UNITED STATES PATENT OFFICE.

MAX J. ULRICH, OF HOLYOKE, MASSACHUSETTS.

CUT-OFF FOR DUPLEX STEAM-PUMPS.

SPECIFICATION forming part of Letters Patent No. 655,498, dated August 7, 1900.
Application filed February 26, 1900. Serial No. 6,459. (No model.)

To all whom it may concern:

Be it known that I, Max J. Ulrich, a citizen of the United States, residing at Holyoke, in the county of Hampden, State of Massachusetts, have invented a new and useful Improvement in Cut-Offs for Duplex Steam-Pumps, which improvement is fully set forth in the following specification and accompanying drawings.

My invention relates to an improved construction of a cut-off-valve mechanism for direct-acting duplex steam-pumps, whereby I am enabled to save a large percentage of steam or other motive fluid by my novel cut-off, which is applicable to any kind of duplex pump without changing its character, it being immaterial whether a single steam-chest or a plurality of steam-chests are employed, the valve-gear being readily adapted to existing pumps without necessitating any increase in the length or the width of the pump or engine and all the moving parts except the valves being outside of the steam-chest and readily accessible for the purposes of inspection, adjustment, or repairs.

To the above ends my invention consists of an improved construction of cut-off valves especially adapted to work in unison with the main valves of a duplex pump, the cut-off-valve rod being actuated by means of a link and a tappet, which are each operated by the main lever located on the same side as its cut-off valve, by reason of which the right-hand cut-off valve will travel in the same direction as its piston, while the left-hand cut-off valve must travel in an opposite direction to its piston.

It also consists of a novel construction of a plurality of steam-cylinders arranged to act with the main slide-valves, cut-off valves, and other operative mechanism of a duplex pump, each of said cylinders having five ports in its face and two in the cylinder-bore, a single port only opening into each end of each cylinder, whereby the clearance is reduced to a minimum.

It also consists of a novel construction of an index supported upon the cut-off-valve rod, which is adapted to indicate the exact amount of cut-off in every instance.

It also consists of the novel provision of guiding devices in the bearing-stand, whereby the free ends of the cut-off-valve rods are supported and guided.

It also consists in the novel manner of actuating the main and cut-off valves.

It also consists in the novel manner of operating the tappet and the novel construction of adjustable collars, whereby the stroke of the tappet is regulated.

It also consists of a novel construction of a main slide-valve provided with a cylindrical or flat seat on its top for the reception of the cut-off valve and means for actuating said valves.

It also consists of the novel construction of a different cut-off valve for the right and left hand main valves and means for actuating the same.

It also consists of the novel location and construction of the mechanism, whereby the lost motion is attained for the main steam-valve.

It further consists of the novel details of construction, all as will be hereinafter fully described, and particularly pointed out in the claims.

Figure 1 represents an end view of a cut-off valve for a duplex steam-pump embodying my invention, a portion of the valve-chest being shown in section. Fig. 2 represents a section on line x x, Fig. 1, showing the right-hand cut-off valve and main valve and their adjuncts. Fig. 3 represents a section on line y y, Fig. 1, showing the left-hand cut-off valve and main valve and their adjuncts. Fig. 4 represents an outside view showing the relative positions of the valve-rods and their adjuncts. Fig. 5 represents, on an enlarged scale, a side elevation of a portion of the valve mechanism seen in Fig. 3. Fig. 6 represents an end view of an adjustable collar seen in detached position. Fig. 7 represents a section on line z z, Fig. 5.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings, I designates the right-hand steam-cylinder, which is provided with only a single port 2 and 3 in each end thereof, as contradistinguished from the usual style of duplex-pump steam-cylinder, where-in two ports at each end are employed, it being apparent that in my style of cylinder, where-in one port at each end is employed, the clear-
The steam reducing its force by expansion there is no necessity for said double ports; but should the engine run full stroke, as will be hereinafter explained, exhaust throttle-valves can be placed at the points 4 and 5 in the short exhaust-ports 6 and 7.

8 designates the main slide-valve, which is provided with the ports 9 and 10, which permit the inlet of the motive fluid to each end of its cylinder, said valve having also the re-cess or port 11, whereby the exhaust is permitted when the parts are in the position seen in Fig. 2 to flow to the main exhaust-port 12.

