(No Model.) 2 Sheets—Sheet 1.

R. H. ISBELL.
HYDRAULIC RAM.

No. 418,132. Patented Dec. 24, 1889.

Fig. 1. Fig. 2.

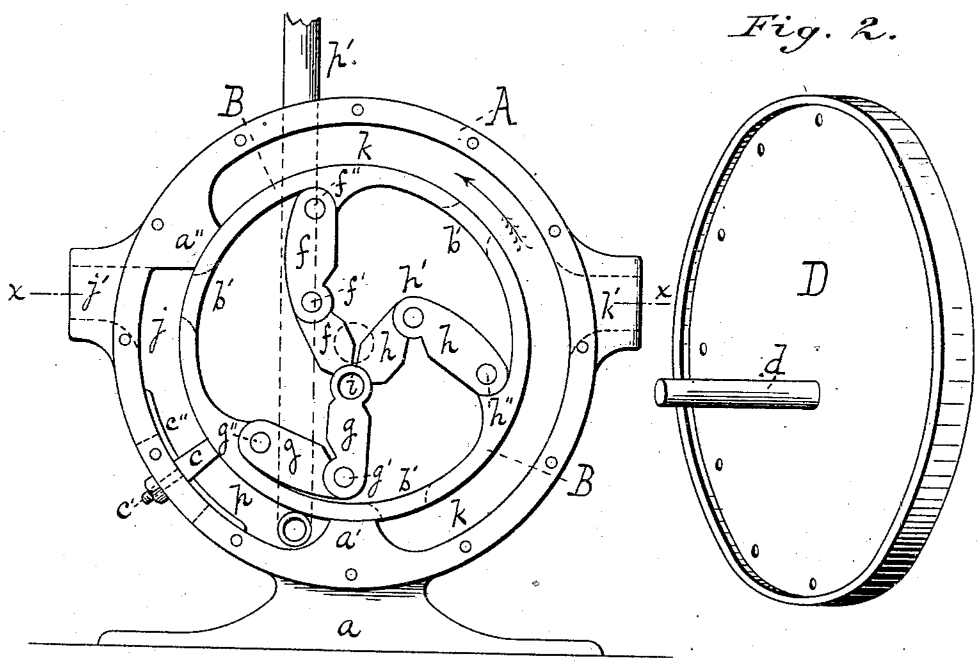
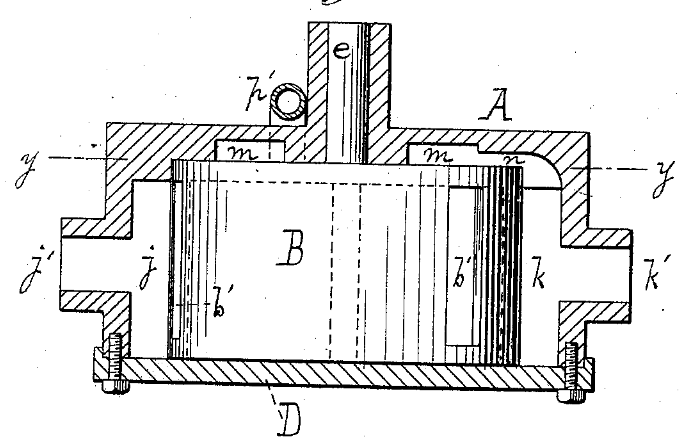


Fig. 3.



Witnesses:
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(No Model.)

2 Sheets—Sheet 2.

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Fig. 4.

