other suitable sound producing device substantially as hereinbefore described with reference to Figures 28 and 29 of the accompanying drawings.

10. The arrangement and combination of parts as a whole for operating theatrical stage scenery and producing scenic and stage effects substantially as hereinbefore described and shewn in Figure 1 of the accompanying drawings.

Dated this 20th day of October 1890.

J. H. JOHNSON & Co.,
Agents.

London: Printed for Her Majesty's Stationery Office, by Darling & Son, Ltd.—1890.

Appendix 7

Crowe, Phillips, and Betts, patent relating to their theatrical rope specification.

N° 19,642 A.D. 1890

Date of Application, 2nd Dec., 1890
Complete Specification Left, 28th Aug., 1891—Accepted, 3rd Oct., 1891

PROVISIONAL SPECIFICATION.

Improvements in the Manufacture of Rope.

We, William James Crowe, Herbert Thomas Phillips and William John Betts, all of Eldon Street, in the City of London, Merchants, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in the manufacture of rope especially applicable for use in raising or lowering scenery in theatres, for fire-escapes, for house ladders, for lifts in buildings and other like uses, the object of the invention being mainly to provide an incombustible rope which shall be safer and stronger than ordinary ropes and equally elastic.

In carrying out our invention we form strands by first spinning asbestos fibre into a core, around which core we wind or twist spirally, wires made of suitable metal, over these wires we twist spirally yarns, spun from Manilla hemp or other suitable fibre which is advantageously dipped in a solution which makes it incombustible.

We lay as many strands, formed as above described, as may be required into a rope, which rope will resemble any ordinary hemp rope as regards bulk or for handling purposes.

By this method of manufacture it will be obvious that if our rope be exposed to fire, the core of the strands being of asbestos will not burn and, as the wires are laid spirally round the cores, they will retain their position without being destroyed even should the outer covering of fibre be destroyed.

In some cases where, for example, incombustibility is not an object we may employ a suitable elastic material such as india-rubber in place of asbestos.

Dated the 2nd day of December 1890.

G. F. REDFERN & Co.,
4, South Street, Finsbury, London, Agents for the Applicants.

COMPLETE SPECIFICATION.

Improvements in the Manufacture of Rope.

We, William James Crowe, Herbert Thomas Phillips and William John Betts, all of Eldon Street, in the City of London, Merchants, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in the manufacture of rope especially applicable for use in raising or lowering scenery in theatres, for fire-escapes, for house ladders, for lifts in buildings for ships rigging and other like uses the object of the invention being mainly to provide an incombustible rope which shall be safer and stronger than ordinary ropes and equally elastic.

In carrying out our invention we form strands by first spinning asbestos fibre into a core, around which core we wind or twist, spirally, wires made of suitable metal, over these wires we twist, spirally, yarns, spun from Manilla hemp or other suitable fibre which is advantageously dipped in a solution which makes it incombustible.

We lay as many strands, formed as above described, as may be required, into a rope, which rope will resemble any ordinary hemp rope as regards bulk or for handling purposes.

To enable our invention to be fully understood we will describe how it may be carried into practice by reference to the accompanying drawing in which:—

Figure 1 represents an elevation, and

[*Price 6d.*]

Figure 2 a cross section of a piece of rope manufactured according to our invention.

a, a, a represent the strands we form by first spinning asbestos fibre into a core *b*, around which core we wind or twist, spirally, metal wires *c*, and over these wires *c* we then twist, spirally, yarns *d* spun from suitable fibre such as Manilla hemp, previously dipped, if required, in a solution such as a solution of tungstate of soda which will make it incombustible.

To make a rope from strands *a* formed as above described we lay the required number of strands and twist them in the ordinary manner. In the drawing it will be seen we have illustrated a rope made from three of our improved strands *a*.

By our improved method of manufacture it will be obvious that if our rope be exposed to fire, the core of the strands being of asbestos will not burn and, as the wires are laid spirally round the cores, they will retain their position without being destroyed even should the outer covering of fibre be destroyed.

In some cases where, for example, incombustibility is not an object we may employ a suitable elastic material such as india-rubber in place of asbestos.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. The described improvements in the manufacture of rope consisting in spinning asbestos fibre into a core, spirally winding or twisting metal wires around the said core, and over these wires spirally twisting yarns spun from suitable fibre, a number of strands thus formed being layed into a rope, substantially as described.

2. The manufacture and use of the improved rope hereinbefore described and illustrated in the accompanying drawing.

Dated the 28th day of August 1891.

G. F. REDFERN & Co.,
4, South Street, Finsbury, London, Agents for the Applicants.

London: Printed for Her Majesty's Stationery Office, by Darling & Son, Ltd.—1891

Fig. 1.

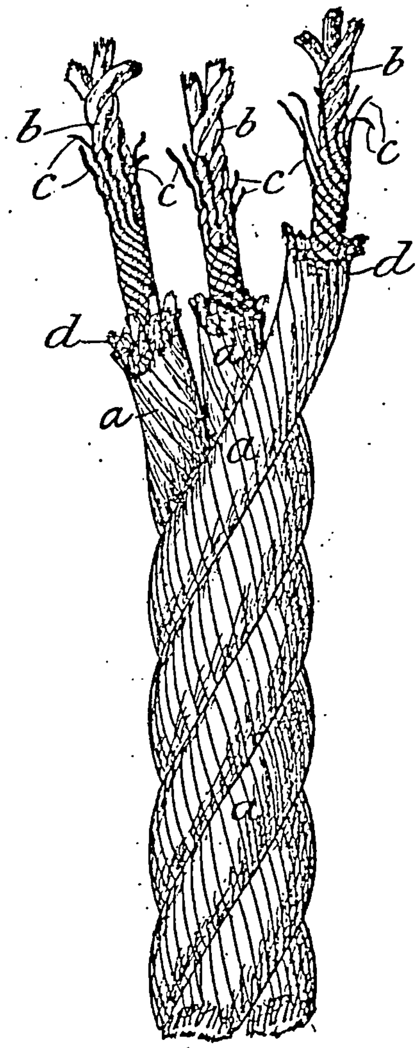
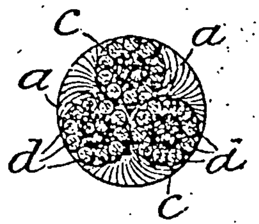


Fig. 2.



A.B.Brown's patent relating to the hydraulic stage machinery for the West End Theatre, Edinburgh.

A.D. 1875, 16th October. N° 3593.

Hydraulic Machinery for Actuating Stage Effects, &c.

LETTERS PATENT to Andrew Betts Brown, of Rosebank Iron Works, Edinburgh, in the County of Edinburghshire, for the Invention of "IMPROVEMENTS IN HYDRAULIC MACHINERY FOR ACTUATING THEATRICAL STAGE EFFECTS, PARTS OF WHICH ARE APPLICABLE TO VENTILATING AND EXTINGUISHING FIRE."

Sealed the 4th January 1876, and dated the 16th October 1875.

PROVISIONAL SPECIFICATION left by the said Andrew Betts Brown at the Office of the Commissioners of Patents, with his Petition, on the 16th October 1875.

I, ANDREW BETTS BROWN, of Rosebank Iron Works, Edinburgh, in the County of Edinburghshire, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN HYDRAULIC MACHINERY FOR ACTUATING THEATRICAL STAGE EFFECTS, PARTS OF WHICH ARE APPLICABLE TO VENTILATING AND EXTINGUISHING FIRE," to be as follows:—

In carrying out my Invention I lay pressure pipes throughout the stage and other parts of a theatre, through which I convey water at high pressure (by preference 800 lbs. per square inch) by means of a boiler and pumping engine, which I place in a fireproof apartment outside the theatre.

The pumping machinery which I prefer to employ is in accordance with a Patent granted to me, dated 14 August 1874, No. 2805. In this pumping machinery I described the piston of a steam accumulator, which on being pumped up over the steam port leading to the steam-pumping engines stopped them. This is however defective in respect that the steam is not entirely shut off from the engines, and my improvement (amongst others) in the pumping machinery consists of the application of a valve and small piston, which is opened and shut by the large piston of the steam accumulator, alternately admitting steam and exhausting it as it passes a small port in the side of the steam accumulator cylinder.

For the purpose of raising and lowering the scene cloths in the stage of a theatre, as well as the sink scenes, paint frames, bridges, and other appliances, I make use of the ordinary and well-known hydraulic hoist, having multiplying pulleys on its ram and cylinder, and I place one of such hoists at the side of each scene, cloth, or sink. This scene is suspended by three or four ropes as may be necessary, which ropes are carried over pulleys immediately above the points of attachment to the scene, and are thereafter gathered into an iron ring. From the hoist the lifting end of the rope is led over a pulley and attached to the aforesaid ring. The ropes on the scenes or cloths are led through eye bolts to belaying pins on the side of the scenes to adjust the stretching of the ropes.

Having set the hoists in position at the side of their respective scenes I place the valves for actuating the same (which are of the slide description) in a group immediately under control of the prompter or other person, the pipes leading from these valves to the hoists; consequently, while the hoists are at the sides and back of the theatre all the valves are in a row at the right-hand side of the stage, so that all the effects of a transformation scene can be produced by one operator.

In producing artificial waterfalls or other water effects on the stage I employ a nozzle, through which I convey a jet of high-pressure water. This nozzle is placed inside a large pipe, which has one end attached to a large tank of water; the other end is carried up over the scenery in which the waterfall is to play. The nozzle has a series of larger shrouding nozzles in the form of an injector. When the high-pressure water is turned on it induces a powerful current in the large pipe, throwing the water out of the tank over the scenery, where it is allowed to run down and drain again into the tank.

An extension of the pipes from the stage machinery is led to the top of the house, and there a hydraulic reciprocating engine, which I will presently describe, is made to actuate a radial piston, wind sail, or punkah, which vibrates to and fro inside a casing to the extent of a quarter of a circle. On each side are placed inlet and outlet valves formed of canvas working on perforated zinc. The suction valves of such an exhauster are in communication with the various parts of the theatre to be ventilated, while the delivery valves communicate with the external atmosphere. The most convenient place for such hydraulic ventilators is upon the roof of the theatre, and it is necessary that the attendant should be able to command the action of such engines from the locality requiring to be ventilated. For that purpose I lead pipes from the pumping machinery, or from the mains on the stage, upwards through the pit, boxes, or other part of the theatre, in which parts I place a regulating valve in the pipe leading to the hydraulic engine. Above this valve, which I prefer to place in that part of the theatre where the heat is likely to collect, is fixed a thermometer, and as the engine which works the ventilators is self-starting the attendant can at once command the ventilation of the house by opening or shutting the valve.

The hydraulic engine consists of a double-acting cylinder fitted with a piston and rod similar to that of a common steam engine. A constant water pressure exists at the front end, while a slide valve admits and exhausts the water from the back of the cylinder. On each end of the slide valve rod is fitted a piston, which works in a subsidiary cylinder, having two extreme admission ports and a centre exhaust port. A small slide valve is worked by a crank pin placed on the top of the shaft of the wind sail, while a larger crank projects in the opposite direction, to which the connecting rod of the hydraulic engine is connected.

The water in all the hoists, engines, &c. herein-before described after having done duty is returned to the pumping engine tank by exhaust mains laid alongside the pressure pipes.

In cold weather I employ the waste steam from the pumping engines to heat the theatre by passing it through the ordinary and well-known arrangement of pipes.

Having on this system a circuit of pressure pipes in the theatre with a store of water and pumping engines capable of keeping it supplied, I introduce fire hydrants in each side of the basement floor, the stage floor, and in the flies, also on each gallery of the front of the house, and I use in connection with these fire hydrants small india-rubber piping of great strength with small directors, so that by the high-pressure of water and the lightness of the hose I have a ready means of extinguishing fire.

I make no claim to the hoist, water injector, or fire hydrants individually, but my Invention consists in the combined arrangement of hydraulic apparatus for doing the varied work of a theatre at present effected by manual labour.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Andrew Betts Brown in the Great Seal Patent Office on the 13th April 1876.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, Andrew Betts Brown, of Rosebank Iron Works, Edinburgh, in the County of Edinburghshire, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Sixteenth day of October, in the year of our Lord One thousand eight hundred and seventy-five, in the thirty-ninth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Andrew Betts Brown, Her special license that I, the said Andrew Betts Brown, my executors, administrators, and assigns, or such others as I, the said Andrew Betts Brown, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for

"IMPROVEMENTS IN HYDRAULIC MACHINERY FOR ACTUATING THEATRICAL STAGE EFFECTS, PARTS OF WHICH ARE APPLICABLE TO VENTILATING AND EXTINGUISHING FIRE," upon the condition (amongst others) that I, the said Andrew Betts Brown, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Andrew Betts Brown, do hereby declare the nature of the said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof, that is to say:—

This Invention has for its object improvements in hydraulic machinery for actuating theatrical stage effects, parts of which are applicable to ventilating and extinguishing fire.

Up to the present time theatrical scenery and stage apparatus has been worked by manual labour, and the number of men which it is requisite to employ in these operations is frequently very large. The employment of these men involves great expense; they require close supervision, and even then mistakes constantly occur, besides which there is often difficulty in obtaining the services of the men at the times when they are required. By my Invention I avoid these uncertainties, and save much of this expense by the use of hydraulic mechanism, which I so combine as to place the whole of the scenery and the stage apparatus under the control of one person.

In conjunction with this hydraulic mechanism, which involves the introduction into the theatre of pipes containing water under very high pressure, I am able very advantageously to combine and apply hydraulic mechanism to the ventilation of the theatre, the extinction of fire, and the production of scenic effects by the exhibition on the stage of cascades or sheets or jets of flowing water.

In order that my said Invention may be most fully understood and readily carried into effect, I will proceed to describe the Drawings hereunto annexed.

DESCRIPTION OF THE DRAWINGS.

Figure 1 is a vertical section of the engine which I employ to maintain a constant pressure in the pressure mains which are led into the theatre. *a* is the accumulator or cylinder, in which the high-pressure water is stored; it is connected with the pressure mains at a^1. *b* is the ram working in this cylinder, and it is loaded by the pressure of steam or of water in an elevated cistern upon the piston *c* working in the large cylinder *d*; *e* is the pipe by which the steam or water enters. The pumping apparatus is built on the top of the accumulator, the pump *f* being placed on the hydraulic cylinder *a*, and the steam or water engine upon the cylinder *d*. The slide valve gear is of the well-known fluid moved type, and will be readily understood on inspecting the Drawing. The steam or water pressure is admitted to the cylinder by a piston valve *g*, having pistons at each end, to which the pressure is admitted by a subsidiary slide valve *h*, which is actuated by tappets *i* and *j*, against which the piston strikes. The apparatus has a wheel and spindle, which controls the speed of the engine by limiting the lift of the valve *k*, which is attached by a spindle to a piston *l* immediately underneath. This piston works in a cylinder, which has a pipe communication with the hole or port on the side of the accumulator cylinder at *m*. The piston having a greater area than the valve *k* will permit it to rise freely when the pressure in the accumulator cylinder at the port *m* is equal to that under the valve *k*, which will be the case in the position of the accumulator piston shown in the Drawing. The engine in such case will continue to work, but directly the piston *c* of the accumulator is pumped up so as to expose the port *m* to the atmosphere, which finds its way to the front of the cylinder through the atmospheric hole *n*, the pressure is exhausted from the under side of the piston *l*, which at once closes the valve *k*. The water is sucked into the pump at *o*, and is discharged through the delivery valve *p* into the accumulator of the hydraulic cylinder, a constant pressure being on the annular area in front of the pump bucket. This apparatus under steam or water pressure is quite automatic, as when the piston *c* descends it exposes the port *m* to pressure, which by communication with the piston *l* raises the valve *k* and so starts the engine, which by its reciprocations charges the hydraulic cylinder, pumping up the piston *c* against the pressure until it exposes the port *m* to the atmosphere, when the engine is stopped.

In place of employing an engine with fluid moved valve an engine with rotating shaft and fly wheel may be employed, as is shown at Figure 2, it is provided with a self-acting valve *k* precisely similar to that described in Figure 1, the water is sucked into the pumps from a tank supply at *o* and discharged through the theatre at a^1. In both engines, whether worked by water or steam, a small tank holding about 400 gallons is placed in the engine room communicating with the suction valve by a pipe into which the return or waste water from the various apparatus in the theatre flows back.

The hydraulic hoist which I employ for the purposes of lifting in the theatre is shewn in Figure 3. *a* is the hydraulic cylinder and a^1 are pulleys turning on an axis carried by a frame attached to the end of the cylinder *a*; *b* is the ram and b^1 are pulleys carried in a frame mounted on its head. The hoist is adapted to suit the use of ropes which make no noise, and it is provided with guide rods having variable stops to limit the action of the hoist in an upward or downward direction. For that purpose the guide rods *c*, *c*, are screwed throughout, and have nuts and jam nuts *d*, *d*, by which the stroke of the ram and cross head can be limited. The rope is led from the belaying pins *e*, *e*, round the first pulley overhead, and to and fro in block and tackle fashion until it leads off the last pulley underneath. The pressure is admitted at the branch *f*.

The arrangement of valves and pipes is described further on.

Figure 4 is a transverse vertical section of the theatre. One of the hoists, as described, is shewn at A, and again another of a larger size at A, A. The rope is shewn rove round the hoist A in dot lining, one end being attached to the belaying pins, while the other is attached to the ring B. This ring however where found more convenient may be replaced by the clamp, shown at Figure 5, which enables the ropes to be taken up quickly. This clamp has a joint at C and a tightening screw at D, the holes E, F, G, receiving the ropes belonging to the pulleys marked E, F, G, Figure 4. These ropes, as shewn, run over the pulleys and lay hold of the wooden beam H carrying the cloth. This beam is grooved at the ends, as shown in Figure 6, and to prevent its fouling the other cloths, as the cloths are necessarily placed close together, it runs upon wire or other rope guides K, K, which enter the notches, and which are attached and held by spiral springs at L, L, the springs keep the rope guides quite tight. As many as 30 cloths may be required to be hung in a theatre, and the rope guides are all taken up by one roller M, M, having ratchet teeth and shaft with a square end so that the rope guides may be tightened up or slackened at pleasure. The tension springs at L, L, are for the purpose of compensating difference in stretch of ropes, so many being all wound on one barrel. When the cloths require to be changed in position it is only necessary to unwind the barrel, when the guide cords K, K, all become slack, and then the cloths may be changed and rearranged.

Although the hoists A are placed in the flies as close together as possible, yet it may happen that the whole are required to be concentrated on cloths occupying a less space, and for that purpose the sliding pulleys shown in Figure 7 are employed, they are shewn in position at N in the flies. The grooved casting O is led along the floor in front of the hoists, and a sufficient number of other castings P with T headed bolts are placed upon it. These castings carry an angle pulley Q which inclines towards the cloth pulley G. By such an arrangement the rope from the hoist A can be led laterally to any distance by passing over one of the pulleys Q and under the next one in position opposite the cloth to be raised, in this way a hoist, whatever its position be, can be made available to work any one of the cloths. The bridge hoist A, A, is placed in the basement, and has its rope (or chain by preference) led to the further end of the bridge over the pulleys R and S, laying hold of the foot of the bridge at T, while its other rope or chain passes over the pulleys at the near end at U and V, laying hold of the bridge again at T. These chains are gathered into a ring at W, to which the hoist chain is attached.

The sink scenes, although not illustrated, are worked in the same manner.

In Figure 4 the boiler is shewn at X, while the pumping engines are at Y. The pressure pipes lead into the building in a way which will be described in respect to Figure 8, but the fire mains are shewn in red lining in Figure 4, the hydrants being shewn at 1, 2, 3, 4, the exhaust mains from the engine passing into the building which they serve to warm through the pipe Z. The exhaust steam pressure is delivered at 10 lbs. per square inch, a safety valve being placed under the smoke box of the boiler to allow any excess of pressure to blow up the chimney.

In Figure 8 a plan of the general arrangement of the stage is shewn. A is the boiler house; B, the engine room; C, the painter's room; D, the stage; E, the prompter's corner. Ten hoists are shewn in the flies at F opposite the prompter's corner, and to these hoists ten lines of pipes are led from the valves underneath the stage floor at the prompter's corner at G. A similar set of ten hoists are placed in the basement. Four heavy bridge hoists and six light sink hoists are also controlled from another line of valves at G, each having its own individual pipe, as shewn. Two hoists at H and I work the curtain and act drop scene, also controlled from the position shewn at G. To show these pipes the Figure shows the stage broken by a line exposing the basement. The pressure pipe from the accumulator J passes into the building and communicates with the row of valves at K, while the exhaust main passes back to the tank at L. A branch M leads to the paint room hoists at N and O, which work the paint frames P and Q by ropes in a similar manner to those already described in the flies. The valves, however, of N and O are placed in that locality so as to be controlled by the artist using the frames. The manner of reeving the ropes is as with the hoists in the flies. The waste steam from the pumping engines passes by the pipe R into the theatre to the various heating apparatus. The fire hydrants are shewn at S and T near the centre of the stage. When it is not convenient to use steam I place the pumping engine shewn in Figure 1 either outside or inside the building, as shewn at U, the pressure pipe passing into the theatre at V, and the water from the large tank supplying the apparatus at W. The arrangement of pressure and return pipes is the same as that shewn in engine and boiler house A and B.

Figure 9 shews a sectional elevation of the apparatus for producing artificial waterfalls on the stage in connection with the machinery already described. A is the stage line; B, the water injector; C, the upper overflow tank; and D the lower receptacle. The water passes from the tank D in the direction of the arrow into the injector B, and rises in the same direction into the tank C, flowing over again into the tank D. The pipe E conveys the jet water back into the engine tank. As this waterfall must be made portable, and be removed from the stage in the intervals of scenery, I make the rising main pipe F of india-rubber. It is coupled readily by the coupling G.

A larger section of the injector is shewn in Figure 10. The pressure water is conveyed in at H, and issues from a nozzle I and annular space J, which can be regulated by the screwed spindle K. It issues through the throat L, which is 1½ inches in diameter, the nozzle I being one-quarter of an inch in diameter and the nozzle J one inch. The suction water enters by L^x and the delivery rises by M. In this way a perpetual current can be kept up from the pumping engines.

For the purpose of ventilation I carry the pressure pipes forward to the auditorium, terminating in the front of the theatre, a transverse section of which is shown at Figure 11. Pressure pipes are represented in heavy dark lines, and rise from a pressure main A by four pipes B, C, D, E, to the roof, there to work the hydraulic engines to be presently described; their passage to the roof is from each department, namely, from the pit, circle, amphitheatre, and gallery. In each department there is a fire hydrant F, a regulating valve G, and a thermometer H. Each line of pipes is quite independent, and controls the action of its own ventilator in the roof at B^1, C^1, D^1, E^1; G, G, G, G, are regulating valves. These ventilators draw the foul air from a flue leading to B^{11} in the gallery to C^{11} in the amphitheatre, to D^{11} in the circle, and to E^{11} in the pit, while they discharge the foul air through the roof into the atmosphere.

Figure 12 is a plan, Figure 13, a horizontal section, and Figure 14, sectional elevation of the hydraulic ventilator or punkah. In Figure 13 a vibrating diaphragm or punkah is shown at A, which is made to move to and fro by an hydraulic engine B. At each flat side of the ventilator casing C and D are arranged valves E and F which are shewn in detail Figures 15. These valves consist of slotted apertures covered with perforated zinc, over which flaps of canvas are secured. The valve F being the suction valve has its canvas inside the casing, while the valve E has the flaps outside, each hydraulic punkah having its own suction conduit and delivery conduit, a sliding door however shewn at G being used to separate the conduits, so that when in winter the differential temperature is sufficient to naturally ventilate the theatre the slide G can be drawn, thus connecting the suction and the delivery conduits, and dispensing with artificial ventilation.

The engine is shewn in sectional plan in Figure 16; G is the hydraulic cylinder in which works the piston and rod H. Constant pressure is admitted to the annular space by the pipe I, while the intermittent pressure is admitted to the full diameter of the cylinder by a slide valve J which is of the single-acting description. The valve rod has pistons K, K, and cup leathers which work in small cylinders, as shewn. Leading to these cylinders are two ports which terminate in a subsidiary slide valve L. Between the ports is the usual exhaust cavity. Pressure water is admitted by the branch M to this small valve casing, and also by a pipe to the larger valve casing, which is however not shown. The slide valve L is moved by a valve spindle N which is jointed by a connecting rod O to a crank pin P on the top of the spindle of the punkah. Motion is given to this spindle by a crank Q which has a sliding crank pin R attached by a connecting rod S to the hydraulic piston rod H, as shewn, the latter sliding in a guide T. The stroke of the hydraulic piston H can thus be adjusted by the variable crank to the work to be done in ventilating. This engine is at all times self-starting, its main slide valve being shifted by the small crank pin P admitting pressure water to and fro to the pistons K, K. The exhaust water returns by pipes to the engine room tank, as shewn in Figure 11 in light lines.

In Figure 17 is shewn the front elevation of the valve box which contains all the slide valves leading to the various hoists; Figure 18 is a cross section of the box, shewing the side elevation of valves; and Figure 19 is a section of the slide valve. In Figure 17 the handles are all arranged side by side, and are labelled with the particular bridge, sink, cloth, or act drop which they control, as well as by numbers, so that a plot of the scenery can be placed above them. In the cross section, Figure 18, A, A, are the admission branches for pressure water; B, B, the branches leading to the hoists by pipes, as already described, while C, C, are the exhaust or return water branches, all leading into one common main. The same letters of reference refer to the section, Figure 19, which represents a single-acting slide valve of the ordinary well-known description.

To control the speed with which the scenes will rise or fall, snugs D, D, are formed on the top of the box; they are shewn in Figure 18, although omitted in Figure 17. These snugs have adjustable screw stops E, E, which limit the travel of the valve lever F. In this way the speed of a transformation scene can be made to accord with the music, and when once set the same speeds can be relied upon either in heaving or lowering.

Having thus described the nature of my said Invention, and the manner of performing the same, I would have it understood that I do not confine myself to the exact details described and illustrated by the Drawings; but I claim,—

The combination of hydraulic machinery for working theatrical scenery and stage apparatus, substantially in the manner described, and also in conjunction therewith I claim,—

The application of hydraulic mechanism, substantially as herein described, for the purposes of ventilation, the extinction of fire, and the production of hydraulic effects upon the stage.

In witness whereof, I, the said Andrew Betts Brown, have hereunto set my hand and seal, this Eleventh day of April, in the year of our Lord One thousand eight hundred and seventy-six.

ANDREW BETTS BROWN. (L.S.)

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1876.

Appendix 9

A.Clark's patent relating to a theatre safety curtain.

A.D. 1883, 24th May. N° 2601.

Fire-proof Screen or Shutter for Separating the Stage from the Auditorium of Theatres.

LETTERS PATENT to Alexander Clark of Lancaster Gate in the County of Middlesex Gentleman for an Invention of AN IMPROVED FIRE-PROOF SCREEN OR SHUTTER FOR SEPARATING THE STAGE FROM THE AUDITORIUM OF THEATRES, TOGETHER WITH MEANS AND APPARATUS FOR WORKING THE SAME

PROVISIONAL SPECIFICATION left by the said Alexander Clark at the Office of the Commissioners of Patents on the 24th May 1883.

ALEXANDER CLARK of Lancaster Gate in the County of Middlesex Gentleman, "AN IMPROVED FIRE PROOF SCREEN OR SHUTTER FOR SEPARATING THE STAGE FROM THE AUDITORIUM OF THEATRES TOGETHER WITH MEANS AND APPARATUS FOR WORKING THE SAME."

My Invention consists in an improved proscenium curtain, screen, or shutter for separating the stage from the auditorium of a theatre in case of fire and in the means and apparatus for working the same whereby its immediate availability in case of need is ensured.

The curtain, screen, or shutter is a rigid structure made of iron or steel plates rivetted to suitable channel and angle iron framing, the curtain, screen, or shutter being constructed double a sufficient air space being left between the two skins to prevent the rapid transmission of heat. Or the intervening space may be filled with water or lined or packed with fire resisting or non conducting material. The curtain would be arranged to slide or work up and down in wrought iron channels of the proper depth (allowing for a proper lap of the curtain) affixed to the proscenium walls. The top portion of the curtain is constructed of channel iron and forms a transverse girder whose ends project at the sides of the curtain and are attached to the heads of hydraulic rams by which the curtain is to be raised and lowered. The cylinders of the hydraulic rams are fixed at each side of the proscenium opening and are equal to the whole vertical motion of the curtain, the ram being of course of corresponding length. The cylinders are charged with water under adequate pressure from a suitable source and under the control of

[*Price 6d.*]

valves operated from any convenient point. The escape of this water from the cylinders permits and regulates the descent of the curtain. With this arrangement the curtain would be partially counterbalanced by suitable weights to enable it to be raised or lowered without too great an expenditure of power.

According to another arrangement instead of the curtain being counterpoised by separate balance weights, the hydraulic cylinders and rams are so constructed and fixed in such position, and the curtain is so connected thereto that the rams themselves act also as counterbalances for the weight of the curtain.

Another arrangement consists in constructing the curtain of two sections, an upper and a lower one arranged to work in opposite directions, the one rising as the other descends and meeting in the centre of the vertical height of the proscenium. The two sections would be so connected by mechanical or hydraulic gear that the one section would more or less counterbalance the other, the working of the two sections being in any case controlled by hydraulic power.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Alexander Clark in the Great Seal Patent Office on the 24th November 1883.

Alexander Clark of Lancaster Gate in the County of Middlesex Gentleman "An improved fire proof screen or shutter for separating the stage from the auditorium of theatres together with means and apparatus for working the same."

My Invention consists in an improved proscenium curtain screen or shutter for separating the stage from the auditorium of a theatre in case of fire and in the means and apparatus for working the same whereby its immediate availability in case of need is ensured.

The curtain, screen or shutter is a rigid structure made of iron or steel plates rivetted to the opposite sides of suitable channel and angle iron framing thus forming a double skin with a sufficient air space between the two skins to prevent the rapid transmission of heat. Or the intervening space may be filled with water or lined or packed with fire resisting or non conducting material. The curtain would be arranged to slide or work up and down in wrought iron channels of the proper depth affixed to the proscenium walls. Near the top of the curtain is a transverse girder constructed of channel iron whose ends project at the sides of the curtain and rest on the heads of hydraulic rams by which the curtain is to be raised and lowered. The cylinders of the hydraulic rams are fixed at each side of the proscenium opening and are equal to the whole vertical motion of the curtain, the ram being of course of corresponding length. The cylinders are charged with water under adequate pressure from a suitable source and under the control of valves operated from any convenient point. The escape of this water from the cylinders permits and regulates the descent of the curtain. With this arrangement the curtain would be partially counterbalanced by suitable weights to enable it to be raised or lowered without too great an expenditure of power.

According to another arrangement instead of the curtain being counterpoised by separate balance weights, the hydraulic cylinders and rams are so constructed and fixed in such position, and the curtain is so connected thereto that the rams themselves act also as counterbalances for the weight of the curtain.

Description of Drawings

Figure 1 is a rear elevation of the curtain showing the hydraulic gear and figure 2 is a vertical section of same. Figure 3 is a horizontal section of one side of the curtain (on line 1—1 figure 1) drawn to a larger scale and figure 4 is a vertical section of the upper part of the curtain showing the girder.

A is the curtain screen or shutter and B are the guides in which it works. C is the transverse girder and D are guides in which its ends work. E are the hydraulic rams and F their cylinders, G are counterweights attached to chains passing over sheaves H and connected to the girder C.

The framing of the curtain A is composed of channel irons *a* around the edges and of upright ribs of T iron *b* united by through rivets. The girder C is preferably of box section and may be made of two channel irons united by through bolts after the plates have been rivetted to their respective halves of the girder. A sufficient space is left between the channel irons to permit the free circulation of air and the top and bottom channel irons *a* are drilled at intervals for the same object, so that although in the event of fire one side of the curtain may become hot the heat will not be transmitted to the other side.

The plates composing the two skins are rivetted to the framing *a b* and to the respective halves of the girder C. The plates butt joint and are rivetted to inside covering plates at the horizontal joints.

The curtain is rather wider and higher than the opening in the proscenium wall K to the back of which the guides B are fixed. The cylinders F rest on a suitable foundation and are fixed to the back of the proscenium wall K, and are constructed in the ordinary way.

The heads of the rams take under the projecting ends of the girder C which work in the guides D formed on the stanchions which carry the sheaves H and which are also fixed against the proscenium wall. The counter balance weights G work in boxes fixed against the wall K. The curtain preponderates sufficiently over these weights to descend slowly of itself when the water is released from the ram cylinders. The cylinders F are supplied with water under pressure from the same main and the supply and release of the water is controlled by a valve L operated by a lever M at one side of the proscenium.

When separate counterbalance weights are not used the cylinders would be inverted and would be fixed to a suitable support and the chains would pass over sheaves mounted on top of the cylinders and under sheaves attached to the lower ends of the rams in the usual way.

Having described the nature of the said Invention and the manner of performing the same I declare that what I claim as the Invention to be protected by the hereinbefore in part recited Letters Patent is:

1. A fire resisting proscenium screen or shutter constructed of a double skin composed of iron or steel plates secured to a suitable frame work with an intervening space between the two skins substantially as shown and described.

2. The combination of a proscenium screen or shutter constructed as herein specified and of hydraulic gear arranged for operation substantially as shown and described.

In witness whereof I the said Alexander Clark, have hereunto set my hand and seal this Twenty fourth day of November A.D. 1883.

ALEX^{R} CLARK (L.S.)

LONDON: Printed by Eyre and Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1883.

Appendix 10

Emden, Walter: 1847 - 1913

Born in London second son of William S.Emden, sometime proprietor of the Olympic theatre: studied mechanical engineering in the workshops of Maudsley, Sons and Field, Lambeth and was a civil engineer in the firm of Thomas Brassey: became an architectural pupil of Kelly & Lawes FFRIBA 1870: was for a long period a member of Strand District Board of Works, and for seven years their Chairman. In 1890 he was elected a member of London City Council 1900, becoming Mayor in 1903. Retired 1906, presenting his practice to his four principal assistants, S.H. Egan, W.S. Emden, A.J. Croughton and T.C. Ovenstone, who carried on as Emden, Egan & Co. Besides theatres, was the architect of many hotels, restaurants and similar buildings.

Emden exemplified the mid-Victorian laissez-faire attitude to theatre architecture: In his 1870 reconstruction of the Globe (done in his first year of "studying" architecture) he was already calling himself "architect". His lack of formal training shows in his early work: until he started collaborating with Crewe and Phipps, his was the epitome of charming architectural illiteracy. The exterior of Terry's was a typical pub of the period and the famous Tivoli a glorified fun palace, quite different in manner to the stately colonnade of the Garrick, which clearly indicates the hand of Phipps. Internally too, he graduated from simple, delicately decorated balconies supported on slender columns curtained at the proscenium ends to form stage boxes to the firm elaborate style (still with low-relief ornament) of the Garrick or the Duke of York's excellent examples of late 1880's -early 1890's Phipps. There is a well-behaved precise quality to Emden's later work which properly reflects his social achievements in the world of affairs.

From: Curtains!!! or A New Life For Old Theatres, op.cit., p.212.

Appendix 11.

"The following are the contractors engaged by Mr.Sachs for the execution of the work:-

The general contractors were Messrs.Colls & Son (manager in charge, Mr.Collins; foreman, Mr.Dowse). The ironwork contractors for everything above stage level were Messrs.Lindsay, Neal, & Co.Limited; whilst the entire complicated structural and mechanical ironwork below stage level, including the stage 'bridges' and lifts, was by Messrs.Drew-Bear, Perks, & Co. (manager in charge, Mr.Simco). The electrical power plant for the 'under machinery' was provided by the Thames Ironwork Shipbuilding Company, Limited, of Blackwall (manager in charge, Mr.Flood); whilst the whole of the elaborate counterweight mechanism above stage level was provided by the well-known Berlin stage machinist and contractor, Mr.F.Brandt, who personally attended to the installation of his appliances in London. The fire-resisting curtain was by Messrs.Merryweather & Sons, Limited, and the alterations in the auditorium by the Army and Navy Auxiliary Supply, Limited (manager in charge, Mr.Player)."

The Builder, 1st June, (1901), p.540.

A list of contractors who were engaged on the reconstruction of the Royal Opera House, Covent Garden, London.

Appendix 12

O.Stoll's patent relating to a triple concentric revolving stage.

N° 18,160 A.D. 1902

Date of Application, 18th Aug., 1902

Complete Specification Left, 18th May, 1903—Accepted, 18th Nov., 1903

PROVISIONAL SPECIFICATION.

Improvements in connection with Stage and Platform Appliances for Producing Scenic and other Displays.

I, Oswald Stoll, of 39, Newport Road, Cardiff, Theatre Proprietor, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in connection with the construction, arrangement and use of platforms, and theatrical and like stages, upon which plays, spectacles and other animated scenic panoramas or displays can be mounted; the object being to enable the stage or platform constructed and arranged as hereafter set forth, to more efficiently display the scene or panorama, and to more realistically portray moving pictures and objects, than is possible with the present forms of platform and stages in use for such purposes.

In carrying my invention into effect I make my stage preferably in the form of two or more concentric sections and I mount these sections upon bearers, rollers, rails, guides and other like retaining devices, so that each member is capable of moving independently of the other or when so adjusted, to move as one uniform or plain surface.

I cause the concentric ring-like members of my improved stage or platform to revolve in either direction, the direction of rotation of each being independent of that of the others, so as to produce upon the one stage section a reverse movement to that of the other section.

I transmit motion to the spindle carrying the concentric disc when such is employed, by means of gearing or by means of any ordinary mechanically driven arrangement or I may mount a motor about the same to convey the necessary revolving movement direct to the disc member of the combination stage surface.

The ring like members which surround the central disc portion of my improved stage I may drive by means of pulleys projecting beneath the stage platform, such pulleys being connected by belting or the like to any motive power pulley on the main driving shaft of the engine or motor which may be employed for such purpose. Instead of driving by pulleys and belting I may employ separate motors for driving by pinions or the like into the rack like surface which I may form upon the underside of the ring like members of the platform, and I may actuate the motors by steam, electric, hydraulic or other power, providing in connection therewith gear changing appliances and adjustable governing apparatus, for varying the speed and for minimising the friction and obviating vibration to suit the purpose for which the moving stage members are required.

I do not limit the application of my invention to any particular method of building up the sections of my platform or to any special manner of setting the same in motion but I vary the mountings, bearings, fittings and apparatus for use in connection therewith to suit the particular position in which the stage or platform is to be erected and the motive power which is available for such purpose, providing also where necessary, means for enabling manual power to be employed for transmitting the motion to the various member when mechanical power is not available therefor.

Dated this 18th. day of August 1902

MARKS & CLERK,
18, Southampton Buildings. London, W.C.
13, Temple Street. Birmingham, and
30, Cross Street Manchester.
Agents.

COMPLETE SPECIFICATION.

Improvements in connection with Stage and Platform Appliances for Producing Scenic and other Displays.

I, Oswald Stoll, Theatre Proprietor, of 39 Newport Road, Cardiff, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in connection with the construction, arrangement and use of platforms, and theatrical and like stages, upon which plays, spectacles and other animated scenic panoramas or displays can be mounted; the object being to enable the stage or platform constructed and arranged as hereafter set forth, to more efficiently display the scene or panorama, and to more realistically portray moving pictures, animals, cycles and other vehicles or objects, than is possible with the present form of platform and stages in use for such purposes.

In carrying my invention into effect I make my stage preferably in the form of two or more concentric sections or platforms and I mount these sections upon bearers, rollers, rails, guides and other like retaining devices, so that each member is capable of moving independently of the other or when so adjusted, to move as one uniform or plain surface.

I cause the concentric ring-like members of my improved stage or platform to revolve in either direction, the direction of rotation of each being independent of that of the others, so as to produce if necessary upon the one stage section a reverse movement to that of the other section.

I transmit motion directly to the concentric platforms or sections by any suitable form of power-driving mechanism or motor depending upon the size of the stage and the source of power at disposal.

Where electrical power is available I prefer to employ electric motors as illustrated in the accompanying drawings, wherein

Figure 1 is a cross sectional elevation, and

Figure 2 a plan of an arrangement of three concentric sections or platforms,

Figures 3 and 4 being detail views illustrating convenient modes of driving such platforms, on a slightly larger scale.

In carrying out the invention in one convenient manner as illustrated three concentric sections or platforms *b*, *c*, *d*, are enclosed within a suitable building, wherein *a* would represent the position of the spectator or audience.

