Sept. 3, 1935. A. O. JUDSON 2,013,609

VALVE GEAR

Filed May 17, 1934 2 Sheets-Sheet 1

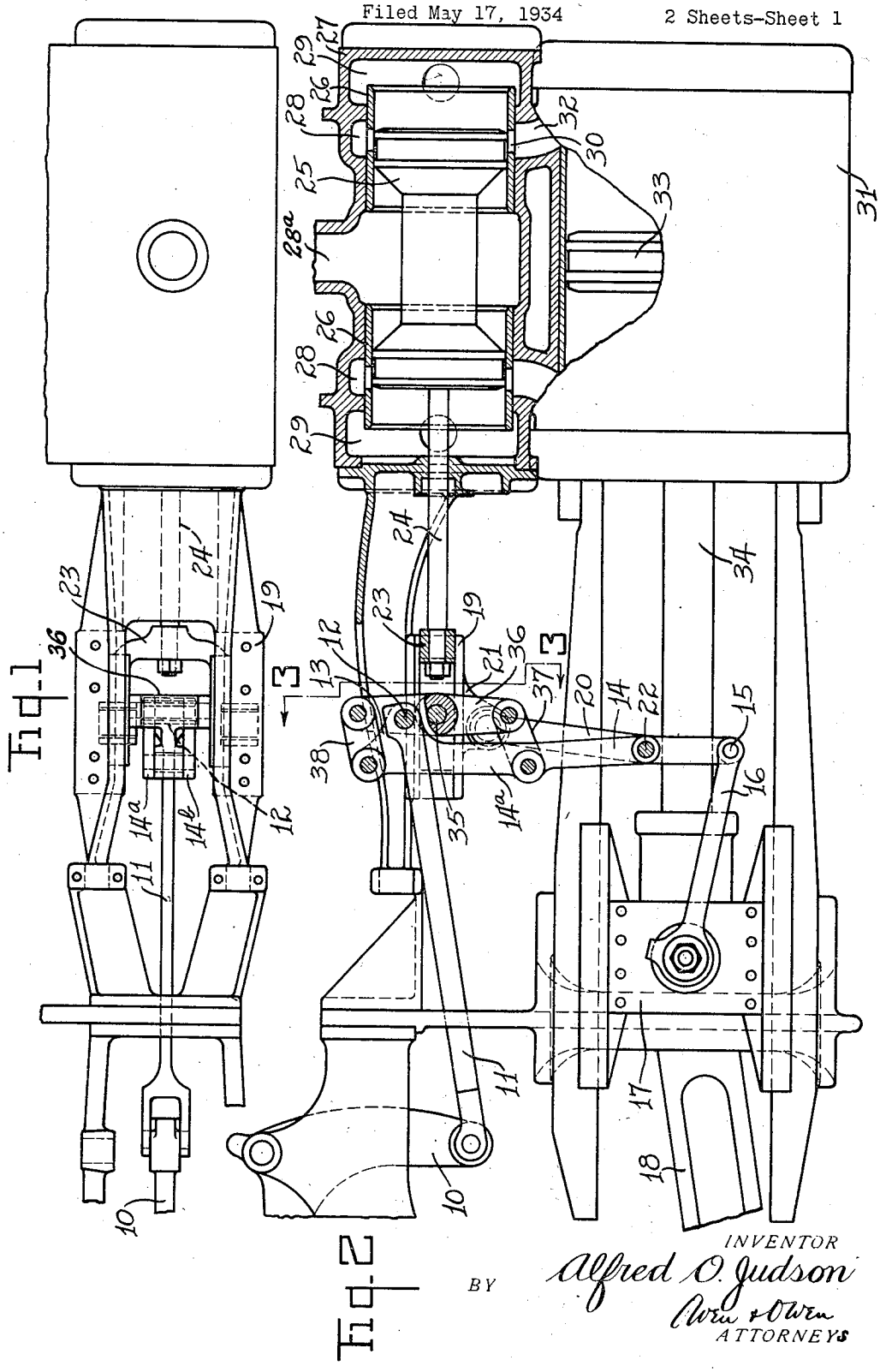


Fig-1

Fig-2

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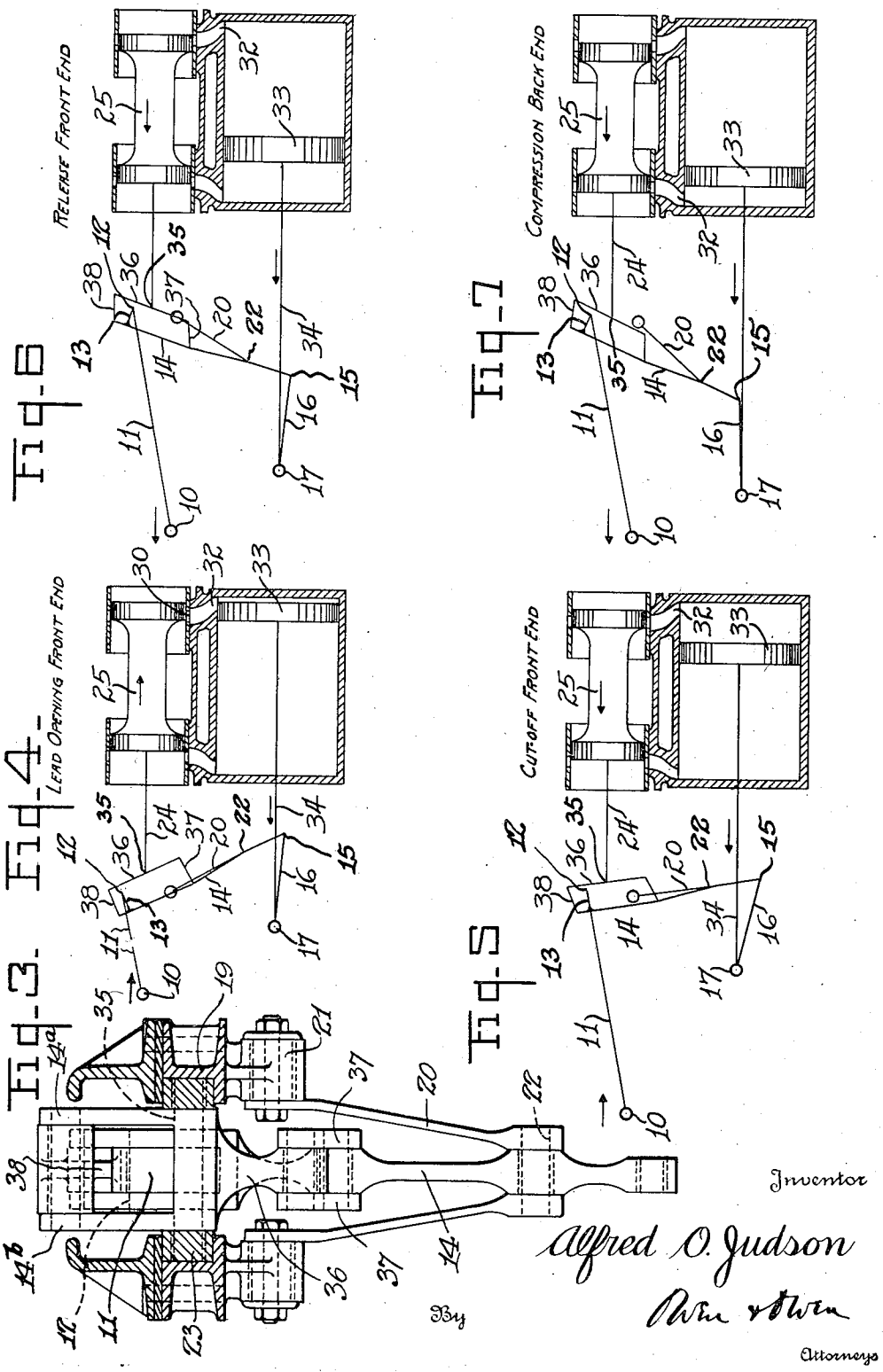


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# UNITED STATES PATENT OFFICE

2,013,609

## VALVE GEAR

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8 Claims. (Cl. 121—163)

This invention relates to reciprocable piston engines, but more particularly to steam or expansible engines of the reversible type, and an object is to produce a new and improved valve gear for an engine of this character which is simple in construction, efficient in operation, and has the novel features of construction, arrangement and operation hereinafter described.

Further objects and advantages of the invention will hereinafter appear, and, for purposes of illustration but not of limitation, an embodiment of the invention is shown in the accompanying drawings, in which:

Figure 1 is a top plan view of the forward end portion of the valve gear arrangement, valve chest, and associated parts;

Figure 2 is a side elevation partly in vertical section of the parts shown in Figure 1 showing the position of the valve gear parts in vertical position while the piston is at mid-stroke;

Figure 3 is an enlarged vertical sectional elevation substantially on the line 3—3 of Figure 2; and

Figures 4, 5, 6 and 7 are diagrammatic views showing the position of the parts at the points of lead, cut-off, release and compression with the valve gear adjusted to approximately 25% forward motion cut-off.

