D. E. MORAN.

SINKING SHAFTS AND THE LIKE.

APPLICATION FILED OCT. 15, 1907.

923,984.

Patented June 8, 1909.

11 SHEETS—SHEET 1.

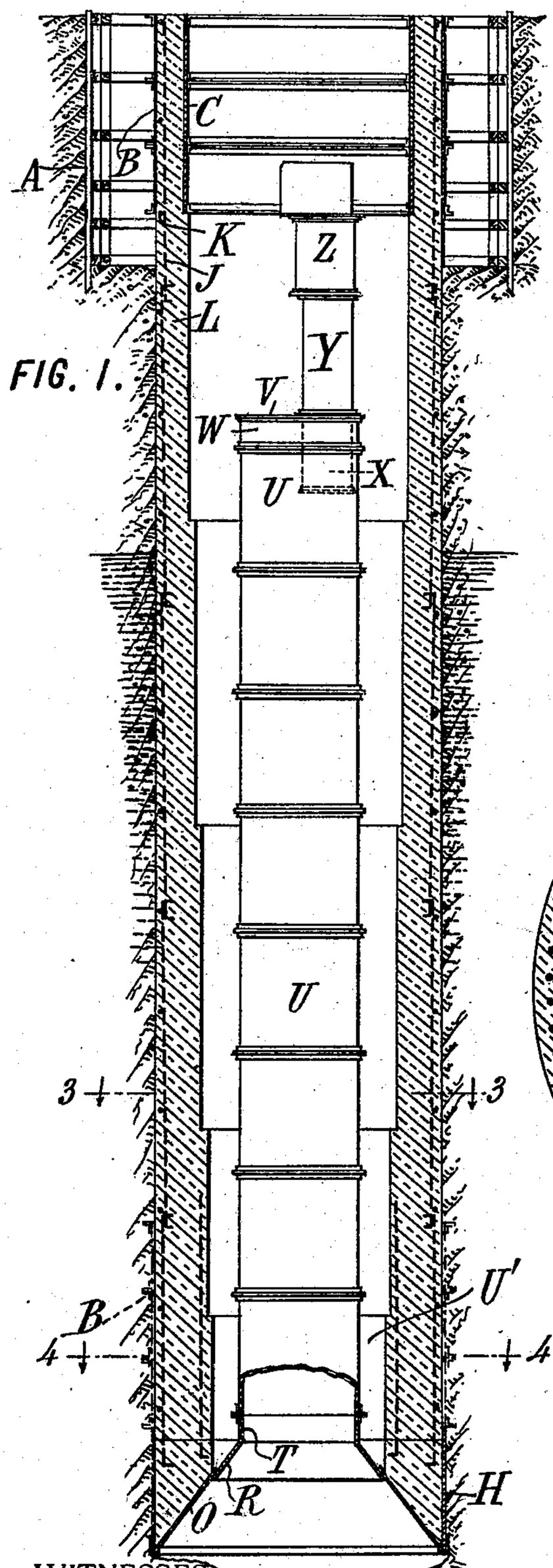


FIG. 1.

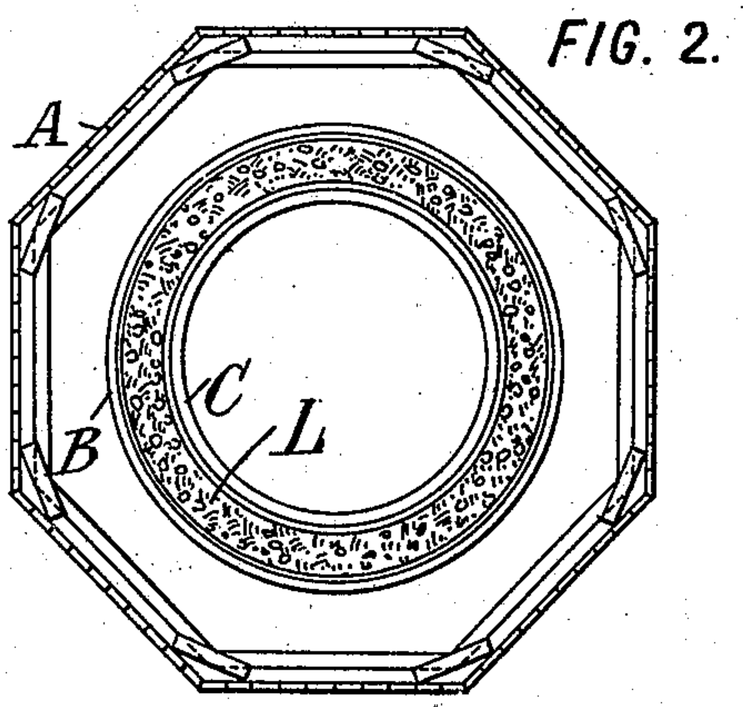
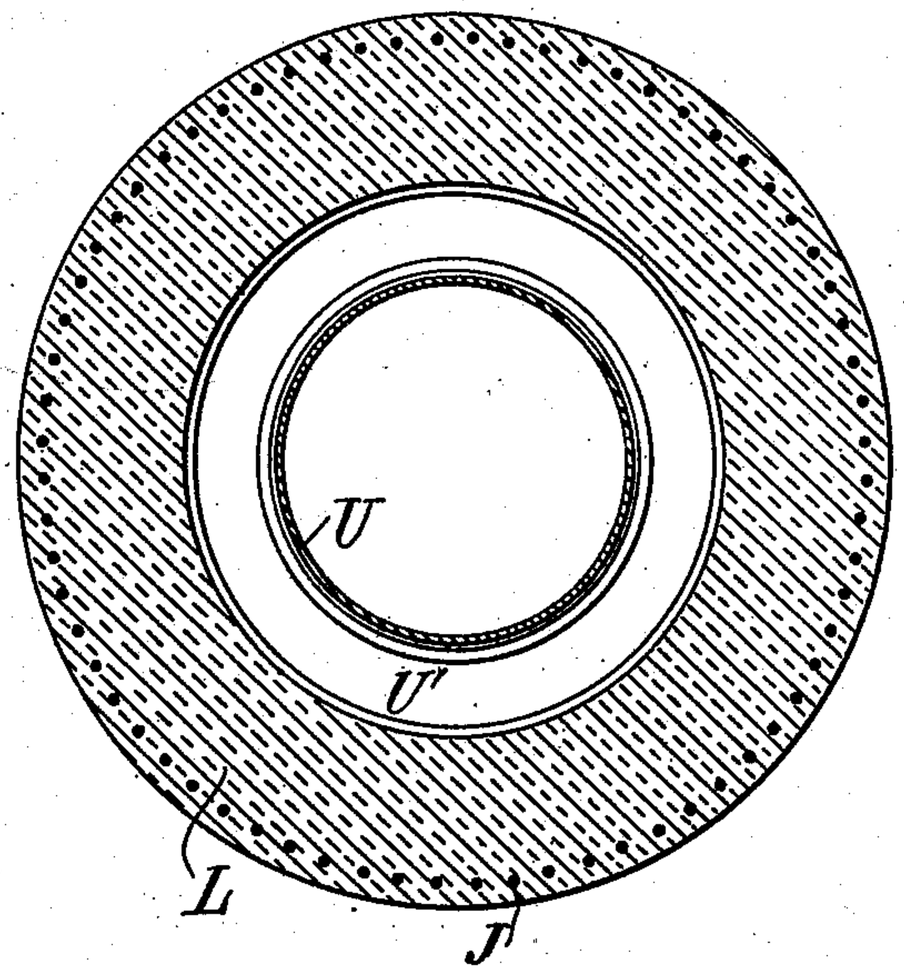


FIG. 2.

FIG. 3.



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11 SHEETS—SHEET 2.

FIG. 4.

