June 21, 1927. 1,633,559

J. S. GULLBORG

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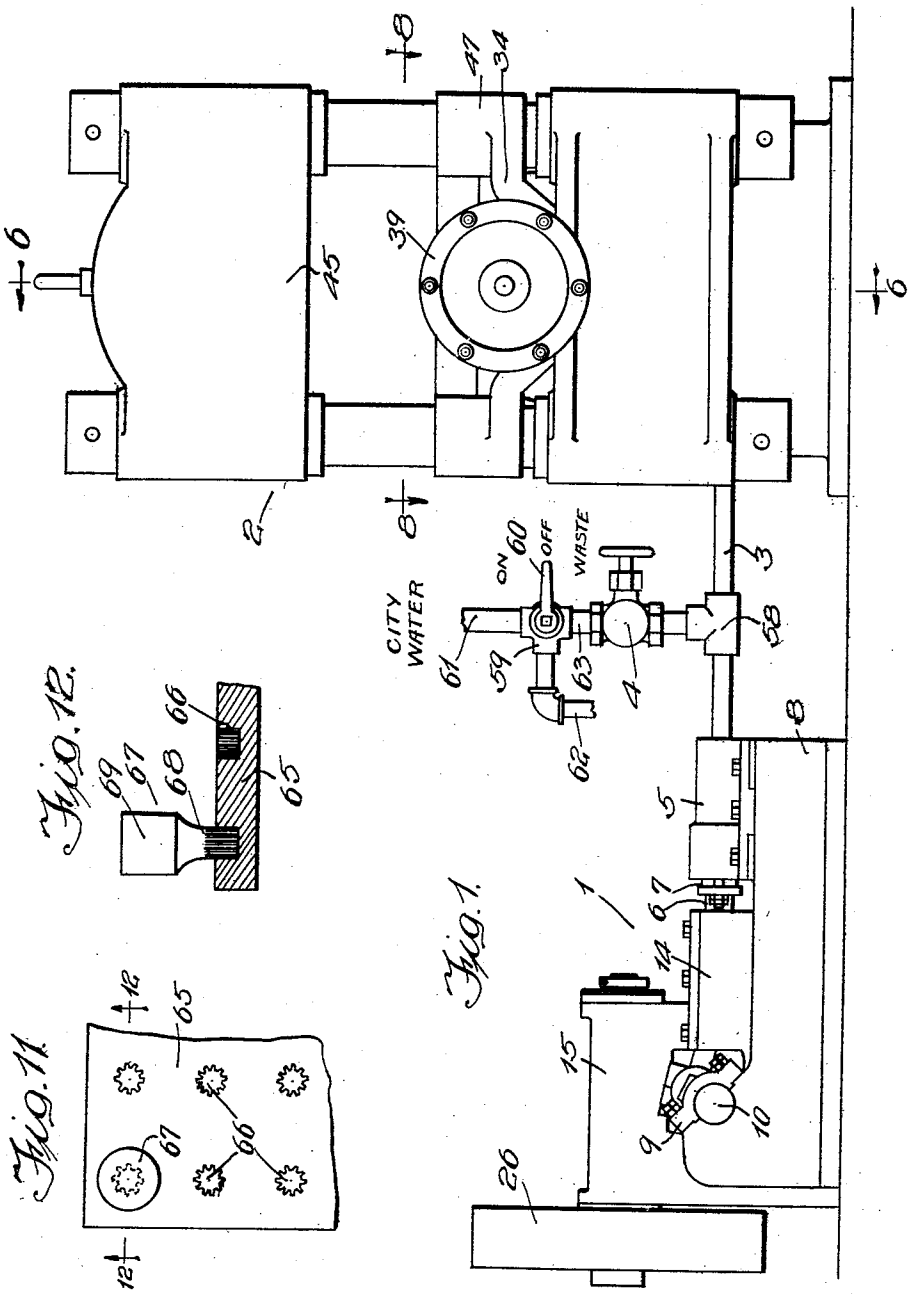


Fig. 12.

Fig. 11.

Fig. 1.

Witnesses:
W. F. Kilroy
Harry C. White.

Inventor:
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June 21, 1927. 1,633,559

