Oct. 8, 1946. L. B. JONES 2,408,980

CUSHIONING MEANS FOR STEAM-ACTUATED VALVES

Filed March 3, 1944 6 Sheets-Sheet 1

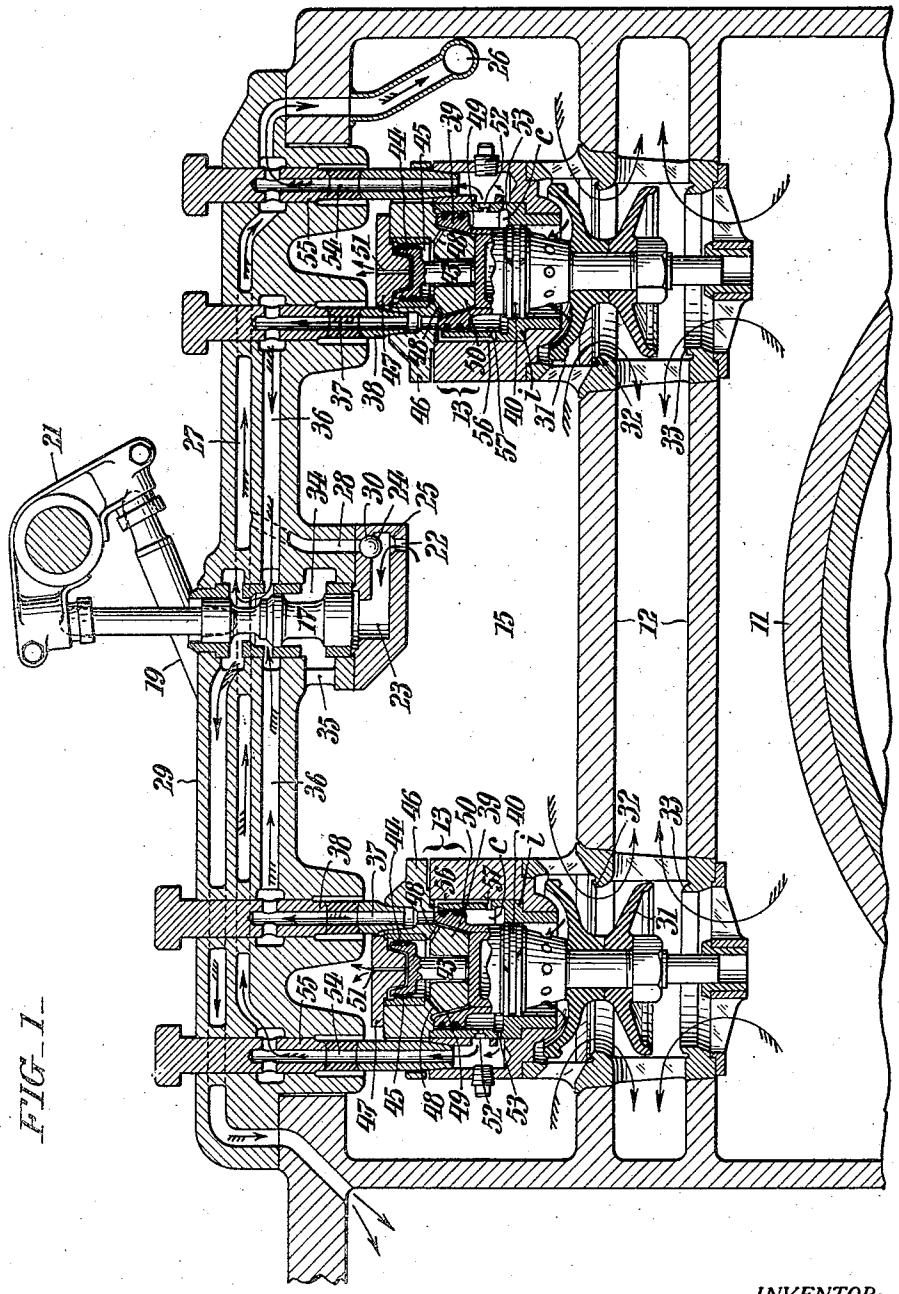


FIG. 1.