The sections or platforms are suitably stiffened by girders or like constructional members and provided with circular races *f* adapted to bear on supporting balls or rollers *e* in such a manner that the platforms are free to be revolved thereon in either direction as required to give the desired scenic effect. The races *f* may in some cases be stationary, the rollers being carried on the platforms, or rollers may be dispensed with the races simply sliding, The races and gears may be either toothed or plain. When toothed races are employed I impart motion to the platforms by means of toothed pinions c^1, c^1 (Figure 3) and when plain races are employed I use plain friction wheels *g* (Figure 4).

In either case I prefer to mount the driving element whether pinion or friction wheel directly upon the motor shaft, the power being thereby applied directly from the motor to the platform.

I prefer to employ a separate motor *m* for each platform as indicated in Figure 1 in order that the separate platforms may be independently operated. When employing electric motors I may either control each motor by separate and independent switches or I may employ a main controller adapted to permit variation in relative speed and direction of motion between the platforms.

The driving motors or mechanism may be carried upon the platforms and the races or racks be secured to a stationary foundation.

In cases where it is impossible to directly apply the motor to the platforms in the manner described I may employ intermediate gear wheels, but in such cases I employ the least possible number of wheels making the application or transmission of power from motor to platform as direct as possible.

I do not limit the application of my invention to any particular method of building up the sections of my platform, but I vary the mountings, bearings, fittings and type of motor for use in connection therewith to suit the particular position in which the stage or platform is to be erected and the motive power which is available for such purpose.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1.—A stage comprising a number of concentric platforms adapted to be rotated in any desired relative directions and at any desired relative speeds by independent motors directly applied to such platforms substantially as described.

2.—A stage comprising a number of concentric platforms having races on their under-surfaces bearing on rollers and adapted to be rotated in any desired relative directions and at any desired relative speeds by independent motors applied directly to said races, substantially as described.

3.—A stage comprising a number of concentric platforms having racks on their under-surfaces bearing on toothed bearing wheels, and adapted to be rotated in any desired relative directions and at any desired relative speeds by independent motors applied directly to said racks substantially as hereinbefore described.

4.—An improved stage comprising a number of concentric platforms adapted to be rotated independently and in any desired relative directions, constructed and arranged substantially in the manner hereinbefore described with reference to the accompanying drawings.

Dated this 18th day of May 1903.

MARKS & CLERK,
18, Southampton Buildings, London, W.C.
13, Temple Street, Birmingham, and
30, Cross Street Manchester.
Agents.

Appendix 13

A description of the panorama apparatus which was installed at the Coliseum Theatre, London.

"The panorama gear consists of the following: three power-driven rollers for ordinary panoramas, and one set of two power-driven rollers for cyclorama, or panorama, together with the necessary grooves crossing the stage. In crossing from one side of the stage to the other the cloths are hung from a wire rope, which winds on to or off the rollers at the same time as the cloths themselves. The ropes run in grooves, suspended from the grid, and are supported by a special form of clip to which the cloths are attached. The lengths of groove between the flies carrying the three ordinary power-driven panoramas are arranged to lift vertically through a height of 12ft., special winches being provided in the O.P. fly for the purpose. The five power-rollers are driven by electric motors placed under the stage, through high efficiency, silent worm gearing enclosed in oil baths. Auxiliary hand gearing is provided on the fly-floor for use as a stand-by. For the purpose of gathering up the three power-driven panorama cloths in the prompt side scene dock, walking ways of light steel are provided, suspended from the fly. The travelling carriages are for the purpose of bringing people and scenery into sight of the audience quickly. The carriages are three in number, coupled together, and they each consist of a light steel framework, carrying a teak platform, 17ft. by 4ft.6in., at about stage level. The carriages depend from and travel 40ft. above stage level, and crossing from side to side. Each carriage has four travelling wheels, arranged in pairs in a bogie frame, to facilitate running round a curve into the scene dock on the prompt side, where they are kept when not in use. An electric winch is provided on the prompt side fly for driving the carriages by means of a steel-wire rope. The maximum speed of the carriages is seven miles per hour, and the weight of the three, when loaded with people and scenery, is eight tons. An electric brake is provided on this winch for pulling the carriages up quickly, but in order to ensure absolute safety, should this brake fail to act and the carriages continue to run, they themselves cut off the current and apply powerful mechanical brakes to the travelling wheels.

Two sets of five power-driven winches are provided, one set on the fly-floor of each side of the stage, for lifting wrought cages in which scenery is placed. Each set is arranged in a line, each winch having three barrels coiling ropes, which pass from the top of the cages over pulleys fixed on to the grid. The winches are arranged so that they can be driven from an electric motor two at a time, or they can be driven independently, clutches being provided for putting into or out of gear any particular winch. An electric brake is fitted to the motor to pull it up quickly after the current has been cut off; also each winch has an independent mechanical brake. Six sets of hand-power winches for raising skycloths, &c., have also been fixed on the fly-floors, each winch being provided with three barrels coiling ropes, to which are attached steel tubes 55ft. long. The ropes are passed over pulleys fixed on the grid. Each winch also has a barrel for coiling a counterbalance rope, the counterbalance weight being arranged to work up and down in guides on the side wall of the building."

Supplement to the Illustrated Carpenter and Builder, 6th Jan.,(1905), p.6.

Appendix 14

The original French text from Contants, Parallèle relating to the 'English system'.

PLANCHE 27.

COUPE TRANSVERSALE, ÉQUIPE D'UN VOL TOURNANT, DES TRAPPILLONS ET DES CHASSIS EN FERMES.

A. Coulisseau mobile guidant la tête des châssis et demi-fermes du fond, mis en état pour le changement.

A*. Position du même coulisseau avant sa mise en état.

a. Tasseaux en saillie sur le plancher de la scène, entre lesquels glissent les patins des châssis et des demi-fermes.

B. Ferme de fond en deux parties réunies au milieu et maintenues jointes par des taquets contrariés hors parement.

C. Coulisses ordinaires ou châssis d'aile.

D. Chemins des vols de travers, etc.

D*. Tambour à roue avec broches en fer entre lesquelles passe le fil sans fin.

E. Char mobile.

E*. Fil sans fin du tambour.

F. Fils d'appel du char au petit diamètre du tambour.

G. Treuil à pignon et manivelle avec double cylindre à engrenages servant à élever ou à baisser à volonté l'appareil du vol.

H. Fils du treuil au char.

I. Traverse horizontale ou porteur d'un nouveau système de vol tournant.

I*. Retraite tendue à ses deux extrémités par des contre-poids après avoir été passée dans des œillets tournés, fixés sur la traverse afin de l'empêcher d'osciller pendant la rotation de la roue qui y est suspendue. (Voir pour les détails la pl. 36, fig. 12 et 13 de ce système.)

J. Fil sans fin de la roue horizontale.

K. Roue en bois avec gorge horizontale sous laquelle est fixée une roue à engrenage.

L. Petit tambour des fils du porteur avec roues en fer s'engrenant avec la roue du dessus et imprimant au vol un mouvement de va-et-vient.

M. Armature en fer à laquelle sont arrêtés les fils de fer ou de laiton.

N. Tambours parallèles, à deux diamètres, manœuvrés à la main. C'est sur le petit diamètre de ces tambours que les trappillons à lames brisées s'enroulent pour livrer passage aux décorations du dessous.

O. Conduits en bois dans lesquels glissent les trappillons en s'ouvrant ou en se refermant.

P. Fils sans fin des tambours parallèles.

Q Moufle et fils servant à rappeler et à joindre les trappillons.

R. Petits tambours à manivelles transmettant les mouvements au gros tambour S au moyen du fil sans fin T.

PLANCHE 28.

DÉTAILS DE LA CONSTRUCTION DES CONDUCTEURS

OU COULISSEAUX MOBILES, CHASSIS ET FERMES DU CINTRE.

A. Plancher du gril.

B. Plancher du premier corridor.

C. Chevalet ou bâti de prolongement des coulisseaux mobiles sous les corridors latéraux du cintre.

D. Partie mobile du coulisseau mis en état pour le mouvement d'une ferme. Les lignes ponctuées indiquent la position du coulisseau lorsqu'il ne sert qu'à manœuvrer le châssis d'aile.

E. Cheville de retraite en échelle pour pratiquer sur le coulisseau.

F. Fil à la main pour baisser ou lever le coulisseau.

G. Chaîne en fer ou support fixe.

G'. Chaîne mobile pour maintenir de niveau l'extrémité du coulisseau.

Fig. 2e. Coupe des planchers et assemblages de chevalets sous les corridors.

Fig. 3e. Plan général du coulisseau.

Fig. 4e, 5e, 6e. Détails d'exécution ou profils, plan et coupe d'un coulisseau.

PLANCHE 29.

DÉTAILS DE CONSTRUCTION DES TAMBOURS OU CYLINDRES.

Fig. 1re et 2e. Coupe et élévation du gros diamètre des tambours ordinaires pour rideaux et plafonds, montrant le moyen d'arrêter les retraites à la main et au contre-poids.

Fig. 3e et 4e. Coupe des assemblages à coins et bourrelets dudit tambour.

Fig. 5e. Roues à chevilles en fer recourbées entre lesquelles passe le fil sans fin des mêmes tambours manœuvrés sans contre-poids.

Fig. 6e. Coupe du bord extérieur de la roue garni de chevilles.

Fig. 7e. Grande poulie avec chape en fer, manivelle et boulon à tige et écrou à oreilles pour tendre à volonté le fil sans fin.

Fig. 8e. Profil de ladite poulie.

Fig. 9e. Coupe d'un petit cylindre sur lequel les rideaux s'enroulent de bas en haut. Ces cylindres ont ordinairement 20 à 25 centim. de diamètre sur 13 à 14 mètres de longueur. Ils sont recouverts sur toute leur circonférence d'une toile collée et clouée, afin qu'ils soient plus légers que s'ils étaient en bois plein; la partie inférieure du rideau est fixée sur le cylindre, la partie supérieure est réglée de niveau aux solives du gril au moyen de cordes mortes ou faux cordages.

Fig. 10e. Coupe du même cylindre terminé à chaque extrémité par un diamètre à douves pleines entre les bourrelets, recevant les fils sans fin qui servent à la manœuvre et qui sont renvoyés sur un tambour à spirale. (*Voy.* Pl. 30, fig. 1 et 2.)

Fig. 11e à 16e. Coupes transversales et longitudinales des divers systèmes de construction des arbres des tambours et treuils.

PLANCHE 30.

CONSTRUCTION DES TAMBOURS.

Fig. 1re et 2e. Tambour à spirale avec volant, ou roue en fonte et manivelle servant à la manœuvre du rideau d'avant-scène et de celui du fond, qui est également enroulé horizontalement sur un cylindre. La retraite du contre-poids occupant le petit diamètre du tambour, les fils sans fin du cylindre parcourant de haut en bas la gorge de la spirale, constituent une manœuvre des plus faciles.

Fig. 3e et 4e. Coupe et élévation d'un tambour ordinaire.

Fig. 5e et 6e. Bâti portatif avec deux petits tambours à manivelle et œillets tournés, dans lesquels passent les fils des divers transparents des rampes à gaz.

Fig. 7e et 8e. Petit tambour mobile servant dans les corridors ou dans le cintre.

Fig. 9e, 10e et 11e. Treuil ou moteur portatif avec deux diamètres à gorge et dont l'axe est mobile, afin de pouvoir tendre convenablement les fils sans fin des tambours ordinaires ou à chevilles en fer auxquels il doit transmettre le mouvement.

PLANCHE 31.

CONSTRUCTION ET ÉQUIPE DES TRAPPES.

Fig. 1re et 2e. Coupe d'un bâti de trappes ordinaires.

A. Plancher mobile de la scène.

B, C. Châssis d'assemblage avec contre-poids plat fixé à ce plancher.

D. Arrêts sur lesquels repose le bâti.

E. Tasseaux ou échantignolle formant feuillure.

F. Levier au moyen duquel se fait le mouvement ascensionnel.

Dès que ce levier est dans la position verticale (indiquée par les lignes ponctuées), le bâti monte. L'acteur soulève le plancher mobile qui est entraîné par le châssis à contre-poids plat dans un coulisseau vertical, et le bâti achève sa course sans secousse, puisque les boulets de fer qui l'entraînent, touchant la terre les uns après les autres, évitent le choc.

Fig. 3e. Coupe d'un autre bâti de trappe, à savoir :

A. Fils agissant sur les leviers qui font ouvrir intérieurement le plancher de la scène en deux parties.

B. Levier à charnière.

C. Contre-poids des fils qui maintiennent les planchers ouverts.

Fig. 4e. Détails indiquant la position du levier et du plancher ouvert pour livrer passage au bâti.

D. Panneton ou arrêt qui tient en joint les planchers lorsqu'ils sont ouverts ou fermés.

Fig. 5e. Bâtis doubles ou trappes à transformation.

A. Bâti de disparition.

B. Bâti d'apparition.

L'acteur qui doit disparaître étant placé sur la trappe A, et celui qui doit le remplacer étant sur la trappe B, on ôte, au signal, le pied-debout I (marqué par les lignes ponctuées). La trappe en descendant vivement fait monter l'autre avec l'acteur, lequel par une secousse imprimée au plancher à pivot C lui fait recouvrir l'espace laissé vide par la trappe qui descend.

D, E, F, G. Contre-poids sphériques accélérant la disparition et espacés de manière à ce que ceux en F, G soient à terre quand le bâti A est à un mètre au-dessous du plancher, et les contre-poids D, E également à terre lorsque le mouvement de ces trappes sera accompli.

H. Fil au bout duquel on peut suspendre un contre-poids qui n'agit qu'au moment où le bâti B est à environ 15 centimètres du plancher de la scène; il empêche que dans un mouvement si rapide il ne dépasse le niveau de ce plancher.

Fig. 6e. Plan du bâti fixe.

Fig. 7e. Plan du plancher mobile de la scène.

PLANCHE 32.

ÉQUIPE DES TRAPPES.

Fig. 1re. Plan d'un bâti de trappes avec contre-poids aux angles.

Fig. 2e et 3e. Coupe dans les deux sens du bâti des trappes, tambours, etc.

Fig. 4e. Plan du dessous du plancher mobile à lames brisées.

Fig. 5e. Plan du dessous du même plancher garni de ses ferrures.

Fig. 6e. Coupe indiquant par des lignes ponctuées la position du plancher à lames brisées pour le passage du bâti de trappes.

A. Poignée mobile pour ouvrir et fermer le plancher de la scène.

B. Traverse servant à fixer ladite poignée.

C. Bouton d'arrêt au verrou.

Les mouvements de ce bâti s'exécutent au moyen du petit tambour à manivelle fixé par deux montants boulonnés aux solives du plancher de la scène.

PLANCHE 33.

ÉQUIPE DES TRAPPES

Fig. 1re et 2e. Coupe dans les deux sens d'un bâti de trappe circulaire.

Fig. 3e. Plan du plancher fixe de la scène.

Fig. 4e. Plan du bâti circulaire.

Fig. 5e. Plan de la moitié du plancher circulaire glissant sous celui de la scène au moyen du pied-debout qui le tient en joint. (*Voir* fig. 2.)

Fig. 6e et 7e. Coupe dans les deux sens d'un grand bâti de trappes.

A. Poignée du châssis mobile au moyen duquel l'on ouvre et l'on ferme à volonté les deux parties du plancher de la scène.

B. Coulisseaux du bâti fixe recevant ce plancher. (*V*. fig. 8.)

C. Coupes de planchers, l'un ouvert, l'autre fermé.

Fig. 8e. Plan du bâti fixe et des coulisseaux.

Fig. 9e. Détail de la coupe D. (*Voir* fig. 2.)

E. Tasseau en chêne sur lequel repose le plancher lorsqu'il est ouvert.

F. Arrêt mobile formant feuillure avec le tasseau.

G. Traverse fixe dans laquelle glissent les tenons de l'arrêt.

H. Traverse en sapin boulonnée en contre-bas du plancher du bâti servant à faire monter au niveau du plancher de la scène le tasseau et l'arrêt en chêne, lesquels redescendent à leur repère en même temps que le bâti disparaît.

Fig. 10e. Moitié du plancher mobile de la scène garni de ses ferrures.

PLANCHE 34.

IMITATION DES ÉCLATS DE TONNERRE.

Fig. 1re et 2e. Coupe et élévation d'un treuil portatif à éclats.

Fig. 3e et 4e. Coupe et plan d'une machine à double mouvant dont l'effet est d'une grande puissance lorsqu'il est mêlé au roulement du tonnerre.

A. Clapets fixes.

B. Clapets mobiles et pivotant

C. Courbes décrites par les clapets.

Le diamètre de cette machine est subordonné à l'importance du théâtre. On l'établit le plus près possible de l'ouverture de la scène, soit au niveau de celle-ci, soit sur le plancher du premier corridor; on la met en mouvement au moyen d'un fil sans fin passé sur la roue ou volant (*Voir* fig. 4).

Fig. 5e et 6e. Plan et coupe d'une machine à deux tambours dentelés montés sur des roues en fonte mises en mouvement par un pignon avec manivelle.

Fig 7e. Éclats à lames d'un mètre de long sur onze centimètres de large et deux centimètres d'épaisseur, en bois de chêne bien sec et sonore.

On lâche cette machine de haut en bas sur la scène; il en faut au moins deux pour produire un effet suffisant. Quelquefois on entre-mêle des feuilles de tôle aux tablettes de bois. Cette machine est en usage à cause de sa simplicité, mais nous croyons les deux autres préférables.

PLANCHE 35.

IMITATION DU VENT, PARALLÈLES EN FER.

Fig. 1re. Coupe transversale d'un treuil ou roue dentelée en bois servant à imiter les rafales du vent.

Fig. 2e. Élévation latérale de cette machine, suspendue sous le premier corridor du cintre et mise en mouvement par un fil sans fin passant dans la gorge extérieure du volant et dans une poulie de renvoi fixée sur le plancher de la scène.

A. Pièce de soie écrue enveloppant la roue dentelée. La ligne ponctuée indique la position de cette étoffe avant sa tension sur la partie inférieure de ladite roue.

B. Fil de tension de la soie passant dans des œillets tournés, en bois dur.

C. Fil sans fin.

Fig 3e et 4e. Coupe et élévation d'un treuil portatif avec roue à manivelle pour imiter le sifflement du vent.

A. Pièce de soie écrue couvrant la partie supérieure de la roue dentelée en bois.

B. Écrous à oreille double pour tendre la soie.

Fig. 5e. Coupe d'une gloire à bascule ou parallèle en fer, équipée pour enlever un acteur à trois mètres du plancher de la scène, au moyen d'un treuil à engrenage en fer avec manivelle. Les lignes ponctuées indiquent le chemin parcouru par le plancher qui porte l'acteur.

Fig. 6e. Plan d'aspect de la parallèle prête à manœuvrer.

Fig. 7e. Élévation de la même parallèle.

Fig. 8e. Coupe et détails d'assemblage de la plate-forme ou du plancher vu de face.

Fig. 9e. Coupe et détails du même plancher vu de profil.

Fig. 10e. Plan et détails de l'armature principale supportant ce même plancher.

A. Gâches en fer dans lesquelles passent les leviers recourbés en bois de hêtre servant à fixer les machines sur la scène.

B. Plate-forme ou coulisseau portant l'appareil.

PLANCHE 36.

CASSETTES ET TREUILS POUR VOLS.

Fig. 1re et 2e. Cassettes pour les fermes du fond montant du dessous, vues par derrière et de face, à savoir :

A. Ferrures servant à fixer la cassette aux solives des planchers de la scène et du premier dessous. Ces ferrures contre-coudées sont percées d'un trou de boulon de quinze millimètres correspondant à ceux des plates-bandes en fer, entaillées de chaque côté des solives dans toute leur longueur et espacées de cinq centimètres, de sorte que la mise en place ou le déplacement d'une cassette s'exécute avec une très-grande facilité.

Fig. 3e. Coupe de la cassette et de la poulie de renvoi du fil de l'âme au tambour.

Fig. 4e. Ame de la cassette équipée de son fil et sur laquelle est boulonnée la ferme.

B. Échantignolle ou tasseau sur lequel repose le patin de la ferme.

C. Cheville pour mettre en retraite le fil de l'âme.

D. Œillet tourné, en bois dur, dans lequel passe ledit fil.

Fig. 5e. Plan de la cassette et de l'âme garnies de leurs boulons.

Fig. 6e. Coupe des sablières et boulons à clavettes E, au moyen desquels on fixe les cassettes dans les dessous du théâtre.

Fig. 7e. Grande cassette assemblée à claire-voie garnie de brides et de boulons en fer pour enlever jusqu'aux frises plusieurs acteurs, comme par exemple dans le ballet de *Faust*.

Fig. 8e. Plan de la cassette et de l'âme garnies de leurs ferrures.

Fig. 9e. Coupe du plancher en saillie supporté par une potence en fer boulonnée sur l'âme de la cassette.

Fig. 10e. 11e, 12e, 13e. Détails d'exécution du travail à double cylindre, mouvement et équipe des contre-poids et du vol tournant. (*Voir* Pl. 27.)

PLANCHE 37.

RAMPES DE GAZ ET D'ARTIFICE.

Fig. 1re. Coupe d'une rampe à gaz hydrogène, construite en bâtis de sapin, à savoir :

A. Tuyau de conduite du gaz et bec à éventail.

B. Tringles en fer fixées dans toute la longueur de la rampe aux cercles saillants pour éviter que les toiles et les cordages du cintre n'approchent trop près des becs de gaz.

Fig. 2e. Élévation et équipe de suspension d'une rampe garnie d'un tuyau en cuir, retenu cylindrique par un ressort à boudin C, alimentant la conduite en cuivre ou en plomb sur laquelle sont branchés les becs de gaz.

Fig. 3e. Plan du dessus de la même rampe garni de ses ferrures.

D. Traverses espacées d'environ 40 centimètres pour recevoir le bâti sur lequel est fixé le réflecteur en tôle.

Fig. 4e et 5e. Élévation de profil et de face d'un treuil à engrenage, rochet et manivelle pour manœuvrer les rampes.

Fig. 6e et 7e. Coupe et élévation d'une rampe d'artifice pour les pluies de feu, etc.

A. Couronnement mobile, maintenu au moyen de crochets en fer servant à empêcher la projection des fusées dans le cintre.

Fig. 8e et 9e. Coupe et élévation d'une herse volante pour éclairer les frises et les rideaux.

Fig. 10e et 11e. Perche des rideaux et des plafonds assemblés en sifflet, cloués et revêtus de lanières de toile trempées dans la colle-forte.

PLANCHE 38.

GLOIRES.

Fig. 1re. Grand plancher de gloire avec plate-forme et gradins de chaque côté pour grouper, par exemple, les divinités de l'Olympe, etc.

A. Bâtis d'assemblage recevant les planchers des stations.

Fig. 2e. Profil et armature de suspension dudit plancher de gloire.

B. Boutons à écrous pour maintenir l'écartement des fermes du bâti.

PLANCHE 39.

ÉQUIPE DES VOLS.

Fig. 1re. Plan du chemin et du char servant à enlever une ou plusieurs personnes.

Fig. 2e. Élévation du chemin du char et du porteur des fils de fer, à savoir :

A. Entrait du plancher du gril.

B. Étriers ou aiguilles pendantes boulonnées sur l'entrait.

C. Montant d'arrêt du porteur.

D. Montant du char garni de poulies de renvoi.

D'. Poulies de renvoi du porteur à celle du char.

E. Porteur du fil de fer.

F. Fil de manœuvre du char.

G. Fil d'appel du char et du porteur.

H. Ligne ponctuée indiquant le char.

I. Galets roulant sur le coulisseau encastré dans les aiguilles pendantes du chemin horizontal.

Fig. 3e. Coupe générale de l'appareil du vol de travers.

Fig. 4e. Brigandins roulant sur une retraite tendue entre les deux corridors du cintre pour un vol de travers exécuté par un enfant ou une femme de petite taille.

A. Brigandin garni de ses fils d'appel.

B. Retraite servant de chemin audit brigandin.

C. Fil de manœuvre.

D. Porteurs des fils de fer.

Fig. 5e. Coupe générale de l'équipe du brigandin.

Fig. 6e. Brigandin dont on se sert habituellement pour faire traverser la scène à des mannequins (diables, dragons ailés, oiseaux, etc.).

PLANCHE 40.

CONSTRUCTION DES FERMES.

Fig. 1re. Fermes d'arbres isolés traversant la scène dans une décoration de forêts, jardins, etc.

Fig. 2e. Ferme pleine ou de fond, pour une décoration d'intérieur, de site pittoresque, etc.

Fig. 3e. Terrain traversant la scène, bordant une rivière ou une vallée et servant également à dissimuler l'ouverture du plancher et à éclairer les décorations.

PLANCHE 41.

SUITE DE LA CONSTRUCTION DES FERMES.

Fig. 1re. Paire de châssis ouverts.

Fig. 2e. Châssis portant des feuilles de décoration chantournées, pour praticables, etc.

Fig. 3e. Paire de châssis fermés avec portes et fenêtres.

PLANCHE 42.

DÉTAILS DE TRAPPES.

Fig. 1re et 2e. Trappes à gradins avec leurs contre-poids latéraux.

Fig. 3e. Coupe de ladite trappe sur la largeur.

Fig. 4e. Coupe sur la largeur d'une trappe à trébuchet, avec ses matelas.

Fig. 6e et 7e. Contre-poids pour les grandes toiles.

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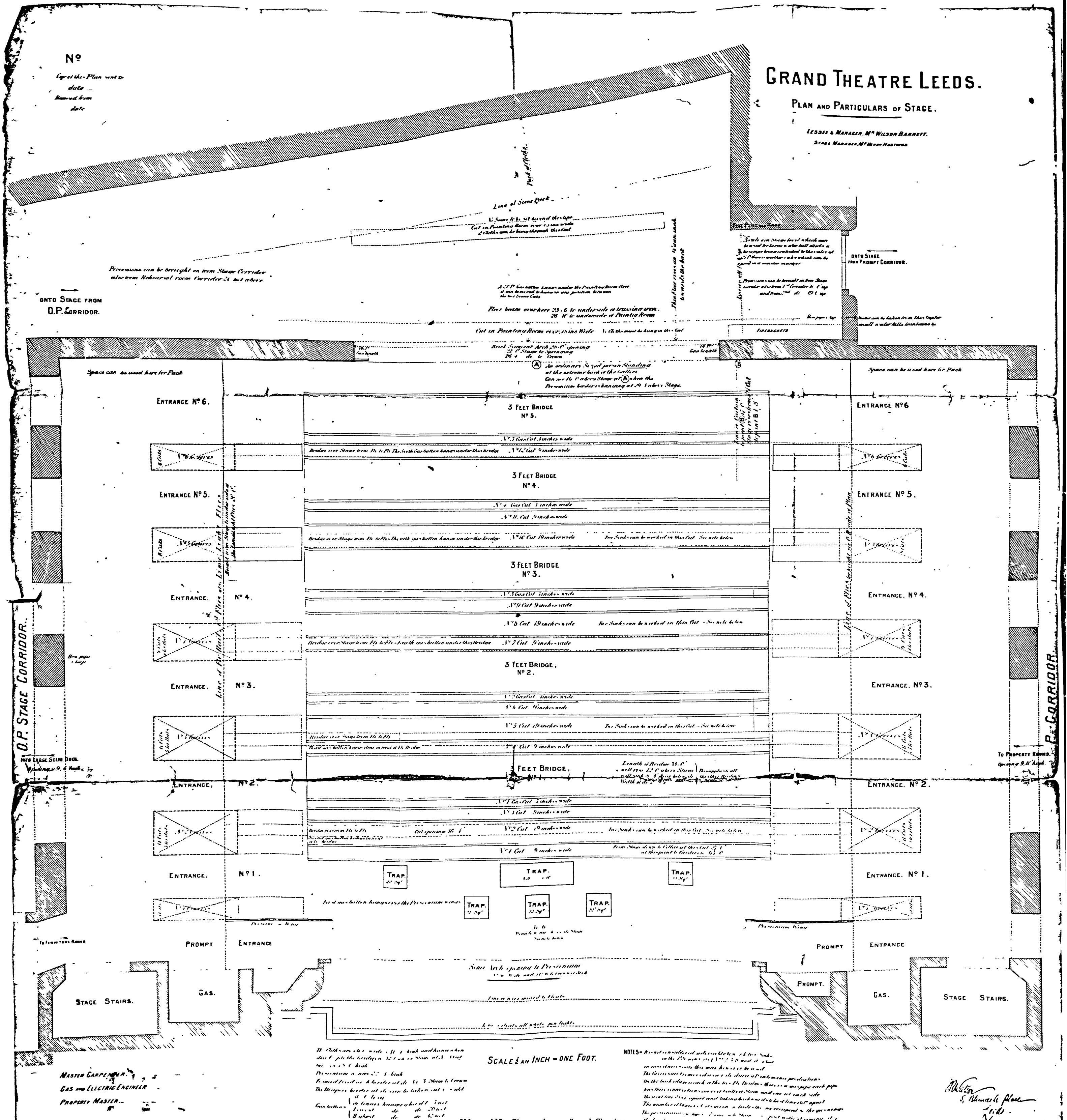

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THE UNIVERSITY OF HULL

The Development of Stage Machinery in the Nineteenth Century British Theatre: A Study of Physical and Documentary Evidence.

Volume II

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in the University of Hull

by

David Wilmore, B.Sc.

March, 1989.

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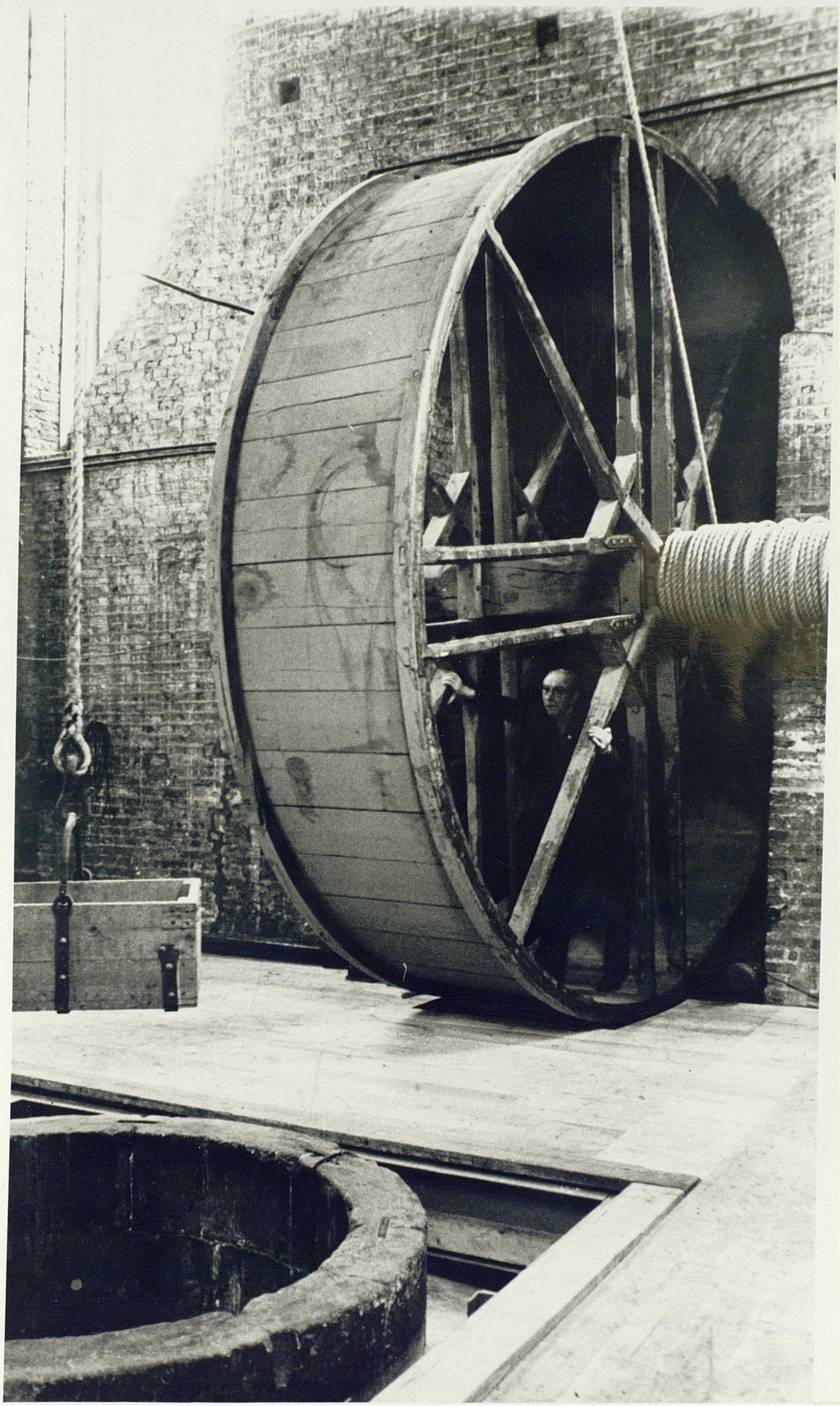

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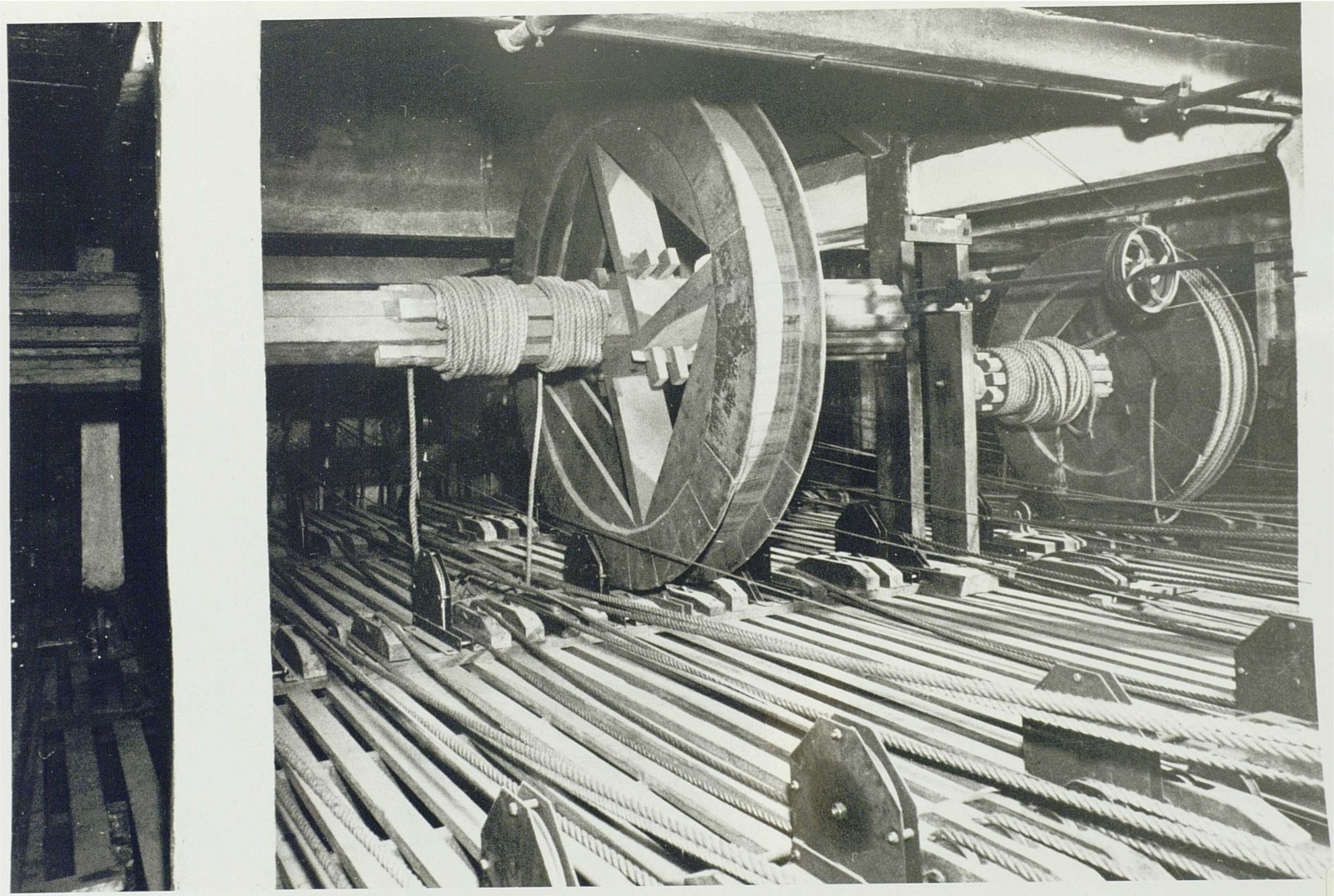

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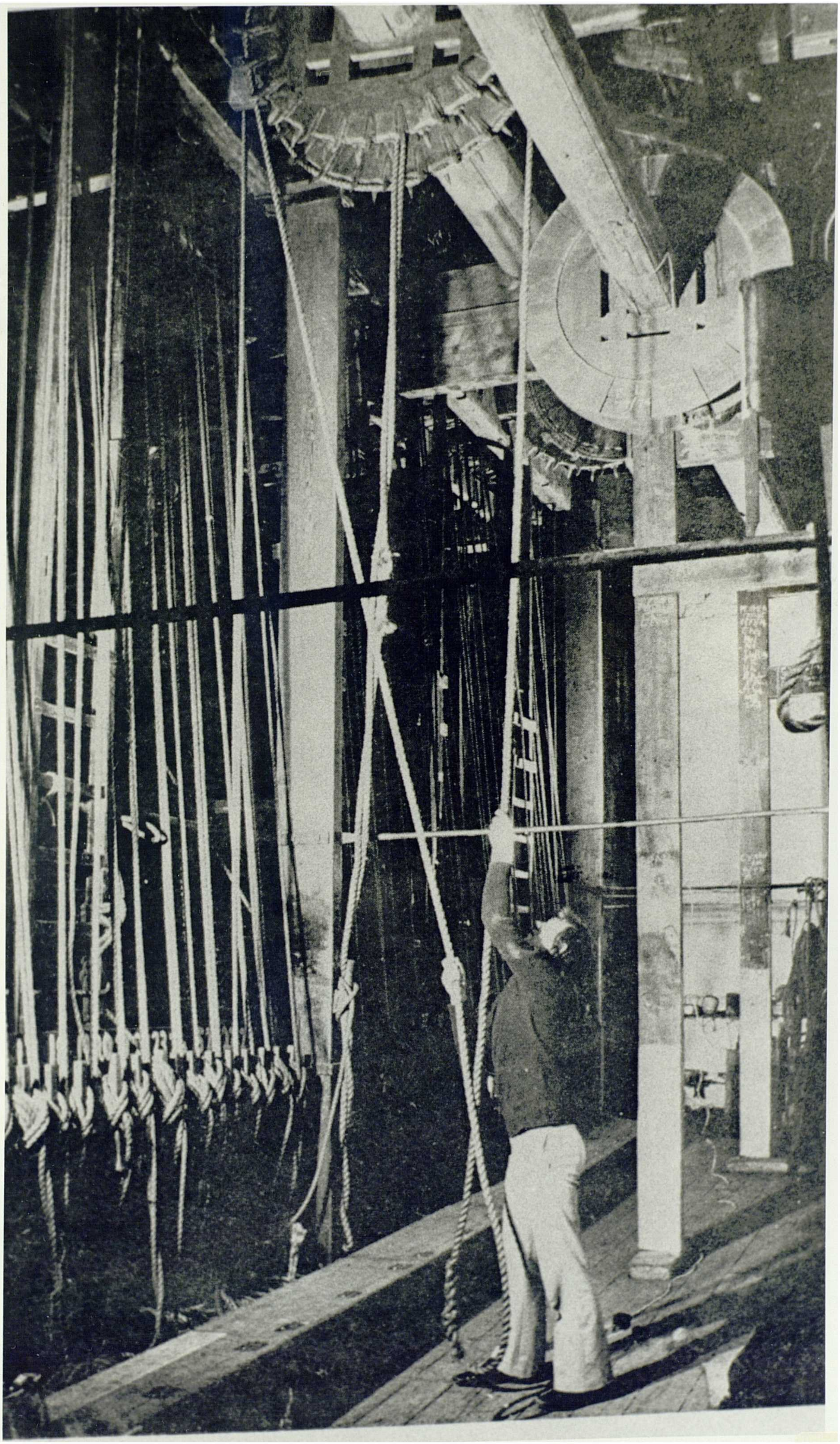

