April 5, 1932. B. B. MILNER 1,852,327

STEAM ENGINE CUT-OFF RESPONSIVE MEANS

Filed Oct. 18, 1926 2 Sheets-Sheet 1

Fig. 1

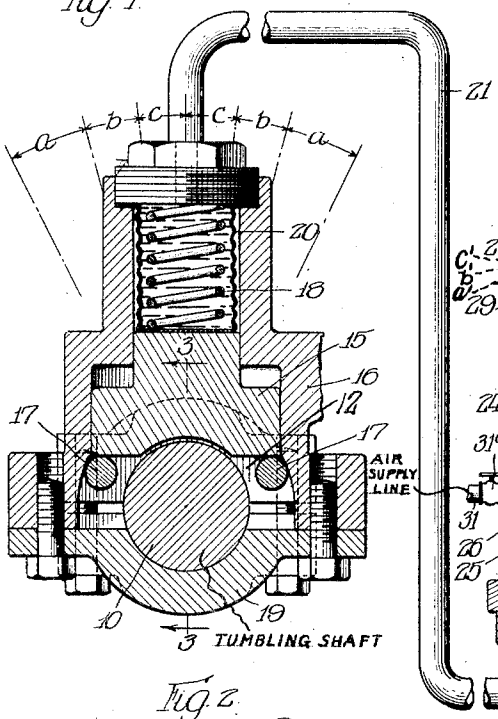
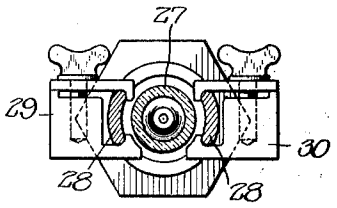


Fig. 4



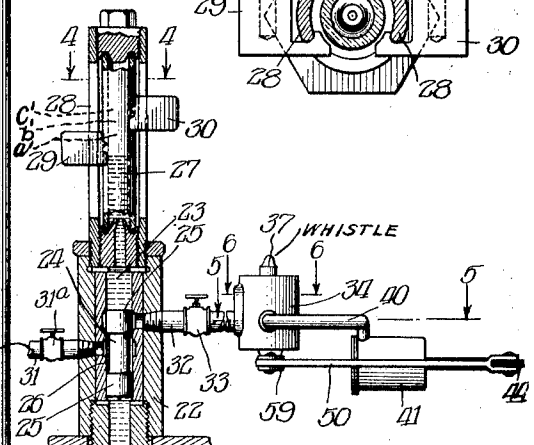


Fig. 2

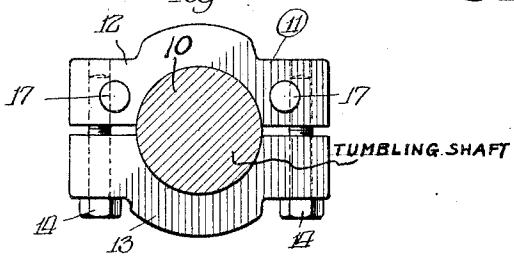


Fig. 6

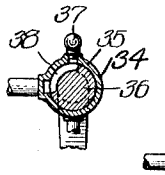
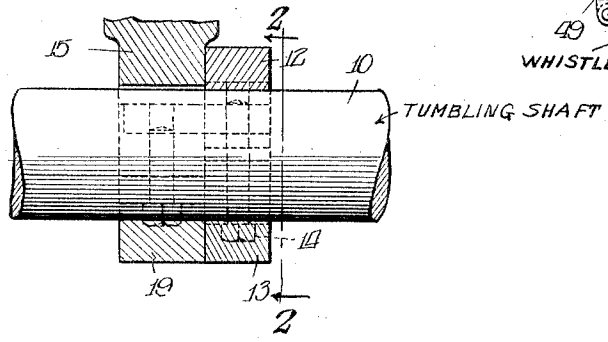


Fig. 5

Fig. 3



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STEAM ENGINE CUT-OFF RESPONSIVE MEANS

