March 25, 1952 C. K. STEINS 2,590,473

LOCOMOTIVE

Filed March 25, 1946 4 Sheets-Sheet 1

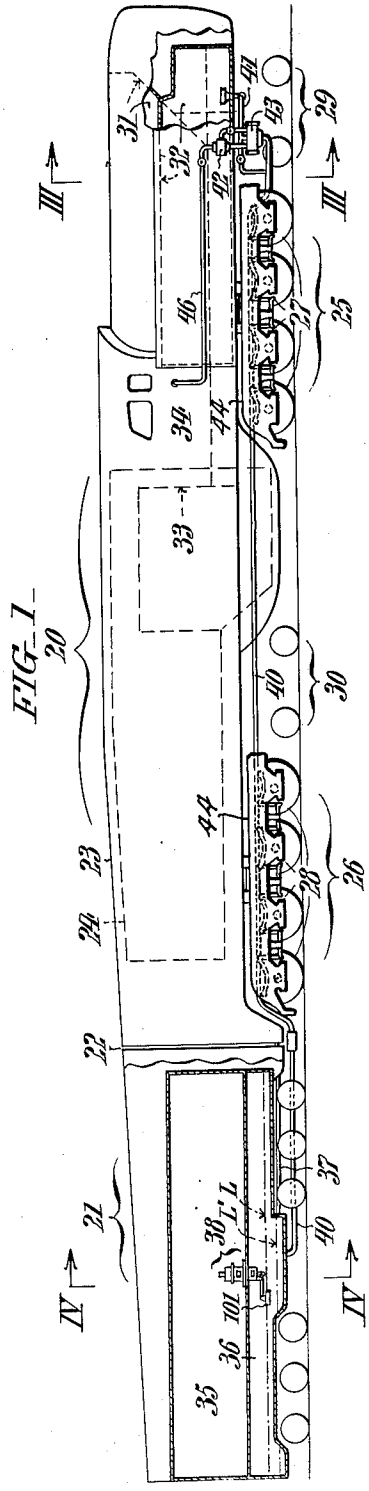


FIG. 1

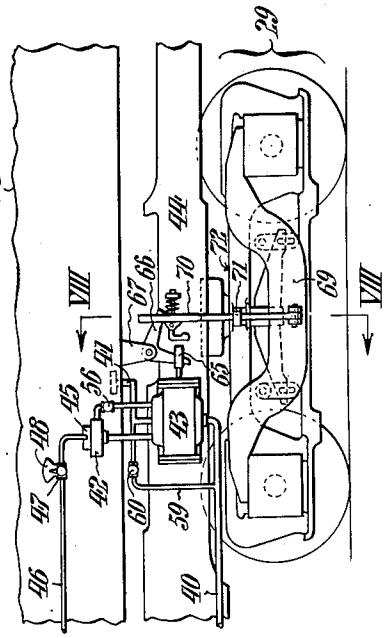


FIG. 2

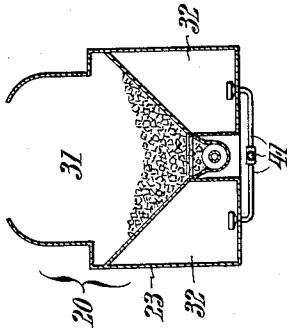


FIG. 3

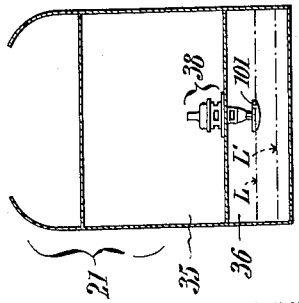


FIG. 4

INVENTOR:
Carleton K. Steins,
BY Paul & Paul
ATTORNEYS.

March 25, 1952 C. K. STEINS 2,590,473

LOCOMOTIVE

Filed March 25, 1946 4 Sheets-Sheet 2

FIG. 6.