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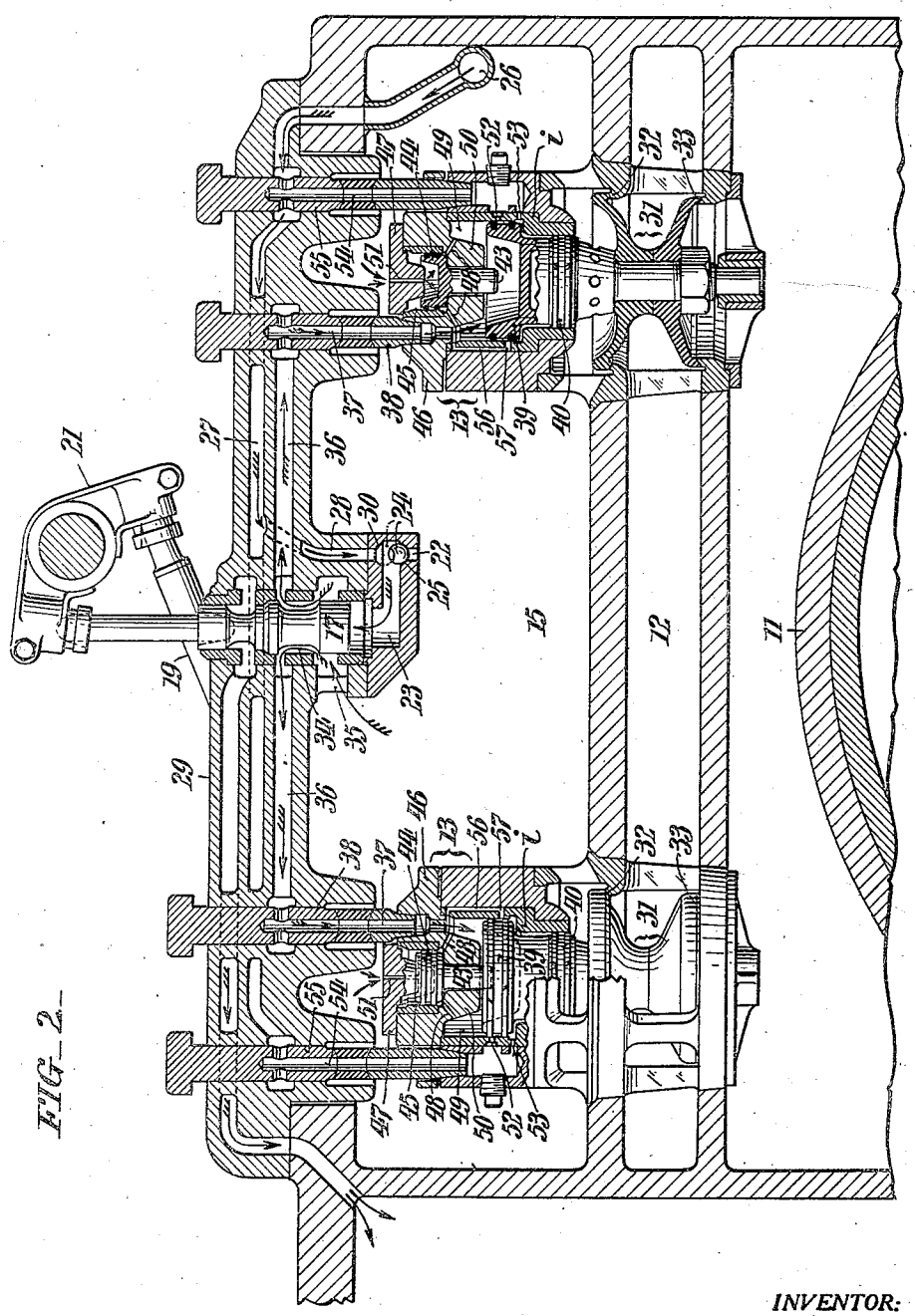


FIG. 2.

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CUSHIONING MEANS FOR STEAM-ACTUATED VALVES

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FIG. 4.

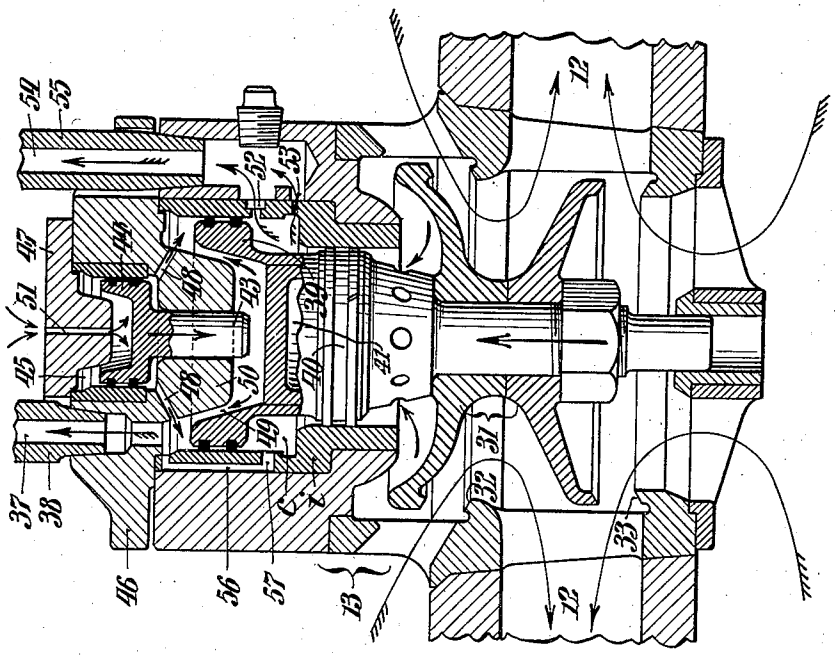
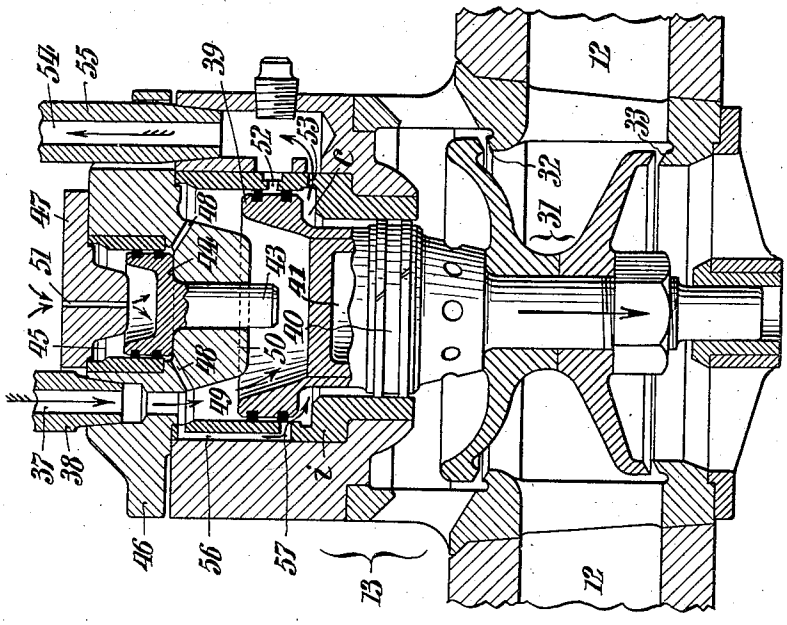


FIG. 3.



