Oct. 21, 1930. H. R. TILL 1,779,056

PRESSURE RESPONSIVE DEVICE

Filed Aug. 20, 1927

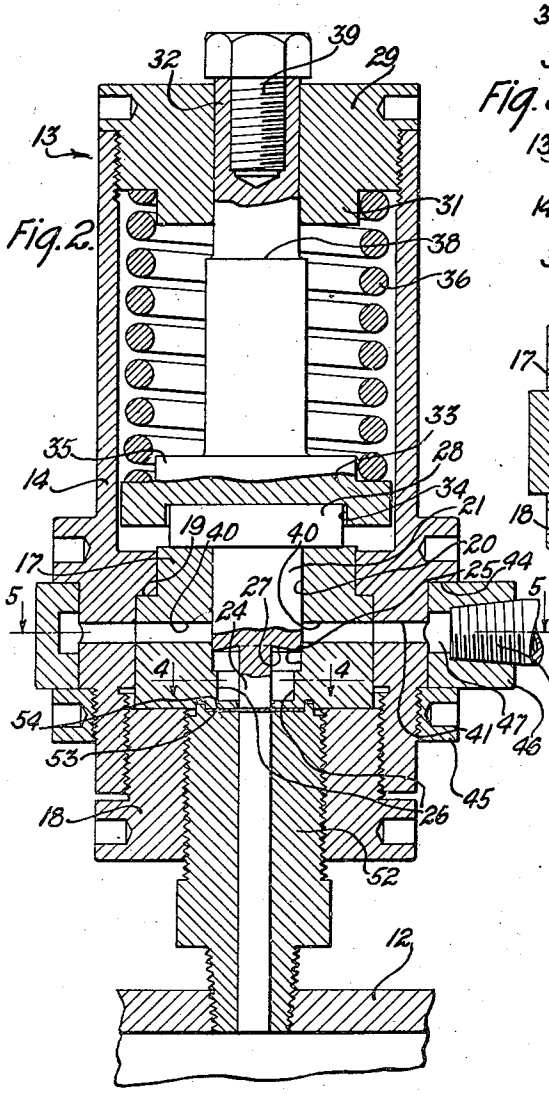


Fig. 2.

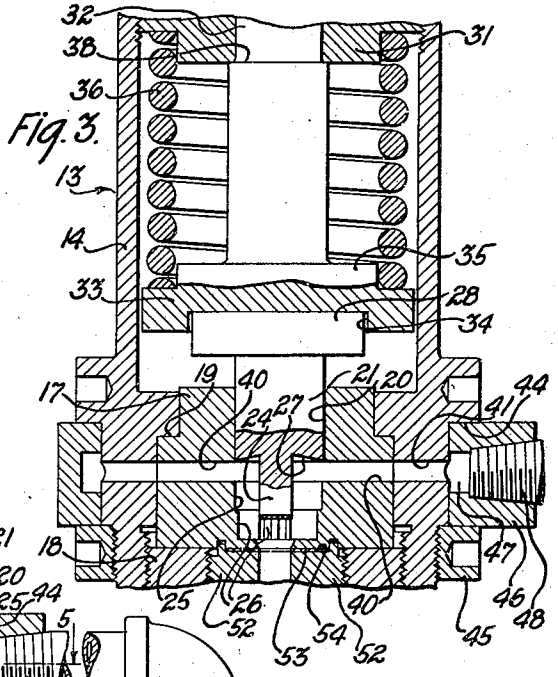


Fig. 3.

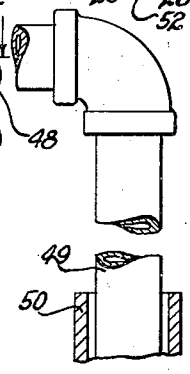


Fig. 4.

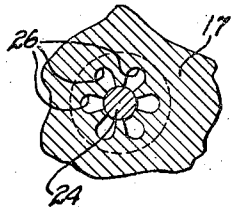


Fig. 5.

