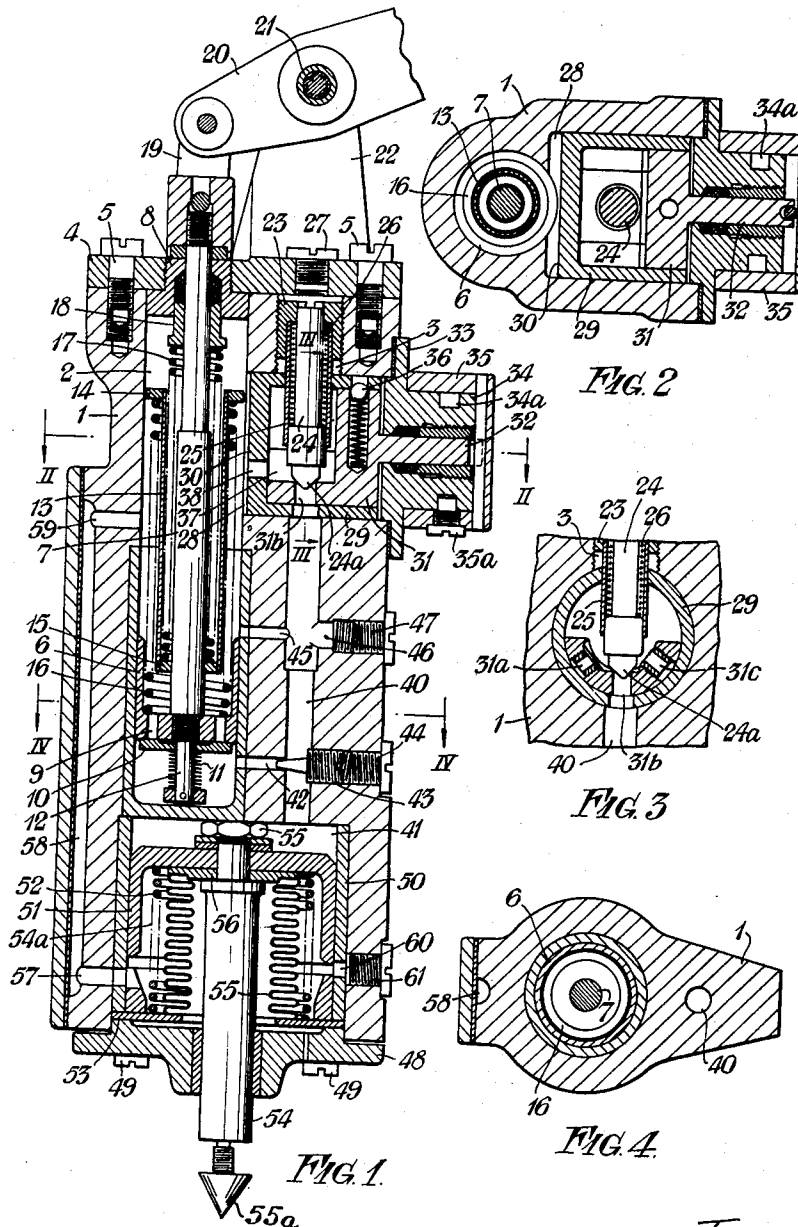


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 APPARATUS FOR APPLYING PREDETERMINED LOADS
 TO OBJECTS FOR TESTING HARDNESS
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APPARATUS FOR APPLYING PREDETERMINED LOADS TO OBJECTS FOR TESTING HARDNESS

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This invention relates to apparatus for applying a predetermined load to an object for purposes such as testing hardness, the apparatus being of the kind in which the said load is applied by displacement of a loading piston in a chamber under the action of liquid pressure, the position of the chamber being fixed in relation to the object. Such apparatus may, for example, conveniently be used in conjunction with a diamond or other indenter for ascertaining the hardness of a specimen of metal, the indenter being impressed into the specimen under known load, which is maintained for a period to overcome resistance to plastic deformation, and subsequently released.

A main object of the invention is to provide a generally improved apparatus of the above kind which is extremely efficient in use and in which the applied load can be varied in a simple manner, the possibility of human error being reduced to a minimum.

