

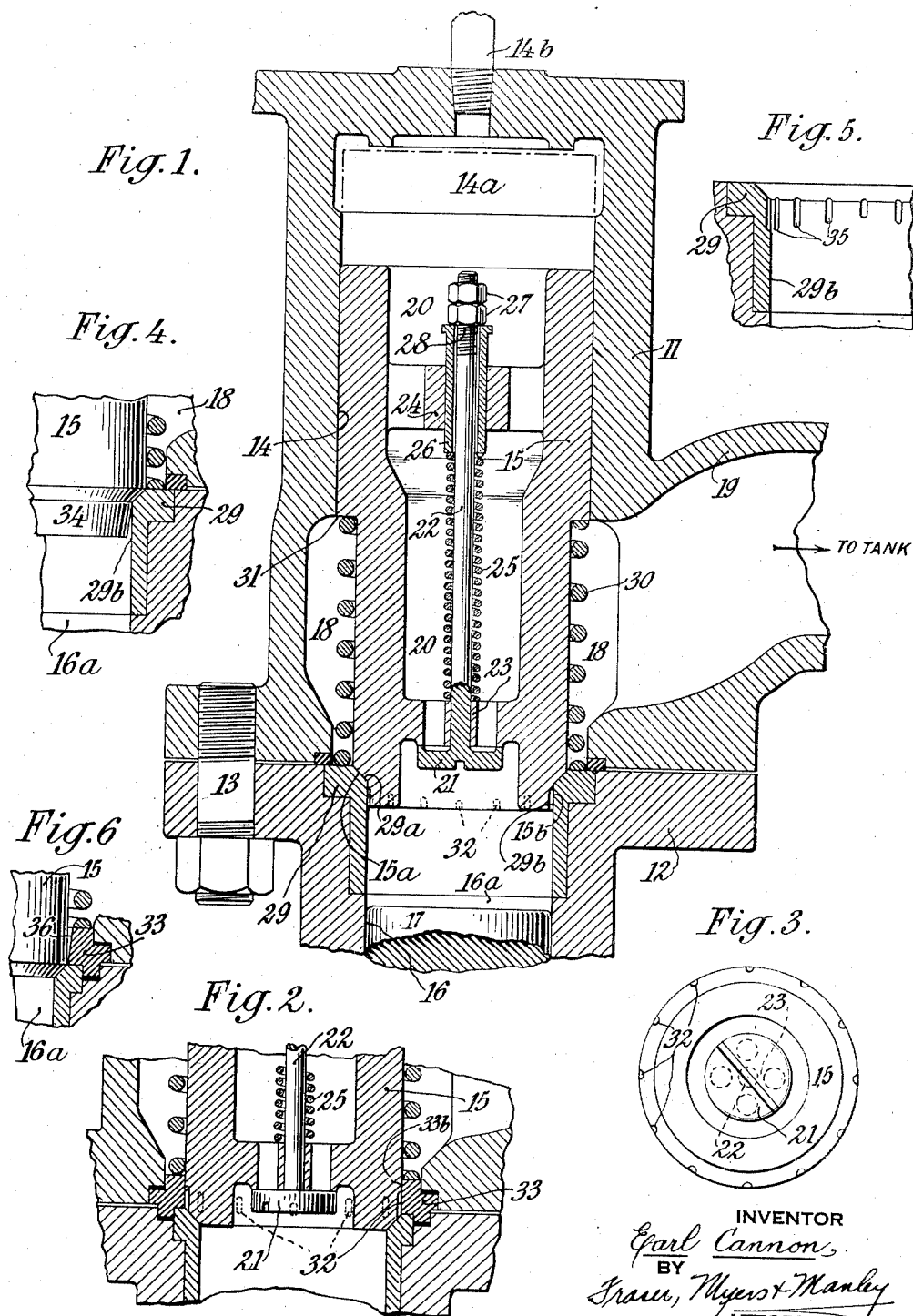
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PREFILL VALVE FOR HYDRAULIC PRESSES

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PREFILL VALVE FOR HYDRAULIC PRESSES

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This invention relates to improvements in prefill valves (otherwise known as surge valves) which are employed for permitting the rapid filling and exhaustion of the ram work chamber of a hydraulic press with oil or other fluid during the operation thereof.