The illustrated embodiment of the invention comprises a valve gear mechanism for imparting reciprocatory movements to the steam admission and exhaust valve, the novel features being illustrated but the remaining parts omitted, since such parts are well known to those skilled in this art, and detailed description and illustration are not considered necessary to an intelligent understanding of this invention. It will be readily recognized by those skilled in this art that the arrangement herein shown and described may be used in conjunction with any well known valve gear mechanism, a portion of the well known Baker gear being illustrated, viz., the bell crank 10 which derives its oscillatory motion through a system of links and levers from an eccentric pin on a driven wheel of the engine or locomotive.

To the lower end of the vertical arm of the bell crank 10 is pivoted a valve rod 11, which inclines forwardly and upwardly, the forward end being pivoted on a pin 12 mounted in forward extensions or lugs 13 adjacent the upper end of a combination lever 14, the upper end of the combination lever being bifurcated to provide laterally spaced arms 14a and 14b, between which is disposed one end portion of the valve rod. The combination lever 14 is vertically disposed and the lower end thereof is connected by a pin 15 to a union link 16, which is connected in the usual manner to the main cross head 17, which is connected by the usual connecting rod 18 to a driven wheel of the engine or locomotive.

The combination lever is suspended or supported from a valve stem cross head guide 19 by a pair of radius bars 20, which are pivoted at their upper ends to brackets 21 depending from a valve stem cross head guide 19, and at their lower ends to the combination lever by a pin 22 which provides a fulcrum for the lower end of the combination lever. It will be noted that the pin 22 is spaced a relatively short distance upwardly from the lower end of the combination lever.

Reciprocable horizontally in the guide 19 is a valve stem cross head 23, the forward end of which is connected by a stem 24 to a spool valve 25 of the usual type which reciprocates in bushings 26 disposed within a valve chest 27 having cylinder ports 28 and exhaust ports 29 arranged in pairs in the usual manner at opposite ends of the chest. Steam is admitted in the usual manner through a central steam admission passage 23a. Ports 30 in the bushings 26 enable the admission of live steam to and exhaust of spent steam from the cylinder 31 through passages 32 at opposite ends of the cylinder. A piston 33 is reciprocated in the cylinder 31 and is connected to the main cross head 17 by a piston rod 34.

Pivotally connected to an intermediate part of the valve stem cross head 23 is a pin 35 on which is pivoted centrally intermediate its ends a rocker arm 36, the lower end of which is connected to the combination lever 14 by downwardly and rearwardly inclined links 37. The upper end of the rocker arm 36 is forked to accommodate the extension 13 of the combination lever, and the upper ends of the fork are connected by a downwardly and rearwardly inclined link 38 to the upper end of the combination lever 14.

It will be understood that the usual valve gear arrangement, of which the bell crank 10 forms a part, imparts the port opening travel to the valve 25 through the above described connections, and the operation of this gear is controlled in the usual manner from a remote point, such as the locomotive cab, for increasing or diminishing the percentages of cut-off, and the direction of movement of the locomotive or engine. The lap and and lead movements for the valves are obtained from the movements imparted to the combination lever 14 from the main cross head 17. These mechanisms operate conjointly in such manner that movement of the valve 25 is accelerated at the desired points in its travel as well as retarded at the desired points in order to effect acceleration and dwell at the proper positions. Retardation of the valve movement is desired as soon as a volume of steam is supplied to the main cylinder 31 sufficient to drive the piston by its expansive properties in one direction, so that the valve closes the respective port openings and fully

opening the exhaust, thereby making most efficient use of the expansive properties of the steam.

The acceleration of movement and dwell in the travel of the valve 25 are due to the manner in which the combination lever 14 is constructed and connected to the valve stem 24 and valve rod 11. It will be apparent that this auxiliary gear works on the principle of a variable lap instead of a constant lap, as generally used heretofore, and that the distance between the pin 35 and pin 12 varies at different points in the piston stroke. On each dead center these parts are at their maximum distance apart, but at midstroke they are at their minimum distance apart. This variation in the relative positions of the pin 35 and pin 12 is caused by the swinging movement of the radius bars 20 which operate gradually to raise the combination lever 14 as they approach from mid-position to each end of their stroke and gradually to lower the combination lever as they swing from their end or extreme positions to mid-position. Such variation in the relative position of these two parts causes the valve 25 to accelerate on each end of the valve stroke and to retard in the middle of the stroke, thereby producing larger steam and exhaust openings when the engine is operating at relatively short cut-offs. Retardation of the central portion of the valve travel operates to lengthen the expansion period between the events of cut-off and release and also to cause the event of compression to come later in the stroke, since it enables the piston 33 to travel a greater distance before the valve 25 operates to cover or uncover the cylinder ports 32.