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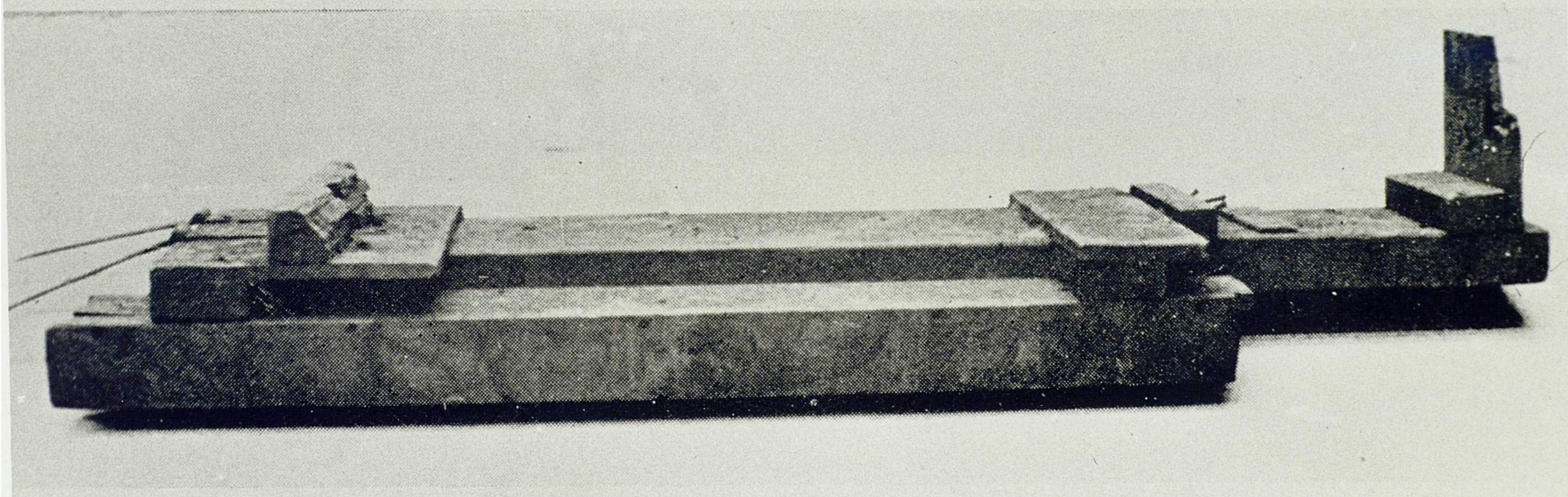

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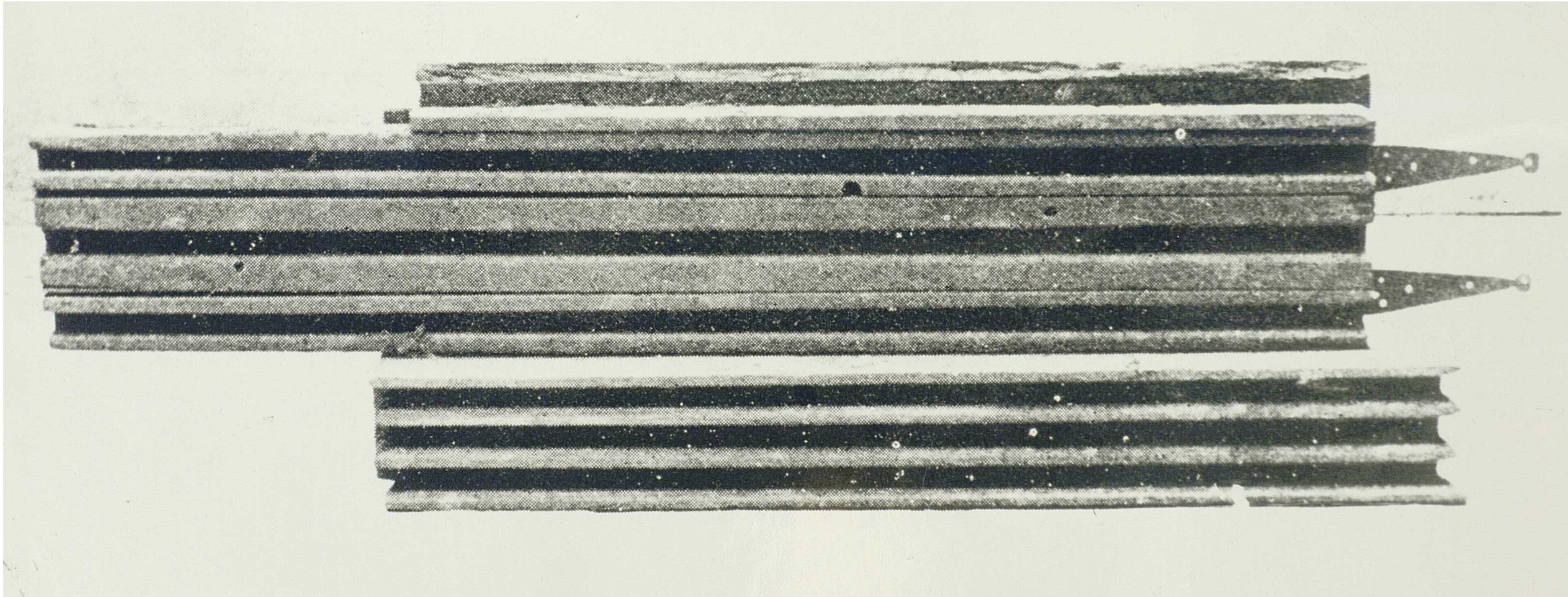

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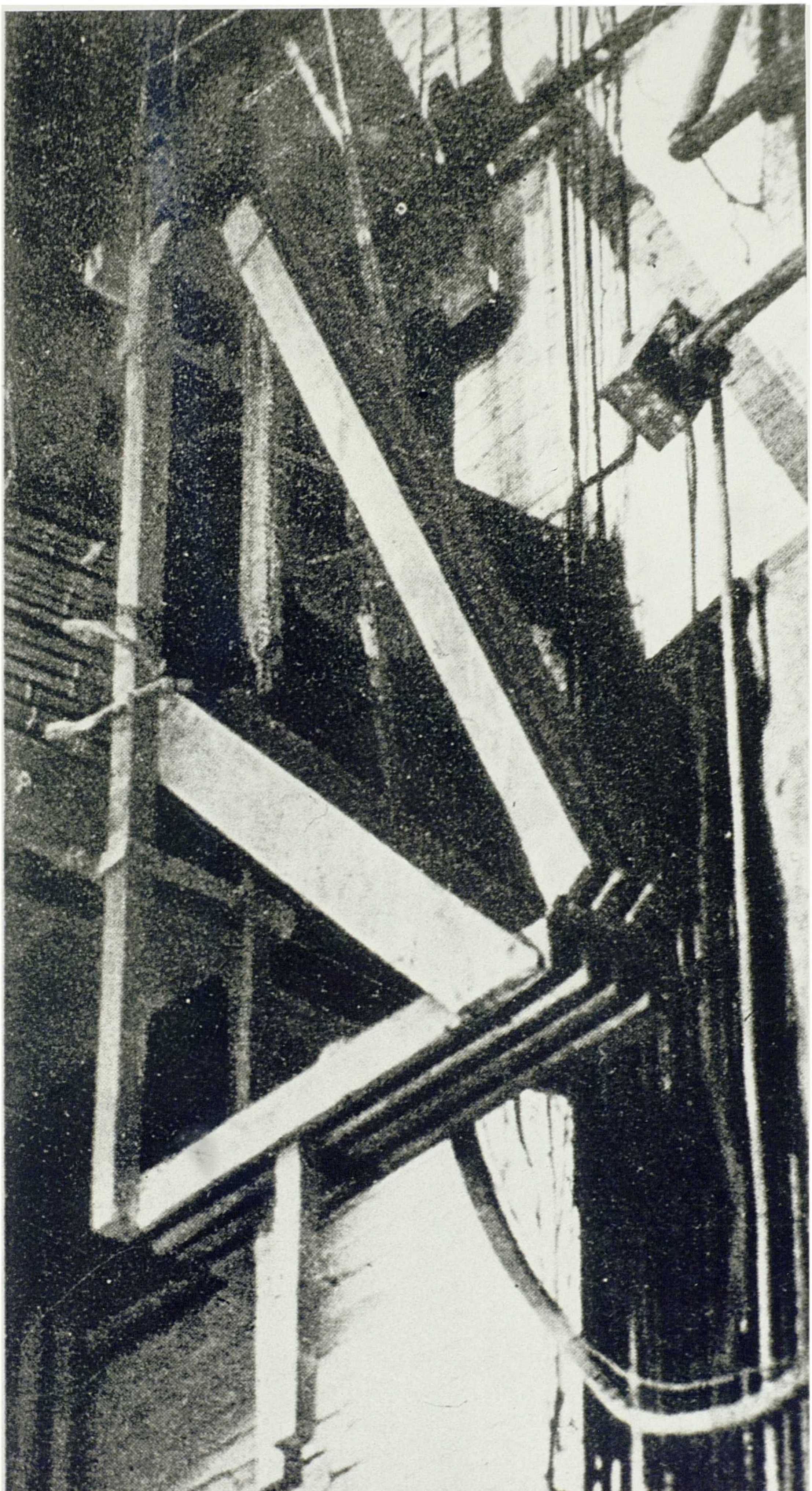

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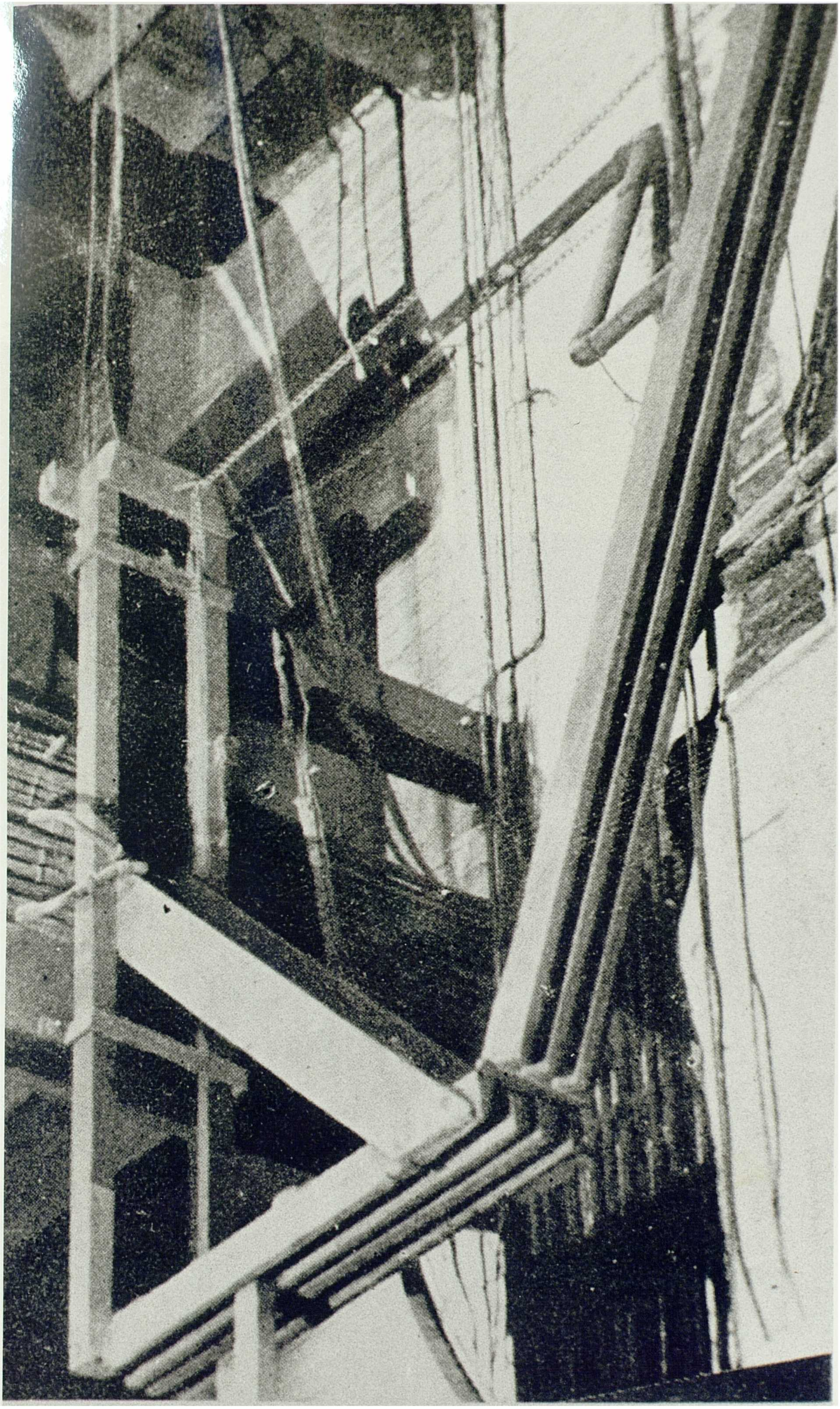

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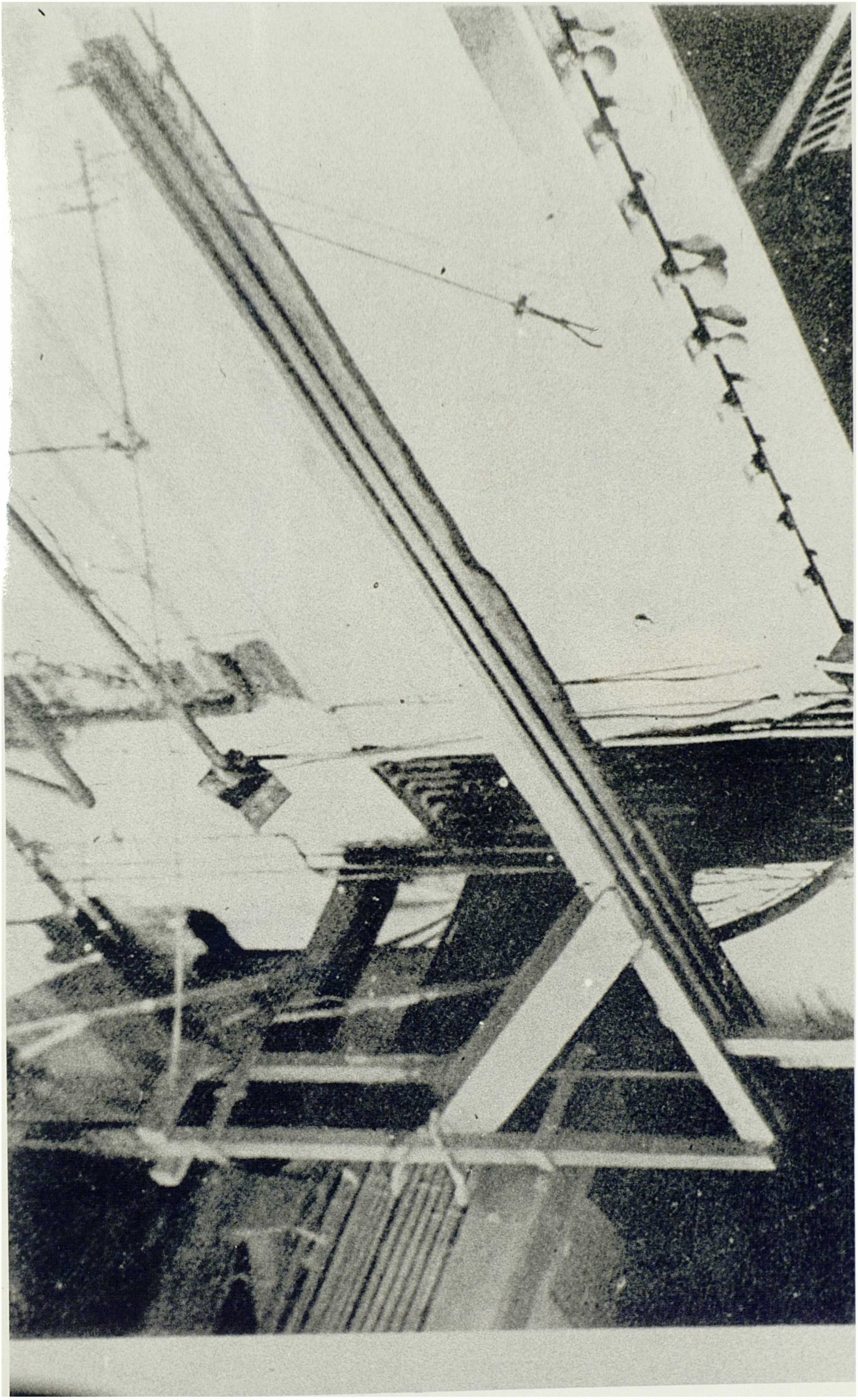

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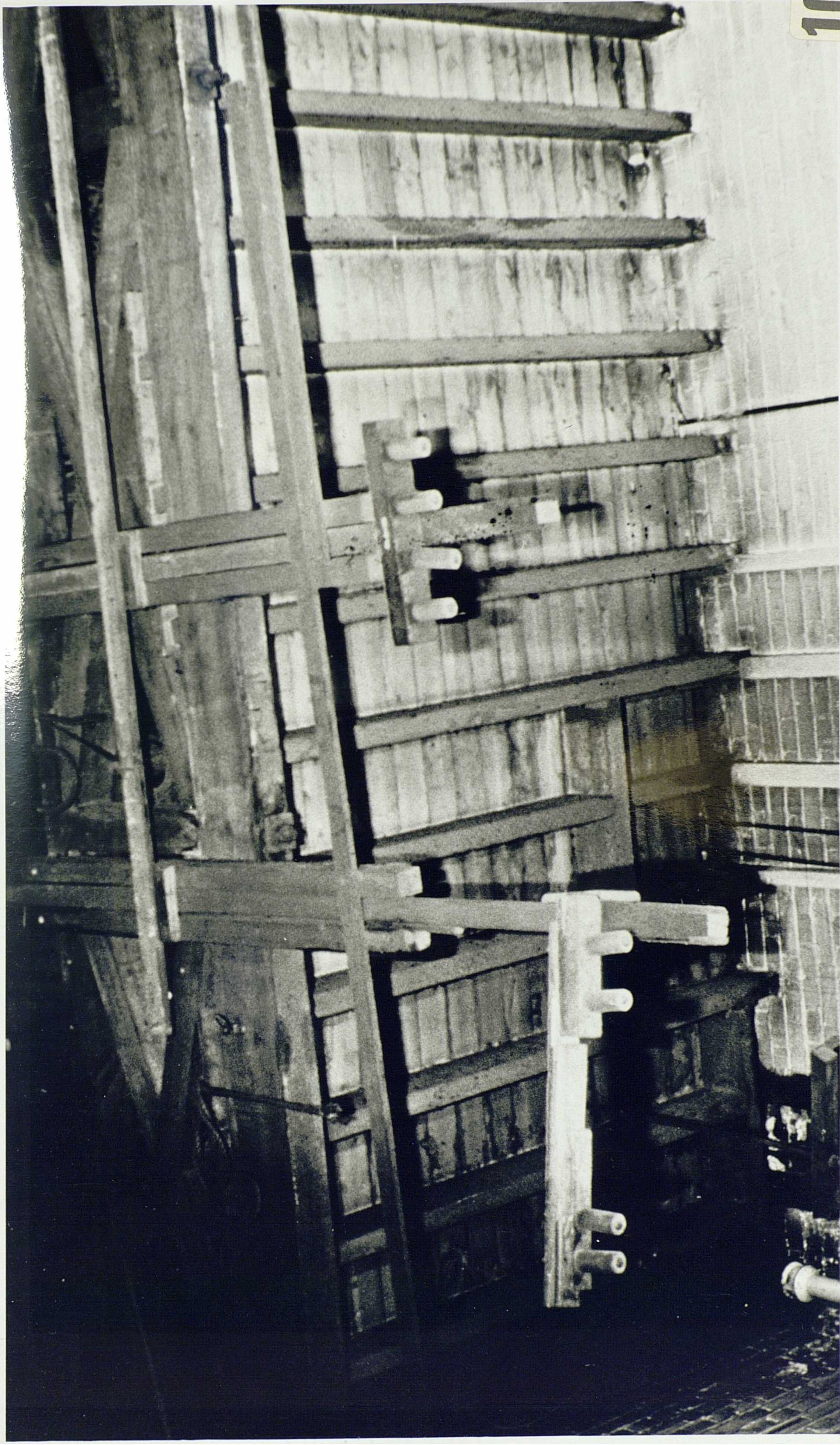

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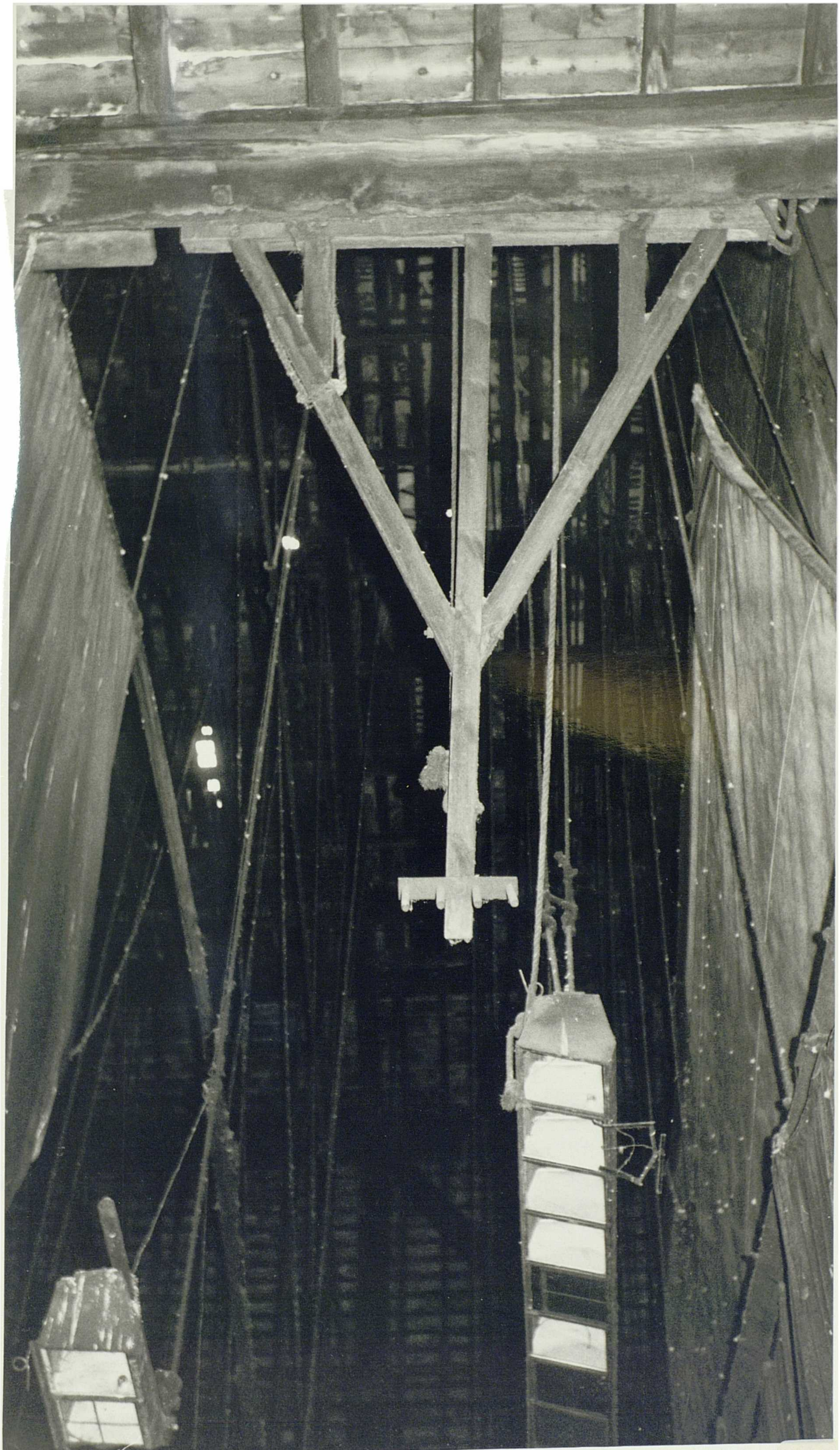

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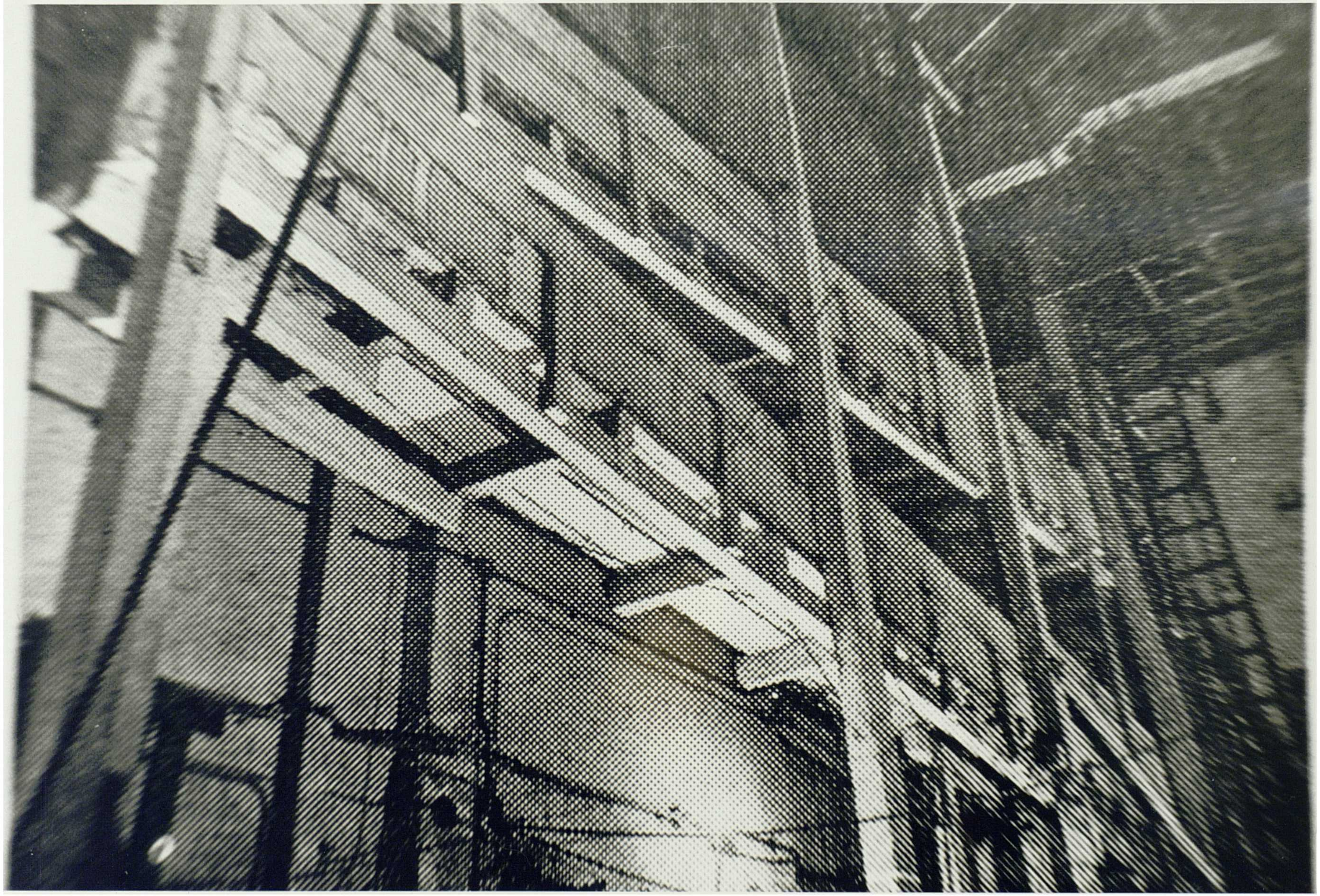

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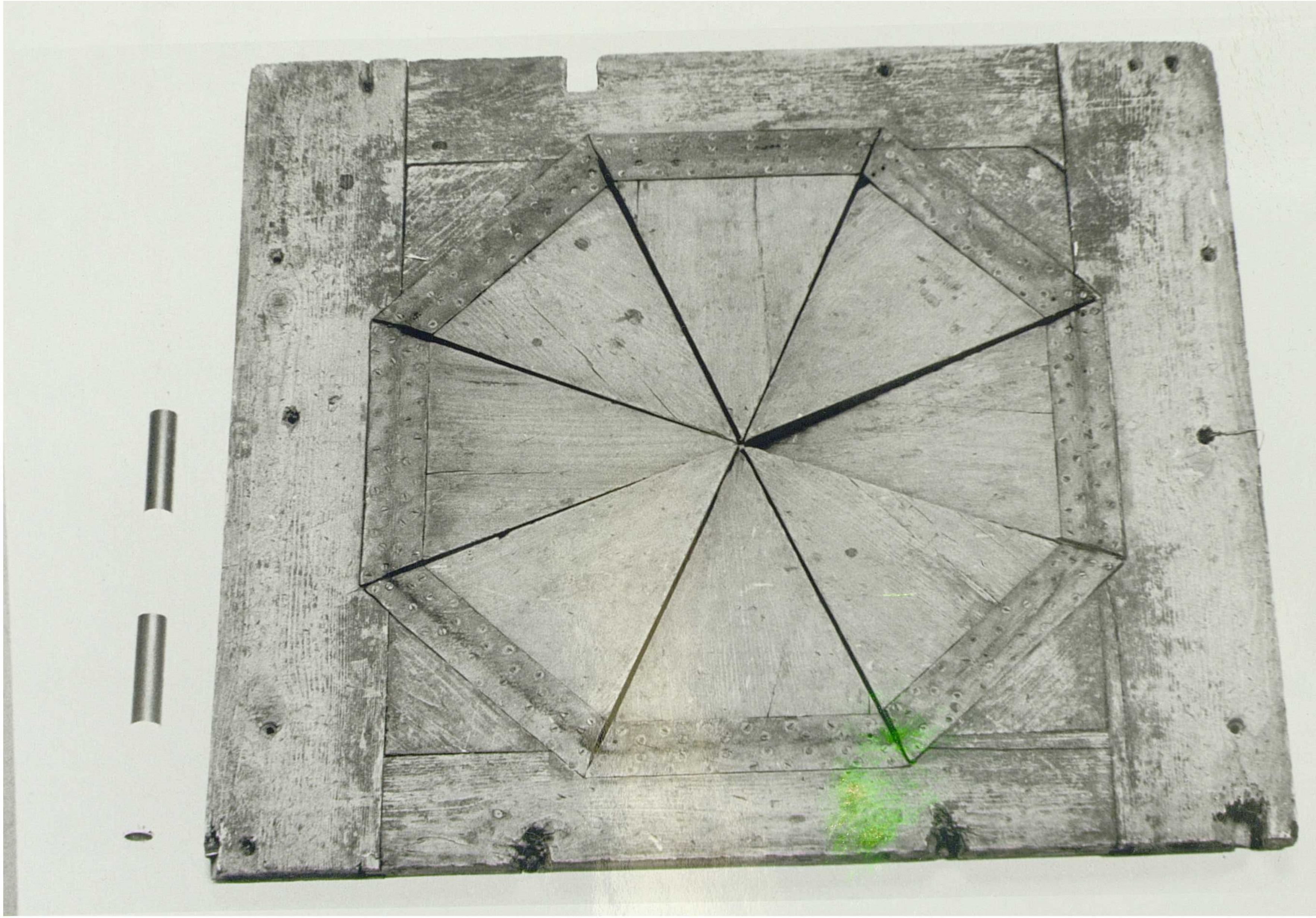

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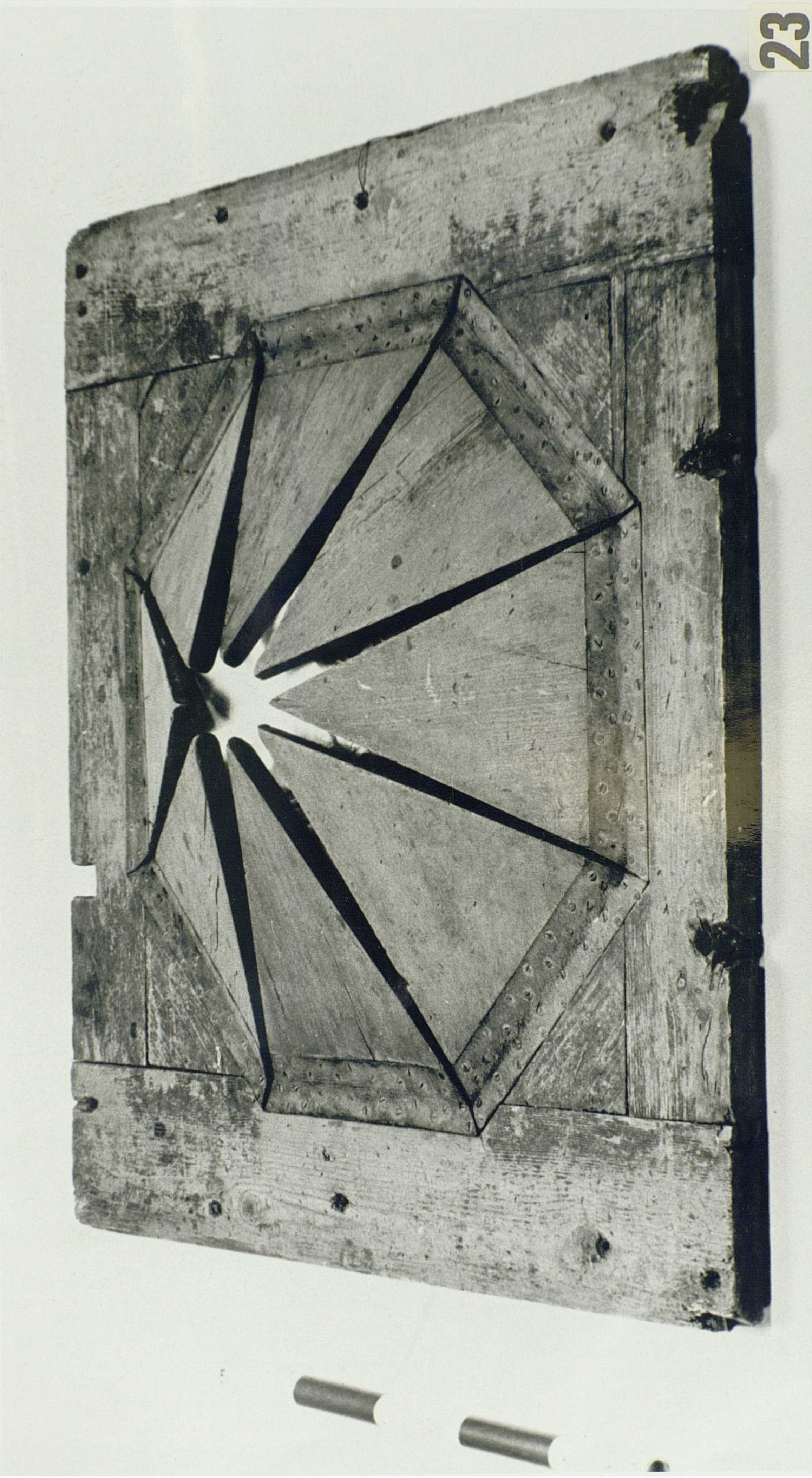
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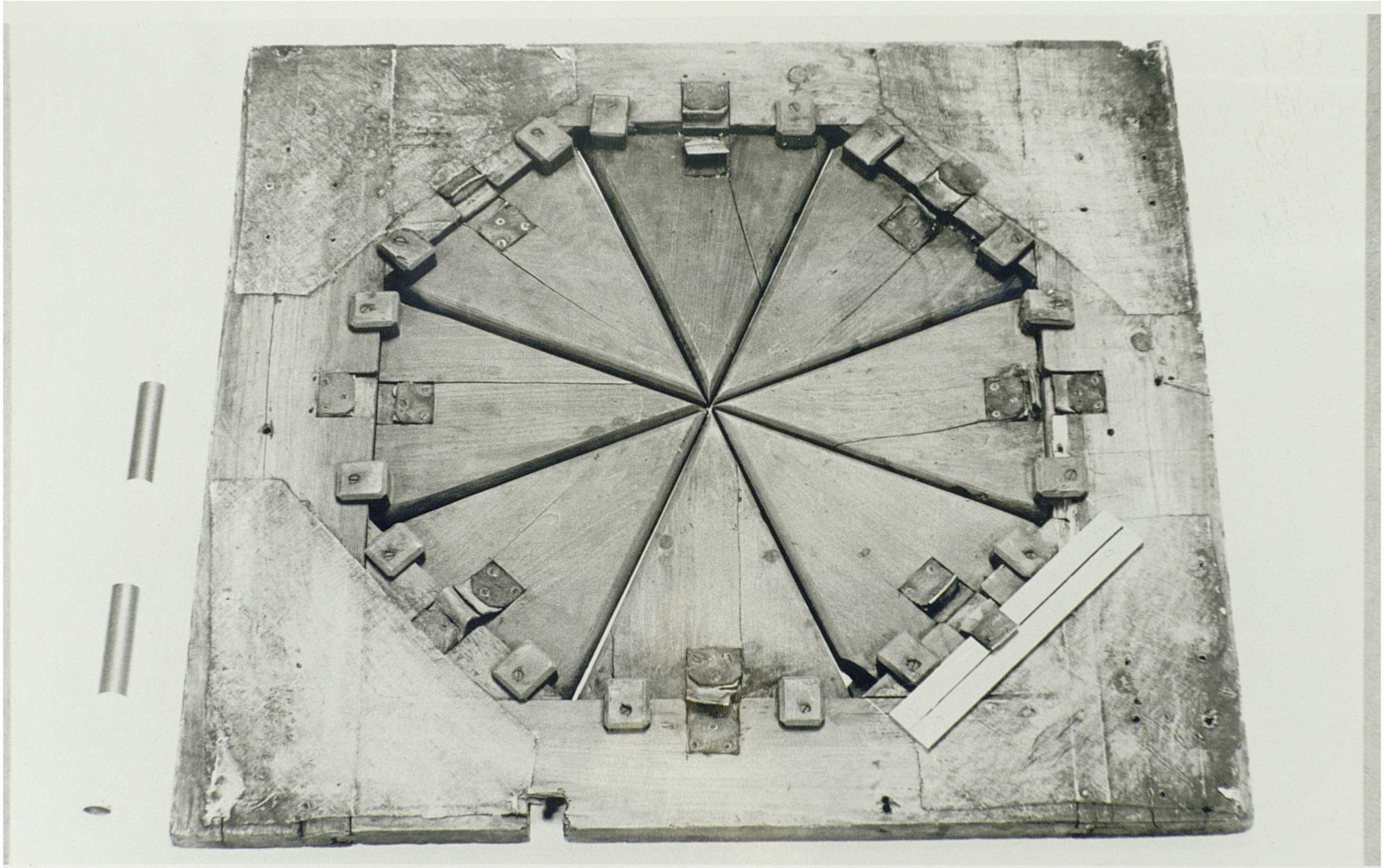

