Nov. 17, 1953 P. H. TAYLOR 2,659,348

MACHINE TOOL WITH LIQUID-SPRING ACTUATED RAM

Filed March 1, 1951

2 Sheets-Sheet 1

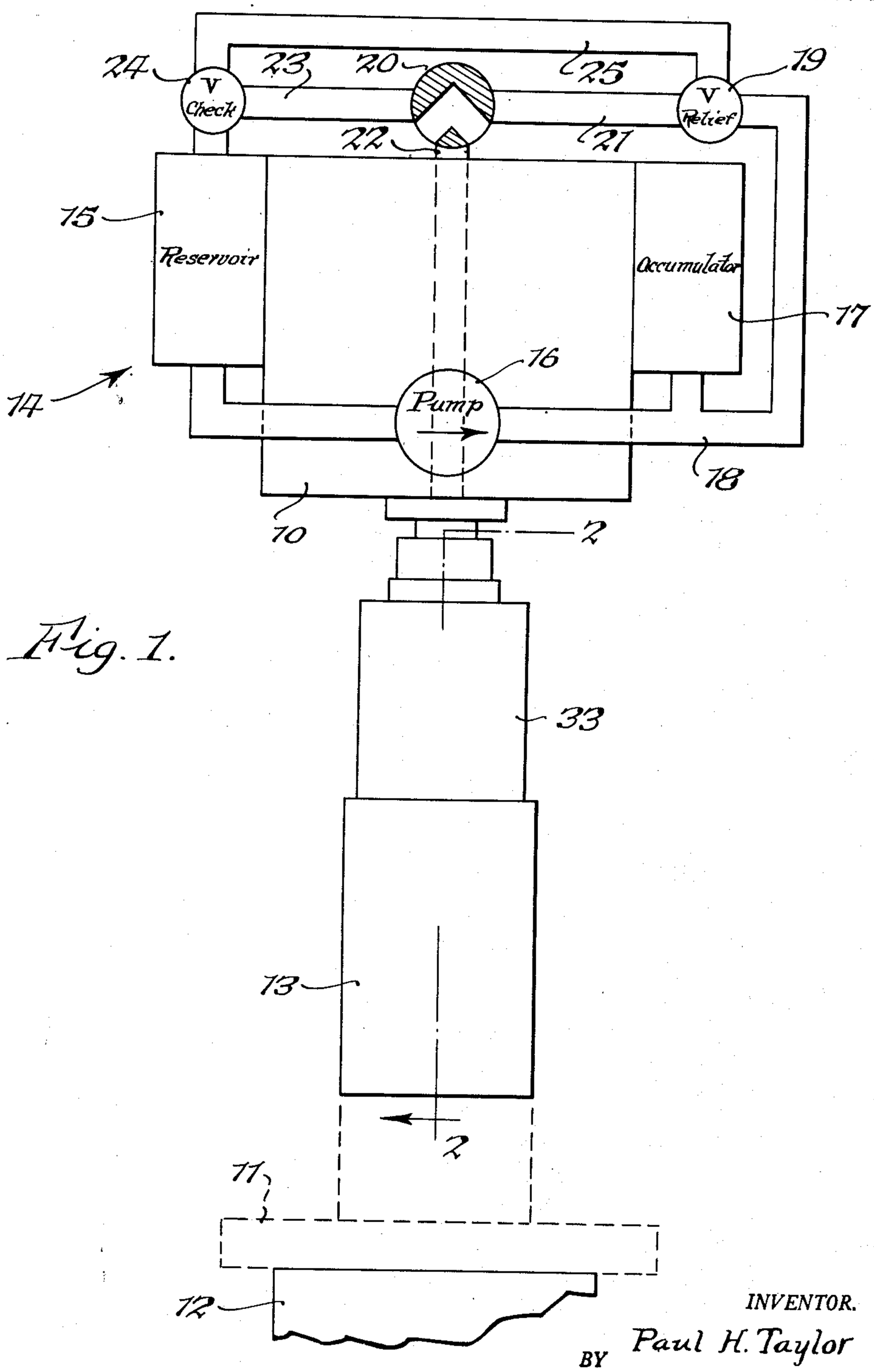

Fig. 1.