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Fig. 7

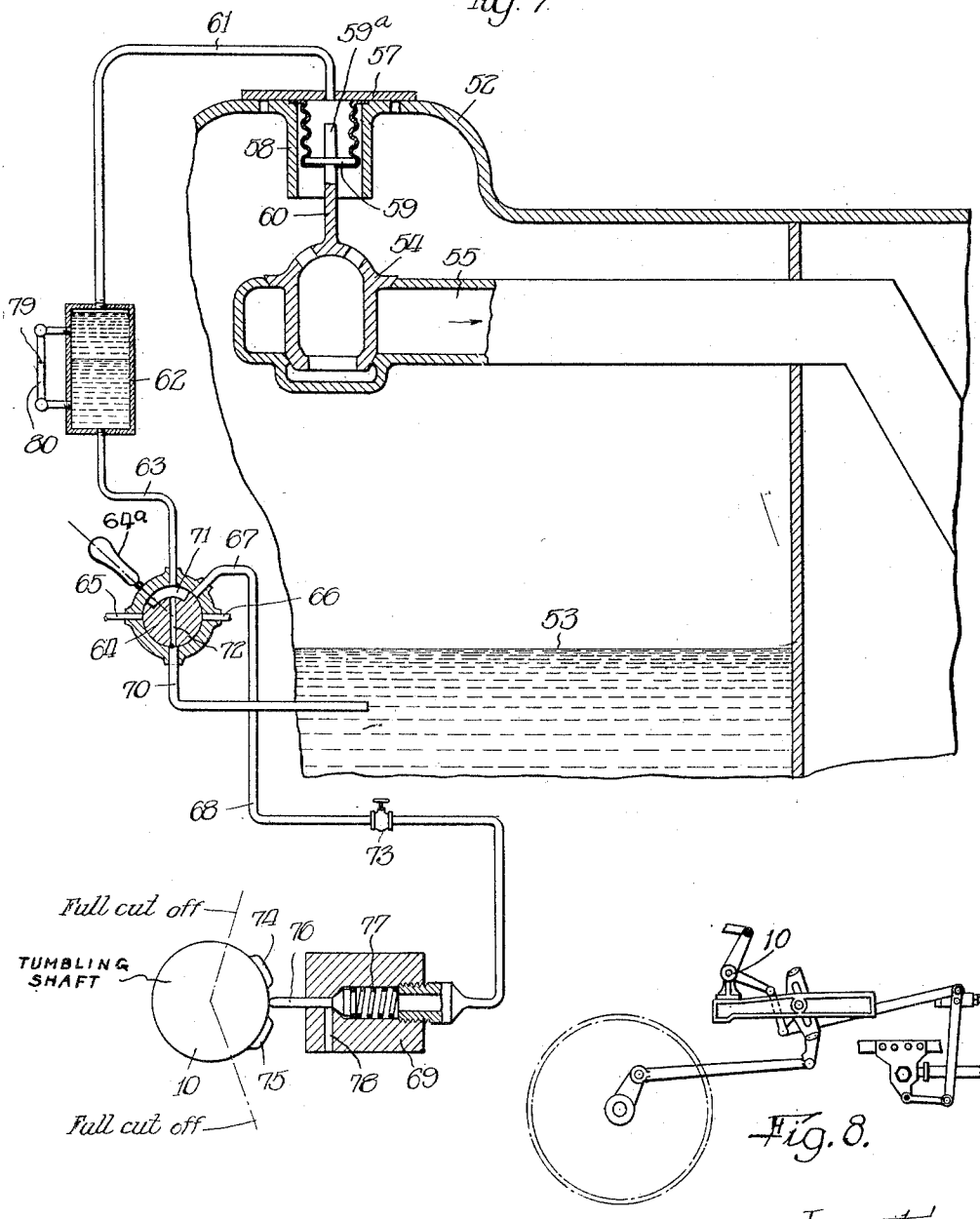

Fig. 8.

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UNITED STATES PATENT OFFICE

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STEAM ENGINE CUT-OFF RESPONSIVE MEANS

Application filed October 18, 1926. Serial No. 142,299.

The present invention relates to steam engine cut-off responsive means.