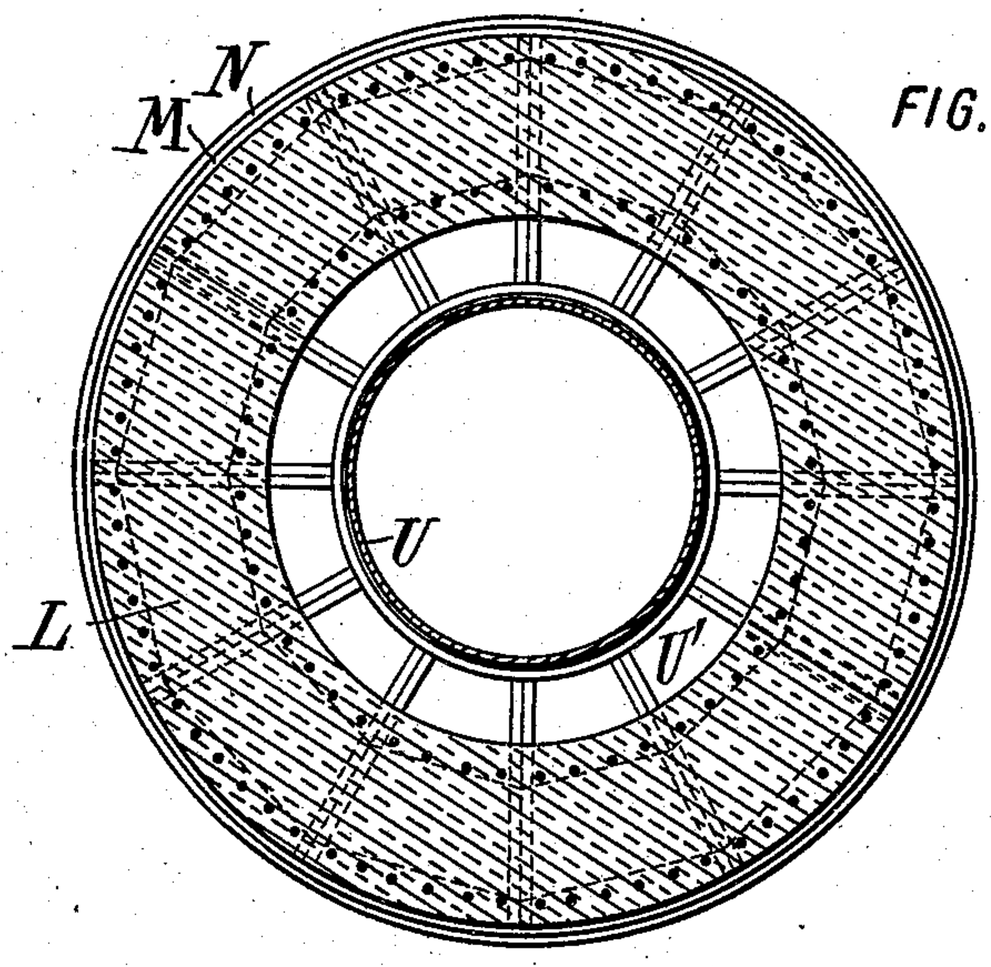
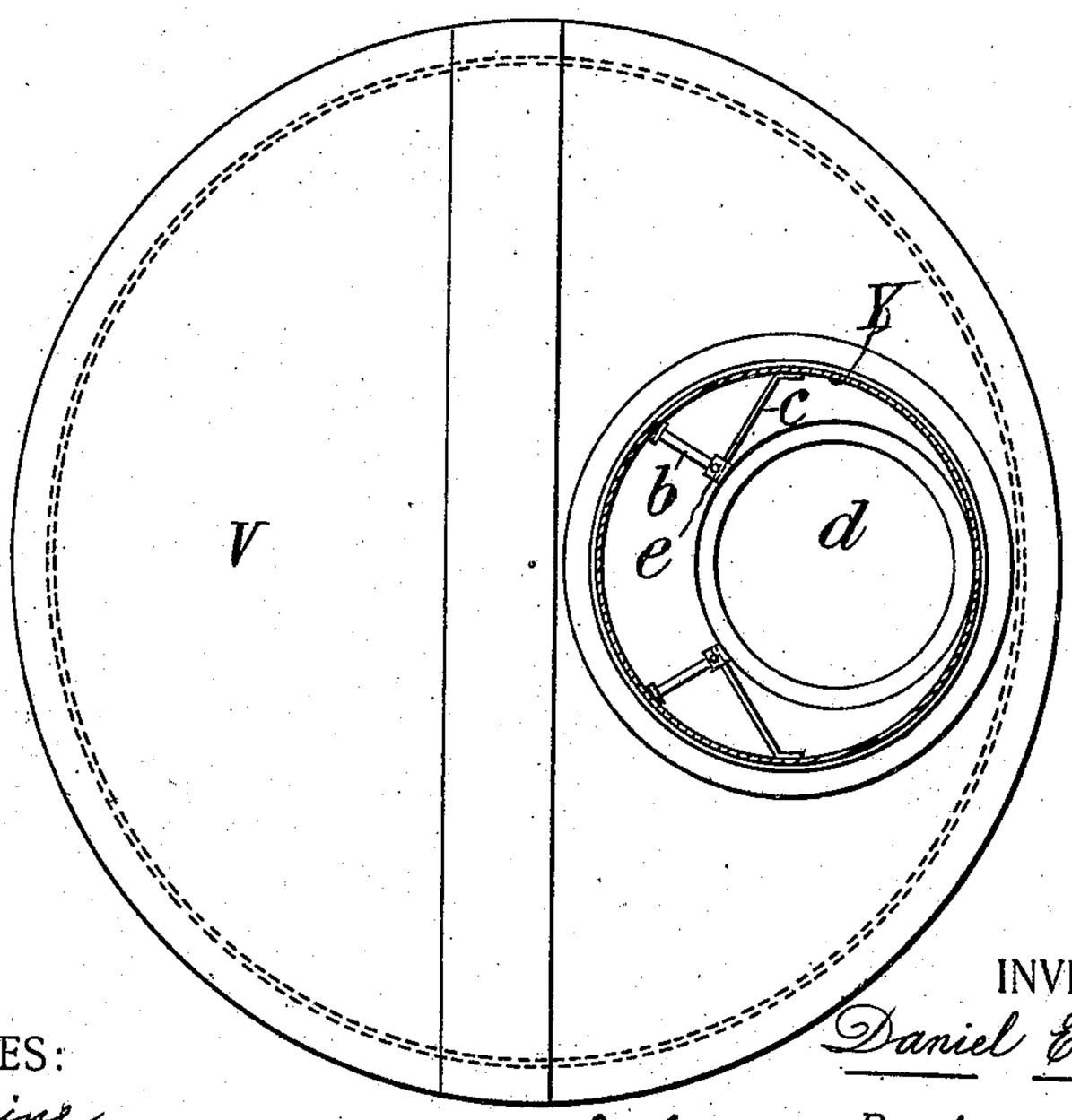


FIG. 5.



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11 SHEETS—SHEET 3.

FIG. 7.

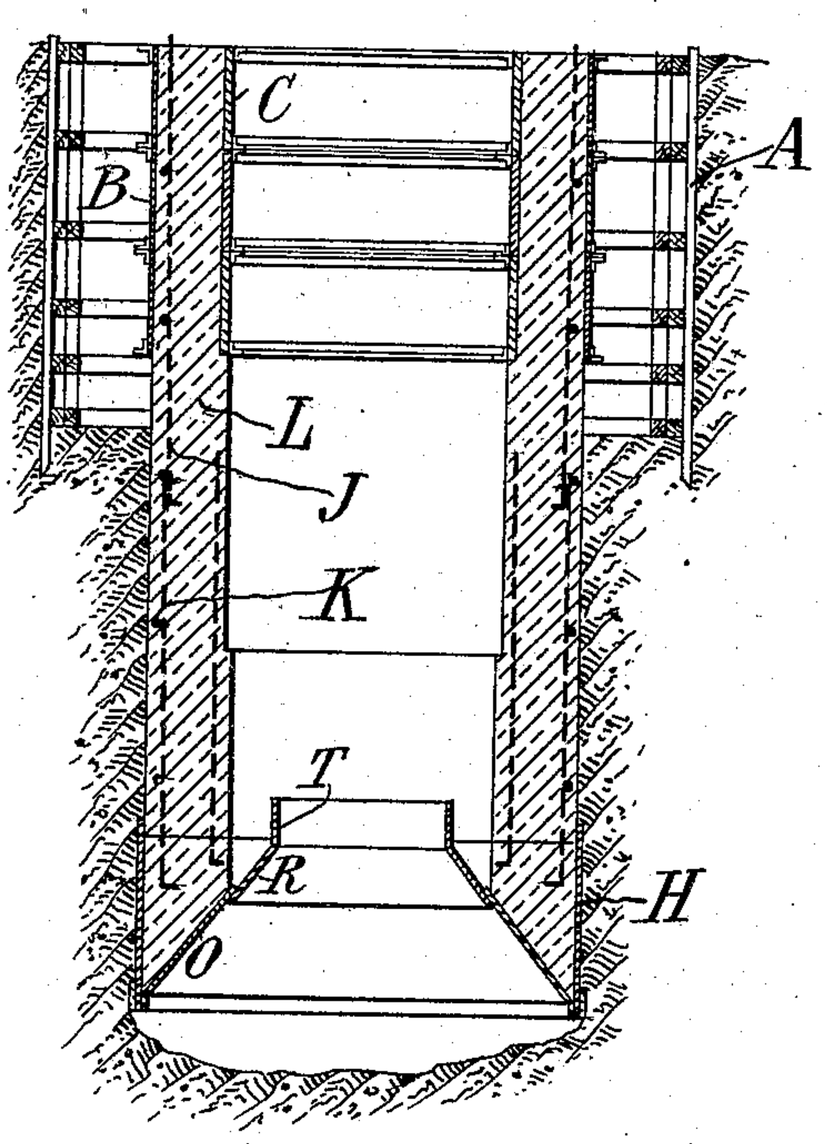

FIG. 6.

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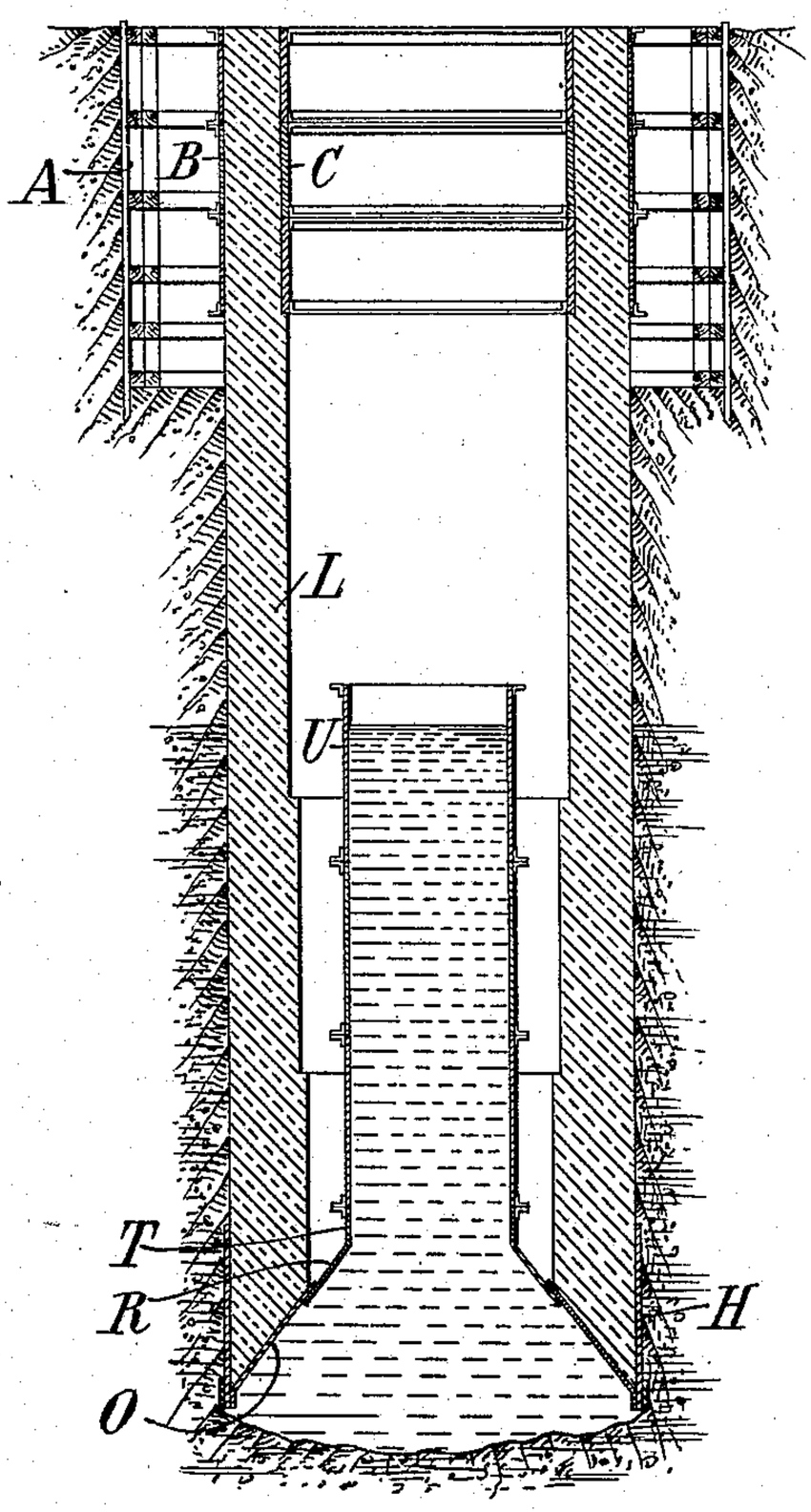
11 SHEETS—SHEET 4.

