(No Model.) 5 Sheets—Sheet 1.

H. FLAD.

PORTABLE CAISSON FOR USE IN BUILDING SUBAQUEOUS STRUCTURES.

No. 303,830. Patented Aug. 19, 1884.

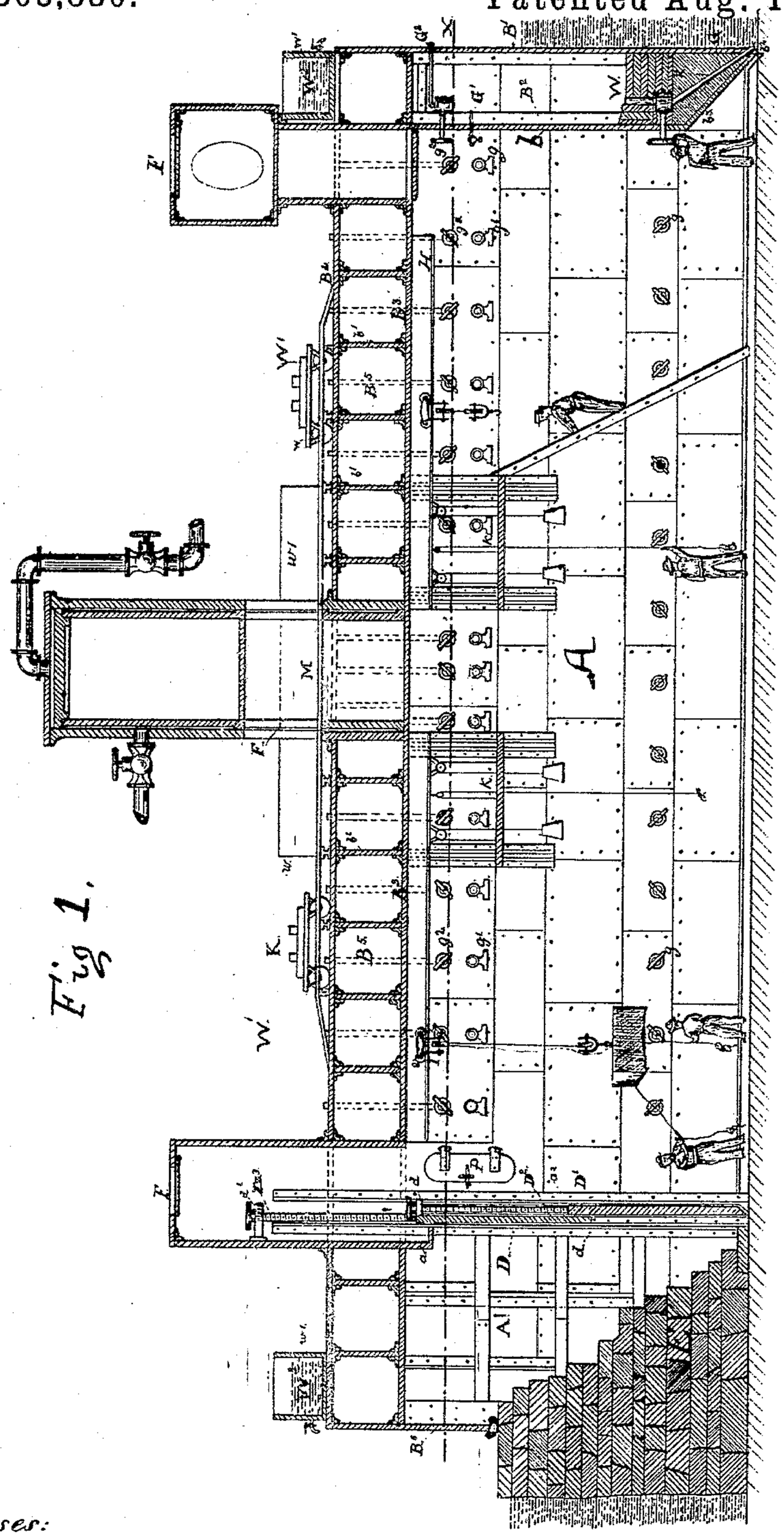

Fig 1.

Witnesses:
A. W. Nibelius
Alexander Lowry

Inventor:
Henry Flad
By his attorney
M Randolph

(No Model.) 5 Sheets—Sheet 2.

H. FLAD.

PORTABLE CAISSON FOR USE IN BUILDING SUBAQUEOUS STRUCTURES.

No. 303,830. Patented Aug. 19, 1884.