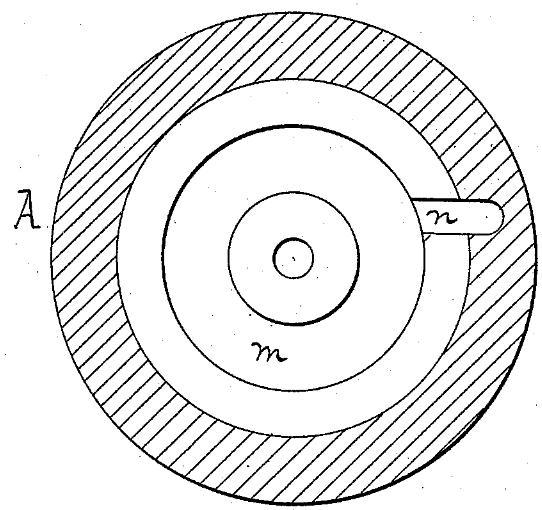


Fig. 5.

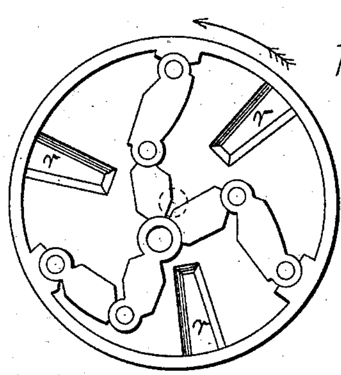
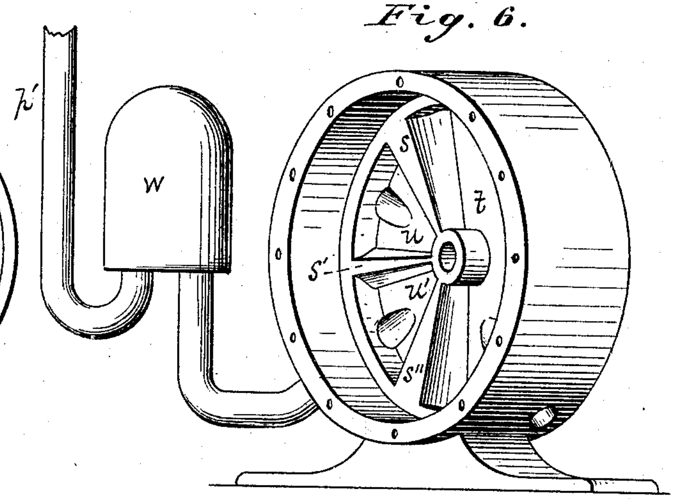


Fig. 6.



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UNITED STATES PATENT OFFICE.

ROBERT H. ISBELL, OF NEW YORK, N. Y., ASSIGNOR TO THE ISBELL MACHINE COMPANY.

HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 418,132, dated December 24, 1889.

Application filed May 26, 1887. Serial No. 239,494. (No model.)

To all whom it may concern:

Be it known that I, ROBERT H. ISBELL, a citizen of the United States, residing in the city and county of New York, within the State of New York, have invented a new and useful Hydraulic Ram, of which the following is a specification.

My invention consists of a series (three or more) of jointed arms revolving within a closed cylinder and dividing such cylinder longitudinally into separate variable chambers, the arms being pivoted together at their inner ends upon a stationary pivot, which lies within the cylinder parallel to its axis, but at some point other than such axis, and at their other ends pivoted at different points at the circumference of the cylinder, the variable chambers formed by the arms and the sides of the cylinder communicating successively with the supply of water or other fluid to be raised during the time they are enlarging and during the time they are contracting, communicating first with the discharge-pipe and then with the pipe through which it is to be raised. Each of the variable chambers has an opening through one of its sides, and the successive communication with the supply, discharge, and elevating conduit is accomplished by this opening passing certain partitions which separate certain compartments from which those conduits lead out.

I know of no prior use of the principle of jointed arms pivoted within a cylinder and so dividing the cylinder into alternately enlarging and contracting chambers for the purpose of using the pressure of a fluid to raise a portion of it higher than its source. There are various methods of applying this principle, several of which are shown in the drawings. In all the forms shown therein the arms are pivoted within an inner cylinder revolving within a cylindrical case.

The objects of the invention are simplification of construction, increase of power, and reduction of friction.