INVENTOR.

BY Paul H. Taylor

Edwin B. Gary

Attorney.

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2 Sheets-Sheet 2

Fig. 2.

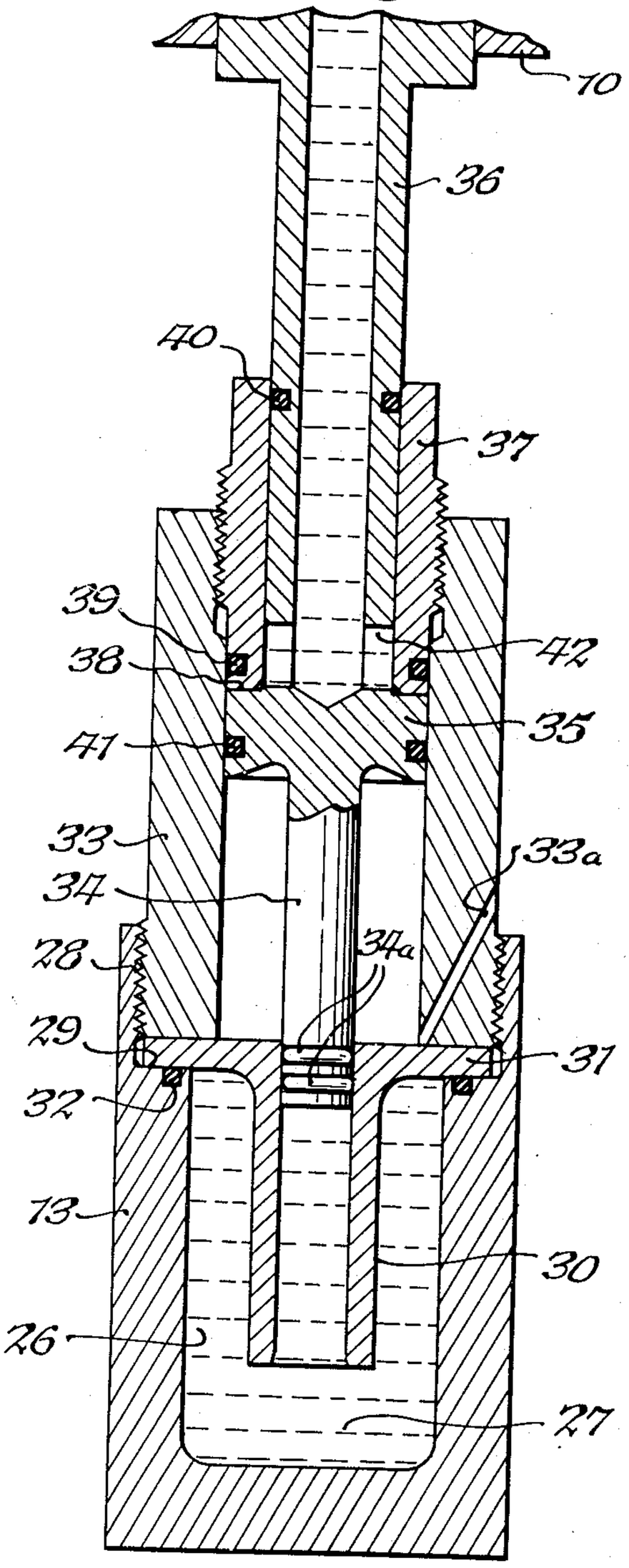
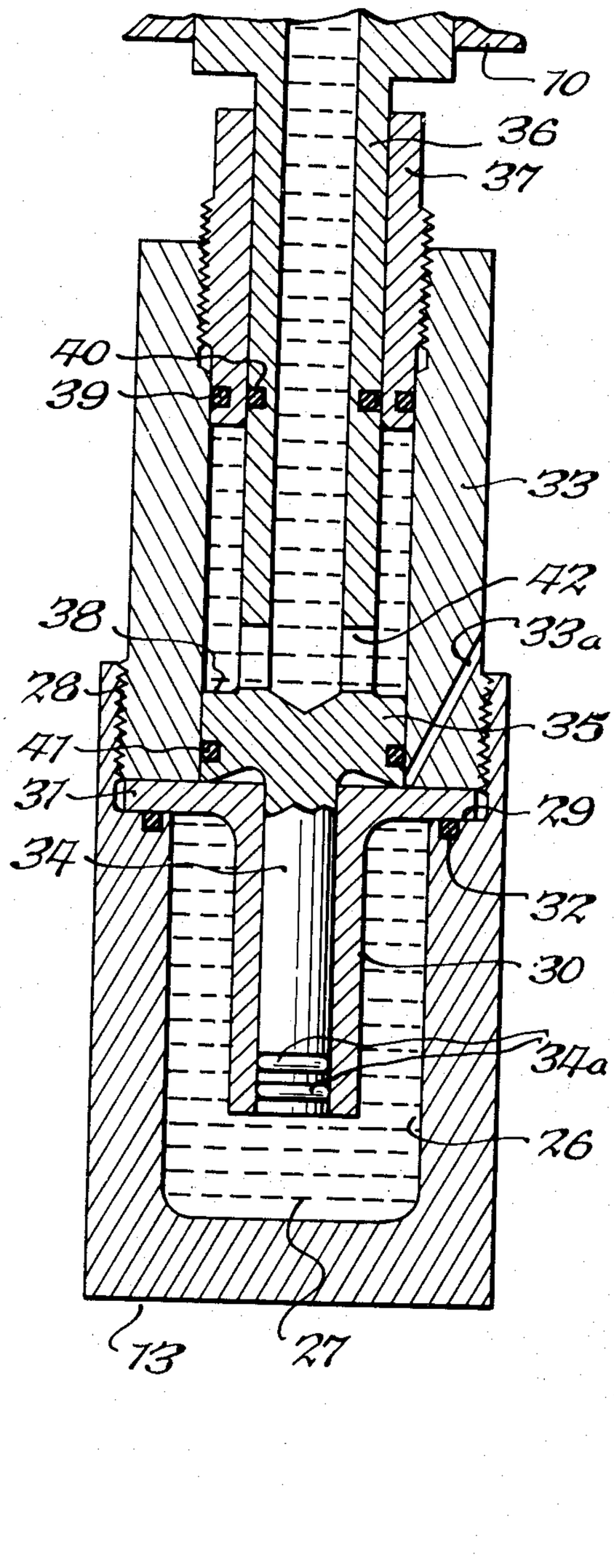