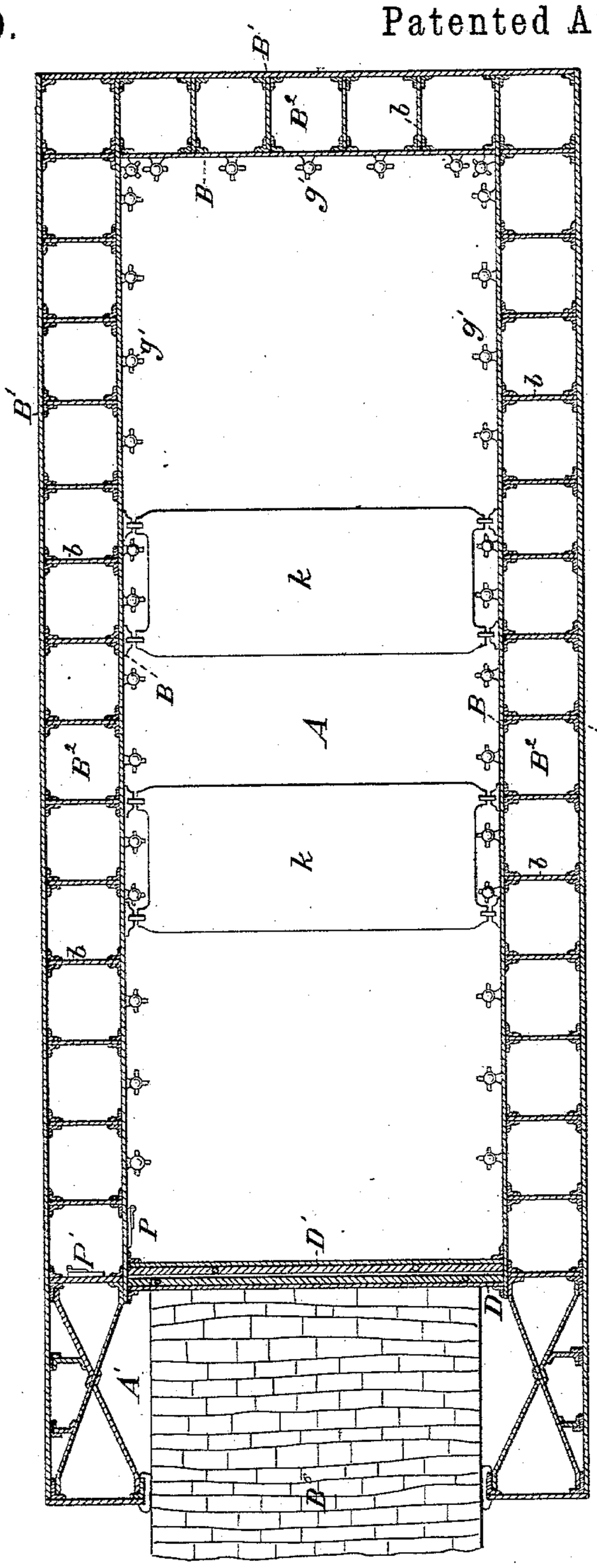

Fig. 2.

Witnesses:
A. W. Ribaline
Alexander Lowry

Inventor:
Henry Flad
By his attorney
M Randolph

(No Model.) 5 Sheets—Sheet 3.

H. FLAD.

PORTABLE CAISSON FOR USE IN BUILDING SUBAQUEOUS STRUCTURES.

No. 303,830. Patented Aug. 19, 1884.

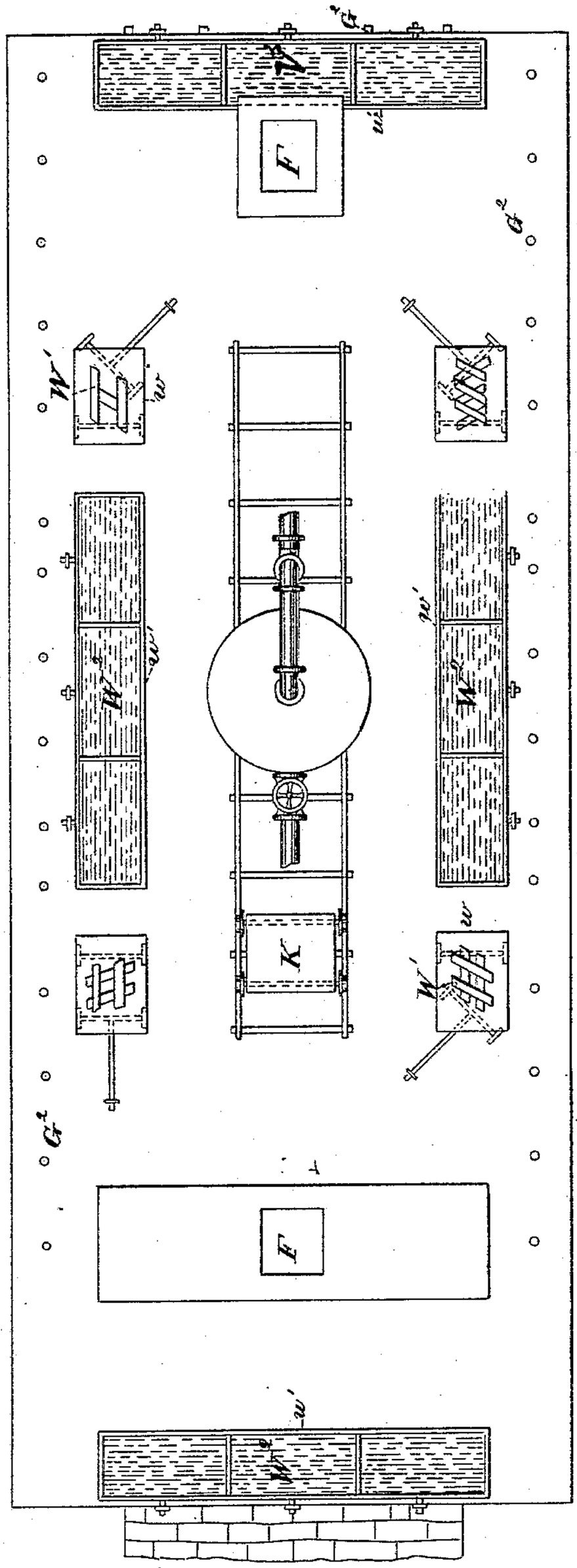

Fig. 3.

Witnesses:
A. W. Nibelius
Alexander Lowry

Inventor:
Henry Flad
By his attorney
M Randolph

(No Model.) 5 Sheets—Sheet 4.

H. FLAD.

PORTABLE CAISSON FOR USE IN BUILDING SUBAQUEOUS STRUCTURES.