As is well known, it is economical in the operation of a steam engine to cut off the steam to the cylinder when the piston has completed only a fraction of its stroke in order that avail may be made of the expansion of the steam. Speaking generally, the shorter the cut-off, the greater the economy. The engine man is prone to drift into what is called long cut-off, controlling his speed by means of the throttle, which is a very uneconimical procedure. There are times, however, when the engine man should be permitted to use the long cut-off and partial throttle, as for example when at low speeds a uniform torque is required or desirable, as in case of switching. Under other conditions, which will be referred to hereinafter, it is desirable to allow the engine man certain discretion in the independent control of the cut-off and the throttle.

An object of the present invention is to provide a structure applicable to locomotives and other steam engines which will suggest to and encourage an engine man to operate his engine with economical full throttle and short cut-off, and, insofar as may be desirable, to enforce the engine man to use this full throttle short cut-off method of operation even to the point of automatically fully opening the throttle for him.

A further object is to provide mechanism which will cause the engine to be operated in the economical full throttle short cut-off manner, but which will permit the engine man to operate at partial throttle at certain times if he should consider such to be the more desirable or necessary.

Further objects will appear as the description proceeds.

Referring to the drawings—

Figure 1 is a more or less diagrammatic view, certain parts being shown in section, illustrating one embodiment of the present invention;

Figure 2 is a sectional view taken along the plane indicated by the arrows 2—2 of Figure 3 illustrating a detail of construction of the apparatus shown in Figure 1;

Figure 3 is a sectional view taken along the plane indicated by the arrows 3—3 of Figure 1;

Figure 4 is a sectional view taken along the plane indicated by the arrows 4—4 of Figure 1;

Figure 5 is a sectional view taken along the plane indicated by the arrows 5—5 of Figure 1;

Figure 6 is a sectional view taken along the plane indicated by the arrows 6—6 of Figure 1;

Figure 7 indicates more or less diagrammatically another construction whereby the throttle will be operated automatically in response to cut-off, means being provided, however, whereby the automatic features may be readily nullified, if preferred; and

Figure 8 is a diagrammatic view of portions of a reverse gear for a locomotive illustrating structure with which the present invention may cooperate.

The numeral 10 indicates a tumbling shaft such as is used in the reverse gear of a locomotive. In the present specification the invention will be described with particular reference to a locomotive, though as the description proceeds it will be apparent that the invention is of broader scope. The tumbling shaft 10, which is indicated in Figure 1 as being in neutral position, controls the cut-off. Rotation of the tumbling shaft 10 in one direction or the other from its neutral position has the effect of lengthening the cut-off for either forward or backward movement of the locomotive or other steam engine. Figure 8 is a diagrammatic disclosure of portions of a reverse gear including the tumbling shaft 10 with which tumbling shaft the present invention may cooperate.

Rigidly fixed upon the tumbling shaft 10 is the split collar 11 comprising the two parts 12 and 13 adapted to embrace said tumbling shaft 10. Said parts 12 and 13 may be held tightly upon said shaft 10 by means of the cap screws 14—14. Mounted adjacent to the collar 11 is the cross head 15, slidably supported within the housing 16. Said cross head 15 is adapted to be actuated by one or the other of the pins 17—17 projecting from

the member 12 and underlying said cross head 15. When the tumbling shaft 10 is moved from its neutral position, as shown in Figure 1, to lengthen the cut-off, one or the other of said pins 17—17 will force the cross head 15 upwardly against the tension of the spring 18. The lower portion of the housing 16 is closed by the bottom member 19, which has a bearing upon the tumbling shaft 10. The cross head 15 may be rounded out on its under side for the purpose of clearing the tumbling shaft 10. Mounted upon the upper side of the cross head 15 is the bellows cup 20, which communicates with the pipe 21 leading to the valve 22. The valve 22 includes the cylinder 23 having the reciprocating plunger 24 mounted therein. According to a preferred embodiment of the valve 22, the plunger 24 comprises the two head portions 25—25, which head portions are separated by the intermediate groove 26. Said head portions 25—25 have a liquid and air-tight fit within the cylinder 23. The space within the bellows cup 20, the pipe 21, and the valve 22 below the plunger 24 is filled with liquid, which should be non-compressible, or substantially so. It will be clear that movement of the cross head 15 will be communicated to the plunger 24 through said liquid.