FIG. 7.



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11 SHEETS—SHEET 5.

FIG. 8.

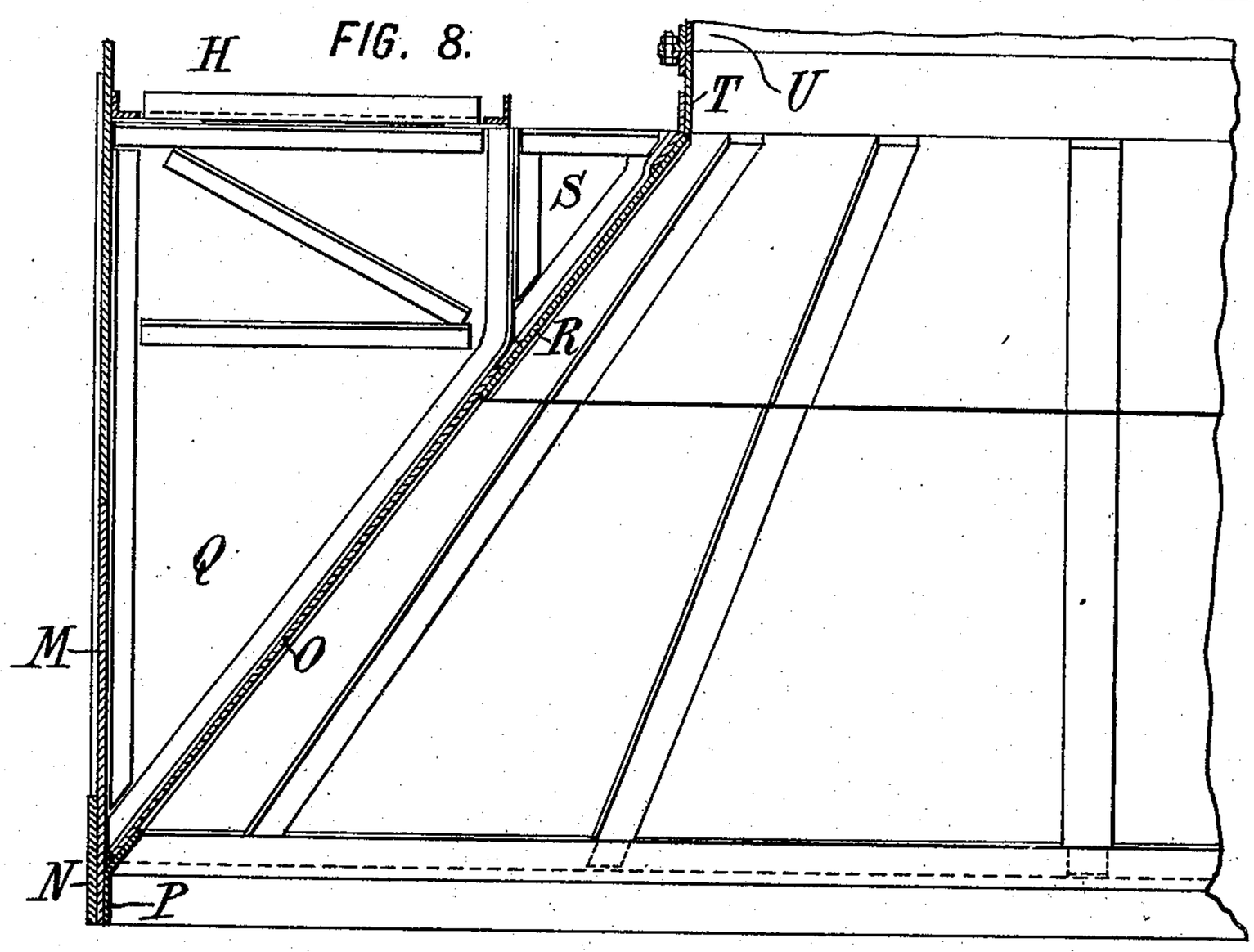
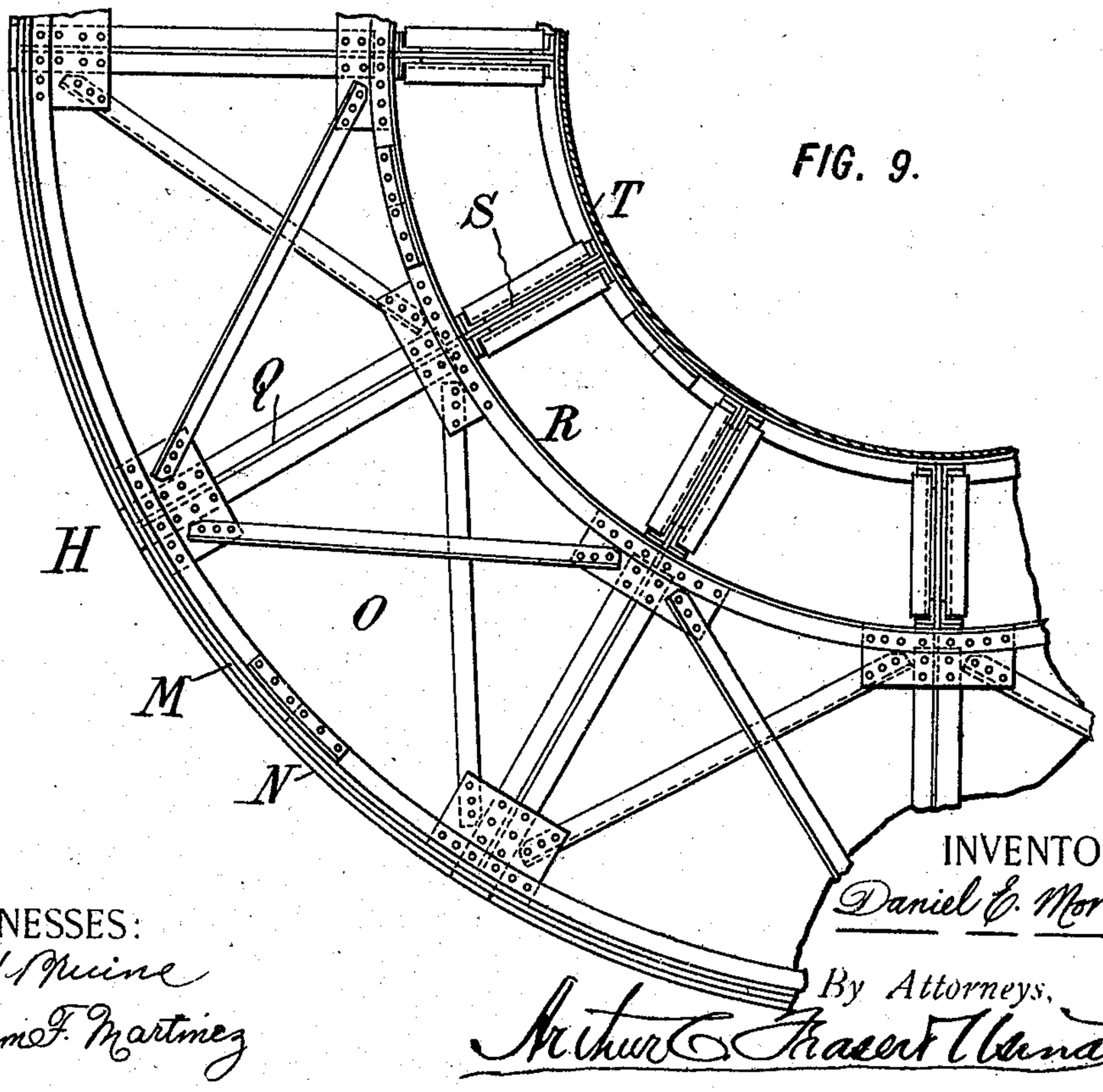


FIG. 9.



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11 SHEETS—SHEET 6.