No. 303,830. Patented Aug. 19, 1884.

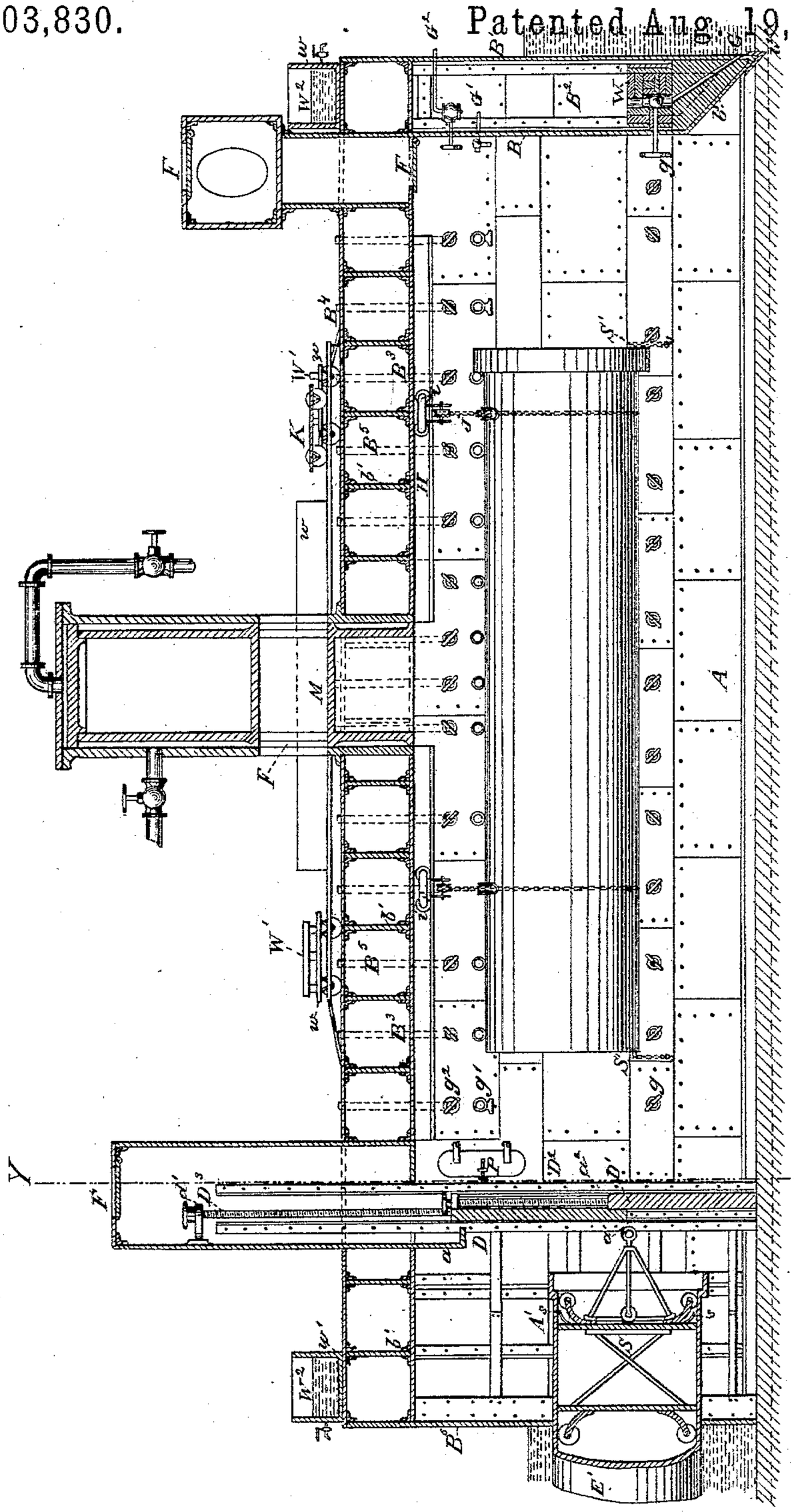

Fig. 4.

Witnesses:
A. W. Nibelius
Alexander Lowry

Inventor:
Henry Flad
By his attorney
M Randolph

(No Model.) 5 Sheets—Sheet 5.

H. FLAD.

PORTABLE CAISSON FOR USE IN BUILDING SUBAQUEOUS STRUCTURES.

No. 303,830. Patented Aug. 19, 1884.