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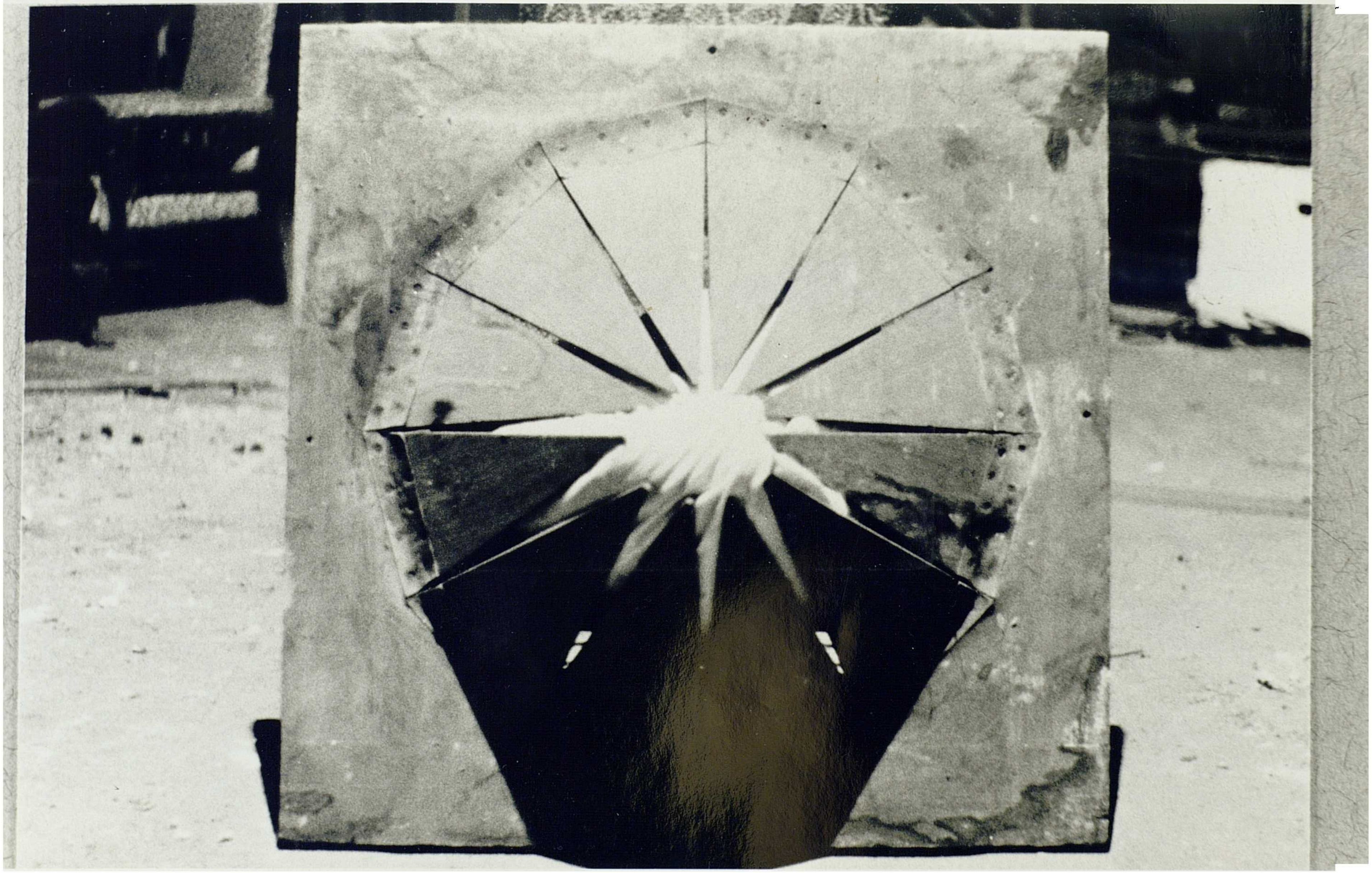

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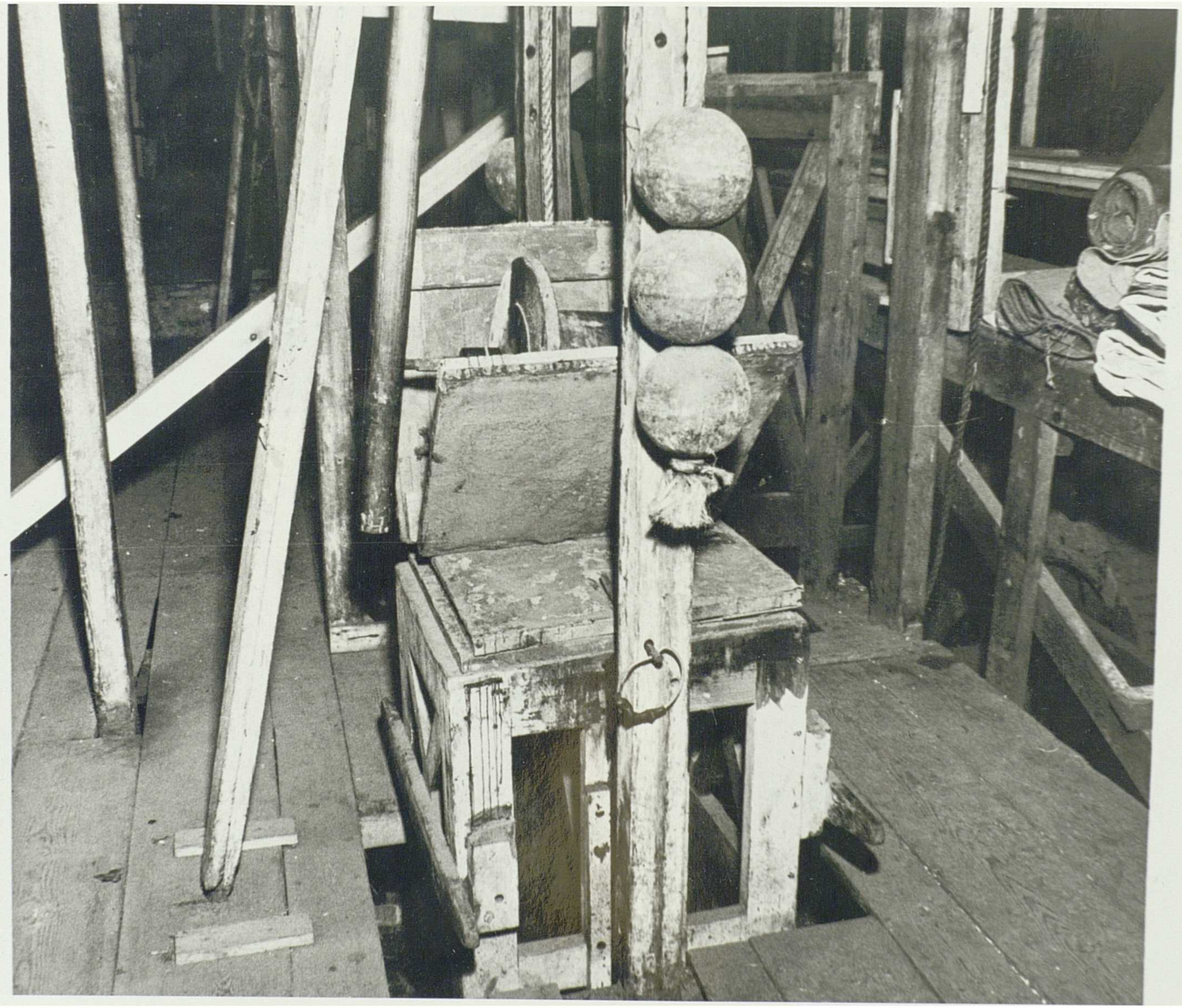

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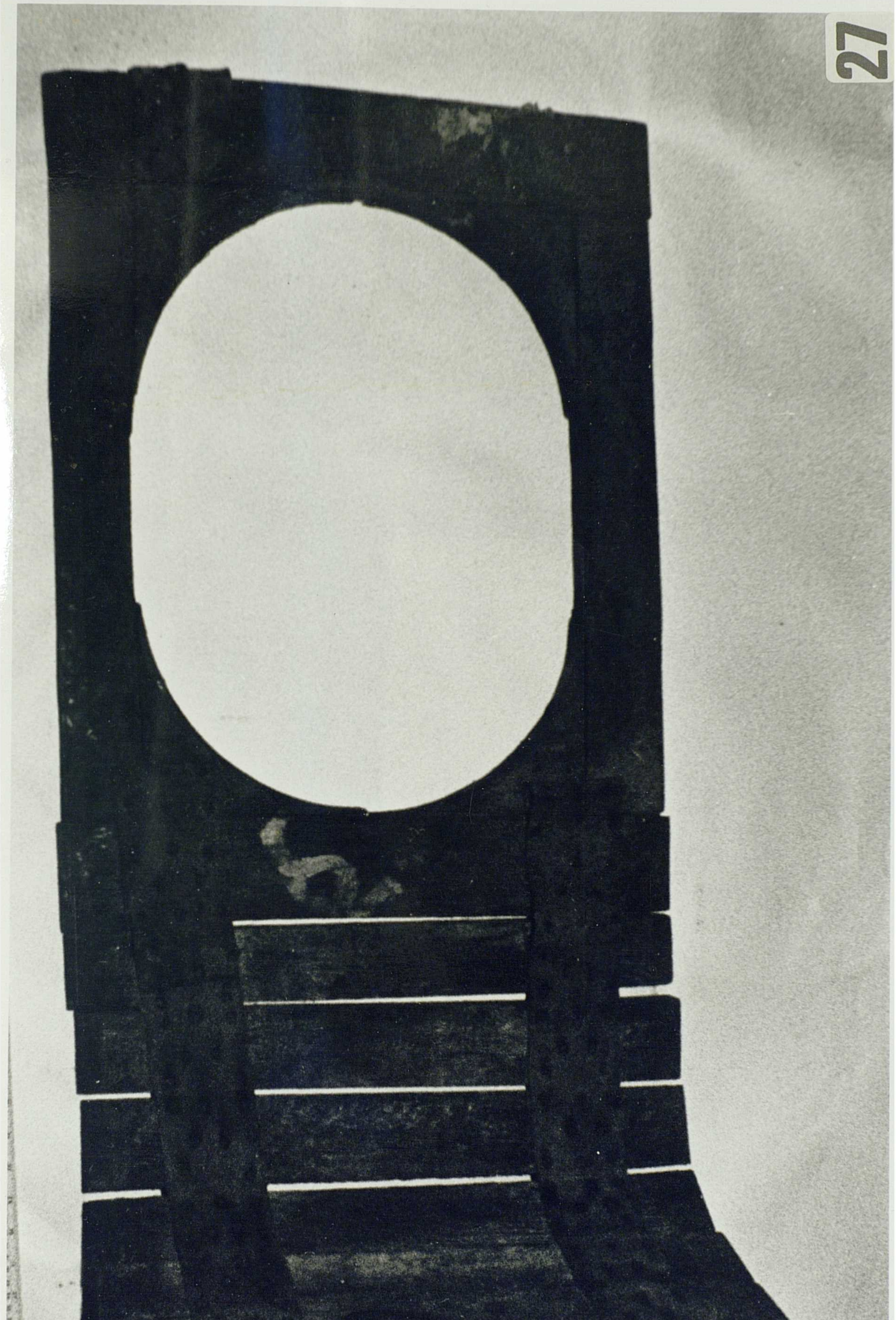
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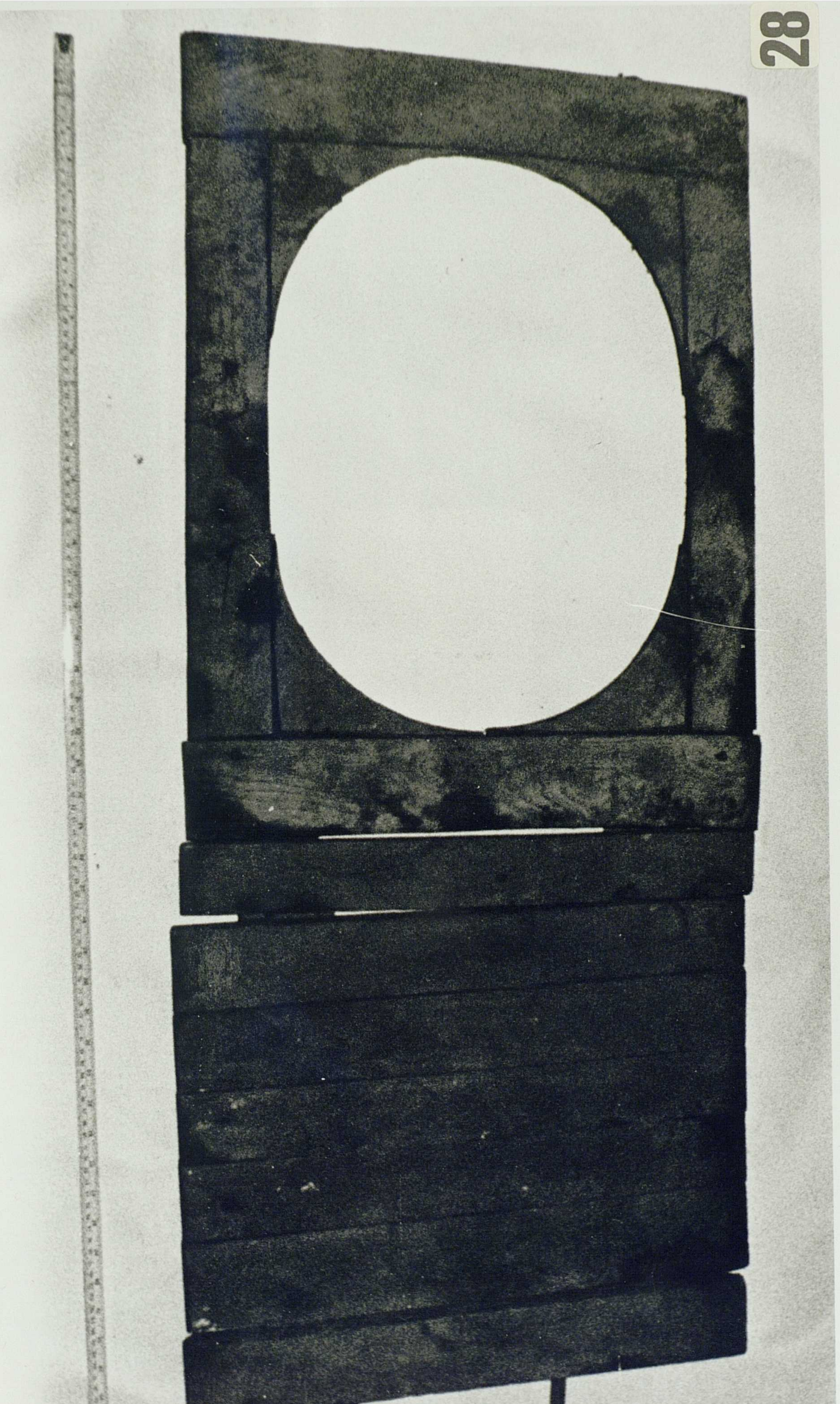
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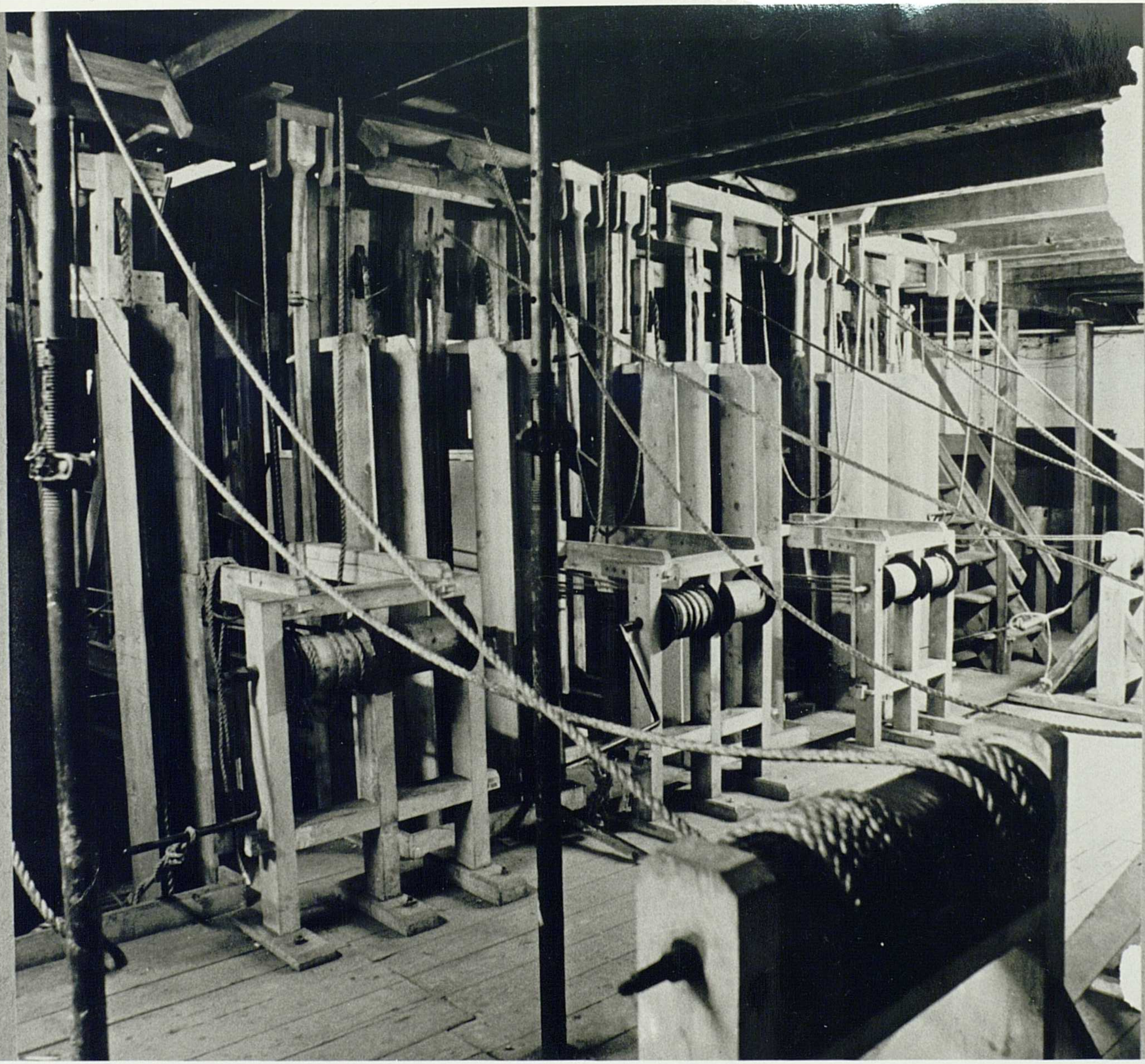

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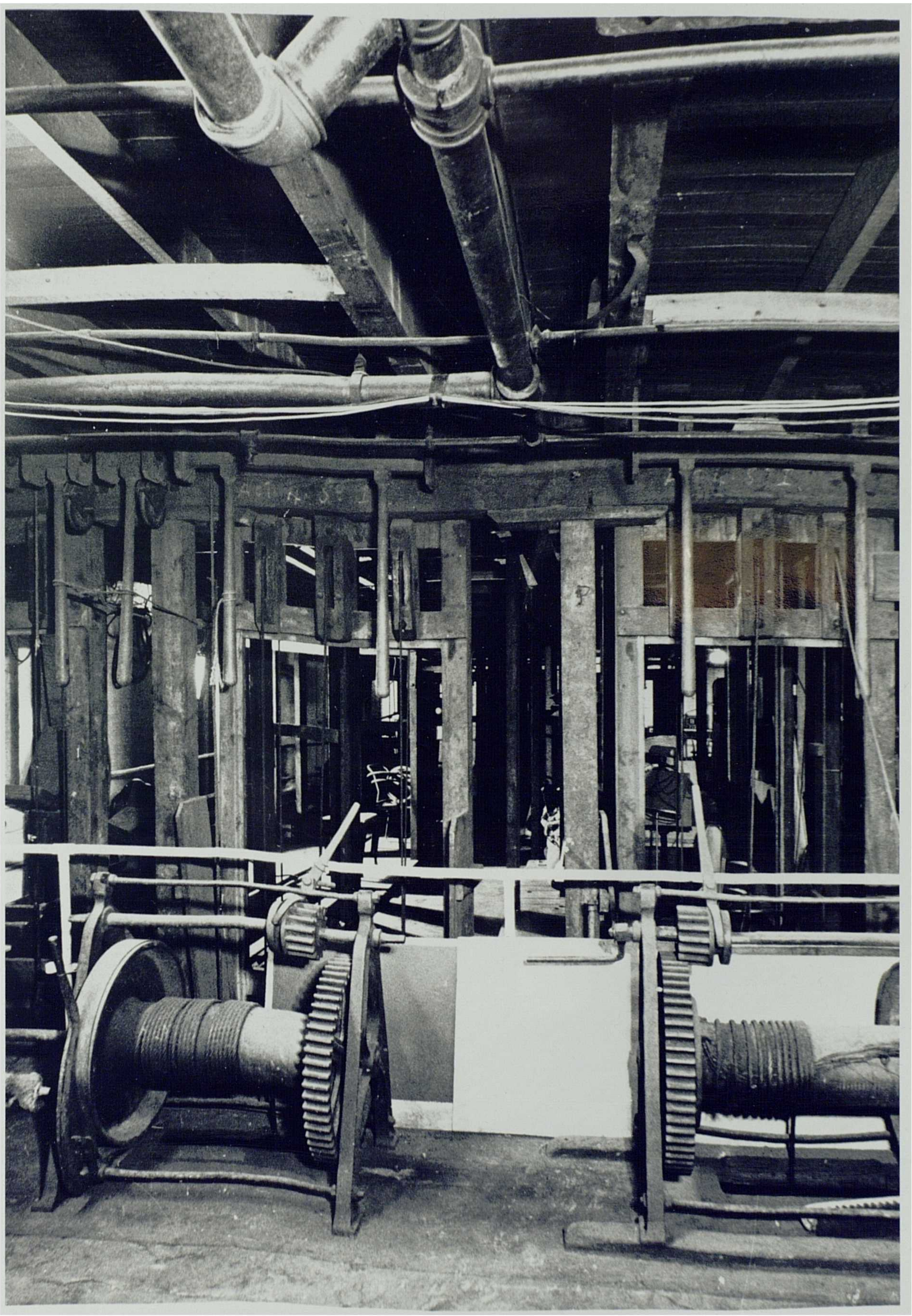

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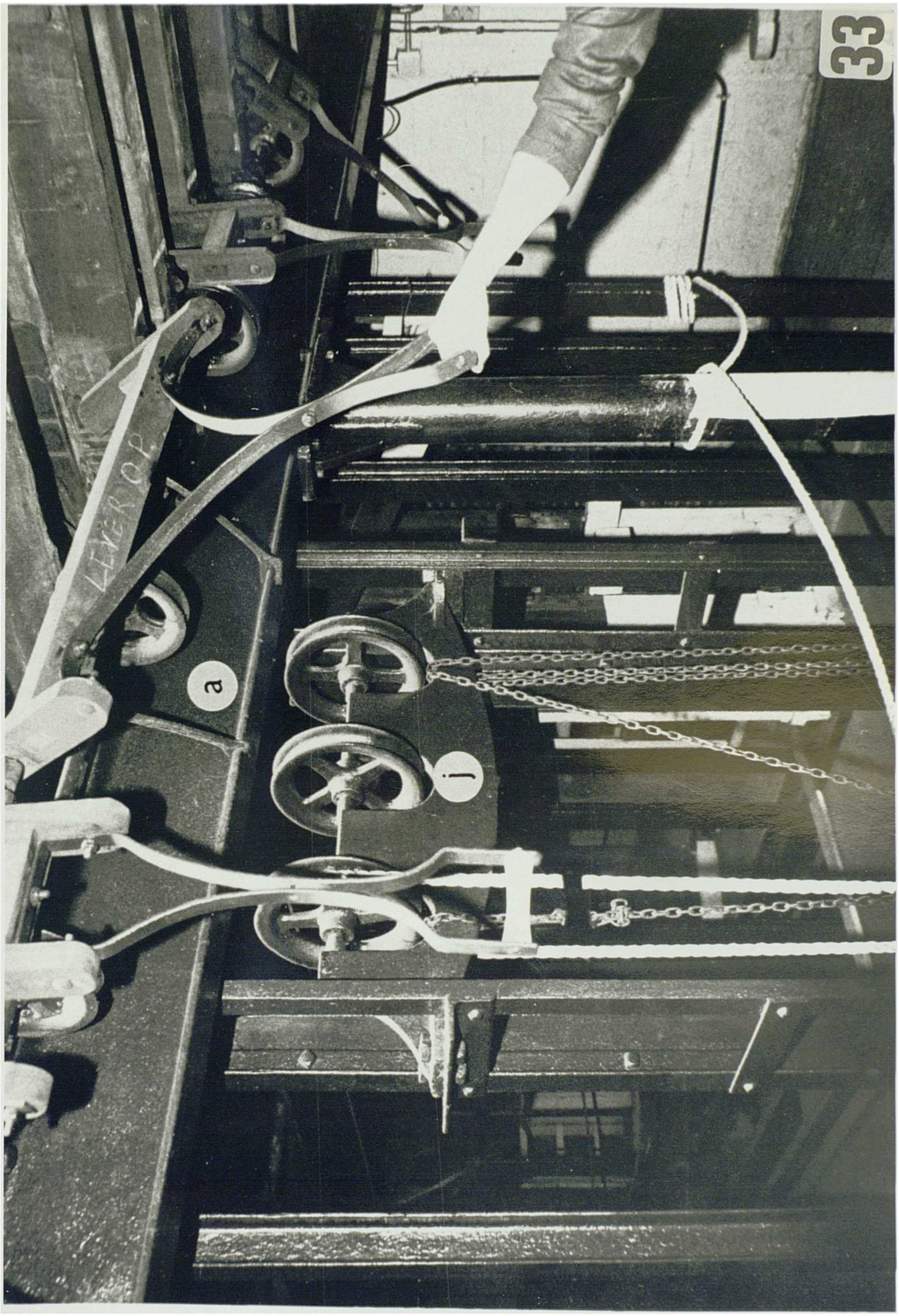
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]


33
LEVER O.P.
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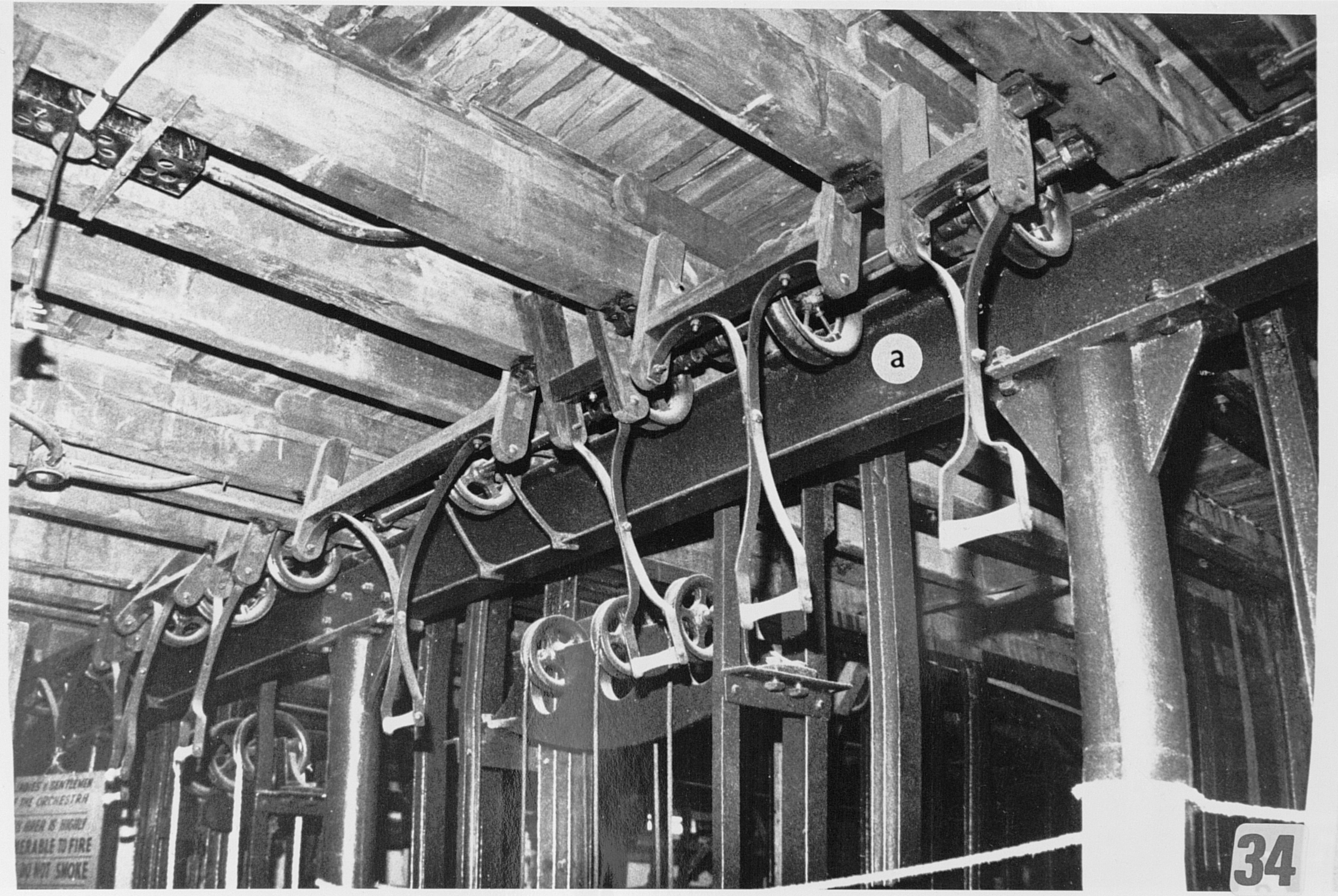
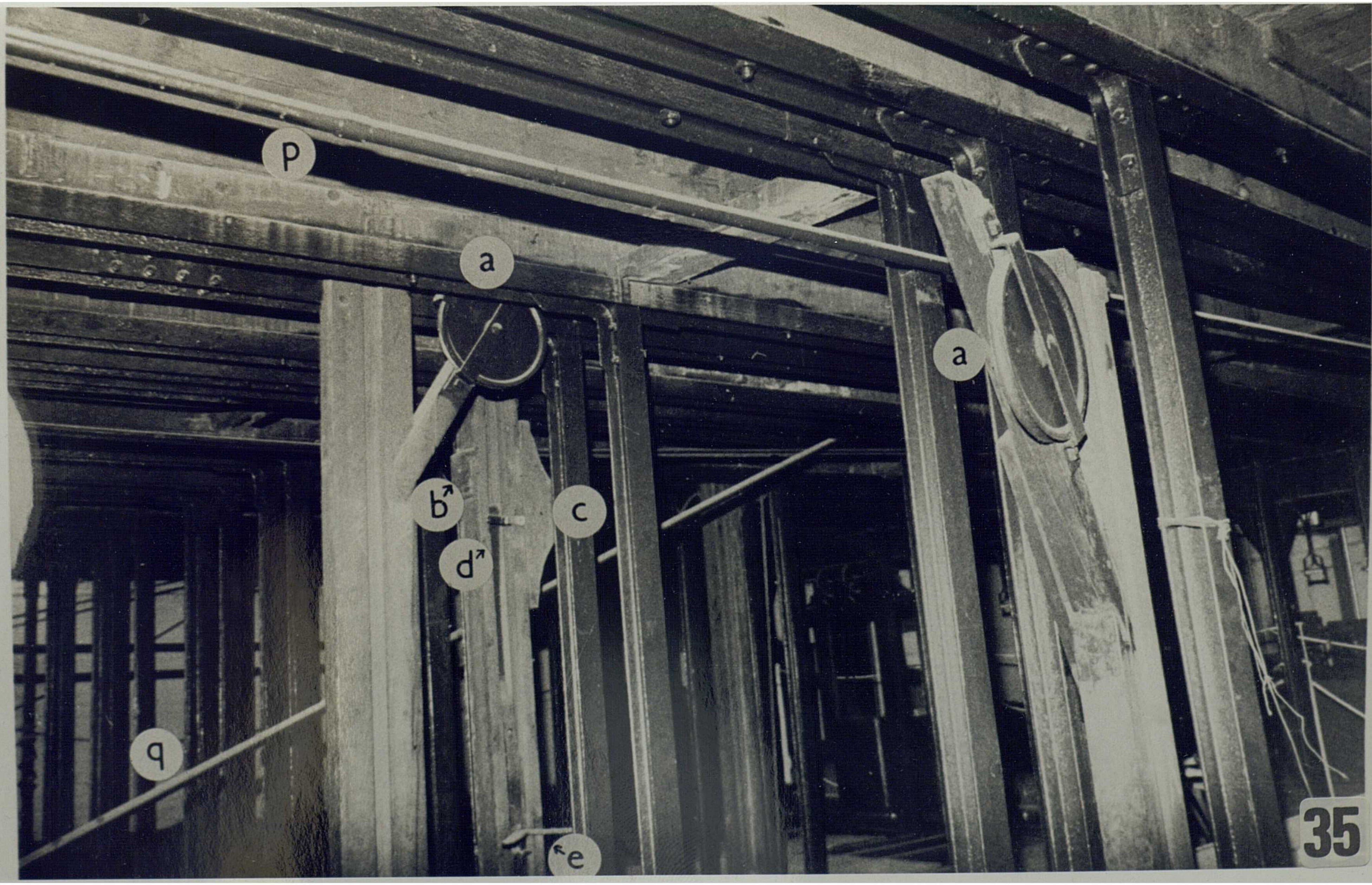
34

General view of stage left upper mezzanine floor.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]


a
34
THE ORCHESTRA

35 Details of sloats and gas pipe in gas cuts.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council].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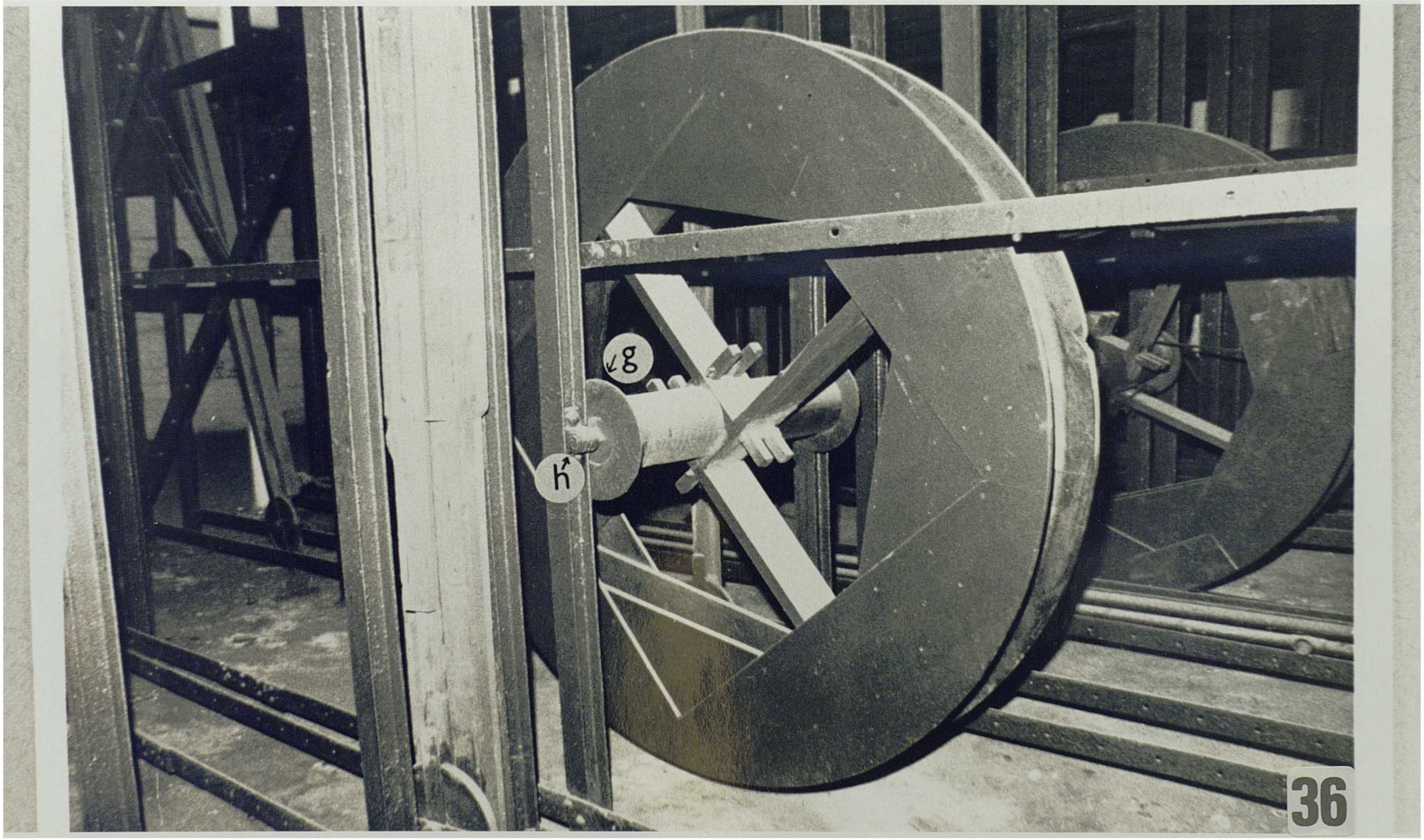
36

