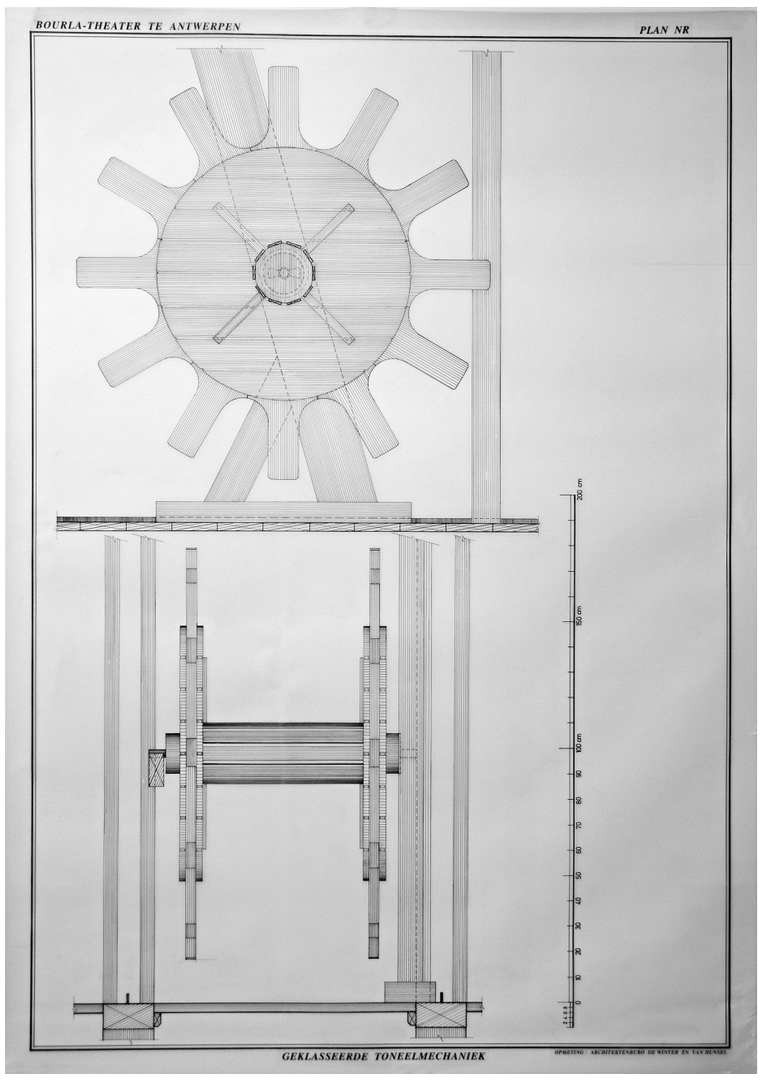
MAKING THE 1 TO 4 MODEL

The idea

Building the model started from the idea that research on historical machinery should be hands-on. Because working with the real machinery was impossible, we decided to build a model scale 1:4. This scale is small enough to work with fast and efficiently, but big enough to have a real “feel”.

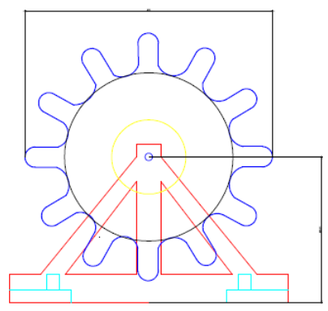
The aim has been, not be to build an exact replica, but to have all essential elements and the relation between them to understand the possibilities and problems of this type of machinery.

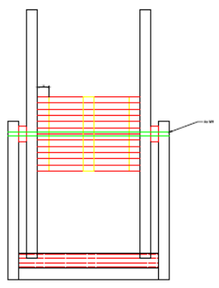


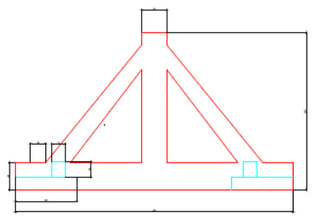
Research

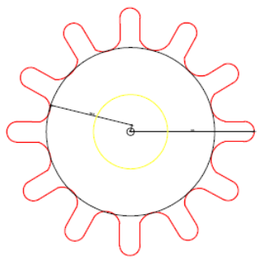
The research for the construction of the different elements is by Rens Planckaert as part of his bachelor thesis for RITS School of Arts, Brussels.

The design of the different elements is based on drawings in books and archives. Starting from the drawings, we made CAD drawings of the different parts.



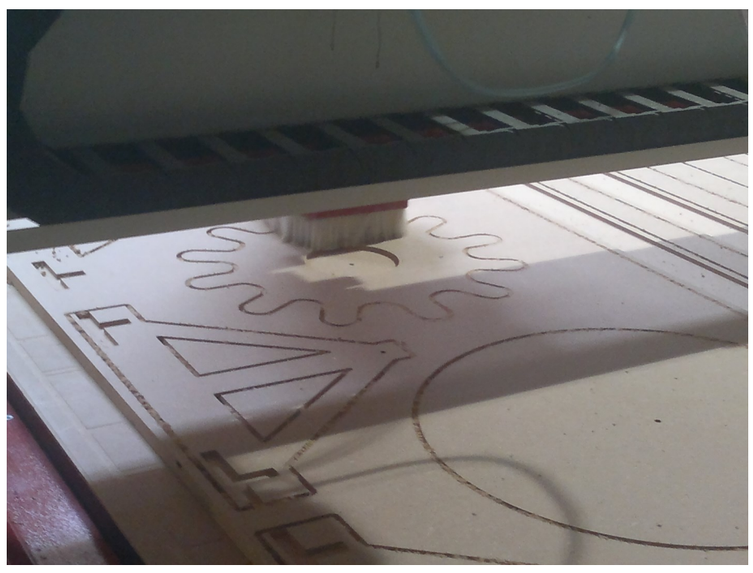


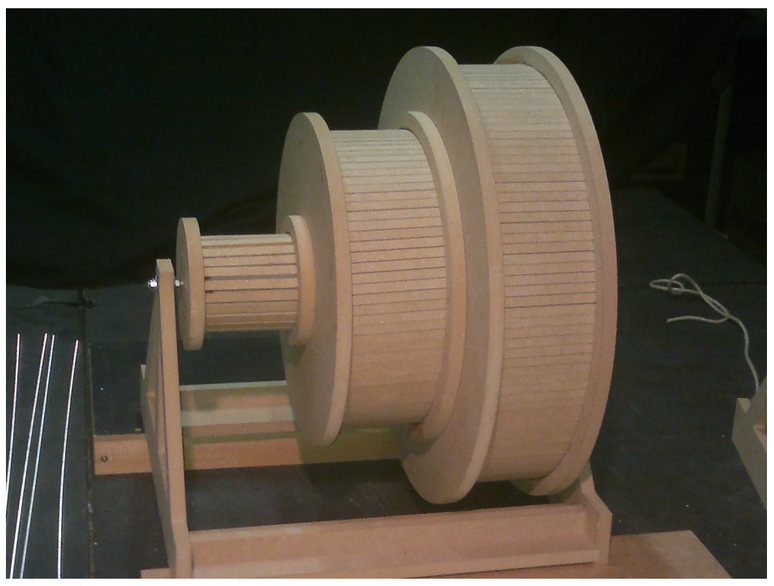




Modern technology for old machinery

The parts of the machinery are made with high tech CNC machines. From CAD drawings, they cut the exact shapes out of plywood. The only thing left to do is glue it all together. The advantage of this method is that once an object is designed, it can be replicated as many times as needed.





The under structure

The structure is a standard riser system that is adapted where needed.

Ropes

The ropes are synthetic hemp. They have the same quality and feel as real hemp, but they are better resistant to moisture.

The sizes are 4 mm and 6 mm, to fit the scale as well as possible.

Pulleys

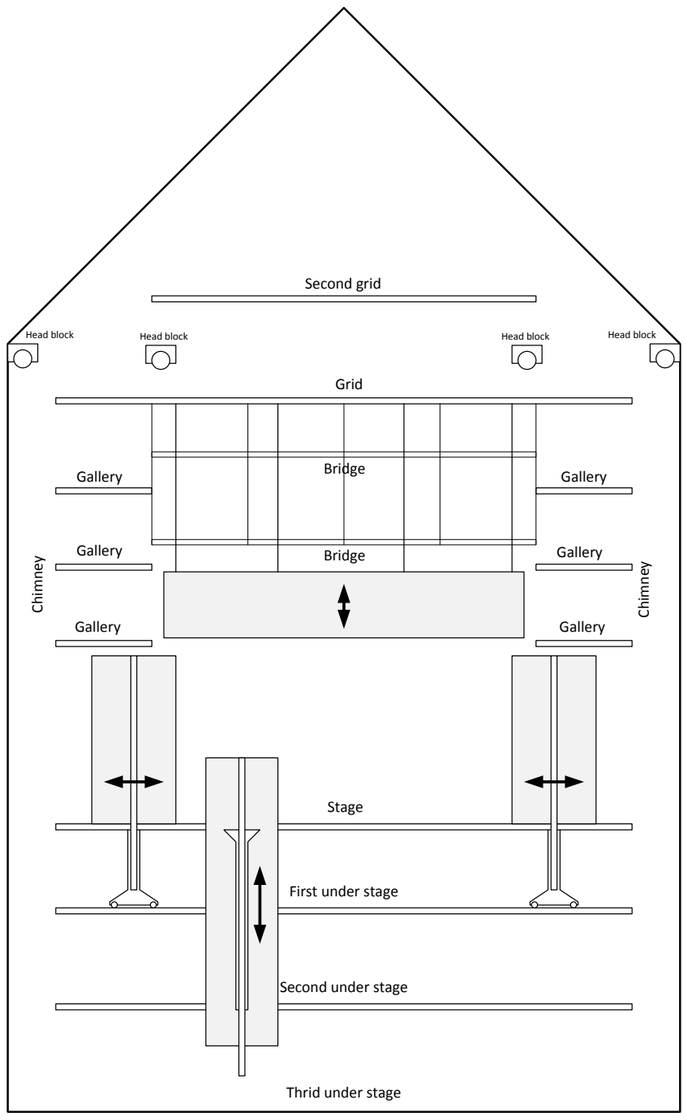
The pulleys are standard sailing pulleys adapted to the size of the rope.