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PRESS

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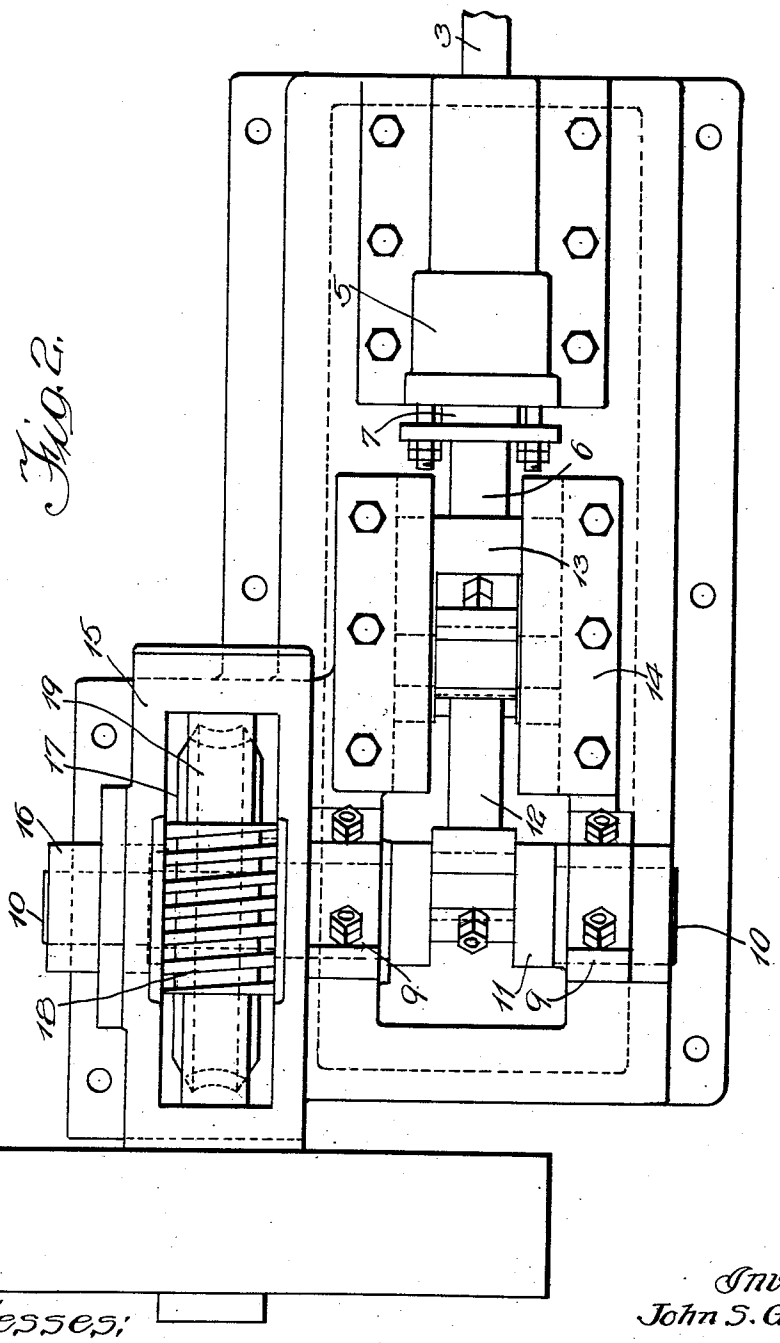


Fig. 2.

Witnesses:
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Harry E. White

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June 21, 1927. 1,633,559

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PRESS

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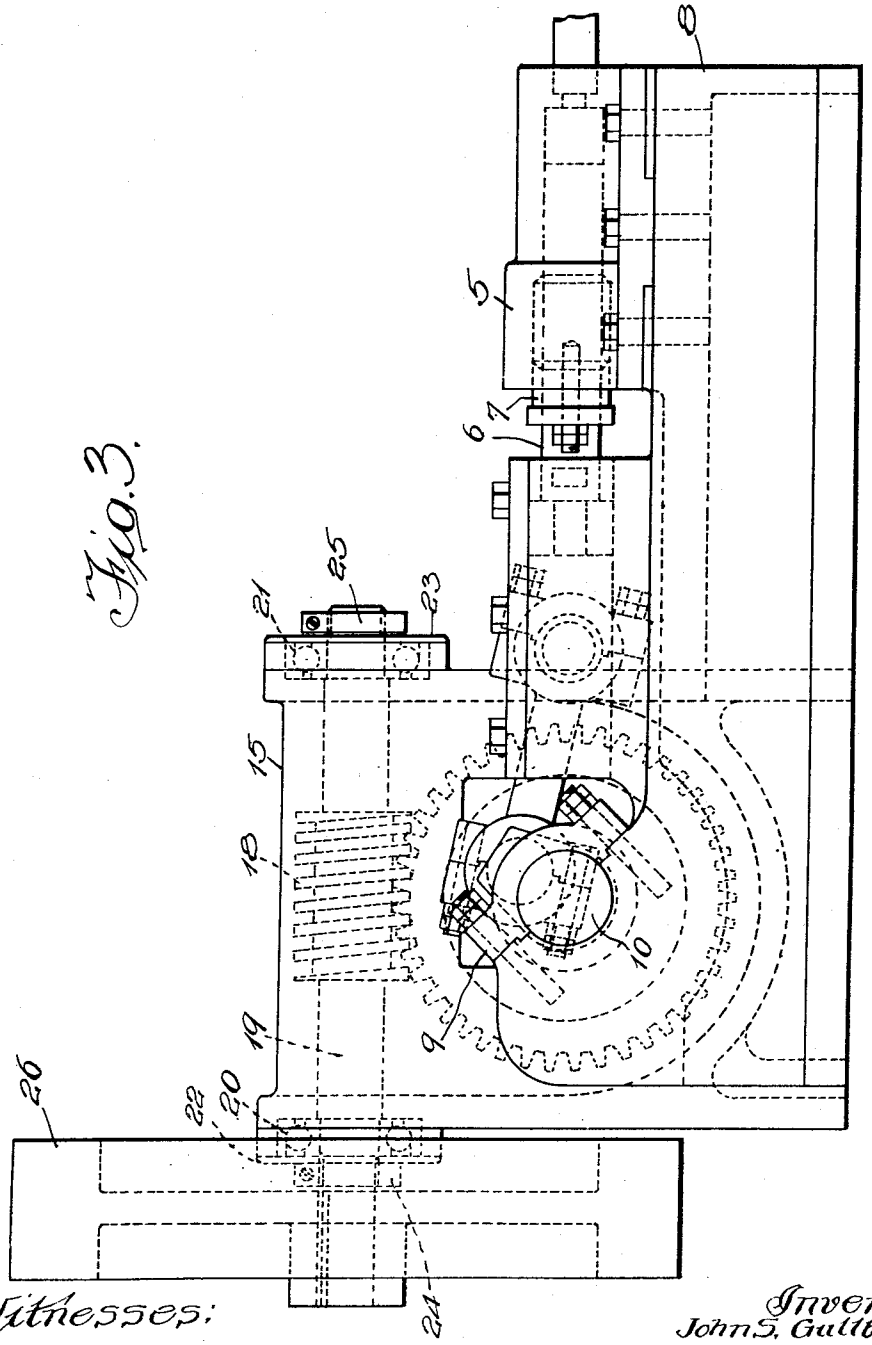