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CUSHIONING MEANS FOR STEAM-ACTUATED VALVES

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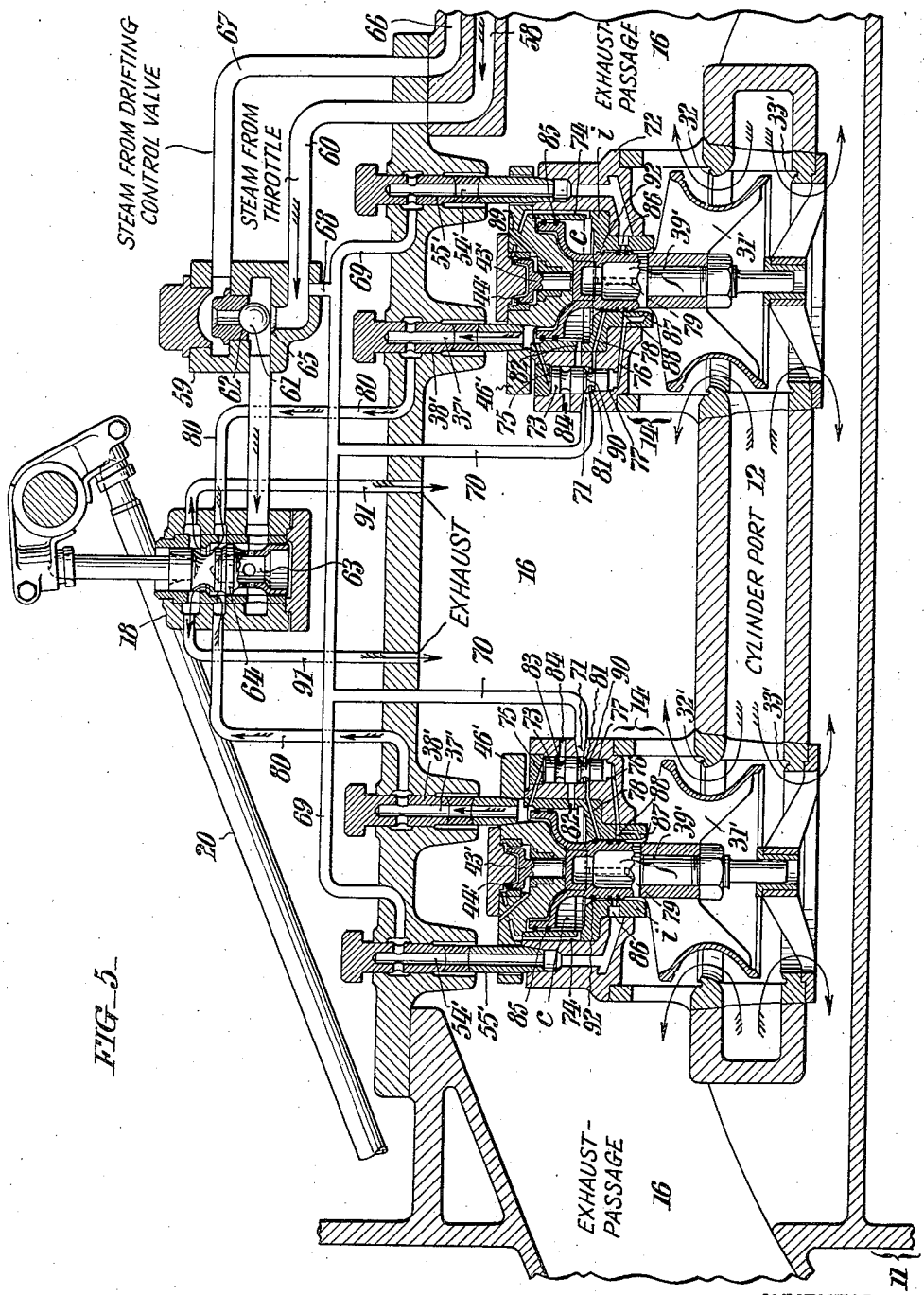


FIG. 5.

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CUSHIONING MEANS FOR STEAM-ACTUATED VALVES

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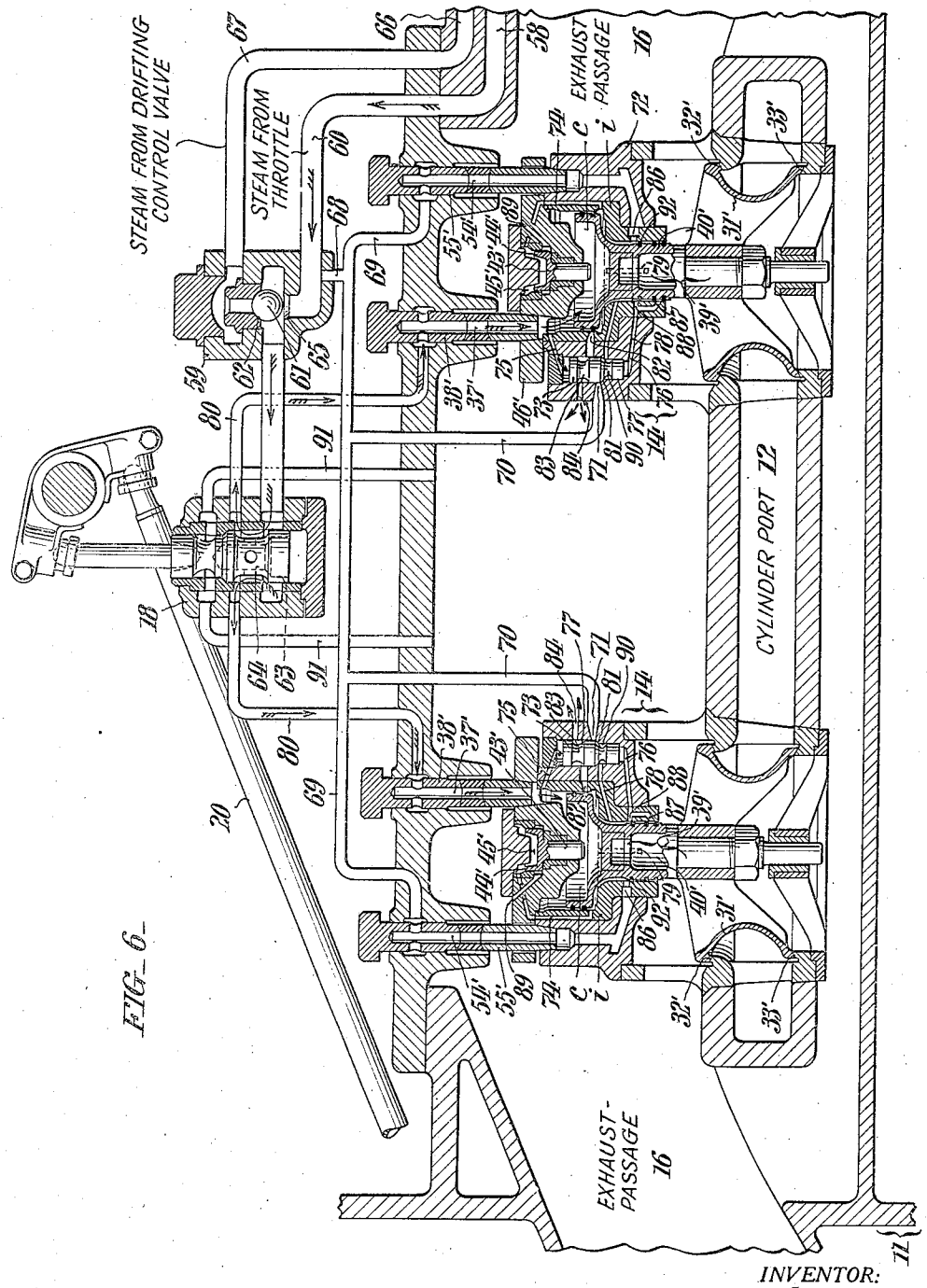