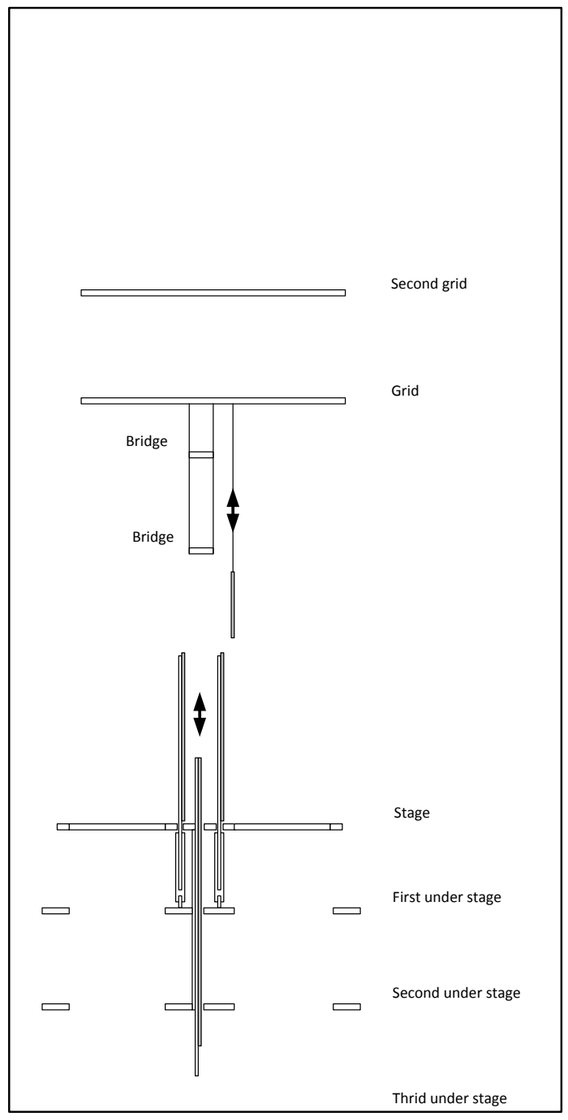
If you would like to make your own model, you can download the drawings at www.podiumtechnieken.be

Text Chris Van Goethem, editing Kate Burnett, print Solution

STRUCTURE OF THE STAGE HOUSE

The drawing below is a schematic drawing to give an overview of different parts of an average theatre equipped with wooden machinery. It is not accurate to scale. We describe the different parts from top to bottom.





Grid

The grid is the walking surface on top of the stage. It is composed of wooden slats, with an opening between them to let the ropes pass through. Pulleys and sheaves can be placed on the slats to guide the ropes. The grid and in bigger theatres also the secondary grid, contain the shafts and drums that are used to control the ropes.

Head blocks

Head blocks assemble multiple lines of rope at one point to change the direction and bring them to the control gallery or counter weight. They are mounted on top of the chimneys and on top of the inner side of the gallery.

Mère de famille (FR)

Galleries

The working galleries exist on different levels on both sides of the stage. This is the best place to manipulate set movements, as the machinists have a clear view on stage. On the outer side of the gallery, you can access the chimney, where the counter weights, hung from the head blocks on the outside, go up and down. On the inner (stage) side, pin rails are placed to fix ropes coming from the head blocks on the grid. Additional winches are placed on different points to be able to pull up the counter weights.

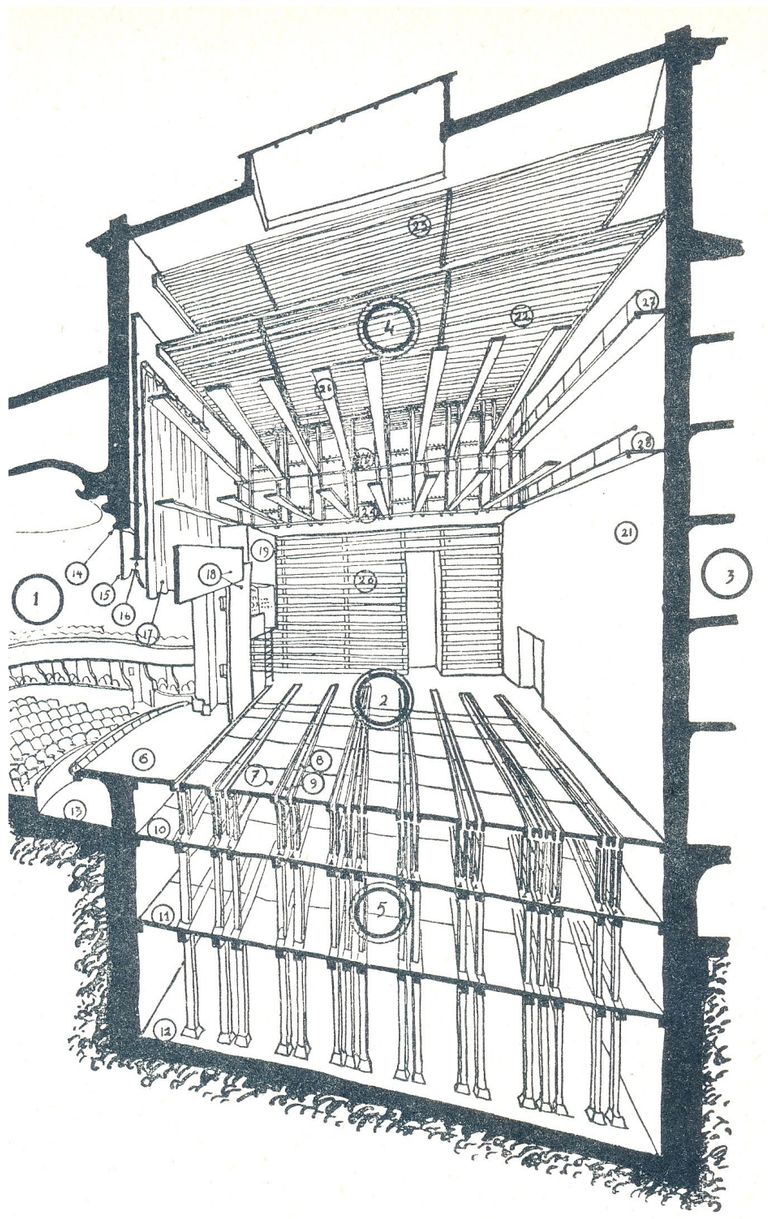
Chimney

The chimney is an open space that spans the whole height of the stage house, including the under stage. This is the place where counter weights move up and down. Multiple head blocks are mounted on top of the chimney.

Bridges

Working bridges span the stage on different levels. They are located on top of “fausse rue” as there is less need to hang sets there. The bridges make it possible to access and manipulate sets hanging under the grid. The fly tower can be pretty full as sets for several performances can be in place at the same time. During movements they have to be kept apart to avoid damage.

A second use of the bridges is to create a dead hung. This is the fixing of a set piece to a fixed rope to free the moving ropes for other purposes.



Text Chris Van Goethem, editing Kate Burnett, print Solution

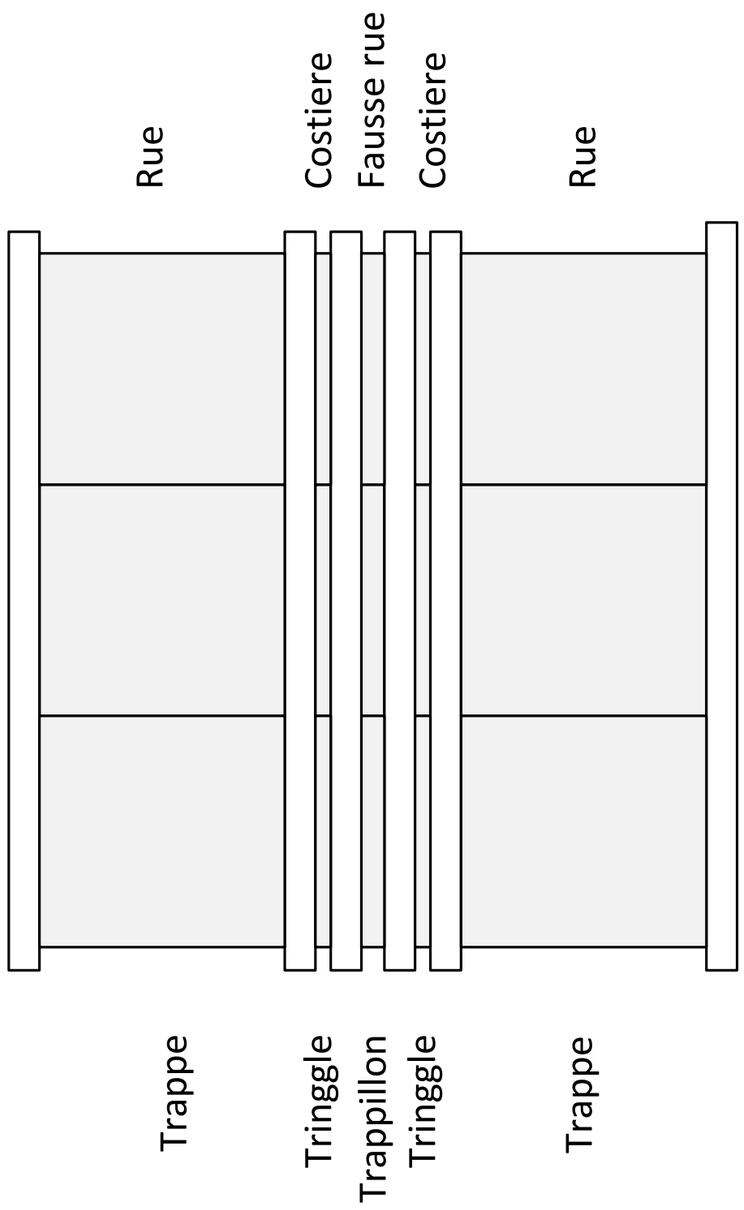
STRUCTURE OF THE STAGE HOUSE II

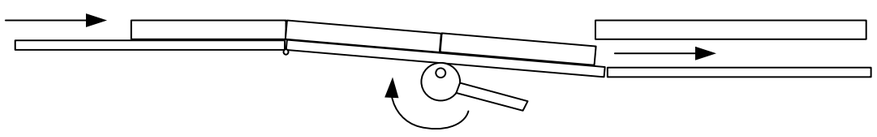
Stage floor

The stage floor is in fact a puzzle of different types of openings for the under machinery. The most common parts are:

