March 3, 1953 A. J. FAUSEK ET AL 2,630,072

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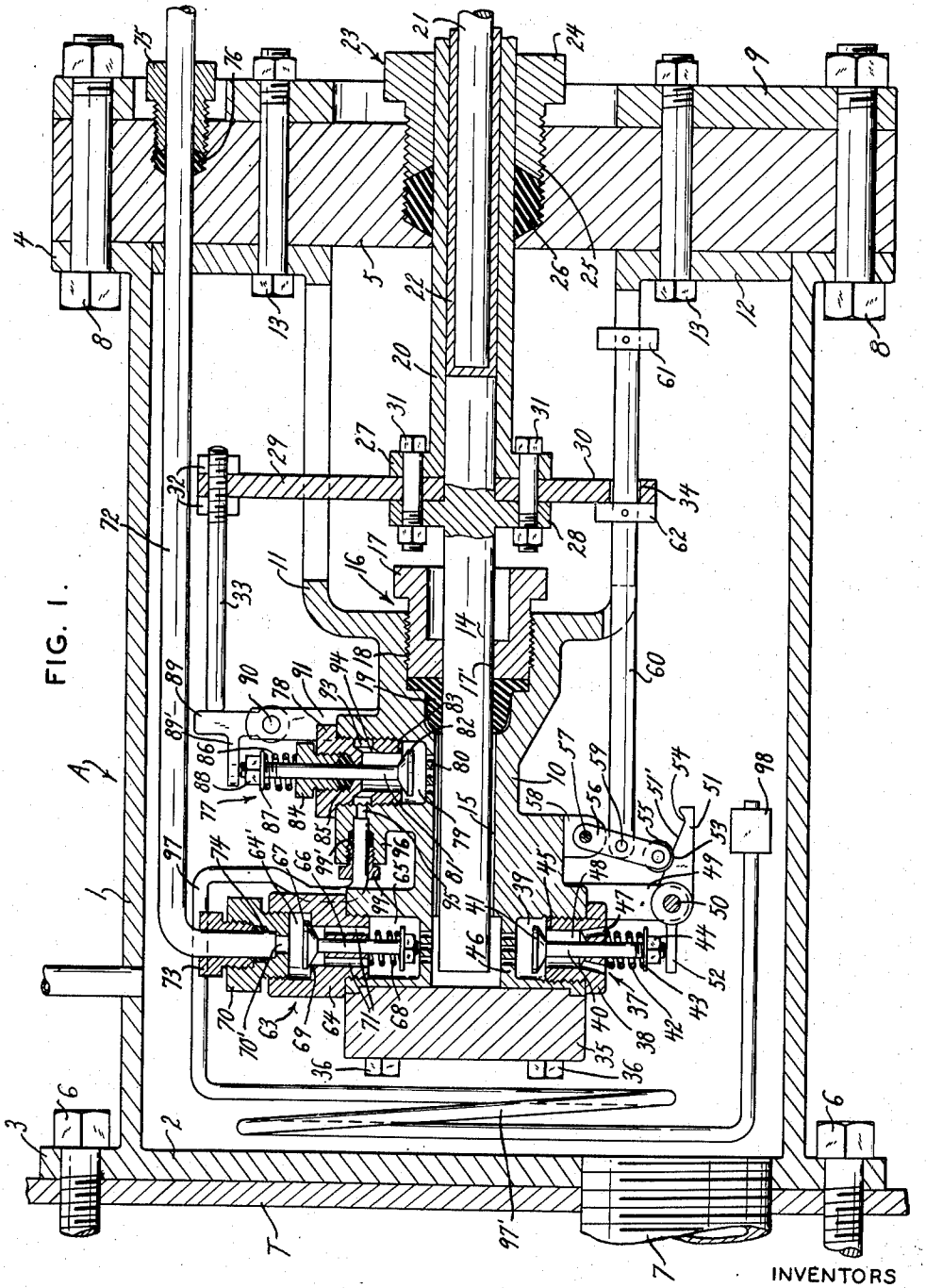


FIG. 1.