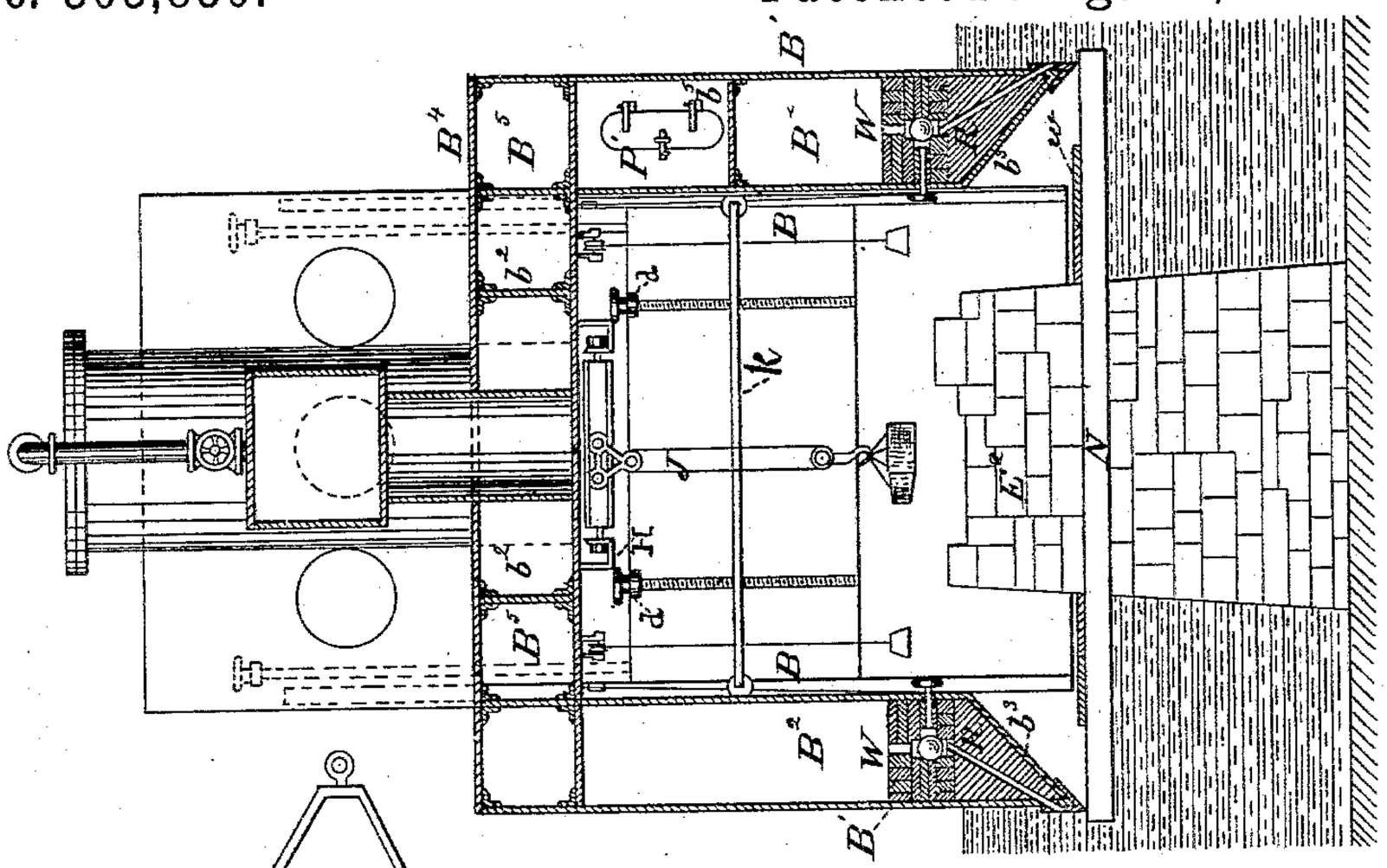

Fig. 8.

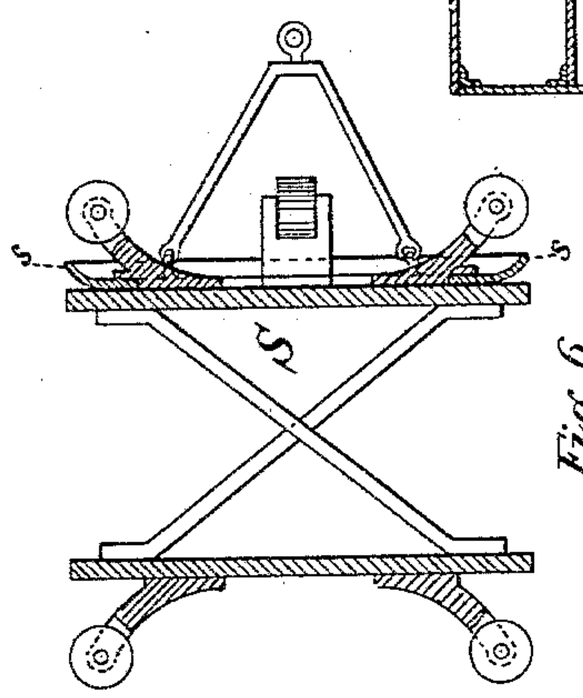

Fig. 6.

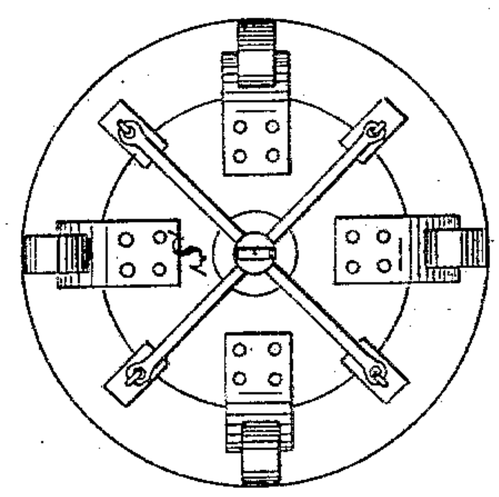

Fig. 7.