Fig. 3.



INVENTOR.
Paul H. Taylor
BY
Edwin B. Gary
Attorney.

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MACHINE TOOL WITH LIQUID-SPRING ACTUATED RAM

Paul H. Taylor, Grand Island, N. Y., assignor to Wales-Strippit Corporation, North Tonawanda, N. Y., a corporation of New York

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10 Claims. (Cl. 121—13)

1

This invention relates to a work-performing instrumentality which is operative during one stage to compress a fluid medium and in so doing store energy therein and which is operative during a second, or work-performing, stage to release and utilize such energy.

The invention has many and varied applications. For example, it is advantageous in many press-working and forging operations to employ a drop hammer for carrying out desired press-working or forging operations upon work-pieces supported upon an anvil, or die.

In most operations of this type, it has heretofore been the practice to employ a double-acting air or steam cylinder for elevating the heavy hammer to the position at which it is released so that the force of gravity may be utilized to effect the working stroke of the hammer, the double-acting air or steam cylinder also being available to accelerate the hammer in its working stroke and thereby increase the forces available for the press-working or forging operations. The utilization of the force of gravity and/or air or steam in the above manner has a number of objections. The air or steam employed for operating such cylinders ordinarily does not exceed 500 p. s. i. Hence a large air or steam cylinder is required to elevate a hammer and properly accelerate it, upon its release, in the direction of the anvil or die. Such large cylinders and associated parts are costly to machine, assemble and service. Moreover, the hammer and other actuating parts employed must necessarily be heavy.

The principal object of the present invention, therefore, is to overcome objections such as above noted, this object contemplating a dynamic work-performing instrumentality which employs a compressible fluid as an energy storing and releasing medium.

Another object of the invention is to provide a work-performing instrumentality in which the acceleration of the dynamic force member is rapid and effected without the development of sudden shock loads in the supporting structure.

A still further object is to provide a work-performing instrumentality which is small, compact and sturdy in construction.

A still further object is to provide a work-performing instrumentality which is so designed that the desired high compression of the actuating fluid may be obtained with a low-pressure energizing fluid.

A still further object is a novel design and arrangement of the parts of the work-performing instrumentality, whereby to provide for simplicity and economy in construction and facilitate fabricating, assembling and servicing operations.

2

The invention is illustrated in the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a work-performing instrumentality in the form of a press and embodying the features of the invention;

Figure 2 is an enlarged vertical section through the portion of the press which includes the ram and the associated ram energizing parts and is taken along line 2—2 of Figure 1, the ram being shown extended to the limit of its working stroke; and

Figure 3 is a similar section in which the ram is shown in its retracted, or loaded, position.

The invention is illustrated by way of example in connection with a press which is sufficiently illustrated for the purpose in view by a showing of an overhead support 10, a ram 13 and an anvil or die 12, the frame-work by which the overhead support and ram are mounted in the desired relation with respect to the anvil or die constituting no part of the invention and hence not being illustrated. A work-piece 11 is shown supported upon the anvil or die 12 under the ram 13.

The ram 13 is energized by a low-pressure hydraulic system 14 which includes a reservoir 15, a pump 16 and an accumulator 17. Fluid under pressure is conducted by a pipe 18 from the pump and accumulator through a relief valve 19 to a two-way selector valve 20. The latter is included in a pipe 21 and is operative in one position of adjustment to permit energizing fluid under pressure to enter a conduit 22 to retract the ram 13 in a manner to be described. In a second position of adjustment of the selector valve 20, fluid may leave the pipe 22 during working strokes of the ram and return to the reservoir 15 through the selector valve, pipe 23 and check valve 24. The relief valve 19 maintains constant the pressure of the fluid delivered to the conduit 22 by by-passing excess fluid through relief valve 19, pipe 25 and check valve 24 to the reservoir 15. The fluid employed in the low-pressure hydraulic system is preferably a liquid such as mineral oil, for example, and the system is so designed that the desired energizing pressures are obtained without compression of such fluid.

The manner in which the fluid from the low-pressure hydraulic system is utilized to operate the ram 13 is illustrated in Figures 2 and 3. Referring to the former figure, it will be noted that the ram 13 is hollow and that the interior thereof provides a chamber 26 for accommodat-

ing a body of fluid 27 which may be, and preferably is, an oil or other liquid which is more compressible than the mineral oil or liquid employed in the low-pressure hydraulic system, a silicone oil, for example. The ram 13 has an open upper end which is threaded as at 28 and which is enlarged to provide an internal shoulder 29. A cylinder 30 occupies the chamber 26, the external diameter of the cylinder 30 being substantially less than the diameter of the chamber 26 and the lower end of the cylinder being spaced from the bottom of said chamber, as illustrated. The upper end of the cylinder 30 is formed with a flange 31 which seats upon the shoulder 29 to support the cylinder in the chamber 26, a suitable sealing ring 32 being carried in an annular channel in the shoulder 29 and cooperating with the flange 31 on the cylinder to prevent leakage of the fluid medium between the shoulder and said flange.