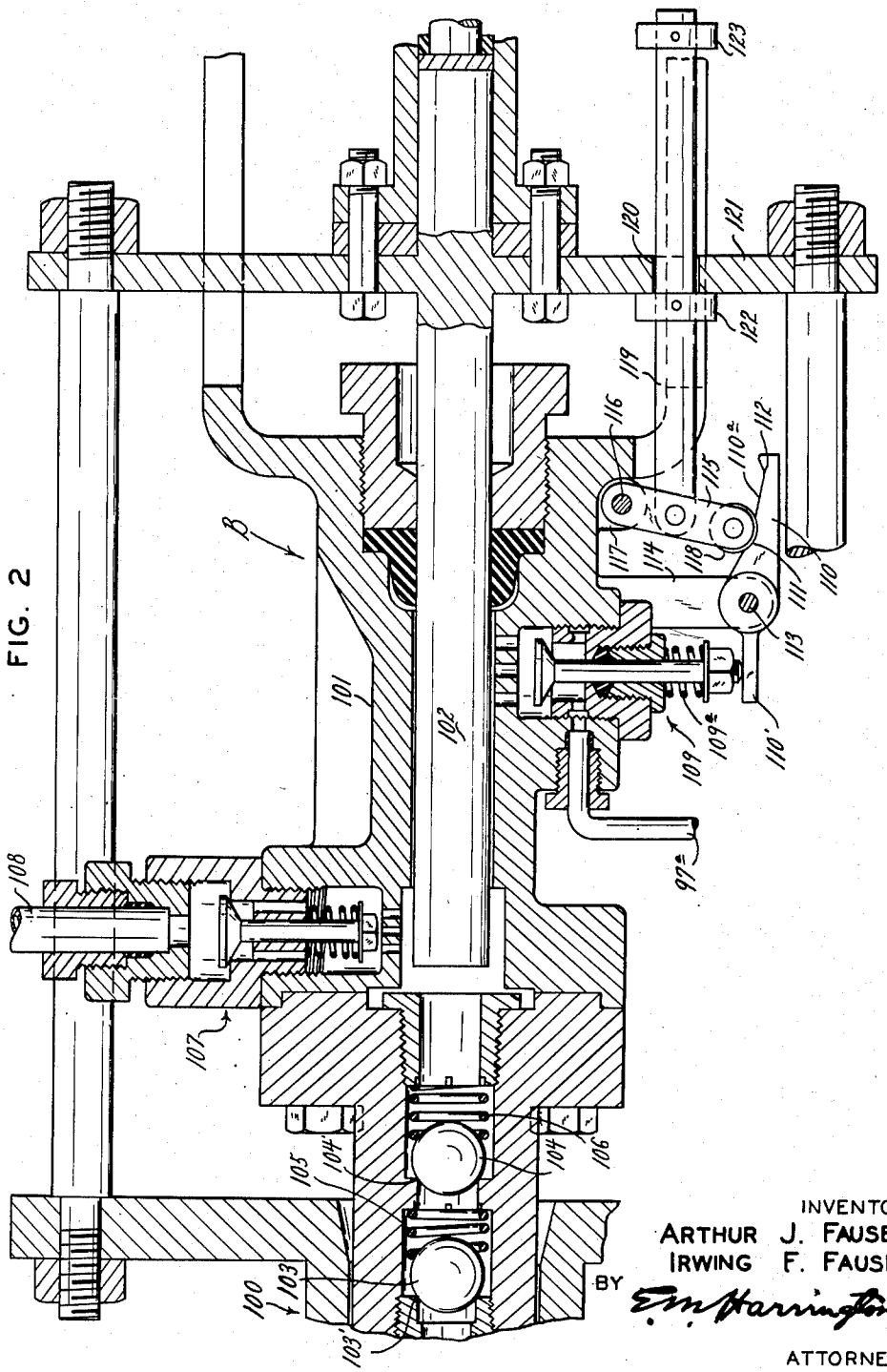
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FIG. 2