FIG. 10

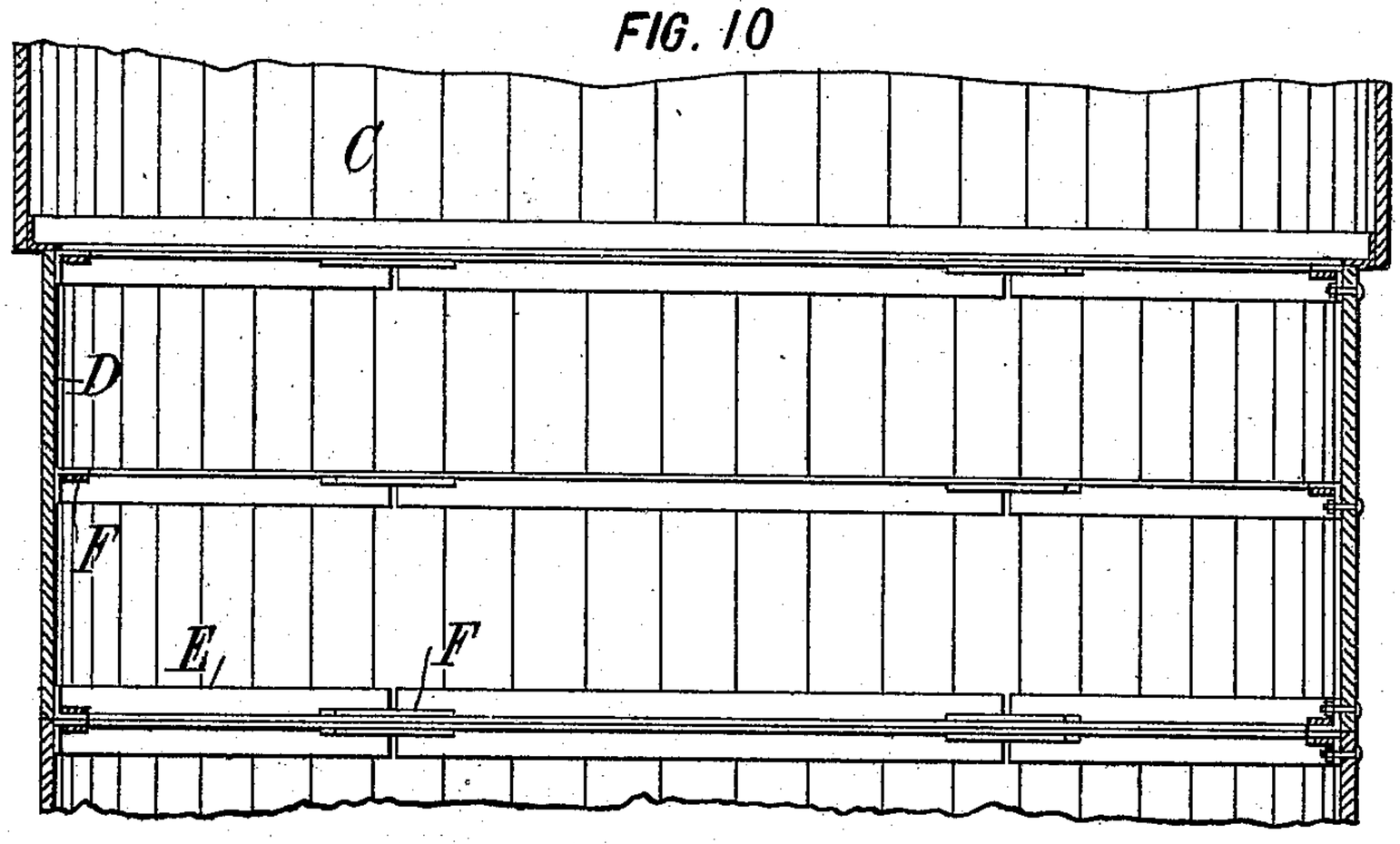
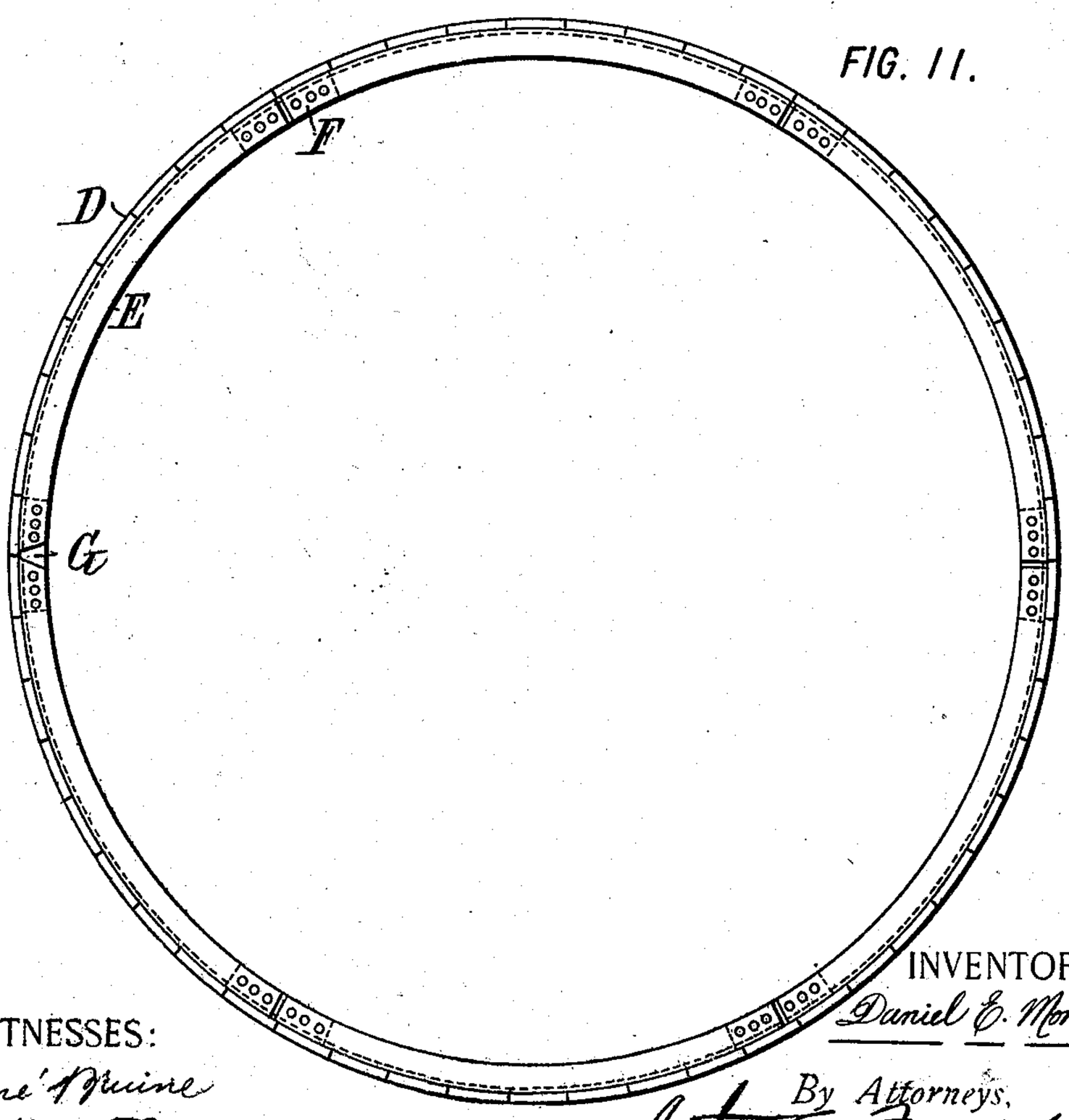


FIG. 11.



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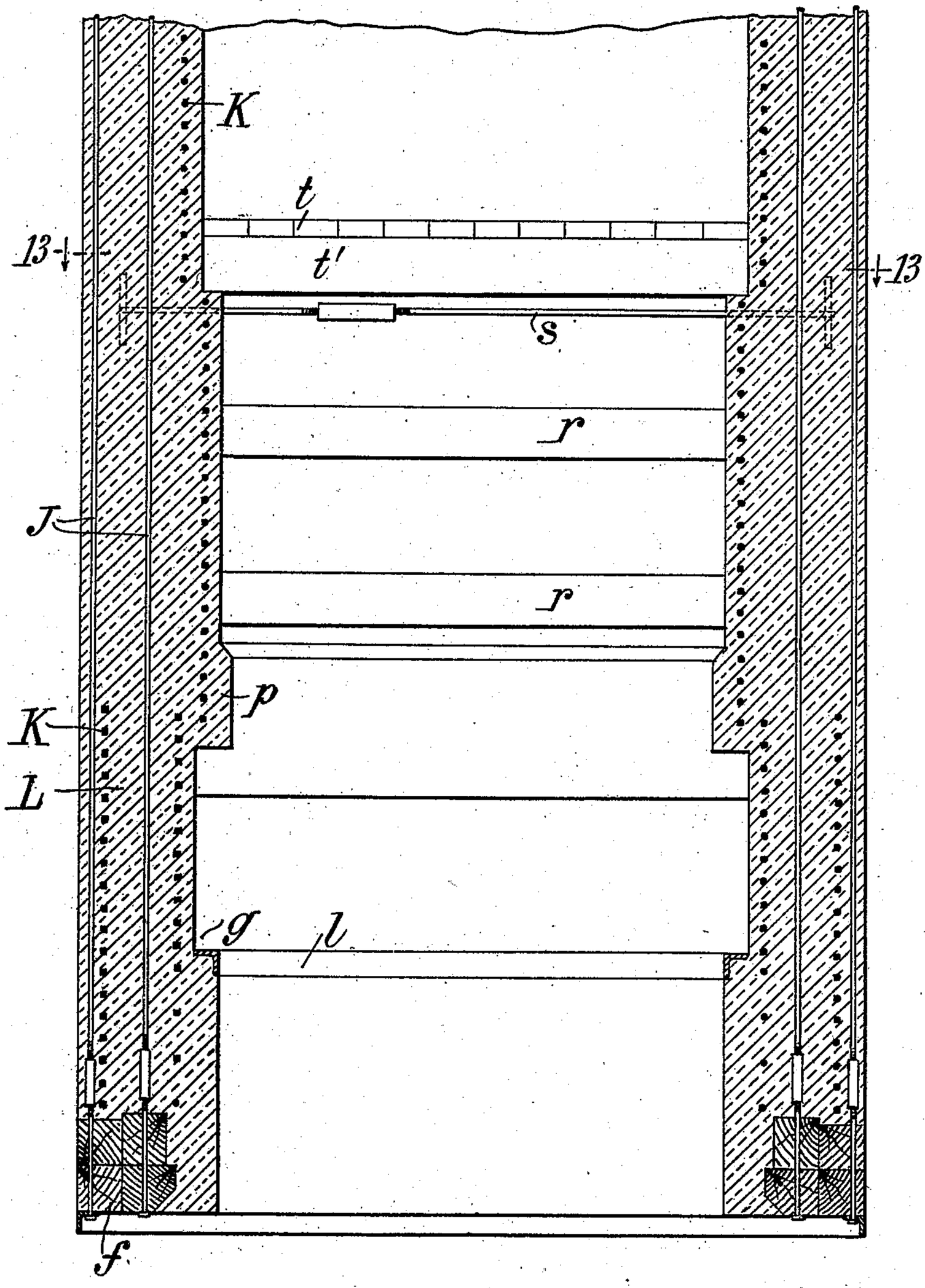
11 SHEETS—SHEET 7.

FIG. 12.