Rue (street)

The street contains traps for elevators, appearances etc. The traps are square wooden planks closing the rue. The traps can be removed individually, or in bigger theatres they can slide under the side stage. The street is around 1m wide.





Sliding traps under stage floor

Fausse rue (false street)

The fausse rue is a smaller version of the street and is only around 10 cm wide. Small traps (*Trapillons* FR) cover the opening when not in use. The fausse rue makes it possible to raise flats by a cassette system.

Costiere

The costiere is the opening in the stage for the posts that contain the sets moved by the chariots. They are closed by “Tringgles”.

The rue, fausse rue, and two costieres form together a plan (a section). This section is repeated several times in the depth of the stage.

(in the Flemish tradition the “rank” of the actors was based on the plans, there was a first plan actor, a second plan actor and so on. The most important actors where at the first plan as the visibility was better there.)

Under stage

The under stage consists of a series of parallel wooden constructions. There are floors at least on 3 levels. The first level contains the rails for the chariots. The second level contains winches, drums and shafts and is used for manipulating the chariots. It sometimes also contains some elevators.

The third level is the full depth of the under stage and is needed for the cassettes, it also contains winches and shafts.

Set manipulation

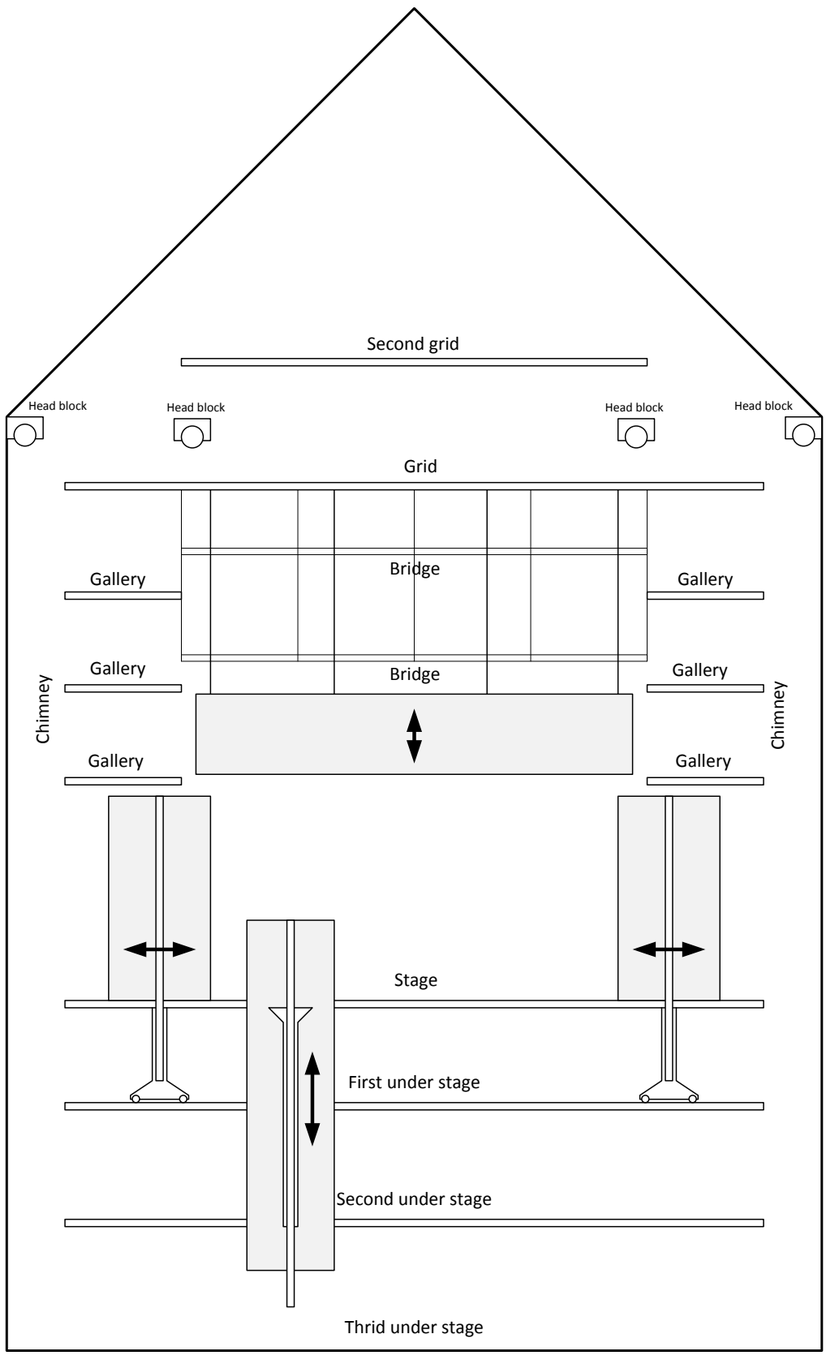
Sets can be moved on and off stage from different directions, using differ types of equipment.

* Flying from grid, the sets are pulled up on ropes.

* Chariots, the sets roll in and out of the side stage.

* Cassettes, the sets appear from the under stage.

* Fly rail (not on drawing), movement of smaller pieces or people in vertical plane.



Text Chris Van Goethem, editing Kate Burnett, print Solution

BASIC ELEMENTS AND TOOLS

A basic set of elements and tools are part of the stage and will be used in different places for different uses.

Pulley

A pulley is a contained sheave that can be fixed. In most cases it will only be used to change the direction of a rope (and so of the force). The need for reduction of forces is limited in this type of theatre as drums are more efficient, create less friction and cause less loss of force.

Poullie (FR)

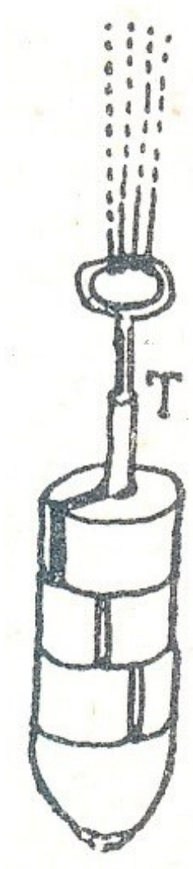
Rope

In most cases hemp or manila ropes were used, which is where the name hemp rigging comes from. The ropes are influenced by hydrometrical conditions. Nowadays, we would use the synthetic version of these ropes. The ropes are connected and fixed by knots, hitches and splices.

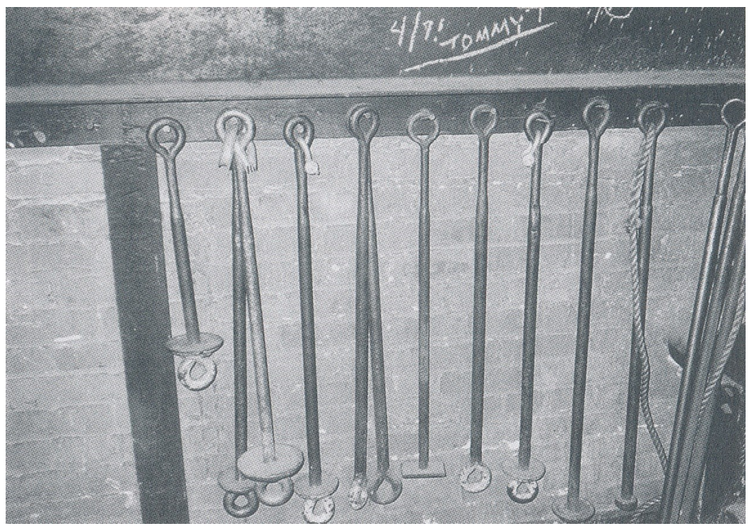
Fil (FR)

Counter weights

Counter weights are mainly used in larger theatres. In small theatres the loads are small enough to pull directly, using sand bags or just winches. The weights are hung temporarily when and where needed. They weigh between 8 and 20 kg.



They are stacked on a counter weight holder, a steel bar with a handle to knot the ropes on.



Contrary to general opinion, most movements in this type of theatre are performed by counter weights and not by winches. The winches are mainly used to bring the counter weights into place.

