(No Model.) 3 Sheets—Sheet 1.

G. H. BREYMANN.

DREDGING AND EXCAVATING APPARATUS.

No. 558,769 Patented Apr. 21, 1896.

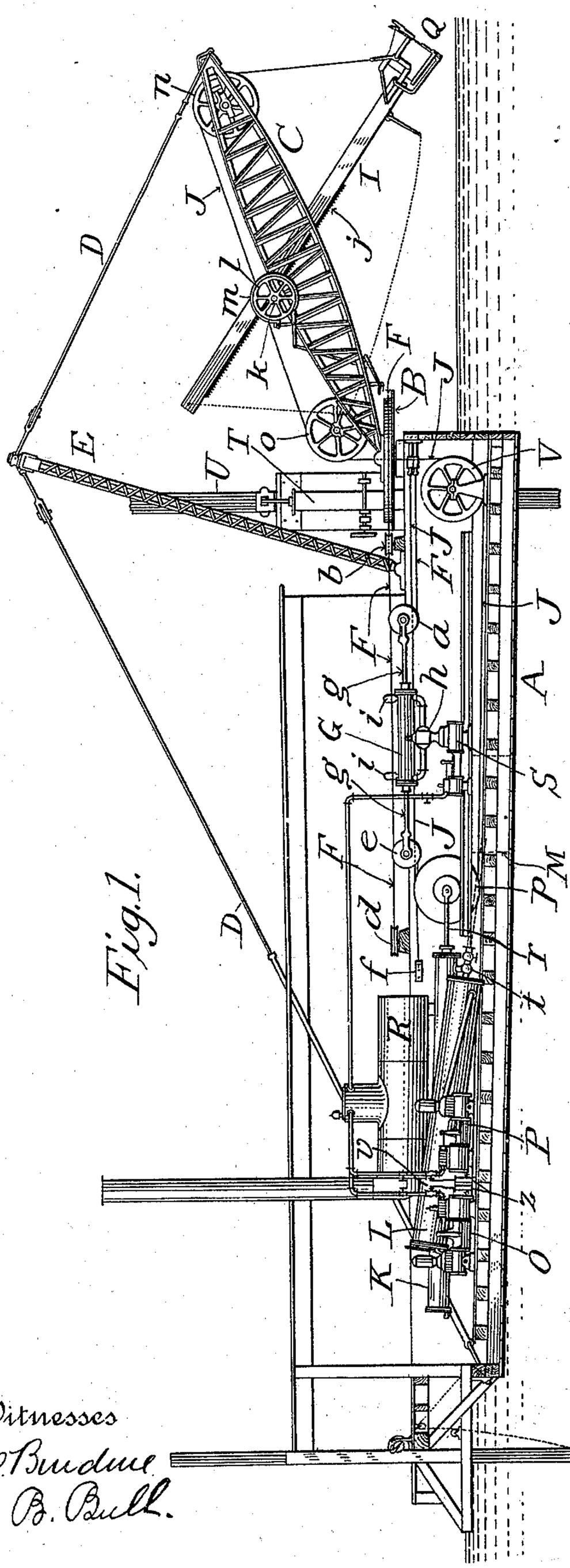

Fig. 1.

Witnesses
C. C. Burdine
C. B. Bull.

George H. Breymann,
Inventor
by Dodger & Lone
Attorneys.