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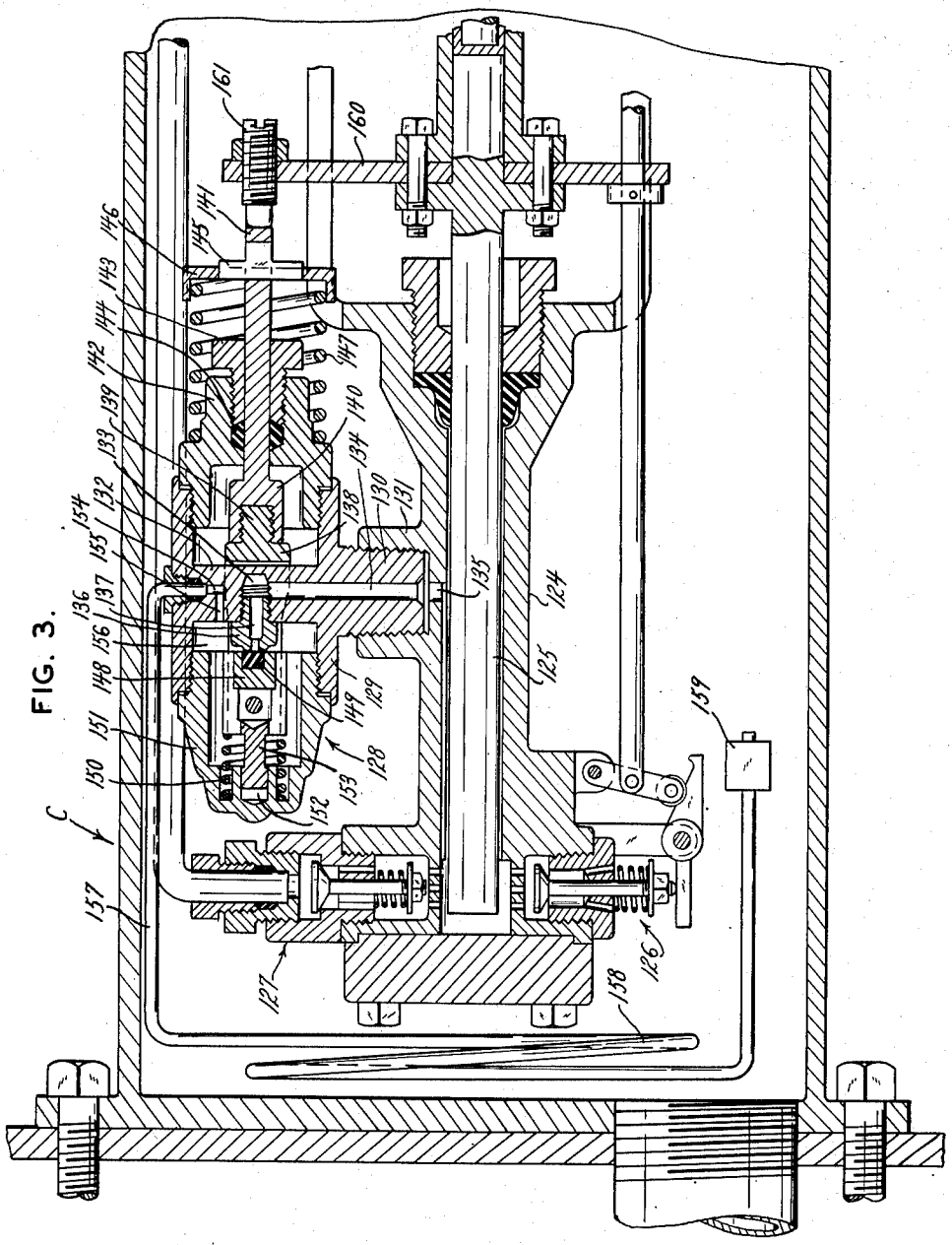


FIG. 3.

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PUMP

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Application February 28, 1949, Serial No. 78,852

6 Claims. (Cl. 103—153)

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This invention relates generally to pumps of the reciprocatory, displacement type and more specifically to such a pump which is adapted for use in displacing highly volatile liquids, such, for instance as liquid oxygen, the predominant object of the invention being to provide a displacement pump of the type referred to which includes valve means for releasing from the cylinder of the pump vapor which is produced therein without intention and which if not released from the pump cylinder might interfere with efficient operation of the pump.

Prior to this invention considerable difficulty was experienced in the use of reciprocatory displacement pumps in pumping highly volatile liquids, liquid oxygen, for instance, because of the fact that the liquids were maintained very close to the vaporization point and when subjected to pressure during the pumping operation, or for other reasons, sufficient heat was developed to cause some vapor to be produced within the cylinders of the pumps. As a result of the presence of such vapor within the cylinders of the pumps vapor locks were heretofore created within the cylinders of the pumps which seriously interfered with efficient operation of the pumps, and in some cases produced hazards which frequently caused damage to be done to the pumps.

The main purpose of this invention is to provide an improved pump of the reciprocatory displacement type in the operation of which the difficulties recited above are eliminated, this purpose being accomplished by providing the improved pump with valve means which is automatically actuated to its open position at the proper time during operation of the pump so as to release from the cylinder of the pump any vapor which may be present within the cylinder of the pump.