Communicating with the upper portion of the valve 22 is the sight tube 27, which may be of glass or other transparent material. Said sight tube according to a preferred embodiment of the present invention is mounted within a housing which includes the vertical columns 28—28. Liquid is disposed above the plunger 24, and the level of said liquid may be viewed through the sight tube 27. Mounted upon the columns 28 are a plurality of adjustable indicators 29 and 30. It will be clear without detailed explanation that the angular displacement of the tumbling shaft 10 from its neutral position will be indicated by the level of the liquid within the sight tube 27 and that certain stages of such displacement may be marked by adjustable indicators such as 29 and 30.

Ranges in the movement of the tumbling shaft 10, which may be indicated by indicators 29 and 30, may be as follows: (*a*) from the longest cut-off up to a slightly shorter cut-off, (the shortest which would ordinarily be used in, for example, locomotive shifting or switching operations), within which range full throttle may be used; (*b*) from such slightly shorter cut-off up to some quite short cut-off (the minimum cut-off desirable), within which range full throttle should be used; and (*c*) above which the cut-off is not to be shortened, but in lieu of further cut-off shortening the throttle is to be restricted to suit load requirements. Said ranges are indicated by the letters *a*, *b* and *c* in Figure 1. The letters *a'*, *b'* and *c'* adjacent to the tube 27 indicate levels which may be assumed by the liquid in the tube 27 within the ranges *a*, *b* and *c*, respectively. It will be understood, of course, that the drawings are not drawn to scale, and that no attempt is made in the drawings to show actual proportions of parts.

Communicating with the valve 22 is the air supply pipe 31 (controlled by the valve 31*a*) and the air outlet pipe 32. Communication between the air supply pipe 31 and the air outlet pipe 32 is controlled by said plunger 24. When said plunger is in its uppermost position (that is, when full cut-off is being used) the lower portion 25 of said plunger will be in position to shut off the supply of air from the pipe 31. The air outlet pipe 32 leads through the manually operable valve 33 to the control valve 34, cross sections of which are shown in Figures 5 and 6. Said control valve 34 in the illustrated embodiment of the present invention includes the valve housing 35 and the rotatable plug 36. The valve 34 is provided with a whistle 37 or other signal device. The outlet pipe 32 has communication with the apertures 38 and 39 in the rotatable plug 36. When the plunger 24 of the valve 22 is in position to allow communication from the air supply pipe 31 to the outlet pipe 32, air will be admitted to the recess 38, and unless the plug 36 has been turned, by means which will be referred to hereinafter, a warning will be given by the signal 37.

The recess 39 in the rotatable plug 36 is adapted to have communication with the pipe 40, which leads to the cylinder 41. Said cylinder 41 contains the piston 42, which by means of the rod 43 controls the movement of the throttle lever 44. Said throttle lever 44 is pivoted to swing about the axis 45 and is provided with a handle 46, by means of which said lever may be manually operated. Connected to said lever 44 is the rod 46*a* connected to the throttle valve (not shown). The pipe 40 is provided with the relief port 47 adapted to permit the slow escape of air from the left-hand side of the piston 42, whereby manual operation of the throttle lever 46 will not be interfered with. Said port 47 may be provided with a whistle or other warning signal 47*a* to indicate to the engine man that the throttle lever 44 is not in extreme open position, in which position the recess 39 of the plug 36 will be in position to drain cylinder 41 through port 48, which leads to the atmosphere. The warning signal 47*a* may be used in conjunction with the signal 37, or either one or both of said signals may be omitted, if preferred. In explanation of the preceding sentence, it may be explained that in certain positions of the rotatable plug 36 the recess 39 of said plug provides communication between the pipe 40 and the port 48, whereby air from the left-hand side of the piston 42 may be exhausted

through said port 48. Connected to the rotatable plug 36 is the crank 49 adapted to be operated by the rod 50. The outer extremity of said rod 50 is provided with the slot 51 adapted to receive the pin 52 located in the throttle lever 44.