FIG. 6.

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CUSHIONING MEANS FOR STEAM-ACTUATED VALVES

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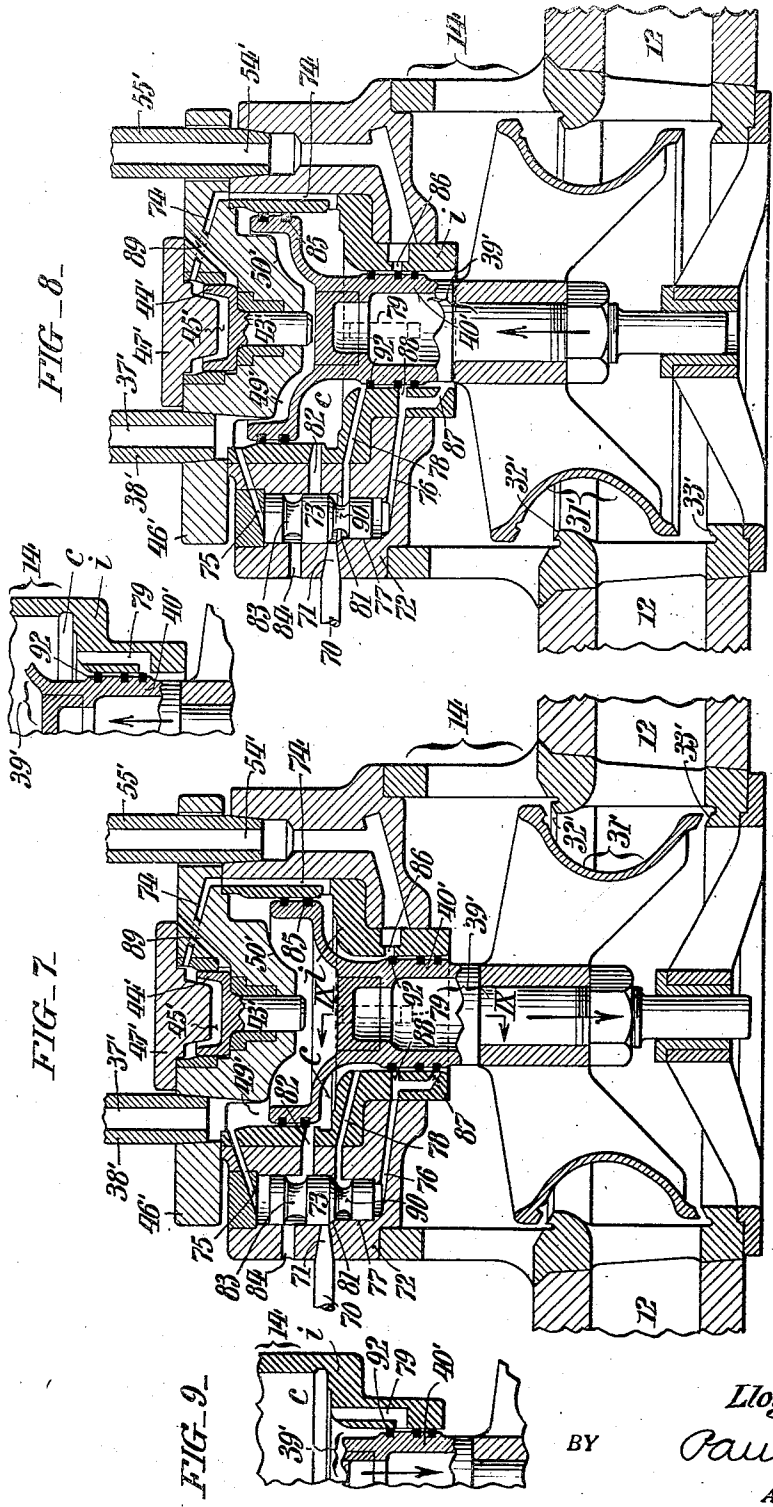


FIG. 8.

FIG. 10.

FIG. 7.

FIG. 9.