The cylinder 30 is secured in the ram 13 in the manner described by the lower end of an upper cylinder 33, the lower end of the latter being externally threaded and occupying the threaded open end of the ram 13 so that the flange 31 of the cylinder 30 is tightly held between the shoulder 29 and the lower end of the cylinder 33. The ram 13, cylinder 30 and cylinder 33 are thus secured together so that they will move as a unit incident to the operation of the ram.

A small diameter piston 34 occupies the cylinder 30 while a large diameter piston 35 occupies the cylinder 33. The pistons 34 and 35, in the embodiment illustrated, are integral and are carried by a tubular member 36, the upper end of the latter being suitably connected to the overhead support 10. The tubular member 36, as shown, is integrally connected at its lower end to the upper end of the piston 35, the pistons 34 and 35 and the tubular member 36 being axially aligned and being supported as a stationary unit by the overhead member 10.

A sleeve 37 having an externally threaded central portion which is screwed into the upper end of the cylinder 33 is slidable along the tube 36 and the lower end of the sleeve provides a stop shoulder 38. The sleeve 37 and the tubular member 36 may carry sealing rings 39 and 40, respectively, to prevent leakage of the low pressure hydraulic fluid which is supplied to the tubular member 36 from the low pressure hydraulic system while the piston 35 may be provided with a similar sealing ring 41.

The lower end of the tubular member 36 is ported at 42 so that fluid from the said member may enter the cylinder 33 and in so doing cause the latter to be elevated to the position shown in Figure 3. As the cylinder 33 is elevated in the manner described, the ram 13 and cylinder 30 are elevated with it. Consequently as the piston 34 is stationary, the fluid in the chamber 27 will be compressed. This is clearly illustrated in Figure 3 wherein it will be noted that the cylinder 30 is entirely occupied by the piston 34. As the body of liquid 27 fills the chamber 26 when in its uncompressed state and when the ram 13 is in the extended position, it will be apparent that as the ram is elevated in the manner described, the body of fluid 27 will be reduced in volume and energy will thereby be stored in said body of fluid.

Assuming the ram 13 to occupy the elevated position shown in Figure 3, a working stroke of the ram is effected by adjusting the selector valve

20 so that the fluid in the cylinder 33 may exhaust through the pipe 22 and return through the selector valve 20 and check valve 24 to the reservoir 15. As this occurs, the body of fluid 27 in the chamber 26, which was compressed when the ram was elevated, expands rapidly to its normal volume and in so doing transforms the pressure existing in the chamber 26 into kinetic energy and rapidly accelerates the ram 13 in the direction of the anvil or die to effect a press-working operation upon the work-piece supported thereon. The press-working operation is effected by the impact of the ram 13 rather than by a squeezing operation such as characterizes a conventional press-working operation.

The piston 34 may carry sealing rings 34a for preventing escape of fluid from the chamber 26 between the cooperating walls of the piston and the cylinder 30. If desired, the sealing rings 34a may serve only during the low-pressure portion of the compression strokes and sealing during the high-pressure range of such strokes may be obtained by so designing the cylinder 30 that it will be compressed around the piston as disclosed and claimed in my co-pending application Serial No. 180,966, filed August 29, 1950.

The work-performing instrumentality described has a number of highly desirable advantages. The parts may be so designed that extremely high forces may be developed in the compressed fluid by a low-pressure hydraulic energizing system, it being apparent that the parts may be so designed that any desired pressure, within limits, may be developed in the chamber 26 by the energizing fluid supplied to the cylinder 33. For example, the parts may be so designed that a pressure of 30,000 p. s. i. may be developed in the chamber 26, thereby pre-loading the ram 13 in its fully retracted position so that upon release of pressure in the chamber 26 in the manner described, the ram 13 will be actuated to utilize such energy in a press-working operation.