It will be clear that as the cut-off is lengthened beyond a predetermined point, by rotation of the tumbling shaft 10, the resulting movement of the cross head 15 will cause movement of the bellows cup 20 to force liquid within the pipe 21 against the plunger 24 disposed within said valve 22. Predetermined movement of the plunger 24 will permit communication from the air supply pipe 31 to the air outlet pipe 32. Under these conditions the rotatable plug 36 is in position to permit communication through the recess 38 to the warning signal 37, which may, by calling the attention of the engine man, be expected to prompt his action to fully open the throttle. As the engine man opens the throttle, the supply of air to the warning signal 37 should be simultaneously and automatically cut off. The cutting off of the warning signal is accomplished, according to the illustrated embodiment of the present invention, by reason of the connection of the rod 50 and crank 49 with the rotatable plug 36. Movement of the throttle lever 46 in a counterclockwise direction (which action is permitted by reason of the port 47) will result in the rotation of the plug 36 to move the recess 38 of said plug 36 out of communication with the warning signal 37. By reason of the pin and slot connection between the throttle lever 46 and the rod 50, the throttle lever 46 may be moved toward closed position without communicating movement to the plug 36. This arrangement is of advantage and is brought into play when the locomotive slips on a slippery rail, for example, and the operator must shut off the steam supply to the cylinders in order to permit the driving wheels to again find non-slipping contact with the rails. By this arrangement the engine man is spared the annoyance of useless warning, though the arrangement does permit the possibility of his then failing, by reason of no warning, to fully reopen the throttle. It will be obvious, of course, that the amount of play between the throttle lever 46 and the rod 50 may be varied as preferred, as for example by shortening the slot 51, whereby the warning whistle may be made to reopen within closer and closer limits.

It is necessary, of course, that the engine man should be able to close the throttle quickly if he desires. The vent 47 in the pipe 40 permits a slow intake of air to the left-hand side of the piston 42, permitting the engine man to move the throttle lever 44 to extreme open position, in which position the exhaust port 48 accomplishes the result of promptly exhausting the air pressure from the left-hand side of the piston 42. The recess 39 in the rotatable plug 36 should be designed to close communication to the air supply pipe 32 before the throttle operating lever reaches its extreme open position. Moreover, communication between the recess 39 and the pipe 40 should be slightly open when the throttle is fully closed. The port 48 should be so located relative to the pipe 40 and the recess 39 that exhaust to the outside atmosphere will occur slightly before the throttle lever has reached its extreme open position. Communication between the supply pipe 32 and the recess 39 will, of course, be cut off slightly before communication is had between the recess 39 and the exhaust port 48, in order to prevent the possibility of the exhausting of air from the supply pipe 32 direct to the atmosphere.

With the throttle lever in extreme open position, wherein communication is had between the pipe 40 and the exhaust port 48, the cylinder 41 is drained of pressure and the engine man is free to quickly close the throttle in case he should find such action necessary or desirable. It will be noted that in order to be able to freely close the throttle the engine man must first move said throttle somewhat past full open position. This arrangement is of decided practical advantage, inasmuch as it provides an added incentive to the engine man to move his throttle lever to the extreme open position, assuring the control of speed by means of the cut-off rather than throttle.

Referring now to Figure 7, the numeral 52 indicates part of a steam boiler, which may be the dome cover of a locomotive boiler. The water level within said boiler is indicated by the line 53. Mounted within the boiler in position below the dome cover 52 is the throttle valve 54, which may be of any preferred type. Said valve 54 controls the admission of steam from the steam space within the boiler to the passage 55 leading to the locomotive steam chests. The structure of the valve 54 need not be described in detail, inasmuch as any of the usual valves may be employed. Said valve is normally held down upon its seat or seats by its own weight, and by means of a spring, if preferred. The steam pressure within the boiler is also commonly utilized for holding the throttle on its seat, the seating effect of the steam pressure being nullified when the throttle is once raised from its seat.