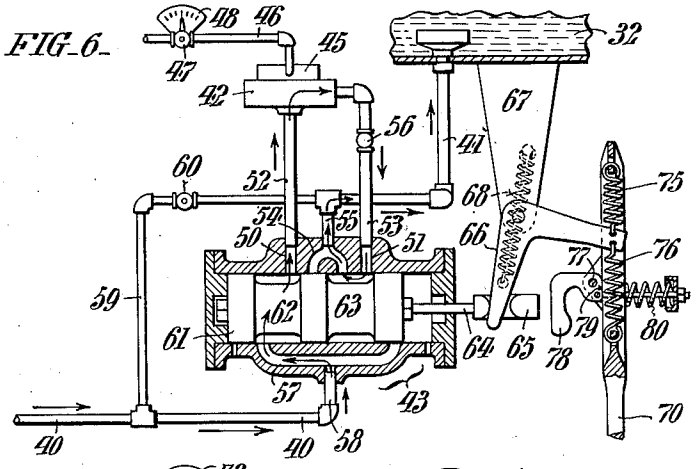


FIG. 8.

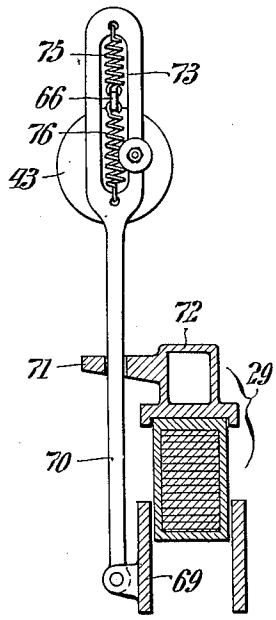


FIG. 5.

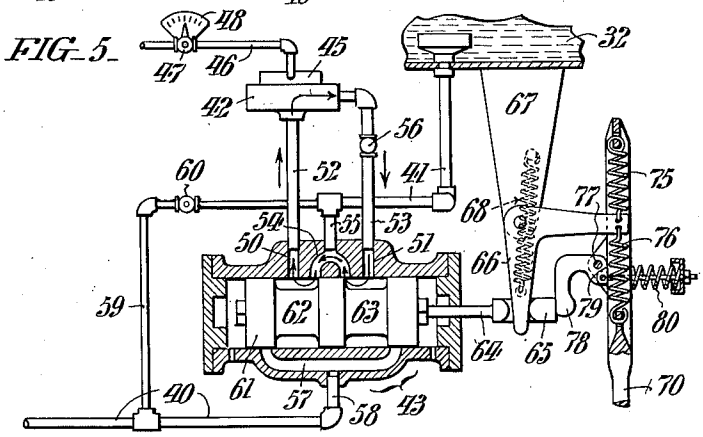
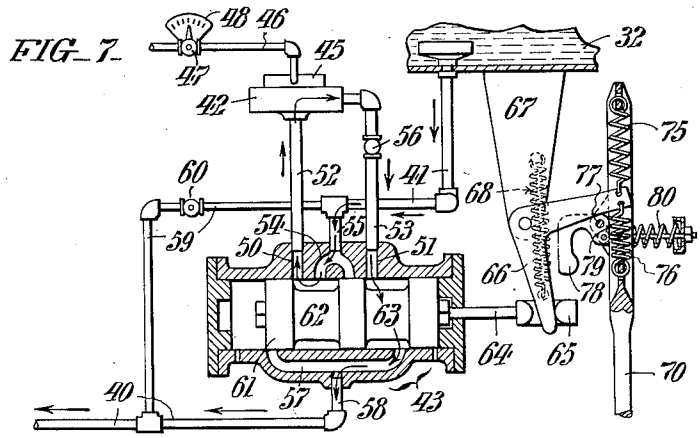


FIG. 7.



WITNESSES

Hubert Fuchs.

Thomas W. Kerr, Jr.

INVENTOR:
Carleton K. Steins,

BY Paul & Paul

ATTORNEYS.

March 25, 1952 C. K. STEINS 2,590,473

LOCOMOTIVE

Filed March 25, 1946 4 Sheets-Sheet 3

FIG. 10.