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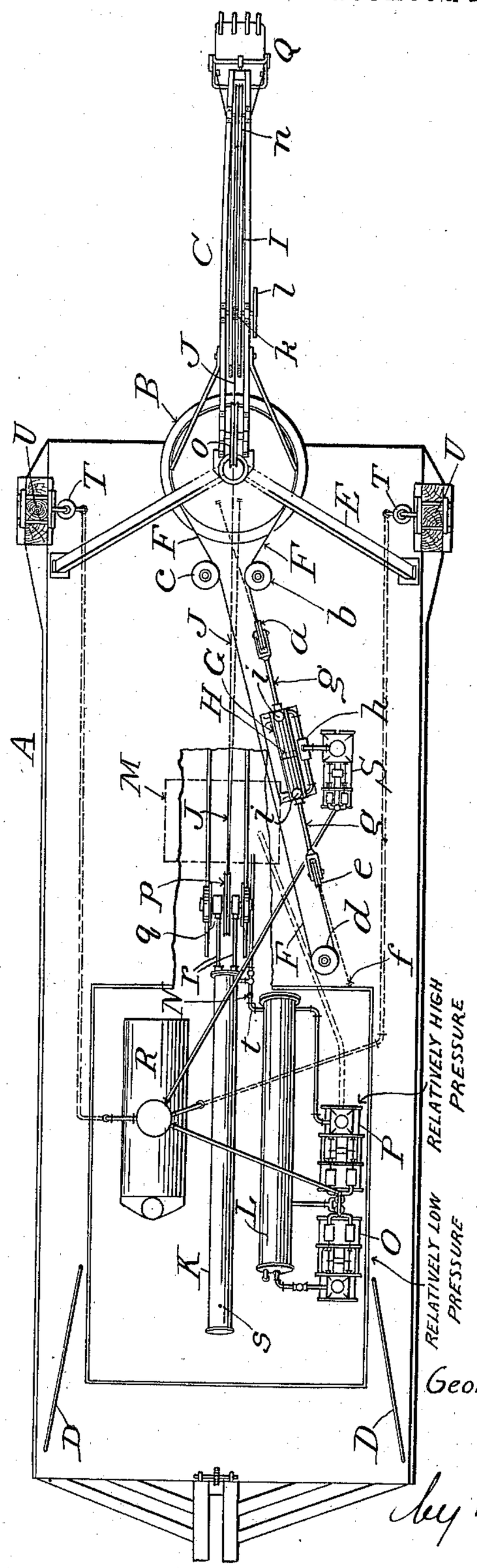

Fig. 2.

Witnesses
C. C. Burdine
C. B. Bull.

George H. Breymann,
Inventor
by Dodger Lowe,
Attorneys.

(No Model.) 3 Sheets—Sheet 3.

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Fig. 3.