In the accompanying drawings, Figure 1 is a view of the jointed arms as arranged within the inner cylinder, and of the inclosing-case, with one side of the case removed. Fig. 2 is a perspective view of the cap fitting over the case and forming one end of it. Fig. 3 is a partly-sectional view of the cap, case, and cylinder in position upon the line x x of Fig. 1. Fig. 4 is a section of the case taken on the line y y of Fig. 3. Figs. 5 and 6 represent a modification of the principle.

A is a stationary inclosing-case, of any suitable shape, resting upon the standard a.

B is a hollow cylinder, somewhat shallow in shape, designed to revolve within the case A in the direction of the arrow. One end—the inner disk—of the cylinder B is entirely closed, and is solid with its circumference. The other end is open, (see Fig. 1;) but when the parts are in position the face-plate or cap D, which fits over the case A and is affixed to it, also closes that end of the cylinder. The shaft e is solidly affixed to the center of the inner disk b of the cylinder B. The bearings in which e turns form a part of the rear plate of the case A, and in the form shown are the only bearings of the cylinder B.

Within the cylinder B lie the jointed arms f f, g g, and h h. They are all of the same depth as the cylinder B, so that they form, with the circumference and rear disk of the cylinder and the cap D, when in position, three separate chambers, which are in all positions entirely closed, except for the openings b', through the circumference of the cylinder, each of the chambers having its separate opening. The arms are pivoted together at i upon the stationary pivot d, which is a bar affixed to the cap D at some point other than its center. They are each jointed at f', g', and h', respectively, and at their outer ends—*i. e.*, at the circumference of the cylinder—are pivoted upon pivots affixed to the cylinder f'', g'', h'', such pivots being equidistant from each other. As the cylinder revolves, the jointed arms move upon the inner surface of D and also upon the surface of the inner disk of B. All the joints are made tight to prevent the passage of the water or other fluid from one chamber to another. Thus while the cylinder revolves upon its center e the pivot around which the arms revolve is situated eccentrically as to e, the arms doubling to allow for the variation of distance between that pivot and the circumference of the cylinder, and this causes each of the chambers formed in the cylinder to alternately increase and decrease in size between given points in the revolution.

The case A incloses the cylinder in such way as to leave three compartments *j*, *k*, and *p* between it and the cylinder, such compartments being entirely separated from each other by the partitions *a′*, *a″*, and *c*, which are inward projections of the case or blocks affixed to it, extending the depth of the case. The surfaces of *a′* and *a″* which touch the circumference of the cylinder B correspond in size and shape with the exterior of the openings *b′*, and the corresponding surface of *c* is made of the same depth and about half of their width. The positions of *a′* and *a″* are fixed, being as far apart upon the circle as the openings *b′* are from each other, so that when one of those openings is opposite *a′* another is opposite *a″*. Each opening *b′* is so placed that when directly opposite *a″* the chamber between the jointed arms with which it communicates is at its largest size, and when opposite *a′* that chamber is at the smallest size. *c* may be placed at any point between the discharge and elevating apertures.

k′ is a pipe leading from the reservoir to the compartment *k*, *j′* a pipe leading from the compartment *j* to a faucet or other discharge into the open air, and *p′* a pipe leading from the compartment *p* to the point to which the water is to be elevated.