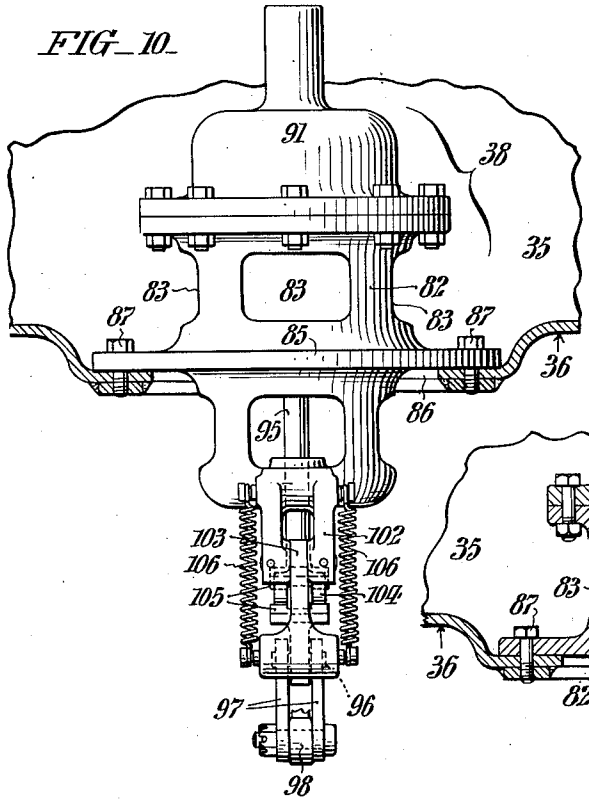


FIG. 9.

WITNESSES

Hubert Fuchs

Thomas W. Kerr Jr.

INVENTOR:

Carleton K. Steins,

BY Paul & Paul

ATTORNEYS.