The initial filling of the ram work chamber, prior to the establishment of a relatively high working pressure therein, ordinarily takes place as a result of suction which is set up in said chamber by the advance of the ram to a point where it initially engages the material being processed, various expedients being available for achieving such advance of the ram. To that end, auxiliary hydraulic rams may, for example, be arranged to coact with opposite sides of the platen or die carried at the outer end of the ram of a hydraulic press, or suitable means may be directly combined with the prefill valve and the working ram of a hydraulic press in a manner clearly described and illustrated in Patent No. 2,127,324, issued upon my co-pending application, Serial No. 105,005, filed October 10, 1936. The present invention, however, does not depend upon the means employed for advancing the ram.

Prefill valves may either be normally held closed by tensioned springs, under which arrangement the flow of fluid past such a valve must work against the tension of the spring, or they may be held normally open by tensioned springs, under which latter arrangement the flow of fluid is substantially unimpeded by the action of the valve as controlled by the spring tension. For this, and other reasons, the latter arrangement is generally preferred.

Where, however, prefill valves are arranged to be held normally open by spring tension, a very objectionable and detrimental shock may be encountered when the valve is opened upon the return stroke of the ram. This shock is apparently caused by the practically instantaneous release of the high working pressure from within the ram work chamber at the instant of the opening of the prefill valve. Spring-opening prefill valves, heretofore developed, are so designed that a relatively slight opening movement thereof suffices to completely and instantaneously release the high working pressure and, hence, to suddenly release the structural stresses normally encountered in the operation of the press. The sudden release of such structural stresses subjects the press to shock and strains which are detrimental to the press structure.

Independent exhaust ports have heretofore been successfully employed with spring-opening

valves to effect a controlled exhaustion of the ram work chamber and thus eliminate shock. With this arrangement, extra piping was needed, yet this disadvantage was outweighed by the several advantages of the valve over the spring-closing type of valve.

The principal object of the present invention is the provision of means in a spring-opening type of prefill valve for alleviating or minimizing any objectionable shock of the character heretofore referred to, without, however, employing any additional piping to achieve such result.

This object and certain advantages which result from the attainment thereof are achieved by my invention as described in the following specification and shown, for illustrative purposes only, in the accompanying drawing, in which:

Figure 1 is a vertical substantially diametrical section of a prefill valve employing a preferred embodiment of my invention.

Fig. 2 is a fractional section, similar to Fig. 1, illustrating another embodiment of my invention.

Fig. 3 is an elevational view of the under side of the valve illustrated in Fig. 2.

Figs. 4, 5 and 6, are details of still further embodiments of my invention.

The invention, as illustrated in Fig. 1, is embodied in a prefill valve comprising a closed-top valve casing 11, and a ram chamber casing 12 held together by bolts 13 (only one being shown), the casing 11 having a bore 14 into which a valve element 15 is accurately fitted and adapted to axially slide therewithin between a lowermost or closed position and an uppermost or open position, as indicated respectively in full and broken lines in the drawing, and the casing 12 having a bore 16, preferably in axial alignment with the bore 14 but being somewhat smaller in diameter than the latter, said bore forming a ram chamber 16a. A ram 17 is accurately fitted into and adapted to slide within said ram chamber.

The interior space above the valve element (said space being hereinafter referred to as a valve-closing chamber 14a) varies in size with the movement of the valve element 15 between its extreme positions. A port 14b in the top of the casing 11 is provided for the introduction of fluid under pressure into said valve-closing chamber and also serves for the exhaustion of said chamber.

The bore 14 in the valve casing is enlarged at its lower end to form an annular surge chamber 18 which may be connected by a pipe 19 to a tank or other suitable container holding a supply of fluid for use in operating the press; such con-

tainer, however, not being shown in the drawing as such a showing is not necessary for an understanding of the invention.