Fig. 1 is a vertical sectional view of the improved pump of this invention, a portion of the tank with which the pump is associated being illustrated fragmentarily.

Fig. 2 is a vertical section view similar to Fig. 1 but showing a modified form of the invention, Fig. 2 being drawn to a larger scale than is Fig. 1.

Fig. 3 is a fragmentary sectional view illustrating another modified form of the invention.

In the drawings wherein are shown for purposes of illustration, merely, several embodiments of the invention, A designates in Fig. 1 the improved pump generally. The pump A includes a cylindrical housing 1 which is provided at one of its ends with an end wall 2 and with an outwardly extended, annular flange 3, said housing at its opposite end being provided with an annular flange 4 which abuts against a head 5 that closes said opposite end of said housing. The housing 1 is supported by a tank T which contains liquid to be pumped by the pump A, there being suitable fastening devices 6 which secure said housing 1 to a wall of said tank, and a conductor 7 is provided which places the interiors of the tank T and the housing 1 in communication with each other. Also, suitable fastening devices 8 are employed for securing the annular flange 4 of the housing 1 to the head 5, these fastening devices 8 serving additionally to secure a plate 9 to the outer face of said head 5.

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Disposed within the housing 1 is the piston cylinder 10 of the improved pump A, said piston cylinder having a rearwardly extended portion 11 of cylindrical shape in cross-section which is provided at its rear end with an annular flange 12 that abuts against the forward face of the head 5, suitable fastening devices 13 being employed for securing said annular flange 12 to the head, and said fastening devices 13 being extended through the plate 9. Arranged for reciprocatory movement relative to the piston cylinder 10 is a piston 14 whose forward end portion is disposed within said piston cylinder, said forward end portion of said piston being of sufficiently less diameter than the bore of the cylinder to provide an annular duct 15 within the bore of the cylinder between the wall of said cylinder bore and the circumferential face of the forward portion of the piston.

The piston 14 is supported for reciprocatory movement in part by a stuffing box structure 16 which includes a gland 17 that is screwthreadedly received within a screwthreaded cavity 18 formed in the piston cylinder 10, the piston being extended through an opening 17' formed through the forward portion of the gland 17 and said gland being adapted to force a body of packing material 19 into fluid-tight contact with the circumferential face of the piston. The rear portion of the piston 14 is received within the forward portion of an elongated sleeve 20, and the rear portion of said sleeve receives therein the forward portion of a piston rod 21, there being a body of suitable heat insulating material 22 interposed between the wall of the bore of the sleeve and the circumferential face of the piston rod, and between the forward end of the piston rod and the rear end of the piston. The piston 14, the elongated sleeve 20, and the pis-

ton rod 21 reciprocate as a unit, such unit being supported for reciprocatory movement by a stuffing box 23 which comprises a screwthreaded gland 24 through which the sleeve 20 extends and which is received within a screw threaded cavity 25 formed in the head 5. The gland 24 of the stuffing 23 is adapted to force a body of suitable packing material 26 into fluid-tight contact with the circumferential face of elongated sleeve 20.

The elongated sleeve 20 is provided at its forward end with an outwardly extended, flange 27 which is spaced apart longitudinally of the piston from a similar outwardly extended, flange 28 that is formed on the piston 14. The related flanges 27 and 28 support arms 29 and 30 which extend outwardly in opposite directions with respect to the piston 14, bolts 31 being employed to secure inner portions of said arms between the flanges 27 and 28, and these bolts also serving to secure the elongated sleeve 20 to the piston 14. The arm 29 has mounted thereon at its outer end by means of nuts 32 a forwardly extended rod 33 which serves a purpose to be hereinafter set forth. Also, the arm 30 has formed therethrough an opening 34, the purpose of which will be hereinafter explained.

The forward end of the pump cylinder 10 is closed by a head 35 which is secured in place by fastening devices 36, and associated with said pump cylinder at a point adjacent to said head 35 is an intake valve 37. The intake valve 37 comprises a valve body 38 which is screwthreadedly received in a screwthreaded opening 39 formed in the pump cylinder wall, said valve body having associated therewith a valve stem 40 that is provided with a valve head 41 at an end thereof. The valve stem 40 has associated therewith a coil spring 42 which is disposed under compression between the outer face of the valve body and a washer 43 that is mounted on the valve stem through the instrumentality of a nut 44. The coil spring 42 urges the valve head toward its closed position where it contacts with a valve seat 45 at the inner end of the valve body 38, and at the inner end of the opening 39 there is arranged a perforated wall 46. Also, the valve body 38 is provided with openings 47 which are open at the outer end of said valve body and communicate at their inner ends with a cavity 48 formed within the valve body.