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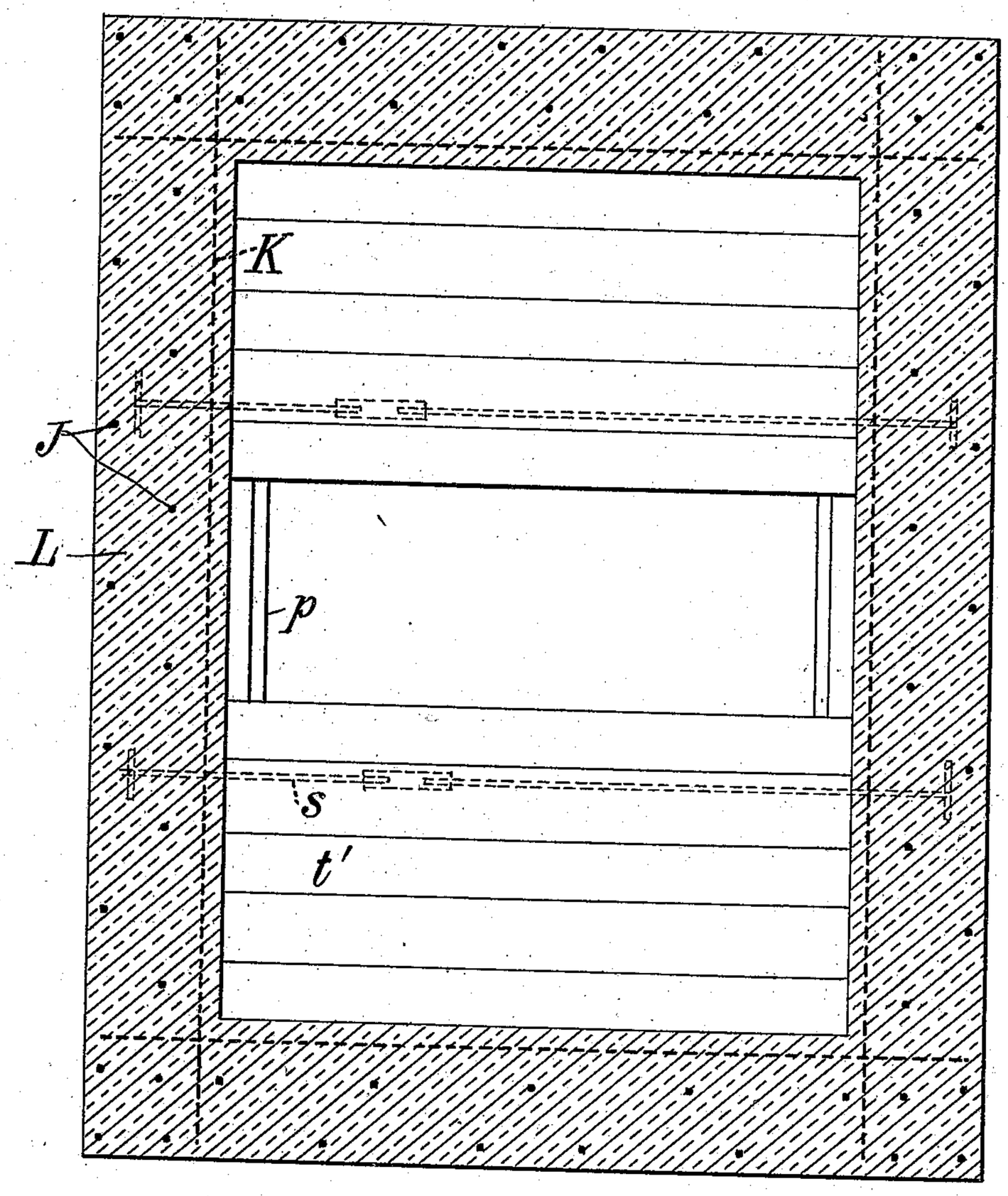
11 SHEETS—SHEET 8.

FIG. 13.



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11 SHEETS—SHEET 9.

FIG. 14.

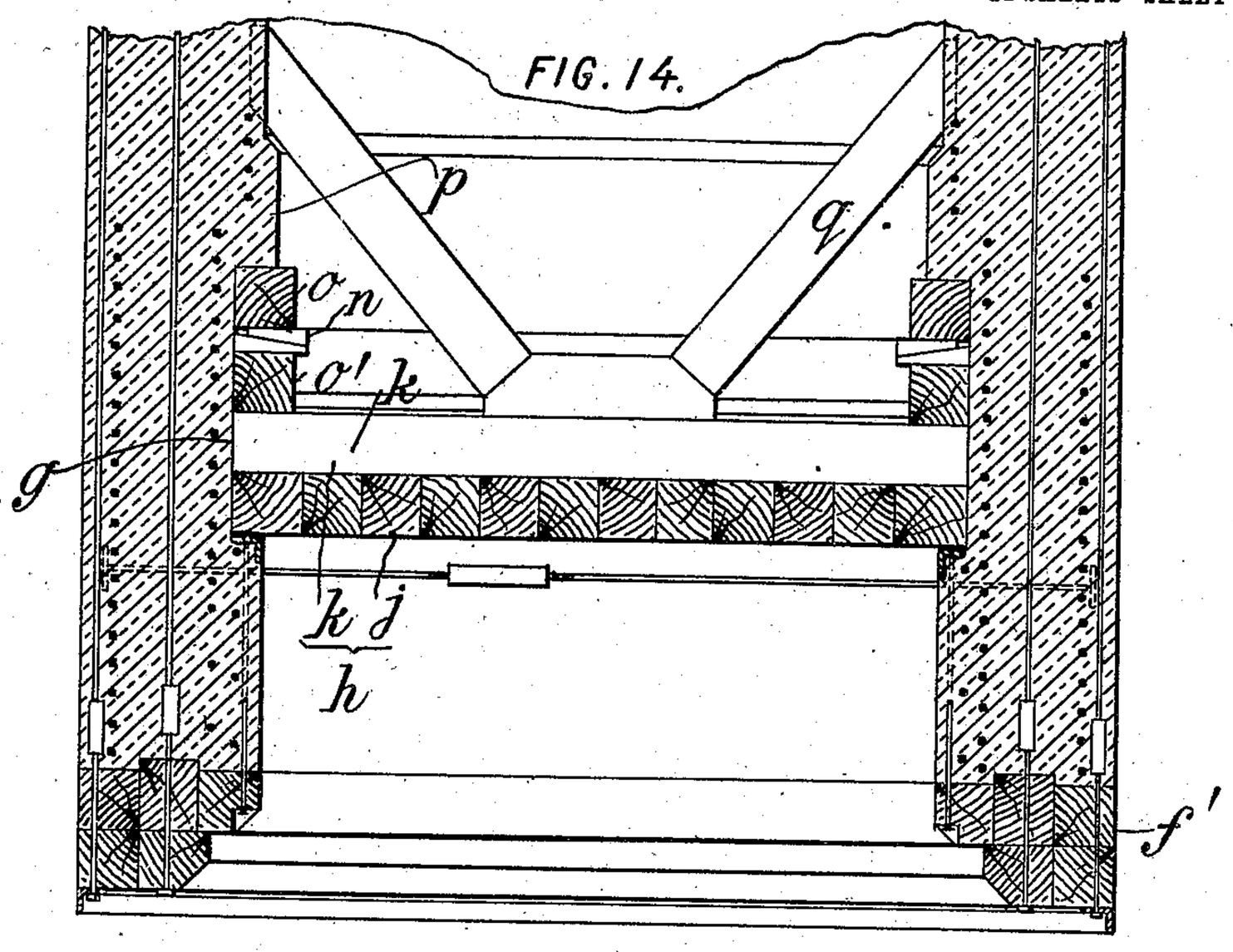
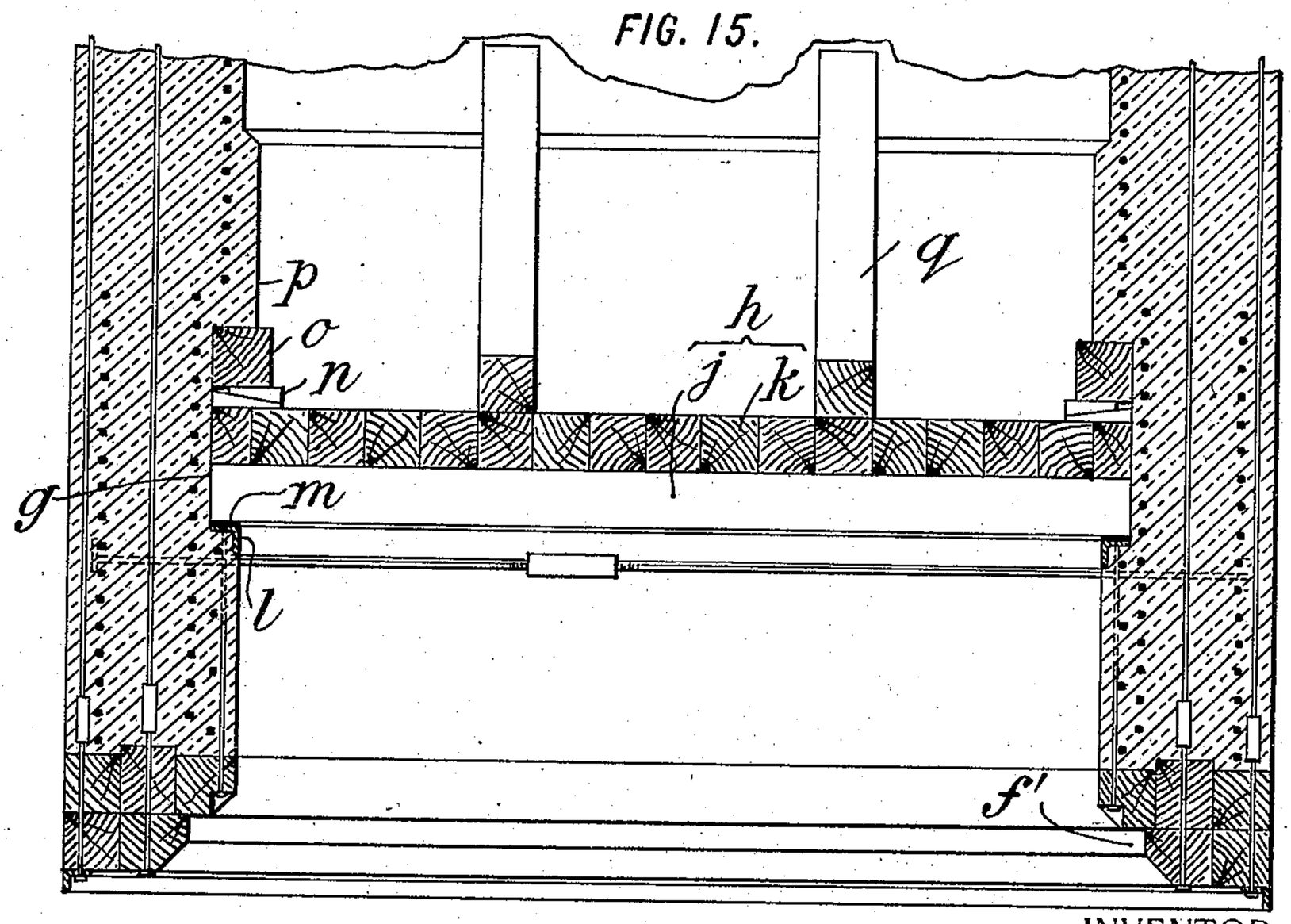


FIG. 15.