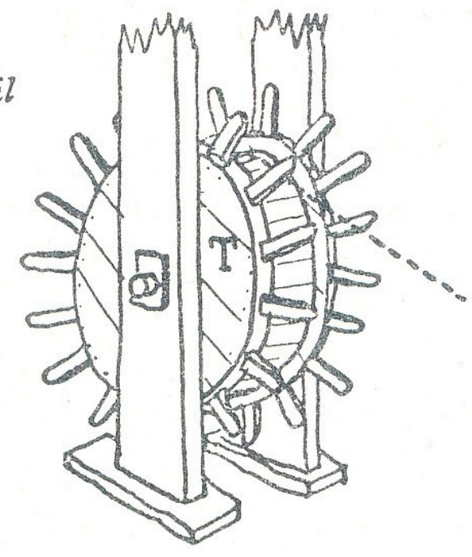
Pain (FR)

Winch

Winches are used to manipulate rope with less effort. According to Pierre Sonrel, one machinist could lift up to 400 kg with a winch. They are mostly used in preparation, to raise counter weights or sets. The movement during performance is done by slowing down or braking the counter weight movement that does the actual work.

Treuil (FR)

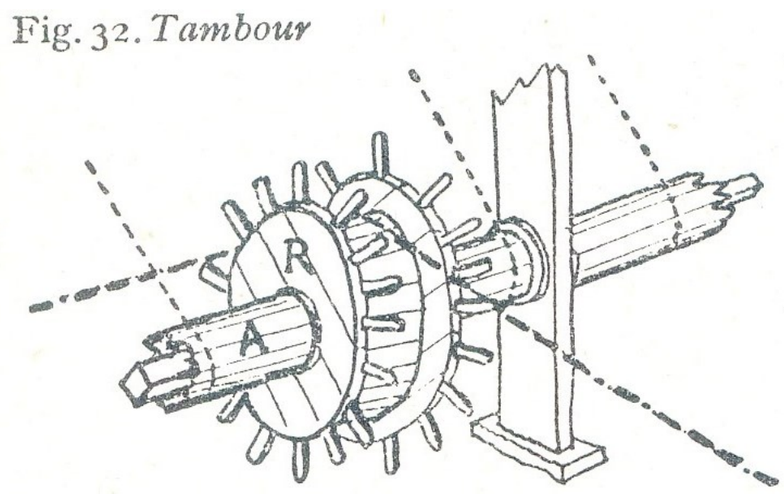
Fig. 31. *Treuil*



Drum

The drum consists of two connected cylinders. The smallest is connected to the load (Tambour *d'appel*, FR), the largest is connected to the control rope (*Tambour des retraites*, FR). The drum reduces the force needed to move a load. On the other hand it increases the distance the rope has to move.

Fig. 32. *Tambour*



As an example, we take a drum with a diameter of 30 cm for the smallest and 110 cm for the largest. One winding on the smallest cylinder is 30 cm x Pi = 95 cm. A winding on the biggest is 110 cm x Pi = 350 cm. This gives a reduction of 27 % or more or less ¼. As force x distance = load x distance, this would mean that to lift 100 kg, we have to pull with a force equal to 27 kg. To move the load 1m we will have to pull the rope 3.66 m.

Tambour (FR)

Text Chris Van Goethem, editing Kate Burnett, print Solution

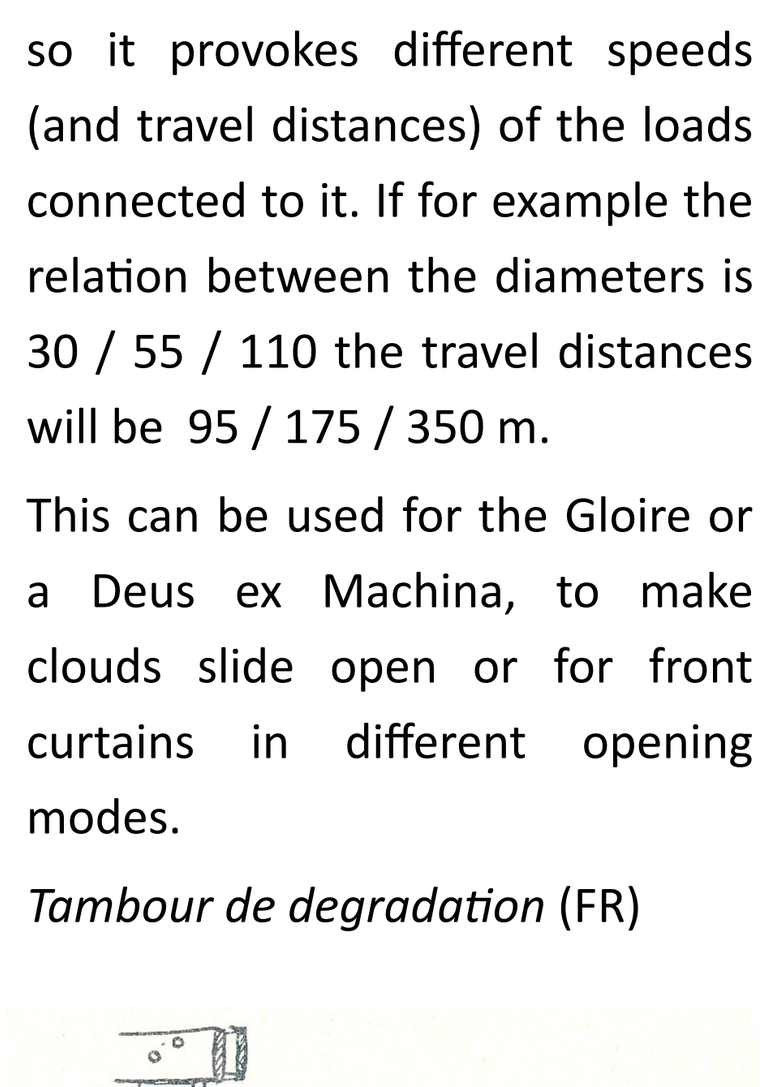
BASIC ELEMENTS AND TOOLS II

Multiple speed drum

The multiple speed drum is a drum with multiple diameters and so it provokes different speeds (and travel distances) of the loads connected to it. If for example the relation between the diameters is 30 / 55 / 110 the travel distances will be 95 / 175 / 350 m.

This can be used for the Gloire or a Deus ex Machina, to make clouds slide open or for front curtains in different opening modes.

Tambour de degradation (FR)



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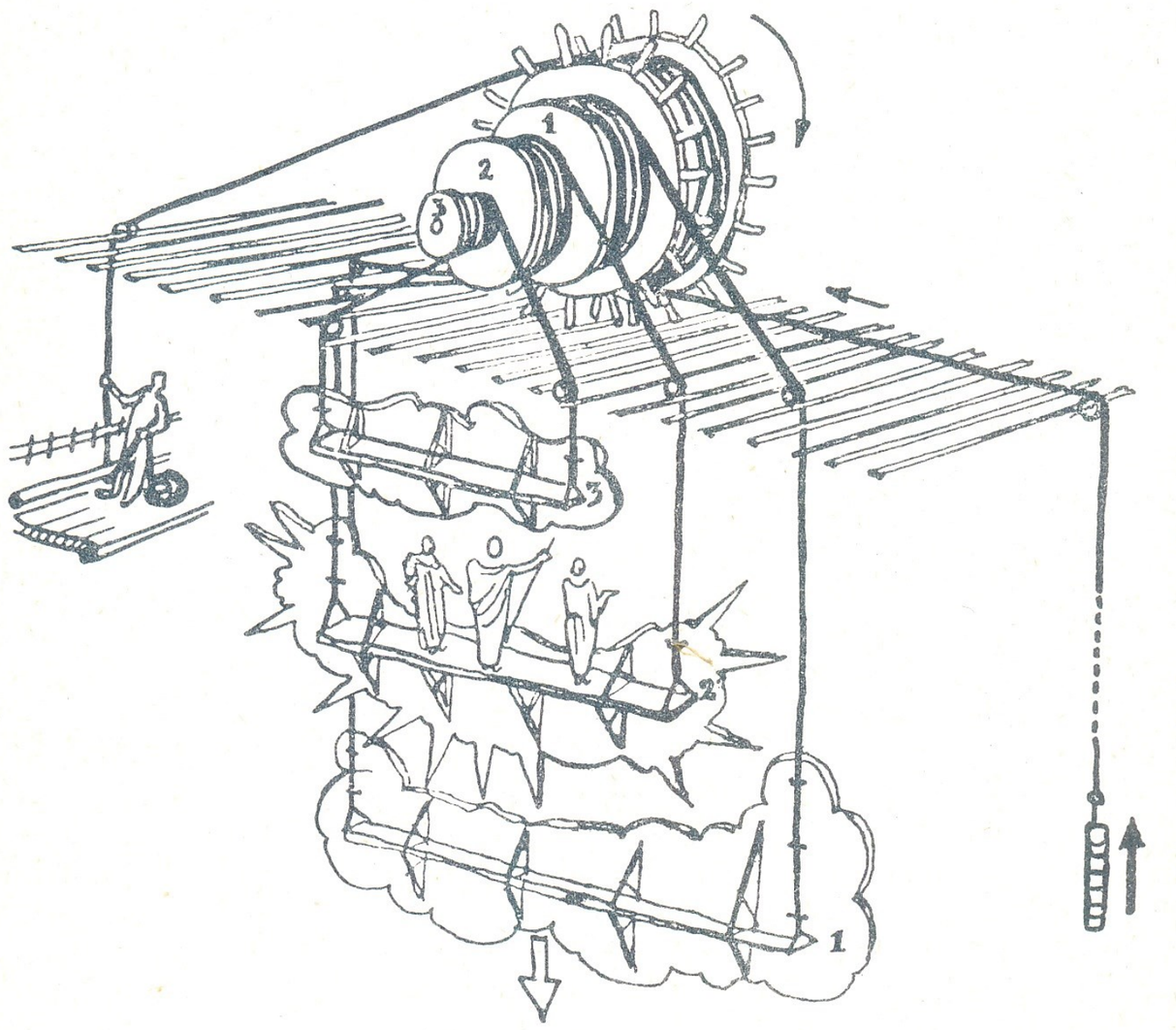


Fig. 53. *Gloire*

Shaft

The shaft is a long wooden spindle that runs over the whole depth of the theatre. By connecting multiple ropes to this axle, the movement will be synchronized. Shafts occur often in combination with a drum.