Fig. 3.

Witnesses:
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Harry B. Whitte

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June 21, 1927. J. S. GULLBORG 1,633,559

PRESS

Filed Aug. 31. 1923 7 Sheets-Sheet 4

Fig. 4.

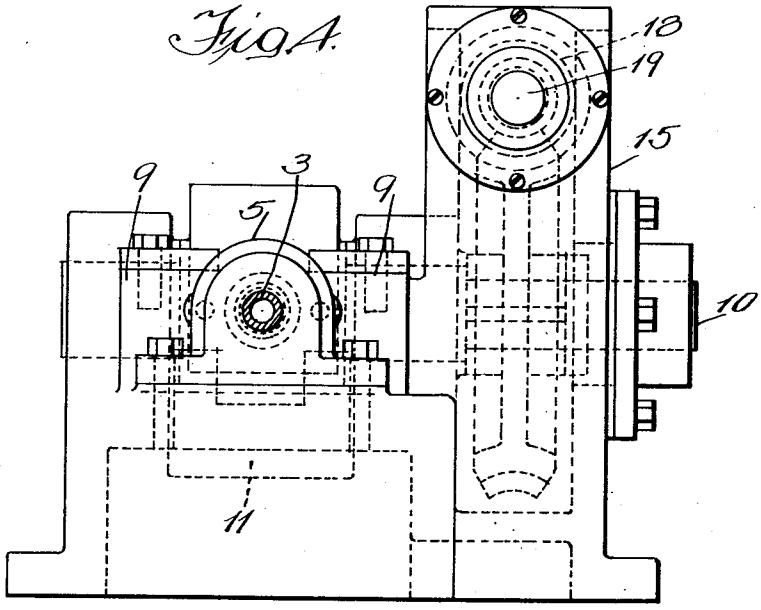
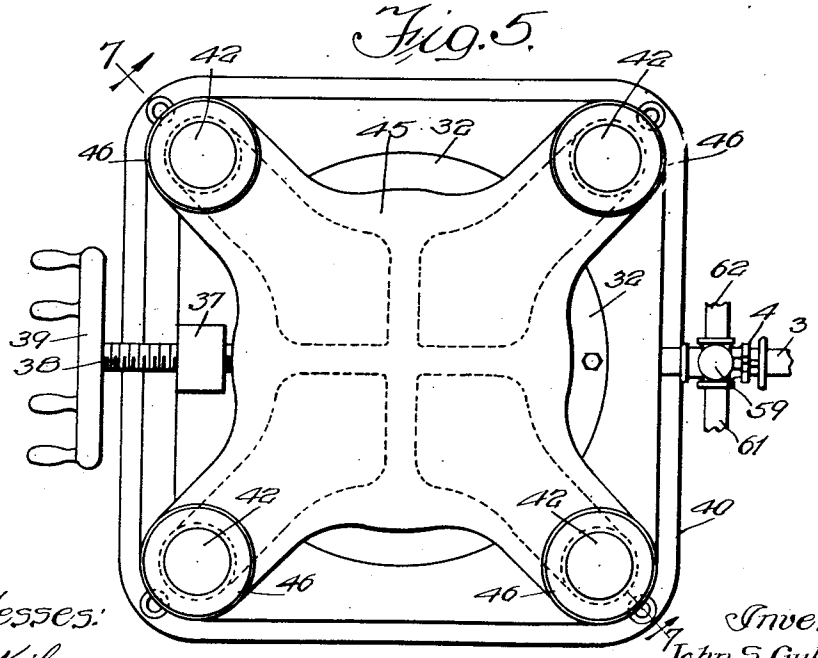


Fig. 5.