It will be understood that the parts are shown in Figure 2 at their midposition, the piston being at the center of its stroke. In this figure the pivot pins 35 and 12 are at their minimum distance apart. As the piston moves forward the radius bars 20 cause the combination lever 14 to raise upwardly until the piston reaches front dead center, where the pins 35 and 12 are at their maximum distance apart. On the return stroke of the piston it will be obvious that the operation is reversed up to the midposition of the parts, causing the pins 12 and 35 to move together, whereas these parts begin again to separate until the rear dead center is reached. Consequently, it will be apparent that as the pins 35 and 12 move apart, due to the suspension of the lower end of the combination lever from the radius bars 30, the movement of the valve 25 is accelerated, but as the pins 35 and 12 move toward each other, the movement of the valve is retarded.

The operation of the auxiliary valve gear will be apparent from an examination of Figures 4 to 7, which shows the position of the parts at the points of lead, cut-off, release and compression. In Figure 4 the parts are at lead position, steam being admitted to the forward end portion of the cylinder to drive the piston 33 to the left, the port 32 at the rear end of the cylinder being open to exhaust. It will be understood that the valve 25 travels a short distance forwardly in the direction of the arrow as the piston 33 starts its movement in the opposite direction. In Figure 5, the cut-off position is shown in which the valve 25 has permitted the desired volume of steam to pass to the cylinder through the forward cylinder port 32 and has moved to close such port. The movement of the valve 25 from lead position to full steam port opening before reaching cut-off is accelerated due to the swinging movement of the radius bars 20 causing the combination lever 14 to move downwardly, thereby decreasing the distance between the pins 12 and 35, which operates to decrease the effective movement of the combination lever with respect to the valve and allow the valve proper through the valve rod 11 to accomplish the valve movement. The movement of the valve 25 from full steam port opening to the point of cut-off is retarded because the valve rod 11 and combination lever 14 are moving in the same direction, but the effective movement of the combination lever is still decreased, as above explained.

The valve 25 continues its movement rearwardly in the direction of the arrow shown on the valve, but the movement from cut-off to the release position is retarded for the reasons above explained inasmuch as the distance between the pins 12 and 35 is still decreasing. The release position is shown in Figure 6, and is the point at which the forward cylinder port 32 begins to be uncovered by the valve for releasing the steam from in front of the piston. Subsequent to release the event of compression occurs, at which time a small volume of steam is trapped in advance of the piston to cushion it at the end of the stroke. It will be noted in Figure 7 that the rear cylinder port 32 is covered and the piston 33 has approximately reached the end of its travel, the steam remaining in the end of the cylinder being trapped and providing a cushion for the piston. It is desirable to have the event of compression take place late in the stroke, and this gear enables the compression to take place at such time that sufficient steam is retained merely to cushion the piston when the latter has approached close to the end of its stroke. Due to the mounting of the combination lever and its connection with the rocker arm 36, the movement of the valve from point of release to that of compression is accelerated since the pins 12 and 35 are being moved apart due to the raising of the combination lever 14 by the upward swinging movement of the radius bars 20. In this manner it will be apparent that the movement of the valve is retarded in the intermediate portion of its travel or between the points of cut-off and release to make most efficient use of the expansive properties of the steam, but at the opposite ends of its travel or at points of lead and compression the movement of the valve is accelerated to admit and exhaust steam quickly to and from the cylinder through the port openings and to provide enough compression merely to cushion the piston at the end of its stroke but without trapping too large a volume of steam for that purpose.

It will further be manifest to those skilled in this art that the port opening movements are imparted to the main valve by the valve rod 11 and main gear mechanism deriving motion from a driven wheel. The lap and lead movements for the valve, however, are effected through the link and lever connections with the main engine cross head 17, and supplement those movements imparted by the valve rod. The port opening movements may be varied according to the desired percentage of cut-off, in the case of a locomotive by the engineer in the cab in the usual manner, but the lap and lead movements are non-adjustable, or operate in substantially the same manner regardless of the percentage of cut-off imposed on the valve rod.

This invention not only provides a new auxiliary valve gear mechanism which is much more efficient and simpler than those presently in use, but also enables engines to be equipped with the above described improvements without material alteration and expense to obtain increased power

and efficiency. This auxiliary gear mechanism is particularly adapted for use in connection with the well known Baker gear, but it may be adapted for use with other types of gears. A marked saving in expense of engine operation can be obtained since it has been found that a very substantial saving in fuel consumption can be had with this auxiliary gear mechanism.