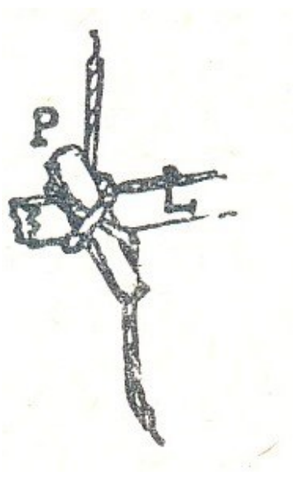
Batten

Battens are long wooden beams or sticks, mostly with a diameter of 5 to 7 cm. They are used to hang soft goods, drops, legs, borders, etc. and connect them to ropes from the fly tower. They are used in different lengths, so a pair of legs can be hung for example without interference with movements in other directions.

Perche (FR, in wood) *Porteuse* (FR, in metal)

Pin rail

Pin rails are mostly found on galleries and other places where ropes have to be controlled. They consist of a strong wooden beam with permanent or temporary pins. Ropes that have to be fixed can be connected to the rail by tying them off (with a specific knot). If a loose pin rail is used, the pins can be retracted to release the rope. In some cases, a double pin rail is used, the lowest position can stay fixed.



Under the pin rail a round strong batten is often mounted. The ropes can be slung around this batten when lowering the loads. The friction provoked by the batten means that one man can manipulate the load.

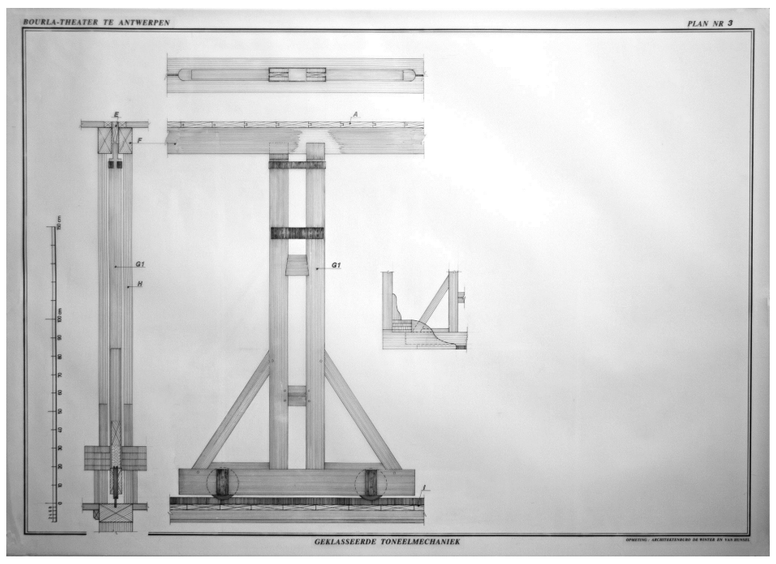
Specific elements and tools

Specific elements and tools like chariots, double chariots, cassettes and fly rails are dealt with on other posters.

Text Chris Van Goethem, editing Kate Burnett, print Solution

CHARIOT (SET WAGON)

A chariot makes it possible to move flats on and off from both sides of the stage. The wheels of the chariot run in a track in the first under stage. The top of the chariot is guided by the sides of the costiere.



A post is mounted on the chariot to fix a flat on. The post will pass from the under stage to the stage through the costieres. In modern theatre the portal towers making the stage less wide are still constructed by this principle. In cases where the flats had to turn, a turning post was used, the “Chasis obliques”

Post = *mât* (FR)

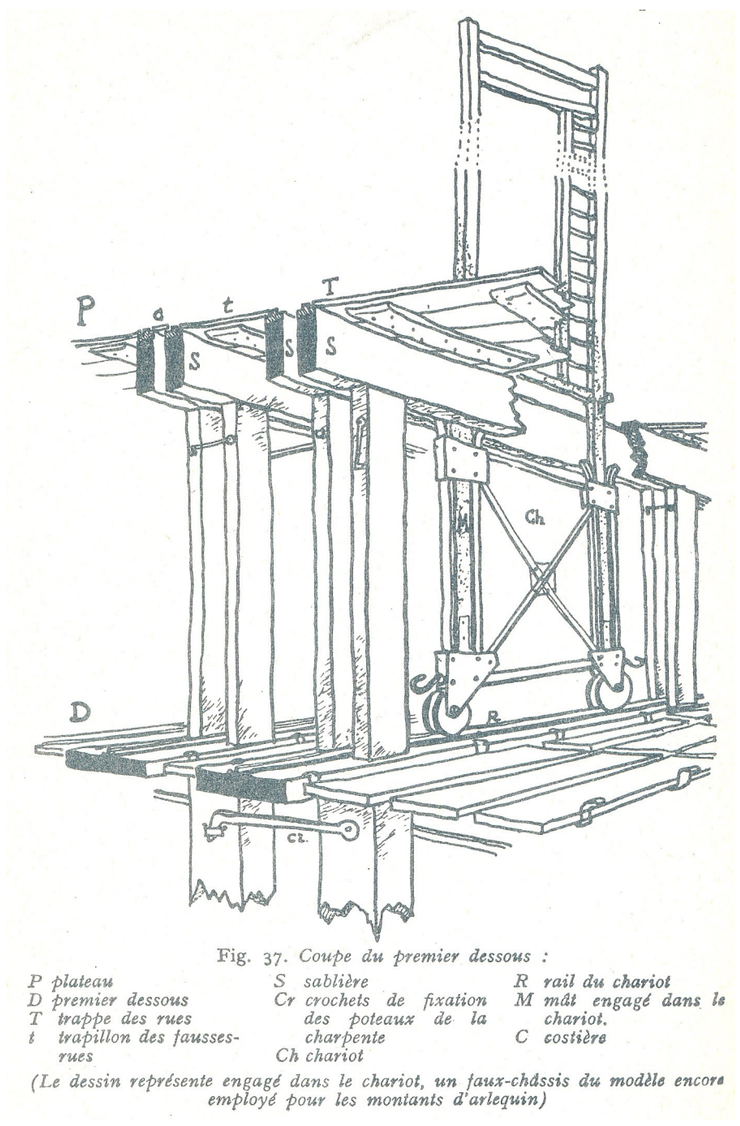


Fig. 37. *Coupe du premier dessous :*

P plateau	*S sablière*	*R rail du chariot*
D premier dessous	*Cr crochets de fixation des poteaux de la charpente*	*M mât engagé dans le chariot.*
T trappe des rues		*C costière*
t trapillon des fausses-rues	*Ch chariot*	

(Le dessin représente engagé dans le chariot, un faux-châssis du modèle encore employé pour les montants d'arlequin)

Mounting flats

The posts have a hook a couple of centimeters above stage level to put the flats on. They ensure the flat doesn’t touch the ground and enable movement. The posts have vertical extensions to be able to tie the flat to the post.

Double chariot

Double chariots are constructed to the same principle, but have a frame or a double post for larger flats.

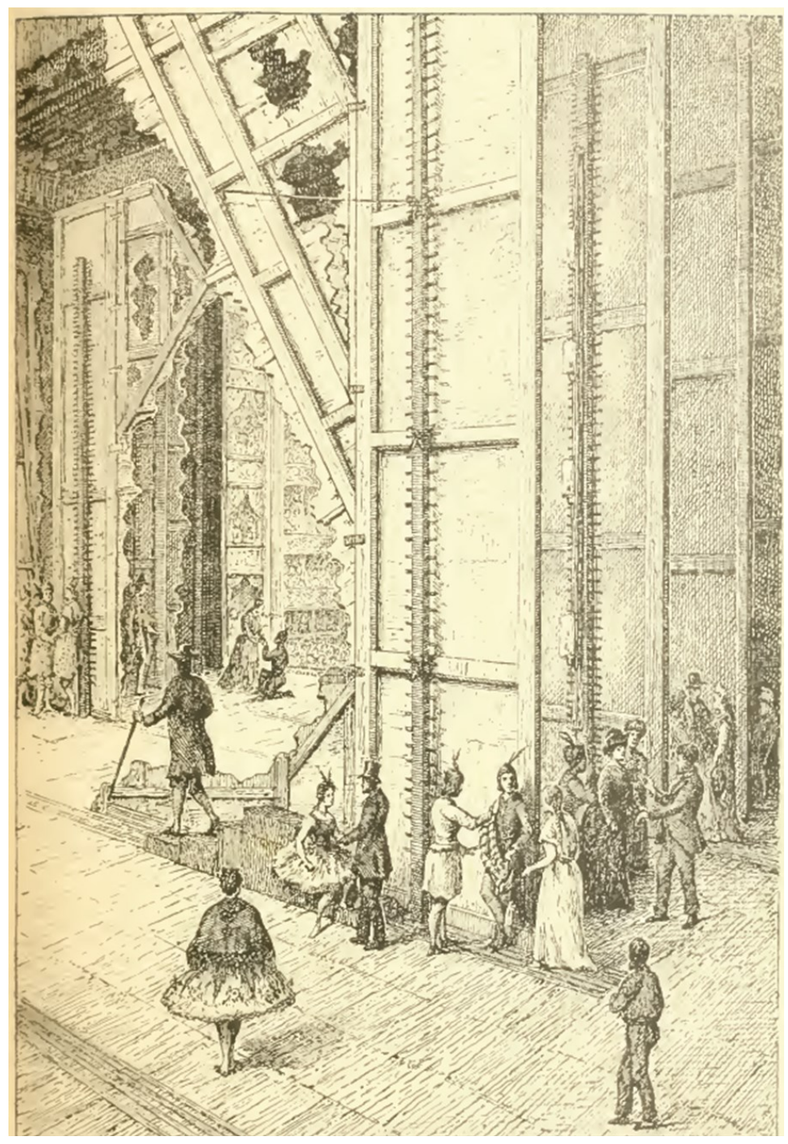
Movement

The chariot can be moved manually (walked). This is mostly done when the movement is out of sight, and there is no need for synchronization. Once in position the chariot can be fixed in position.