13 designates a preferably-cylindrical bore on the back of the main slide-valve, wherein reciprocates the cut-off valve 14, said main slide-valve receiving its motion, as usual, from the opposite steam side, while the cut-off valve obtains its motion from its own side of the engine. For example, if three-quarters cut-off is desired after the right-hand steam-piston 15 has traveled three-quarters of its stroke the main lever 16, which operates in unison with said piston by reason of its engagement with the spoon 17 on the rod 18 by reason of its connection to the tappet 19 by the link 20, will, in conjunction with the collars 21 or 22, at the proper time close the steam-port of the main slide-valve. It will thus be apparent from Figs. 2 and 4 that to effect a cut-off on the right-hand side the cut-off valve will have to travel in the same direction as its piston is traveling, while on the left-hand side, as will be explained, the corresponding cut-off valve has to travel in a direction opposite to its piston, the main slide-valves thus being constructed alike, while the cut-off valves slightly differ in construction. The motion and regulation of each of the cut-off valves are effected by the proper tappet, which receives its motion from the proper main lever. The collars 21 and 22 are similar in construction and are preferably threaded internally, so as to engage the threaded portions of the cut-off-valve rod 23, it being apparent that when said collars are adjusted nearer to the tappet an early cut-off results and when adjusted farther apart a late cut-off results. Each collar is preferably slotted, as at 24, and provided with set-screws 25, whereby said collars can be firmly retained in any desired position.

26 designates an index clamped or other-wise secured to each cut-off-valve rod, whereby is indicated precisely at what cut-off each steam end is working under, each of said cut-off-valve rods having their free ends guided in ways 27 in the bearing-stand 28. The lost motion of the main slide-valve, which must necessarily exist in this class of pumps, is either of the fixed or adjustable type, and I have changed the usual location of the lost-motions block to the valve-rod head, thereby diminishing the length of the steam-chest and simplifying the construction, and thus reducing the cost of manufacturing to a minimum. The valve-rod-head pin 29 of the main right-hand valve-rod 30 runs directly in the slot 31 of its link 32 without necessitating the employment of any blocks as used heretofore—that is, if a so-called "fixed" inadjustable lost motion is used.

It will be seen upon reference to Fig. 2 that the distance between the steam-ports on the upper portion of the main slide-valve—that is, the ports in the bore which receive the cut-off valve—is diminished in such a way that at any cut-off called for there will always be a free opening for the entering steam at either the forward or return stroke, said main valve having on its front end a pocket 33, which is cored out or otherwise formed to receive the collar of its valve rod, it being apparent that no lost motion is allowed here. The cylindrical shape of the cut-off valves has been chosen, so as to enable the same to work with the greatest possible freedom, each cut-off valve being balanced and consisting of a closed cylinder perfectly guided, which is a very important feature in ease the steam end of the pump should stand upright or be hung vertically, as in the case of vertical marine pumps.

The right-hand cut-off valve 14 is in order to get short straight ports in the main valve 8 made in the sections 34 and 35, which are joined by the neck or hub 36, adjacent to which latter are the ports 37, whereby steam is permitted to enter from the valve-chest at any time from both ends to fill the inner portion of the right-hand cut-off valve and hence to enter its steam-cylinder.

38 designates the main valve of the left-hand cylinder, said valve being provided with ports and the cylindrical bore 39, constructed substantially as has already been described with reference to the right-hand main valve.

40 designates the left-hand cut-off valve, (best seen in Fig. 3), which in the present instance a simple cylinder having its free end guided in the hub in which is secured an end of the left-hand cut-off-valve rod 41. The left-hand cut-off-valve rod is also provided with an index 42, tappet 43, and adjustable collars 44 and 45, all of which are similar to the corresponding parts seen in Fig. 2, said cut-off-valve rods 41 and 23 having their free ends guided and supported at its valve-rod head 46, as already been explained. The left-hand tappet 43 has connected thereto one end of the link 46, the other end of the latter being connected to the lever extension 47 of the left-hand main lever 48, it being of course understood that the well-known duplex motion is employed in the left-hand as well as the right-hand side of the pump or engine, as already explained, one piston following the other after the first has nearly completed its stroke. In other words, each slide-valve receives its motion, as usual, from the opposite piston,
while each cut-off valve obtains its motion from the main lever on its own side.

The left-hand main-valve rod 49 is provided with a lost-motion connection between the valve-rod heads 50 and 51, as will be clearly understood from Figs. 3 and 5, said lost-motion connection being similar to that already described in connection with Fig. 3. It will thus be seen that by my variable cut-off valve gear any ratio of expansion can be had in the limit of one-half stroke to full stroke on each side and that, furthermore, the right-hand and left-hand sides can be adjusted independently of each other, which also holds good for the yoke end and head end of each cylinder.