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UNITED STATES PATENT OFFICE

2,408,980

CUSHIONING MEANS FOR STEAM-ACTUATED VALVES

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Application March 3, 1944, Serial No. 524,851

7 Claims. (Cl. 121—132)

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This invention has general reference to fluid-actuated reciprocating engines and the means for controlling admission and exhaust of motivating medium to the cylinders thereof. More particularly, the instant improvements relate to a novel method and means for efficiently cushioning the movements of the poppet-valves which control the distribution of steam to the cylinder of locomotive engines.

Heretofore, and as well understood, the steam distribution to modern locomotive engine cylinders is generally controlled by admission and exhaust poppet-valves which, of necessity, must move with great rapidity and unless said valves be properly cushioned they are very liable to deteriorate or break, due to the heavy mechanical wear and tear imposed by normal service.

Bearing in mind the noted liabilities it is a primary object of the instant improvements to positively overcome such liability by providing a novel method and means whereby the cushioning and quick action of poppet-valves on locomotive engine cylinders is positively ensured. In such connection two fundamental conditions are necessarily involved, namely those of proper cushioning, and rapidity of motion. Accordingly another object of this invention is to provide novel improvements, preferably for incorporation in poppet-valves, whereby said fundamental conditions are positively interassociated or efficiently correlated.

A further object is to provide novel means effective to positively cushion the terminal impact of a poppet-valve operating-piston at one end of the stroke by fluid pressure inserted against an axially and spacially aligned relatively small coactive piston, and at the other end of the stroke by compression of presssure fluid in a special or circumferential cavity surroundingly intermediate the end of said piston.

A still further object is to insure prompt responsive actuation of a poppet-valve operating-piston when the fluid pressure acting to cushion the terminal portions of its stroke is released to exhaust.

Other objects with ancillary advantages will be duly noted or become apparent to those skilled in the art, upon a full understanding of the construction, arrangement and operation of the means hereinafter disclosed.

For the purpose of illustrating this invention, there is shown by the accompanying six sheets of drawings a typical embodiment of a preferred means which has been found in practice to definitely carry out the objects above stated; although it is to be understood said means is not conclusive, inasmuch as it may be otherwise arranged and organized with corresponding advantageous results; hence the instant disclosure should not be considered as limitative other than reasonable interpretation of the concluding claims requires.

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In the drawings:

Fig. 1 is a fragmentary sectional view of a part of an engine cylinder including admission poppet-valve as well as the associated pilot, and flow connections, in accordance with the instant invention, all of said valves being shown as in open position.

Fig. 2 is a similar sectional view to the preceding but illustrating the respective valves differently located, or in the closed position with the pilot in proper position to keep said valves closed.

Fig. 3 is a larger scale sectional view of one of the admission poppet-valves shown in Figs. 1 and 2, but illustrating said valve in an intermediate location or as proximate to closed position.

Fig. 4 is a similar sectional view to Fig. 3 but showing the admission poppet-valve approaching the full open position.

Fig. 5 is a sectional view similar to Fig. 1 of the exhaust poppet and pilot-valves, as well as the associated flow connections, with all of said valves in open position.

Fig. 6 is a corresponding sectional view to Fig. 5, but showing the valves in closed position.

Fig. 7 is a sectional view, corresponding to Fig. 3, of the exhaust poppet-valve.

Fig. 8 is a similar view to Fig. 4 of the exhaust poppet-valve.

Fig. 9 is a fragmentary sectional detail view taken on the plane designated by the angle-arrows IX—IX in Fig. 7; and,

Fig. 10 is a similar detail view to the preceding but showing the parts in the position of Fig. 8.

In describing the form of the invention exemplified by the above captioned drawings, specific terms will be employed for the sake of clarity, but it is to be understood the scope of said invention is not thereby limited, each such term being intended to embrace all reasonable equivalents which perform the same function for an analogous purpose.

Referring in greater detail to the drawings and, more particularly to Figs. 1, 2, 5 and 6, the reference character 11 designates a fragmentary portion of a locomotive engine cylinder having a cylinder port 12 under control of admission and exhaust poppet-valves 13, 14 respectively; while 15 indicates the steam chest and 16 the exhaust

passage. The admission and exhaust poppet-valves 13, 14 respectively have companion pilot-valves 17, 18; said pilot-valves being individually shiftable by push-rods 19, 20 under actuation of a master controlling cam, not shown; all of which parts are substantially in accordance with my prior Patent No. 2,260,458, dated October 28, 1941.

In Fig. 1 two admission poppet-valves 13 with their controlling pilot-valve 17, are shown in position in the steam chest 15, said pilot-valve being equipped with a suitable rocker 21 whereby it is vertically activated from the associated push-rod 19, in a manner well understood without further elaboration herein. Note is to be had, at this juncture, that the return movement of the pilot-valve 17 is accomplished by steam-chest pressure being directly admitted from the latter through a port 22 into a chamber 23, under control of a ball-valve 24, and being lifted from its lower seat 25, as readily understood from Fig. 1. On the other hand, when the locomotive throttle is closed, and there is no pressure in the steam-chest 15, steam, from another source of supply such as the "drifting" control means, is admitted below the pilot-valve 17 by way of a manifold 26 and flow-passage 27 and a duct 28, in the steam-chest cover 29, with forcing of the ball-valve from its upper seat 30 onto the lower seat 25 and closure of the port 22, whereby the pilot-valve 17 is maintained in proper position with respect to the push-rod 19.