Figure 7 indicates diagrammatically certain means for operating the valve 54. Said means includes a plate 57 mounted upon the dome cover, and extending downwardly from said plate is the guide cylinder 58 provided with the bellows cup 59. Said cup 59 is connected to the valve 54 by means of the strut 60. Said cup may constitute a spring for holding the throttle 54 upon its seat.

The construction illustrated in Figure 7

contemplates the utilization of the pressure within the boiler for controlling the position of the valve 54 in opposition to gravity and to the force of the spring effect of the bellows cup 59. Disposed within the cup 59 is the valve 59*a*, which, when the throttle 54 is in open position, closes communication to the pipe 61 and prevents crushing of the cup 59.

Connecting with the cylinder 58 on the opposite side of the piston 59 from the strut 60 is the pipe 61, which pipe 61 is connected to the upper portion of the reservoir 62, the lower portion of which reservoir 62 is connected by means of the pipe 63 to the operator's valve 64, which valve is indicated only diagrammatically.

Said valve 64, which is indicated in the form of a plug valve, is provided with the operating handle 64*a* and with the exhaust ports 65 and 66, which lead to the atmosphere, and with the port 67, which port 67 connects through the pipe 68 to cut-off responsive valve 69. Said valve 64 is also provided with a port communicating with the pipe 70, which connects with the boiler below the water line 53. The rotor of the plug valve 64 is provided with the arcuate recess 71 and the diametric aperture 72. It will be clear without detailed explanation that when the valve 64 is turned a sufficient distance in a counter-clockwise direction, communication will be had from the lower part of the reservoir 62 to the atmosphere through the exhaust port 65. When the rotor of the valve 64 is turned in a clockwise direction a sufficient distance, communication will be had between the lower part of the reservoir 62 to the port 67, which, through the pipe 68, leads to the cut-off responsive valve 69. Further movement of the rotor of the valve 64 in a clockwise direction will connect the lower portion of the reservoir 62, through the pipe 63, to both the port 67 and the port 66. Under the last named conditions, if the valve 69 is in closed position, exhaust from the lower part of the reservoir 62 will go direct to the atmosphere through the exhaust port 66. If said valve 69 is in open position, the exhaust from the lower portion of the reservoir 62 will be divided, part passing through port 66 and part passing through the port 67, pipe 68 and valve 69, to the atmosphere. A valve 73 may be provided in the pipe 68, whereby to close communication to the valve 69, if preferred.

As noted above, the valve 69 is responsive to the cut-off. The tumbling shaft 10 is indicated in Figure 7 in a neutral position. Said tumbling shaft has mounted on the periphery thereof suitably arranged cams such as 74 and 75, which, when the tumbling shaft is turned for forward or reverse movement of the locomotive, are adapted to engage a plunger 76 of said valve 69. Said plunger 76 is biased, as for example by means of a spring 77, to a position to close said valve 69. When either one of the cams referred to is in position to hold the plunger 76 inwardly against the tension of the spring 77, said valve 69 will be open, providing communication between the pipe 68 and the exhaust port 78.

The reservoir 62 is, according to an embodiment of the invention illustrated in Figure 7, provided with water from the boiler. Disposed above said water is a supply of a lighter fluid, which may be oil. The water level within the reservoir 62 is indicated by the numeral 79. It will be understood that the space between the water level 79 and the upper side of the sylphon 59 will be filled with oil. The space between said water level 79 and the boiler will be filled with boiler water. The numeral 80 indicates a sight glass, which may be provided, if desired, for indicating the amount of oil within the pipe 61 and reservoir 62. Said sight glass 80, by indicating the water level marking the lower extremity of the oil, may indicate the position of the throttle valve 54.