I desire to lay especial emphasis upon my novel feature of providing each high-pressure cylinder in a duplex engine with but a single port leading into each extremity of each steam-cylinder, each of the latter being provided with a cut-off valve coacting with its main slide-valve, in combination with the other novel features of my invention. As is well known to those skilled in this art, in the high-pressure steam-cylinders of a duplex pumping-engine where no cut-off is employed it is the usual practice to employ two ports at each end of said cylinders for the purpose of creating a cushioning effect upon the piston. It being evident that the live steam has to fill these two ports before any propulsion of the steam-piston can take place, it being also apparent that as quick as the main slide-valve opens to the atmosphere said live steam contained in these two ports will escape to the atmosphere without doing any useful work, said ports having to be refilled at every stroke, which is very wasteful, as is evident. Now when a cut-off valve is employed for each cylinder in conjunction with a single port at each end of each cylinder it is unnecessary to make allowance for any cushioning, since the latter is perfectly under the control of the operator and is effected by adjusting the cut-off, whereas the piston is prevented from striking the cylinder-heads, and a single port leading into the end of each cylinder will suffice. The throttle-valves may be employed at the points 4 and 5 for the purpose of additional security, as has been heretofore explained.

My invention can be readily applied to the smallest as well as the largest steam-pumps and is also equally well adapted to compound or triple-expansion pumping-engines. It will be apparent that a duplex pump equipped with my invention can readily show an economy or saving of thirty per cent. to fifty per cent. In fuel and that under certain conditions its efficiency will equal that of a compound pumping-engine. It will be understood that I do not limit myself to steam pumping-engines exclusively, as the principle of my invention is equally well adapted to compressed-air and other engines as well.

When my invention is applied to compound or triple-expansion engines, it will of course be apparent that the cut-off valve is applied to the high-pressure cylinder only, and in such cases flat as well as round cut-off valves may be employed, if desired. In cases where an intermediate cylinder is employed between the high-pressure and low-pressure cylinders in a triple-expansion engine it will be understood that the low-pressure and intermediate cylinders will have the usual slide-valves, which will coact with the main slide-valve on the high-pressure cylinder, upon which latter slide-valve my improved cut-off valve 80 is mounted. I have deemed it unnecessary to illustrate the various modifications hereinabove referred to, as the principle of operation is the same in each instance. It will also be evident that the form or structure of the cut-off valve may be changed as to requirements. It will be further apparent that changes may be made by those skilled in the art which may come within the scope of my invention, and I do not therefore desire to be limited in every instance to the exact construction I have herein shown and described.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A duplex steam-pump consisting of a plurality of steam-cylinders, steam-chests therefor, each cylinder having five ports on its face, three of said ports serving as exhaust and a single port communicating with each end of each cylinder the outer of said exhaust-ports communicating with the adjacent single ports, main slide-valves for each cylinder, cut-off valves for each of said slide-valves, means for causing one of said cut-off valves to travel in the same direction as its piston, and means for causing the other cut-off valve to travel in an opposite direction to its piston.

2. In a duplex steam-pump, a plurality of cylinders, steam-chests therefor, each of said cylinders having five ports on each of their faces and a single port communicating with each end of each cylinder, the outer exhaust-ports being adapted for the reception of exhaust throttle-valves and said outer exhaust-ports communicating with the adjacent single port, main slide-valves for each cylinder, cut-off valves reciprocating directly upon each of said slide-valves, means for actuating said slide-valves, means for causing one of said cut-off valves to travel in the same direction as its piston, and means for causing the other cut-off valve to travel in an opposite direction to its piston.

3. The combination of a plurality of cylinders, main slide-valves therefor, a cylindrical bore in the top of each of said valves, cut-off valves located in said bores, one of said valves consisting of sections joined by a hub, ports in said sections, adjacent said hub for permitting the motive fluid to flow therethrough to said slide-valves, and means for actuating the latter and said cut-off valves.

4. The combination of a cylinder, a main
slide-valve therefor, a cylindrical bore in the top of said slide-valve, a cut-off valve located in said bore said valve consisting of sections, joined by a hub, ports in said sections adjacent said hub and mechanism for operating said slide and cut-off valves.

8. In a duplex pumping-engine, a plurality of cylinders, main slide-valves therefor, cut-off valves movable in said slide-valves for the high-pressure cylinders only, valve-rods for said cut-off valves, one of the latter consisting of sections joined by a hub, ports in said sections adjacent said hub a bearing-stand, means for guiding the free ends of said rods in said bearing-stand a tappet and tappet-collars for each of said rods and means for operating said valves, in combination with an index mounted on said rods and extending over said collars whereby the cut-off of each high-pressure steam-cylinder end can be precisely ascertained.

9. In a duplex high-pressure pumping-engine, cylinders, main slide-valve and a cut-off valve for each of said cylinders, cut-off valve rods, a tappet mounted on each of said rods, a pair of adjustable threaded collars mounted on said rods on each side of said tappet, an index carried by said rods and extending over said collars, means for operating each cut-off valve from the main lever located at the same side of the engine, and means for operating each main slide-valve from the opposite side of the engine.

10. In a duplex pumping-engine, a pair of cylinders, main slide-valves therefor, valve-rods for each of said slide-valves, heads on said each of said valve-rods, pins in said heads, links having slots therein, said slots being engaged by said pins and means for operating said links and valves, said slotted-link and pin connection serving to make provision for lost motion.