It will be noted that the energy which is released by the expanding fluid in the chamber 26 is transferred to the ram 13 throughout its full range of movement so that the reaction forces acting on the supporting frame structure are progressively transmitted to the latter in a similar manner. As the forces to which the supporting frame structure is subjected are dissipated over the entire stroke of the ram, such structure may be relatively light and of corresponding low cost.

Although the use of oils and liquids of different compressibilities in the low-pressure hydraulic system and high pressure energy storing system has been described, it will be apparent that the work-performing instrumentality contemplated is of such a character that oil or other liquids of the same compressibility may be employed in both systems, if desired.

The features of the invention may be employed to advantage in connection with various devices having a member which is advanced incident to a work-performing stroke and which is retracted preparatory to such a stroke. The specific embodiment illustrated and described, therefore, is intended by way of example only.

I claim as my invention:

1. A device of the character described comprising a member having a hollow chamber therein, a cylinder extending into said chamber and spaced from the inside wall of said chamber, said cylinder having its inner end open and

communicating with said chamber, said chamber and cylinder being filled with a body of liquid and confining said body of liquid, a piston reciprocable through the outer end of said cylinder, a second piston rigidly secured to the first piston, a second cylinder rigidly secured to the first cylinder and in which the second piston reciprocates, means for applying a hydraulic motive fluid to one side of the second piston and exhausting said motive fluid therefrom to advance and retract the first piston in its cylinder, said first piston when advanced into its cylinder compressing said body of liquid, and valve means controlling the direction of flow of the hydraulic motive fluid to the said one side of the second piston.

2. A device of the character described comprising a reciprocable member having a hollow chamber therein, a cylinder extending into said chamber and spaced from the inside wall of said chamber, said cylinder having its inner end open and communicating with said chamber, said chamber and cylinder being filled with a body of liquid and confining said body of liquid, a stationary piston reciprocable through the outer end of said cylinder, and means for moving said reciprocable member in one direction to compress said body of liquid, and means for releasing said reciprocable member to permit said body of liquid to expand to drive said member in the opposite direction.

3. A device having a member which is advanced to perform a working stroke and which is retracted preparatory to a succeeding working stroke, said member having a chamber in which a body of liquid is confined, a cylinder extending into said chamber and spaced from the walls thereof, a stationary piston which occupies said cylinder, means for retracting said member and in so doing causing said piston to compress said body of liquid, and means for relieving said last mentioned means so that said body of liquid may expand to effect said working stroke of said member.

4. A device having a member which is advanced to perform a working stroke and which is retracted preparatory to a succeeding working stroke, said member having a chamber in which a body of liquid is confined, a cylinder extending into said chamber and spaced from the walls thereof, a stationary piston which occupies said cylinder, a fluid motor which is energized for retracting said member and in so doing causing said piston to compress said body of liquid, and means for deenergizing said fluid motor so that said body of liquid may expand to effect said working stroke of said member.

5. A device having a member which is advanced to perform a working stroke and which is retracted preparatory to a succeeding working stroke, said member having a chamber in which a body of fluid is confined and providing a cylinder, stationary first and second connected pistons, said first piston occupying said cylinder, a fluid motor having a second cylinder connected to said member and occupied by said second piston, means for supplying fluid under pressure to said motor to effect relative movement between said second cylinder and said second piston and in so doing cause said first piston to compress said body of fluid, and means for relieving said last mentioned means so that said body of fluid may expand to effect said working stroke of said member.

6. A device having a member which is advanced to perform a working stroke and which is retracted preparatory to a succeeding working stroke, said member having a chamber in which a body of liquid is confined, a cylinder extending into said chamber and spaced from the walls thereof, stationary first and second connected pistons, said first piston occupying said cylinder, a fluid motor having a second cylinder connected to said member and occupied by said second piston, means for supplying fluid under pressure to said motor to effect relative movement between said second cylinder and said second piston and in so doing cause said first piston to compress said body of liquid, and means for relieving said fluid motor so that said body of liquid may expand to effect said working stroke of said member.