The valve element 15 is provided with an interior passage 20 which extends axially and preferably concentrically from the outer or upper end of said element to the inner or lower end thereof. The said passage is normally closed by a check valve 21 having a stem 22 extending through openings in lower and upper perforate webs 23 and 24, respectively, within the valve element 15. The said check valve normally seats upon the under side of the web 23 in position to close the perforations in the latter and, hence, to effect closure of the passage 20. The check valve is normally held in its uppermost or closed position, as shown in the drawing, by a compression spring 25 which is disposed about the stem 22. Said spring seats at its lower end against the web 23 and at its upper end against a bushing 26 which is accurately fitted to slide within the web 24 and extends upwardly therefrom and is held upon the said stem by locking nuts 27 screwed onto a threaded upper end portion 28 thereof.

The mounting of the check valve upon the two webs 23 and 24 serves to maintain the valve 21 in proper alignment and the bushing 26 serves to transmit the force of the spring 25 to a point above the upper web 24 where it acts upon the nuts 27 to normally hold the check valve closed. The disposition of said nuts above the web 24 renders them easily accessible for adjusting the tension of the spring 25, the threaded portion 28, for this purpose, being of sufficient length to permit any desired range of adjustment.

The downward movement of the valve element 15 is limited by its engagement with an annular valve seat member 29 which is fitted tightly within the upper end of the bore 16 in the ram chamber casing. Coacting oblique seating surfaces 15a and 29a are provided on the valve element 15 and the valve seat member 29, respectively, and coacting vertical seating surfaces 15b and 29b are provided on said valve element and valve seat member respectively, all said seating surfaces contributing to afford a substantially tight seal against the passage of fluid when the valve is closed. It is to be understood, of course, that the seating surfaces 29a and 29b may, if desired, be formed directly upon the casing 12, thus eliminating the valve seat member 29 as a separate member. The illustrated construction is preferred, however, as it permits the ready and economical replacement of worn seating surfaces.

A compression spring 30 is disposed about a reduced lower portion of the valve element 15, and seats, at its lower end, against the valve seat member 29, and at its upper end, against a shoulder 31 on said valve element whereby to normally hold the latter in its uppermost or open position.

A plurality of grooves 32 of various lengths are provided in the lower part of the valve element 15. These grooves are disposed about and interrupt the vertical seating surface 15b of the valve element and extend, preferably vertically, from the lower edge of said seating surface to points thereon which are at various distances from the upper limit thereof. The said disposition is such that each groove is matched by a diametrically opposite groove of a similar size, whereby to maintain a balance in the effect of said grooves in the operation of the valve. It will be seen that, as the valve element 15 rises to open, the oblique seating surfaces 15a and 29a become instantly disengaged

over their entire areas and the longer grooves 32 and then the shorter grooves 32, in succession, extend beyond the upper edge of the vertical seating surface 29b of the valve seat member, thus establishing a relatively gradual progressive fluid communication between the fluid inside the ram chamber and the fluid in the surge chamber 18 and permitting a relatively gradual release of the high working pressure existing in the ram chamber. Although the opening of the valve, in the practical operation of the press, takes place in a fraction of a second, the grooves 32 may nevertheless be so proportioned and arranged that the fluid pressure in the ram chamber 16a may be sufficiently reduced to substantially alleviate and minimize any objectionable shock, before the relatively sliding seating surfaces 15a and 29a become completely disengaged upon the opening of the valve.

The cycle of operation commences with ram 17 in its uppermost position, as indicated in the drawing, the valve element 15 in a raised or open position, as indicated in broken lines, the check valve 21 closed and with fluid under substantially atmospheric pressure in the ram chamber 16a, the surge chamber 18, and in the valve closing chamber 14a. The ram 17 is caused to descend by any suitable means, as, for example, by separate hydraulically operated rams (not shown) which may operate directly upon the platen or die normally attached to the lower end of the ram 17. The descent of the ram causes fluid to be drawn or sucked through the pipe 19 into the surge chamber 18 and thence past the raised valve element 15 into the ram cylinder 16a.

Fluid is then admitted under relatively high pressure through the port 14b into the valve-closing chamber 14a causing the valve element 15 to descend to a closed position. The continued introduction of pressure through the port 14b sets up pressure in the valve-closing chamber sufficient to open the check valve 21 against the tension of the spring 25, thus establishing fluid communication between the valve-closing chamber 14a and the ram chamber 16a and permitting the introduction of a suitable working pressure into the latter chamber. The pressure thus introduced into said ram chamber through the port 14b may be raised to the extent necessary to cause the ram to fully perform its desired work.