Drum and shaft of No.1 bridge.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]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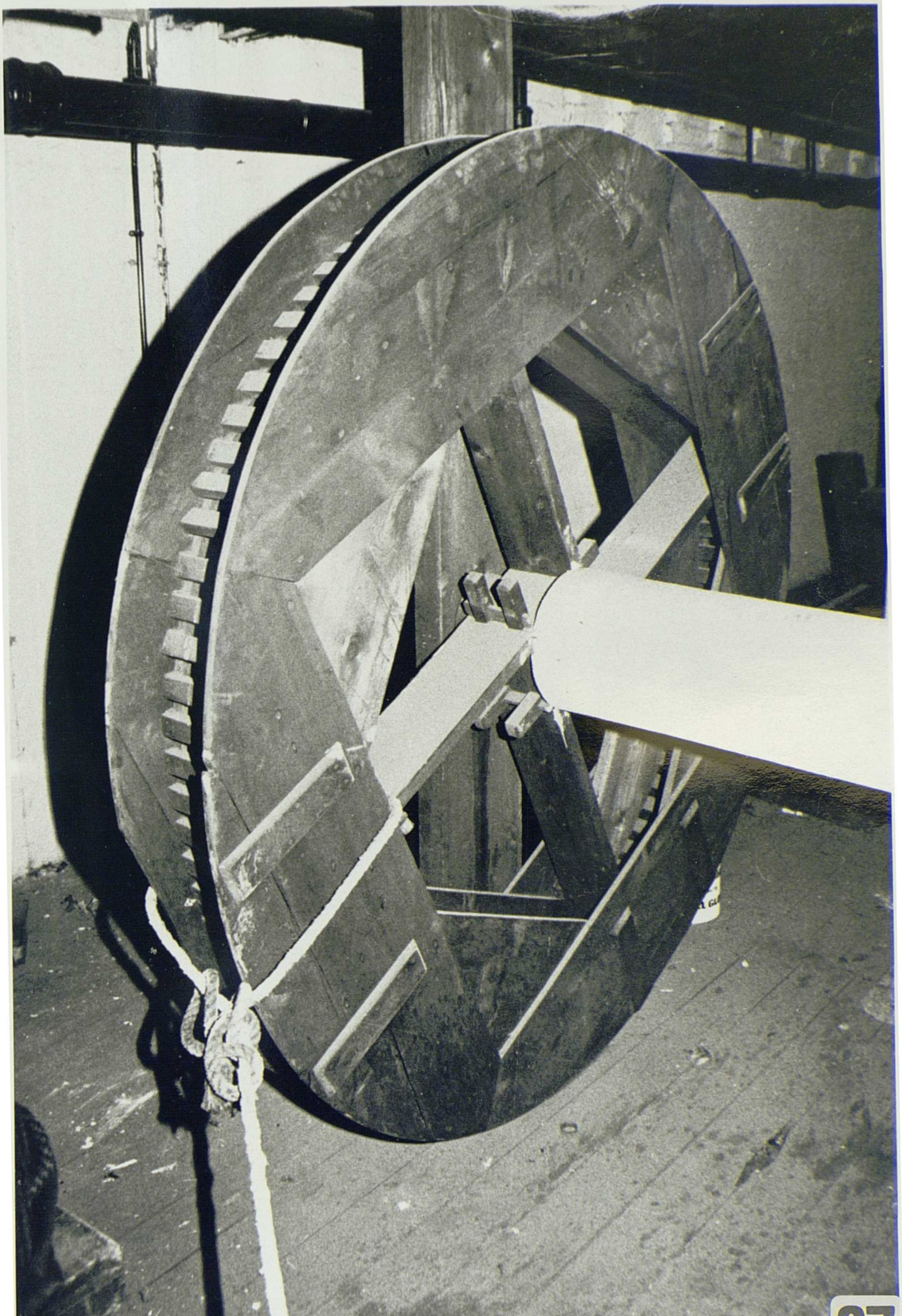
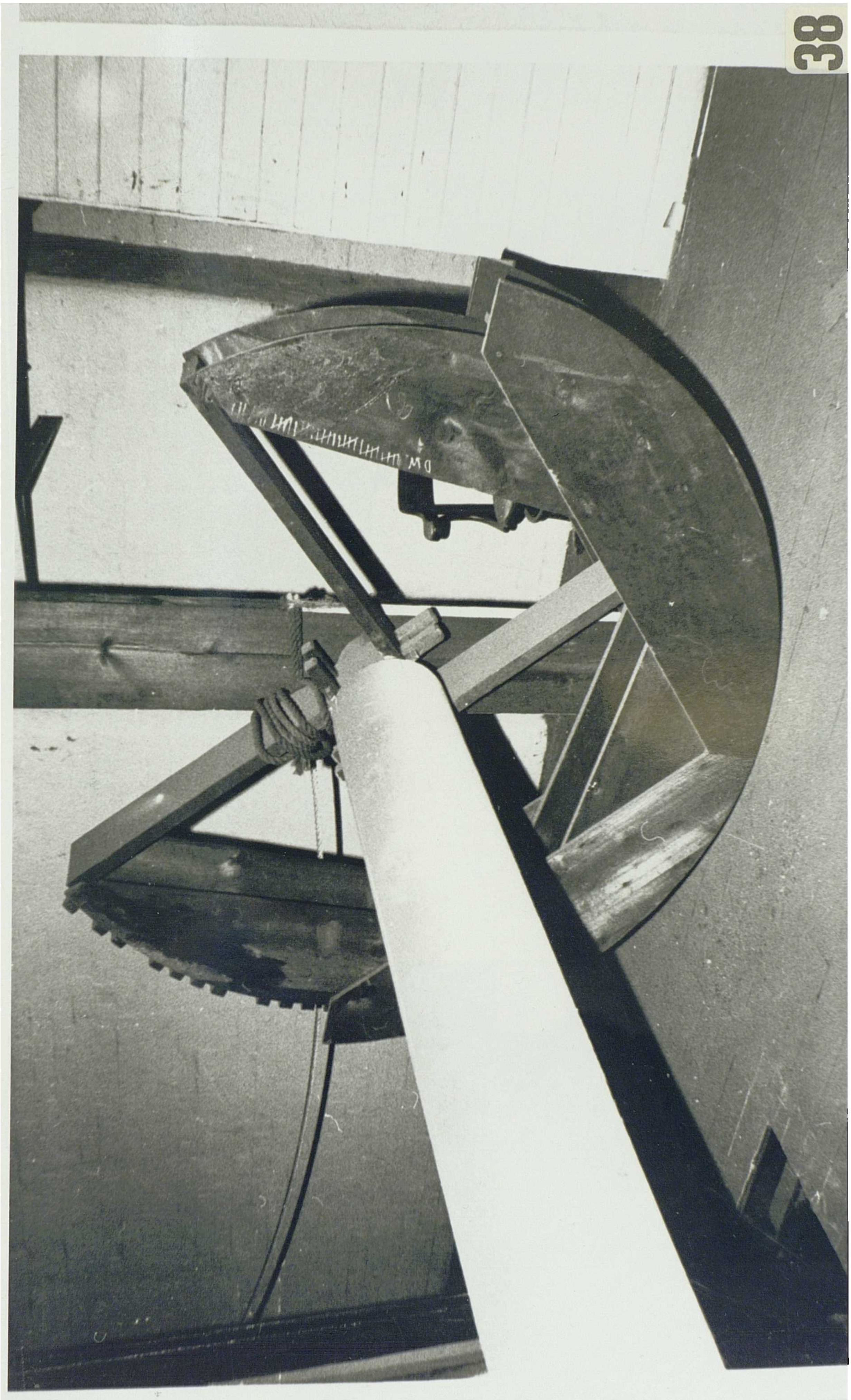
36

37 Drum and shaft on stage left side of lower mezzanine floor.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]


37

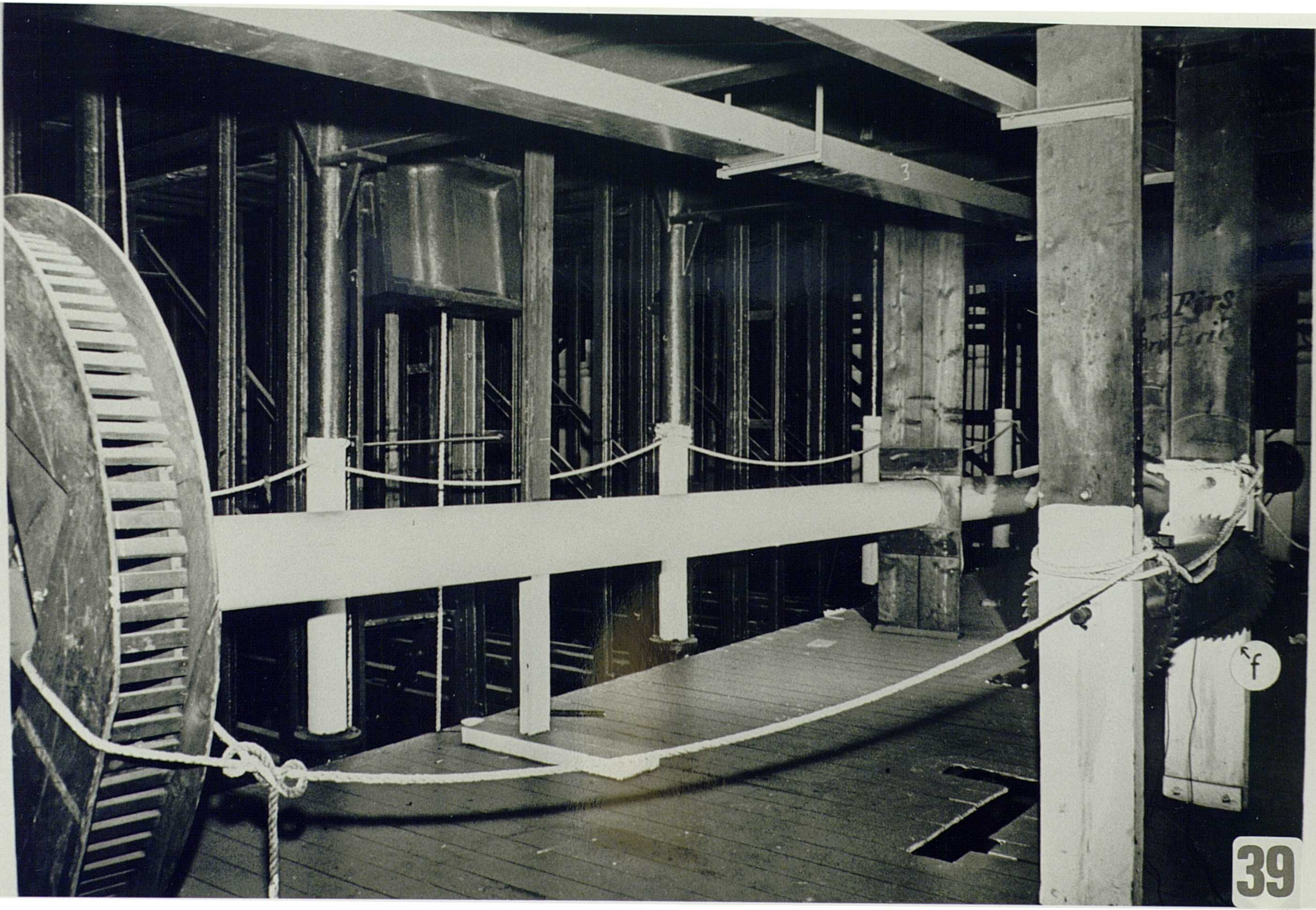
38

Drum and shaft on stage right
side of lower mezzanine floor.
Grand Theatre, Leeds.
[Photo: Dept. of Planning, Leeds
City Council.]


38

39

General view of stage left side of cellar.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]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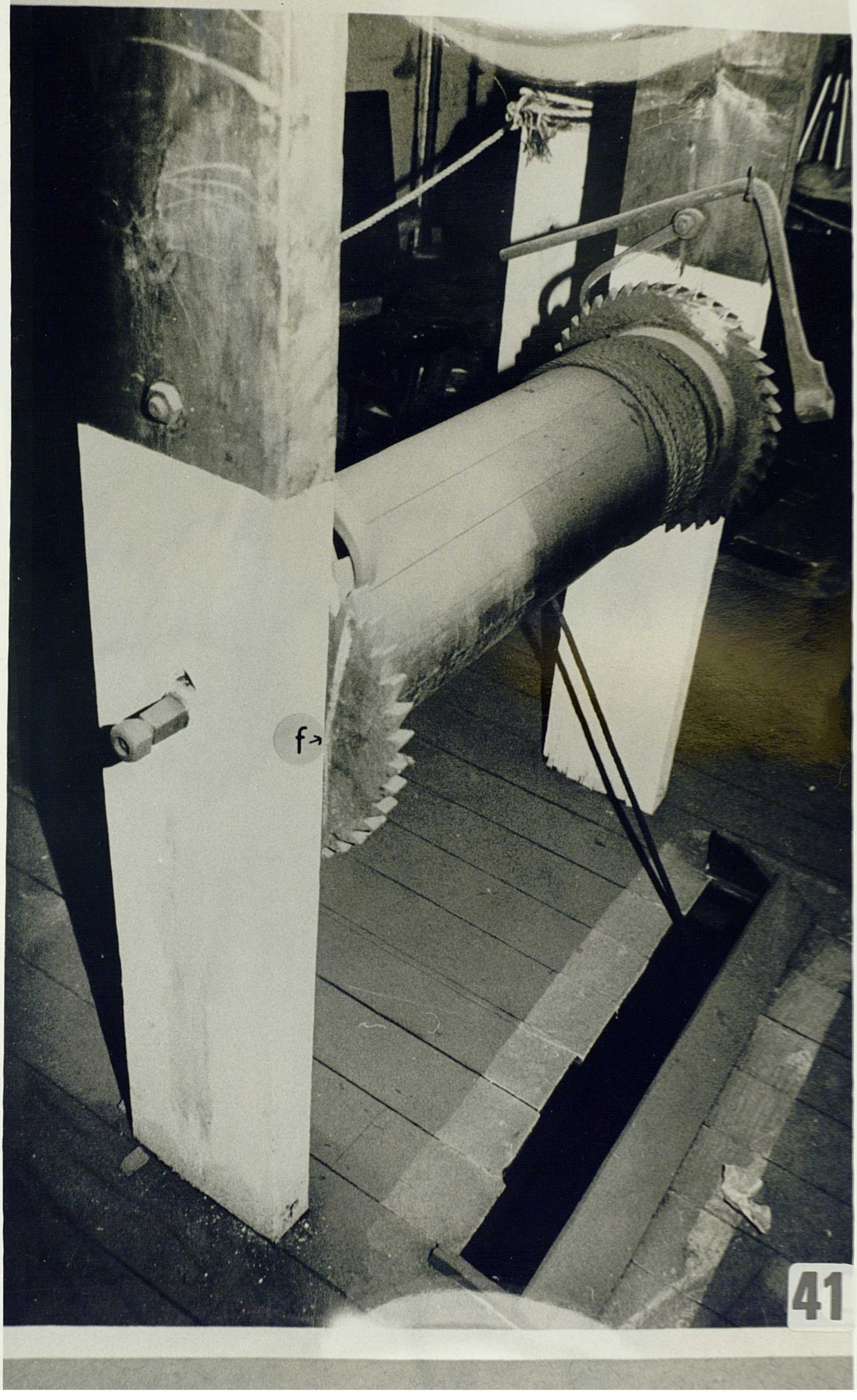
40

View of stage right lower mezzanine floor.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]


40

41

No.2 bridge winch looking downstage on the stage left lower mezzanine floor.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]



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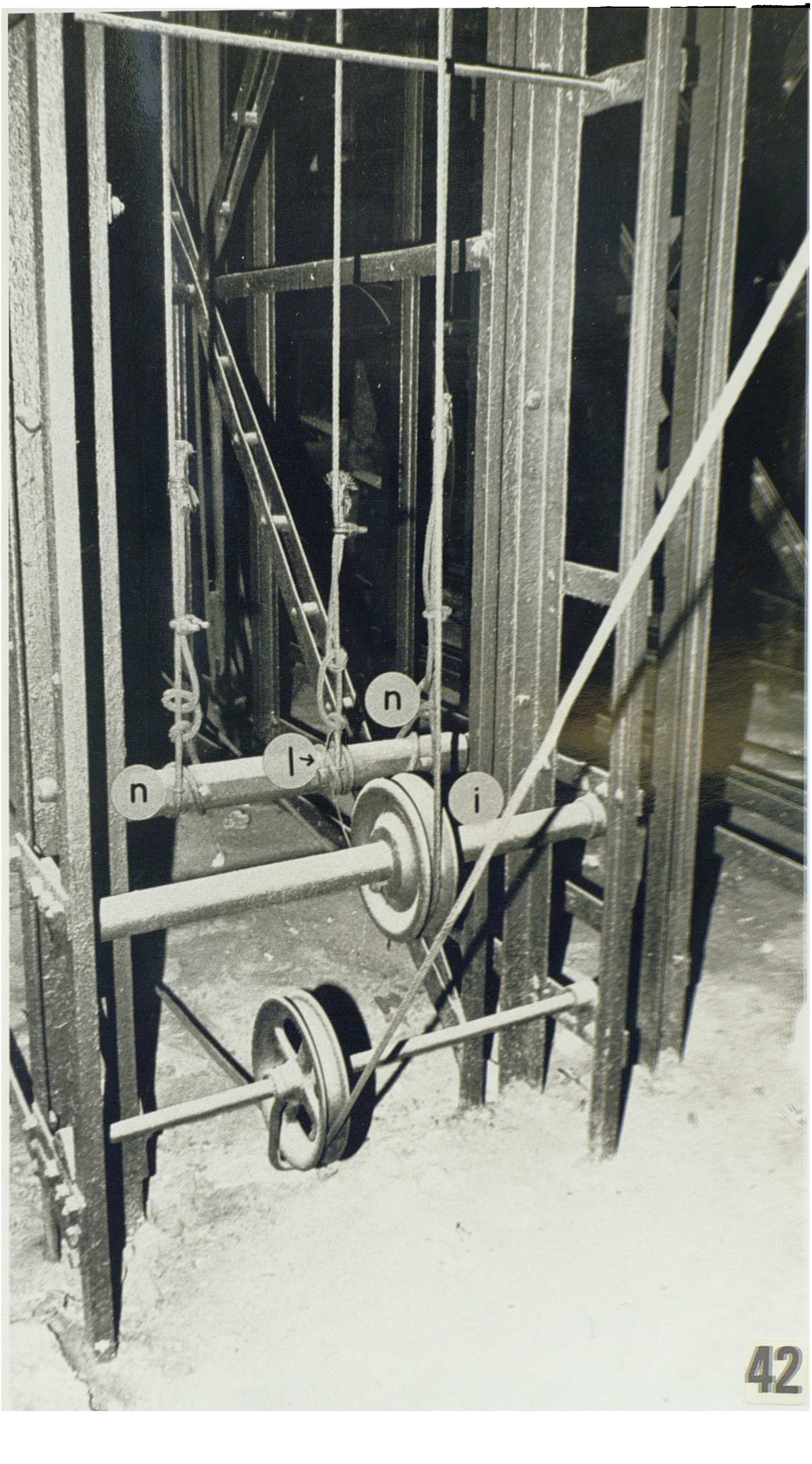
42

Bridge No.2 viewed from stage left at cellar level.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]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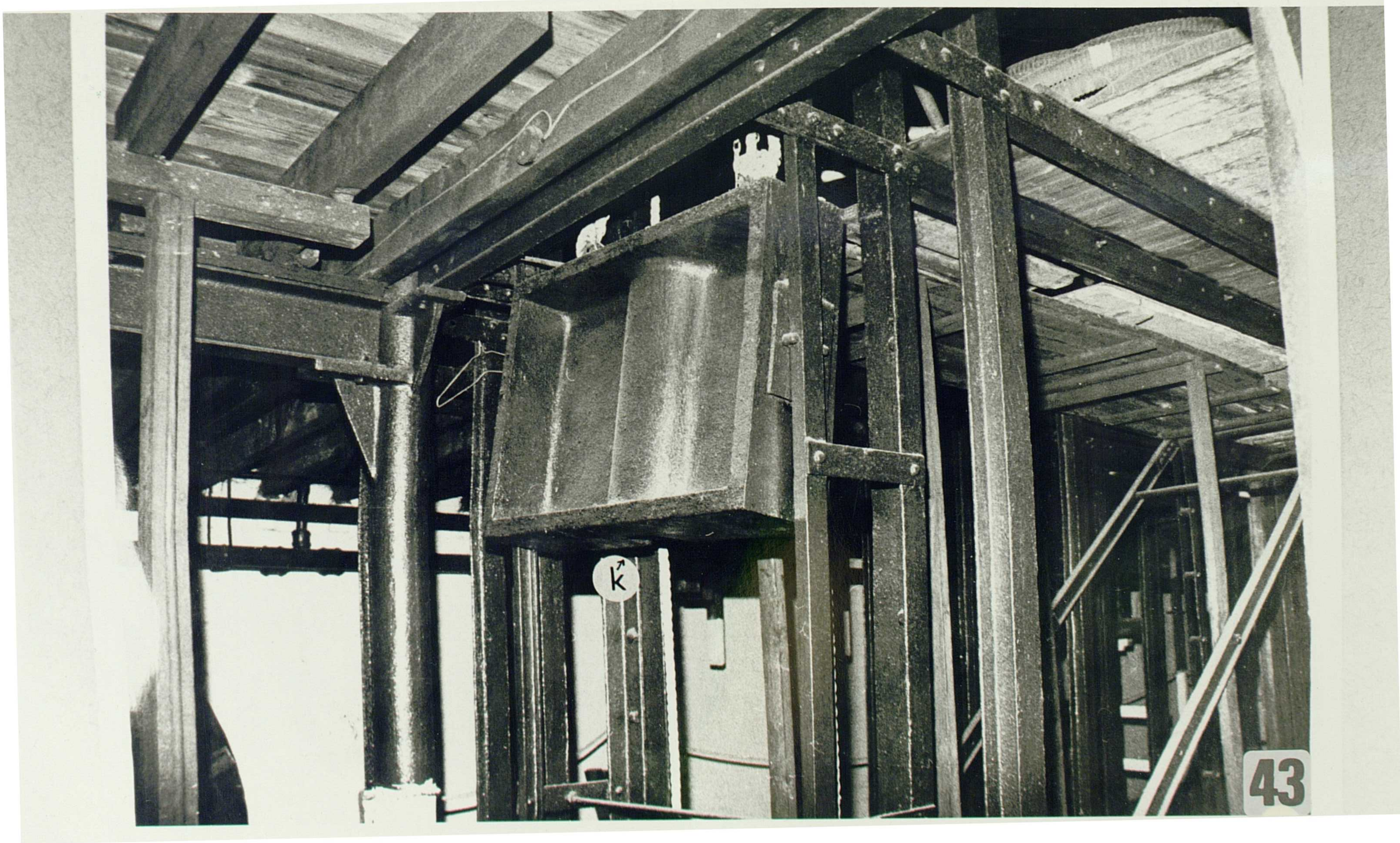
43

Stage left end of No.1 bridge at lower mezzanine floor showing counterweight.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]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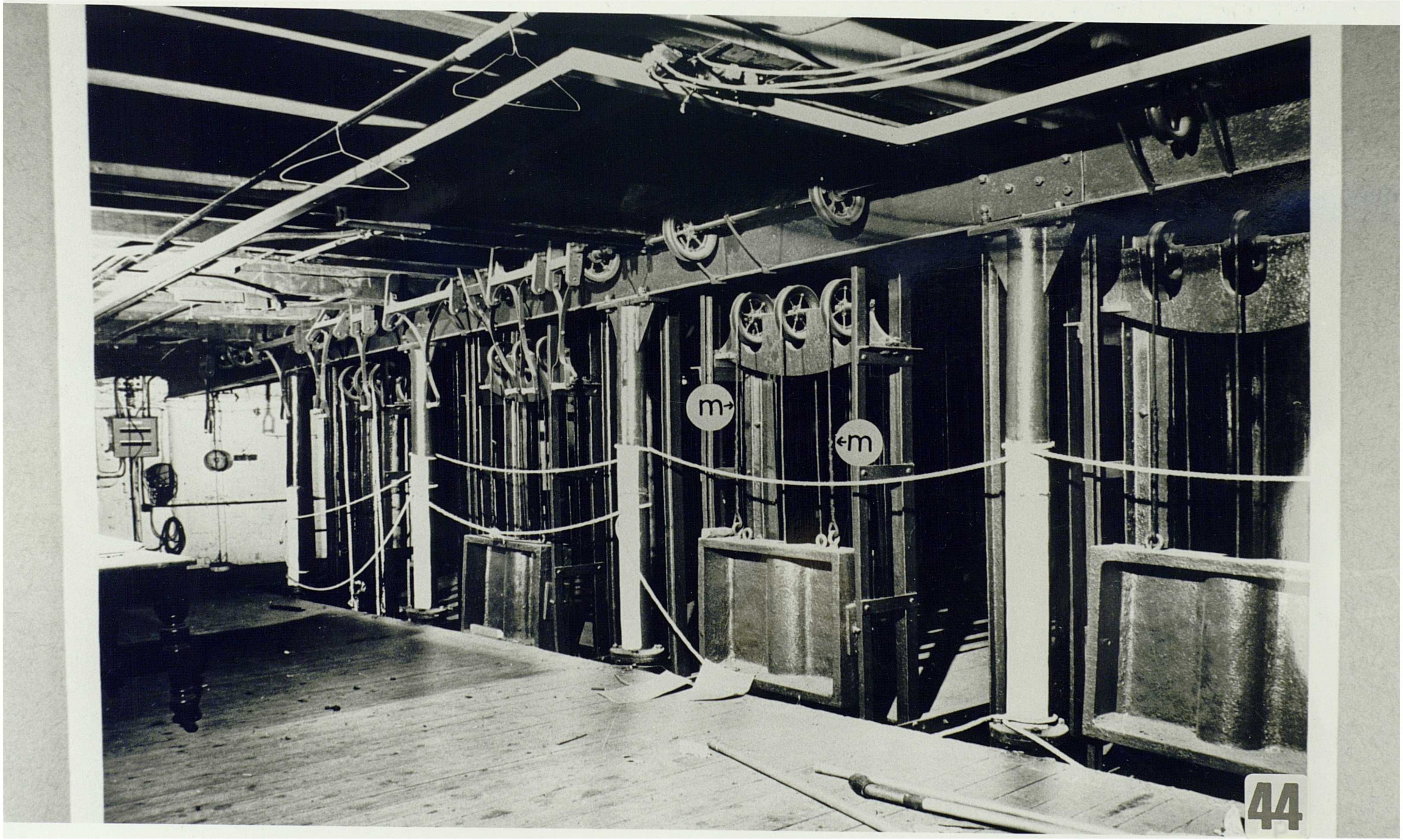
43

44 View of stage left upper mezzanine floor.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council]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44

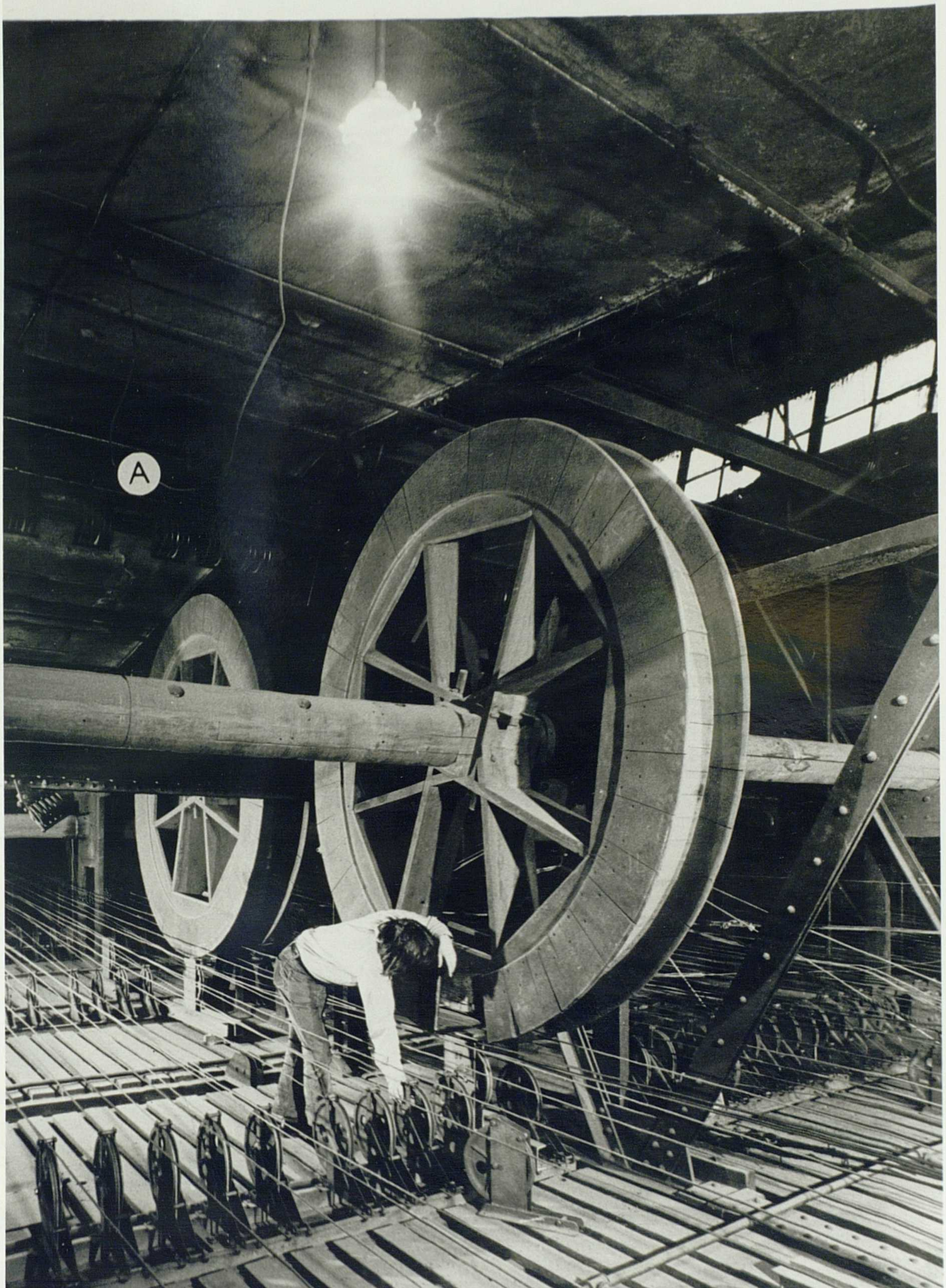
45 View from stage left end of No.2 bridge on lower mezzanine floor.
Grand Theatre, Leeds.
[Photo: Dept.of Planning, Leeds City Council].


45

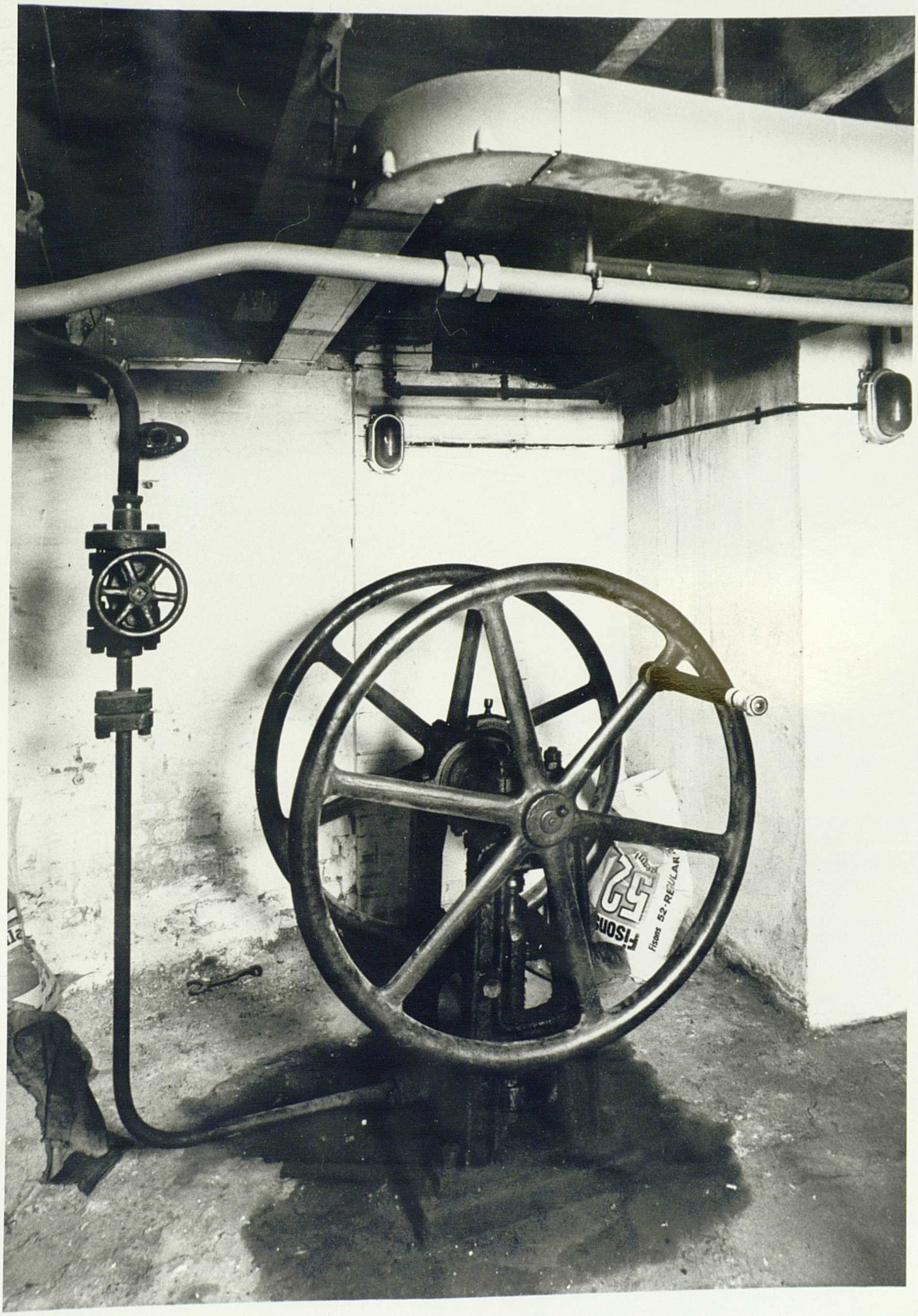
46 Mr.Walter Pfeffer Dando
[Photo: the *Sketch*, 14th March 1894,
p.373]

46

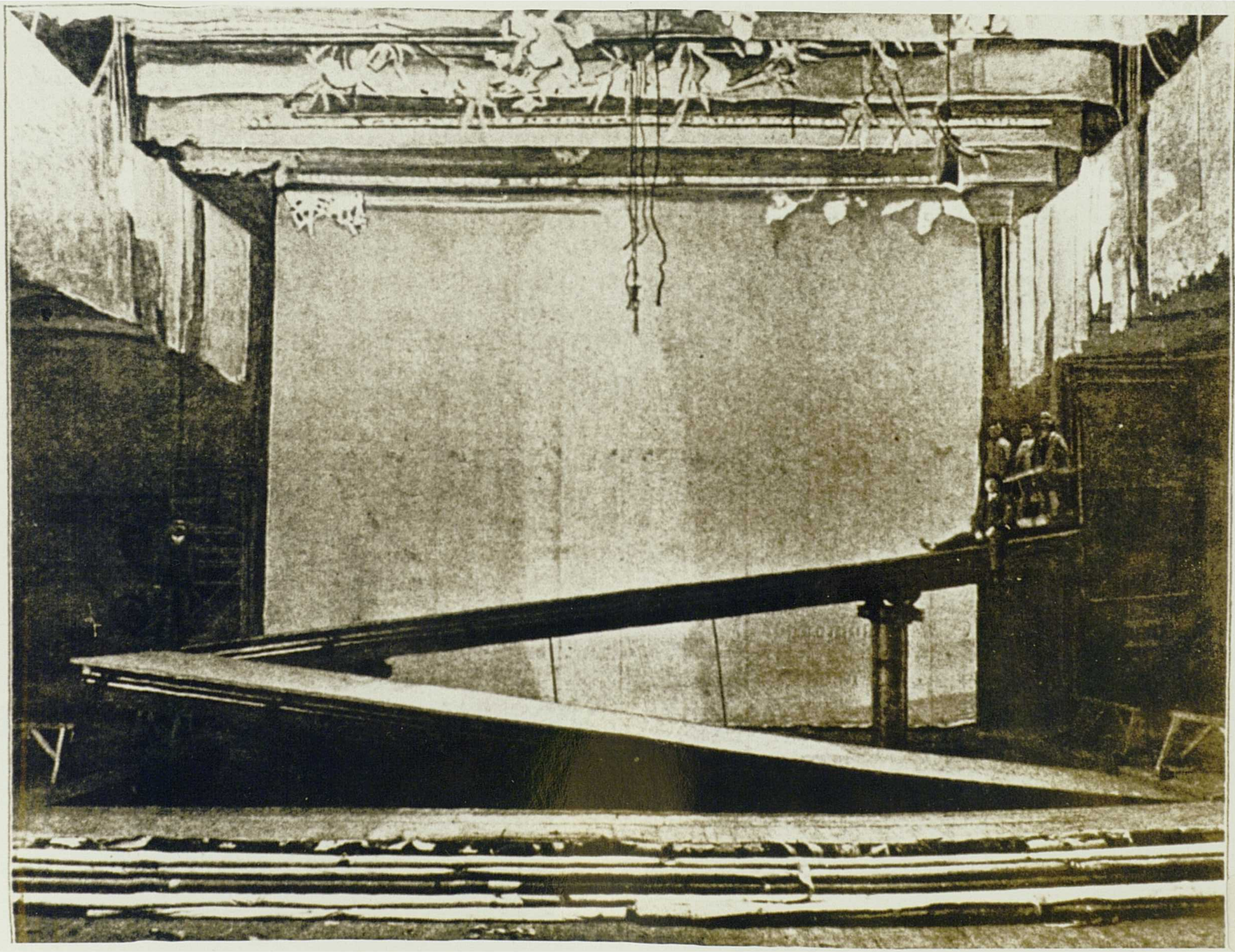
47 Large drum and shaft on the grid, and original pulley sheaves at A.
Royal English Opera House, (Palace Theatre) London.
[Photo: G.L.C. Ref.No.,72 2056]


A

48 Standy-by pump for safety curtain
manufactured by Clark and Bunnett,
1888. Located in the substage.
Lyric Theatre, Shaftesbury Ave.,
London.
[Photo G.L.C., Ref.No.72 1818]



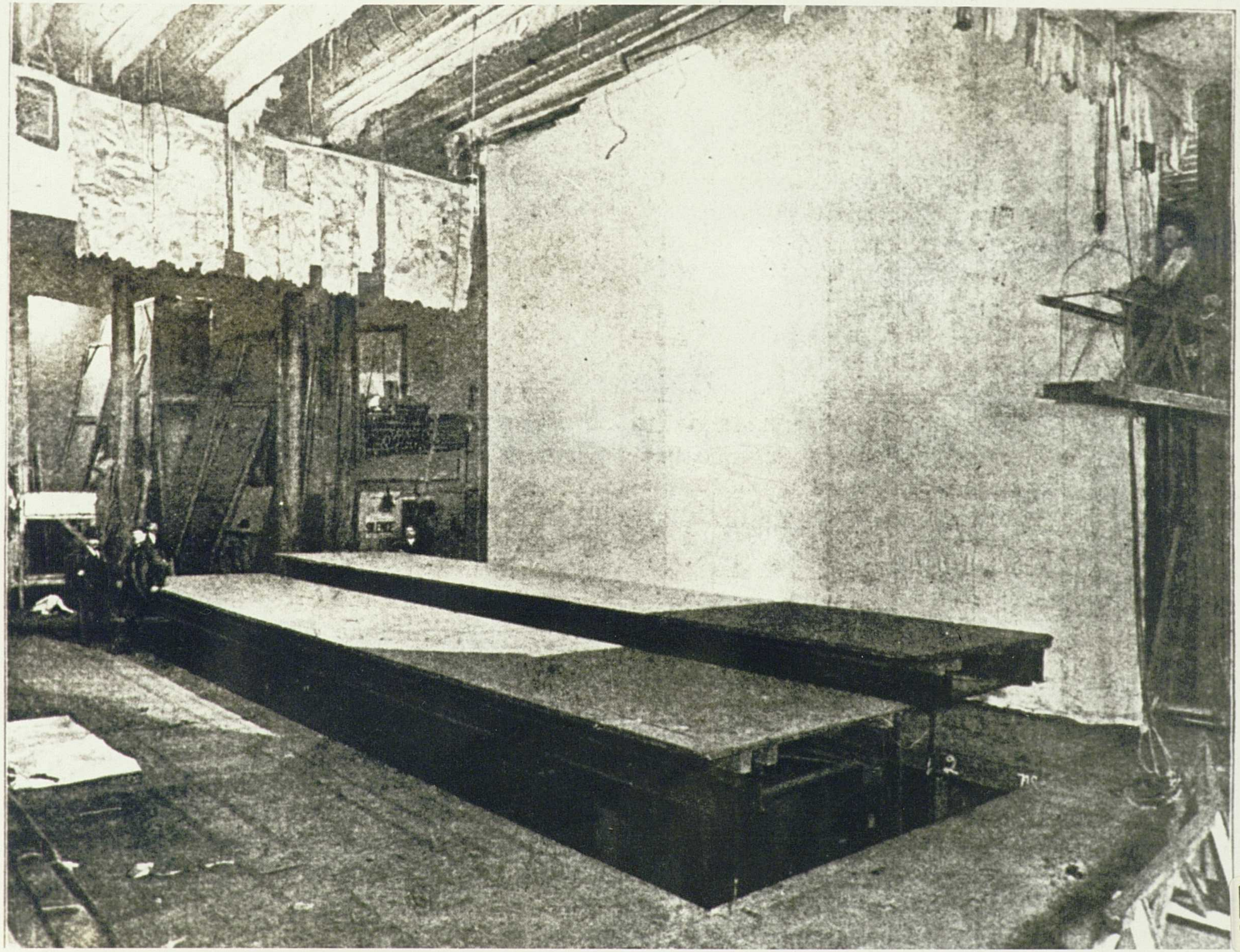
49 The Tilting hydraulic bridges Theatre Royal, Drury Lane, London.
[Photo: Engineering, 17th June 1898, p.754]



49

50

Two hydraulic bridges elevated above stage level.
Theatre Royal, Drury Lane, London.
Photo: <u>Engineering,</u> 17th June, 1898, p.754]



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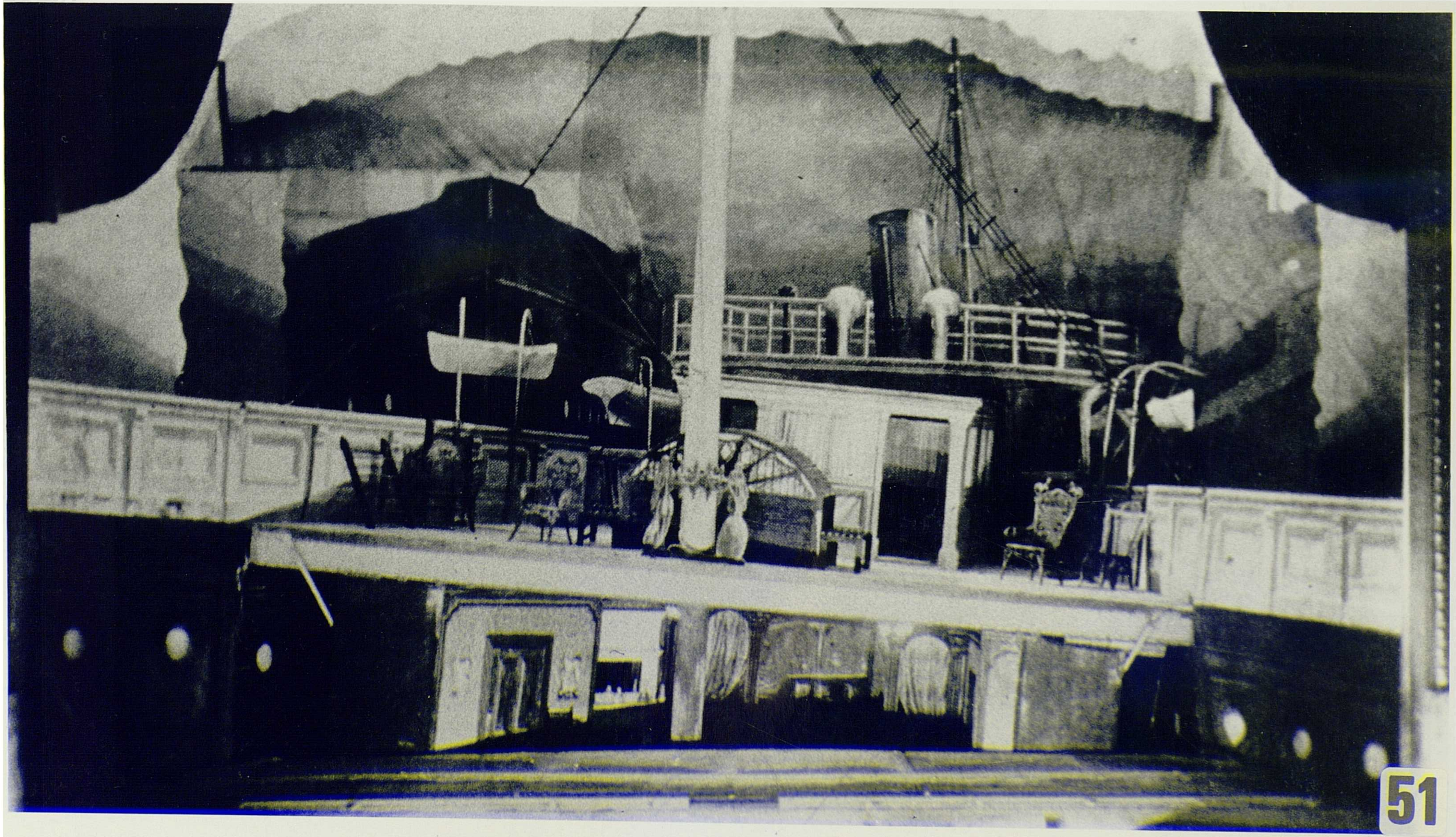
51

Photograph of the set for _The Price of Peace_
Theatre Royal, Drury Lane, London.
[Photo: The Theatre Museum].