The operation of the machine is as follows: The water (or other fluid) lies in the compartment *k* under the pressure of the supply. The compartment *j* is then relieved of all pressure by the pipe *j′* being opened to the outer air. The water thereupon presses from *k* into the two variable chambers in communication with it, and its pressure therein upon the jointed arms, enlarging those chambers, revolves the cylinder in the direction of the arrow. As soon as the opening *b′* of a chamber which is full of water passes the partition *a″* its contained water discharges into *j* until that opening passes the partition *c*. After passing *c* the remainder of the water in that chamber is forced by the further contraction of the chamber into *p*, and thence through *p′* to the desired height. The amount of water and height to which it may be carried depend upon the well-known principles governing hydraulic rams. There is no dead-point, because one variable chamber is continuously in communication with the supply, and pressure within that chamber, when relieved from the pressure outside it, must revolve the cylinder in the direction of the arrow. The face of the partition *c* is made narrower than the opening *b′* in order that there may no stoppage of the flow. For an instant the water is discharging into both *j* and *p*. There is affixed to *c* a stem *c′*, which extends through a slot in the case and has a nut outside the case. This slot is along the circumference and its limits are shown by the dotted lines each side of *c′*. *c″* is a curved plate affixed to *c*, the object of which is to cover the slot in the case whatever the position of *c*. By these means *c* may be moved nearer to the discharge or elevating conduits in order to regulate the amount of water to be raised.

The distance of the bar *d* from the center, or, which is the same thing, the position of the point *i*, is not invariable; but I have discovered that the best results are obtained if *i* is placed one-third of the way across the circle connecting the outer pivotal points *f″*, *g″*, and *h″* upon its diameter. The position of *i* being fixed upon, the positions of the ports *b′* and the cut-offs *a′* and *a″* are determined as follows: The purpose to be attained is that the water shall begin to enter each chamber *k* from the moment it reaches its smallest capacity and shall have open communication for discharge at the moment it reaches its largest capacity. This is a matter of exact calculation. In the form shown the chambers are smallest when the outer ends of their two inclosing-arms (*g″* and *h″*, for instance) are upon the same side of the circle as the pivotal point *i* and equidistant from the line connecting *l* and the center of the cylinder. At that instant *b′* must pass *a′*. In the drawings *b′* is shown as half-way between *g″* and *h″*; but it may be placed in any other convenient place upon the circle, provided the position of *a′* is changed to correspond. In like manner the chamber reaches its largest capacity in two-thirds of the revolution, and *a″* will consequently be two-thirds of the circle distant from *a′*. As the chambers change from contraction to enlarging, and vice versa, instantaneously, the cut-offs must just cover the ports, and no more, at the instants of passing; otherwise the machine will pound. The ports *b′* should be made somewhat larger than the pipes *j′* and *k′* to allow free flow of water through them. The two legs into which each of the jointed arms is divided I make equal to each other. I have discovered that that arrangement yields better results than any other, though it is not essential to obtain some result. The number of legs or parts into which the jointed arms are divided is not involved in the main principle of action. An arm may be made of three or even more jointed parts; but there is an advantage in confining the parts to two. To avoid possibility of an arm catching upon the center of its joint, I make them so that when farthest extended they will not come quite to a straight line. The variable chambers do not contract to nothing, and there are spaces within each chamber which the arms do not touch in their movement. These may be filled or manufactured solid with the side and rear plate of the cylinder. With water, however, there is little or no advantage in this, owing to its non-compressibility. In applying this principle of jointed arms pivoted eccentrically within a closed cylinder I do not confine myself to three arms. Subject to conditions of space, any greater number may be used;

but the three-armed machine has a decided advantage over all others. It attains the best result, considering both power and friction.

In Figs. 5 and 6 the modification of the principle consists merely in putting the openings or ports of the variable chambers in the rear disk of the cylinder instead of in its circumference. This, of course, necessitates the placing of the three compartments and their separating-partitions behind the rear disk instead of around the circumference of the cylinder. Fig. 5 represents the cylinder, and Fig. 6 the case within which it revolves. The cap D fits upon the case as before. The jointed arms are arranged within the cylinder precisely as before.

r are the ports, which, by passing successively the partitions or cut-offs *s*, *s'*, and *s''*, admit the fluid from the water-chest *t* during the enlarging of the chambers and allow its exit into *u* and *u'* during their contracting, *u* and *u'* being connected, respectively, with the discharge and elevating pipes. There is a decided advantage in placing the ports upon the circumference instead of in the rear disk, especially with non-compressible liquids, for the reason that it allows a much more direct course for the flow of the liquid through the cylinder. This would, with water, for instance, make a large difference in efficiency.