As the several admission and exhaust poppet-valves 13, 14 are substantially alike and conformatory with known structure the following description will be confined to the changes therein made, in order to avoid the necessity of needless descriptive matter. It is to be observed, however, that the double-seating member 31 of the poppet-valve 13, Fig. 2, is held closed to the associated seats 32, 33 respectively, by pressure from the steam chest 15 entering the bore 34 of the pilot-valve 17, through a port 35, with flow along a second passage 36, into the axial bore 37 of the valve part 38, to exert its force on top of the operating-piston 39: as clearly understandable from the associated arrows shown in Fig. 2. Contrariwise, opening or movement of the valve member 31 away from the seats 32, 33 for passage of pressure, from the steam chest 15, into the cylinder port 12, is accomplished by exhausting the first mentioned passage 36, when steam-chest pressure acts on the lower or smaller portion 40, of the operating piston 39. More particularly it will be observed that in Fig. 2 the poppet-valves 13 are shown in closed position and the pilot valve 17 located to keep said poppet-valves closed. However, it is noteworthy that the manifold 26 leading to the drifting-valve, not shown, has a dual function depending on whether the main throttle is opened and pressure being maintained in the steam chest 15: also that as long as there is pressure in the steam chest 15 the ball check-valve 24 would remain against its upper seat 30 as indicated by a dot-and-dash circle in Fig. 2, due to such pressure while the passage 27 and manifold 26 serve as an exhaust from the bore 54 and ports 52, 53. When the main throttle is closed, however, and there is no longer any pressure maintained in the steam chest 15 the drifting-valve will turn live steam from the boiler into the manifold 26 and passage 27, which, acting through the bore 54 and ports 52, 53 will hold the admission valves 13 in open position: and under such conditions the ball check-valve 24 will drop and rest on its lower seat 25 closing the inlet port 22 from the steam chest 15, and thereby holding the pilot-valve 17 up or collectively engaging the push-rod 19. As the operating-piston 39 moves upward it engages the stem 43 of a small cushioning-piston 44, operative in the bore 45 of the cap member 46 of the valve 13; while a closure gland 47, is suitably clamped to said member. Now it will be readily apparent that, when the passage 36 is exhausted, the volume of pressure under the cushioning-piston 44 discharges through an inclined radial duct or ducts 48, see Fig. 4 to best advantage, provided for the purpose, into the annular clearance 49 about the tapering central portion 50 of the cap member 46, and from thence to exhaust by way of the bore 37 of the valve element 38, as also indicated by associated arrows in Fig. 1; whereupon steam-chest pressure entering through a central port or small orifice 51 in the closure gland 47 acts on the cushioning-piston 44 to drive it inward, relative to the operating-piston 39; or in a direction opposite to that of said operating-piston. Now it will be further seen and readily understood, on examination of Figs. 1 and 2, that when the operating-piston 39 engages the inner or lower end of the stem 43 of the cushioning-piston 44, the steam thereabove will be compressed and forced outwards or back into the steam chest 15 through the orifice 51 above referred to, with the result that the operating-piston 39 is retarded or slowed down by the very high compression developed on top of the cushioning-piston 44, whereby said operating-piston will be brought to the end of its upward stroke without any excessive blow or jar; or, in other words, the upward movement of the operating-piston 39 is effectively cushioned.

When the operating-piston 39 is in the "up" position of Fig. 1, see also Fig. 4, the pressure force between the two pistons 39 and 44 is connected by way of radial ports 52, 53, as well as the bore 54, of a second valve element 55, to the flow-passage 27 and drifting-control manifold 26, as indicated by the associated arrows in Fig. 1; while the operating-piston 39 is held in the "up" position by steam-chest pressure acting on, or in, the hollow 41 of its smaller and lower portion 40, as aforesaid.

Closing of the admission poppet-valve 13 is effected by admission of steam, from the associated pilot-valve 17, to the passage 36 through the bore 37 of the valve part 38 and, as the operating-piston 39 moves downward, some of said steam will be diverted, in differential volume, by way of a duct 56 and port 57, see the left-hand side of Figs. 3 and 4 more particularly, into the space or circumferential cavity *c* about the lower or smaller portion 40 of the operating-piston 39, for a purpose now to be explained. Incidentally it is to be observed that the cavity *c* is defined by the stepped bore of the poppet-valve structure, or by a liner insert *i* fitted therein; as readily understandable by those conversant with the art. As the operating-piston 39 moves downward the port 52 is first cut-off and then the port 57, after which the diverted steam, of differential volume, is trapped and forced at high pressure through the port 53, which is purposely made small, or critical, to insure adequate "down" cushioning, for the piston 39, while at the same time permitting the high-pressure or compressed steam in the circumferential cavity *c* to escape or exhaust after said piston reaches the limit of its down movement. This trapping of the high-pressure steam

in the cavity c in differential volume, results in slowing the downward movement of the operating piston 39—with the poppet-valve 31 on the seats 32, 33—at a speed so greatly reduced that any blow or jar is eliminated. It is also to be particularly noted that by properly proportioning the size and location of the ports 52, 53 as well as the duct 56 and port 57, any desired degree of cushioning can be effected, with optimum results obtainable when the piston 39 descends at maximum speed, with quick closing of the poppet-valve 31; and said piston being effectively slowed during the terminal portion of its downward travel. On the other hand, if the degree of compression in the circumferential cavity c is not enough, the piston 39 will be insufficiently slowed down and the poppet-valve 31 will strike the seats 32, 33 with a hard and objectionable blow; or, conversely, if there be an excess of compression in said cavity the piston 39 will "bounce" or rebound a short distance, thereby opening the poppet-valve 31 when it should be closed. Accordingly it is again stressed that the size and location of the ports 52, 53, as well as the duct 56 and port 57 respectively, should be accurately determined and maintained.

The port 52, which it will be seen on examination of the drawings, is larger than the port 53, has a further function to that above explained; in that, by promoting quick action of the operating-piston 39 it also keeps the differential volume of steam connected to the exhaust flow-passage 27, while said piston 39 is in the "up" position, and thereby eliminates any upward force opposing said piston due to pressure of the differential volume in the cavity c. Also, when the piston 39 starts downward, it is opposed only by steam-chest pressure acting against the lower or smaller portion 40 of said piston, which is readily overcome incidental to the larger area of the upper end of such piston; as is quite obvious.