It will be seen that after the check valve 21 opens, a substantially uniform fluid pressure is present in both the valve-closing chamber 14a and the ram chamber 16a. As the effective upper surface of the valve element 15 which is subjected to downward pressure is of greater area than the effective lower surface thereof which is subjected to upward pressure, it is obvious that there is a predominant downward force exerted upon the valve element 15 which operates to hold said element in a closed position while working pressure is maintained in the ram chamber, it being apparent that the excess downward force must be sufficient to overcome, in addition, the expansive force of the spring 30.

The return stroke of the ram is accomplished by simultaneously releasing the pressure in the valve-closing chamber 14a through the port 14b and raising the ram by any suitable means which may be the same or similar means as were used to effect the descent of the ram on the down stroke. The release of the pressure in the valve-closing chamber permits the exhaustion of said chamber through the port 14b, which exhaustion takes place as the valve element 15 is forced up-

wardly toward its open position by the expansive force of the spring 30 and by the raising of the ram.

The valve element 15, at the commencement of the return stroke of the ram, first becomes unseated at the oblique seating surfaces 15a and 29a, while the vertical seating surfaces 15b and 29b remain in substantially coacting relationship, but as the valve element 15 continues its upward movement and while said coacting relationship continues, the several grooves 32, in succession, establish a relatively gradual progressively increasing fluid communication between the ram chamber 16a and the surge chamber 18 and, hence, a gradual release of the working pressure in the ram work chamber, thus preventing any detrimental sudden release of structural stresses. First the longer of said grooves becomes effective in the manner stated, and then the shorter of said grooves, the communication between the two said chambers becoming progressively greater as the upward movement of the valve element continues until the seating surfaces 15b and 29b become completely disengaged, whereupon there is a substantially complete communication between the ram chamber and the surge chamber. Although the opening of the valve and the return stroke of the ram is substantially instantaneous in practice, nevertheless the grooves 32, as hereinbefore stated, may be proportioned to gradually, but quickly, release the working pressure and thus eliminate objectionable shock.

While the embodiment of Fig. 1 provides vertical seating surfaces which are below the oblique seating surfaces, the said relative positions thereof may be reversed if desired, as illustrated in Fig. 2. The embodiment illustrated in the latter figure includes a packing ring 33 having a vertical seating surface 33b coacting with the lower portion of the outer vertical wall of the valve element 15, which portion serves as a vertical seating surface and has a plurality of grooves 32 of various lengths extending upwardly from the lower edge of said vertical wall, the longer of said grooves extending to a point on said wall which, when the valve is completely closed, is just below the top surface of the packing ring 33. In this modification, the grooves 32 operate similarly to those employed in the modification of Fig. 1. As the valve element 15 is raised, the oblique seating surfaces first become disengaged, and then grooves 32 in succession establish communication between the ram chamber and the surge chamber.

The embodiment illustrated in Fig. 4 functions similarly to that illustrated in Fig. 1 but differs from the latter structurally in that no grooves such as grooves 32, are employed, but an outer surface 34, referred to hereinafter and in the appended claims, as a seating surface, is provided to coact with the vertical seating surface 29b of the valve seat 29 to permit a relatively gradual establishment of fluid communication between ram chamber 16a and surge chamber 18. The seating surface 34, as illustrated herein, is angularly disposed relatively to the seating surface 29b, being slightly spaced from the latter at its lower end and entering into engagement therewith at its upper end. The principle employed in this modification is similar to that employed in the other modifications. As the valve element 15 moves upwardly to an open position, the oblique seating surfaces first become completely disengaged, whereupon there is first established a restricted communication between the ram and surge chambers—which communication, because

of the angular relationship of the seating surfaces 34 and 29b, becomes progressively greater as the valve opens and permits a substantial reduction of the pressure in the ram work chamber before the coaction between the seating surfaces 34 and 29b ceases.

Fig. 5 illustrates a further embodiment of the invention, which differs from the embodiment of Fig. 1 only in that grooves 35 are provided in the vertical seating surface 29b of the valve seat member instead of the grooves 32 in the vertical seating surface 15b of the valve element. Obviously, if the valve seat member 29, as a separate element, were to be omitted, as hereinbefore suggested, the grooves 35 could be formed in the upper portion of the bore 16. It may also be desirable, under some circumstances, to provide grooves in both the valve element and the valve seat member.