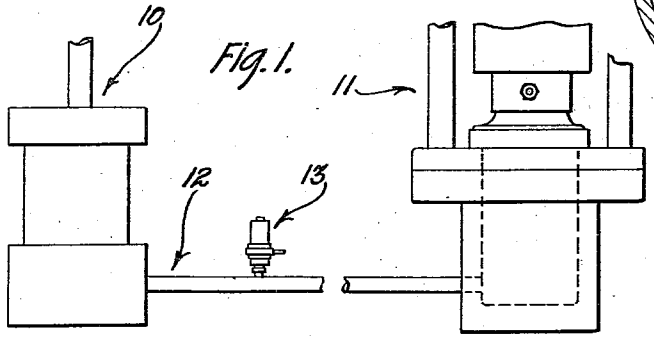


Fig. 1.

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UNITED STATES PATENT OFFICE

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PRESSURE-RESPONSIVE DEVICE

Application filed August 20, 1927. Serial No. 214,272.

This invention relates to pressure responsive devices, and more particularly to a safety pressure relieving device for a pressure medium transmission line.

The primary object of this invention is to provide a safety pressure relieving device which is immediate and certain in its action and uniformly effective for automatically relieving excess pressure developed in a pressure medium transmission line.

In accordance with one embodiment, this invention contemplates a device employing a hardened steel die cooperating with a fragile soft metal diaphragm which upon the development of an excessive or abnormal pressure ruptures and permits a pressure to develop on an enlarged surface of a spring pressed plunger sufficient to overcome the action of the spring, thereby accelerating the relieving of the pressure in the associated pressure line. Fatiguing of the diaphragm due to normal pressure conditions is minimized by limiting the movement thereof toward the plunger to the point of its resting only lightly on a reduced surface of the plunger to maintain it in an undistorted, level plane. The plunger and its spring are contained in a housing which may be quickly and easily removed from the line as a unit to allow the insertion of another diaphragm or disassembled with safety when adapting the device to another predetermined pressure.

Other objects and advantages of this invention will more fully appear from the following detailed description taken in connection with the accompanying drawing, in which

Fig. 1 is a diagrammatic fragmentary illustration of a hydraulic compressor connected to a lead extrusion press used to sheath telephone cables and an interconnecting hydraulic transmission line with one embodiment of this invention inserted therein;

Fig. 2 is a vertical sectional view of the safety pressure relieving device embodying this invention;

Fig. 3 is a fragmentary view of Fig. 2 upon the diaphragm being ruptured by an excess pressure;

Fig. 4 is a fragmentary section taken on the line 4—4 of Fig. 2, and

Fig. 5 is a horizontal section taken on a reduced scale on the line 5—5 of Fig. 2.

Referring now to the drawing in detail wherein like reference numerals indicate similar parts, particularly Fig. 1, a hydraulic compressor 10 is connected to a lead sheath extrusion hydraulic press 11 by a header, pipe or line 12, which discloses one application of the safety pressure relieving device. In the lead sheathing of telephone cables the ram (not shown) of the press 11 is actuated by hydraulic pressure furnished by the compressor 10, such pressure may be six thousand pounds per square inch or more. For a more detailed illustration and description of a hydraulic press of the type referred to herein reference may be had to Patent 1,583,814 to H. R. Till, dated May 11, 1926. Whatever pressure used, it is necessary to prevent an excess pressure being formed or transmitted to protect the compressor, the press or the interconnecting line. An abnormal increase in the hydraulic pressure may be caused, for example, by the ram of the press 11 striking a solid stop, in which case the water pressure may rise to a dangerous point in a tenth of a second and it is therefore necessary in order to protect the various apparatus, to immediately relieve with certainty the pressure upon it reaching a predetermined point. Also, particularly in the application of the device to a hydraulic press used to extrude molten lead to sheath telephone cables, in the case of an excess pressure being developed in the hydraulic line with a consequent actuation of the pressure relieving deviee to relieve such pressure it is desirable in order not to delay the operation of the press to be able to reset the device in a minimum of time. In the application of the safety pressure relieving device as illustrated in the drawing, the device indicated generally by the numeral 13 is inserted in the transmission line 12.