Referring now, more particularly, to the arrangement of parts for cushioning the movement of the exhaust poppet-valves 14, as shown in Figs. 5 to 10 inclusive, all parts similar to those previously described, in connection with the admission poppet-valve 13, will be designated by corresponding reference characters with an added prime exponent in order to obviate unnecessary repetitive explanation. Live steam from the locomotive throttle and steam chest 15 flows, by way of a passage 58 and a conduit 69 to one side, the lower for example, of a double-seating check-valve 59, to hold the ball 61 elevated against the upper seat 62, and from thence into the hollow 63 of the lower portion of the vertically-operative piston 64, in the exhaust pilot-valve 18. When the locomotive is "drifting," and the locomotive throttle closed the ball 61 in the check-valve 59, drops to its lower seat 65, while steam from the drifting control-valve, not shown, flows through a second passage 66 and conduit 67 into the upper part of the check-valve 59, as well as to the exhaust pilot-valve 18, and thereby holds the ball 61 to the seat 65. An orifice 68 in the check-valve 59 affords flow communication from the passage 58 into a conduit 69 connecting with the bore 54' of the respective valve elements 55'; while said conduit 69 has branches 70 each, in turn, leading to a flow-constricting port 71 in the wall of the poppet-valve cylinder 72, whereby live steam from the throttle and steam chest 15 is afforded

access to an auxiliary-cushioning valve 73, later on more fully explained.

In the position shown by Fig. 5 each exhaust poppet-valve 14 is open, with the associated operating-piston 39' at the top of its stroke. The small cushioning-piston 44', which contacts the operating-piston 39' through its stem 43', has also been moved to the uppermost limit of its stroke, while the steam above said cushioning-piston 44' has been forced through an angled-duct 74 downwardly into the circumferential cavity c, defined by the differential portions of said operating piston with respect to the surrounding cylindrical walls of the valve 14: whereas the restriction imposed by the angled-duct 74 on the downwardly forced steam is sufficient to build-up a high degree of compression against the cushioning piston 44' which materially slows down its movement. Now, it will be apparent that, with the operating piston 39' in the position just described and inclined port 75, through the top of the poppet-valve structure that communicates from above the auxiliary-cushioning valve 73 to the bore 37' of the exhaust-valve part 38', is open to exhaust. A duct 76 from the lower end of the bore 77, in which said valve 73 operates, is open to exhaust, as indicated by the associated arrows in the left-hand side of Fig. 8, but it is to be remarked the valve 73 is held in its "up" position until it is blanked-off by upward movement of the piston 39'. In other words live steam from the port 71 holds the auxiliary-cushioning valve 73 in the "up" position until it is driven down by admission of steam on top of the piston 39', which also enters through the port 75; while a port 79, indicated by dotted lines in Figs. 7 and 8 and shown in full in Figs. 9 and 10, is open to exhaust and thereby affords outlet for the steam in the circumferential cavity c intermediate the upper and lower portions of the operating piston 39'.

Turning now more particularly to Fig. 5, when live steam is admitted from the pilot-valve 18 through the conduit 80 to the top of the operating-piston 39', the double-seating member 31' of the poppet-valve 14 commences its downward movement, live steam being also admitted through the inclined-port 75 to the top of the auxiliary-cushioning valve 73, thereby moving the latter down and onto a seat 81, just below the steam flow-constricting port 71, and thus closing the duct 78. With the auxiliary-cushioning valve 73 in the "down" position, just referred to, a port 82 from the circumferential cavity c is opened to exhaust about the reduced part 83 of said valve 73 with outlet through an orifice 84 in the wall of the poppet-valve 14, as readily seen on examination of the left-hand portion of Fig. 7, more particularly. As soon as the operating-piston 39' starts down, the port 79 is closed by the smaller portion 40' of said piston, but the circumferential cavity c above referred to, still continues open to exhaust by way of the port 82 until the lower packing ring 85 about the upper portion of the operating-piston 39' passes over said port. With the port 82 closed the remaining steam in the circumferential cavity c is compressed, as the downward movement of the operating piston 39' advances and, as such movement continues, a lower or supply port 86, for live steam, is opened, whereby, there results a combination of compressed and entering live steam pressures which, jointly function to slow down the travel of the operating-piston 39' just before the poppet double-seating member 31' contacts the associated seats 32', 33',

and thereby effectively cushions the impact of contact. Now it will be seen that, upon completion of the downward stroke of the operating-piston 39', the inner or lower end 87 of the duct 76 will be cut-off from connection to exhaust, whereas the upper end 88 of said duct is in communication with the circumferential cavity c by way of the port 79, as before noted, and thus pressure steam is conducted to the lower or smaller end of the auxiliary-cushioning valve 73, in a manner clearly apparent upon examination of Fig. 6 of the drawings. At the same time live steam is also admitted by way of the angled-duct 74 to the top of the cushioning piston 44', which is consequently moved inward to the limit of its downward stroke, incidental to the provision of an exhaust outlet or port 89.

When the pilot-valve 18 again lifts or opens, the steam acting on the larger or upper end of the operating piston 39' flows out or exhausts by way of the bore 37' of valve element 38' and conduit 80, while the live steam now filling the circumferential cavity c, hereinbefore explained, causes said piston 39' to move upward, and thereby opens the poppet or lifts the double-seating member 31' from the seats 32', 33'. The action just described also effects exhaust of the pressure acting on top of the auxiliary-cushioning valve 73, by way of the inclined port 75, and permits it to ascend by reason of the pressure steam acting thereunder through the duct 76. Such action, in turn, admits live steam to the smaller reduced portion 90, of the auxiliary-cushioning valve 73, by way of the duct 78 and causes said valve to lift and cut-off or close the port 75 to exhaust, so that the circumferential cavity C is first supplied with live steam through the port 86 and later by way of the duct 78, until said piston reaches the limit of its up-stroke, by which time the duct 78 is cut-off incidental to passage thereover of the upper ring 92 of the smaller portion 40' of the piston 39', as clearly seen on reference to Fig. 5 of the drawings; while the port 79 is now open to exhaust as hereinbefore stated. The port 79 is also blanked or shut-off from the circumferential cavity c, as the piston 39' moves upward, and opens to exhaust, as before described, to thereby exhaust the steam from below the lower end of the auxiliary-cushioning valve 73. Toward the end of the up-stroke of the operating piston 39', it engages the confronting end of the stem portion 43' of the cushioning-piston 44' and is thereby slowed down during the end portion of its stroke, as explained in connection with the admission poppet-valves 13 of Figs. 1 to 4, inclusive.