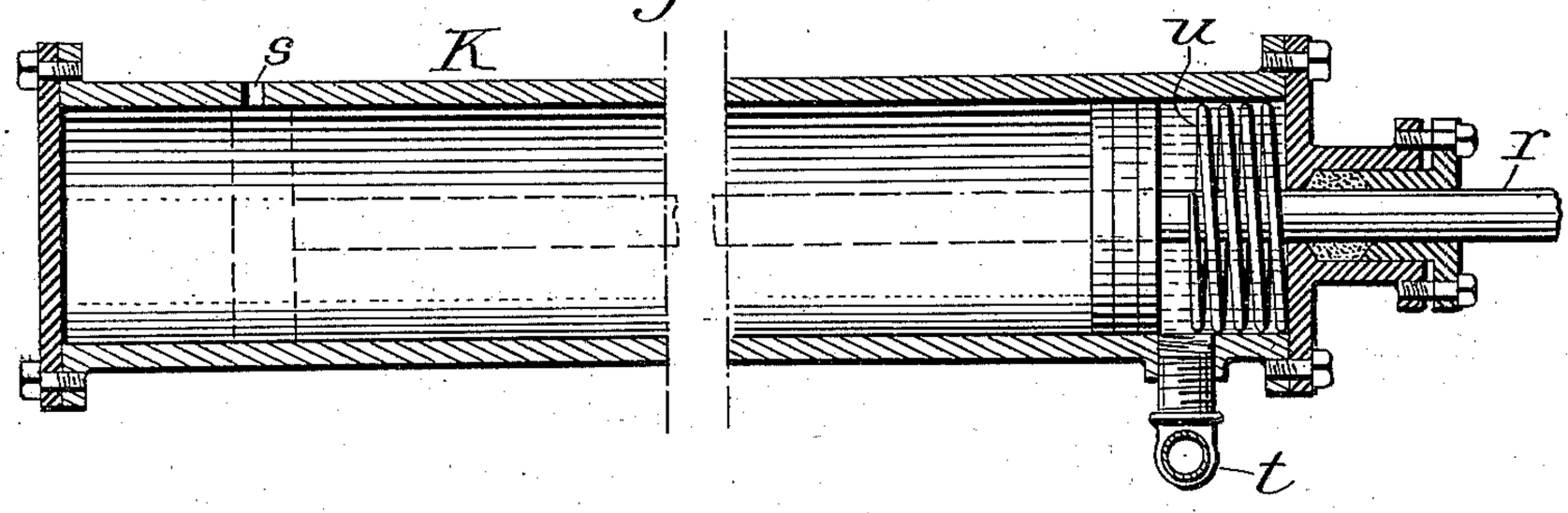


Fig. 4.