Synchronizing movement

When a “Changement a vue”, a set change in view of the audience, is performed the chariots will be connected to each other and to a shaft for synchronized movement. In this way they will simultaneously roll on or off stage. The shaft will be connected to counter weights to help the movement.

Once everything is in place and the movement needs to start, the machinist slacks the rope to make the chariots move. At the end of



the movement, the next movement is prepared. The counter weights are pulled up by a winch, the control rope is pulled in again and the rope is changed to the other chariot. The set is now ready to move in the other direction.

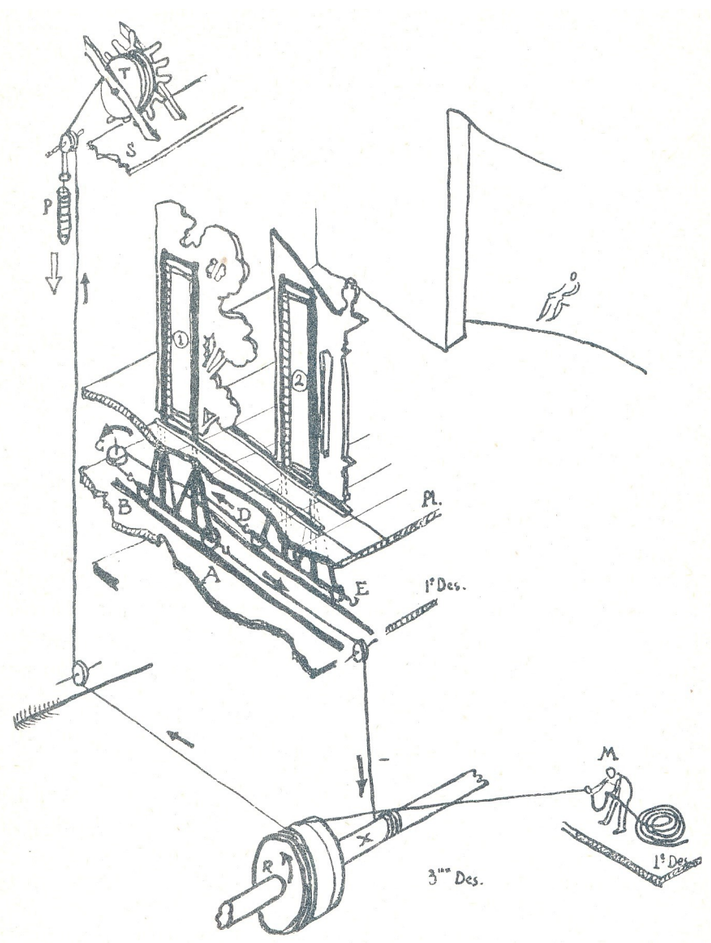


Fig. 38. *Manœuvre d'un changement à vue*

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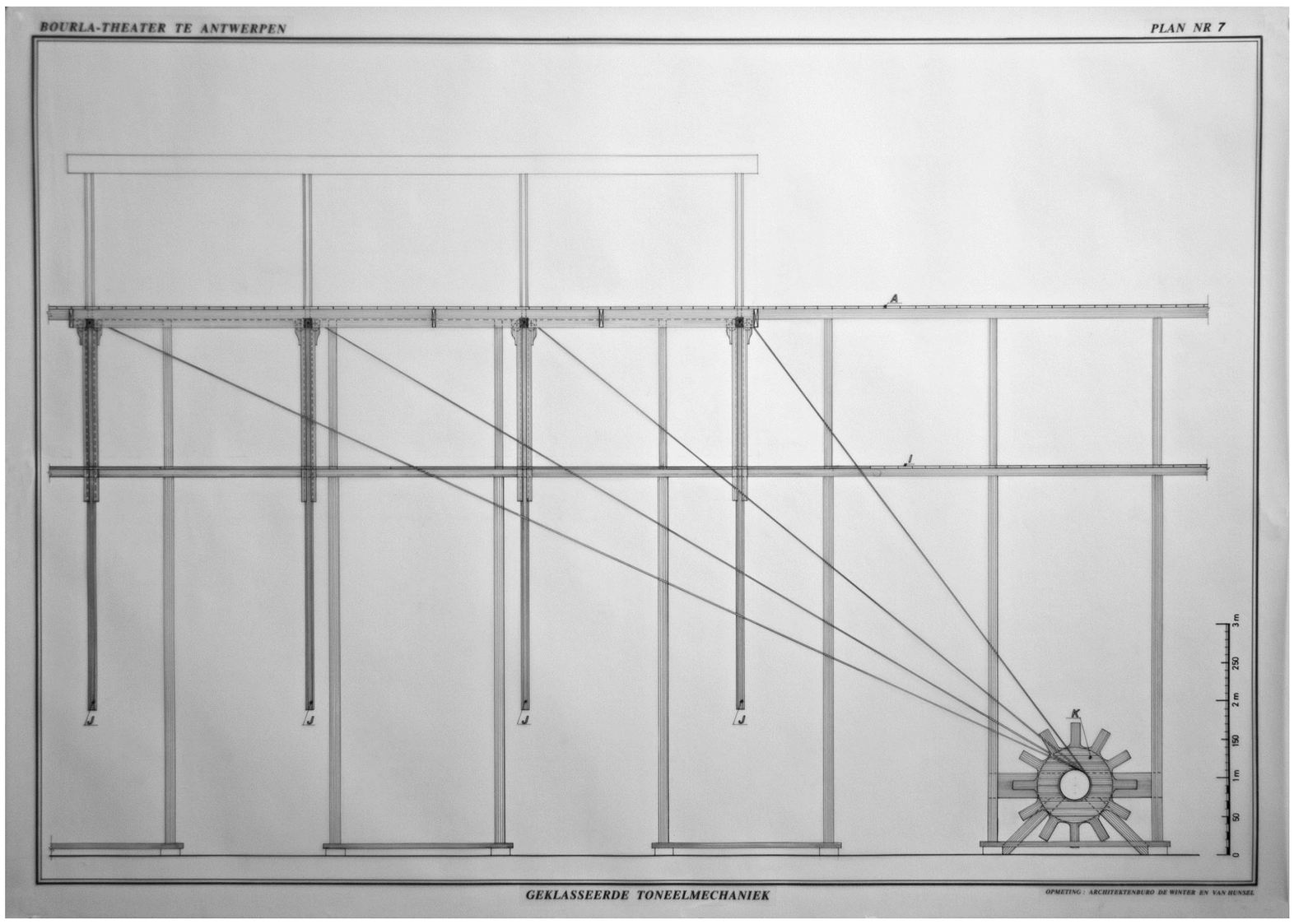
CASSETTE

Cassettes are used to move objects from below the stage onto stage (vertical movement). This is the main reason why the under stage is so deep, the full height of a flat must be able to disappear in the under stage.

In a “changement a vue”, the principle was that everything that was “earthly” would disappear to the under stage, everything that was “heavenly” would come from above and disappear there again. In other words, mountains, pillars, buildings, etc. would appear from the under stage, while clouds and heavens would be lowered from the grid.



Construction

The cassette is a sliding rail fixed firmly to the different levels of the under stage. Within this rail a wooden batten (*âme* FR) can slide up and down. The flats are bolted onto this batten. On the lowest part of the batten, a rope is connected that runs into a slit along the batten. The cassette contains sheaves that change the direction of the rope in order to manipulate the height of the batten and to connect counterweights.