Witnesses:
W. E. Kilroy
Harry E. White

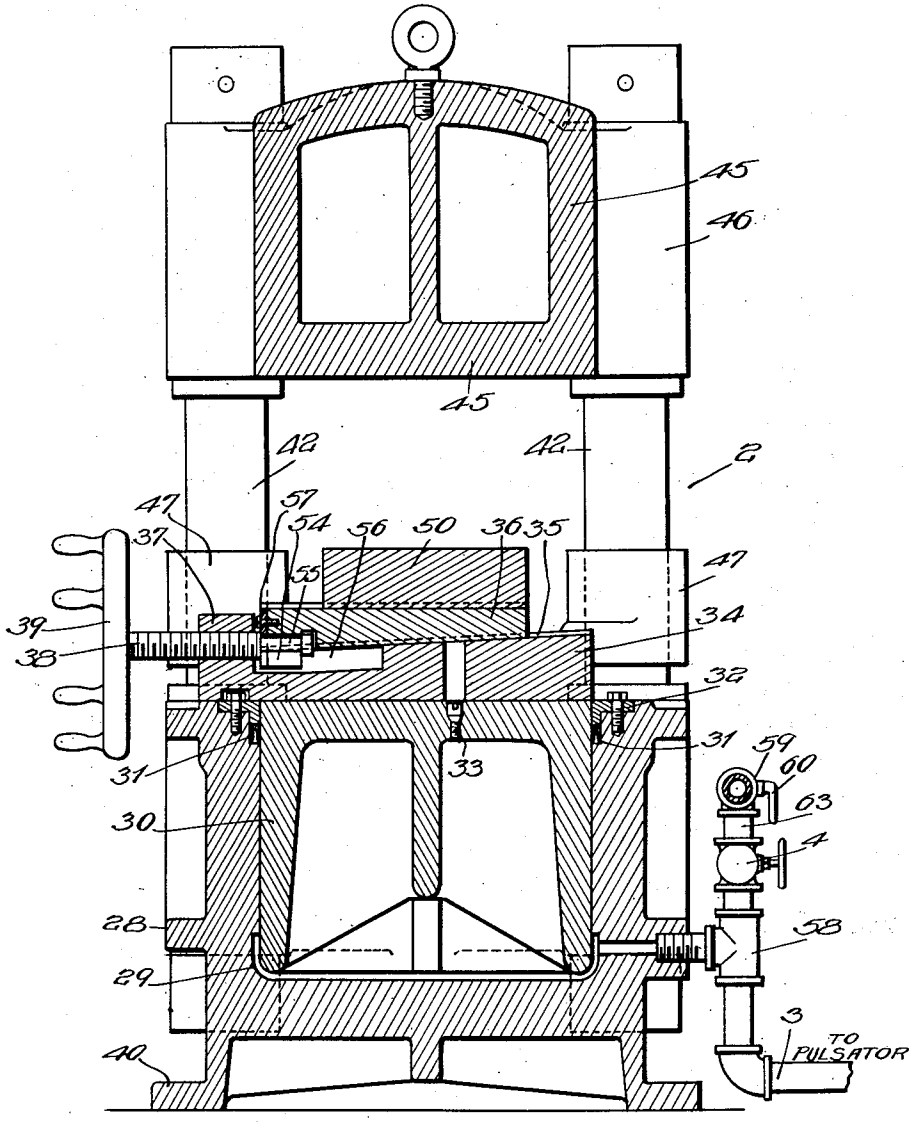
Inventor:
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June 21, 1927. J. S. GULLBORG 1,633,559

PRESS

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Fig. 6.



Witnesses:
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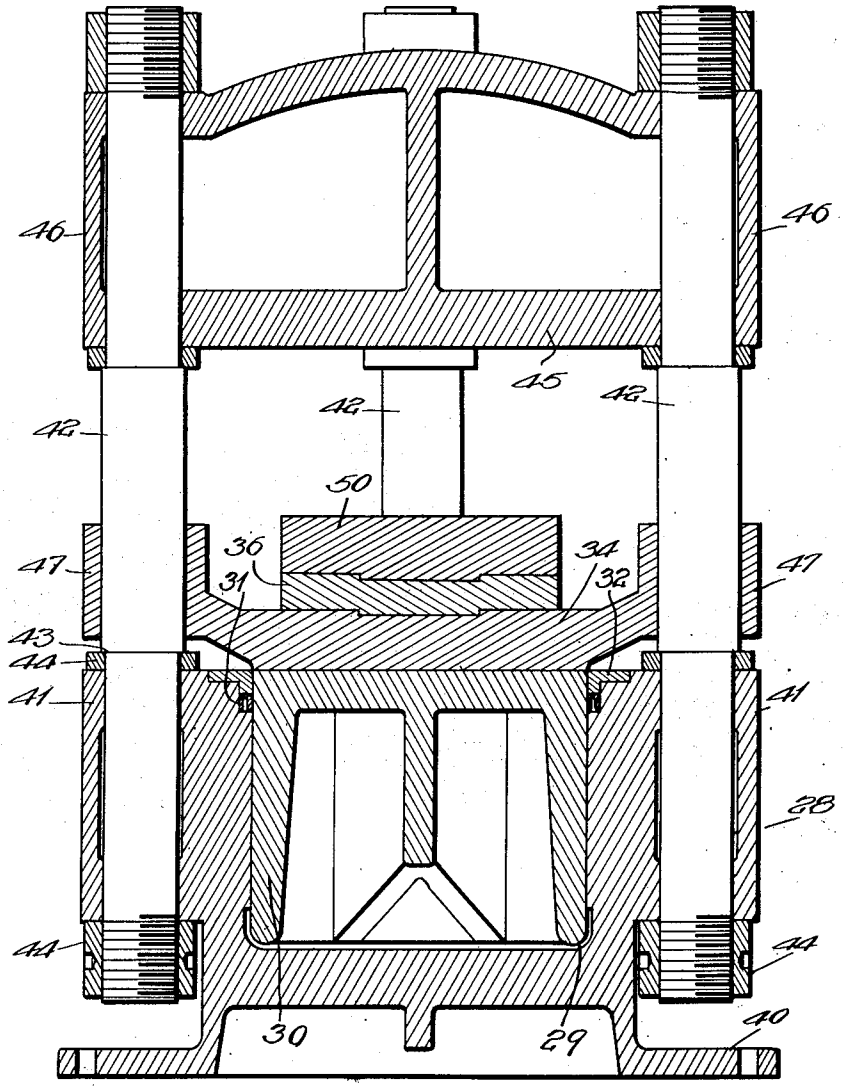
June 21, 1927. 1,633,559

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PRESS

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Fig. 7.