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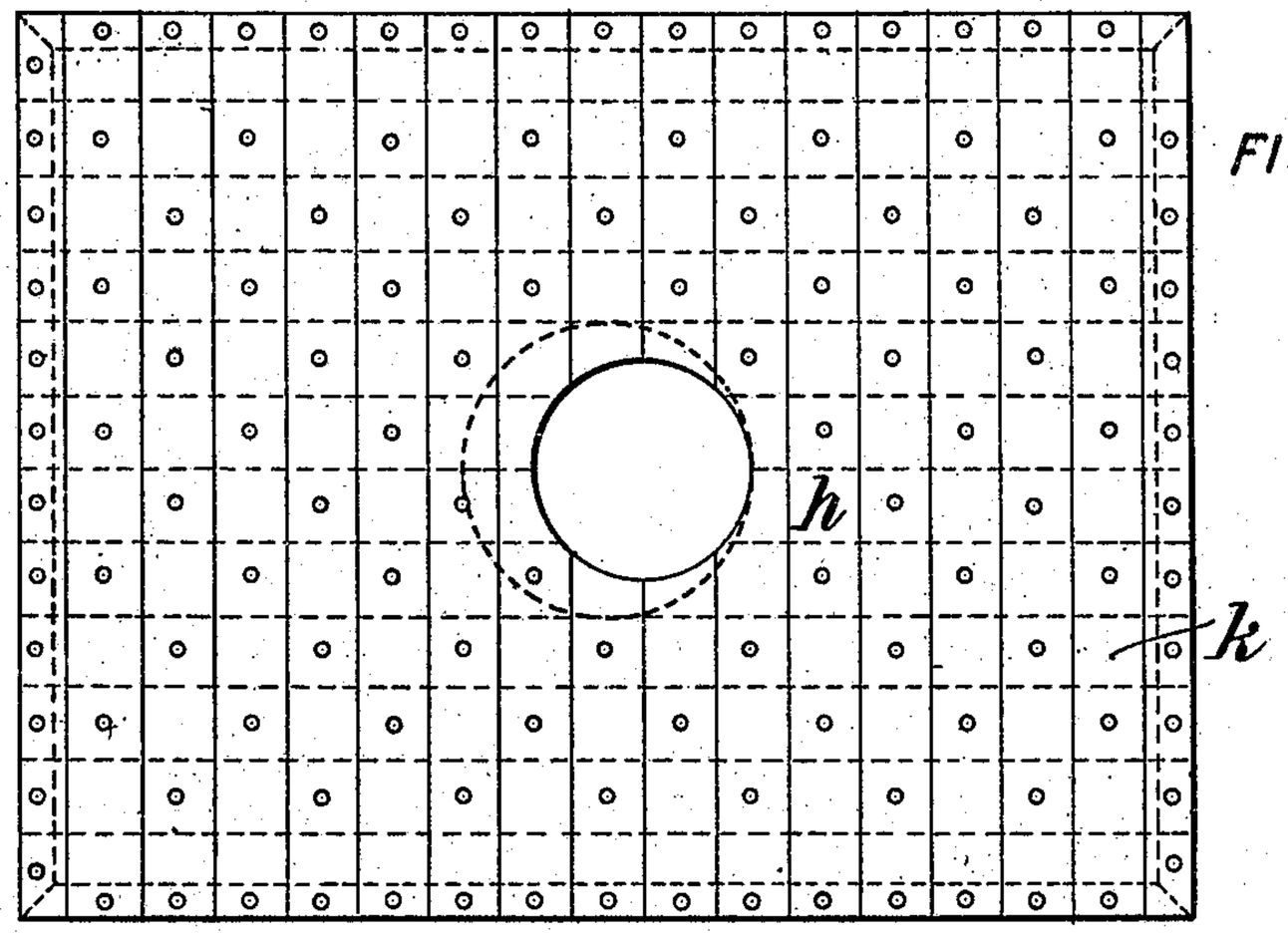

FIG. 16.

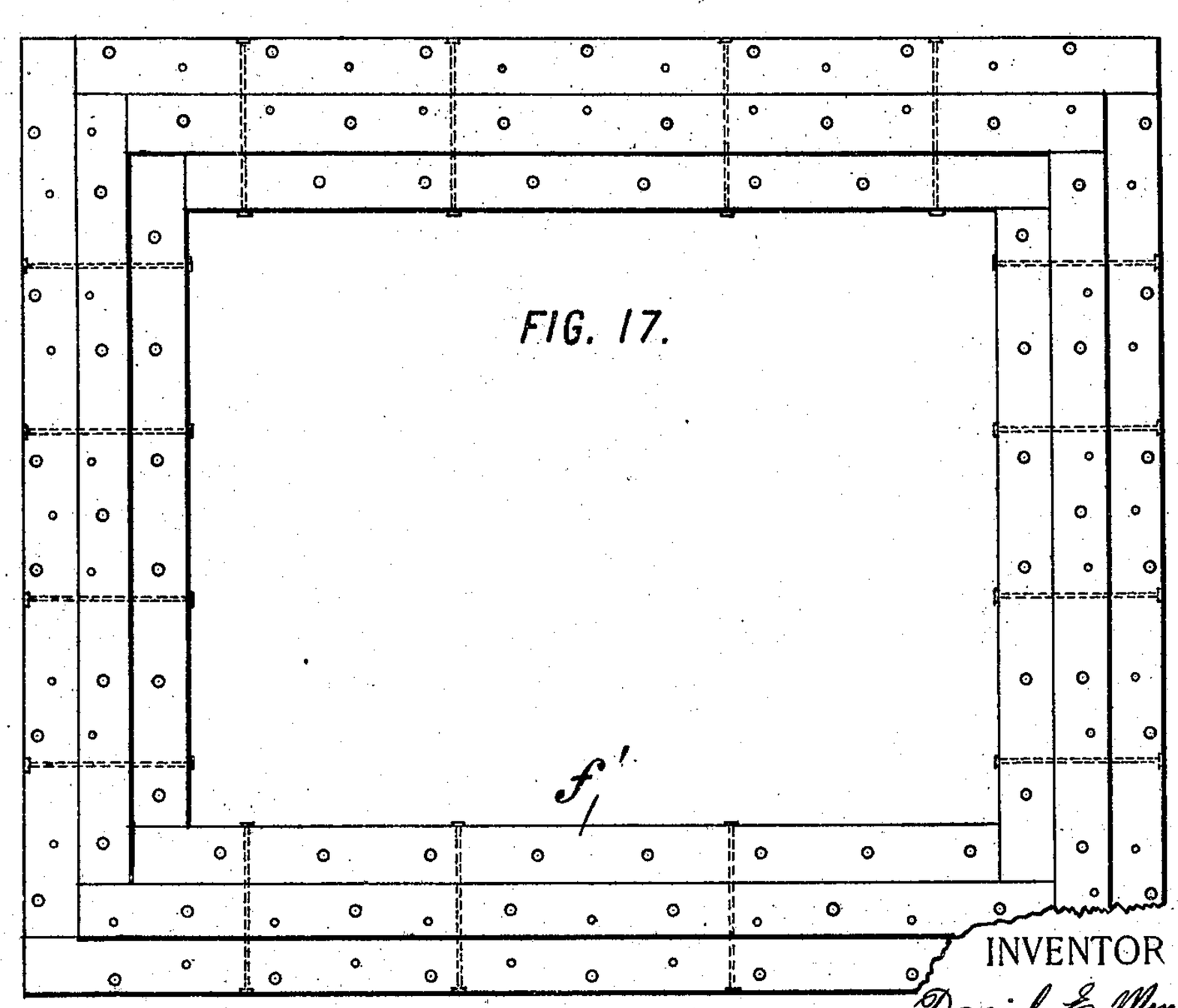

FIG. 17.

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11 SHEETS—SHEET 11.

FIG. 18

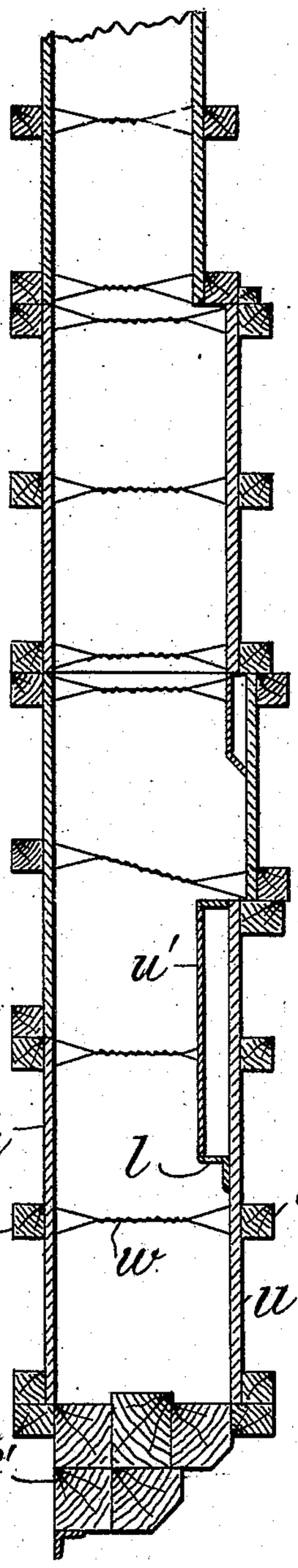
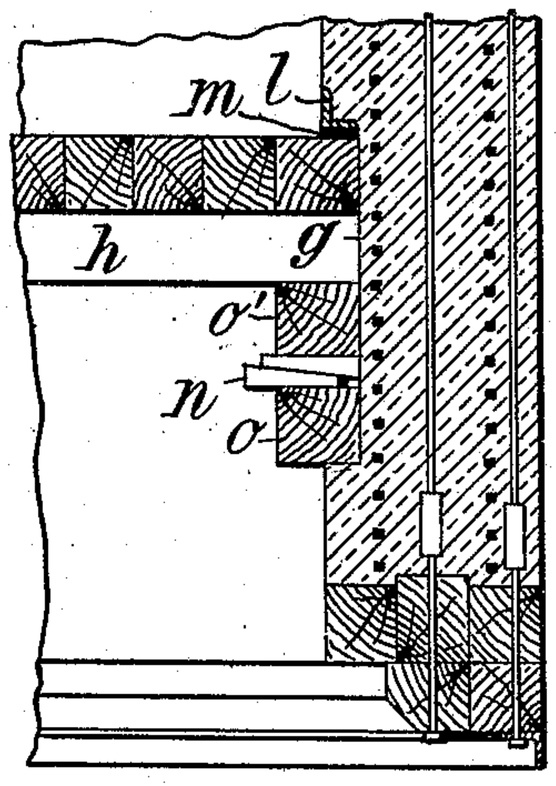


FIG. 20.