Mounted for pivotal movement on a supporting arm 49, by means of a pivot 50, is a lever 51 which is provided with an extension 52 that engages the outer end of the valve stem 40 of the inlet valve 37. The lever 51 is of tapered shape, having an inclined face 51' in which an arcuate seat 53 and a seat 54 are formed. One or the other of the seats 53 and 54 receives a roller 55 that is rotatably supported by the outer end portion of a link 56, the inner end portion of said link being pivotally attached by a pivot element 57 between a pair of ears 58 that are extended from the pump cylinder 10. The link 56 has pivotally connected thereto, by a pivot element 59, a rod 60, said rod being extended through the opening 34 formed through the arm 30, which has been previously referred to herein. Also, the rod 60 has fixedly mounted thereon a collar 61 and a collar 62, said collars being arranged in spaced relation and being intended for a purpose to be hereinafter explained.

Arranged in opposed relation with respect to the intake valve 37 is an outlet valve 63 which is similar in construction to the illustrated intake valve 37. In other words, the outlet valve 63 includes a valve body 64 which is screwthreadedly received in a screwthreaded cavity 65 formed in the wall of the pump cylinder, and with which is associated a valve stem 66 having a valve head 67, said valve stem being provided with a coil spring 68 which tends to draw the valve head 67 of the outlet valve to its closed position in contact with a valve seat 69 located within the valve body 64. The outer end portion of the valve body 64 is internally screwthreaded and this outer portion of said valve body screwthreadedly receives a bushing 70 that is provided with an opening 70' which communicates with the cavity 64' within the outer portion of the valve body 64. Also, the valve body 64 is provided with passageways 71 which are open at the inner end of the valve body and through which liquid medium moves during its passage from the bore of the pump cylinder through the outlet valve 63.

Connected into the bushing 70 is a discharge conductor 72 for conducting liquid medium pumped by the pump A to a place of disposition of such liquid medium, there being a packing gland 73 for forcing a body of packing material 74 into tight contact with the outer face of a portion of the discharge conductor and with a portion of the bushing 70 so as to avoid leakage of liquid medium between said parts. Also, the discharge conductor 72 extends through an opening formed through the head 5 and a packing gland 75 is provided which acts against a body of packing material 76 so as to prevent leakage of liquid medium between the circumferential face of the discharge conductor and the wall of the opening through the head 5 through which said discharge conductor extends.

The improved pump of this invention includes a third valve 77 which is located adjacent to the rear portion of the pump cylinder 10. The valve 77 is a vapor discharge valve and it comprises a screwthreaded valve body 78 which is received in a screwthreaded cavity 79 formed in the wall of the pump cylinder 10, there being a perforated wall 80 between said cavity and the bore of the pump cylinder. The valve 77 includes a valve stem 81 that is provided with a valve head 82 which is movable toward and from a valve seat 83 located at the lower end of the valve body 78. The valve body 78 screwthreadedly receives a packing gland 84 which is adapted to act against a body of packing material 85 so as to prevent leakage of liquid or vapor around the valve stem 81, and said valve stem is embraced by a coil spring 86 which is interposed under compression between the outer face of the packing gland 84 and a masher 87 which abuts against a nut 88 that is mounted on the valve stem 81. The coil spring 86 urges the valve head 82 toward its related seat 83 for closing egress of liquid or vapor through the valve 77, and the outer end of the valve stem 81 is engaged by an extension 89' of a bell crank lever 89 that is pivotally mounted, by means of a pivot element 90 on an arm 91 which is extended from the wall of the pump cylinder 10.

The valve body 78 of the valve 77 is provided with an annular passageway 93 into which passageways 94 lead from the interior of said valve body, said annular passageway being in communication with a passageway 95 which is formed in an extension 96 forming part of the wall of the pump cylinder. Arranged in communication with the passageway 95 is a conductor 97 which merges into a condensing coil 97', there being a check valve 98 at the discharge end of said con-

densing coil 97' which permits of the discharge of liquid from the condensing coil into the interior of the housing 1 but which bars reverse movement of liquid. The conductor 97 has associated therewith a packing gland 99 which is screwthreadedly received by the extension 96 of the pump cylinder wall and acts against a body of packing material 99' in a manner to prevent leakage of vapor or liquid around the end portion of the conductor which is disposed within said extension 96.