Referring now in detail to Figs. 2 and 3 the device 13 comprises an internally shouldered sleeve or housing 14 having mounted along the lower portion of its bore an externally shouldered circular hardened steel die

block 17. A collar 18 threaded into the bore of the housing 14 and engaging the lower surface of the die block 17 maintains an annular horizontal surface of the latter in engagement with a corresponding surface provided in the housing 14 as indicated by the numeral 19, thus fixedly positioning the die block 17 in the housing. Having a sliding fit within a central aperture 20 provided in the die block 17 is a hardened steel plunger 21 provided at its lower end with a reduced portion 24 positioned in a pressure receiving chamber 25 provided at the lower end of the aperture 20. The extreme lower end of the aperture 20 is of a diameter corresponding to the diameter of the reduced portion 24 of the plunger 21, the wall of the aperture being inclined or flared upwardly and outwardly from its extreme lower end. The aperture 20 between its lower flared end and the chamber 25 is provided with a plurality of uniformly spaced radially arranged offset passages 26, as clearly shown in Figs. 2 and 4. A lower annular surface 27 of the plunger 21 at the point where the reduced portion 24 thereof commences is under-cut or inclined downwardly to the peripheral edge of the plunger to provide a pocket. The purpose of the offset passages 26 and the pocket formed by the under-cut surface 27 of the plunger 21 will become apparent as this description progresses. Formed upon the upper end of the plunger 21 is a circular head 28, the under surface of which rests upon the top surface of the fixed die block 17, which thus determines the normal position of the reduced lower end of the plunger within the extreme lower end of the aperture 20. Threaded into the upper end of the housing 14 is a plug or cap 29 provided upon its lower surface with a reduced shouldered portion 31. Having a sliding fit within a central aperture of the cap 29 is a shouldered stem 32 provided at its lower end with an enlarged circular head portion 33 which rests upon the upper surface of the plunger head 28, the head 28 engaging within an annular depression 34 formed in the lower surface of the portion 33. The head portion 33 of the stem 32 is provided upon its upper end surface with a reduced shouldered portion 35 corresponding to the portion 31 of the cap 29. Mounted between the shouldered portions 31 and 35 of the cap 29 and the head portion 33 respectively, is a compression spring 36 of predetermined reaction which serves to normally maintain the plunger head 28 in contact with the upper end surface of the die block 17. A shoulder 38 formed upon the stem 32 a predetermined distance below the lower surface of the cap 29 provides a stop for predeterminedly limiting the upward movement of the plunger 21 upon actuation of the device as will be more fully described hereinafter.

Threaded centrally into the stem 32 which extends for a slight distance above the upper surface of the cap 29 is a headed screw 39 which serves to lock the stem 32 to the cap 29, thereby retaining the spring 36 under compression when unthreading the cap 29 from the housing 14 upon disassembling the device 13. This construction eliminates the possibility of a person not familiar with the device unthreading the cap and suddenly releasing the compressed spring 36 which may have a compression of several hundred pounds, depending upon the hydraulic pressure being used in the line 12. It will be apparent that upon the cap 29 being unthreaded from the housing 14 the spring 36 will be maintained under substantially its normal compression between the shouldered portions 31 and 35 of the cap and the head portion 33 of the stem 32, the upper surface of the cap first engaging the lower surface of the head of the screw 39 and thereafter by continuing to unthread the cap, the cap, the stem and the spring may be removed from the housing as a unit. Formed in the die block 17 at a point above the pressure receiving chamber 25 disposed at the lower end of the aperture 20 are a plurality of radially extending uniformly spaced apertures 40 (Figs. 2, 3 and 5) which are aligned with similarly arranged apertures 41 provided in the housing 14. Mounted for rotation upon the housing 14 between an annular shoulder 44 formed upon the periphery of the housing and a clamping collar 45 threaded onto the lower end of the housing is a collar 46 provided upon its inner periphery with an annular chamber 47 which is aligned and at all times in communication with the apertures 40 and 41 of the die block 17 and the housing 14, respectively. Threaded into the chamber 47 of the collar 46 is a pipe 48 which is disposed parallel to the axis of the device 13 at its discharge end 49 and entered for free vertical movement in a pipe 50 which may be connected to a drain for disposing of the water passing through the pressure receiving chamber 25 when an excess pressure is developed in the line 12 in the application of the device 13 as illustrated.