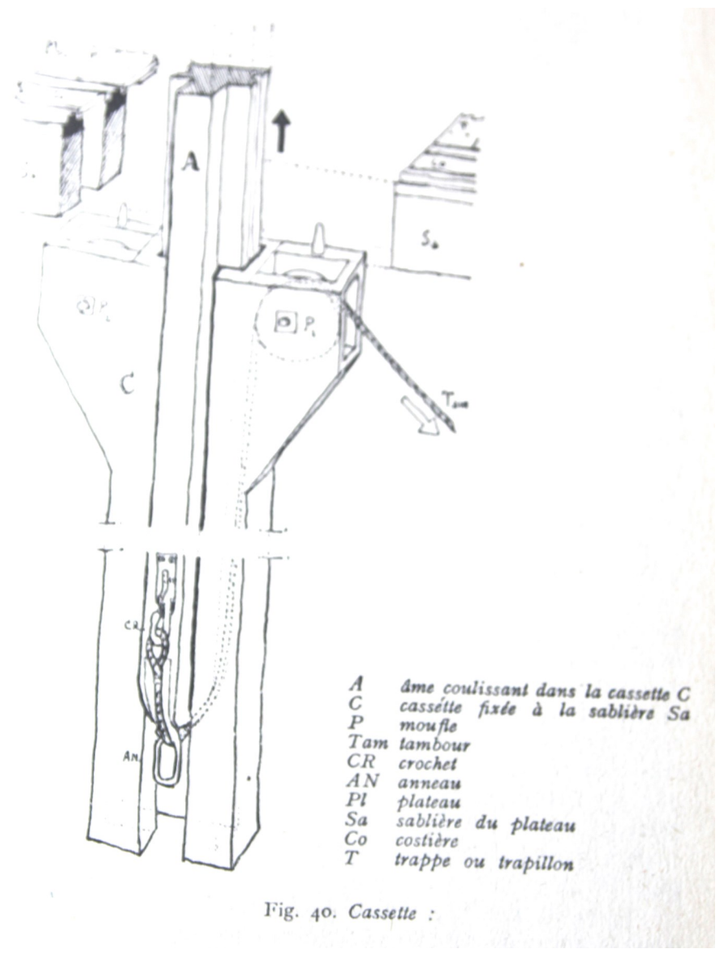
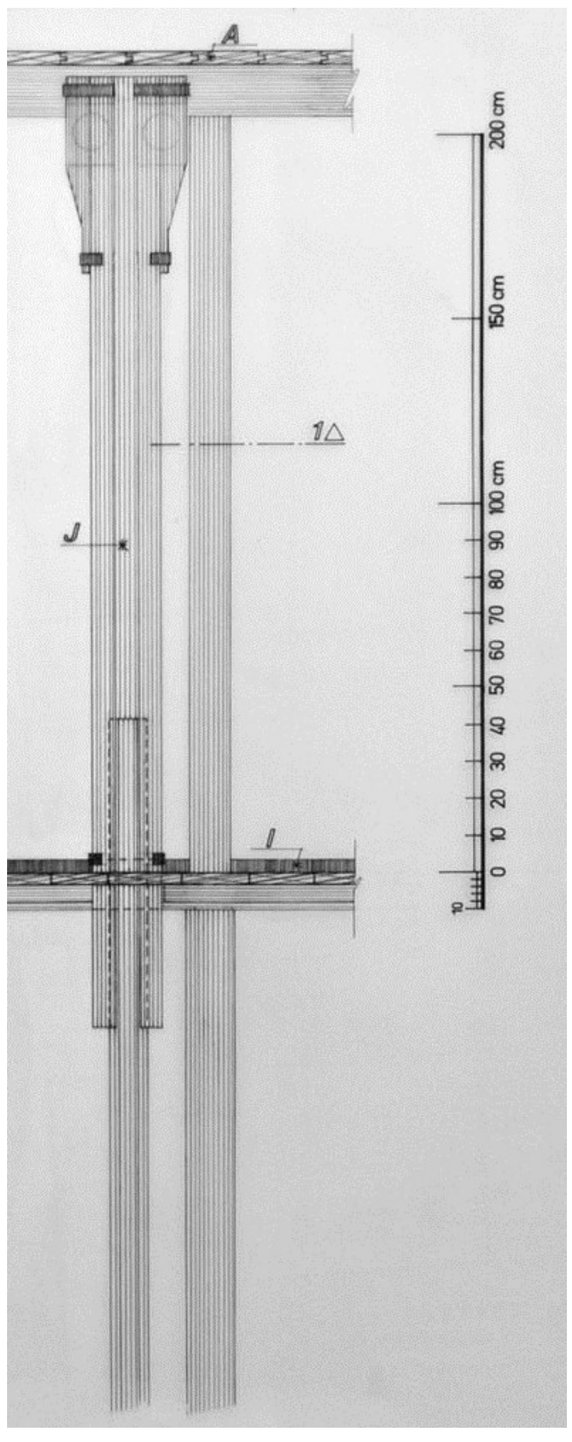


Fig. 40. *Cassette :*



Movement

Moving the batten with the flat attached upwards can be done by using a drum. The rope from the cassette will be pulled and the set will rise. In most cases a counterweight is used. This can be connected directly to the batten using the second sheave, or indirectly through the drum. In this case the operator would slack the line to release the counterweight in order to move the set up.

Several cassettes can be synchronized by the use of a shaft. In this manner, larger sets can be moved.

Other applications

The basic principle of the cassette is also used in other machines. Elevators, risers and specific effects like a “sea rail” can be lifted from the under stage using variations of the cassette.

Text Chris Van Goethem, editing Kate Burnett, print Solution

FLY RAIL

A fly rail is a rail with a small wagon running over it. The rail consists of two parallel wooden beams, the wagon is a small wooden construction with the wheels connected to it and multiple attachment points and sheaves.

The fly rail is used for movement in vertical plane parallel to the stage opening, but there are also examples of movements from the back of the stage to the front.

Depending on rigging the rail can be used for different movements. The most important, standard ones are:

Horizontal flight

For a horizontal flight, the object or actor hangs under the wagon with a line of a fixed length. When the wagon moves from left to right, the object or actor will move along. There is only a limited force needed, the weight of the object is carried by the wagon, so only the friction determines the force needed.

Diagonal flight

For a diagonal flight, the object hangs on rope that runs over sheave in the wagon to a fixed point on the opposite side of the control gallery. The control rope holds the wagon in place. Slackening the rope makes the object go down at a 45° angle.

The machinist doesn't need to use much force, slackening the rope can be done by creating friction around a beam.

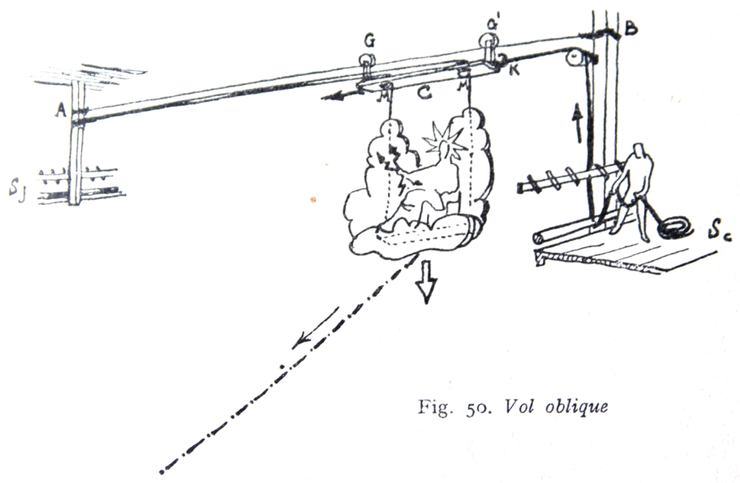


Fig. 50. *Vol oblique*

Curved flight

For a bow flight, the object hangs on a rope that runs over the sheave in the wagon to a fixed point in the middle of the stage above the rail. A counter weight pulls the wagon to the side opposite of the control gallery.

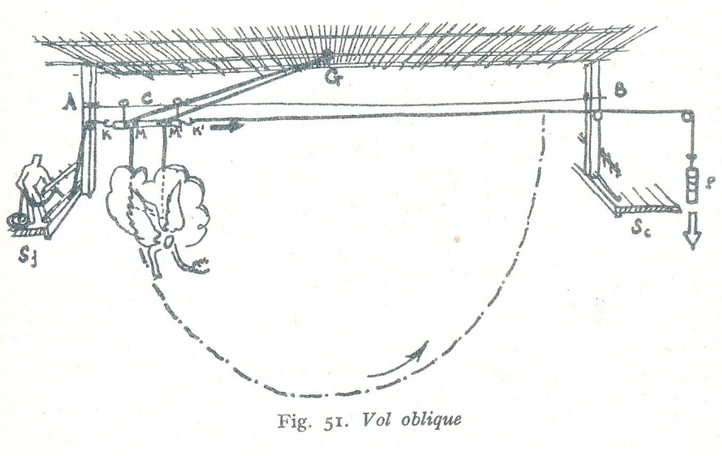


Fig. 51. *Vol oblique*

The control rope holds the wagon in place. Slackening the rope makes the object go in a curve with the lowest point under the fixed point.

Variable flight

To create a variable flight, both horizontal and vertical movements are counter weighted. The movements can be controlled independent from each other, but a horizontal movement influences the vertical movement.

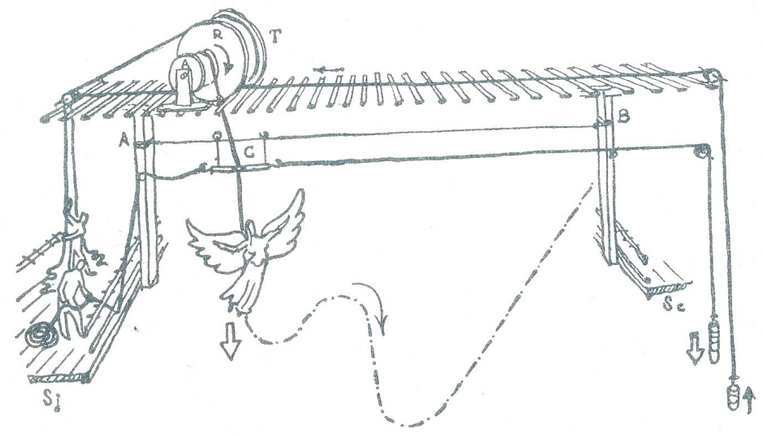
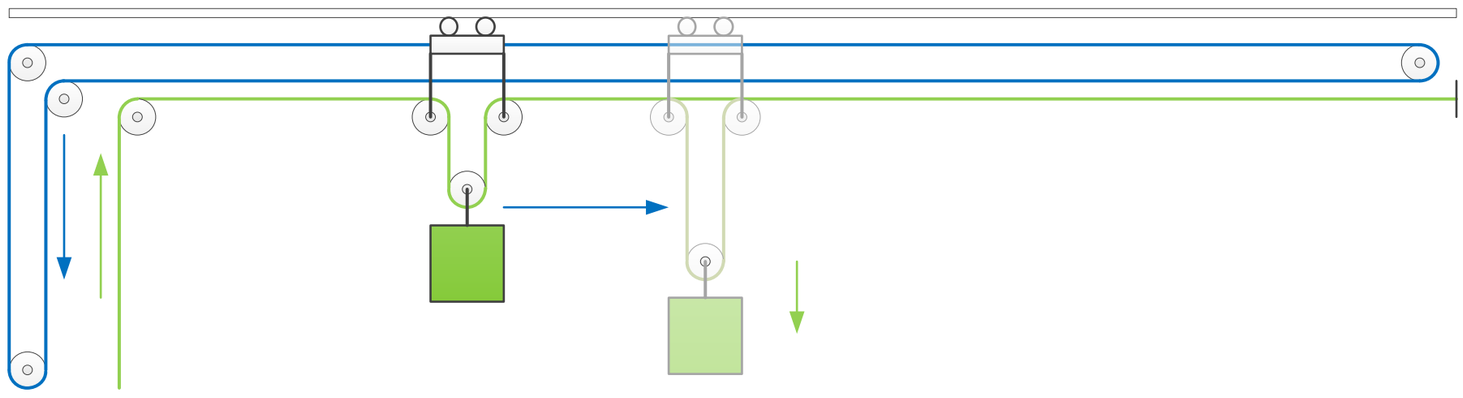


Fig. 52. *Vol oblique combiné*

In modern theatre this movement is controlled differently now. By using a double sheave system the vertical movement is not influenced by the horizontal movement.