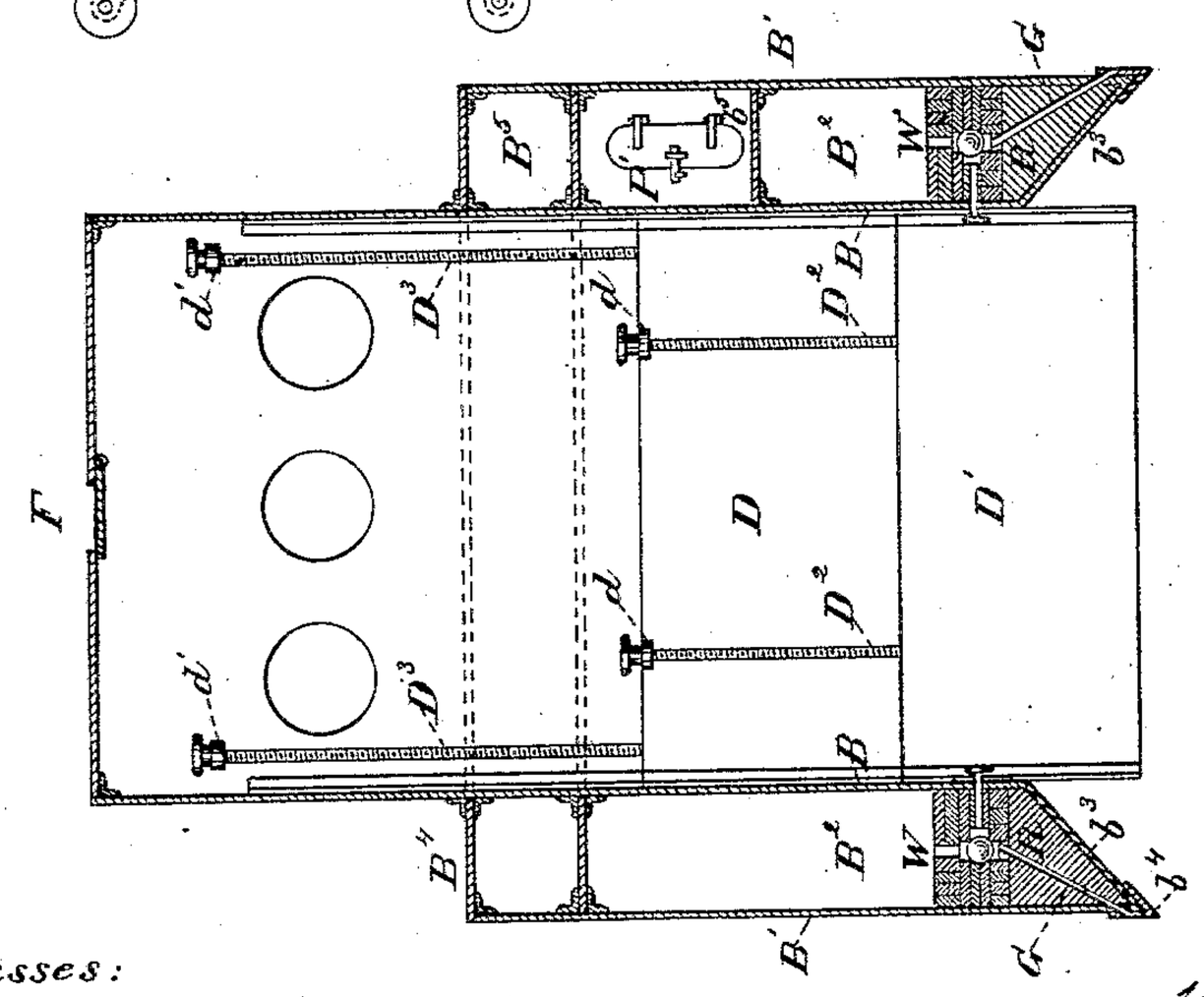

Fig. 5.

Witnesses:
A. W. Nicolaus
Alexander Lowry

Inventor
Henry Flad
By his attorney
M Randolph

UNITED STATES PATENT OFFICE.

HENRY FLAD, OF ST. LOUIS, MISSOURI.

PORTABLE CAISSON FOR USE IN BUILDING SUBAQUEOUS STRUCTURES.

SPECIFICATION forming part of Letters Patent No. 303,830, dated August 19, 1884.

Application filed July 15, 1882. Renewed September 11, 1883. Again renewed April 18, 1884. (No model.)

To all whom it may concern:

Be it known that I, HENRY FLAD, of the city and county of St. Louis, and State of Missouri, have invented a new and useful Portable Caisson for Use in Building Subaqueous Structures; and I hereby declare the following to be a full and clear description thereof.

The object of this invention is to construct a portable caisson having a central working-chamber at the bottom, from which the water may be expelled by means of compressed air, so as to allow workmen to enter the said working-chamber and construct whatever work may be required therein, and then, after having completed such work, to allow the air to escape and water to re-enter the said working-chamber, and the arrangements to be made so that after completing the work in the caisson, the caisson may be moved off to another section of the work, as of a continuous wall or duct, or to another site, as in the case of a pier.

Detail features of the invention will be fully explained in the subjoined specification, and the invention will be readily understood by reference to the accompanying drawings, of which—

Figure 1 is a longitudinal sectional elevation of one of the improved caissons as it appears when sunk ready for work on the end of a continuous wall. Fig. 2 is a sectional plan of the same, taken on the line *x x* of Fig. 1. Fig. 3 is a general deck plan of the improved caisson. Fig. 4 is a longitudinal sectional elevation of the improved caisson, showing the method of using it for laying a continuous duct or pipe. Fig. 5 is a transverse section of the caisson, taken on the line Y Y of Fig. 4, and looking toward the raising-gates at the opening end of the caisson. Figs. 6 and 7 are, respectively, a longitudinal sectional elevation of the shield for closing a pipe or duct while it is being laid, and a front elevation of said shield. Fig. 8 is a central sectional elevation of the caisson, taken through the elevator or dumb-waiter, and showing the caisson in position for building an upper section of a wall.