With the parts in the positions shown in Figure 7, boiler pressure will be applied on the two sides of the bellows cup 59, boiler pressure being effective directly on the under side of the bellows cup and being effective upon the upper side of said bellows cup through the liquid in pipe 70, aperture 72 in the valve 64, pipe 63, reservoir 62 and pipe 61. The valve, being biased to closed position, will remain in said closed position. When the tumbling shaft 10 is in full cut-off position, neither cam 74 nor cam 75 will be in engagement with the plunger 76 and no automatic control of the throttle is had. When a shorter cut-off is being used, either cam 74 or cam 75 will engage the plunger 76 to open the valve 69 against the tension of the spring 77. Under these conditions, if the engine man moves the valve 64 in a clockwise direction a sufficient distance to permit communication between the recess 71 and port 67, pressure will be relieved on the upper side of the bellows cup 59. Pressure on the upper side of the bellows cup being thus relieved, water will be delivered from the lower part of reservoir 62, through pipe 63, recess 71, port 67, pipe 68 and valve 69, to the atmosphere by the boiler pressure which will raise said bellows cup, resulting in proportional opening of the throttle valve 54. The engine man may then turn the valve to a position wherein the recess 71 is out of communication with the port 67 and the aperture 72 is out of communication with the port leading to pipe 70. Under these conditions the fluid within the pipe 61, reservoir 62 and pipe 63 will be trapped, and boiler pressure will hold the throttle valve 54 immovable in the position to which it has been moved.

The engine man has the option at all times of, himself, controlling the opening of throt-

tle valve 54 independently of the position of the tumbling shaft 10, by reason of the fact that he may open the throttle valve by turning the valve 64 in counterclockwise direction a sufficient distance to permit access through recess 71 between pipe 63 and port 65, or he may permit the automatic opening of the throttle valve by turning the valve 64 in a clockwise direction a sufficient distance to permit access through recess 71 between pipe 63 and port 67, which port 67 connects to valve 69.

When the engine man desires to close the throttle valve 54, he will move the valve 64 to the neutral position indicated in Figure 7, so that boiler pressure will be applied to the upper side of the bellows cup 69, and whereby the throttle valve 54, being biased to closed position, may move to said closed position.

In both embodiments of the present invention hereinabove described, the means responsive to the cut-off may be nullified, if desired. Referring to Figures 1 and 5, if the valve 31*a* is closed, the engine man may operate the throttle lever 46 independently of the position of the tumbling shaft 10. In Figure 7, the engine man, by closing the valve 73, may eliminate the control responsive to the cut-off, whereby the features responsive to the cut-off position will be out of service.

Though preferred embodiments of the present invention have been described in detail, it will be clear that many modifications will occur to those skilled in the art. It is intended that all such modifications falling within the scope of the appended claims be covered.

What is claimed is—

1. In a steam engine, in combination, a throttle, means responsive to boiler pressure for operating said throttle, said means having opposite sides for receiving boiler pressure, valve means for controlling the ratio of the pressures applied to the two sides of said operating means, and cut-off responsive means for relieving pressure upon one side of said operating means through said valve means.

2. In a steam engine, in combination, a throttle, means responsive to pressure for operating said throttle, said means having opposite sides for receiving boiler pressure, valve means for controlling the ratio of the pressures applied to the two sides of said operating means, and cut-off responsive means for relieving pressure upon one side of said operating means through said valve means, said valve means being provided with means for relieving pressure upon said operating means independently of said cut-off responsive means for opening and closing said throttle.

3. In combination, a steam engine, a throttle, operating means for said throttle, said throttle being biased to closed position, said operating means being subject to boiler pressure on the one side and being subject to a variable pressure on its other side, a valve for selectively supplying boiler pressure or reduced pressure to said other side of said operating means, and means responsive to the cut-off of said steam engine for cooperating with said valve to reduce the pressure applied to said other side of said operating mechanism.

4. In combination, in a steam engine, a throttle, said throttle being biased to closed position, operating means subject on one side to boiler pressure for operating said throttle, and means for communicating boiler pressure to the other side of said operating means, said communicating means including fluid carrying means, fluid trapped therein, and a valve for selectively controlling the escape of fluid from said fluid carrying means and for supplying fluid to said fluid carrying means.

5. In combination, in a steam engine, a throttle, said throttle being biased to closed position, operating means subject on one side to boiler pressure for operating said throttle, means for communicating boiler pressure to the other side of said operating means, said communicating means including reservoir means, fluid trapped therein, a valve for selectively controlling the escape of fluid from said reservoir means and for supplying boiler water to said reservoir means, and cut-off responsive means for controlling said fluid when said valve is in a predetermined position.