Witnesses:
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June 21, 1927. J. S. GULLBORG 1,633,559

PRESS

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Fig. 8.

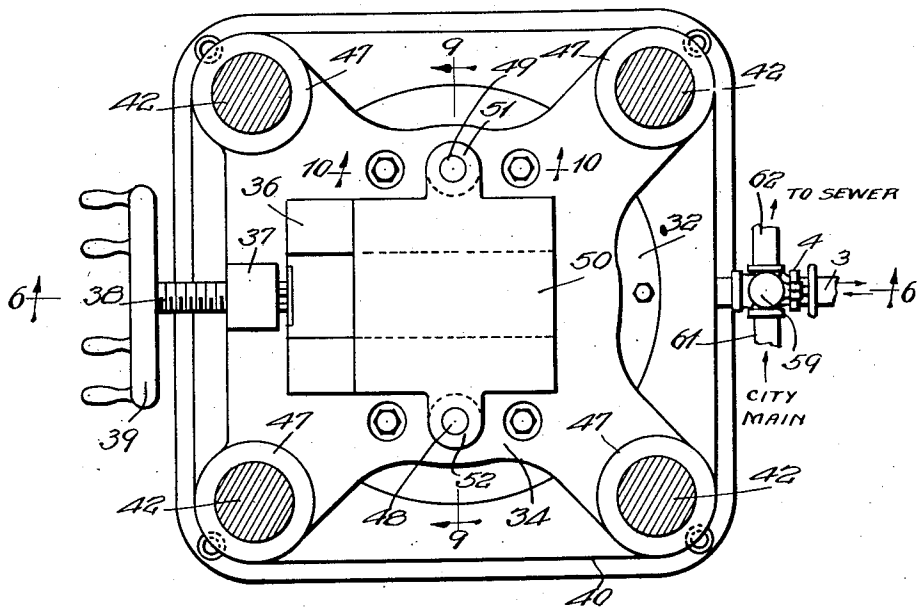


Fig. 9.

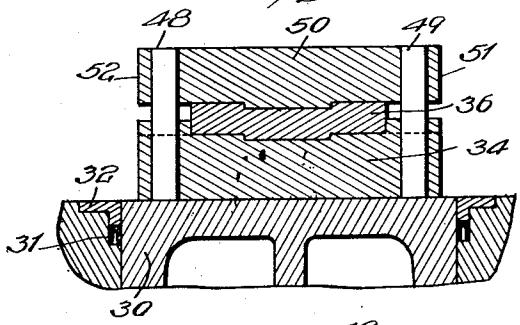
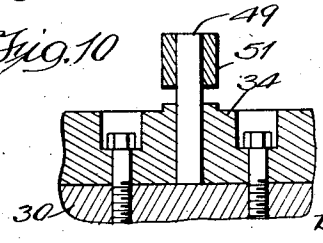


Fig. 10



Witnesses:
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Patented June 21, 1927. 1,633,559

UNITED STATES PATENT OFFICE.

JOHN S. GULLBORG, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ALEMITE DIE-CASTING & MFG. CO., OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

PRESS.

Application filed August 31, 1923. Serial No. 660,303.

My invention relates to presses. While the invention is primarily related to presses, it will be understood from the following specification and claims that it is not intended to limit the invention to use in presses only as the principles thereof may be applied in machines of a similar class where a large force is to be developed.

While the particular embodiment which I shall herein illustrate and describe is a hydraulic press, it is to be understood that the principles of the invention are not limited to hydraulic transmission of pressure, but may be applied to presses and like machines operated solely by mechanical connections or transmissions.

According to my invention, I employ a continuously acting motor such as an electric motor steam engine or any other suitable source of power, and convert the motion of the same into a reciprocating motion of relatively slow action and short travel in a predetermined fixed path, but with great mechanical advantage or leverage, so as to exert great force or pressure. This motion alone is not suitable for compressing a body to any great extent unless the same is to extend through only a very short range. This is because the traverse of the reciprocating member is limited and is, in practice, preferably only a fraction of an inch. Hence, when the work to be done requires a travel of the head or jaws or other object engaging members through a considerable distance, such limited reciprocatory motion, while it is capable of exerting sufficient pressure, is not capable unaided of covering the required path. I provide additional means in the shape of an extensible connection between one of the jaws or other work engaging members for following up the work and taking up the lost motion upon the return or in-stroke of the reciprocating plunger. In other words, I extend the application of the force to a point in advance of its first application. Where the load is not a constant load, this interposition of the extensible connection may be done quite easily manually by inserting a wedge or turning a jackscrew or the like. Thus, when a piece of metal is formed, or a fibrous body compressed, there is a tendency for the load to set or remain and the pressure between the load and the plunger is less for the return stroke than it was upon the out stroke. In such case, the wedge or jackscrew or the like may readily be advanced upon the cessation of pressure between the parts. However, when the load is a uniform one or substantially uniform, as, for example, when the load is a gravity load to be raised, additional means must be provided for holding the load in its advanced position to permit the introduction of the extensible connection. Whereas the plunger reciprocates or traverses a closed path, the extensible connection does not do so, but presents an irreversible power transmitting device of relatively great strength, but of relatively little force as compared with the reciprocating member.