The caisson is divided interiorly into two chambers, A and A′, by means of a transverse partition, *a*, and the sliding doors or gates D and D′. The sides and stationary end of the compartment A (which is the larger and also the working compartment) are formed of inner and outer walls or plates B and B′, so as to leave a chamber between them, which said chamber is subdivided into smaller cells or compartments B^2 by means of the transverse partitions *b*. The whole of the compartments A, A′, and B^2 are roofed or decked over by the roof or ceiling plates B^3, and if the caisson be a large one it will require a second cover or deck, B^4, placed some distance (possibly one or two feet or more) above the ceilings B^3, and in this latter case transverse and longitudinal partitions *b′* and b^2 subdivide this deck-chamber into small compartments B^5. The transverse partitions in this case act as deck-beams. The chambers or cells B^2 have sloping bottoms b^3, which slope downward and out from the interior wall, B, so as to form a chisel-shaped cutting-edge, b^4, vertically below or a little outside of the outer wall B′, and these cutting-edges b^4 should be made of steel plates, and have their lower edges as sharp as practicable.

All of the walls, partitions, and roofing of this caisson will be made of sheet metal, and secured in place to angle-irons or **I**-beams, wherever required, by means of suitable riveting.

All of the work forming the compartments of this caisson will be put together air-tight, so as to make the said compartments as nearly as possible air and water tight. The working-compartment A is separated from the smaller or outside compartment or overhang, A′, by means of sliding doors or gates D and D′, in such a manner that the said doors or gates may be closed or open, so as to form the two compartments or unite them into one, as may be desired. These doors or gates D D′ must necessarily be made strong and air-tight, and move as nearly as possible air-tightly in their ways *a′* and a^2, which are secured to the inside of the wall or partition B.

If the caisson be a small one, or there be a chamber of sufficient size made above the deck for the working of these gates or doors, the whole slide or gate may be made in one single piece; but for ordinarily large work I prefer to have the door or gate made in two

parts and slide one inside of the other, as shown in Fig. 1; but of course in this case it is necessary to have the joint between the gates or doors formed as nearly as possible air-tight, and so also must be the joint between the top part of the upper door and the transverse partition or stop *a*. These doors or gates are arranged to move up and down in their said ways a' a^2 by means of the actuating-screws D^2 and D^3, which are applied to their respective doors, D and D′, and work through their fixed nuts *d* *d*′, the former of which, however, is preferably only relatively fixed, for it is or may best be fixed to the top of the upper door, and therefore moves up with it. The outer end or front of the overhang, or part outside of the gates D D′, will only be partially closed in ordinary cases by the outer wall or casing B^6, an aperture being formed in it to fit, as nearly as possible, the contour of the work under construction. This work is represented in Fig. 1 as a continuous wall, the unfinished end E of which is terminated within the outer chamber, A′, of the caisson; and in Fig. 4 the work is represented as a pipe or sewer, E′, the unfinished end of which also terminates in the chamber A′ of the caisson; but in Fig. 8 the work represented as being under construction is a detached pier, E^2. In the first two of these cases the outer wall or casing is formed (in each case, of course, especially for the particular work intended) with the aperture in the said casing B^6 just a little larger than the section of the work, be it wall, pipe, or anything else, and, as above remarked, as nearly coinciding with the contour of the said work as possible, so as to afford the opportunity for calking or packing the interstice between the casing B^6 and the work E E′, as the case may be, with any suitable packing—such as cotton bags, felt, blankets, or any other suitable material—so as to form an air-tight or nearly air-tight joint between the said work and the said plate B^6.

In the case of a detached work, as of a pier, (shown in Fig. 8,) the outer wall B^6 will be dispensed with, and in lieu thereof the end closed by gates similar to those described as D D′, or the caisson constructed as first above described, except with the end B^6 left off, the gates D and D′ being fully sufficient for closing this end of the caisson in the positions first above described.

Suitable man-holes, F F, with proper air-locks, will be formed in the top or roof of the caisson, for the ingress and egress of the workmen and the admission of materials for the work; but as there is nothing new about this part of the caisson no particular description of it will be made. The lower or acute angle formed in the bottoms of the chambers or compartments B^2 will be filled with a strong timber backing, R, which will give stiffness and the proper strength to this part of the caisson, and this timbering will also serve as a floor on which to place weights W, of pig-iron, stone, or any suitable weighting material for sinking the caisson. These weights W may be put in or removed from the compartments as occasion may require, proper doors or apertures being formed in the walls of these compartments for this purpose; but of course such doors or apertures must have proper covers arranged to be secured air-tightly over these openings. Each of the compartments B^2 will have three ducts, (marked on the drawings, respectively, G, G′, and G^2.) These ducts or pipes will each have suitable valves or stop-cocks, *g*, *g*′, or g^2, as the case may be, and suitable rods or devices (not shown) will be attached to these stop-cocks, and arranged to open or close them at pleasure, as the requirements of the service in the caisson may arise. It will probably be advisable to place the rods or devices for working these valves so they may be operated by the workmen in the chamber A, or above the deck; but this is a matter of no particular importance here, as the engineer in charge of the work can arrange that to suit himself. In locating these ducts or pipes, however, one of them, G, must be placed in the bottom of the chamber B^2, through the sloping plate forming the bottom thereof, so as to admit or expel water to or from the said chamber B^2 by means of withdrawing or forcing in compressed air for the purpose of sinking or raising the caisson, as required. The pipe G′ must be placed through the wall or partition B and secured thereto, and this pipe or duct will provide communication between the interior or working chamber, A, and the ballast-chamber B^2, so as to allow the compressed air from the chamber, A, to enter and fill the chamber B^2 when required, or be shut off therefrom by means of the stop cock *g*′. The pipe G^2 will be placed in the top part of the cell B^2, and extend through and be secured to the decking, so as to allow air from the cell B^2 to escape into the open air outside the caisson whenever required.