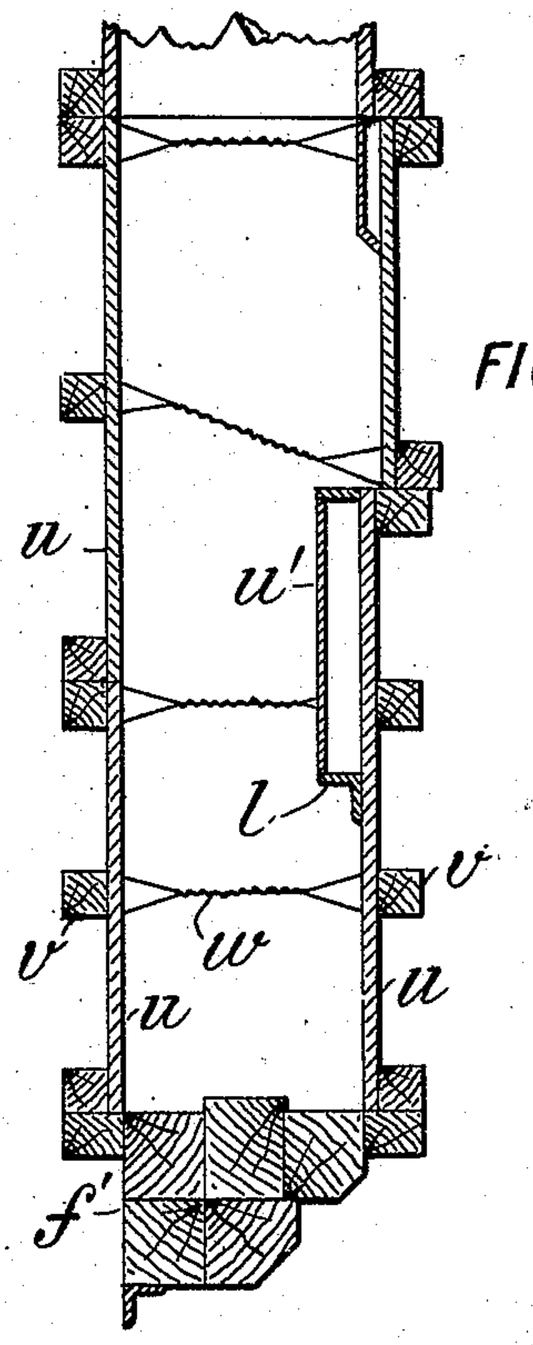


FIG. 19.

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UNITED STATES PATENT OFFICE.

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SINKING SHAFTS AND THE LIKE.

No. 923,984. Specification of Letters Patent. Patented June 8, 1909.

Application filed October 15, 1907. Serial No. 397,539.

To all whom it may concern:

Be it known that I, DANIEL E. MORAN, a citizen of the United States, residing at Mendham, in the county of Morris and State of New Jersey, have invented certain new and useful Improvements in Sinking Shafts and the Like, of which the following is a specification.

The invention is especially designed for the sinking of mining shafts with a concrete or similar molded curb or lining. Various features of the invention are also adapted for use in connection with curbs of other materials and in various classes of work ordinarily performed by open excavation or under compressed air; open methods of excavation including such operations as dredging etc. which are carried out at atmospheric pressure either with or without the removal of water. The curb is constructed with provisions for subsequently inclosing a space at the bottom while initially permitting excavation by dredging or other open methods. After sinking it a suitable depth by open methods, the operation is continued under compressed air, the provision for inclosing the space at the bottom being utilized in this part of the operation. In the entire operation of sinking there is included a vertical movement of the curb down to its bed and the subsequent finishing of the bed and closing of the lower end of the curb. The open excavation may be continued throughout the downward movement of the curb, and compressed air be put on only for the final operations which do not involve any movement of the curb; or the open excavation may continue only during part of the downward movement of the curb, depending upon the material being excavated and upon other conditions, the excavation for the continued downward movement being effected under compressed air. Preferably an air-tight shaft adapted to permit excavation by open methods is connected to the lower part of the curb, and the open upper end of this shaft is maintained above water lever as the curb is sunk. Then when it is desired to put on compressed air the upper end of the shaft is closed by any suitable closure such, for example, as a horizontal diaphragm carrying an air lock. The shaft or similar structure may be separable at its lower end from the curb, so as to be usable over again, and is in itself a complete article of manufacture. The inside shaft is preferably smaller than the inside cross-section of the curb, so as to leave a space between the two into which may be introduced a load of water or the like to assist in the sinking of the curb. Preferably the inside diameter of the curb increases upwardly. This gives an advantage in excavating. Even where no inside shaft is used, the dredging buckets or other excavating means should move vertically, and in previous structures this vertical movement has sometimes been interfered with by the curb's working more or less out of plumb as it sinks. Where an inside shaft is to be used the difficulty is even more serious. By increasing the diameter of the curb at its upper end, the center line of the curb may be more or less out of plumb without the side walls interfering with the vertical path required for the excavating bucket or for the shaft.

Other features of improvement are referred to in detail hereinafter.

The accompanying drawings illustrate embodiments of the invention.

Figure 1 is a longitudinal section of a curb in process of sinking under pneumatic pressure. Fig. 2 is a plan of the upper end. Fig. 3 is a cross-section on the line 3—3 of Fig. 1. Fig. 4 is a cross-section on the line 4—4 of Fig. 1. Fig. 5 is a cross-section through the reduced upper part of the inner shaft. Fig. 6 is a central vertical section of Fig. 5. Fig. 7 is a vertical section in the process of sinking by open methods before striking the water level. Fig. 7[a] is a similar section under open methods after passing below water level. Fig. 8 is a vertical section showing one quadrant of the steel frame constituting the shoe of the lowermost section of the curb. Fig. 9 is a plan of Fig. 8. Figs. 10 and 11 are respectively a vertical and horizontal section of an inside mold. Figs. 12 and 13 are respectively a longitudinal section and a horizontal section on the line 13—13 of Fig. 12 illustrating another embodiment of the invention. Figs. 14 and 15 are longitudinal sections at right angles to each other illustrating the curb of Fig. 12 with a timber deck applied thereto. Fig. 16 is a plan of the deck. Fig. 17 is a plan of the timber edge of the lowermost section. Figs. 18 and 19 are vertical sections of molds of the lowermost sections. Fig. 20 is a vertical section of a modification of the arrangement shown in Figs. 14 and 15.

Referring now to the embodiments of the

invention illustrated, and especially to Figs. 1 to 11 inclusive, the side of the shaft is first surrounded by sheeting A down to any desired depth. The space within the sheeting is excavated and the sheeting braced in any suitable way. A steel form B constituting the outer mold is then erected consisting of successive rings of sheet steel superposed one upon another and fastened by outside angles, each ring being formed of a number of plates connected by vertical angles on the outside. The inside molds C (Fig. 10) are of varying diameters and are constructed of sheeting D assembled in sections stiffened and edged with horizontal angles E by which the sections are connected to each other. The ends of the angles are connected by means of splice-plates F. At one or more points in the circumference of each ring the angles are cut away as at G so that when the splice-plates are removed, one of the edges of the two adjacent sections may be drawn inward to free the mold from the concrete. At suitable intervals the inside mold is made of increased diameter, the angle at the lower edge of the new section being fastened directly on top of the smaller section below. The first or lowermost section is molded within a shoe which I designate as a whole by the letter H, the outer removable mold B being attached thereto by suitable horizontal angles as indicated in dotted lines in Fig. 1. The outer and inner forms or molds being erected to suitable height, a number of vertical reinforcing rods J are set up near the outer mold and tied together by annular rods K, and the concrete forming the curb L is cast between the molds. When the section of concrete has hardened between the molds, the molds are withdrawn sufficiently, the earth excavated below the molded unincased concrete curb, and the latter sunk to a suitable depth, whereupon the molds are reassembled and a new section of curb is molded. The reinforcing rods J are preferably arranged with their ends bent inward and overlapping as shown so as to form a substantially continuous metal structure.

The shoe at the lower end may be any suitable strong preferably metallic structure, such, for example, as the annular trough indicated in detail in Figs. 8 and 9. The outer vertical ring M in sections is spliced by vertical plates and stiffened and braced by an outside ring N. An inner conical ring O is provided at its lower edge with a reinforcing ring P, connected to the lower edge of the vertical ring M and its reinforcing ring N. A number of suitable axial plates Q extend between the rings M and O, being connected to said rings and stiffened by suitably disposed angles. The inner ring O of the shoe is extended inward beyond the inner face of the curb by means of a second conical ring R stiffened by axial web plates S and carrying at its inner edge a short vertical ring T of the diameter of the air shaft and adapted to permit the erection of said shaft thereon. The joints of the rings R and T are calked so as to be substantially air tight under pressure. The outer ring M of the shoe preferably extends up to approximately the level of the upper edge of the conical ring R so as to brace the latter. The space within the conical rings O and R constitutes the working chamber and is designed of sufficient height for this purpose. Projecting upward from the ring T are a number of sections of shafting U most conveniently connected to each other by outside angles bolted together. Sections are added from time to time to keep the top at a desired level, preferably above water level. The shaft U is large enough to permit dredging or other open excavation, and is preferably small enough to leave a space U′ for water or other load between the shaft and the curb. When work under compressed air is to begin the upper end of the shaft is closed. To the upper end of the last section U of the shaft there is applied a diaphragm V with a vertical ring W adapted for attachment to the highest section U and arranged for the passage through it of a smaller shaft which is made in two sections X and Y respectively, the section Y being connected in turn to the air lock Z. Section X of the smaller shaft is provided at its lower end with a door *a* opening downward. Each of the sections X and Y is divided into a space for the bucket and a separate space for the passage of the workmen by the use of a pair of ladders *b* projecting into the shaft and braced at their inner edges by means of braces *c*. The vertical plates or bars *e* constituting the inner sides of the ladders define a bucket space *d*, as indicated in Fig. 5, to which a workman on the ladder has free access, while at the same time he is protected from being accidentally struck by the bucket or from having his escape from the caisson blocked by the bucket.

The first part of the sinking operation is indicated in Fig. 7, the curbing not having gone down to water level and being open to the atmosphere, and the space below it being in course of excavation by open dredging or any similar process. Fig. 7[a] shows the work advanced to a deeper stage, below water level, and the top of the shafting U above the water, so that it may be continued upward and the air lock finally applied without any necessity for the workmen to go below the water.

The construction described above utilizes steel for the cutting off of communication with the atmosphere, and also for the molds. Where rectangular shafts are to be sunk or under various other conditions of size and relative expense, timber may be substituted for steel to a large extent, as illustrated in

Figs. 12 to 19. In this case the lowermost section of the curb L is provided at its lower end with a reinforcement *f* (Fig. 12) or *f'* (Figs. 14 15 and 17) made of timber suitably braced to protect the cutting edge of concrete. The vertical reinforcing rods J are fastened at their lower ends to said reinforcement *f* or *f'*, and annular reinforcing rods K are embedded in the concrete near its inner face, and also near the outer face of the lowermost section. The section to which the deck is to be applied, and which will ordinarily be the lowermost section, is formed with a groove *g* extending entirely around its inner face for the reception of the deck. The deck, which I designate as a whole by the letter *h*, is composed of two sets of timbers crossing each other and bolted together, a lower set of longitudinal timbers *j*, and an upper set of transverse timbers *k*. The groove *g* has its lower shoulder formed of a steel angle *l*, upon which the deck rests when in place, suitable substantially air-tight packing such as a heavy jute gasket *m* being arranged between the angle *l* and the deck. The deck is pressed down to its joint upon the jute gasket by means of wedges *n* driven under timbers *o*, which are held down by the projecting upper shoulder *p* of the groove *g*. Along the longitudinal side of the curb the groove *g* is made of greater vertical width (Fig. 14) than along the transverse side (Fig. 15) for the purpose of permitting the insertion of an extra timber *o'* in the longitudinal grooves to bear upon the ends of the upper tier of timbers *k* of the deck. The central portions of the deck are braced against the upward pressure of the compressed air by means of oblique braces *q*, which have their upper ends embedded in suitable recesses in the inner face of the curb.