The press of the present invention is particularly useful in connection with the forming of metal under pressure. This is due to the unsymmetrical nature of the load which permits of a simple form of press, but furthermore, the use of the press permits of a novel mode of treatment of the metal or similar material. The transmitting connection which imparts the reciprocatory motion to the plunger gives it a sine-wave motion, that is, a motion like the motion of a crank driven piston in a cylinder, starting slowly, speeding up in the middle of the stroke, and again stopping slowly, all without impact or shock which has a shattering effect. This sine-wave form of motion gives the metal or other material time to start it slow, then moves it rapidly, and again gives it time to set. The force of the stroke throughout this movement is in inverse proportion to its speed, and this is highly beneficial in that maximum force is provided for overcoming the static friction of the particles and again maximum force is available as the particles come to rest.

The range of motion may be selected to secure varying effects. For example, maximum pressure may be secured when the plunger approaches the outward end of its stroke. The periods of rest between impulses of flow are beneficial in permitting the heat to be dissipated and permitting the grain of the metal to assume its new position without so great injury or so great a resistance as might be caused by a continuous motion.

In order to acquaint those skilled in the

art with the manner of constructing and operating the device of my invention and practicing the method therein embodied, I shall now describe a particular press and its mode of operation.

In the accompanying drawings:—

Fig. 1 is a side elevational view of a press embodying my invention;

Fig. 2 is a plan view of the hydraulic pulsator or vibrator;

Fig. 3 is a side elevational view of the same;

Fig. 4 is an end view taken from the right of Fig. 3;

Fig. 5 is a plan view of the press;

Fig. 6 is a longitudinal vertical section taken on the line 6—6 of Fig. 8;

Fig. 7 is a longitudinal vertical section taken on the line 7—7 of Fig. 5;

Fig. 8 is a horizontal section taken on the line 8—8 of Fig. 1;

Fig. 9 is a fragmentary sectional view of the take-up wedge viewed on the line 9—9 of Fig. 8; and

Fig. 10 is a similar sectional view through the guides, as indicated on the line 10—10 of Fig. 8.

Fig. 11 is a fragmentary view of a die blank;

Fig. 12 shows the type of hob used in forming the die.

The device shown in Fig. 1 comprises a mechanically driven hydraulic pulsator 1 and a hydraulically operated press 2 connected together by a hydraulic connection or pipe 3. The hydraulic connection between the pulsator 1 and the press 2 constitutes a closed system without any automatic valves. This hydraulic system is closed by a high presure hydraulic valve 4 of great strength to resist the enormous fluid pressures which are created in the closed system. The vibrator 1 comprises essentially a cylinder 5 and a cooperating reciprocable piston 6, shown more clearly in Figs. 2, 3 and 4. The cylinder 5 comprises a relatively unfinished interior wall in which the liquid is confined by a stuffing box or gland 7 which fits closely about the plunger 6. The plunger 6 is of relatively small diameter and has a fairly long stroke, that is to say, of the order of twice the bore, although these proportions may be varied, as will be appreciated by those skilled in the art. The cylinder 5 is securely mounted upon a base or frame member 8. This base 8 provides a suitable split box or bearing 9, said bearing being split in such a manner as to relieve the cap of the bearing from major stresses, as is common in engine practice. A heavy crank shaft 10 has suitable bearings in the boxes 9 and this crank shaft has a crank 11, the crank pin of which is connected through a suitable connecting rod 12 to a cross head 13 mounted in guides 14 on the bed or frame member 8. This cross head is suitably connected to the plunger 6. At the outside of the top bearing 9, as viewed in Fig. 2, I provide a worm gear and wheel housing 15 which is provided with an outboard bearing 16 for the end of the crank shaft 10. Within this housing 15 and securely keyed to the crank shaft 10 is a worm wheel 17, and cooperating with it is a worm 18. This worm 18 is mounted on a suitable drive shaft 19, said shaft having bearings, in this case anti-friction bearings 20 and 21, at the end of the housing 15. The housing 15 forms a container for a suitable lubricant. The outer races for the anti-friction bearings 20 and 21 are seated in stationary annular seats in the ends of the housing 15 and the same are held in said annular seats by rings 22 and 23 which overhang said outer races. The inner races are held in place upon the shaft 19 by suitable collars 24 and 25 secured upon said shaft 19. These bearings 20 and 21 are preferably ball bearings, adapted to take not only the radial thrust, but also the end thrust caused by the mutual action of the worm and worm wheel. A suitable driving pulley 26 is keyed upon the end of the worm shaft 19 and this wheel serves not only as a driving belt pulley, but also as a fly wheel to assist in the overcoming of momentary high resistance to the action of the plunger 6. The wheel 26 is adapted to be driven by a belt trained over it and trained over the pulley of a suitable electric motor. The inertia of the fly wheel 26 is intended to be and is made great enough to throw the crank 11 over center when it encounters a particularly high resistance near the end of its stroke. Thus, as will be explained more in detail later, there is available not only the maximum pressure due to the sine-wave character of the stroke of the piston 6, but also the inertia of the fly wheel back of it. This will be better understood when the crank and the connecting rod are considered as parts of a toggle for exerting a high pressure upon the piston 6 as it nears the end of its outward stroke.