In the operation of the improved pump disclosed herein, the piston 14 is subjected to reciprocatory motion in the conventional manner so that its forward portion reciprocates within the bore of the pump cylinder 10. On the rearward stroke of the piston the intake valve 37 is maintained in its open position because the roller 55 of the link 56 is seated in the seat 53 of the lever 51, and therefore during such rearward movement of the piston 14 liquid will pass through the intake valve 37 into the bore of the pump cylinder. As the piston approaches the limit of its rearward movement the arm 30, which moves with the piston, engages the collar 61 on the rod 60 and moves said rod rearwardly so as to disengage the roller 55 of the link 56 from the seat 53 of the lever 51 and swing the outer portion of the link 56 rearwardly. As the link roller 55 is disengaged from the seat 53 of the lever 51 the coil spring 42 moves the valve head 41 of the intake valve 37 to its closed position relative to the valve seat 45 and the roller of the link 56 is caused to be seated in the seat 54 of the lever 51.

The compression stroke of the piston is now started and as the piston approaches the limit of its forward movement the forward end of the rod 33 engages the bell crank lever 89 and the extension 89' of said bell crank lever depresses the valve stem 81 of the valve 77 and moves its valve head away from its related valve seat 83 to open the valve 77 and permit any vapor which may be present within the bore of the pump cylinder to pass therefrom through the valve 77. Any vapor which passes through the valve 77, as described, moves through the conductor 97 and through the condensing coil 97', wherein said vapor is condensed, and such condensate is returned to the interior of the housing 1 by way of the check valve 98. Also, during forward movement of the piston 14 liquid is compressed within the bore of the pump cylinder and such compressed liquid forces the outlet valve 63 to its open position whereupon liquid is forced by the pump through the conductor 72 to its point of disposition. As the piston approaches the limit of its forward movement the arm 30 engages the collar 62 on the rod 60 whereby said rod 60 is moved forwardly so as to swing the roller 55 of the link 56 from the seat 54 of the lever 51 to the seat 53 of said lever. This will again adjust the inlet valve 37 to its open position and the sequence of operations just described is repeated.

The structure illustrated by Fig. 2 differs from the structure of Fig. 1 in that the pump B of Fig. 2 includes an auxiliary loading device 100. The pump B of Fig. 2 includes a pump cylinder 101 within which the forward portion of a piston 102 is disposed for reciprocatory movement. The auxiliary loading device includes a pair of ball valves 103 and 104 which are forced against their valve seats 103' and 104' by coil springs 105 and 106, these ball valves being unseated by suction during the suction stroke of the piston 102 of the pump to permit liquid to pass by said ball valves into the bore of the pump cylinder. The pump B of Fig. 2 is provided with an outlet valve 107, said outlet valve being constructed in accordance with the outlet valve 63 of Fig. 1, and a conductor 108 being related to said outlet valve 108 which conducts liquid passing through said outlet valve to a point of disposition of said liquid.

The pump of Fig. 2 is provided with a vapor release valve 109 which is constructed in accordance with the vapor release valve 77 of Fig. 1. However, the vapor release valve 109 of Fig. 2 is operated mechanically by means which differ from the means for actuating the vapor release valve 77 of Fig. 1. In other words, the means for actuating the vapor release valve 109 of Fig. 2 comprises a lever 110 which is provided with an extension 110' that engages the outer end of the valve stem 109*a* of the vapor release valve 109. The lever 110 is tapered and the inclined face 110*a* thereof is provided with a curved seat 111 and a seat 112, and said lever is pivoted by a pivot element 113 to an arm 114 which is extended from the wall of the pump cylinder 101. The lever 110 has related thereto a link 115 which is pivoted at an end thereof by a pivot element 116 to ears 117 which are formed on the wall of the pump cylinder, and mounted on said link at its opposite end is a roller 118. Additionally, the link 115 has pivotally attached thereto a rod 119 which extends through an opening 120 formed through an arm 121 which is movable with the piston 102, said rod having fixedly mounted thereon a pair of spaced collars 122 and 123.