7. A device having a member which is advanced to perform a working stroke and which is retracted preparatory to a succeeding working stroke, said member having a chamber in which a body of fluid is confined, a cylinder extending into said chamber, stationary first and second aligned, connected pistons, said first piston occupying said cylinder, a reciprocatory fluid motor having a second cylinder connected to said member and occupied by said second piston, a stationary tube which enters and which communicates with said second cylinder and axially of which said second cylinder may slide, means for supplying fluid under pressure through said tube to the interior of said second cylinder to effect relative movement between said second cylinder and said second piston and in so doing cause said first piston to compress said body of fluid, and means for permitting the fluid in said second cylinder to exhaust so that said body of fluid may expand to effect said working stroke of said member.

8. A device having a member which is advanced to perform a working stroke and which is retracted preparatory to a succeeding working stroke, said member having a chamber in which a body of fluid is confined, a cylinder extending into said chamber, stationary first and second pistons, said first piston occupying said cylinder, a reciprocatory fluid motor having a second cylinder connected to said member and occupied by said second piston, a stationary tube which enters and which communicates with said second cylinder and axially of which said second cylinder may slide, said first and second pistons and said tube being serially connected in axial alignment, means for supplying fluid under pressure through said tube to the interior of said second cylinder to retract it and in so doing cause said first piston to compress said body of fluid, and means for permitting the fluid in said second cylinder to exhaust so that said body of fluid may expand to effect said working stroke of said member.

9. A device having a member which is advanced to perform a working stroke and which is retracted preparatory to a succeeding working stroke, said member having a chamber in which a body of liquid is confined, a cylinder extending into said chamber and spaced from the walls thereof, stationary first and second pistons, said first piston occupying said cylinder, a reciprocatory fluid motor having a second cylinder connected to said member and occupied by said second piston, a stationary tube which enters and communicates with said second cylinder and axially of which said second cylinder may slide, said first and second pistons and said tube being serially connected in axial alignment, means for supplying liquid under pressure through said tube to the interior of said second cylinder to

retract it and in so doing cause said first piston to compress said body of liquid, and means for permitting liquid in said second cylinder to exhaust so that said body of liquid may expand to effect said working stroke of said member.

10. A compound fluid motor comprising a hollow member open at one end, a cylinder extending into said hollow member and open at its inner end to communicate therewith, a piston reciprocable in said cylinder, means including said cylinder and said piston for closing the open end of said hollow member, said hollow member and cylinder being filled with a body of liquid which is of high compressibility, a second piston secured to the first piston, a second cylinder in which the second piston reciprocates, said second cylinder being secured to the first cylinder, and means for supplying a liquid of low compressibility between one end of the second piston and the adjacent end of the second cylinder and for exhausting said last-named liquid therefrom to compress said body of highly compressible liquid and to permit the same to expand, respectively, and a valve for controlling the direction of flow of the liquid of low compressibility.

PAUL H. TAYLOR.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
786,236	Ross	Mar. 28, 1905
904,528	Hamilton et al.	Nov. 24, 1908
1,857,624	Degenhardt et al.	May 10, 1932
2,163,982	Mercier	June 27, 1939
2,346,667	Dowty	Apr. 18, 1944
2,560,005	Shawbrook et al.	July 10, 1951
2,563,194	Shawbrook	Aug. 7, 1951
2,574,875	Lang	Nov. 13, 1951

FOREIGN PATENTS

Number	Country	Date
485,617	Great Britain	May 16, 1938

OTHER REFERENCES

Dow Corning Silicone Note Book, Fluid Series No. 3, issued September 1948, page 27, published by Dow Corning Corp., Midland, Mich.