The in and out reciprocatory motion of the piston 6 in its cylinder 5 is transmitted to the cylinder of the press 2.

The press 2 comprises a space member 28 providing a cylinder 29 in which there is guided the hydraulic piston 30. This piston 30 closely fits the bore of the upper end of the cylinder 29. A suitable flexible packing ring 31 is held in place by a retainer ring 32 to pack the joint against leakage. The piston 30 is made hollow for the purpose of decreasing the weight of the same, and suitable strengthening webs are formed on the interior thereof to brace it against the stresses to which it is subjected. Since the piston is hollow and there would be a tendency to trap air in the same, I provide a suitable bleeding opening or vent in the

top of the same as shown at 33, this vent being normally closed by a suitable screw plug. The top of the piston 30 is planed off at right angles to the axis of the same, and a guide frame 34 is secured to said piston or plunger. This guide frame 34 has a flat bottom face cooperating with the top of the plunger 30 and an inclined top face, as indicated at 35 for cooperating with the takeup wedge 36. It has, furthermore, a suitable lug 37 for mounting the lead screw 38 for the wedge 36. The lug 37 is preferably provided with a suitable bushing having threads cooperating with the lead screw 38. The lead screw is preferably provided with a hand wheel 39 for turning said screw, although any other suitable means for turning said lead screw may be employed.

The frame member 28 is provided with a suitable pedestal 40 for supporting the entire press and for mounting the same upon a suitable foundation. This frame member 28 has four equally spaced lugs around its sides, the lugs being indicated at 41 in Fig. 7, and in these lugs are mounted the guide and tie-rods 42. The rods 42 are shouldered, as indicated at 43, and suitable collars 44 are set between these shoulders and the top edges of the lugs 41. The lower ends of the rods are threaded and threaded collars or nuts 44 hold these rods in place. At the upper ends of the rods I have provided a platen or bed 45, which similarly has four lugs 46 mounted upon the upper ends of the rods in a simpler manner.

The intermediate parts of the rods 42 are finished to form guides for the collars 47 which extend outwardly from and form parts of the platen 34. These collars 47 may be provided with suitable bushings, if desired, for renewing the bearing surfaces. A pair of guide pins 48—49 are mounted in the guiding frame 47, and a suitable head 50, which has lugs 51 and 52, is guided on said pins. The wedge 36 lies between the head 50 and the guide frame 47, being rabbeted into the guide frame 47 and the head 50 being rabbeted into the wedge 36, as will be apparent from Figs. 7 and 9. The wedge 36 has a pair of depending lugs 54, as shown in Fig. 6, which are adapted to fit over the reduced portion 55 of the end of the lead screw 38, to connect said lead screw and wedge together. The lugs 54 are adapted to travel in a recess 56, formed in the top surface of the guide frame 34. It will be observed that the feed screw 38 is stationary in its lug 37 and that the depending lugs 54 travel upward as the wedge is advanced. A suitable wear plate 57 is secured at the front end of the wedge 36 in advance of the lugs 54 to take the pressure of the feed screw 38 as the wedge forced between the guide frame 34 and the head 50.

The interior of the cylinder 29 is connected to the pulsator through the pipe 3. The high pressure shut-off valve 4 (see Figs. 6 and 8) is in practice placed adjacent the side of the press where it is convenient for the operator. I have shown the valves further removed in Fig. 1 in order to make a clear diagram of the connection. The high pressure shut-off valve is connected through a T 58 to said pipe 3. Beyond valve 4 there is provided a stop and waste cock 59 having a suitable operating handle 60. This valve has a threeway connection; a connection 61 to the city water supply; a waste connection 62 running preferably to the sewer; and the connection 63 leading to the high pressure valve 4. The system is charged with water by opening the high pressure valve 4 and the vent plug 33 in the plunger 30 of the press 2. The stop and waste cock 59 is then moved to the on position, connecting the pipe 3 to the city water main 61 for filling of the system with water. The plunger 30 of the press 2 is of such an area that the pressure of the city water readily raises the same to the desired height. After all of the air has been expelled from the system, the plug 33 is closed. Thereupon, the cock 59 may be closed and the high pressure valve 4 is closed. The drive wheel 26 is turned by the driving motor and this in turn operates the plunger 6 of the pulsator 1 at a greatly reduced speed, but with greatly increased force. This plunger or piston 6 has a motion of a character well known by those skilled in the art, the speed of which varies in accordance with the sine of the angle of the crank which drives it. We may term this "harmonic motion". The plunger 30 of the press and its connected parts partakes of the same character of motion, that is to say, it has a harmonic motion of greatly reduced travel, but also greatly increased force. Thus assume that the system has been filled with suitable liquid, preferably water, and that the plunger 30 has been set at the proper height, any object to be compressed may be placed upon the block 50. The plunger 30 will then be raised and lowered as the plunger 6 is moved in and out of the cylinder 5. Since there are no valves, such as check valves, to be taken into account, the liquid in the closed system may be subjected to very high pressures, and as a result enormous force may be exerted upon the object between the block 50 and the platen 45. As the piston 30 rises and falls, the pressure upon the object will be increased and decreased accordingly. In order to follow up the first compression stroke of the plunger 30, the operator turns the hand wheel 39 to advance the screw 38 and thus enter the wedge 36 to a greater extent between the block 50 and the frame 34. The wedge, while it is of very small lead or angle, and is therefore self-locking, is of