It is to be understood that numerous changes in details of construction, arrangement and operation may be effected without departing from the spirit of the invention, especially as defined in the appended claims.

What I claim is:

1. A valve gear mechanism for steam engines having a driven rotatable member, a driven reciprocable member, and a steam admission and exhaust valve, comprising a combination lever deriving motion at its lower end portion from said reciprocable member and at its upper end portion from said rotatable member, a reciprocable cross head for said valve, a rocker arm pivoted intermediate its ends to said cross head, links connecting the ends of said rocker arm to said combination lever, a depending radius bar pivoted to a lower portion of said combination lever, and means providing a pivotal mounting for the upper end of said radius bar.

2. A valve gear mechanism for steam engines having a driven rotatable member a main cross head and a reciprocable steam valve, comprising a combination lever deriving motion at its lower end from said cross head and at its upper end portion from said rotatable member, a link pivotally mounted at its upper end and pivoted at its lower end to a lower portion of said combination lever, a vertically disposed rocker arm, means providing a connection between said rocker arm and said valve enabling horizontal translatory movement of said arm for reciprocating said valve, and link means connecting opposite ends of said rocker arm to said combination lever.

3. A valve gear mechanism for steam engines having a driven rotatable member, a main cross head and a reciprocable steam valve, comprising a combination lever deriving motion at its lower end from said cross head and at its upper end portion from said rotatable member, a vertically disposed rocker arm, means providing a connection between said rocker arm and valve, means for enabling translatory movement of said rocker arm, links connecting opposite ends of said rocker arm to said combination lever, and means operable to raise said combination lever adjacent each end of the valve stroke for accelerating the movement of the valve.

4. A valve gear mechanism for steam engines having a driven rotatable member, a main cross head and a reciprocable steam valve, comprising a combination lever deriving motion at its lower end from said cross head and at its upper end portion from said rotatable member, a vertically disposed rocker arm, means providing a connection between said rocker arm and valve, means for enabling translatory movement of said rocker arm, links connecting opposite ends of said rocker arm to said combination lever, and means connected to a lower end portion of said combination lever for raising same adjacent each end of the swinging movement thereof for accelerating the movement of the valve at such points.

5. A valve gear mechanism for steam engines having a driven rotatable member, a main cross head and a reciprocable steam valve, comprising a combination lever deriving motion at its lower end from said cross head and at its upper end portion from said rotatable member, a vertically disposed rocker arm, means providing a connection between said rocker arm and valve, means for enabling translatory movement of said rocker arm, links connecting opposite ends of said rocker arm to said combination lever, and a depending link pivotally mounted at its upper end and connected at its lower end to the combination lever at a point spaced a short distance above the lower end thereof.

6. A valve gear mechanism for steam engines having a driven rotatable member, a main cross head and a reciprocable steam valve, comprising a combination lever deriving motion at its lower end from said cross head and at its upper end portion from said rotatable member, a vertically disposed rocker arm, a cross head connected to reciprocate said valve, a pivotal connection between the central portion of said rocker arm and cross head, an upper link connecting the upper ends of said rocker arm and combination lever, a lower link parallel to said upper link connecting the lower end of said rocker arm and combination lever, and a radius bar pivotally mounted at its upper end and pivoted at its lower end to said combination lever at a point below said lower link.

7. A valve gear mechanism for steam engines having a driven rotatable member, a main cross head and a reciprocable steam valve, comprising a combination lever deriving motion at its lower end from said cross head and at its upper end portion from said rotatable member, a vertically disposed rocker arm, a cross head connected to reciprocate said valve, a pivotal connection between the central portion of said rocker arm and cross head, an upper link connecting the upper ends of said rocker arm and combination lever, a lower link parallel to said upper link connecting the lower end of said rocker arm and combination lever, and means for supporting said combination lever and operable to raise same adjacent each end of the swinging movement thereof for accelerating the movements of the valve at such points.

8. A valve gear mechanism for steam engines having a rotatable driven member, a main cross head and reciprocable steam valve, comprising a combination lever deriving motion at its lower end from said cross head, mechanism deriving motion from said rotatable member for actuating the upper end of said combination lever and connected thereto below the extreme upper end and at a point forwardly thereof, a vertically disposed rocker arm, a cross head connected to reciprocate said valve, a pivotal connection between the central portion of said rocker arm and cross head, an upper link connecting the upper ends of said rocker arm and combination lever, a lower link parallel to said upper link connecting the lower end of said rocker arm and combination lever, and means for supporting said combination lever, and operable to raise same adjacent each end of the swinging movement thereof for accelerating the movement of the valve at such points.

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