Threaded into the aperture of the collar 18 at the lower end of the casing 14 is a nipple 52, the lower end thereof being threaded into the header or line 12 interconnecting the compressor 10 and the press 11 (Fig. 1). The upper end of the nipple 52 is provided with a depressed annular machined surface 53 which lies parallel with the adjacent lower end surface of the die block 17, which is also machined. Clamped between the parallel surfaces of the die block 17 and the nipple 52 is a fragile soft metal diaphragm 54 which serves to normally close or seal the pressure receiving chamber 25 from the line 12. The aperture through the

nipple 52 is preferably the same as the reduced portion 24 of the plunger 21 and the reduced portion of the aperture 20 into which the portion 24 extends during normal pressure in the line 12. The lower end surface of the portion 24 of the plunger 21 rests flush without pressure upon the diaphragm 54, thus forming a support for the portion of the diaphragm extending across the inlet end of the pressure receiving chamber 25 and maintaining the diaphragm in a perfect plane without any deleterious strain or distortion.

The operation of the safety pressure relieving device hereinbefore described is as follows: A spring 36 of a predetermined reaction which is adapted to counter-balance the normal hydraulic pressure to be used to operate the press 11 is selected and mounted in the housing as hereinbefore described along with a suitable diaphragm 54 to seal the die aperture 20. As long as the hydraulic pressure contained in the line 12 is normal or within the prescribed limits, the plunger 21 and diaphragm 54 will assume the position as shown in Fig. 2. Immediately upon an abnormal pressure being developed in the line 12, due to any cause, the reaction of the spring 36 will be overcome due to the column of water, which acts as a punch, pressing upon the lower surface of the diaphragm 54, the upper surface of the diaphragm lying flush against the under surface of the reduced portion 24 of the plunger which is entered in the restricted flared entrance port to the pressure receiving chamber 25, as hereinbefore described. This pressure it will be apparent will instantaneously deform the soft metal diaphragm 54 to such an extent that a complete rupture or shearing thereof will occur, as clearly shown in Fig. 3, thus unsealing the restricted entrance port to the pressure receiving chamber 25 whereupon the sudden release of the compressed column of water through the entrance port and the offset passages 26 quickly fills the chamber and is directed upon the under-cut annular surface 27 of the plunger 21. It will be readily understood that due to the flared wall of the entrance port to the chamber 25 it is not necessary for the plunger 24 to move very far before the diaphragm is ruptured to freely admit the water to the chamber. The movement of the plunger 21 upwardly is thereby accelerated to open the pressure receiving chamber 25 to the radial apertures 40 in the die block 17, the plunger coming to a rest when the shoulder 38 of the stem 32 engages the lower surface of the cap 29, as clearly shown in Fig. 3. The inclining or undercutting of the annular surface 27, as shown in the drawing, it will be apparent serves to direct and concentrate the pressure of the water upon the plunger, thereby serving in addition to accelerating the movement thereof to the position shown in Fig. 3, to hold it in this position until the pressure is relieved. In this latter position of the parts it will be apparent that the water will freely escape from the chamber 25 to the apertures 40, into the annular channel 41 and thence into the chamber 47 of the collar 46, through the pipes 48 and 50 where it is directed to the drain or other suitable receiving means. Thus all possible damage to the compressor 10, press 11 and line 12 upon the pressure rising to an abnormal predetermined point likely to cause damage is entirely eliminated.