6. In a steam engine, in combination, a throttle, means subject to boiler pressure for opening said throttle, said throttle being biased to closed position, liquid carrying means adapted to be connected to the liquid in said boiler for nullifying the effects of said boiler pressure, and a valve in said liquid carrying means adapted to provide communication between said liquid carrying means and the atmosphere, whereby to control the capacity of said liquid carrying means, said valve being provided with a port adapted to have communication with the liquid within said boiler for replenishing the liquid in said liquid carrying means.

7. In a steam engine, in combination, a throttle, means subject to boiler pressure for opening said throttle, said throttle being biased to closed position, fluid carrying means adapted to be connected to the pressure within said boiler for nullifying the effects of boiler pressure, and a valve in said fluid carrying means adapted to provide communication between said liquid carrying means and the atmosphere, whereby to control the volume of said liquid carrying means, said valve being pro-

vided with a port adapted to have comunication with the liquid within said boiler for replenishing the liquid in said liquid carrying means, and cut-off responsive means for delivering liquid from said liquid carrying means when said valve is in a predetermined position.

8. In a steam engine, in combination, a throttle, means responsive to pressure for operating said throttle, valve means for communicating counteracting pressures to the two sides of said operating means, and cut-off responsive means for relieving pressure upon one side of said operating means through said valve means.

9. In a steam engine, in combination, a throttle, means responsive to pressure for operating said throttle, control means for controlling the ratio of pressures on the two sides of said operating means, a reservoir system between said control means and said operating means, two liquids distinguishing in appearance in said reservoir system, one of which liquids floats upon the other, and sight means cooperatively associated with said reservoir system for indicating the position of the line of demarcation between said liquids.

10. In a steam engine, in combination, a throttle, means responsive to pressure for operating said throttle, control means for controlling the ratio of pressures on the two sides of said operating means, a reservoir system between said control means and said operating means, two liquids distinguishing in appearance in said reservoir system, one of which liquids floats upon the other, and sight means cooperatively associated with said reservoir system for indicating the position of the line of demarcation between said liquids, said means including cut-off responsive means for relieving pressure upon one side of said operating means to permit the opening of said throttle.

11. In a steam engine, in combination, a throttle, means responsive to pressure for operating said throttle, said means comprising a bellows cup, a reservoir system communicating with the interior of said cup, and control means for controlling the ratio of pressures to the two sides of said cup, said cup being provided with a valve for closing communication to said reservoir system when said cup has been collapsed to a predetermined extent.

12. In a steam engine, in combination, a throttle, means for operating said throttle including a bellows cup, a liquid reservoir system connected with the interior of said cup, control means for controlling the ratio of pressures on the two sides of said cup, two liquids within said reservoir system distinguishing in appearance, one of which floats upon the other, and sight means for indicating the line of demarcation between said liquids in said reservoir system.

13. In a steam engine, in combination, a throttle, means for operating said throttle including a bellows cup, a liquid reservoir system connected with the interior of said cup, control means for controlilng the ratio of pressures on the two sides of said cup, two liquids within said reservoir system distinguishing in appearance, one of which floats upon the other, and sight means for indicating the line of demarcation between said liquids in said reservoir system, said bellows cup being provided with a valve for closing communication between said cup and said reservoir system when said cup has been collapsed to a predetermined region.

14. In a steam engine, in combination, a throttle, means for operating said throttle including a bellows cup, a liquid reservoir system connected with the interior of said cup, control means for controlling the ratio of pressures on the two sides of said cup, two liquids within said reservoir system distinguishing in appearance, one of which floats upon the other, and sight means for indicating the line of demarcation between said liquids in said reservoir system, said control means including a manually operable valve and a cut-off responsive valve cooperatively associated to control the liquid within said reservoir system.

15. In a steam engine, in combination, a throttle, means responsive to boiler pressure for operating said throttle, said means having opposite sides for receiving boiler pressure, and valve means for controlling the ratio of the pressures applied to the two sides of said operating means.

Signed at Chicago, Illinois, this 1st day of October, 1926.

BERT B. MILNER.