According to the present invention, there is provided an apparatus of the kind specified for applying a predetermined load to an object for testing hardness and other purposes, wherein the spring-actuated return stroke of an operating piston working in a liquid reservoir, is arranged to apply the necessary pressure to the working liquid for operating the loading piston and wherein the said reservoir, on the pressure side of the operating piston, is connected with the chamber containing the loading piston through a conduit system which includes a return conduit leading back into the reservoir on the non-pressure side of the operating piston, said return conduit being controlled by a regulating valve having a movable valve member which is subjected to liquid pressure equally with the loading piston and which valve can be adjusted manually so as to open when said pressure reaches any one of a number of predetermined maximum values thereby permitting liquid to flow back into the reservoir on the non-pressure side of the operating piston and preventing further build-up of pressure on the loading piston above the selected maximum value, the arrangement being such that the pressure on the loading piston can be maintained at the said maximum value until a predetermined point in the return stroke of the operating piston is reached whereupon the pressure in the system is automatically relieved and the moving parts of the apparatus are free to return to their starting positions under spring-influence.

In order that the invention may be clearly un-

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derstood and readily carried into effect one embodiment thereof will now be described in detail with reference to the accompanying drawings wherein—

Figure 1 is a sectional side elevation illustrating one form of apparatus according to the invention, part of the operating handle being broken away,

Figure 2 is a cross-section on the line II—II of Figure 1,

Figure 3 is a sectional elevation on the line III—III of Figure 1, and

Figure 4 is a cross-section on the line IV—IV of Figure 1.

Referring now to the drawings, a body member 1 is arranged for mounting on any suitable structure, not shown, of sufficient strength to hold the body member rigid whilst a load is being applied to any particular object. The body member 1 is formed internally with a cylindrical liquid reservoir 2 and with an internally screw-threaded bore 3 both of which open through the top of the body member and are located with their longitudinal axes substantially parallel to the longitudinal axis of the body member. The reservoir 2 and bore 3 are closed at their upper ends by means of a plate 4 which is bolted to the top of the body member 1 by means of bolts 5.

An operating or pressure piston 6 is arranged to reciprocate within the reservoir 2, and a piston rod 7, the upper end of which extends through a bush 8 screwed into an aperture in the plate 4, is secured to the piston 6. A plurality of apertures 9 extend axially through the head of the piston from front to rear, these apertures being normally closed by a non-return valve disc 10 which is urged against the working face of the piston 6 by means of a spring 11 mounted on a headed pin 12 which projects centrally from the working face of the piston 6. A floating sleeve member 13 surrounds the piston rod 7, this member 13 having an outwardly directed flange 14 at its upper end and an inwardly directed flange 15, which closely surrounds the piston rod 7, at its lower end. A coil spring 16 surrounds the sleeve 13 and bears, at its lower end, against the rear surface of the head of the piston 6 and, at its upper end, against the under-surface of the flange 14. Within the annular space between the piston rod 7 and the sleeve 13 there is arranged a second coil spring 17 which bears, at its lower end, against the upper surface of the inwardly directed flange 15 of the sleeve and, at its upper end, against the under-surface of a flanged bush 18 which closely surrounds the piston rod 7 and

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which is secured partially within the bush 8 as shown.

The upper end of the piston rod 7 which extends through the plate 4 is connected, by means of a pivoted link 19, to one end of a handle 20 which is pivotally mounted intermediate its length as at 21 on an upstanding lug 22 which is secured on the plate 4.

A screw-threaded plug 23 having an axial aperture therethrough, is screwed into the bore 3 and serves as a guide for the valve stem 24 of an axially displaceable pressure-regulating valve member or head 24a. Surrounding the valve stem 24 is a sleeve 25 within which is arranged a coil spring 26 which surrounds the valve stem 24 and bears between the valve member 24a and an annular ledge within the plug 23. The plate 4 is formed with a screw-threaded aperture immediately above the plug 23, this aperture being normally closed by a screw-threaded plug 27.