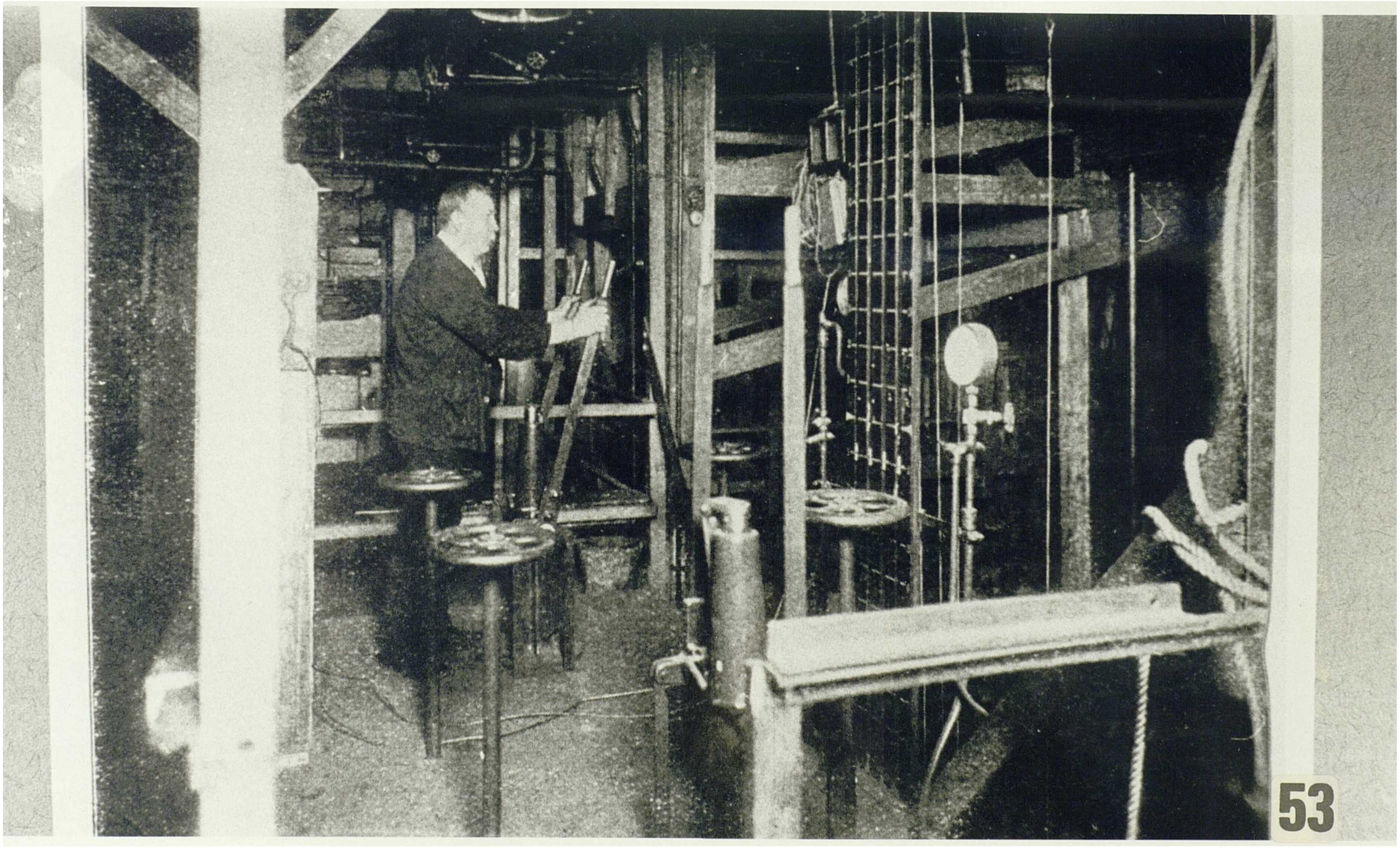

51

52

Illustration of the set for *The Price of Peace*.
Theatre Royal, Drury Lane,
London, 1888.
[Photo: *The Graphic*]

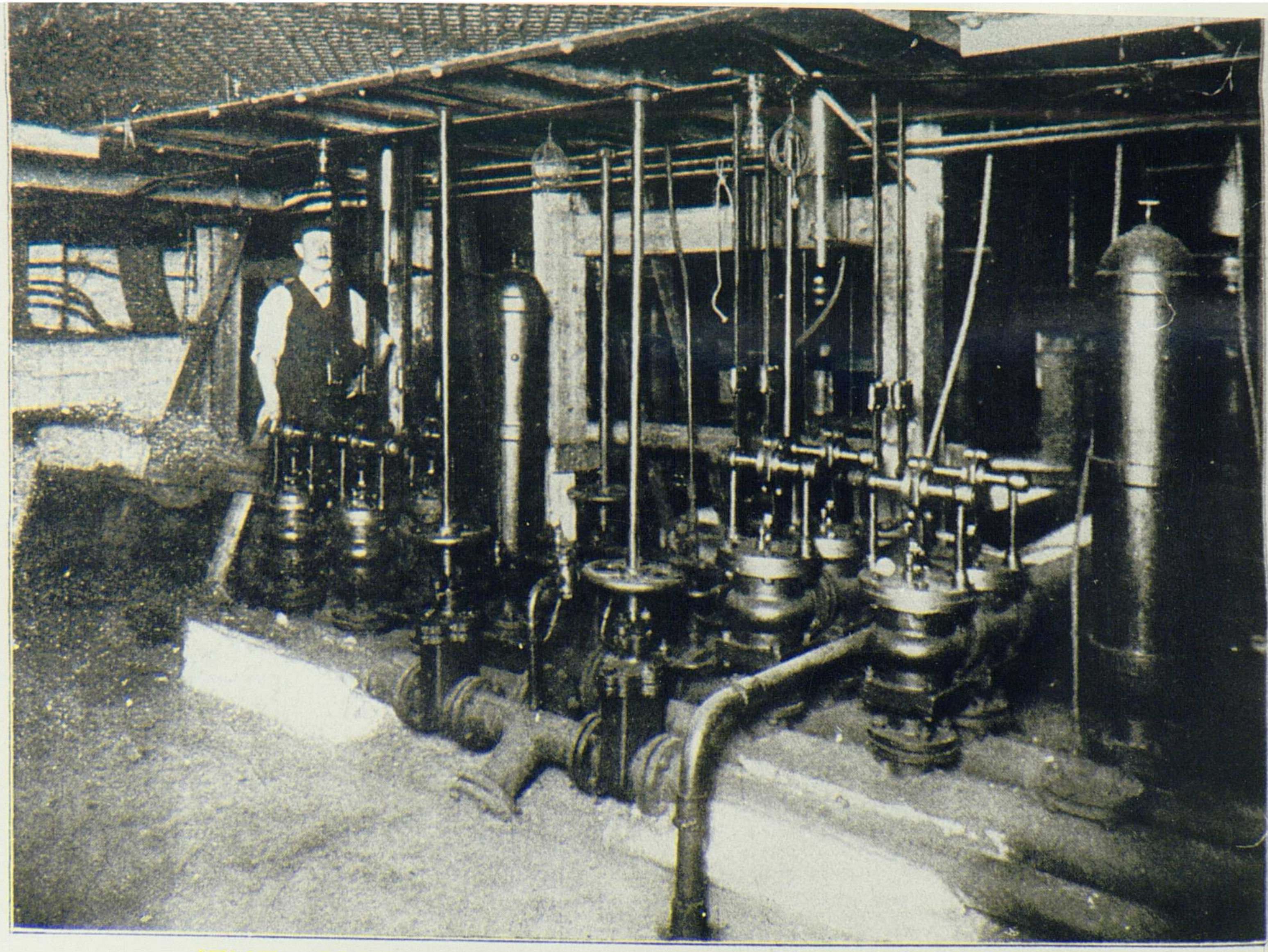
53

Control handles for the hydraulic bridges. Note the position indicators on the right.
Theatre Royal, Drury Lane, London.
[Photo: The Stage Year Book, 1910]


53

54

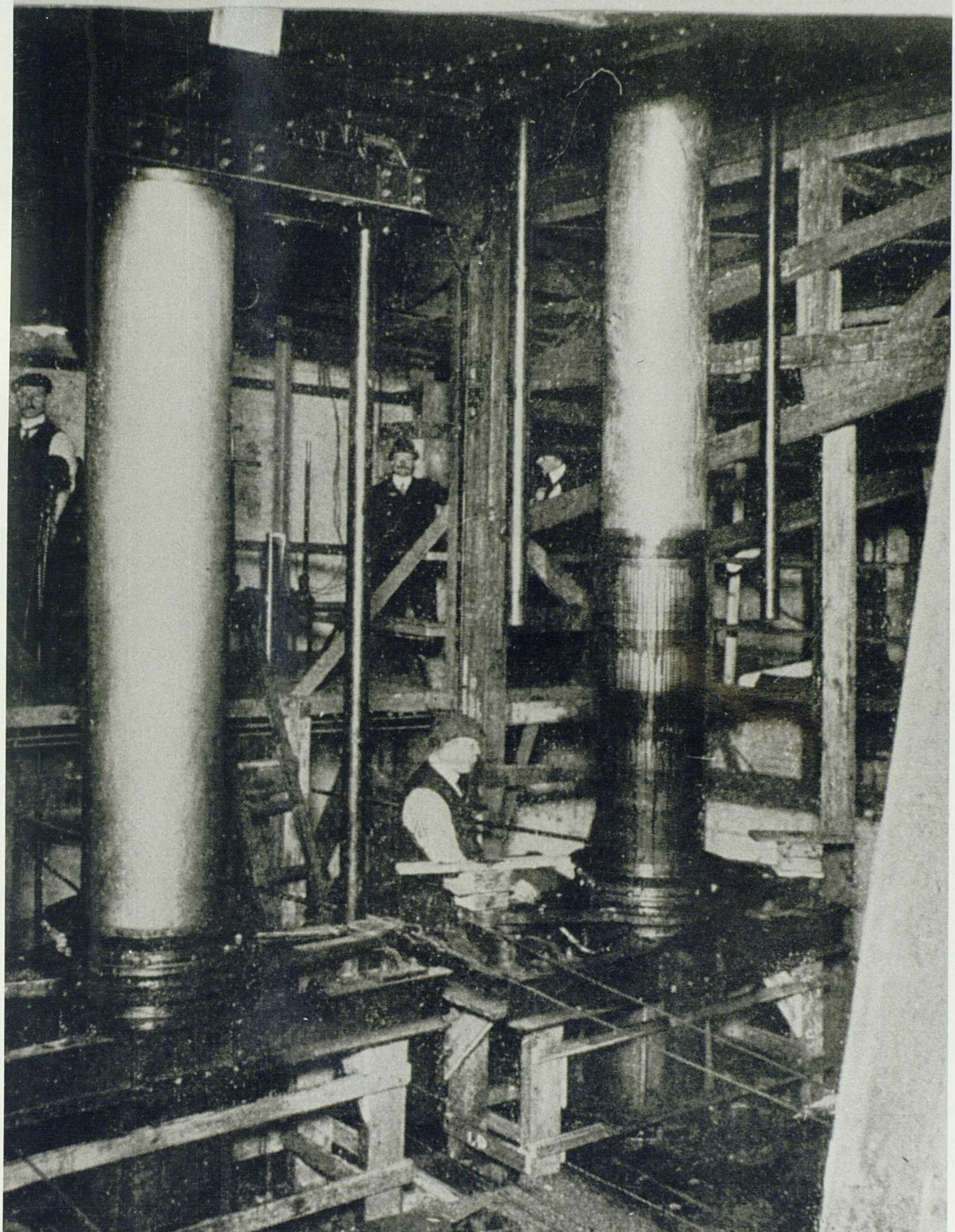
The control valves for the hydraulic bridges.
Theatre Royal, Drury Lane, London.
[Photo: The Stage Year Book, 1910]



THE CONTROL VALVES FOR THE BRIDGES

54

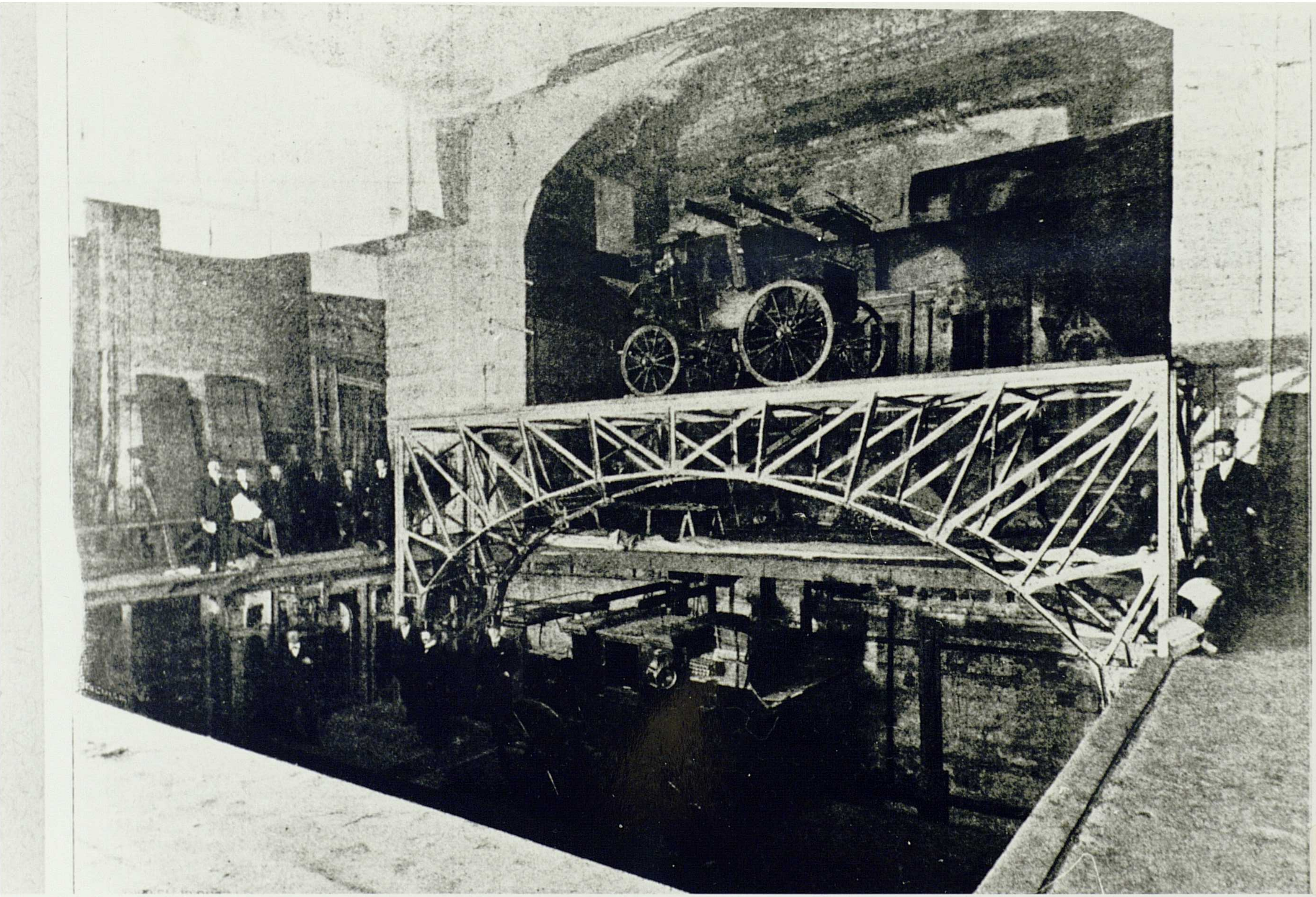
55 The hydraulic rams extended in the cellar.
Theatre Royal, Drury Lane, London.
[Photo: The Stage Year Book, 1910]



THE UNDERSIDE OF THE STAGE,

Showing the massive plungers.

56 The electric bridges (sections V and VI) V below the stage, VI above. Theatre Royal, Drury Lane, London. [Photo: _Engineering_., 23rd Dec. 1898, p.834]



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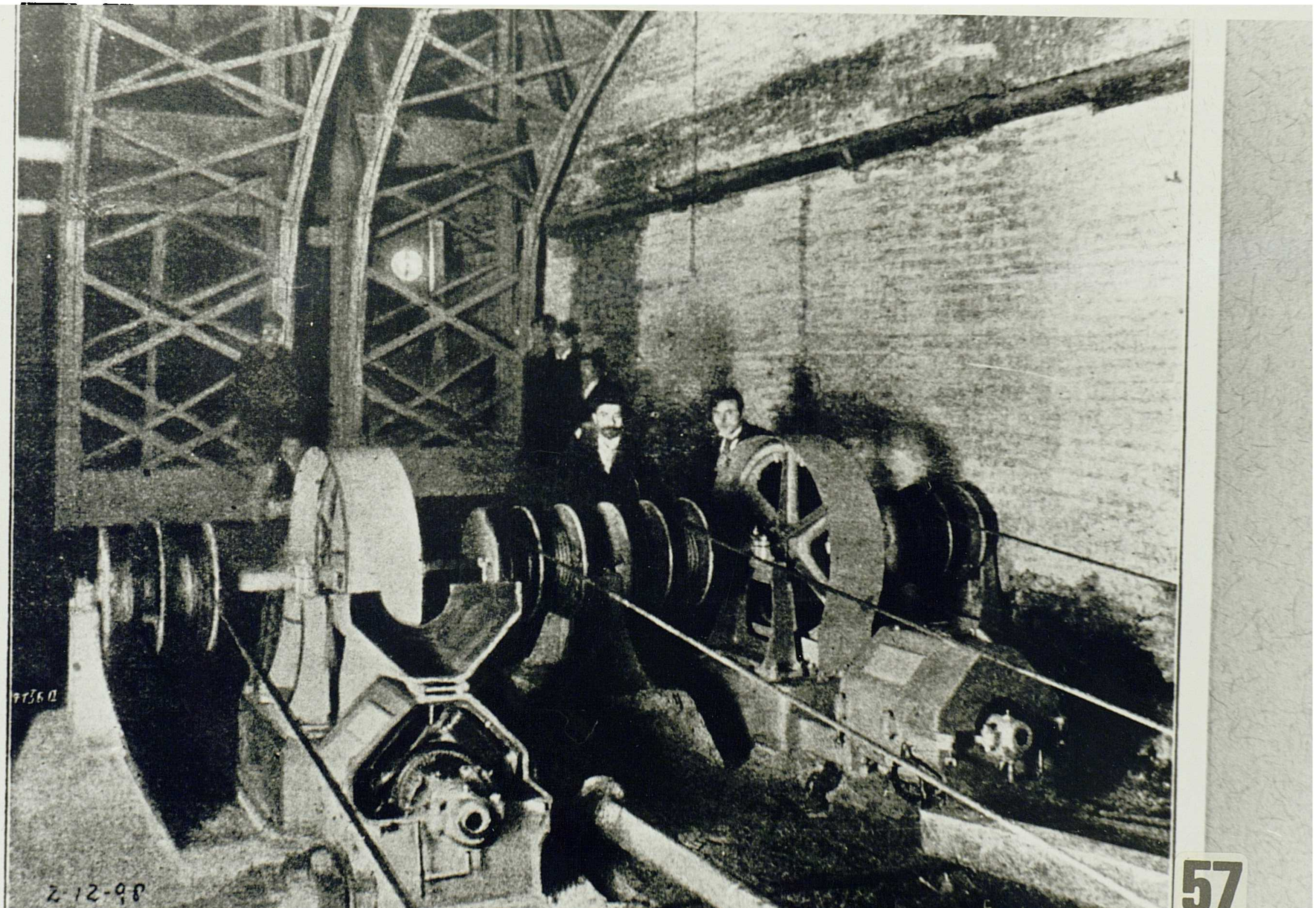
57

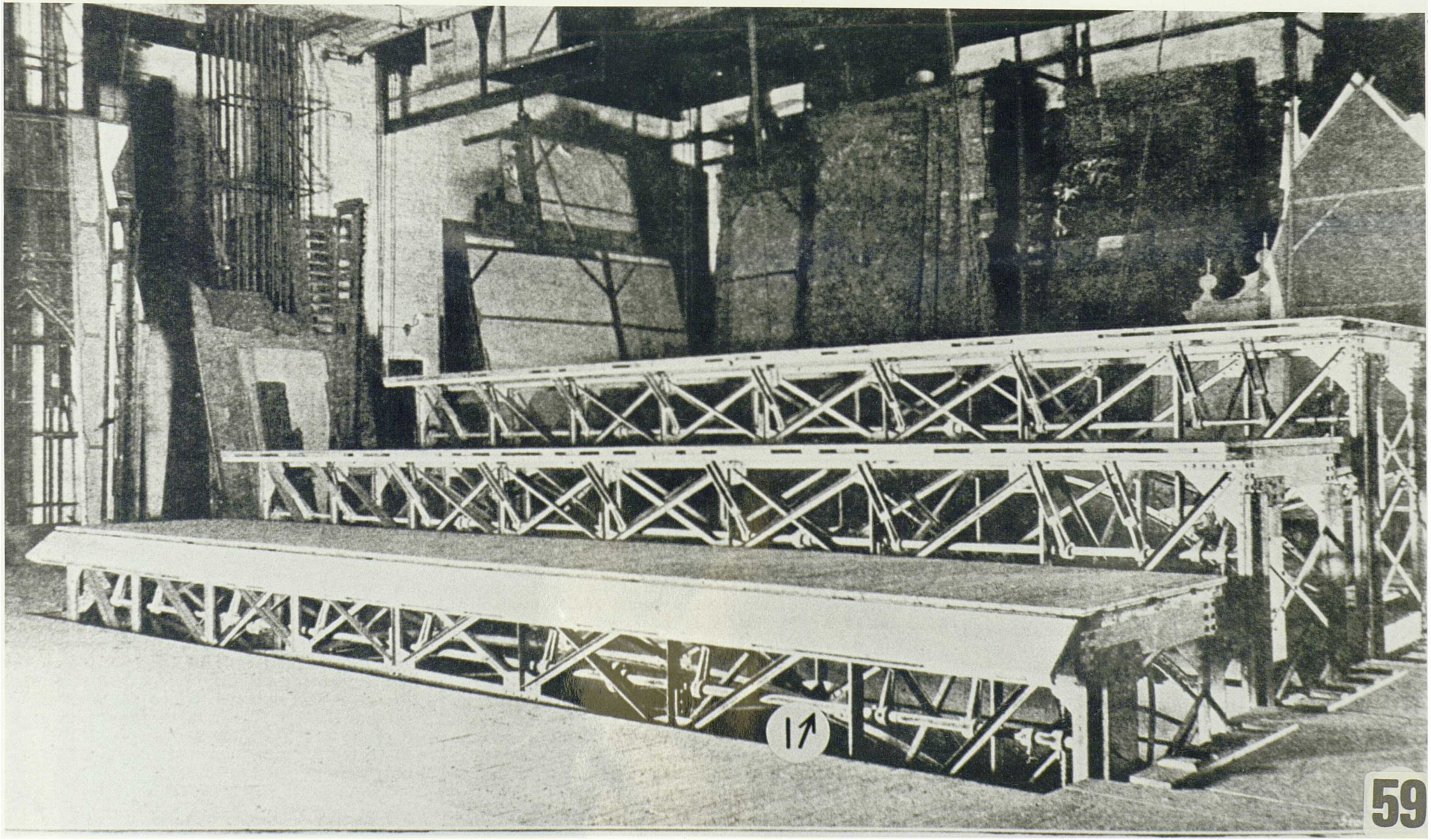
Electric four-pole shunt-wound motors for the stage sections V and VI. Theatre Royal, Drury Lane, London. [Photo: Engineering 23rd Dec.1898, p.835].


2-12-98
57

58 Edwin Otho Sachs
[Photo: _The Sketch,_ 3rd April 1901, p.426.

59

Electric bridges at various heights.
Royal Opera House, Covent Garden,
London.
[Photo: Encyclopaedia Brittanica,
XXVI, 11th edn.]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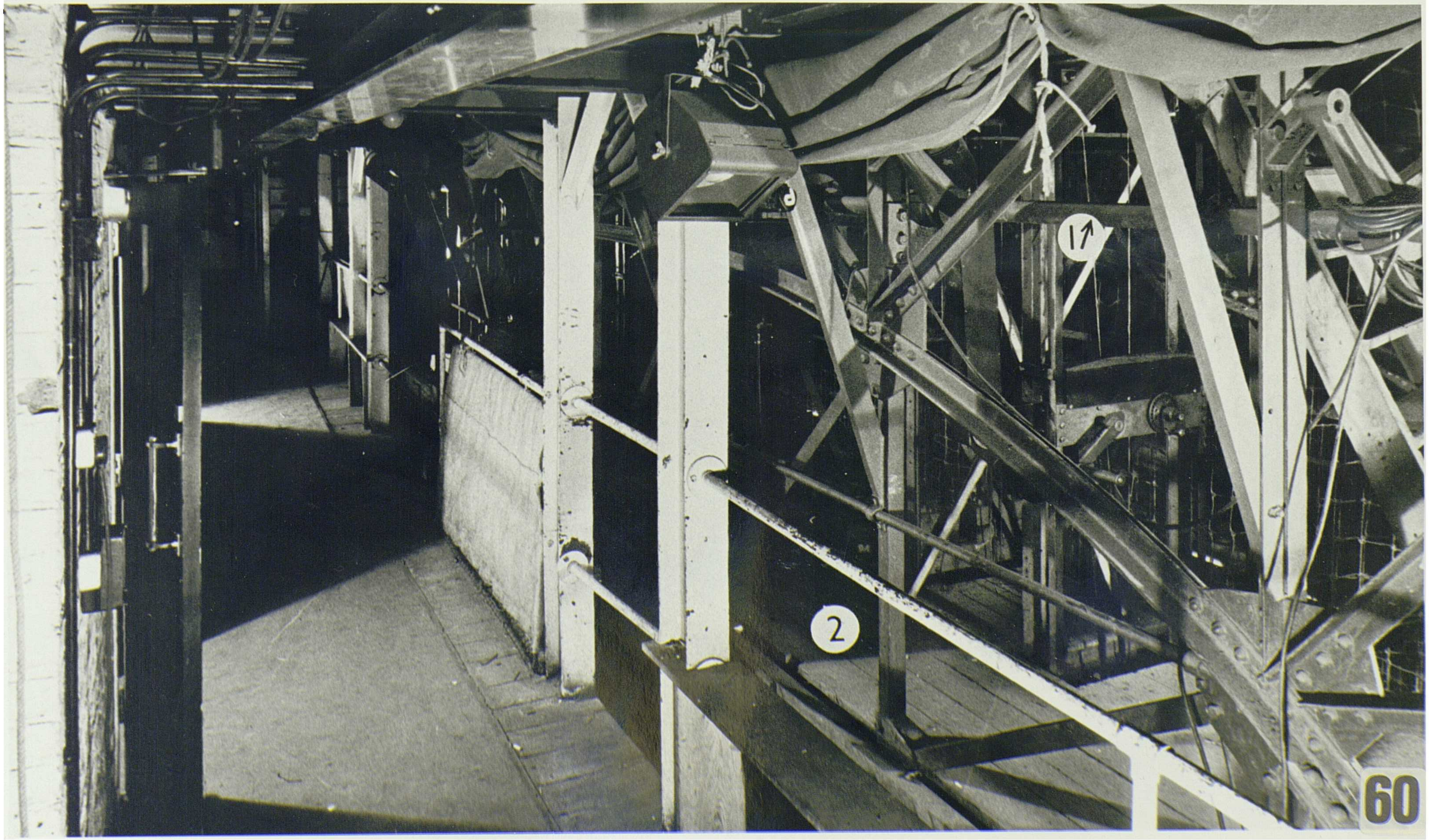
59

60

Stage section No.1. Note small traps contained within the lattice framework. Also the horizontal shaft which controls the position of the intervening stage flap.
Royal Opera House, Covent Garden, London.
[Photo: G.L.C. Ref.No.,72 3526].



1↗
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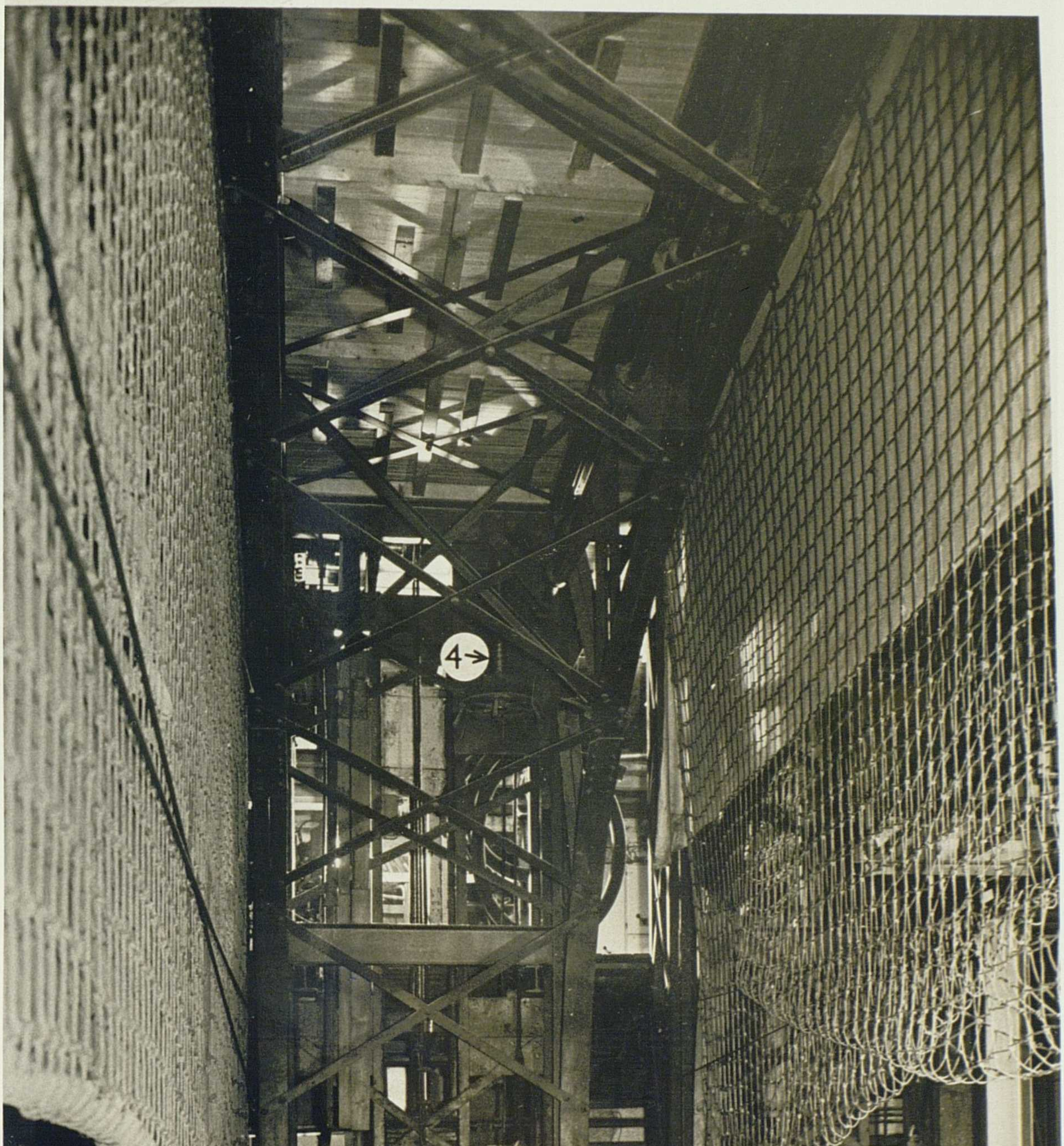
60

61 View of stage left end of bridge showing vertical worm screw for operating intervening stage flaps (see 4).
Royal Opera House, Covent Garden, London.
[Photo: G.L.C. Ref.No.,72 3530]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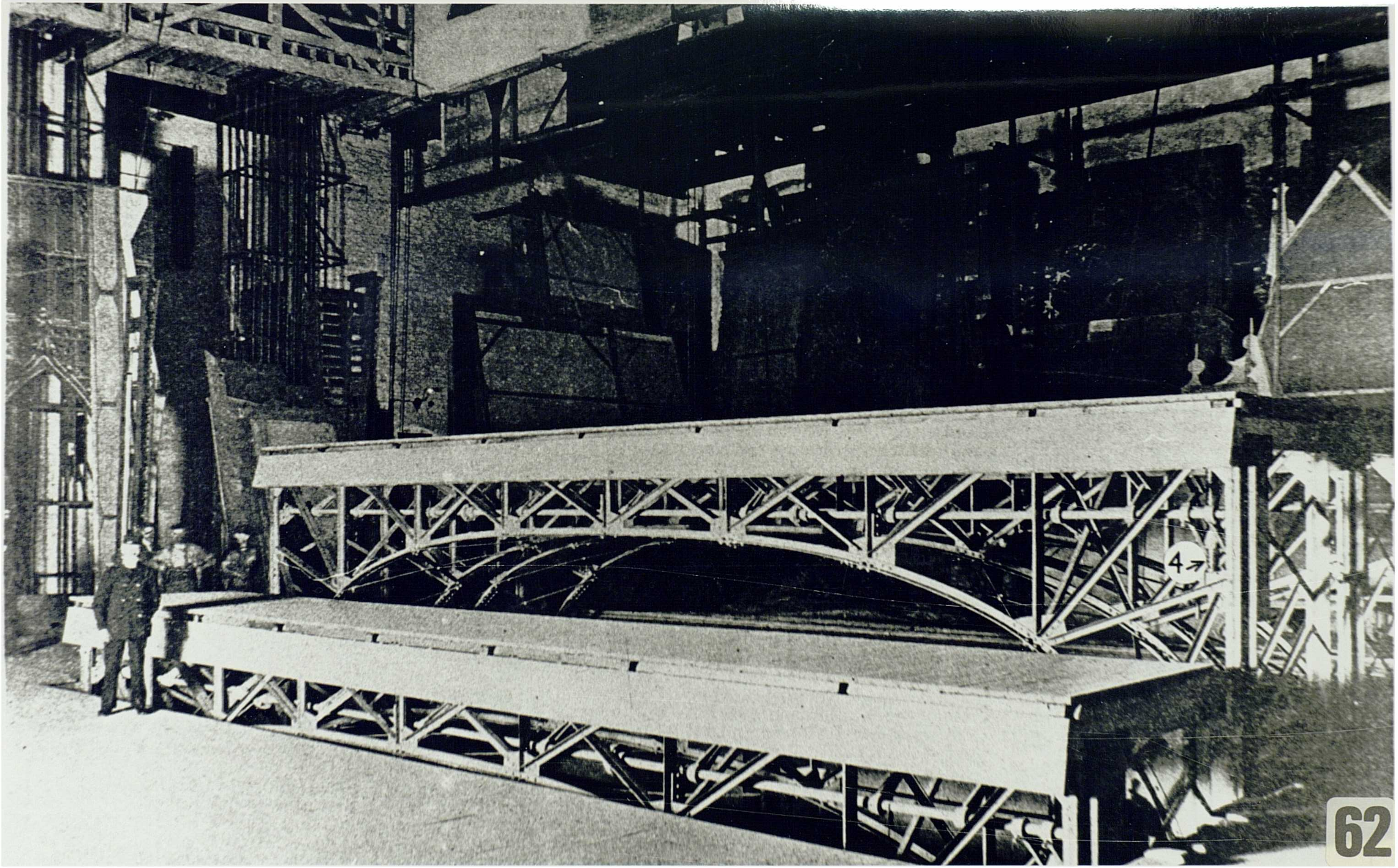
62

Two electric bridges elevated above stage level.
Royal Opera House, Covent Garden, London.
[Photo: The Scientific American Supplement, No.1342, 21st Sept., 1901, p.21511]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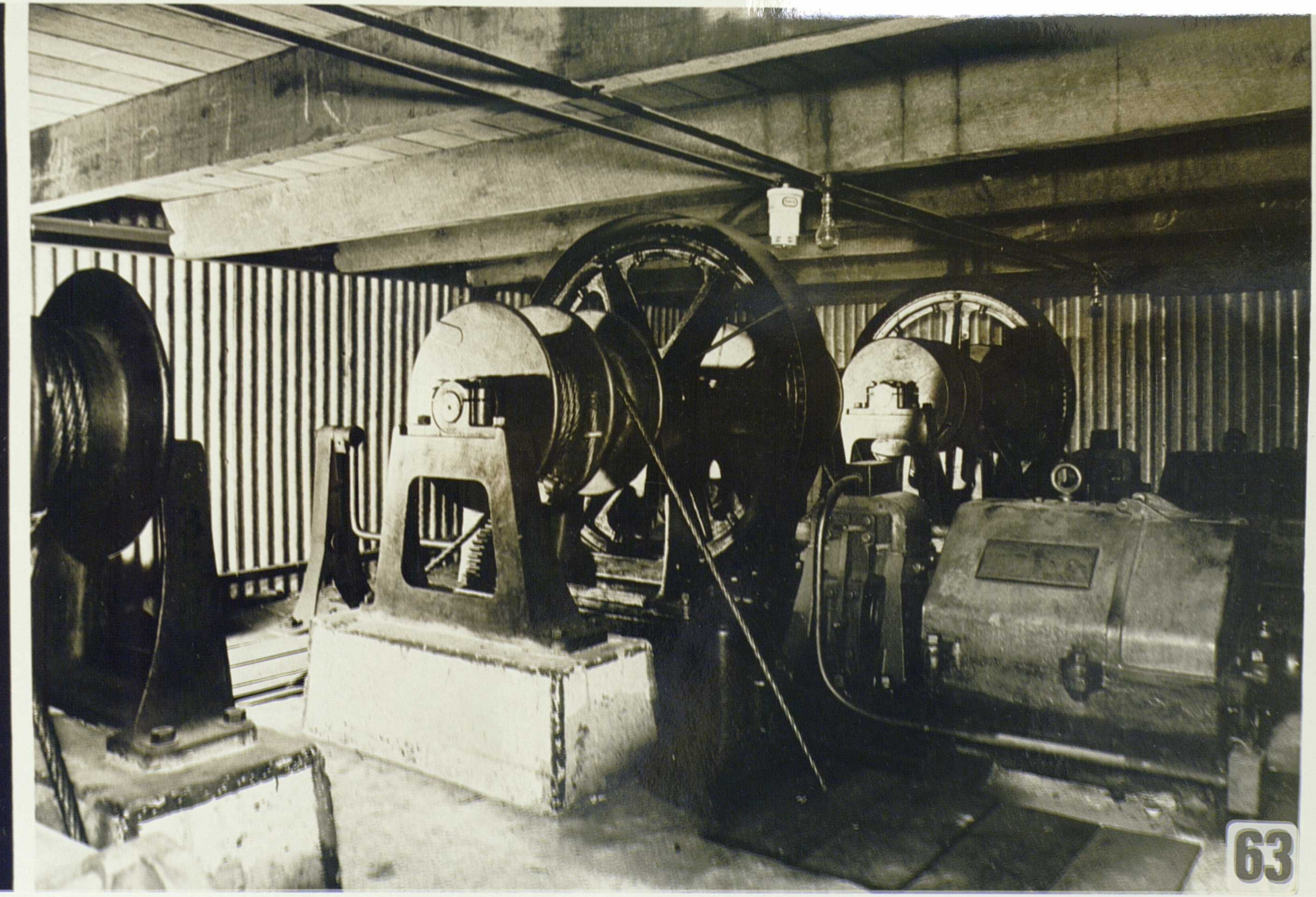
63

Bridge electric motor 7 b.h.p.
shunt-wound.
Royal Opera House, Covent Garden,
London.
[Photo: G.L.C.,Ref.No.,72 3527].