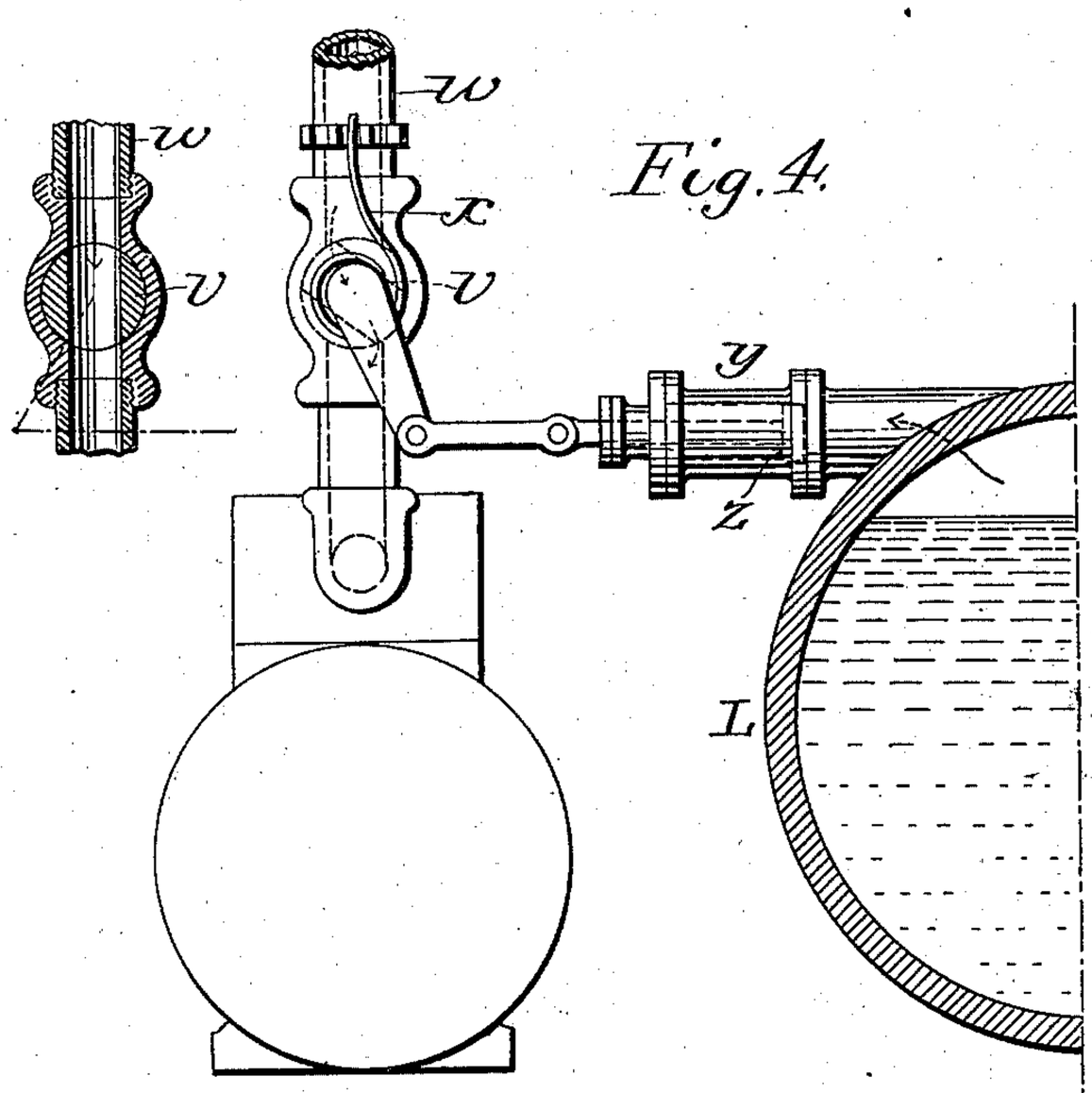
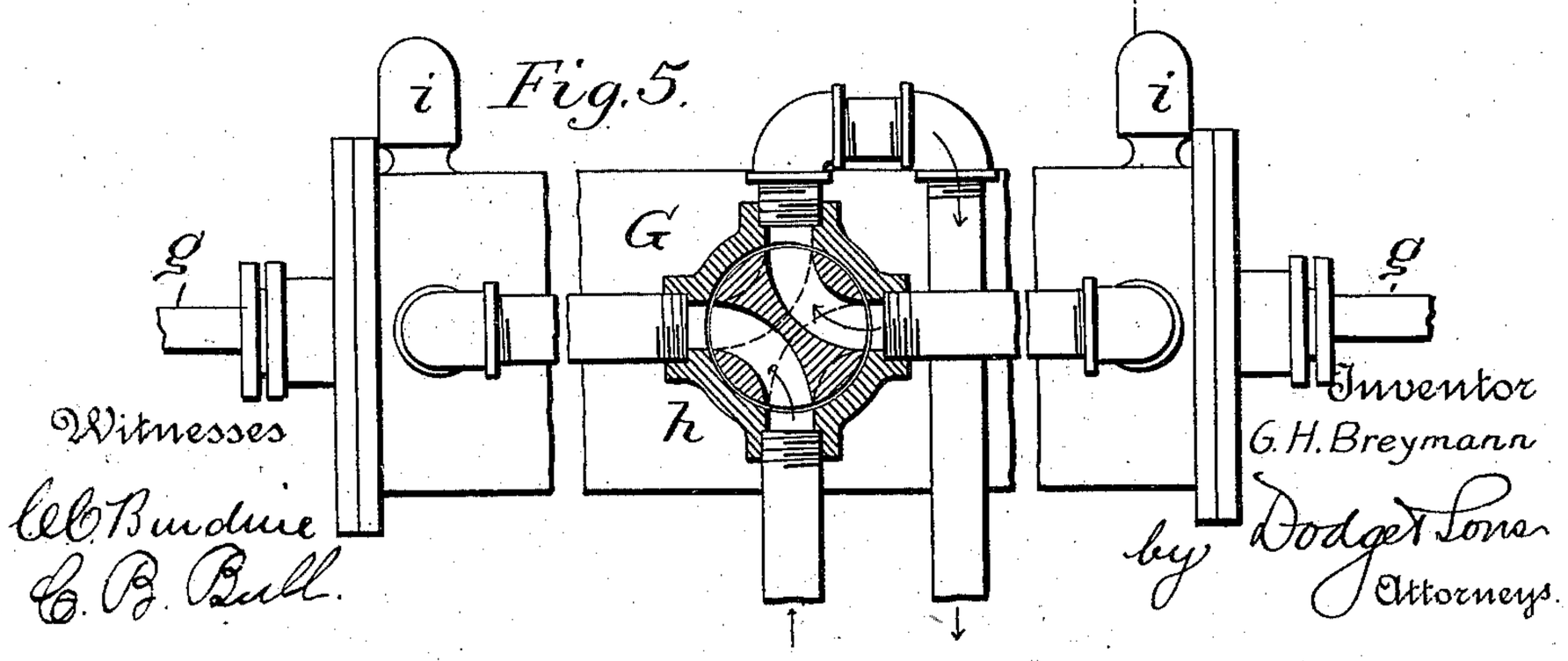


Fig. 5.