An ordinary air-chamber may be added to the elevating-pipe in order to make a more steady flow therein, such as *w* in Fig. 6.

Figs. 3, 4, 5, and 6 illustrate another important feature of my invention. In machines of this character friction is a very important item. In this invention much of the friction ordinarily encountered is obviated by the position of the chamber from which the supply is drawn with reference to the position of the inner disk of the revolving cylinder. Thus in Figs. 5 and 6 the pressure of the water in the water-chest *t* against the inner disk of the revolving cylinder is balanced (or nearly so) by the pressure within the two variable chambers in communication with it. There is thus no pressure tending to cause the disk of the revolving cylinder to bear hard against the cut-offs *s*, *s'*, and *s''*, or tending to press the shaft of the cylinder against its bearings in any direction. In other words, there are no parts moving under pressure exerted against such movement; but all the power is utilized in doing the work. There is also, of course, far less wear. The same advantage is gained in the form where the ports are on the circumference by placing an annular compartment in the case behind the inner disk of the revolving cylinder and having it in communication with the supply-compartment. Thus, in Figs. 3 and 4, *m* represents this annular compartment having open communication with the compartment *k* by means of the conduit or pipe *n*. In either form, in order to balance the disk *b* between the two pressures on either side of it, the rear surface exposed to the annular compartment must be as nearly equal as possible to the inner surface exposed to the pressure in the two variable chambers which are in communication with the supply. As the latter varies during the revolution, the best plan is to take the medium size for the former.

It is not essential to the principle of this ram that it should consist of an inner cylinder revolving within a cylindrical case. Jointed arms pivoted eccentrically constitute the main essential idea, the gist of the invention, as it were, and the other parts shown may be varied without departing from the main principle. Thus in the form shown in Figs. 5 and 6 all of the circumference of the revolving cylinder may be entirely dispensed with, provided the outer ends of the arms are arranged to move water-tight against the circumference of the case. In that case we would have merely a revolving disk with the jointed arms pivoted upon posts standing at its circumference instead of a revolving cylinder. The case itself would be the "closed cylinder."

I claim as my invention—

1. A hydraulic ram consisting of a series of jointed arms contained within a closed cylinder and dividing such cylinder into variable chambers pivoted together at their inner ends upon a stationary pivot which lies within the cylinder at some point other than its axis, and at their outer ends pivoted at different points at the circumference of the cylinder, each of the variable chambers having an opening by which it communicates as the arms revolve with the supply while enlarging and successively with the discharge and elevating conduits while contracting.

2. A hydraulic ram consisting of a series of jointed arms contained within a closed revolving cylinder and dividing such cylinder into variable chambers pivoted together at their inner ends upon a stationary pivot which lies within the cylinder at some point other than its axis, and at their outer ends pivoted at different points upon the circumference of the cylinder, each of the variable chambers having an opening through the circumference of the cylinder, by which it communicates as the arms revolve with the supply while enlarging and successively with the discharge and elevating conduits while contracting.

3. The three-armed hydraulic ram shown in the drawings, consisting of cylinder B, case A, cap D, and shaft *e*, the cylinder B having three jointed arms pivoted at their outer ends at equidistant points upon the circumference of the cylinder, and at their inner ends pivoted together upon the pivot *d*, affixed to the cap D, and having openings *b'* into the variable chambers formed by the jointed arms, the case A having partitions *a'*, *a''*, and *c*, dividing the space outside the

cylinder B into three compartments—viz., the supply-chamber k, communicating with the inlet k', the waste-chamber j, communicating with the waste-outlet j', and the elevating-chamber p, communicating with the elevating-pipe p'—substantially as and for the purpose described.

In witness whereof I have hereunto put my hand this 25th day of May, 1887.

ROBERT H. ISBELL.

Witnesses:
H. B. HATHAWAY,
SALTER S. CLARK.