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UPPER MACHINERY

In theory there's nothing permanent in the upper machinery. It is an empty fly floor or grid with openings to let the ropes through. Pulleys and sheaves are placed where needed. Winches, drums and shafts are permanent and are connected to the structure of the roof, in some cases they are mounted on different levels. But there are no permanently connected ropes. They are just tools ready to use.

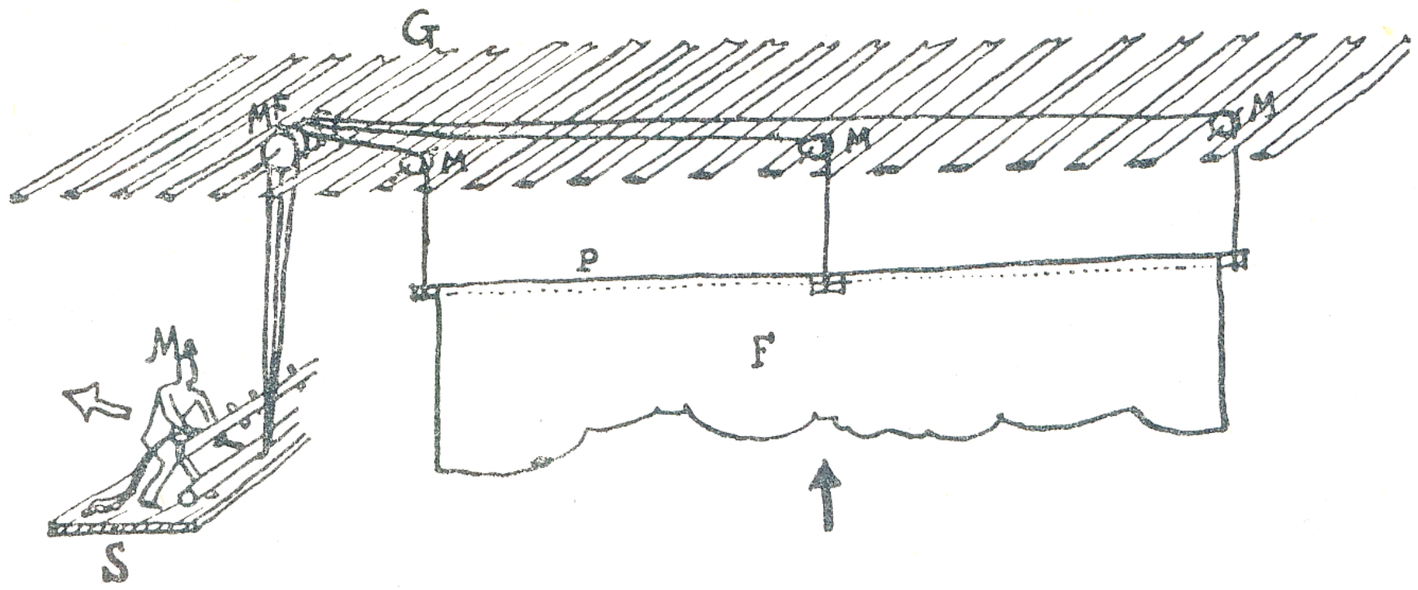


Fig. 34. *Equipe à main ou équipe légère*

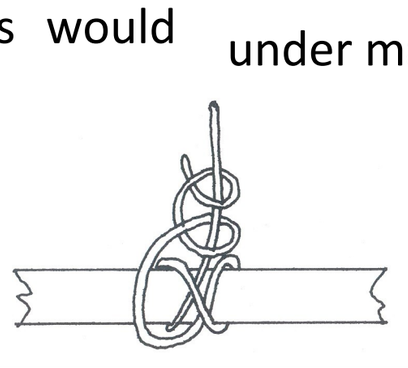
Flexible

The upper machinery is mostly used to hang objects parallel to the stage opening, ropes can be lowered everywhere, so hanging objects diagonal or perpendicular to the stage opening is possible. The system makes it also possible to fly 3D objects.

As there are only ropes where needed, flats hung on the sides don't impede movements in the middle. This makes it for example possible to have a fly rail from front to back stage.

To hang a drop

As an example of the use of the upper machinery we will hang a simple drop. The machinist would lower 3, 4 or 5 ropes. The rope closest to the gallery is called the short rope, furthest away is the long rope. Stage hands would knot a batten to the ropes and would hang the drop on the batten.



On the fly floor, the ropes would pass a sheave each and would be collected in a head block.

Depending on the weight of the drop, it would be counter balanced with weights or just pulled and secured on the pin rail. The length of the ropes would be adjusted in order to hang the drop straight and a trim mark would be added by pulling a yarn trough the rope.

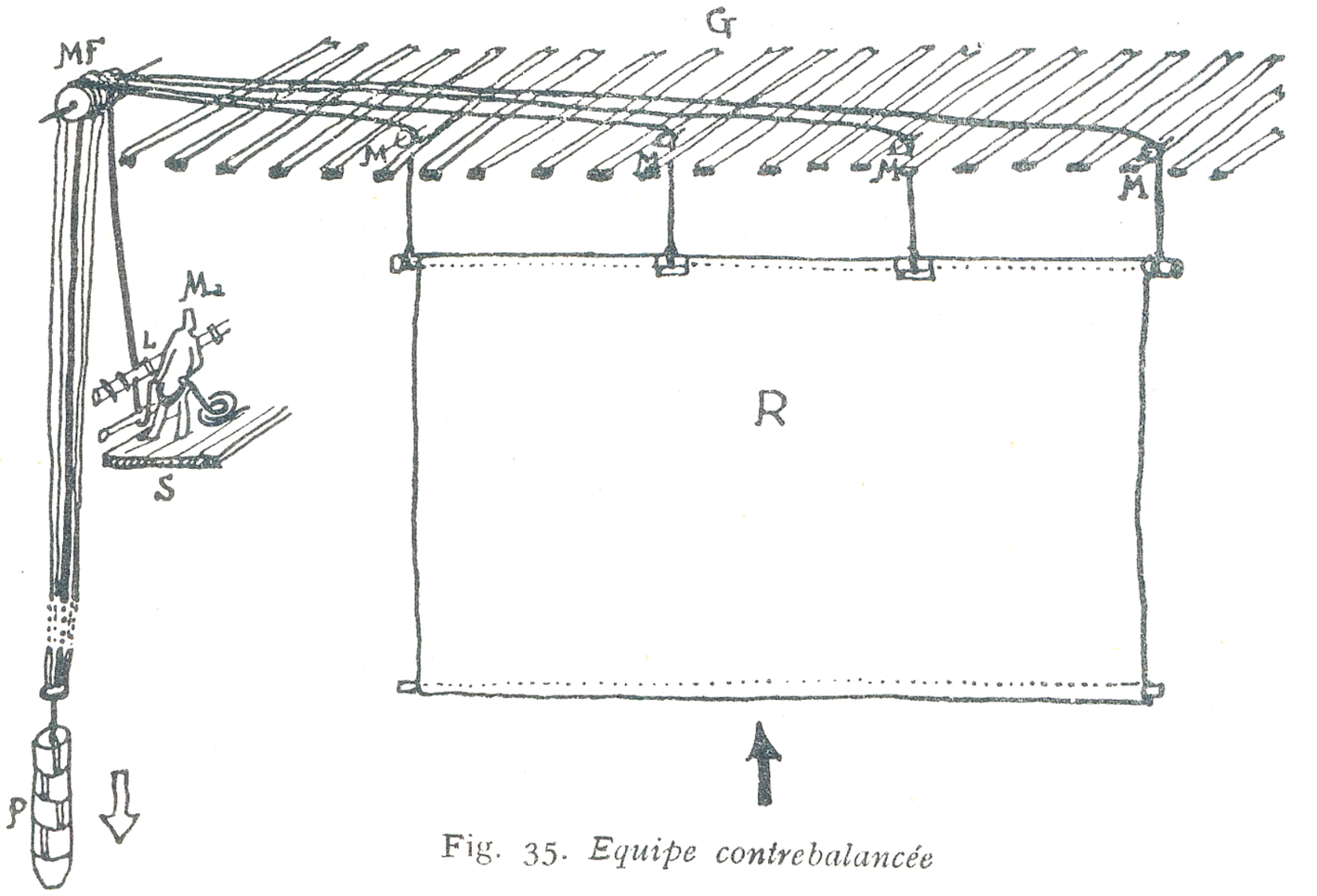


Fig. 35. *Equipe contrebalancée*

Synchronizing

If synchronization was needed, they would use a shaft. In and outgoing objects would be connected and would balance each other. If needed the shaft could even be connected to the under machinery.

Movements with different speeds

Where different speeds are needed, a multiple speed drum would be used. In the upper position, all objects would be the same height, When going down they move at a different speeds. This could show an effect of opening, sliding apart of different pieces, for example for a Gloire.

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