Witnesses
C. C. Burdine
C. B. Bull.

Inventor
G. H. Breymann
by Dodger & Sons
Attorneys.

UNITED STATES PATENT OFFICE.

GEORGE H. BREYMANN, OF TOLEDO, OHIO.

DREDGING AND EXCAVATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 558,769, dated April 21, 1896.

Application filed March 22, 1895. Serial No. 542,811. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. BREYMANN, a citizen of the United States, residing at Toledo, in the county of Lucas and State of Ohio, have invented certain new and useful Improvements in Dredging and Excavating Apparatus, of which the following is a specification.

My invention relates to machinery for dredging, excavating, and performing like work; and it consists in various novel features, combinations, and details hereinafter set forth.

In the drawings, Figure 1 is a longitudinal section of a dredge embodying my invention; Fig. 2, a top plan view of the same; Fig. 3, a view illustrating a spring-cushion for the piston of the hydraulic cylinder, and Figs. 4 and 5 views illustrating other details hereinafter referred to.

As heretofore commonly constructed and used, dredges, excavators, and like machinery have employed winding drums and chains for controlling the boom and actuating the dipper, scoop, or shovel. Long experience has demonstrated that such construction involves rapid wear, frequent breakage, and consequently heavy loss through stoppage and cost of repairs. To overcome these serious objections, it was long ago proposed to substitute wire ropes or cables for chains and to employ hydraulic pressure for actuating and controlling the boom and the scoop, dipper, shovel, or other implement. This idea has from time to time been brought forward, but so far as I am aware has never been made practically available, owing to failure to provide for certain conditions inherent in the work to be performed. Water being incompressible, it is apparent that if the boom or the beam of the scoop, dipper, or shovel be put into rapid motion and then suddenly stopped parts will be subjected to enormous strains. This is peculiarly true of modern dredges and excavators, which employ dippers or scoops capable of handling from five to ten tons at a load. Such heavy mass, carried on the end of a beam often forty to sixty feet in length, which beam is in turn carried by a boom, in some cases eighty feet long, the whole weighing from fifty to sixty tons and making two dips a minute, lifting, swinging laterally, depositing, and returning, subjects the parts to strains hitherto unknown in such work. When the dipper, scoop, or shovel is being forced into and through the material—mud, earth, or other matter—great power is required; but after the digging operation proper is completed materially less power will suffice to lift the load and swing it over the scow or dump. It is therefore desirable that the apparatus be so contrived that power shall be stored up and made readily available for the digging or dredging work proper, and that for the remaining operations only so much power shall be used as is necessary efficiently to perform the labor required. With these conditions and requirements in view I make use of hydraulic cylinders in combination with accumulators, into which latter air is pumped to any desired pressure, and when the heavy work of digging or cutting is to be performed I open free communication between the hydraulic cylinder and the accumulator and thus supply the full power required. The capacity of the cylinder and accumulator is so proportioned that the dipper, scoop, or shovel shall be moved the necessary distance before the power falls unduly; but owing to the expansion of the air due to communication between the accumulator and the cylinder the power of course decreases from the commencement to the end of the digging or scooping operation, and hence by the time it is ended the power is reduced to such as is necessary for elevating, holding, and delivering the load. The accumulator is supplied by pumps, which are furnished with steam by automatically-controlled valves, so that they go into and out of action in accordance with variations in pressure, and hence the pressure is automatically regulated and adapted to the stage and condition of the work.