In the operation of the pump illustrated in Fig. 2, the vapor release valve 109 is adjusted to its open position by the arm 121 engaging the collar 122 on the rod 119 and moving said rod forwardly so as to cause the roller 118 on the link 115 to be seated in the seat 111 of the lever 110, this action taking place as the piston 102 approaches the limit of its forward, compression stroke. The vapor release valve 109 remains in its open position during substantially the entire suction stroke of the piston in order that any vapor which may be present within the bore of the pump cylinder may be exhausted therefrom, such vapor being conducted to a condensing coil (not shown) by a conductor 97*a*. When the piston approaches the limit of its rearward, suction stroke the arm 121 engages the collar 123 on the rod 119 thereby moving said rod rearwardly and swinging the roller 118 from the seat 111 of the lever 110 to the seat 112 of said lever and permitting the vapor release valve 109 to close, said vapor release valve remaining closed during substantially the entire compression stroke of the piston 102 and again being opened as said piston approaches the forward limit of its compression stroke. Thus, the difference between the structures of Figs. 1 and 2 is that in Fig. 1 the vapor release valve 77 is opened momentarily as the piston approaches the limit of its forward, compression stroke, while the vapor release valve 109 of Fig. 2 remains open during substantially the entire suction stroke of the piston of the pump B.

The form of the invention illustrated in Fig. 3 is intended for use in situations where such high pressure is produced within the cylinder of the pump that opening of the vapor relief valve (the valve 77 of Fig. 1 or the valve 109 of Fig. 2) against the high pressure is rendered difficult. In Fig. 3 the pump C is provided with a cylinder 124 within which the forward portion of a piston 125 is arranged for reciprocation therein. The

pump C is provided with an intake valve 126 and an outlet valve 127, said intake valve and said outlet valve of Fig. 3 being actuated in accordance with the operation of the intake valve 37 and the outlet valve 63 of the form of the invention shown in Fig. 1, as has heretofore been described herein.

The vapor relief valve of Fig. 3 is designated generally by the reference character 128 and it comprises a valve body 129 which is provided with an externally screwthreaded stem 130 which is received within an internally screwthreaded extension 131 that is formed on the wall of the cylinder 124. The outer portion of the valve body 128 is generally cylindrical, and a bridge portion 132 extends transversely of said cylindrical, outer portion of said valve body, said bridge portion having a cavity 133 formed therein, the wall of which is screwthreaded. The cavity 133 communicates with a passageway 134 which is formed partially through the bridge portion 132 and through the stem 130, this passageway 134 in turn communicating with a passageway 135 which is formed through a wall portion of the cylinder 124. The cavity 133 formed in the bridge portion 132 receives a screwthreaded stem of a nozzle 136, said nozzle having a passageway 137 formed therethrough.

Arranged in embracing relation with respect to the bridge portion 132 is a yoke 138, said yoke being U-shaped and spaced legs thereof being disposed at opposite sides of said bridge portion. The yoke 138 is provided with a screwthreaded stem 139 which is received within a screwthreaded opening formed in a socket member 140, said socket member being arranged at the forward end of a rod 141 which extends rearwardly of the pump C. The valve body 129 has screwthreadedly associated therewith at its rear end a fitting 142 which is provided with an opening through which the rod 141 extends, said fitting having a packing gland 143 related thereto which serves to force a body of packing material 144 against the circumferential face of the rod 141 so as to prevent leakage of vapor or liquid around said rod. The rod 141 has fixed thereto, by means of a key 145, a spring seat 146, a coil spring under compression 147 being arranged with one of its ends in contact with said spring seat 146 and with its opposite end in contact with a portion of the fitting 142 so that said coil spring tends to move the rod 141 rearwardly.

Mounted between the spaced legs of the yoke 138 is a closure element 148 which is provided with a seat 149 that normally contacts with the forward end of the nozzle 136, and arranged forwardly of the yoke is a coil spring 150 which contacts at its opposite ends with a portion of said yoke and a portion of a fitting 151, said coil spring 150 tending to move the yoke 138 rearwardly. The fitting 151 is screwed into the forward portion of the valve body 129 and said fitting is provided with a guideway 152 which receives a guide stem 153 that is movable with the yoke 138. The valve body 129 is provided with a passageway 154 which communicates with a passageway 155, said passageway 155 being in communication at its forward end with a cavity 156 located within the valve body 138. Disposed in communication with the passageway 154 is a conductor 157 which merges into a condensing coil 158, said conductor at its discharge being provided with a check valve 159.