11. In a duplex pumping-engine, a pair of cylinders, main slide-valves therefor, cut-off valves movable directly upon said slide-valves one of said cut-off valves consisting of sections joined by a hub and ports in said sections adjacent said hub, main levers, means substantially as described operated by the latter for causing the right-hand cut-off valve to travel in the same direction as its piston, means substantially as described for causing the left-hand cut-off valve to travel in an opposite direction to its piston, and means for operating said slide-valves.

12. In a duplex pumping-engine, a pair of cylinders, main slide-valves therefor, cut-off valves movable in said slide-valves, valve-rods for said cut-off valves, a tappet and collar for said cut-off valve rods, an index mounted on said valve-rods and extending over said collars, a bearing-stand, means for guiding the free ends of said rods in said bearing-stand, a lost-motion connection for said slide-valves, heads on said valve-rods, pins in said heads, links having slots therein, said slots being engaged by said pins, and means for operating said links and valves.

13. In a duplex pumping-engine, a pair of cylinders, main slide-valves therefor, cut-off valves movable in said valve-rod, valve-rods for said cut-off valves, a bearing-stand, means for guiding the free ends of said rods in said bearing-stand, a lost-motion connection for said slide-valves, consisting of valve-rod attached to said slide-valves, heads on said valve-rods, pins in said heads, links having slots therein, said slots being engaged by said pins, and means for operating said links and valves.

14. In a duplex pumping-engine, a pair of cylinders, main slide-valves, cylindrical cut-off valves reciprocating directly upon said slide-valves, one of said cut-off valves consisting of sections joined by a hub and ports in said sections adjacent said hub, pistons in said cylinders, means for causing one of said cut-off valves to travel in the same direction as its piston and means for causing the other of said cut-off valves to travel in an opposite direction to its piston.

15. In a duplex pumping-engine, a plurality of cylinders, main slide-valves therefor, cut-off valves movable in said slide-valves, valve-rods for said cut-off valves, a bearing-stand and means for operating said slide-valves.

16. In a duplex pumping-engine, a plurality of cylinders, main slide-valves therefor, cut-off valves movable in said slide-valves, valve-rods for said cut-off valves, a longitudinally adjustable graduated index mounted on said
valve-rods, a bearing-stand, means for guiding the free ends of said rods in said bearing-stand and means for operating said valves.

17. In a duplex pumping-engine, a pair of cylinders main slide-valves therefor, valve-rods for said slide-valves, heads on said valve-rods, pins in said heads, links having slots therein, said slots being engaged by said pins, means for operating said links and slide-valves, said slotted-link and pin connection serving to make provision for lost motion, cut-off valves mounted on said slide-valves, and means for operating said cut-off valves.

18. In a duplex pumping-engine, a pair of cylinders, main slide-valves therefor, valve-rods for said slide-valves, heads on said valve-rods, pins in said heads, links having slots therein, said slots being engaged by said pins, means for operating said links and slide-valves, cut-off valves mounted on said slide-valves, means for operating said cut-off valves, valve-rods for said cut-off valves, a bearing-stand and means for guiding said cut-off valve rods in said bearing-stand.

19. In a duplex pumping-engine, a pair of cylinders, main slide-valves therefor, valve-rods for said slide-valves, heads on said valve-rods, pins in said heads, links having slots therein, said slots being engaged by said pins, means for operating said links and slide-valves, cut-off valves mounted on said slide-valves, valve-rods for said cut-off valves, a bearing-stand and means for guiding said cut-off valve rods in said bearing-stand, in combination with an index mounted on said cut-off valve rods, whereby the cut-off which each steam end is working under can be precisely ascertained.

20. In a pumping-engine, a plurality of cylinders, main slide-valves therefor, valve-rods for said slide-valves, heads on said valve-rods, pins in said heads, links having slots therein, said slots being engaged by said pins, means for operating said links and valves, valve-rods for said cut-off valves, a tappet and collars for said cut-off valve rods and an index mounted on said cut-off valve rods and extending over said collars.

21. In an engine, cut-off valves, valve-rods for the latter, collars mounted on said valve-rods, an index mounted on the latter and extending over said collars, main slide-valves, cylinders therefor, and means for actuating said valves.

22. In an engine, a valve, a valve-rod therefor, collars on said valve-rod, means for actuating the latter and an index mounted on said valve-rod and extending over said collars.

23. A steam pumping-engine, consisting of a plurality of high-pressure steam-cylinders, a single port leading to each end of each of said cylinders, main slide-valves for each cylinder, cut-off valves for each of said slide-valves, one of said cut-off valves consisting of sections joined by a hub, ports in said sections adjacent said hub, and means for actuating said valves.

MAX J. ULRICH.

Witnesses:
H. E. CASTELLON,
J. GEO. GOTTSMANN.