The embodiment of Fig. 6 employs the principle of angularly disposed coacting seating surfaces similarly to Fig. 4, but an angular seating surface 36 is provided upon the packing ring 33 instead of on the valve element 15.

In the following claims the expression "cut away portion" or the limitation that a surface or portion is "cut away" are not used to define the method by which such portion or surface is formed but to define a structural characteristic or form of such portion or surface.

It will be apparent from the foregoing that my invention as described herein and illustrated in the accompanying drawings, solely for illustrative purposes, may be employed in various structures and in various modifications of the seating surfaces without, however, departing from the spirit of the invention as defined in the following claims.

What I claim is:

1. A hydraulic press or the like and a prefill valve therefor, comprising a ram chamber having a port for the filling and exhaustion thereof, means for conducting fluid at relatively low pressure to and from said port and a reciprocating valve element coacting with said port whereby to close the latter and retain fluid at relatively high working pressure in said ram chamber, said valve element and port having coacting surfaces one of which is substantially parallel to the line of movement of the valve element and another of which, at one extreme position of the valve element is adapted to coact with said substantially parallel surface whereby to substantially close said port, and has a progressively cut away portion which, during movement of the valve element from said extreme position, forms with the said parallel surface, a progressively enlarging means for passing fluid through said port.

2. In a prefill valve for hydraulic presses or the like having a ram chamber, a port to said chamber for passing fluid therinto and a movable valve element adapted to close said port, means for establishing a relatively gradual increase in the passage of fluid through said port during the opening movement of said valve, said means comprising a pair of coacting oblique seating surfaces on the valve element and about the port, said surfaces being disposed obliquely relatively to the line of movement of said valve element, and a second pair of seating surfaces on said element and about said port, one seating surface of said second pair being disposed substantially parallel to the line of movement of said valve element, the said second pair of surfaces being adapted to coact in varying degrees to effect a relatively

gradual increase in the passage of fluid through said port during the opening movement of the valve element, and one of the seating surfaces of said second pair being cut away to varying degrees along its effective axial length, whereby to variably restrict the passage of fluid through said port.

3. A hydraulic press or the like and a prefill valve therefor, according to claim 1, the said cut away portion comprising a plurality of grooves adapted to successively become operative as fluid passages with the movement of the valve element.

4. A hydraulic press or the like and a prefill valve therefor, according to claim 1, the said cut away portion comprising a plurality of grooves in the valve element adapted to successively become operative as fluid passages with the movement of the valve element.

5. A hydraulic press or the like and a prefill valve therefor, according to claim 1, the said cut away portion comprising a plurality of grooves, in the said surface of the port, adapted to successively become operative as fluid passages with the movement of the valve element.

6. A hydraulic press or the like and a prefill valve therefor, according to claim 1, the said cut away portion being cut away angularly to the said parallel surface, whereby to provide various-sized passages between said surfaces when the latter are disposed in various relative positions.

7. A hydraulic press or the like and a prefill valve therefor, according to claim 1, the said cut away portion being on the valve element and being cut away angularly to a coacting portion of the surface of the port, whereby to provide vari-

ous-sized passages between said surfaces when the latter are disposed in various relative positions.

8. In a prefill valve for hydraulic presses or the like having a ram chamber, a port to said ram chamber for passing fluid therein, and a movable valve element adapted to close said port, means for restricting the passage of fluid through said port during the opening movement of the valve element, said means comprising coacting seating portions disposed on said element and about said port, and coacting surfaces disposed on said element and about said port, one of said surfaces having spaced-apart portions comprising a plurality of grooves of various lengths adapted to successively establish fluid communication through said port during the opening movement of the valve element.

9. In a prefill valve for hydraulic presses or the like having a ram chamber, a port to said ram chamber for passing fluid therein, and a movable valve element adapted to close said port, means for restricting the passage of fluid through said port during the opening movement of the valve element, said means comprising coacting seating portions disposed on said element and about said port, and coacting surfaces disposed on said element and about said port, one of the said coacting surfaces being disposed angularly relatively to the other whereby to afford a gradually increasing fluid communication through said port during the opening movement of the valve element.

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