The lower end of the bore 3 is arranged to open into a cylindrical transverse chamber 28 which opens at one end into the reservoir 2 and at the other end through the side wall of the body 1. Fitting tightly within this chamber is a cylindrical liner 29 the inner end 30 of which is closed. The liner 29 is provided with two diametrically opposed apertures in its side wall and the valve member 24a projects diametrically into the liner 29 through one of these apertures. Rotatably arranged within the liner 29 is a valve body 31 formed with three radial apertures 31a, 31b and 31c therethrough, the axes of these apertures all extending radially with respect to the transverse longitudinal axis through the centre of the valve body and also lying in a common plane which is perpendicular to the said axis. By rotating the valve body 31 about its transverse axis as aforesaid any one of the three apertures, all of which have different cross-sectional areas, can be brought into alignment with the aperture through the liner wall 29 which lies opposite the valve member 24a and in this position, provide a seating for the said valve member. The valve body 31 is provided with an outwardly projecting stem 32 which is arranged to extend axially through a plate 33 covering the outer end of the chamber 28 and formed with a concentric boss 34. At the outer end, the stem 32 is attached to a manually operable knob 35 which is rotatably held on the boss 34, by means of a screw 35a engaging in an annular groove 34a around the boss, for the purpose of turning the body member within the liner to change the valve seating as aforesaid. A spring-influenced ball member 36 is carried by the valve body 31 and arranged to co-operate with recesses in the liner 29 for the purpose of locating the valve body in predetermined positions of adjustment. The body 31 is shaped to provide a valve chamber 37 within the liner 29 and this chamber communicates with the reservoir 2 through a port 38 in the closed end 30 of the liner.

The valve chamber 37 communicates through one of the valve-controlled seatings 31a, 31b, or 31c, according to the position of adjustment of the valve body 31, and through the adjacent aperture in the wall of the liner 29, with an axially extending conduit or bore 40, the lower end of which opens into a cylindrical recess 41 in the lower end of the body member. The conduit or bore 40 also opens, through a conduit or orifice 42 into the lower end of the reservoir 2, this conduit or orifice 42 being controlled by a time-regulating valve 43 which is mounted in a screw-

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threaded aperture in the wall of the body 1. The outer end of the aperture containing the time-regulating valve is closed by a screw plug 44. The bore or conduit 40 also opens intermediate its length and through a conduit or orifice 45 into the reservoir 2 at a point adjacent the upper edge of the piston 6 when the latter is in its lowermost position as shown in Figure 1. The conduit 45 is accessible from the outside of the body 1 through a coaxial passage 46 in the body wall, this passage being normally closed by a plug 47.

The cylindrical chamber 41 is closed by a plate 48 secured by screws 49 to the lower end of the body 1. The chamber 41 is lined by a bush 50 and contains a loading piston 51 which is arranged to reciprocate therein, a coil spring 52 being arranged to bear between the under-surface of the piston head and a plate 53 which latter is clamped between the cover 48 and bush 50. A piston rod 54 extends, at its upper end, through the piston head where it is secured by means of a nut 55 and, at its lower end, through a central aperture in the plate 48 for the reception of a suitable indenter shown diagrammatically at 55a. An auxiliary liquid reservoir 54a is provided beneath the piston 51, the inner wall of the reservoir being formed by a flexible metal bellows 55 which is soldered at its upper end to a plate 56 clamped beneath the head of the piston by means of a shoulder on the rod 54, and at the other end is soldered to the plate 53. This auxiliary reservoir is connected through conduits 57, 58 and 59 with the main reservoir 2, the conduit 59 opening into the latter reservoir on the non-pressure side of the piston 6, and serves to prevent external oil leakage from the system. An outlet 60 from the chamber 41 to atmosphere is formed through the bush 50 and body wall, this outlet being normally closed by a screw plug 61.

In operation, assuming that a known load is to be applied for a predetermined period to an object positioned beneath the rod 54, the body member 1 being attached to a fixed structure as aforesaid, the handle 20 is depressed so as to turn it about the pivot 21 and thereby lift the piston 6 in the reservoir 2 against the action of the springs 16 and 17 which are consequently compressed. During this upward movement of the piston 6, the non-return valve disc 19 will move away from the piston face against the action of its spring 11 and permit liquid in the reservoir 2 to pass freely through the apertures 9 in the piston head and into the lower portion of the reservoir 2 which is below, and therefore on the pressure side of, the said head. When the handle 21 is released, the springs 16 and 17 tend to restore the piston 6 to its starting position shown in Figure 1. The liquid between the working face of the piston 6 and the lower end of the reservoir 2 cannot now however flow back through the apertures 9 during the downward movement of the piston under the spring action, since these apertures are masked by the non-return valve disc 19. A pressure is thus set up which causes the liquid to flow through the conduit 42 past the time-regulating valve 43 and into the conduit 40 from whence it flows downwards into the chamber 41 and upwards towards the valve chamber 37 so as to transmit pressure equally to the loading piston 51 and the valve head 24a. At this stage the conduit 45 is masked by the side wall of the downwardly traveling piston 6.