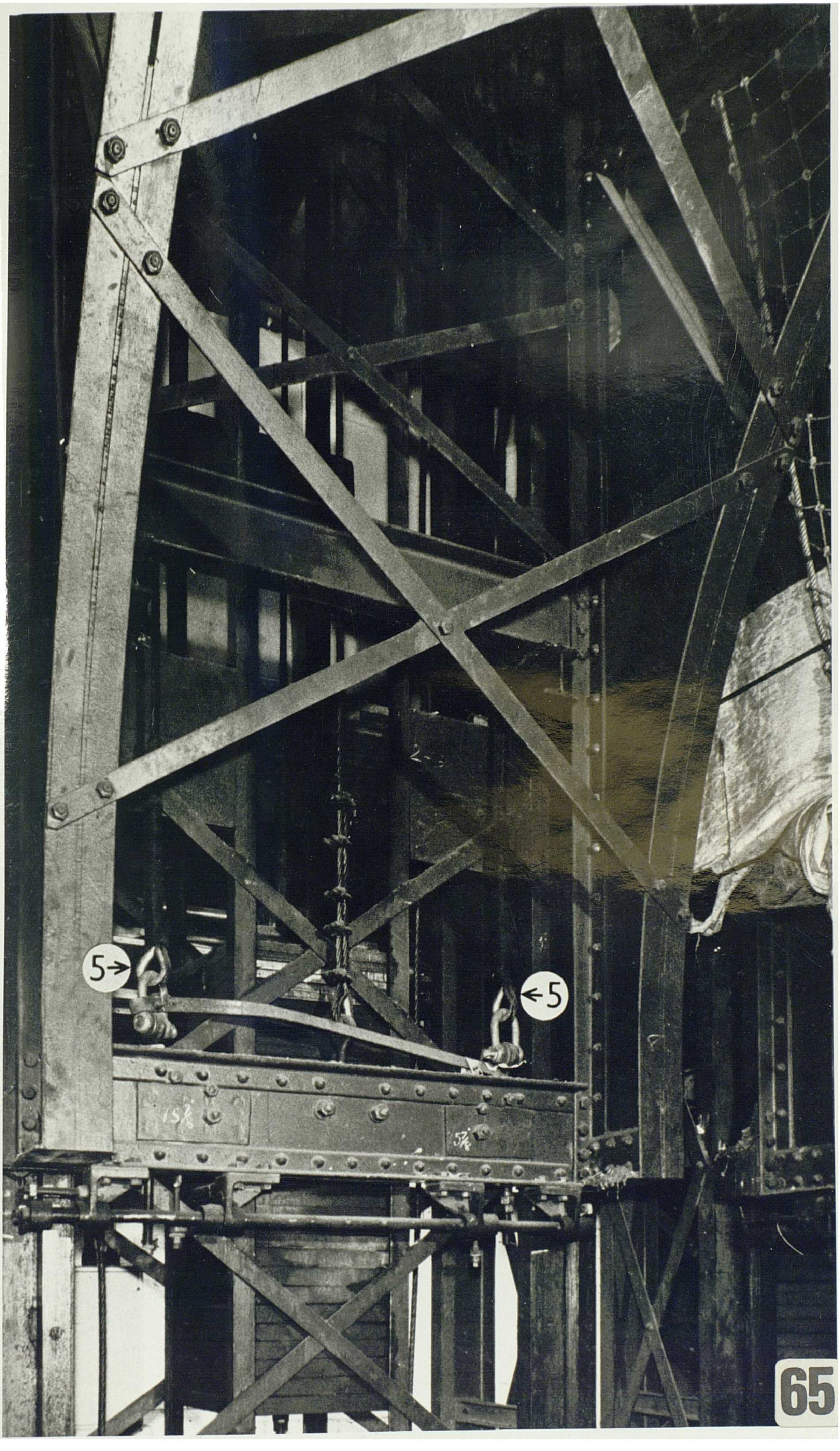

63

64

Control cables emerging from guide tunnels at the base of the bridge stanchions in the cellar. Royal Opera House, Convent Garden, London.
[Photo: G.L.C. Ref.No.,72 3529].


64

65 Details of cable attachments at the base of the bridge stanchions.
Royal Opera House, Covent Garden, London.
[Photo: G.L.C. Ref.No..72 3522]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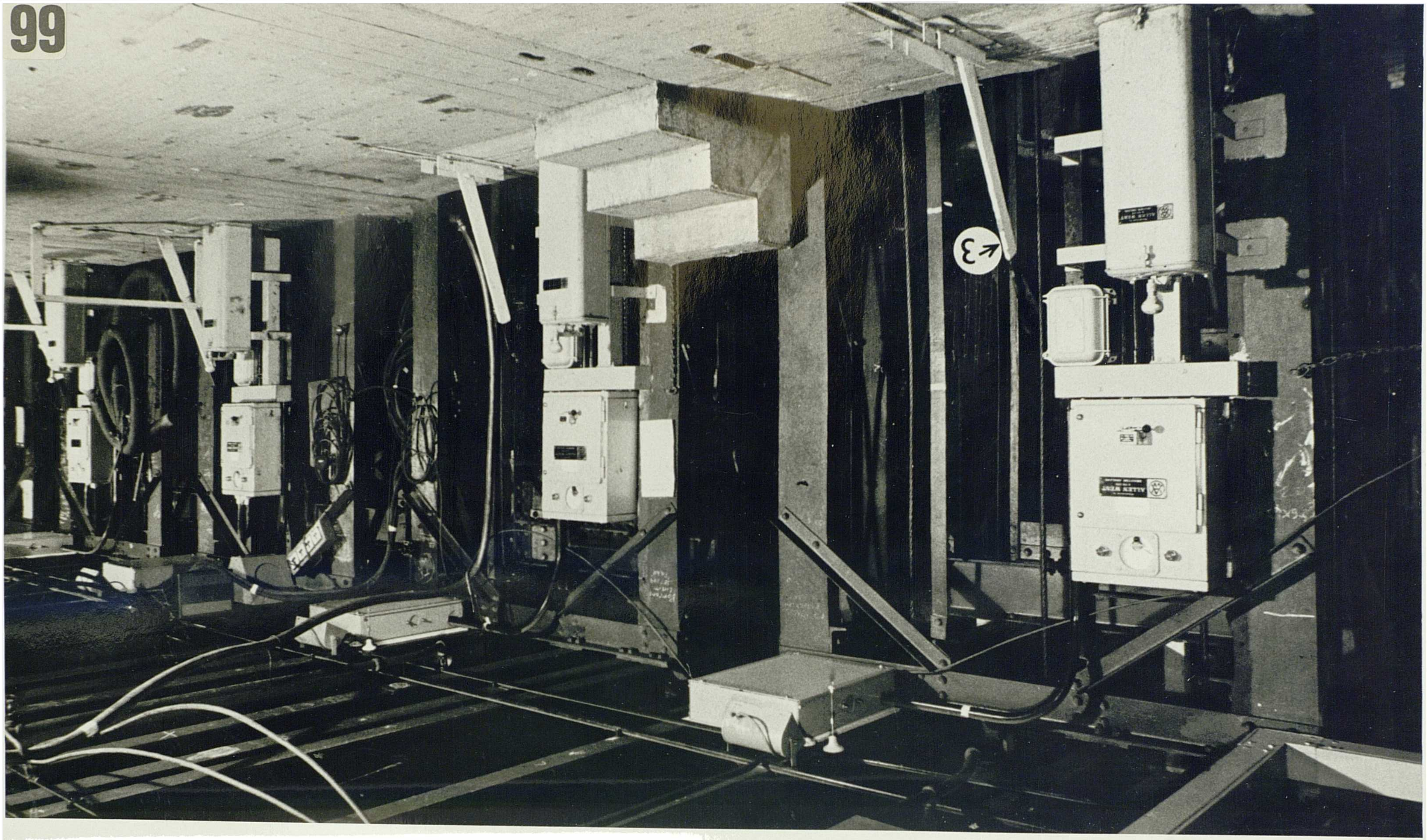
66

Bridge locking lever on stage left mezzanine floor (see 3). Royal Opera House, Covent Garden, London.
[Photo: G.L.C. Ref.No..72 3533].


99
3

67

The electric bridges in course of construction. The Gridiron. The mezzanine floor and wing chariots. Royal Opera House, Covent Garden, London. [Photo: *Engineering*, 24th May, 1901, p.674].

STAGE ALTERATIONS AT COVENT GARDEN THEATRE, LONDON.

MR. EDWIN O. SACHS, ARCHITECT, LONDON.

(For Description, see Page 659.)

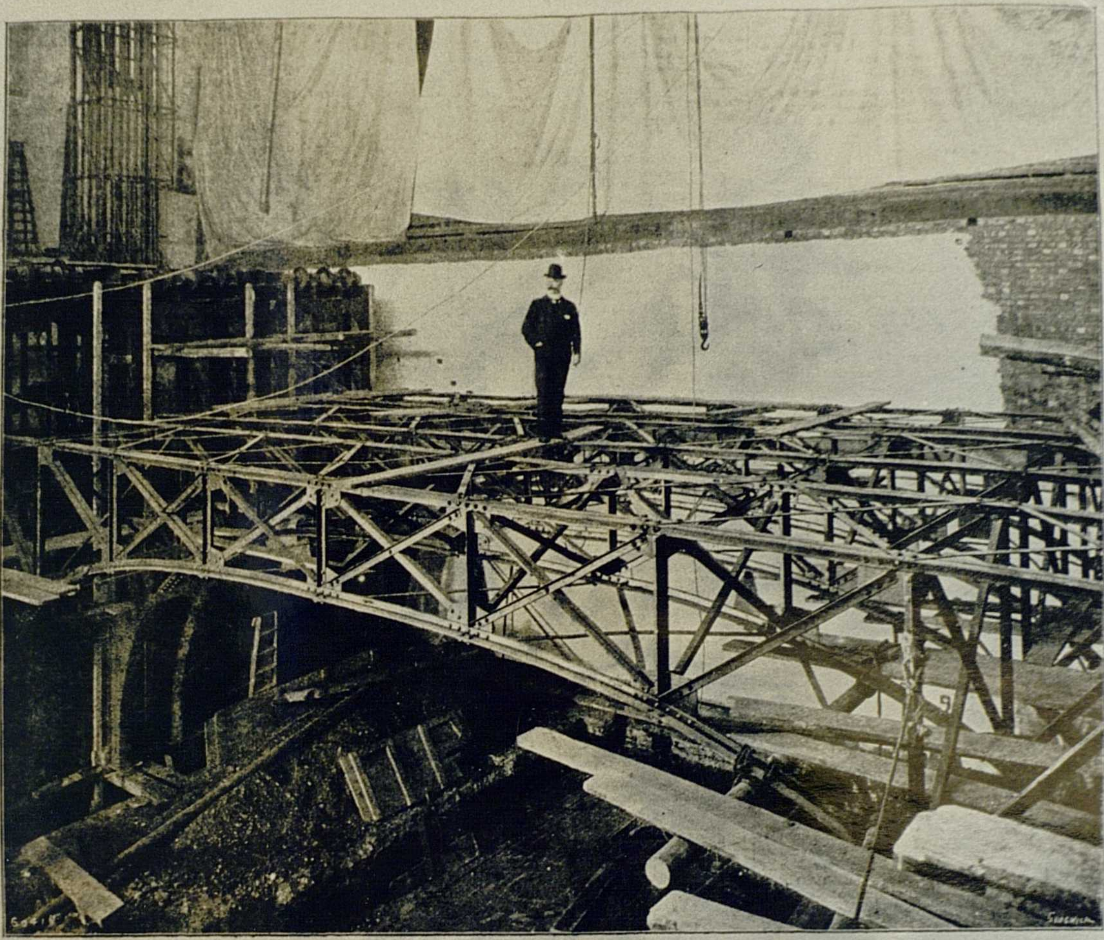


FIG. 17. THE ELECTRIC BRIDGES IN COURSE OF CONSTRUCTION.

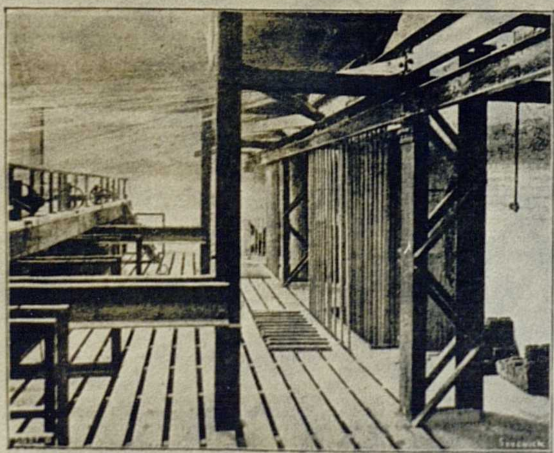


FIG. 18. THE GRIDIRON.

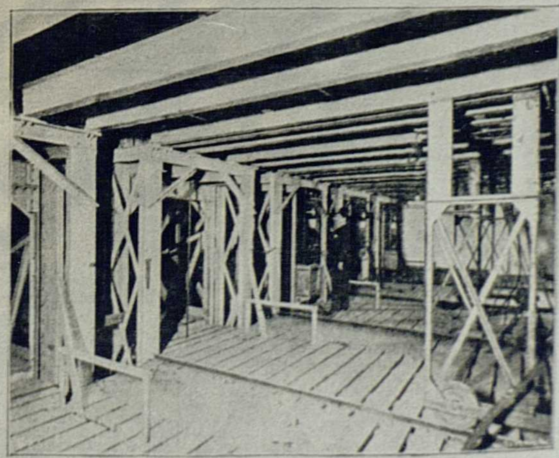
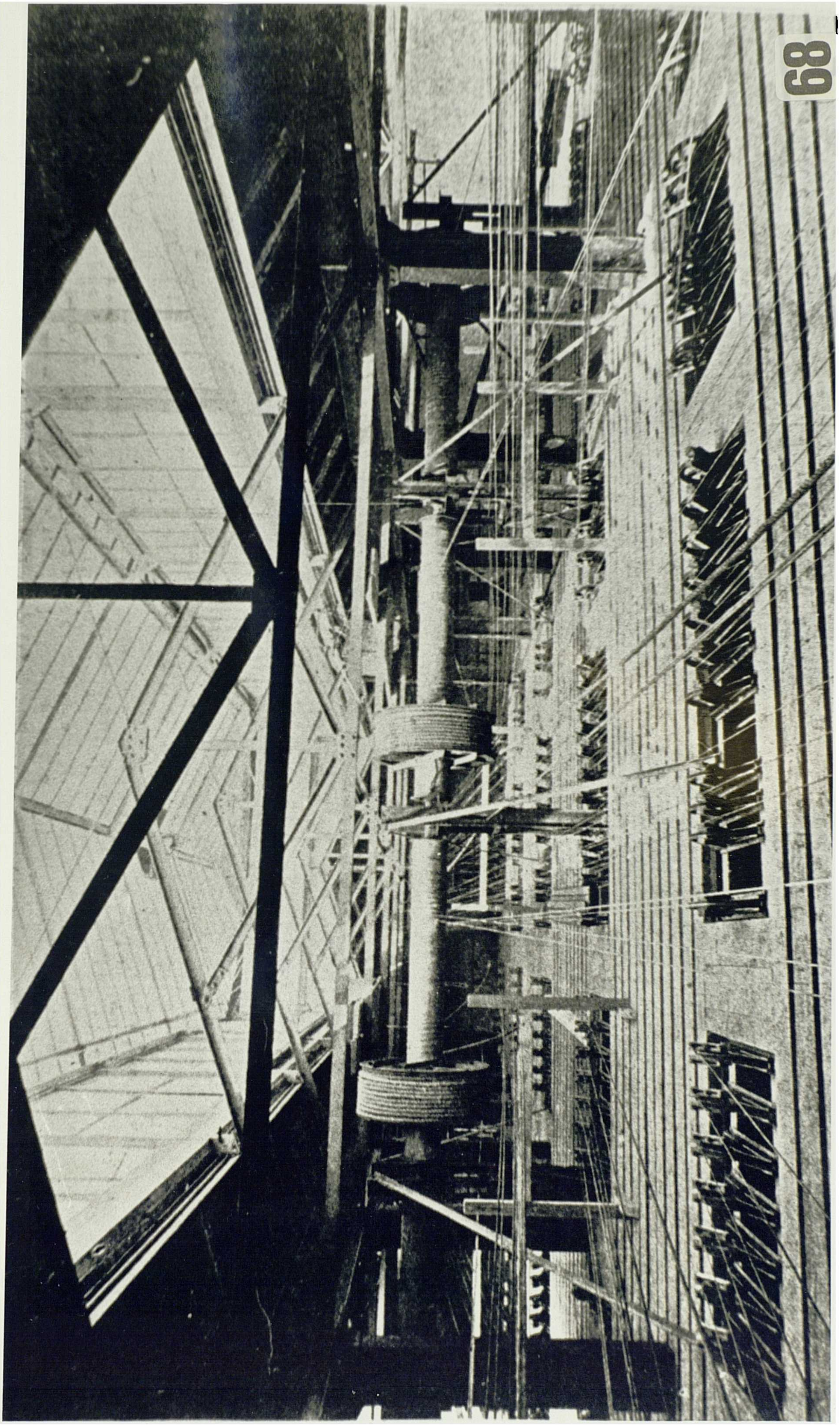


FIG. 19. THE MEZZANINE FLOOR.

67

68

View of the gridiron including small drums and shafts for flying effects.
Royal Opera House, Covent Garden, London.
[Photo: _Engineering_, 17th May 1901, p.640].

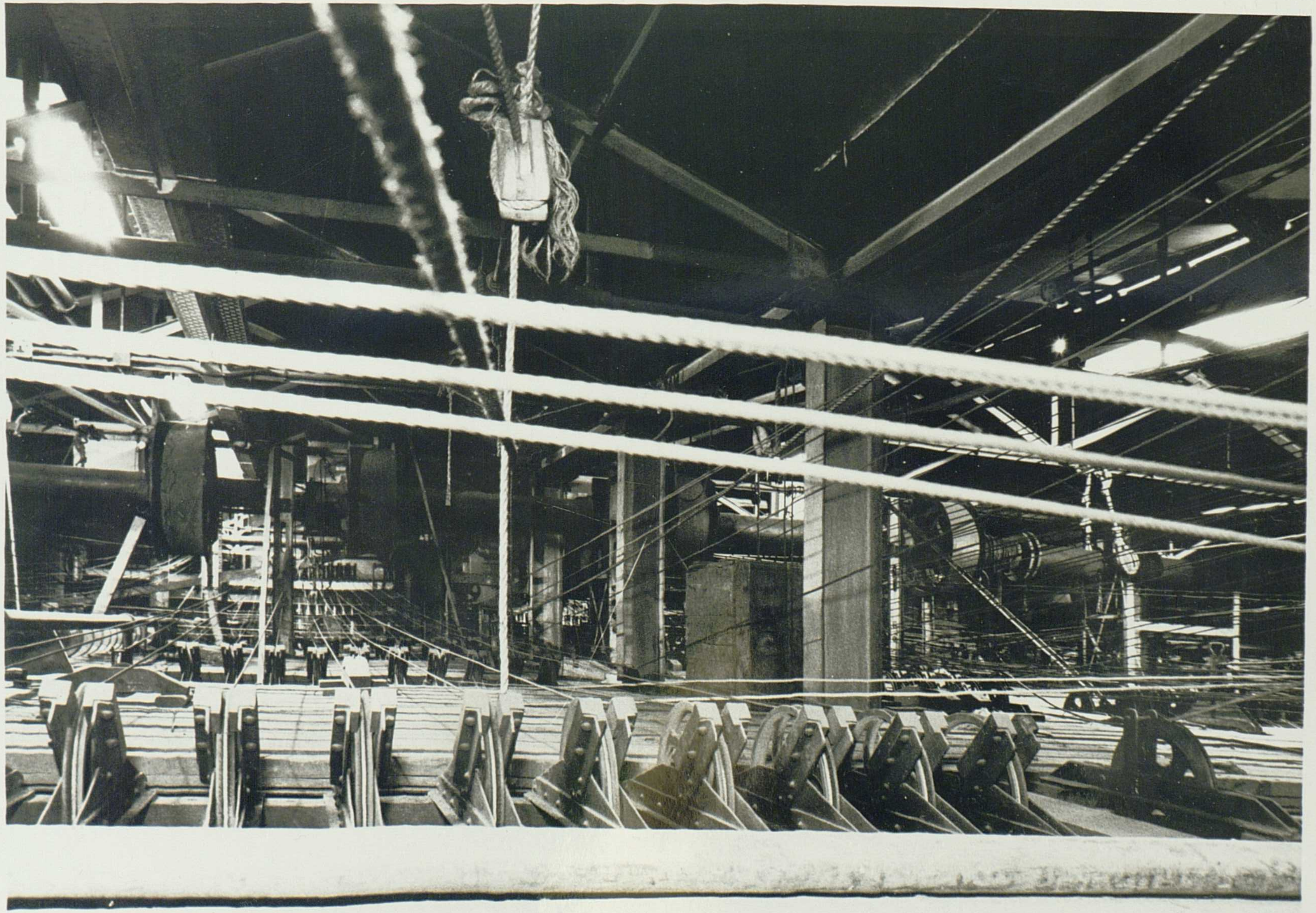


69 General view of the gridiron.
Royal Opera House, Covent Garden, London.
[Photo: Encyclopaedia Brittanica, XXVI, 11th edn.]

69

70

General view of gridiron, 1972.
Royal Opera House, Covent Garden,
London.
[Photo: G.L.C. Ref.No.,72 3525]



71 The mechanism of grand opera: the scenery from behind.
Royal Opera House, Covent Garden, London.
[*Supplement to the Illustrated London News*, 30th April 1904, CXXIV, No.3393].

71 THE MECHANISM OF GRAND OPERA: THE SCENERY FROM BEHIND

1. One of the breaking-walls in "Götterdämmerung".

2. Scene for Act III of "Die Walkure".

3. A page from the prompt-book, showing elaborate directions for the mechanical staff.

4. Scenery in the making; the paint-room.

5. The new patent trap, showing how a singer can be raised to the stage for a sudden appearance.

6. The first electric bridge raised.

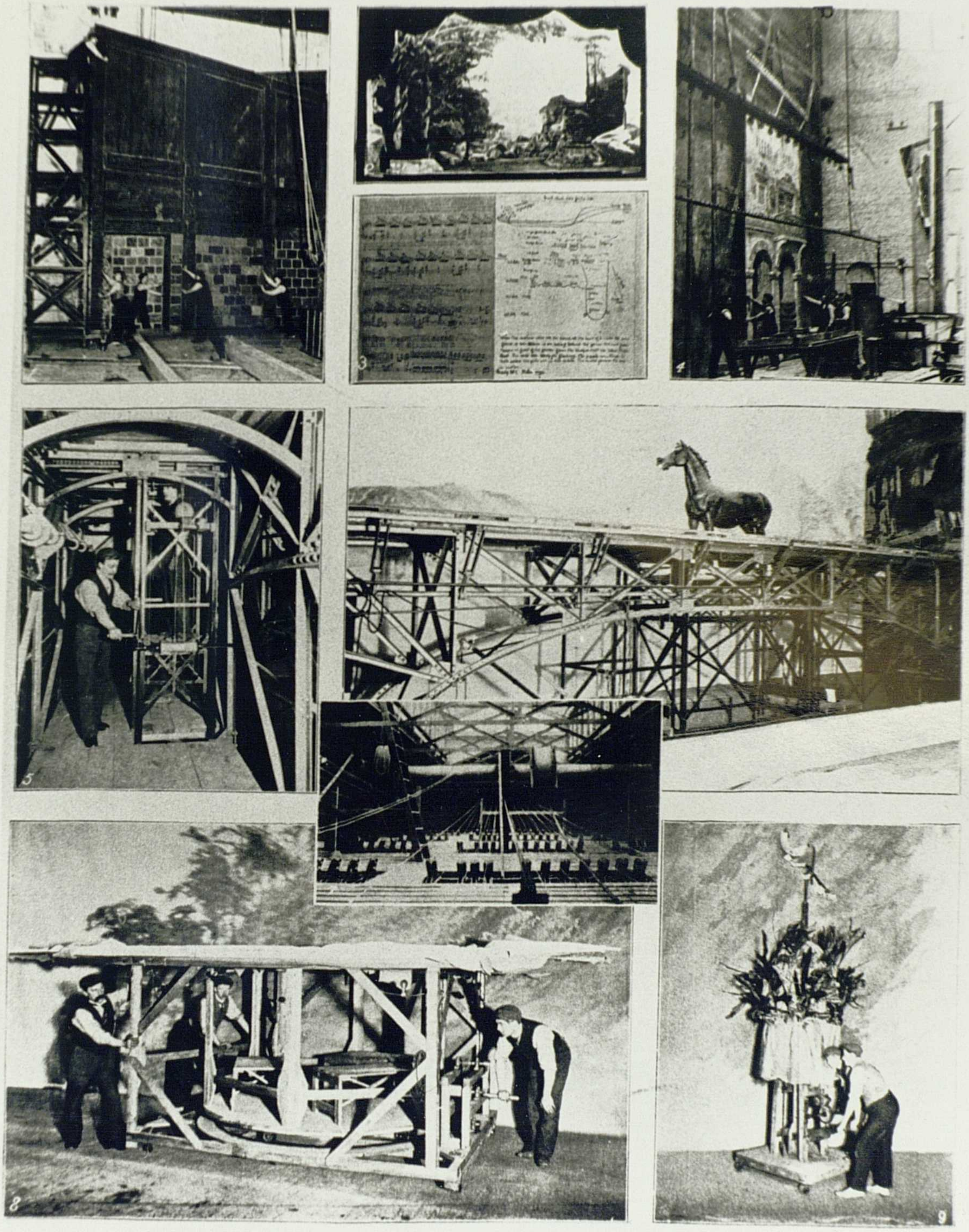
7. Central view of the "gridiron", showing the mechanism for holding and hanging stage cloths.

8. The turn-table swimming apparatus for the Rhine Maidens in "Gotterdammerung".

9. The swimming apparatus for "Das Rheingold".

Royal Opera House, Covent Garden London.
[Photo: Supplement to the Illustrated London News,
30th April, 1094, CXXIV, No 3393.]

THE MECHANISM OF GRAND OPERA: THE SCENERY FROM BEHIND

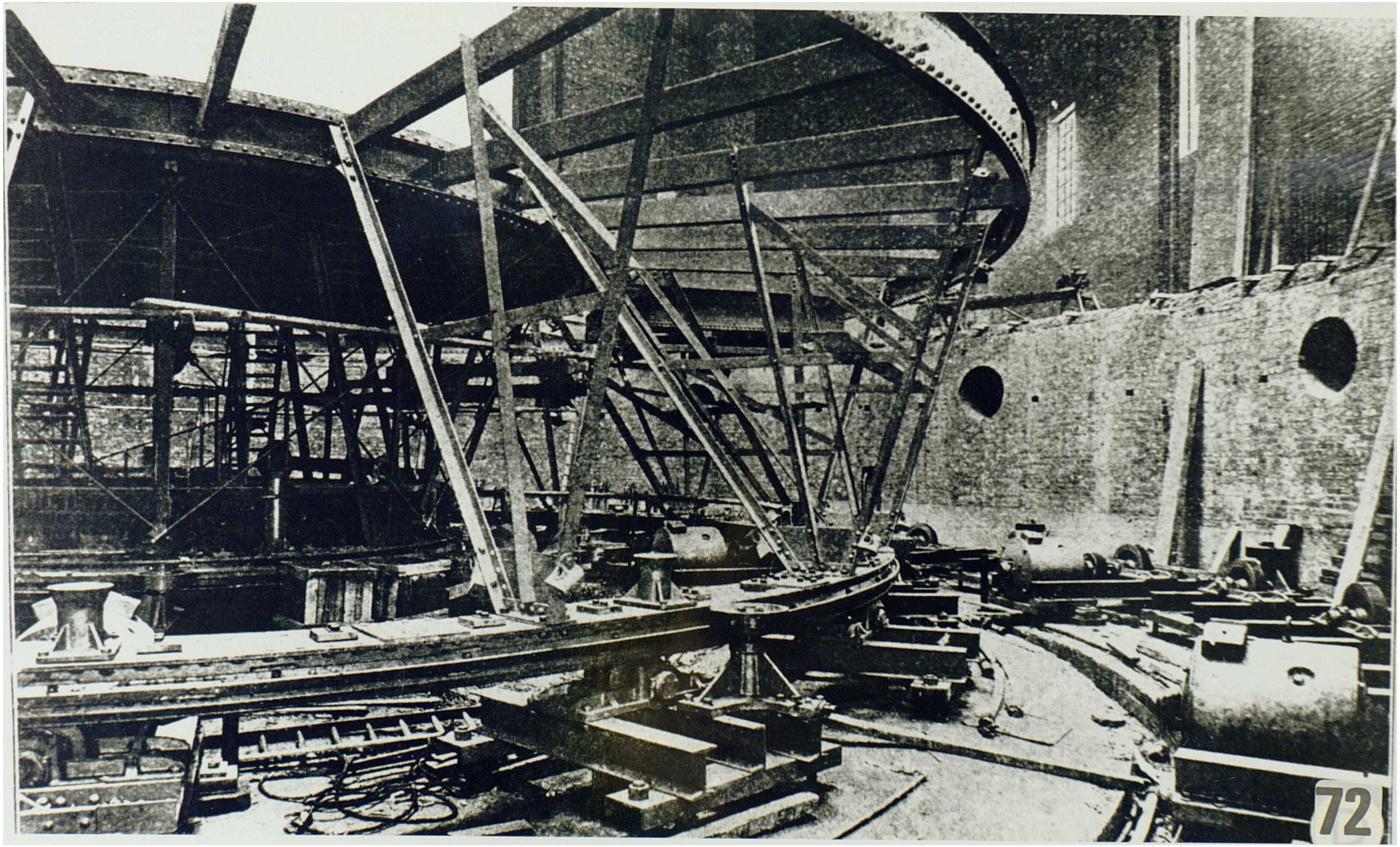


1. One of the Revolving Walls in "Götterdämmerung."
2. Scene for Act III. of "Die Walküre."
3. A Page from the Prompt-Book, Showing Elaborate Directions to the Mechanical Staff.
4. Scenery in the Making: [illegible]
6. The New Patent Trap, Showing How a Singer can be Raised to the Stage for a Sudden Appearance.
7. The First [illegible]
[illegible]

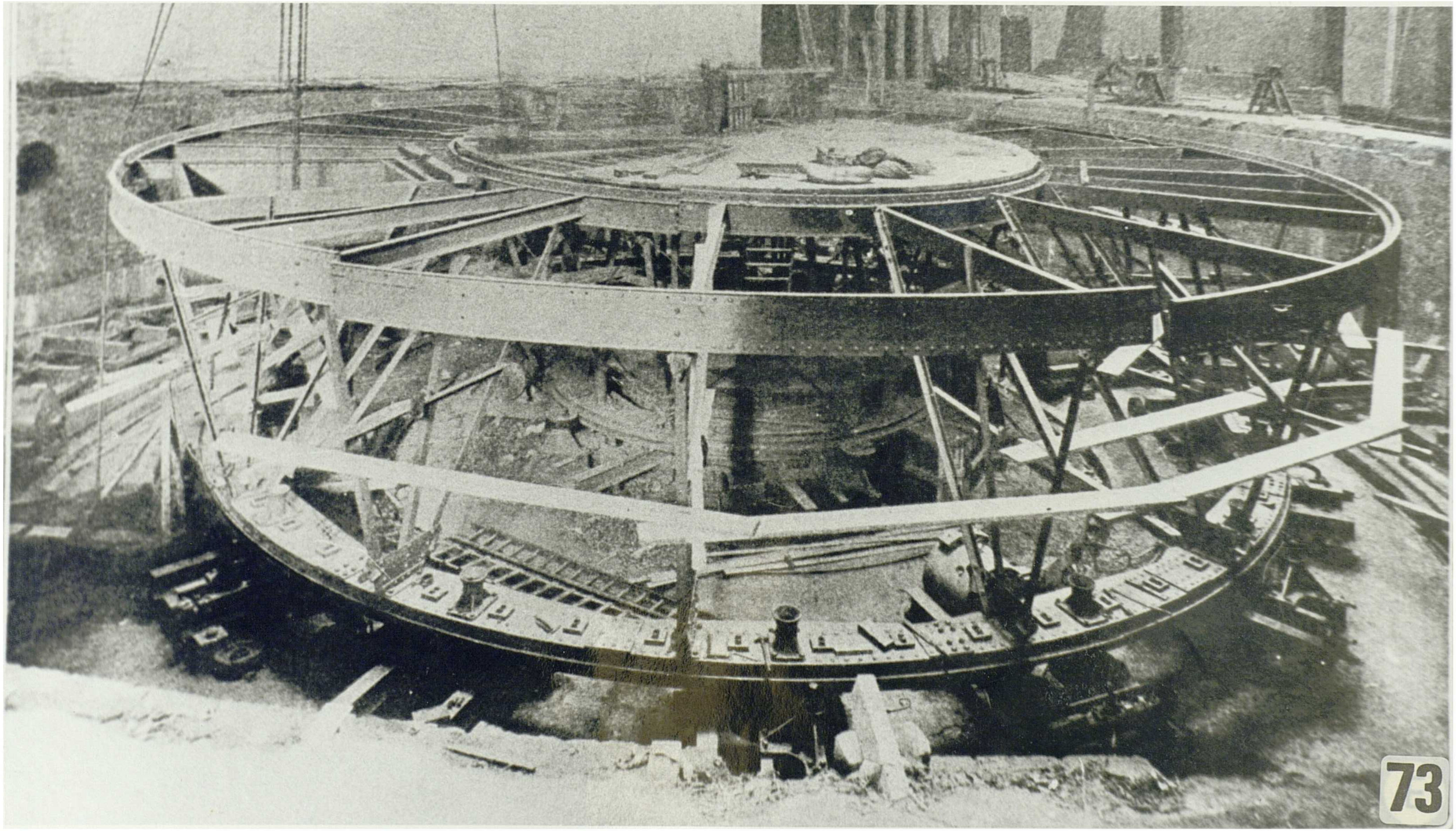
71

72

The centre table and intermediate tables during installation.
The Coliseum theatre, London.
[Photo: The Electrician, 27th Jan. 1905, p.577].


72

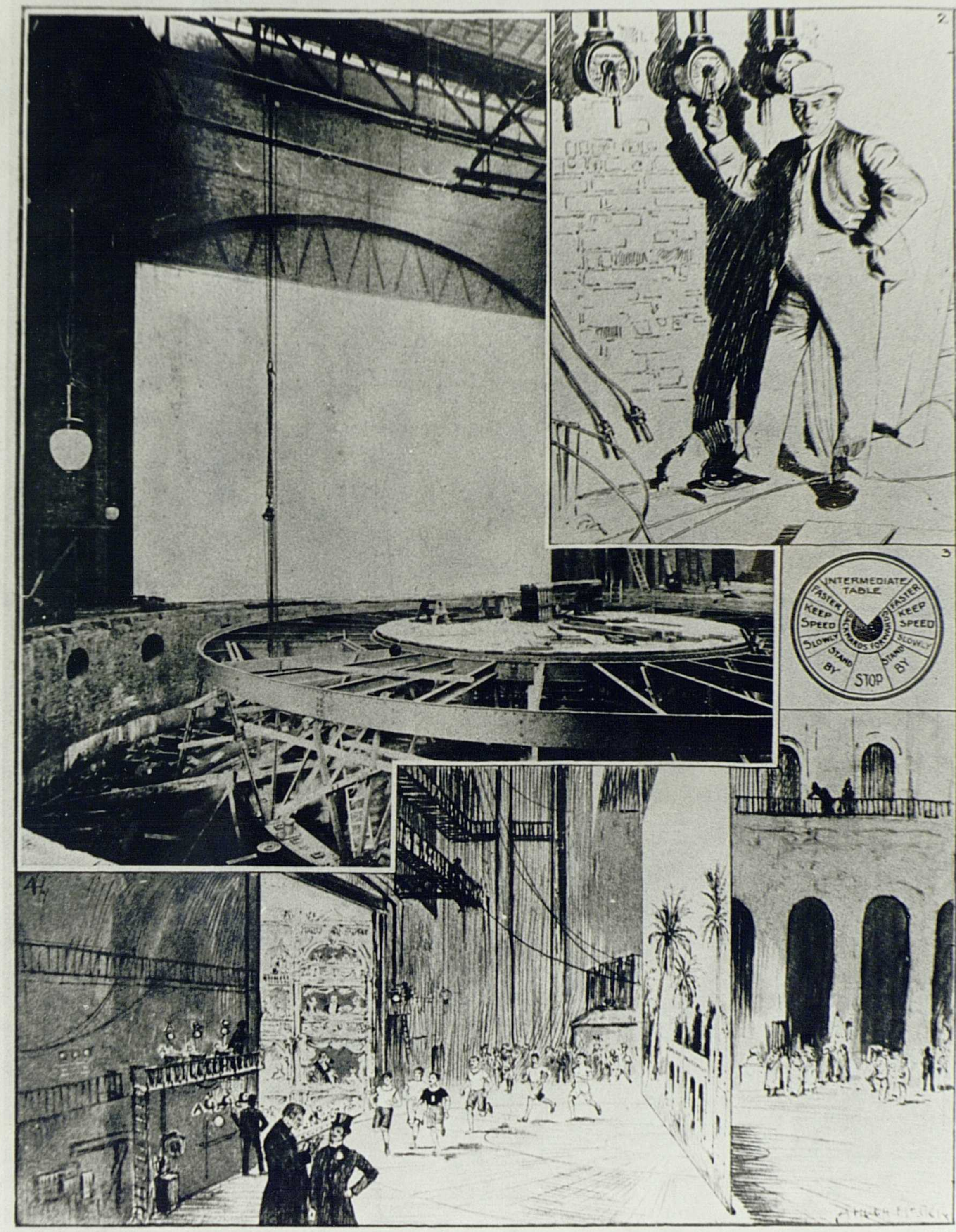
73 The centre and intermediate tables during installation.
The Coliseum Theatre, London.
[Photo: The Sketch, 14th Dec., 1904 p.311]


73

74 "The Wonderful stage at the London Coliseum opened Dec.21st".
The Coliseum Theatre, London.
[Photo: The Illustrated London News, 24th Dec.1904, p.952.