Where the curb is of rectangular shape and of sufficient size to require it, the sides are pressed apart by means of struts *r* and are held from bulging outward by means of tension rods *s* with turn buckles, the ends of the tension rods being embedded in the concrete. Platforms *t* supported upon joists *t'* resting on shoulders of the concrete, may be provided at suitable heights for carrying temporary loads to assist the sinking analogous to the water or other temporary loading outside of the shaft U and within the curb for the structure shown in Fig. 1. The air shaft and lock will be mounted upon the deck in the usual or any suitable way, their position being indicated upon Fig. 16.

The timber deck is to be used in substantially the same way as the conical steel ring or deck R. That is to say, the inner shafting U is to be applied thereto and its upper end maintained above water level as the excavation proceeds, so as to facilitate the application of a lock when air pressure is to be used. The steel ring R, however, is preferably sunk with the lowest section of the curb from the beginning, while the timber deck will not ordinarily be put in place until the curb shall have been sunk to water level or to a point where the excavation can no longer be kept dry by pumping.

A system of timber forms is illustrated in Figs. 18 and 19, the former being a section of the forms for the longer side of the curb, and the latter a section for the shorter side. The vertical sheathing or mold boards *u* are connected to the reinforce *f'* and braced by transverse braces *v* at suitable intervals, the braces at opposite sides of a wall being connected by twisted wires *w*, and suitable spacers being introduced where necessary. The angle *l* constituting the lower shoulder of the groove *g* of the concrete curb, is supported from the inner sheathing, and a supplementary line of sheathing *u'* is built up thereon to form a groove in the concrete. With this style of construction the curb will be sunk in the form shown in Fig. 12 until water is reached, after which the deck will be put in with the first section of shafting. The excavation may then proceed by dredging or the like through said shafting, and as the curb is lowered the shafting will be raised by successive small and easily manipulated units so as to maintain its upper end above water level. Then when it is desired to put on compressed air it will be a simple matter to close the upper end of the shaft, as by means of the diaphragm previously described and an air-lock applied to such diaphragm or otherwise arranged to give access to the working chamber below.

Various modifications in details of construction may be effected. For example, the shoe H is not essential, and there are cases in which it may be absent. The ring R which connects the bottom of the shaft U with the bottom of the curb may be flat instead of conical. The molds for the concrete curb may be of wood or of metal independently of the shape, and the various parts of the structure for permitting the air-tight inclosure of the bottom of the curb may be made of steel or of timber or of other materials, in accordance with the conditions and expense, and independently of the shape. The connection of the deck *h* with the concrete walls may be made by wedging it against the upper shoulder of the groove *g* instead of against the lower shoulder, as shown in Figs. 14 and 15. For example, as shown in Fig. 20, the reinforcing angle *l* may be provided in the upper shoulder, and the blocks *o* and *o'* with the wedges *n* between them may be introduced between the deck *h* and the lower shoulder of the groove. By this arrangement the joint at *m* is secured both by the wedges and by the upward pressure of the air when working under pressure.

The air lock may rest directly upon the

diaphragm V, the section of shafting Y being omitted, and the section of shafting X may also be omitted. These two sections of shafting with the door *a* at the bottom, are useful in case it is desired to pass long objects such as timbers up or down through the shaft, the door *a* serving to prevent too great loss of air in passing the timbers through the lock.

The provision for applying a temporary load within the curb to assist in sinking it is of great importance, especially where the shaft is to be sunk to a great depth or where for any other cause the curbing encounters great frictional or other resistance to further sinking. The area of the curb at its upper end and the height to which weights may be applied on the upper end are both quite limited, and the necessity of removing such weights to build up the successive sections of the curbing is so burdensome that the applying of the desired loads within the curb greatly facilitates the operation at the same time that it permits the use of a comparatively heavy load.

I claim as my invention:—

1. In the sinking of shafts, the method which consists in forming an open curb of molded and unincased concrete, and partially sinking the same, and then inclosing the lower part of the curb, and continuing the operation under compressed air.

2. In the sinking of shafts, the method which consists in molding an open curb of molded and unincased concrete, closing air-tight the lower part of said curb by a non-plastic structure, and continuing the operation under compressed air.

3. In the sinking of shafts, the method which consists in excavating to a suitable depth, molding a curb in the excavation, sinking the curb below the bottom of said excavation, and adding successive sections at the top.

4. In the sinking of shafts, the method which consists in molding an open curb of plastic material in sections of successively larger inside diameter upon one another, removing the inside mold, excavating below the lowest section, and sinking the curb as successive sections are added at the top.

5. In the sinking of shafts, the method which consists in excavating to a suitable depth, erecting molds within the excavation and molding a curb therein, and sinking the curb below the bottom of said excavation and adding successive sections to the top at the level of said excavation.

6. In the sinking of shafts, the method which consists in sinking a curb by open dredging, and maintaining during such sinking of the curb a means extending above water level for completing an air-tight space extending to the bottom of the curb.

7. In the sinking of shafts, the method which consists in sinking a curb by open dredging, maintaining during such sinking of the curb a means extending above water level for completing an air-tight space extending to the bottom of the curb, and continuing the operation under compressed air.

8. In the sinking of shafts, the method which consists in sinking a curb by open dredging, maintaining during such sinking of the curb an interior air-tight shaft through which excavation by open methods may be conveniently carried on, and which shaft extends above water level, closing the upper end of said shaft so as to form an air-tight space extending to the bottom of the curb, and continuing the operation under compressed air.

9. In the sinking of shafts, the method which consists in sinking a curb by open dredging, building up within such curb during such sinking an air-tight shaft in successive small units through which excavation by open methods may be conveniently carried on, closing the upper end of said shaft to form an air-tight space extending to the bottom of the curb, and continuing the operation under compressed air.

10. In the sinking of shafts, the method which consists in providing a curb, excavating below said curb by open methods, and assisting its downward movement during such open excavation by temporary loads within the curb.

11. In the sinking of shafts, the method which consists in providing a curb, excavating beneath the same, and adding successive sections at the top, and assisting its downward movement by temporary loads within the curb.

12. A curb designed to permit excavation below it by open methods and having within it means for supporting a temporary load to assist in sinking it.

13. A curb of molded concrete having within it means for supporting a temporary load to assist in sinking it.

14. A curb of molded and unincased concrete formed with a provision for attaching it by a substantially air-tight joint to a structure for cutting off communication between the lower part of the curb and the atmosphere so as to permit the sinking of said curb by open methods or under compressed air.

15. The combination of a curb of molded and unincased concrete with an air lock and shaft smaller than the inside of said curb and connected with the space below said curb for excavating under compressed air.

16. A curb of concrete molded in a continuous mass from the bottom upward, and having its inside diameter increasing upwardly.

17. A curb having its inside diameter increasing upwardly and its outside diameter constant.

18. A curb having its inside diameter increasing upwardly, in combination with a

shaft within said curb and through which excavation may proceed for the sinking of the curb.

19. The combination with a curb of molded and unincased concrete, of a structure of non-plastic material closing the lower part of the space within said curb, to permit sinking under compressed air.

20. A structure for use in sinking a curb, said structure being adapted for attachment to the curb, and having a large passage through which excavation may proceed by open methods, and adapted to receive an air-tight closure at the end opposite its attachment to the curb so as to permit excavation under compressed air.

21. In combination, a curb, an air lock, and a structure connecting them and having a passageway larger than that through the air-lock so as to permit excavation by open methods when the air-lock is removed.

22. A structure for use in sinking a curb, said structure being adapted for attachment to the curb, having a large passage through which excavation may proceed by open methods, and adapted to receive an air-tight closure at the end opposite its attachment to the curb so as to permit excavation under compressed air, said structure being also readily detachable from the curb to permit its removal after sinking.

23. A structure for use in sinking a curb, said structure being adapted for attachment to the curb, having a large passage through which excavation may proceed by open methods, and adapted to receive an air-tight closure at the end opposite its attachment to the curb so as to permit excavation under compressed air, said structure being extensible to maintain its upper end above water level.

24. A structure for use in sinking a curb, and consisting of a shaft in combination with a diaphragm adapted for attachment to its upper end, said structure being adapted for attachment to the lower part of the curb and being air-tight so that upward pressure on the diaphragm when attached is transmitted to the lower part of the curb.

25. In combination with a curb, a shaft attached to said curb, a diaphragm across said shaft and having a passageway therethrough smaller than the passageway through the shaft, and an air-lock communicating with said passageway.

26. In combination with a curb, a shaft smaller than the inside size of the curb but large enough to admit of excavation by open methods and extending from the lower part of the curb to a point above water level, the space between the curb and the shaft being adapted to receive a load to facilitate sinking.

27. The combination with a curb of molded and unincased concrete, of a structure removably attached thereto and closing the lower part of the space within said curb, to permit sinking under compressed air.

28. The combination with a curb of molded plastic material, of a shoe at the lower end thereof, a metal plate attached to said shoe by an air-tight joint and projecting beyond the inner wall of the curb, and a shaft connected to said metal plate.

29. The combination with a curb of molded plastic material, of a metal shoe at the lower end thereof, including an inner conical ring O, a conical ring R projecting inward beyond the inner face of the curb and connected by an air-tight joint with said ring O, and an air shaft connected by an air-tight joint with said ring R.

30. The combination with a curb of molded and unincased concrete having a shoulder on its inner periphery, of a deck the edges of which are adapted to bear on said shoulder so as to cut off the space below from connection with the atmosphere, and to permit excavation under compressed air.

31. The combination with a curb of molded plastic material having a shoulder extending around its inner face, and having a non-plastic member *l* reinforcing said shoulder, of a deck *h* fitting said shoulder and adapted to be pressed against said shoulder to form a substantially air-tight joint.

32. A shaft for caissons having a ladder *b* projecting into the shaft so that its inner edge forms a guide for the bucket.

33. A shaft for caissons having a pair of ladders *b* projecting into the shaft so that their inner edges form guides for the bucket, and inclosing between them a space which is protected from the bucket.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

DANIEL E. MORAN.

Witnesses:
DOMINGO A. USINA,
THEODORE T. SNELL.