To reset the safety device 13 after a release of an abnormal pressure in the line 12 it is merely necessary to loosen the clamping collar 45, which it will be apparent will permit the housing 14 to be rotated within the collar 46, thereafter removing the device as a whole from the upper threaded end of the nipple 52, thus providing access to the ruptured diaphragm 54. Upon release of the excess pressure in the line 12, the spring 36 it will be apparent will move the plunger 21 back to its normal position and with it the sheared disk of the diaphragm 54. Thus upon removal of the device 13 from the nipple 52, as just described, the sheared diaphragm 54 may be readily removed from the depressed surface 53 of the nipple 52 and replaced with another. Thereafter the device is threaded onto the upper end of the nipple 52, the discharge end 49 of the pipe 48 being entered in the pipe 50 at this time, until the diaphragm 54 is clamped tight between the lower surface of the die block 17 and the portion 24 of the plunger 21 upon one side and the surface 53 of the nipple upon its opposite side. The clamping collar 45 is then threaded up tight to secure the chambered collar 46 against the annular shoulder 44 of the housing 14.

Although this invention has been disclosed and described as applied to a particular apparatus wherein water is preferably used as the pressure medium, it is clear that it may have a more general application and is not necessarily limited to the relieving of excess hydraulic pressure, but is equally adapted to function regardless of the type of the particular pressure medium being used. Also, it is clear that modifications can be made in the device without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a safety pressure relieving device, a housing having a stepped aperture, a plunger mounted therein having a plurality of surfaces of different areas each adapted to close a step of the aperture and to be acted upon by a pressure medium, means for limiting the forward movement of the plunger, and a fragile means normally closing the aperture and bearing against the surface of the plunger having the smaller area, responsive to a pre-

determined pressure for communicating the pressure to the surface of larger area whereby movement of the plunger is accelerated and an exit for the pressure medium is established.

2. In a safety pressure relieving device, a housing having an inlet and an outlet port, an apertured member supported in the housing having a plurality of passageways extending laterally from the walls of the aperture thereof to the outlet port, a plunger mounted in the aperture having a plurality of surfaces of different areas adapted to be acted upon by a pressure medium and normally positioned to completely close the passageways and the aperture, a surface of the plunger having a smaller area being entered within and flush with a restricted inlet mouth of the aperture, means for limiting the forward movement of the plunger, an elastic medium operatively associated with the plunger for normally urging the same in one direction under a predetermined pressure, and a fragile diaphragm exposed upon one side to the pressure medium with its opposite side bearing lightly against the surface of smaller area, a surface of larger area than the latter surface forming one end of a chamber formed along the aperture and against which the pressure medium is directed upon rupture of the diaphragm in response to a predetermined pressure whereby movement of the plunger is accelerated and an exit for the pressure medium is established between the inlet and outlet ports of the housing.

3. In a safety pressure relieving device, a housing having an aperture, a plunger mounted therein having a plurality of surfaces of different areas each adapted to close the aperture and to be acted upon by a pressure medium, one of the surfaces being annular and under-cut to increase the action of the pressure medium thereon, another of the surfaces fitting closely within a restricted portion of the aperture, means for limiting the forward movement of the plunger, and a fragile diaphragm normally closing the aperture and bearing lightly against the surface of the plunger having the smaller area, responsive to a predetermined pressure for concentrating the pressure upon the before mentioned under-cut surface whereby movement of the plunger is accelerated to establish a passage for the exit of the pressure medium and for maintaining the plunger in its actuated position until the pressure is relieved.

4. In a safety pressure relieving device, a housing having an aperture, a plunger mounted therein having a pair of surfaces of different areas adapted to be acted upon by a pressure medium, the surface of larger area normally completely closing one end of the aperture, the plunger portion having the smaller area exactly fitted in the other end of the aperture, means for limiting the forward movement of the plunger, and a fragile means normally closing the aperture and bearing against the surface of the plunger having the smaller area responsive to a predetermined pressure for communicating the pressure to the surface of larger area whereby movement of the plunger is accelerated and an exit for the pressure medium is established.

In witness whereof, I hereunto subscribe my name this 10th day of August, A. D. 1927.

HARRIS RAYMOND TILL.