As a result of this pressure, the spring 52 is overpowered and the loading piston 51 moves

from its initial position as shown in Figure 1 in a downward direction until the indenter or the like carried on the lower end of the rod 54 contacts the object upon which it is desired to exert and maintain a known pressure for a predetermined period. As this contact constricts movement of the loading piston 51 and as pressure is still being exerted by the operating or pressure piston 6, the pressure on the loading piston and on the relief valve 24a builds up until it reaches a predetermined value, dependent upon the strength of the spring 26 urging the valve 24a against its seating and upon the cross-sectional area of the aperture through the seating. At this predetermined value the valve 24a lifts against the action of its spring and permits liquid to pass from the pressure side of the system through the valve chamber 37 and port or conduit 38 thereby preventing further build-up of pressure, the liquid returning to the reservoir 2 on the non-pressure side of the piston 6. When the valve 24a is unseated, the pressure which is still being exerted by the operating piston 6 causes the liquid to continue to flow past the time-regulating valve 43 and maintain the predetermined pressure on the loading piston 51 and at the same time causes the liquid to flow past the valve 24a into the chamber 37 as aforesaid. This continues until sufficient liquid has passed to permit the piston 6 to travel sufficiently far towards its initial position to uncover the conduit 45 in the reservoir wall. When this stage is reached, liquid can flow freely from the pressure-exerting parts of the system, i. e. the valve 24a, the piston 51 and the piston 6. The pressure is thus released from the valve 24a which re-seats itself under the action of its spring 26; from the loading piston 51 which assumes its initial position under the action of its spring 52 and from the operating piston 6 which is then fully returned to its starting position under the action of its springs 16 and 17. All the parts are therefore brought automatically to their initial positions as shown in Figure 1, at the end of the operating cycle which can be repeated as required by actuating the handle 20. The time taken to complete a cycle of operations can be adjusted by means of the time-regulating valve 43 and similarly the maximum pressure which is applied to the loading piston 51 can be varied by rotating the knob 35 to bring a valve having a larger or smaller aperture into alignment with the regulating valve 24a. For additional regulation of the pressure at which the valve 24a opens, the spring 26 may, of course, be replaced by a weaker or stronger spring.

During downward movement of the piston 51, the bellows 55 are compressed and the volume of the auxiliary reservoir 54a is correspondingly reduced, the reduction of volume being compensated by a flow of liquid from the auxiliary reservoir through conduits 57, 58 and 59 into the main reservoir 2. Upon return of the piston 51 a similar flow occurs in the reverse direction. Thus if any liquid under pressure leaks past the walls of the piston 51 during operation of the latter, a similar compensatory flow will take place through conduits 57, 58 and 59.

As will be appreciated, the apparatus as described is not limited to use in ascertaining the

hardness of objects and can in fact be applied wherever it is desired to maintain a known load on an object for a predetermined period.

I claim:

1. An apparatus for applying predetermined loads to objects for measuring hardness comprising a body member adapted for mounting in a fixed position relatively to an object under test, a loading piston mounted in a closed cylindrical chamber in said body member, means extending through an adjacent closed end of said chamber for transmitting a load on said piston to the object under test, a main reservoir for working liquid, conduit means connecting said reservoir with said cylindrical chamber in front of the working face of said loading piston, a pressure piston operative in said reservoir to cause said working liquid to flow under pressure through said conduit means and into said chamber thereby applying a load to said loading piston, a flexible sealing bellows secured between the rear face of said loading piston and the said end of the cylindrical chamber through which the load transmitting means passes to form the inner wall of a substantially annular auxiliary reservoir of variable volume, the outer wall of said auxiliary reservoir being constituted by the chamber wall located behind said piston, and conduits connecting said auxiliary reservoir with said main reservoir on the non-pressure side of said pressure piston, the arrangement ensuring that any working liquid which leaks under pressure past said loading piston enters said auxiliary reservoir and is thence returned to said main reservoir.

2. An apparatus as claimed in claim 1 in which said load transmitting means is constituted by a piston rod extending from the rear face of said loading piston through the adjacent closed end of said cylindrical chamber, said flexible bellows being arranged concentrically around said piston rod and having opposite ends secured, in a liquid-tight manner, respectively to the rear loading piston face and said adjacent closed end of the chamber.

3. An apparatus as claimed in claim 2 having an outlet to atmosphere from said auxiliary chamber, and a removable plug inserted in said outlet.

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