It is obvious that the enormous weights handled, when moved at the speed indicated and with the great leverage afforded by the long beam and boom, must subject the machinery to very great strains, and it therefore becomes necessary to introduce the element of elasticity at some point between the power and the work. This I do by providing the hydraulic cylinders with air-cushions,

thus obviating the difficulties due to the employment of an incompressible fluid. This provision I believe to be essential to the use of hydraulic pressure in this class of work.

As an incident to the adoption of this system of operation, I may mention the fact that it enables me to use with advantage compound engines, and thereby to secure the advantages due to repeated expansion and to vacuum. In attempting to make use of compound engines under ordinary conditions in this class of machinery it has been found that no saving was effected, because, while the condenser was necessarily operating constantly, the direct-pressure cylinders alone were constantly in use, and the others came into play only occasionally and for short periods, so that any gain in power at that point was balanced by loss in operating the condenser. Under my plan the same condenser is made to serve for all the engines about the dredge or excavator, and the several cylinders of the compound engines are kept in play all or nearly all the time in charging the accumulator. Hence the advantages of expansion as well as direct pressure may be had.

Referring again to the drawings, A indicates the hull of a barge or boat of suitable character and dimensions, which may also represent or stand for the body of a car or other structure upon which excavating machinery may be carried. At one end of the structure A there is mounted a turn-table B, upon which is carried the lower end of a boom C, the upper and outer end of which is sustained by heavy cables D, which proceed from a truss or derrick E, overhanging the turn-table B and suitably braced and sustained by guys, as usual.

For the purpose of swinging the boom laterally I make use of a cable F, one end of which is made fast to the structure A, and which passes thence about a movable sheave *a*, thence to and about a fixed sheave or guide-pulley *b*, thence about the circumference of the turn-table B, thence to a fixed guide-pulley *c*, thence to and about a fixed guide-pulley *d*, and finally about a second movable sheave *e* to a fixed anchor or fastening *f*, as shown in Figs. 1 and 2.

In the drawings I have represented the two movable sheaves *a* and *e* as carried at opposite ends of a piston-rod *g*, projecting from a piston H through the two ends of a hydraulic cylinder G, and I prefer this arrangement because it insures movement of the two in perfect unison; but separate cylinders and pistons may be employed, each piston having its rod provided with one or the other of the two movable sheaves.

The cylinder G is provided with a valve *h*, which serves to reverse the direction of flow of liquid, taking it from one side of the piston and delivering it to the other side in whichever direction may at the time be required. When brought to an intermediate adjustment, the valve causes the liquid to be held against movement, and consequently to hold the piston, the cable F, and the turn-table, with the parts carried thereby.

As stated, the incompressibility of the liquid employed in cylinder G and the consequent sudden and complete stoppage of movement of the piston H and the heavy parts moved and controlled thereby render it necessary to cushion the piston or the water which moves it. I accordingly provide the cylinder G with air-chambers *i*, one at either end, as shown in Figs. 1 and 2. With this provision the water entering the cylinder under high pressure and unable instantly to start the piston because of the inertia of the parts connected therewith compresses the air in the chamber of the then receiving end of the cylinder and is cushioned thereon, the piston coming gradually into movement as the air becomes more and more compressed. Similarly, when the valve is closed to bring the turn-table and swinging boom to rest, the piston being connected with the moving mass carries the water before it into the air-chamber at that end of the cylinder G, thus causing the stoppage to take place somewhat gradually instead of instantly, and thus excessive strain of parts is avoided.

I indicates a beam carrying a dipper, scoop, or shovel of usual construction, which beam passes through and is maintained in working position by guides in the boom C. It is furnished with the usual rack-bar *j*, which meshes with a pinion *k*, the shaft of which carries a brake-wheel *l*, to which is applied the ordinary friction brake-band *m*. These details may be of usual arrangement and constitute no part of my invention.

J indicates the main hoisting-cable by which the dipper, scoop, or shovel is forced into and through the mud, earth, or other matter and by which it is lifted, the movements or direction of travel being controlled by the rack-bar and brake and other customary appliances in the well-known way.