Within the working-chamber of the caisson there are longitudinal ways or beams H, formed of channel-bars or other suitable form of beams, which are suspended from or bolted to the ceiling of the caisson, and which said beams furnish longitudinal ways on which a traveler or cross-bar I will slide or travel on suitable sheaves or rollers for moving or carrying material for use on the work in progress. The cross-bar or traveler I may be a single beam or a pair of beams bolted together, and provided with sheaves or rollers *i* at their ends, so arranged as to rest on and roll on the flanges or ways of the beams H, so as to carry heavy material for the work in progress from one end of the caisson to the other.

J represents a set of differential pulleys attached to or carried on the transverse beam or traveler I, and arranged to lower material upon the work in any desired position, the said pulleys J, with their load, having a trans-

verse movement on the traveler I by means of their sustaining-sheave *i'* (which is allowed to roll back and forth on the said traveler) and a longitudinal movement in the caisson on the beams H, in the manner above described. (See Fig. 8.)

The material is lowered into the caisson on a truck, K, which is lowered into the caisson-chamber A on the dumb-waiter M through one of the air-locks or man-holes F. The dumb-waiter M is such as is described in Patent No. 109,505, dated November 22, 1870, and issued to myself, and its particular description herein therefore becomes unnecessary.

In operation, when the stone or other material shall have been lowered by the dumb-waiter to the proper position within the caisson, the truck K will be landed on the platform *k*, and from this position the stone or other material will be taken up or lifted by the differential pulleys J, and thereon conveyed to the required position on the hook, in the manner above described.

For the purpose of sinking and trimming the caisson properly when in use, in addition to the weights above described as being placed in the chambers or cells B^2, I place weights W' and W^2 on the deck of the caisson. The weights W' are placed on trucks *w*, so as to be adjustable as to position, and consist simply of heavy weights, of iron or stone, in any desired or convenient form. The weights W^2 are formed of water contained in troughs or tanks *w'*, and any of these tanks may be wholly or partially filled or emptied, so as to regulate the position and quantity of weight as desired. The overhang or outer chamber, A', will not have any side cells, B^2, but the outer wall or plating, B', of the caisson will continue straight along to the full length of the caisson, and be supported and held in the proper position by inside bracing and angle-iron frame-work. Access to this outer compartment, A', will be established from the main chamber A through the two cells B^2 next to the said outer chamber, A', the upper parts of which said cells or compartments B^2 will be formed into air-locks by placing in them and securing air-tightly to their sides transverse plates or partitions b^5, and placing in the sides of the said compartments B^2, thus cut off from the bottom sections of the said compartments or cells, man-holes or doors P P', the doors P leading from the caisson-chamber A into the air-lock thus constructed, and the doors P' leading from the said air-locks into the outer chamber, A'. Of course these doors must close air-tightly. Access from the chamber A to the chamber A', when the doors or gates D D' are closed, will be made through these air-locks in the usual manner of entering caisson-compartments where compressed air is used, and need not, therefore, be herein particularly described.

The caisson being built as above described, the operation of using it will be as follows: The chambers B^2 will be empty, except as to the weights W, which are disposed therein, and the stop-cocks or valves *g*, *g'*, and g^2 will be closed. In this condition the caisson will be floated to the position it is intended to occupy on the work; but if the depth of water in which the operations are to be conducted should be too shallow to float the caisson, increased buoyancy or floating capacity may be given to it by means of pontoons placed by the side of and lashed to it. If, however, the caisson is to be used on marshy ground where floating it is impracticable, it may be suspended from a frame-work erected for the purpose, or from piles driven in the ground, so as to sustain it. When the caisson shall have been placed in the position it is desired it shall occupy on the work, it will be lowered into the water and mud by opening the valves or cocks *g* and g^2, so as to allow water to flow into and air out of the chambers B^2, and thus sink the caisson. If more weight be required to sink the caisson, it can easily be supplied by pumping water into the chambers *w'* on the deck, so as to allow the weight W^2 thus supplied to sink the caisson as far as required. The weight thus placed upon the caisson must be sufficient to not only sink the caisson, but also to counteract the upward pressure of the compressed air, which is now forced into the interior or working chamber A from any suitable air-compressor or forcing apparatus. As soon as sufficient compressed air shall have been forced into the compartment A workmen may enter therein and pass thence into the chamber A' through the intervening air-locks above described, in cases where work in the outer chamber is to be performed, and this will be in all cases where the caisson is used for building a continuous work, like a quay-wall, or laying a pipe or sewer. In all such cases the workmen, in placing and lowering the caisson will take care to have the outer or cut-out wall B^6 of the caisson embrace the end of the unfinished work, whether it be a wall, pipe, duct, or any form of work the unfinished end of which will terminate within the outer chamber, A'. As soon as the workmen enter the outer chamber, A', where they will at first find but little air-space in the top part of the said chamber, they will commence to force the packing material, consisting of bags, felt, blankets, oakum or any suitable packing material, into the open space between the wall, pipe, or other work and the edge of the opening in B^6, which is left in the said wall or side of the caisson for the entrance of the said wall or pipe, as the case may be. As soon as the upper part of the aperture between the work and the caisson is thus stopped up and the outward flow of air is prevented compressed air will be let into the chamber A' from the chamber A, and the work of calking or stopping up the aperture between the work and the caisson will then proceed from the top downward until the whole aperture shall have

been stopped up, and when this is done the compressed air will stand in the whole of the chamber A′ at the same pressure which is maintained in the chamber A, and the gates or slides D D′, which have until that time been shut down, will then be raised up and the unfinished end of the wall or other work will then be accessible from and in direct communication with the main working-chamber A, and work in building the structure may then be resumed.