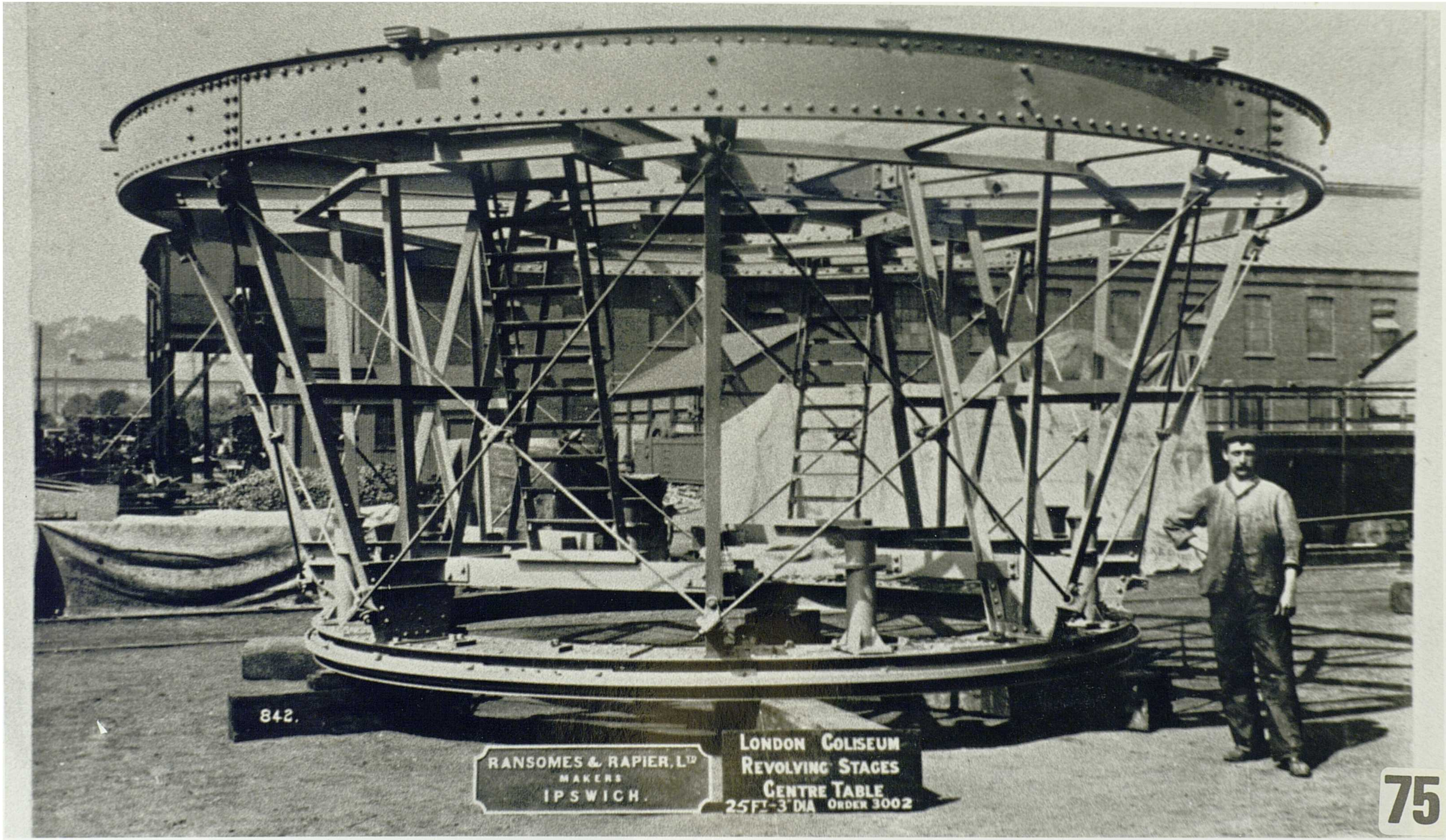
THE WONDERFUL REVOLVING STAGE AT THE LONDON COLISEUM, OPENED DECEMBER 21.

Drawn by A. Hugh Fisher; Photograph by Bassano.

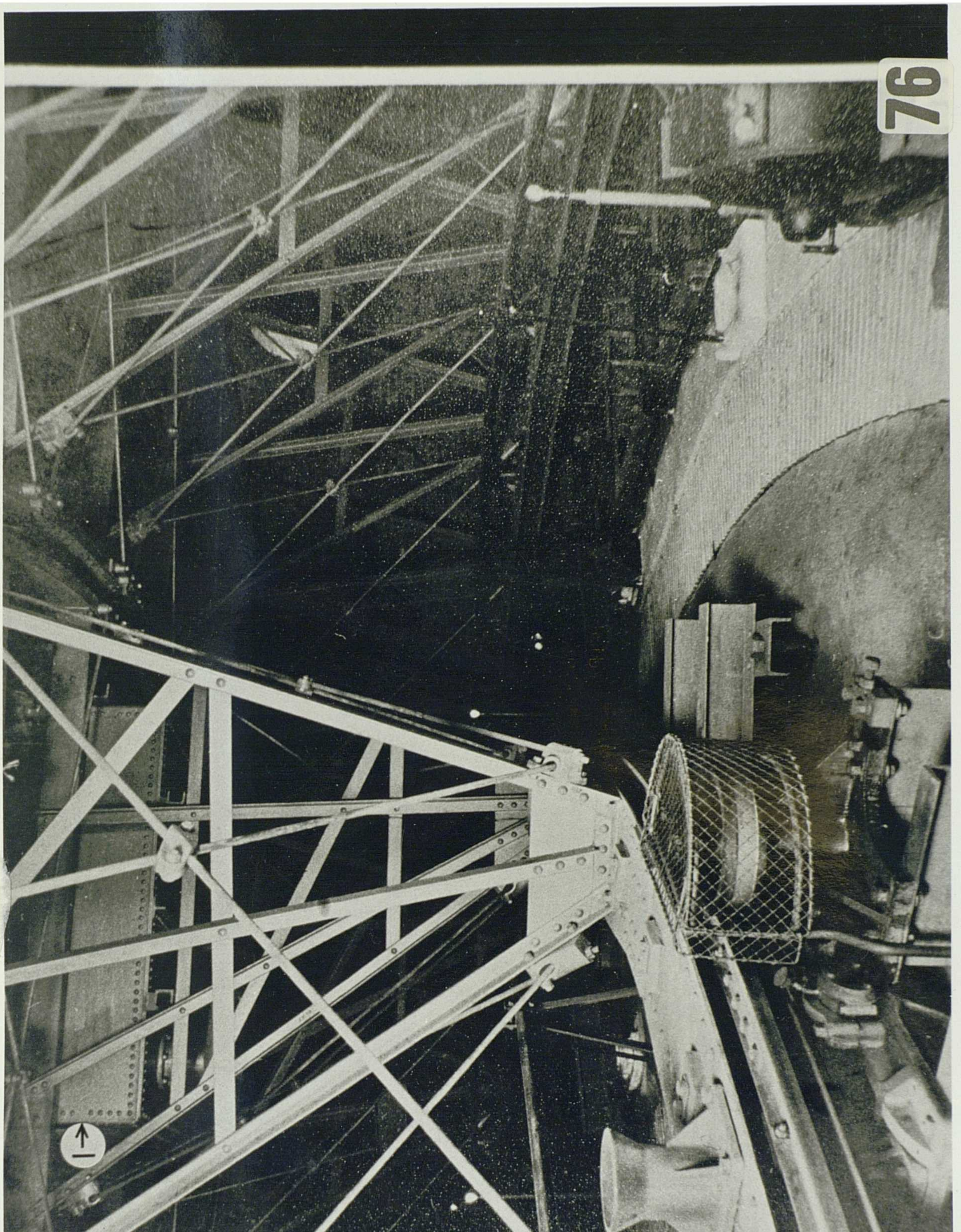


1. The Revolving Stage during Construction, Showing the Concentric Circles which, by Means of Fourteen Small Electric Motors, Revolve at Different Speeds.
2. Mr. Marshall Moore Telegraphing the Desired Speeds of the Three Concentric Circles to the Operator in Gallery above (See Fig. 4, Dials and Indications A, B, and C).
3. One of the Telegraph Dials in Detail.
4. General View of the Stage at the Coliseum, Showing a Foot-Race in Progress on the Revolving Tables. [illegible]

75 The centre table during construction at Ransome and Rapier's in Ipswich. The Coliseum Theatre, London. [Photo: Ransome and Rapier archive]

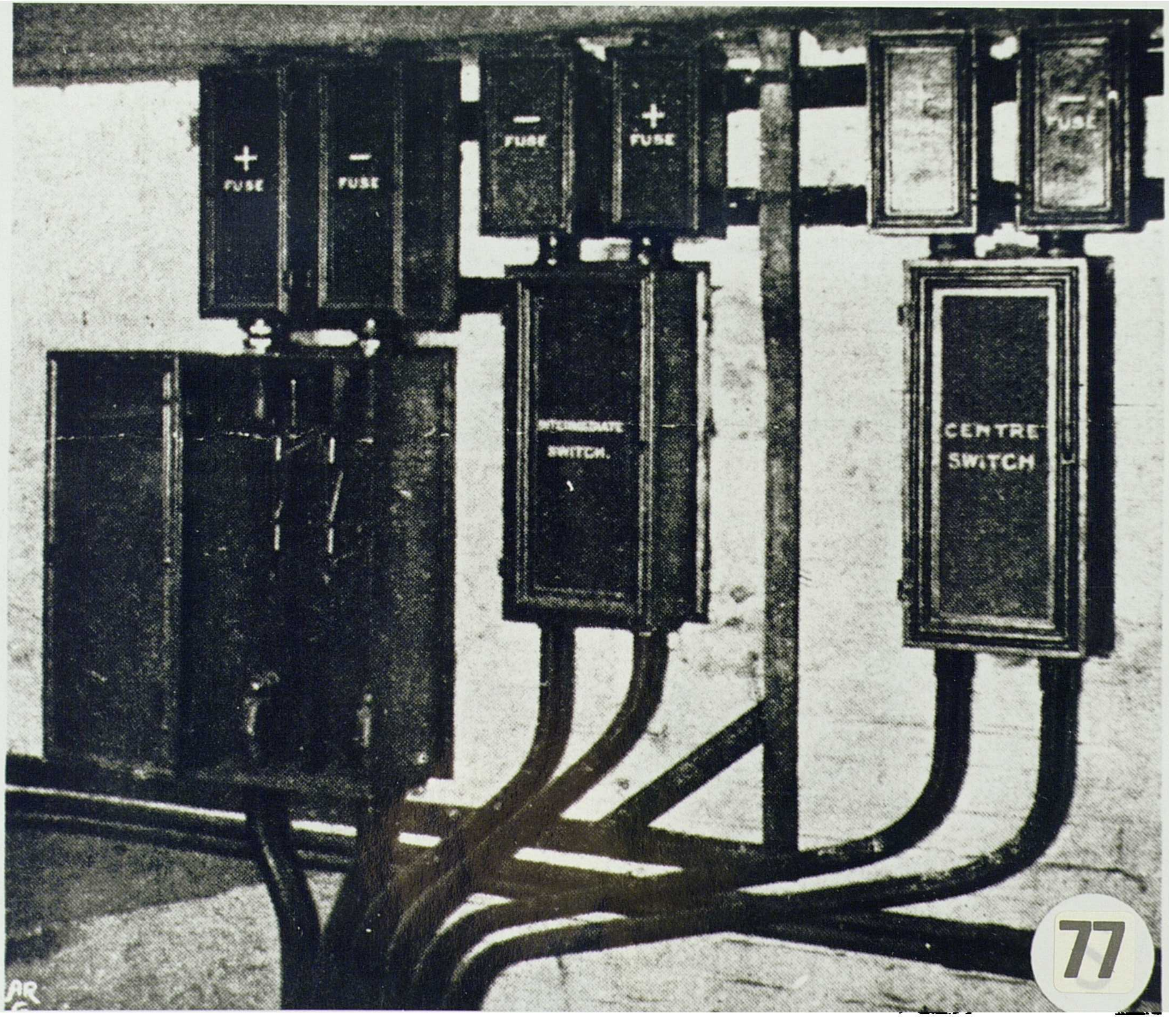

842.
RANSOMES & RAPIER, L^TD
MAKERS
IPSWICH.
LONDON COLISEUM
REVOLVING STAGES
CENTRE TABLE
25FT-3"DIA ORDER 3002
75

76 Details of the outer and intermediate tables showing electric motors and water tank.
The Coliseum Theatre, London.
[Photo: John Wyckham Collection]


76

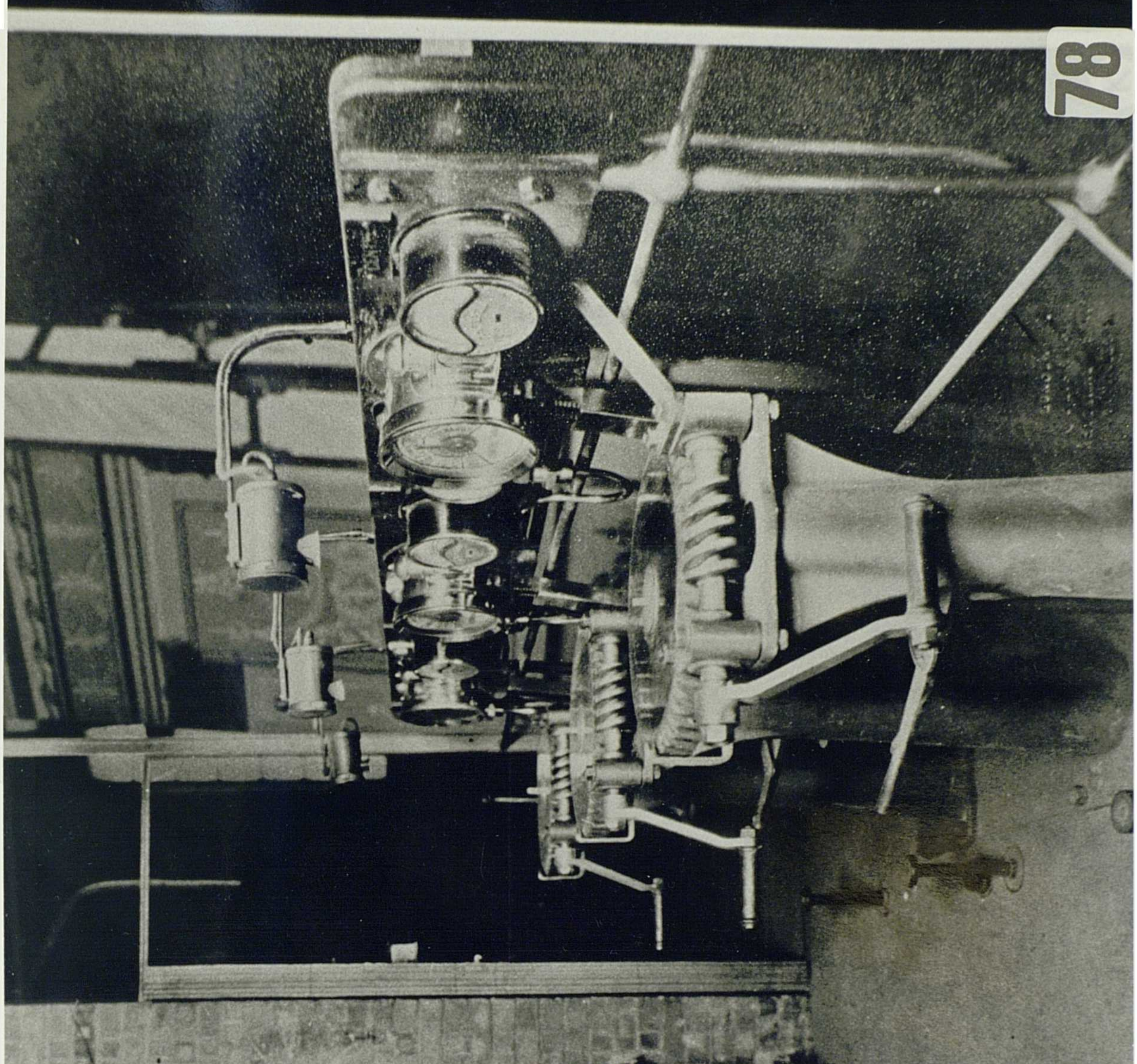
77

The main switches and fuses in
table mains
The Coliseum Theatre, London.
[Photo: <u>the Electrician,</u>
27th Jan.1905, p.577.


+ FUSE
− FUSE
− FUSE
+ FUSE
FUSE
INTERMEDIATE SWITCH.
CENTRE SWITCH
77

78

Control equipment for the triple
revolve.
The Coliseum Theatre, London.
[Photo: John Wyckham Collection].



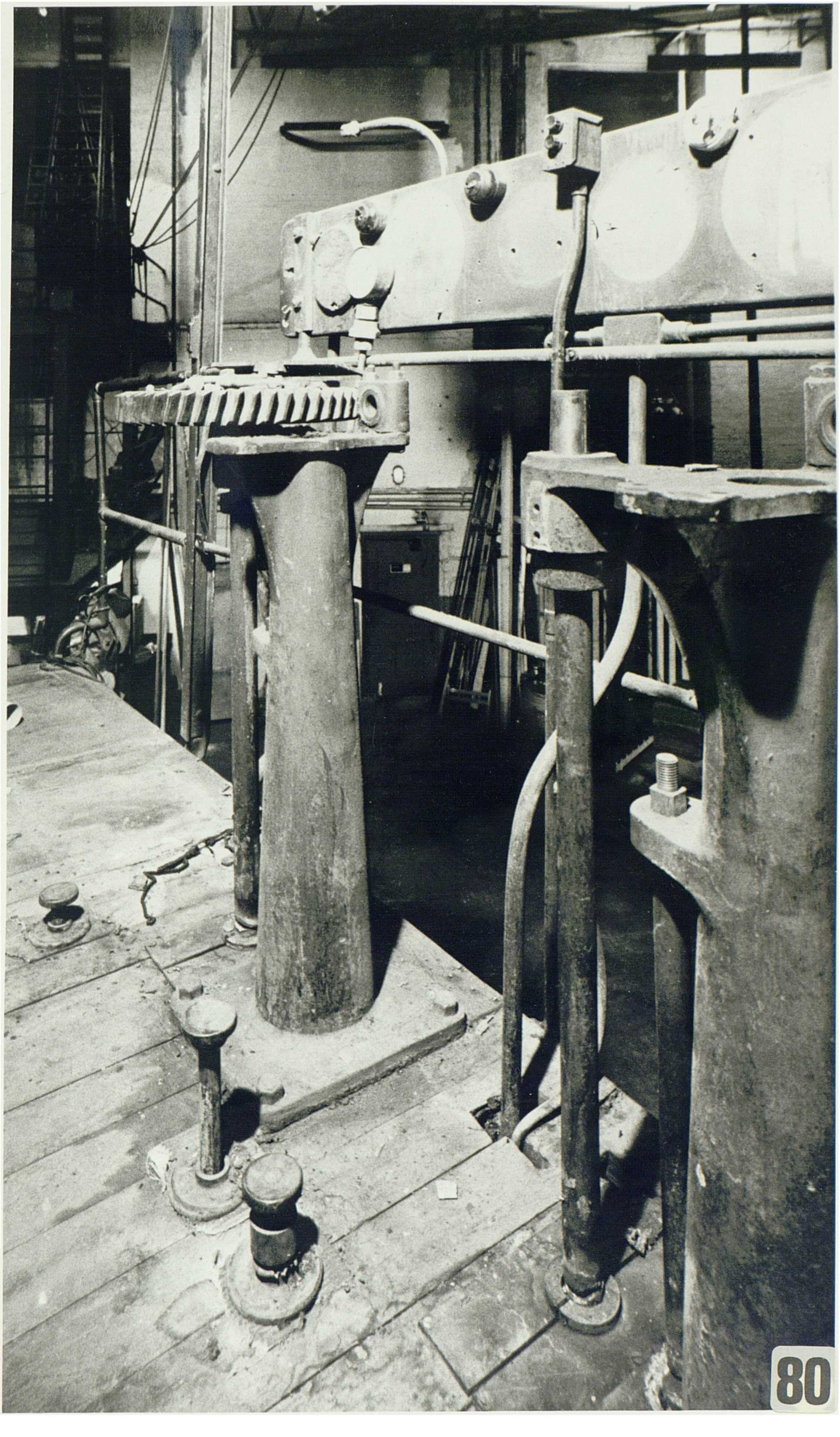
79 Electrical control gear for triple
revolve as new (insert) and prior
to removal in 1972.
The Coliseum Theatre, London.
[Photos: large photo: G.L.C.,

Ref.No.72 4515, small insert;
The Sphere, 9th May 1914, p.171.

Portion of the Resistance Room for Control Motors for Revolving Stage

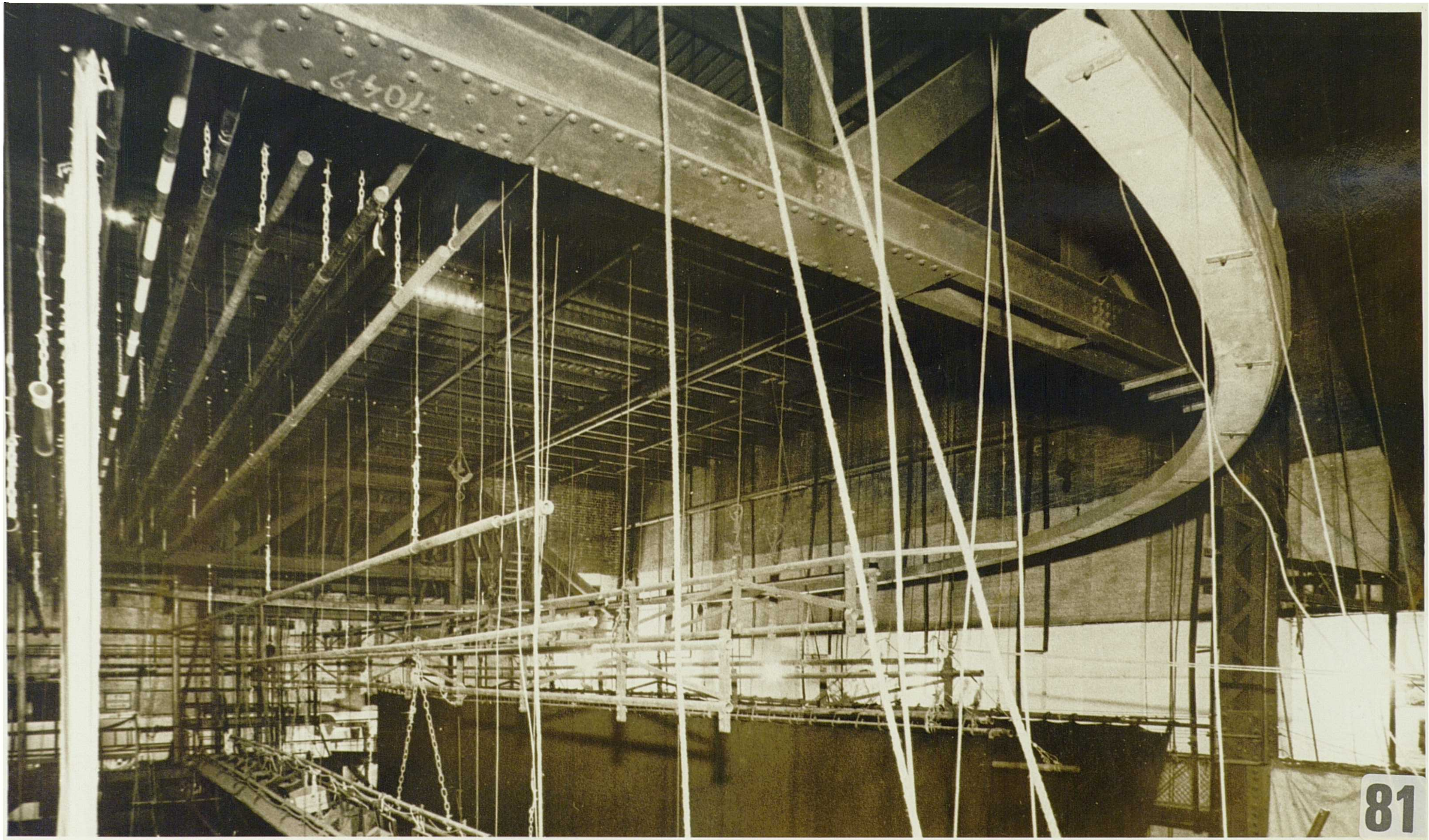
80

Control equipment for the triple revolve after falling into disrepair, 1972.
The Coliseum Theatre, London.
[Photo: G.L.C. Ref.No., 72 4159]



81

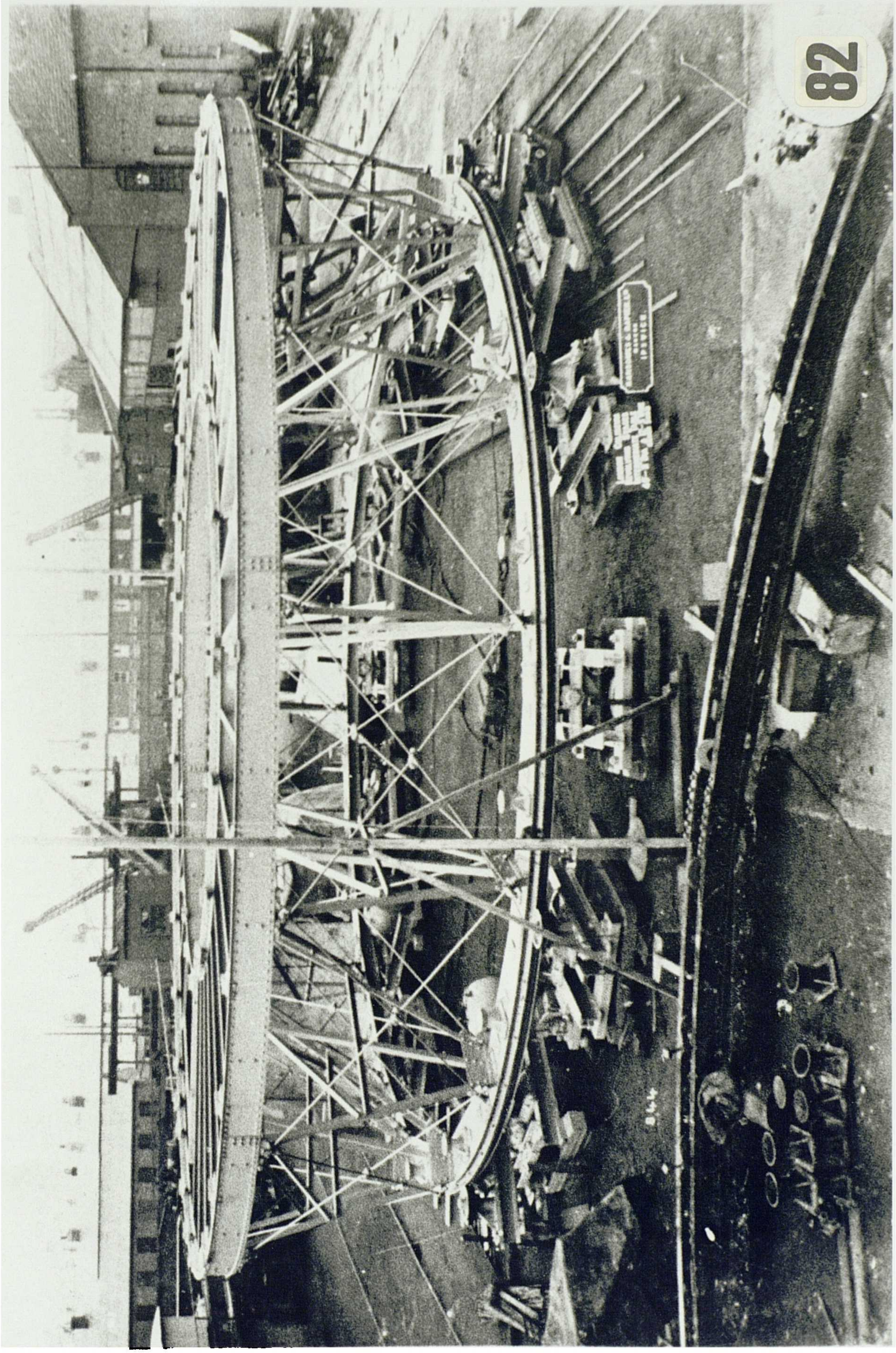
Details of panorama equipment still extant in 1972.
The Coliseum Theatre, London.
[Photo: G.L.C., Ref.No.,72 4515]



81

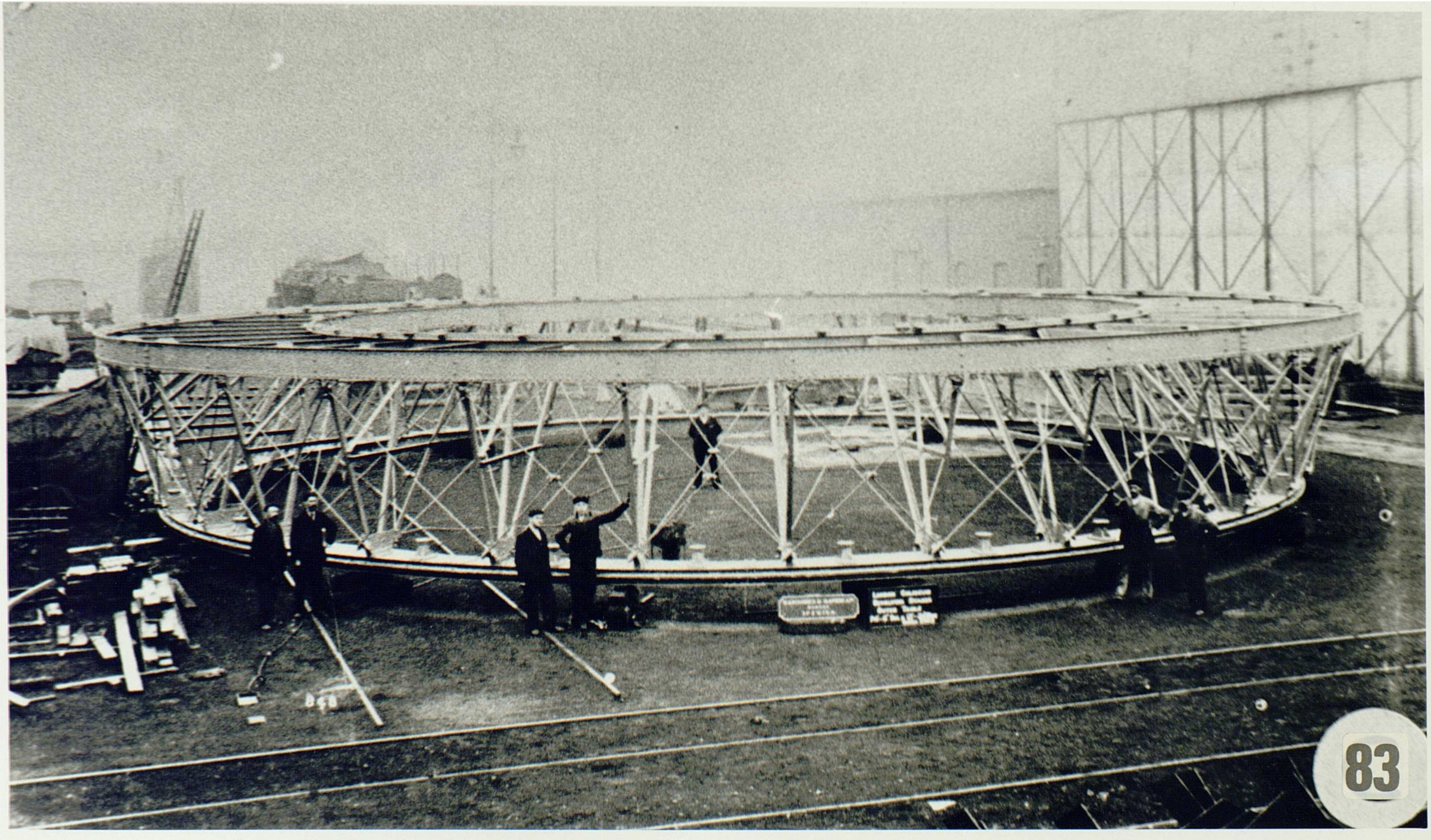
82

The intermediate table during construction at Ransomes and Rapier in Ipswich.
The Coliseum Theatre, London.
[Photo: Ransomes and Rapier archive].


82

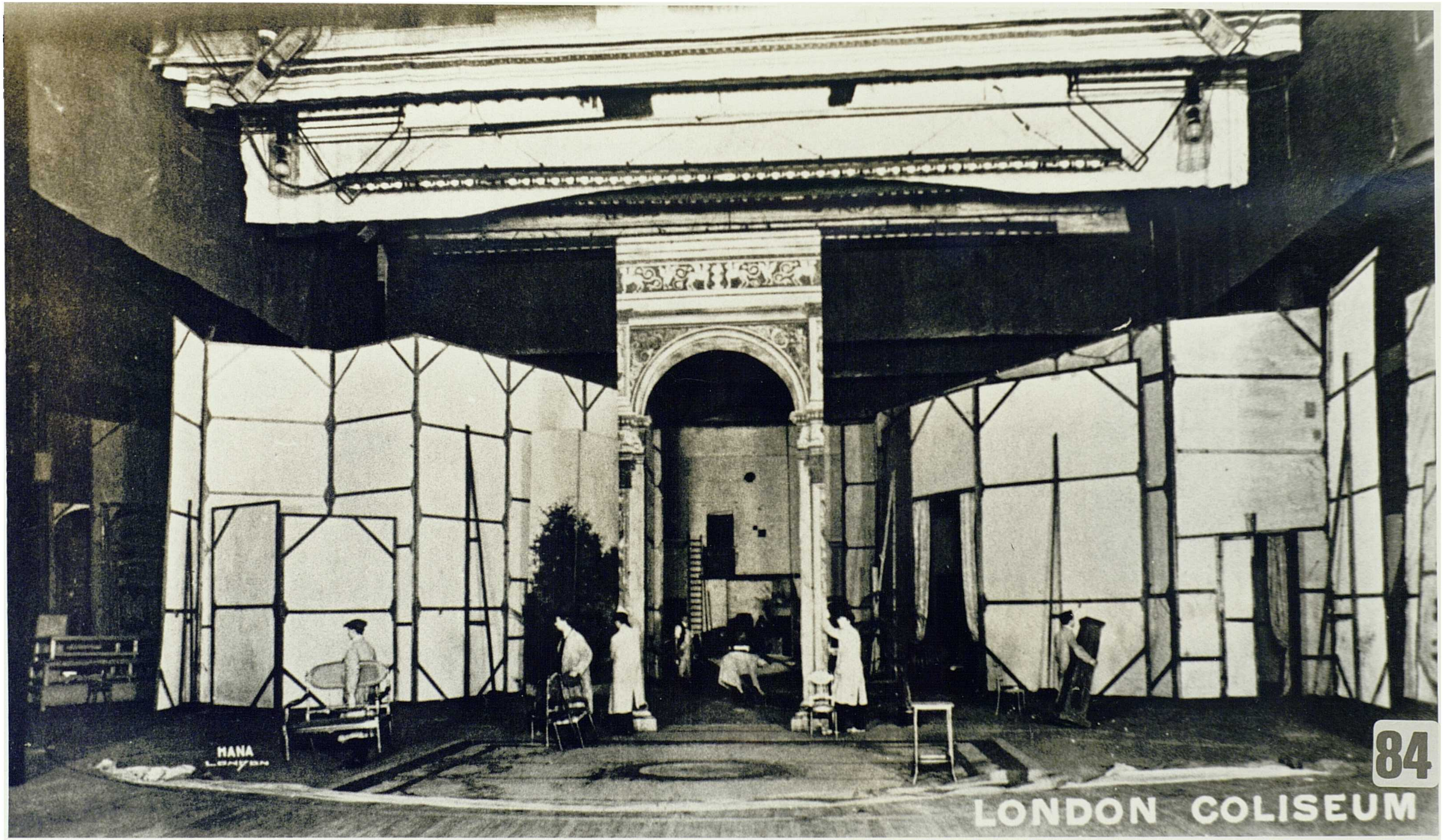
83

The outer table during construction
at Ransomes and Rapier in Ipswich.
[Photo: Ransomes and Rapier archive].

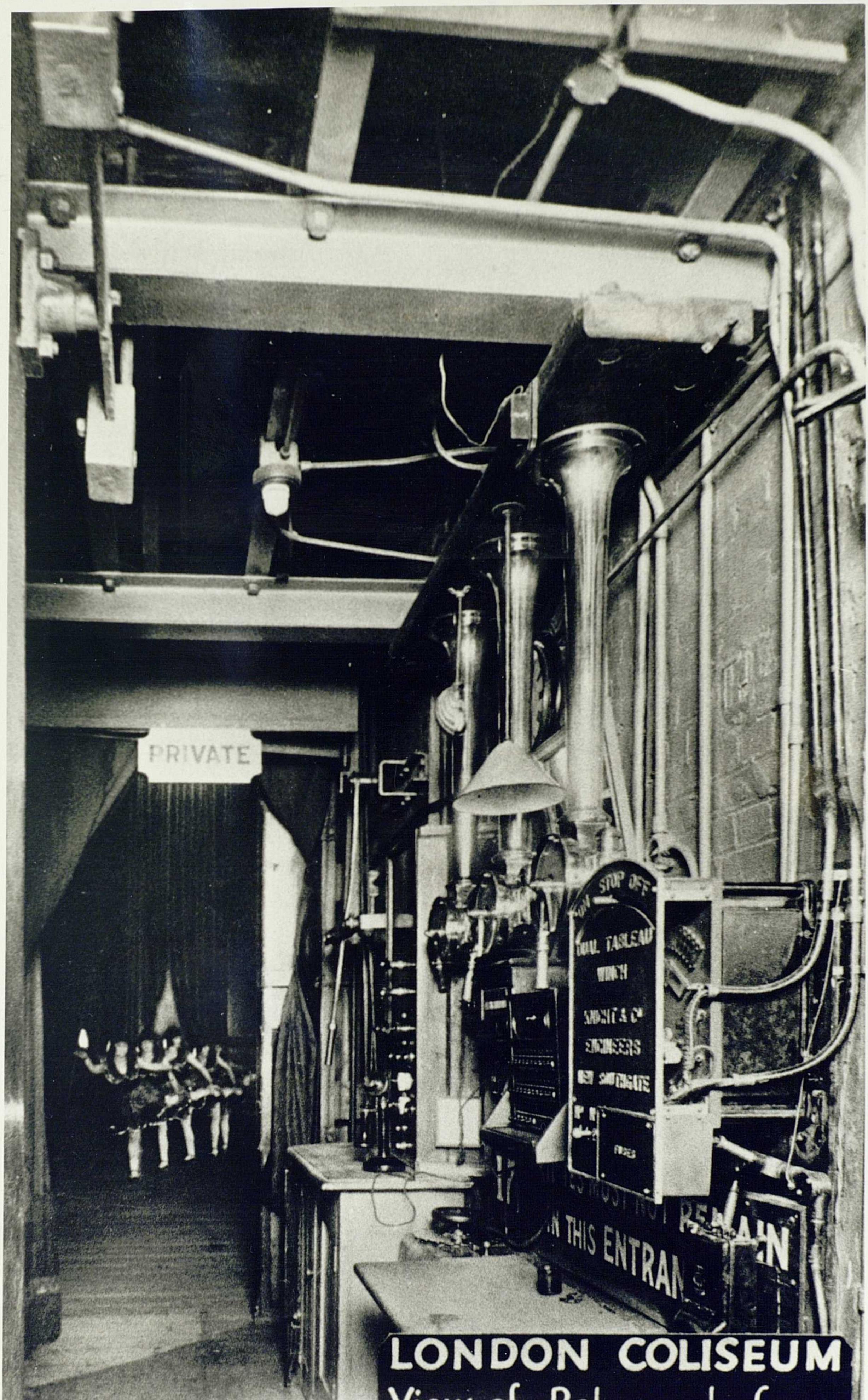

83

84

Scene setting.
The Coliseum Theatre, London.
[Photo: Hana postcards, London]


84
LONDON COLISEUM
MANA
LONDON

85 View of rehearsal from stage managers corner.
The Coliseum Theatre, London.
[Photo: Hana postcards, London]



LONDON COLISEUM
View of Rehearsal from Stage Manager's Corner

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Below the revolving stage.
The Coliseum Theatre, London.
[Photo: Hana postcards, London]


LONDON COLISEUM
Below the Revolving Stage
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