itself a means for raising the head 50, but of vastly less force than the plunger 30. Hence the operator will normally be unable to advance the feed screw 38 while the piston is moving upwardly, but as soon as it starts on its downward excursion he will be able to turn the wheel 39 and thus advance the wedge between the frame 34 and the head 50 to take up the advance which had been made by the previous upstroke of the plunger 30. It will at once be understood that the wedge and lead screw are but one of many ways in which this advance may be taken up and that a suitable jack screw or the like might be employed instead of the equivalent of what I have shown. However, I find that less space is required by the wedge as I have employed it than would be required for a jackscrew. Moreover, the construction which I employ is simple and relatively inexpensive and easy to machine.

It is also to be understood that I do not limit the invention to the employment of a hydraulic connection for increasing the mechanical advantage or leverage, and that for certain classes of work such connection is not necessary.

The invention is of value regardless of the manner employed in reciprocating the actuating plunger 30.

A particularly useful application of the principles of my invention is found in the hobbing of dies. Thus, for instance, let it be assumed that it is desired to make a number of moulds all of like form to be used at the same time for forming articles. In die-casting and the like work, a number of identical dies for the same object are often highly desirable. The same thing is true in moulded work for such material as bakelite, condensite, etc. It is customary to form the dies of steel. The practice known as "die-hobbing" has come into general use. This consists in forming a positive or male die member corresponding to the shape of the article itself and forcing said hob into a suitable piece of steel to form the mould. Heretofore, it has been customary to force the hob into the steel blank under hydraulic pressure.

I find that my press is peculiarly useful in work of this character and in fact in any work in which high pressures are employed to produce a flow of the material under consideration.

In Fig. 11 I have shown a piece of stock 65 forming a die blank. This blank has formed therein the impressions 66, in this case in the shape of a pinion. These impressions 66 are formed by the hob 67 having at its lower end 68 an exact counterpart of the finished article which the moulds are to produce and having at its upper end 69 sufficient stock to form a fairly extensive area for applying pressure.

In employing the device of my invention the blank 65 is laid upon the head 50 with a suitable pad or pillow block between them, and then the hob 68 is set in place upon said blank. A suitable pillow block may be interposed between the top of the hob 67 and the platen 45, if desired. Whereupon, the pulsator 1 is set into operation. The valve 4 is opened and the cock 59 is opened to admit city water pressure to bring the jaws of the press into engagement with the hob and blank. Thereupon, the valves 59 and 4 are closed off tight. The plunger, with its cooperating parts now reciprocates up and down with a harmonic motion of relatively short extent. The pressure is great enough to force the hob into the blank upon the upward excursion of the plunger 30. As the plunger 30 moves downwardly, the hand wheel 39 is rotated to advance the wedge between the frame 34 and the head 50 so that upon the return upward movement of the piston 30 the hob and blank are pressed towards each other with the result that a further embedding of the hob in the blank is secured. This action is carried on until the hob is embedded in the blank to the desired degree.

This action of repeated impulses of pressure separated by a period of cessation of pressure is highly desirable. It permits the metal to start its flow and carry it through a certain cycle, and then rest for a moment and again take up its travel. The wear upon the hob is greatly reduced and the work is made much easier. The heating of the particles by flow over each other has a chance to be dissipated between periods of movement, and it is possible for a lubricant to find its way into the working space between periods of pressure.

This action of intermittent flow and cessation of flow is highly advantageous in other cases where metal or other material is to be shaped or caused to flow, or the particles to move with respect to each other.

I do not intend to be limited to the details shown or described, or to the materials which I have referred to in the above specific embodiment of the invention.

I claim:—

1. In a hydraulic press system, a hydraulic press including a cylinder, a piston reciprocably mounted in the cylinder, and a platen spaced from and connected to the cylinder having a portion cooperable with the top of the piston, a pulsator including a reciprocatory member having a small amplitude of movement, but moving with great force, said member moving slowly initially, speeding up in the middle of the stroke, and ending the stroke relatively slowly, and a fluid connection between the press cylinder and said reciprocatory member for causing the force of said member to be

applied to and magnified by the liquid in the press to actuate said press piston, said movement of the reciprocatory member causing said press piston to move the metal being worked slowly initially to move it more rapidly on the intermediate portion of the stroke and to move it slowly finally so as to give the metal time to set.

2. In a hydraulic press system, a hydraulic press including a cylinder and a reciprocable piston therein having a metallic object to be worked thereon, said piston being adapted to be set initially in a given position, a pulsator including a reciprocatory member having a crank movement, a fluid connection between the liquid in the cylinder and said reciprocatory member for causing the force of said member to be applied to and magnified by the liquid in the cylinder to actuate said press piston, and take-up means associated with the press operable during the retrograde movement of the pulsator member to advance the metallic object and load on the piston, said crank movement of the reciprocatory member causing said press piston to move the metal being worked slowly initially, to move it more rapidly on the intermediate portion of the stroke and to move it slowly finally so as to give the metal time to set.

In witness whereof, I hereunto subscribe my name this 28th day of August, 1923.

JOHN S. GULLBORG.