If the work to be performed in the caisson be the building of masonry, all of the material for the work may be sent down into the caisson by the dumb-waiter; but if it be a section of pipe which is to be laid, the pipe, or rather the section of pipe, to be placed must be sent into the chamber A through the open doors or gates D D′ before the caisson is lowered, and such section of pipe or duct will be held up by chains or ropes to the ways H, or to some other suitable part of the caisson, until the water shall have been forced out of the working-chambers, so as to give the workmen an opportunity to lay and adjust the pipe or duct.

In working with this caisson on laying of pipes or ducts, it will be necessary to stop up the otherwise open end of the pipe within the caisson to prevent the escape of the compressed air through the pipe or duct, and in order to do this I use the pipe stopper or shield S, which is shown clearly in Fig. 4, and which fits as closely up to the inside of the pipe or duct as possible, the intervening space between the shield and the pipe being calked up with any suitable packing each time the shield is set or placed. In using or setting this shield, each time a new section of pipe is added to the duct, as soon as the new section is fully set and fixed in place the shield is drawn forward toward the outer end of the said pipe by means of a chain, S′, which has been previously passed through the newly-laid section of the pipe or duct and attached to the outer side of the said shield by means of some suitable catch attached to the shield, so as to receive it. By means of this chain the shield is then drawn forward close up to the end of the pipe, and the said shield is then calked air-tightly in its new position, and so on, the shield S is moved forward to the end of the pipe as fast as the pipe is laid.

In building detached works, like piers, the caisson may be lowered over the position required, and the doors or gates D D′, either in the position shown in Fig. 1 or placed at the end of the caisson in lieu of the wall B^6, used in precisely the manner hereinbefore described, except that they will remain closed during the entire time of conducting operations within the caisson, and be opened only when the caisson is to be raised or moved. In building works of greater height than can be built in the limited dimension of the compartment A, the work may be built in sections, one higher than the other, in which case the caisson will first be sunk to the lowest position required; and after as much work shall have been completed as possible in that position the caisson will be raised up to the next position, and in the more elevated position the caisson will be steadied and partly supported on temporary transverse beams N, laid across the wall in notches or openings left in the work for that purpose, as shown in Fig. 8. These beams N will have to be taken into the caisson before it is sunk into its first position, and held in the caisson out of the way until required for use, and planking *n* may be put on top of them, when these are in use, as shown in Fig. 8, so as to afford a scaffold for the workmen within the caisson while the men are engaged on the work of the upper section.

The shield S, which is inserted in the completed pipe or tube, is shown best in Figs. 4, 6, and 7, and as rapidly as a section of the pipe is laid and completed, as is shown in Fig. 4, this movable shield will be drawn to the inner end of the said completed pipe F′, so as to prevent the compressed air of the caisson from escaping through the otherwise open tube or conduit. This shield is formed of two parallel disks connected together by suitable stays and braces, and the said disks of which it is formed are made enough smaller than the pipe in which it is placed to allow the said shield to be easily drawn forward therein by means of the traction chain or rope S′, attached to it for that purpose. On the front face of the outer disk—*i. e.*, the one nearest the caisson—there will be attached flexible packings *s*, which will fit tightly to the inside of the tube or pipe, and thereby prevent the escape of air from the caisson; yet these packings will be attached to the traction-bars at the front end of the shield, so as to be drawn forward and partially off of the pipe, so as to afford no impediment to the forward movement of the shield when it is to be moved forward in this manner. There should be suitable anti-friction rollers attached to the sides of the shield, so as to keep it off of the pipe sufficiently to prevent undue friction thereon.

Having described my invention, I claim—

1. In a portable caisson, the central working-chamber, A, and extension A′, formed of continuous double side walls, and transverse partitions forming air or water spaces within said double walls, and compressed air locks provided with air-tight doors P P′, and the vertically-moving air-tight partition D D′, and suitable elevating-screws, whereby the two compartments or chambers are separated, substantially as shown and described.

2. In a portable caisson, the combination of the air-tight working-chamber A, provided with suitable vertically-moving partitions, with the projecting overhanging building-chamber A′, formed with end wall, B^6, supported on the completed portion of the structure, and suitable packing interposed between the end wall and the structure, and adapted to be retained

in position by the weight of said building-chamber, substantially as shown and described.

3. The shield or air-stop S, in combination with the pipe or conduit E′, and a suitable compressed-air chamber, substantially as set forth.

4. The combination of the section E′ of a subaqueous pipe or conduit, the movable caisson or compressed-air chamber, and the movable air stop or shield S, provided with the circumferential elastic packing *s*, substantially as shown and described.

5. In a portable caisson, the combination, with the air-tight working-chamber A, having suitable vertically-moving air-tight partitions, of the fixed ways or track H, the traveler I, and differential pulleys J, depending from and adapted to move across the said traveler I, and a suitable dumb-waiter or elevator, substantially as shown and described.

6. In a portable caisson, the combination of the continuous outer and inner walls, B B′, and rectangular braces or partitions *b*, forming air and water cells B^2, provided with cocks *g*′, communicating with the working-chamber, the air-locks F F F, doors P P′, partition B^5, the suitably-located ballast-compartments W^2, and movable trimming or counter weights W′, the vertically-moving separating partition D D′, and elevating-screws, and the end walls, B^6, adapted to be supported on the completed portion of the work, and suitable interposed packing, substantially as shown and described.

7. The supporting-beams N, arranged on the pier E^2, and in combination with the caisson, substantially as described.

HENRY FLAD.

Witnesses:
M. RANDOLPH,
J. B. THURSTON.