The piston 125 of the pump illustrated in Fig. 3 supports an arm 160 on which is mounted an abutment element 161 and when, in the operation of the pump C, the piston approaches the limit of its forward movement, the forward end of the abutment element 161 engages the rear end of the rod 141 and moves said rod forwardly. The yoke 138 moves forwardly with the rod 141 so as to move the seat 149 of the closure element 148 away from the forward end of the nozzle 136 and thereby permit any vapor which may be present within the bore of the cylinder to pass from the nozzle 136 into the cavity 156 of the vapor relief valve 128 and to move through the passageways 155 and 154 to the conductor 157, such vapor passing through and being condensed in the coil 158 with the condensate being discharged through the check valve 159. Thus, even though rather high pressure be present within the bore of the pump cylinder 124, such high pressure will in no manner interfere with the free actuation of the vapor relief valve 128.

We claim:

1. A displacement pump comprising a pump cylinder, a piston arranged for reciprocatory movement within said pump cylinder, inlet valve means for admitting liquid medium into the bore of said pump cylinder, outlet valve means for permitting discharge of liquid medium from the bore of said pump cylinder, a vapor release valve movable to open position for releasing vapor from the bore of said pump cylinder, as said piston approaches the limit of its compression stroke and means for automatically actuating said vapor release valve, the last-mentioned means including an outwardly extended element movable with said piston, a member related to said outwardly extended element and moved thereby, and an element for actuating said vapor release valve which is operated in response to movement of said member.

2. A displacement pump comprising a pump cylinder, a piston arranged for reciprocatory movement within said pump cylinder, inlet means for admitting liquid medium into the bore of said pump cylinder, outlet valve means for permitting discharge of liquid medium from the bore of said pump cylinder, a vapor release valve movable to open position for releasing vapor from the bore of said pump cylinder, as said piston approaches the limit of its compression stroke and means for automatically actuating said vapor release valve, the last-mentioned means including an outwardly extended element movable with said piston, a rod related to said outwardly extended element and moved thereby, and a lever for actuating said vapor release valve which is operated in response to movement of said rod.

3. A displacement pump comprising a pump cylinder, a piston arranged for reciprocatory movement within said pump cylinder, inlet means for admitting liquid medium into the bore of said pump cylinder, outlet valve means for permitting discharge of liquid medium from the bore of said pump cylinder, a vapor release valve movable to open position for releasing vapor from the bore of said pump cylinder, as said piston approaches the limit of its compression stroke and means for automatically actuating said vapor release valve, the last-mentioned means including an outwardly extended element movable with said piston, a rod related to said outwardly extended element and moved thereby, and a pivotally supported lever for actuating said vapor release valve which is operated in response to movement of said rod.

4. A displacement pump comprising a pump cylinder, a piston arranged for reciprocatory

movement within said pump cylinder, inlet means for admitting liquid medium into the bore of said pump cylinder, outlet valve means for permitting discharge of liquid medium from the bore of said pump cylinder, a vapor release valve movable to open position for releasing vapor from the bore of said pump cylinder, as said piston approaches the limit of its compression stroke and means for automatically actuating said vapor release valve, the last-mentioned means including an outwardly extended element movable with said piston, a rod supported by said outwardly extended element, and a lever for actuating said vapor release valve which is engaged and operated by said rod.

5. A displacement pump comprising a pump cylinder, a piston arranged for reciprocatory movement within said pump cylinder, inlet means for admitting liquid medium into the bore of said pump cylinder, outlet valve means for permitting discharge of liquid medium from the bore of said pump cylinder, a vapor release valve movable to open position for releasing vapor from the bore of said pump cylinder, as said piston approaches the limit of its compression stroke and means for automatically actuating said vapor release valve, the last-mentioned means including an outwardly extended element movable with said piston, a rod movably supported by said outwardly extended element, and a pivotally supported lever for actuating said vapor release valve which is engaged and operated by said rod.

6. A displacement pump comprising a pump cylinder, a piston arranged for reciprocatory movement within said pump cylinder, inlet means for admitting liquid medium into the bore of said pump cylinder, an outlet valve for permitting discharge of liquid medium from the bore of said pump cylinder, a vapor release valve movable to open position for releasing vapor from the bore of said pump cylinder, as said piston approaches the limit of its compression stroke and means for actuating one of said valves, the last-mentioned means comprising an element movable with said piston, a rod having abutments mounted thereon which are engaged by said element for moving said rod in one or the opposite direction, a pivotally supported link pivotally connected to said rod, a lever for actuating said one of said valves which is subjected to movement by movement of said link, a rotatable element mounted on said link, and a pair of spaced seats formed in said lever one or the other of which receives said rotatable elements at different stages of the operation of the means for actuating said one of said valves.

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