From the foregoing it will be seen that the movement of the operating piston 39' is effectively cushioned as it approaches the limit of its stroke, in one direction, by means of the piston 44', and at the other end of its stroke by the compression of steam in the circumferential cavity c, supplemented by admission of live steam through the port 86, which latter condition also insures the prompt response of the piston 39' to upward movement when the steam on top of it is exhausted by the pilot-valve 18; while any steam about the upper part of said pilot-valve flows to exhaust 16 by conduits 91, in an obvious manner. It is also to be particularly remarked that by the arrangement of the several ports and ducts, as above described, said arrangement and careful dimensioning thereof, serve to materially speed-up the movement of the operating-piston 39 or 39', as well as insuring and promoting quick opening and closing of the respective poppet-valves 31 or 31'. With the piston 39' at the top of its stroke, the port 79 exhausts the circumferential cavity c, so that the larger portion of said piston can respond quickly when steam is admitted on top of it and, since the port 82 remains open to exhaust until the piston 39' has nearly completed its down stroke, there is but little resistance to such down movement until it is essential to slow it up toward the end of the stroke. Similarly, the port 78 continues to supply live steam to the circumferential cavity c, during the "up" stroke of the piston 39', until it is cut-off by the upper piston ring 92, Figs. 7 and 8, just before the port 79 opens to exhaust at the terminal part of said stroke. Effective cushioning of the exhaust poppet-valves 14 is therefore accomplished with a minimum of moving parts, while such parts as are requisite, simply consist of the cushioning-piston 44 or 44', and the auxiliary-cushioning valve 73; all of which valves are comparatively small, have limited movement and, consequently, are subject to minimum wear.

From the foregoing it is considered the merits and advantages of the poppet-valve cushioning means hereinbefore disclosed will be clearly apparent; also that the explained embodiment thereof fully justifies the objects set forth in the prefatory paragraphs of this specification; and furthermore that changes may be made in the form, location, and assembly of the various parts, without departing from the spirit of said invention as comprehended within the scope of the following claims.

Having thus described my invention, I claim:

1. In a locomotive engine having piston-operated poppet-valves controlling the admission and exhaust of pressure-steam to the engine steam chest and cylinder, with individual pilot-valves effective to open and close said poppet-valves, means for cushioning the terminal impacts of the operating-piston, said means comprising a relatively small individually and axially-shiftable piston, said piston being spacedly-aligned in respect to the poppet-valve operating piston at one end thereof; means in the body of the poppet-valve defining a circumferential cavity about and intermediate the ends of the operating piston; and conduit means with associated ports controlling supply of pressure from the cylinder steam chest to and from the small axially-shiftable piston, as well as to the circumferential cavity for effecting positive cushioning of the poppet-valve operating-piston when approaching the limits of its movement.

2. The combination of claim 1 wherein a small port or orifice is provided in the poppet-valve axially outward relative to the small shiftable-piston for the admission of steam-chest pressure to drive said piston in one direction, and means forming a part of the shiftable piston for engagement by the poppet-valve operating piston to effect expulsion of the admitted steam-chest pressure above the shiftable-piston under high compression whereby the poppet-valve operating-piston is effectively cushioned.

3. The combination of claim 1 wherein one of the supply ports is of a critical size to restrict exhaust of steam compressed in the circumferential cavity, and one of the conduit means with an associated port serves to divert steam-chest pressure directly into said cavity to positively insure adequate cushioning of the poppet-valve operating-piston during the terminal parts of its

strokes and thereby prevent the valve from "striking" its seat.

4. The combination of claim 1 wherein a double-seating ball-valve is provided in connection with the pilot-valve controlling the steam admission poppet-valve, and an associated conduit and port means supplies pressure-steam to said ball-valve, from another source than the steam chest, to shut-off the pilot-valve from actuation, by steam-chest pressure, when the locomotive is "drifting."

5. The combination of claim 1 wherein the operating-piston of the poppet-valves embodies hollow-sections of different diameter, and the circumferential cavity in the poppet-valve body is defined by an associated insert within the body of the poppet-valve.

6. In a locomotive engine having piston-operated poppet-valves controlling the admission and exhaust of pressure-steam to the steam chest and cylinder thereof, with individual pilot-valves effective to open and close said poppet-valves; means operative to effect cushioning of the terminal impacts of the operating-piston, said means comprising a relatively small axially-related shiftable-piston having a stem with its inner end normally spaced away from the confronting end of said operating-piston; means in the body of each poppet-valve defining an annular cavity, about and intermediate the ends of the operating-

piston; an auxiliary cushioning-valve in the aforesaid poppet-valve body cooperative with the axially shiftable-piston; and means in the form of ducts and ports effective to supply live steam to as well as steam under constricted flow through said auxiliary cushioning-valve, whereby the terminal portions of the stroke of the operating-piston in either direction are effectively slowed down and noisome impacts positively prevented.

7. The combination of claim 6 wherein the axially shiftable-piston has a stem adapted for coaction with the confronting end of the poppet-valve operating-piston, conduit means from the pilot-valve, with associated ports for supplying live steam from the pilot-valve to move the poppet-valve operating-piston in one direction, and to divert a part of such supply for concurrent movement of the auxiliary shiftable-piston in the same direction to open a port in the valve to exhaust, individual ports in the body of the valve for maintenance of the circumferential cavity open to exhaust until the operating-piston approaches the end of its stroke in the direction aforesaid, and other conduit means with associated ports admit live steam to the circumferential cavity and to the auxiliary shiftable-piston for movement of the latter in the reverse direction and to adequately cushion the first mentioned relatively small shiftable-piston.

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