The cable J may be carried about any suitable number of pulleys according to the power required, but will in any event pass upward over a sheave *n* at the outer end of boom C, thence to a sheave *o* at the inner end of the boom, thence downward concentrically with the axis of the turn-table to and about a sheave V, thence to and about a traveling sheave *p*, and finally to an anchor-bolt at the end of the barge or structure A.

It will of course be understood that the number and arrangement of sheaves may be varied according to the capacity of the engines, the power required, the space available, and like considerations, but the above-described arrangement includes the more essential sheaves.

The traveling sheave *p* is mounted in a wheeled yoke or frame *q*, which is attached to and moved by the piston-rods *r* of a piston movable within a hydraulic cylinder K. The wheeled frame serves to guide the end

of the piston-rod and prevent it from sagging, the two rods tending to prevent cramping of the truck-wheels. When the piston is moved in a direction to withdraw the rod and draw pulley *p* toward the cylinder, the cable J is taken up and the dipper is drawn forward or elevated, as required.

Cylinder K communicates at one end with an accumulator L, which is designed to receive water sufficient to fill the cylinder K, and also to contain a sufficient body of compressed air to give any desired pressure to the water. The cylinder K discharges its water into a tank M, the beam and dipper or shovel descending by gravity and drawing the piston forward in the cylinder.

To permit the piston to move freely back and forth in cylinder K, an air-vent *s* is made in said cylinder a short distance from its rear end, as shown in Figs. 2 and 3, or at such point that the piston must pass it in making a full stroke. The purpose of this arrangement is to confine a body of air in the rear end of the cylinder to act as a cushion for the piston as its travel is nearing completion, so that its arrest shall be easy and gradual and that the parts may not be subjected to undue strain or concussion.

The accumulator L communicates with cylinder K by a pipe *t* of ample capacity, provided with a valve N, by which such communication may be opened or closed at will.

O and P indicate pumps of any approved type, which take water from tank M and deliver it into accumulator L. As the accumulator remains always charged with air at or above atmospheric pressure, it is evident that the introduction of water will cause the air to be compressed more and more as the quantity of water increases, and thus, with proper proportioning of parts, any desired pressure may be attained. Suitable water and pressure gages will be provided.

Assuming now that the dipper or scoop is lowered and drawn back to the point at which the digging or cutting operation is to begin, the piston of cylinder K being then at or near the forward end of the cylinder and due pressure having been stored in accumulator L, if valve N be opened the water contained in the accumulator will pass into cylinder K under full pressure and move said piston backward. This in turn will cause cable K to be shortened or taken up by sheave *p*, thereby forcing forward the dipper, scoop, or shovel Q with the maximum power of the apparatus. As the cutting or digging progresses the compression of the air in the accumulator decreases, owing to discharge of water from said accumulator, and the power is lessened, though the pumps by their continued operation prevent an undue lowering of pressure. By the time the cutting or digging is completed the pressure will have fallen considerably, but will still be entirely sufficient to effect the elevation of the dipper, scoop, or shovel and the holding thereof in its elevated position while the boom is swung off to one side to deposit the contents of the dipper.

It is desirable that the piston of cylinder K be cushioned at the end of its outward movement as well as its inward or rearward travel, and an air-cushion may be provided for the purpose. As this would, however, involve the use of a valve or valves and tend to complication, I propose to employ instead a heavy spring *u*, as shown in Fig. 3.

R indicates a steam-generator, which supplies steam to the pumps O and P of the accumulator and also to pump S, which moves the water or other liquid of cylinder G to opposite sides of its piston. It may, and ordinarily will, supply steam also to cylinders T for raising and lowering spuds U, by which the barge is anchored or made fast. If any of these pumps be driven by compound engines, as I contemplate in practice, such compound engines will be arranged to exhaust into a common condenser, which may thus be economically employed, even though the engines be not all in operation at one time.

A single pump or any desired number of pumps may be employed to charge accumulator L, and one may be an air-pump, if desired, or a certain percentage of air may be introduced with the water by one and the same pump. In practice it is desirable to employ two pumps, or more, one designed for volume and the other for pressure. The capacity of each pump for both volume and for pressure is determined by the relative areas of inlet and outlet openings and of steam and water cylinders and pistons. The greater the excess of area of the water-piston over that of the steam-piston the greater will be the volume delivered; but the lower will be the pressure at which it is delivered, and vice versa. Thus, assuming that it be desired to attain a pressure of five hundred pounds to the inch, pump O may be made to pump a large volume of water up to or against a pressure of three hundred pounds and pump P to pump up to or against a pressure of five hundred pounds. In such case both pumps will act until a pressure of three hundred pounds is reached in the accumulator, which pressure reacting upon the pump O will bring the latter to rest. Pump P will, however, continue in operation until the pressure is raised to five hundred pounds, or until communication is opened between the accumulator and the cylinder K. The pressures mentioned are merely adopted for illustration.

It will be seen that if the pumps O and P were started with full steam supply, with little or no pressure in the accumulator, their engines would race and severely rack or strain themselves. Hence I propose to provide the steam-pipe of each with a throttle-valve *v*, subject to the pressure of a weight or spring tending to close it and to the pressure of the accumulator tending to open it. Such a valve is illustrated in Fig. 4, in which *w* indicates the steam-pipe; *v*, the valve; *x*, a spring tend-

ing to close the valve and capable of regulation as to pressure or power, and *y* a cylinder communicating with the interior of the accumulator and containing a piston *z*, which acts in opposition to the spring *x*. The valve is so set that it shall not entirely close, but shall permit steam to pass at all times in quantity sufficient to operate the pumps against a minimum resistance. As the pressure increases the piston *z* will be forced outward and the valve will be opened more and more as the work requires. In this way the control of the apparatus is rendered completely automatic.

The pump P, being constantly in operation, may obviously be of the compound type with advantage, since the condenser will in such case be giving a return for the power it absorbs, which would not be the case were the pump only used at intervals and the condenser kept in operation.

Fig. 5 shows a suitable form of valve for use between pump S and hydraulic cylinder G; but obviously any other common form suited to the purpose may be adopted.

It is obvious that the arrangement of guide-pulleys for the cable F, by which the turn-table is rotated, may be varied at will, and the same is true as to the guides of cable J.

If desired, both air and spring cushions may be employed to relieve the shock due to suddenly bringing the boom to rest and to the stoppage of the pistons of the hydraulic cylinders.

Having thus described my invention, what I claim is—

1. In an apparatus for dredging, excavating, and the like, the combination of a dipper, scoop or shovel; a cable connected with and serving to move the same; a hydraulic cylinder; a piston movable within the cylinder and connected with the cable; an accumulator communicating with the hydraulic cylinder; a steam-pump for supplying the accumulator; a self-closing throttle-valve for controlling the supply of steam to said pump, and a piston subject to the pressure within the accumulator and serving to open the throttle as pressure increases.

2. In apparatus for dredging and the like, the combination of a hydraulic cylinder and piston for actuating the dipper or like device; an accumulator communicating with the hydraulic cylinder; and two pumps for supplying said accumulator, one pump adapted to deliver a large volume at relatively low pressure and the other adapted to deliver at a relatively high pressure, substantially as and for the purpose set forth.

3. In apparatus for dredging, excavating, &c., the combination of a main frame or platform; a turn-table mounted thereon and carrying the excavating or dredging appliances; a hydraulic cylinder; a piston movable within the cylinder; a cable connected with opposite sides of the piston and with the turn-table; and a pump adapted and arranged to withdraw liquid from one side of the piston and to deliver it to the other side, substantially as set forth.

In witness whereof I hereunto set my hand in the presence of two witnesses.

GEO. H. BREYMANN.

Witnesses:
HORACE A. DODGE,
WILLIAM W. DODGE.