March 25, 1952 C. K. STEINS 2,590,473

LOCOMOTIVE

Filed March 25, 1946 4 Sheets-Sheet 4

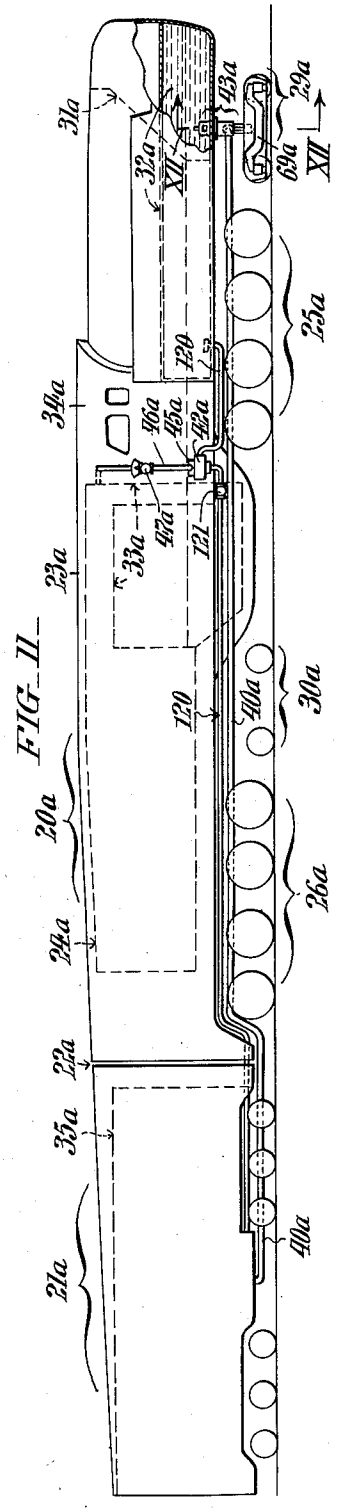


FIG. 11

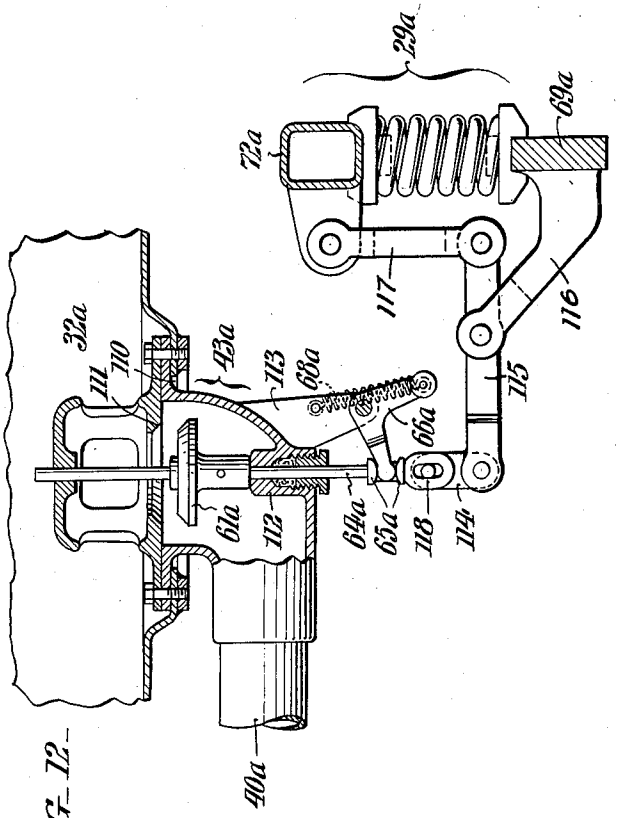


FIG. 12

INVENTOR:
Carleton K. Steins,

BY Paul & Paul
ATTORNEYS.

Patented Mar. 25, 1952

2,590,473

UNITED STATES PATENT OFFICE

2,590,473

LOCOMOTIVE

Carleton K. Steins, Merion, Pa., assignor to The Pennsylvania Railroad Company, Philadelphia, Pa., a corporation of Pennsylvania

Application March 25, 1946, Serial No. 656,912

7 Claims. (Cl. 105—73)

1

This invention relates to locomotives. More particularly it is concerned with steam locomotives of the type disclosed in U. S. Patent No. 2,338,212, granted to me on January 4, 1944, characterized by having its boiler located at one end of a locomotive body and a fuel storage compartment at the other end; separately powered drive wheel trucks connected for independent swivelling to the body beneath the boiler and the fuel water compartments respectively; and a coupled tender in which water for replenishment of the supply in the boiler is carried. In the operation of a locomotive of this type, the weight on the powered truck beneath the boiler remains substantially constant since the water level in the boiler is always maintained at a predetermined level by automatic injection of replenishing feed water. The weight on the other truck, however, decreases gradually with consumption of fuel, with the result that the drivers of such truck will exert correspondingly less tractive effort and so tend to slip, especially at starting of the locomotive under heavy loads.

In Patent No. 2,413,119 granted to me on December 24, 1946, I have disclosed a conduit system by which water can be transferred under control from the tender to a ballast water compartment at the fuel carrying end of such locomotive to compensate for weight loss due to fuel consumption, with a view toward keeping the load on the corresponding truck uniform. This arrangement, however, requires constant attention on the part of the engine crew in addition to the many other duties which they are called upon to perform incident to train operation.

The chief aim of my present invention is to overcome the drawback just referred to, which objective I have made possible of realization through provision of means such as hereinafter more fully set forth, whereby ballast water is automatically transferred from the tender to the fuel carrying end of the locomotive in such a way as to compensate for the decrease in weight due to fuel consumption without requiring any supervision whatever on the part of the locomotive crew. Another object of my invention is to so organize such an automatic means that it will also operate to return the ballast water from the ballast tank on the locomotive to the tender during re-charging of the fuel compartment, likewise without requiring supervision on the part of the engine crew.

Thus, through my invention, a uniform load is at all times maintained on the powered truck beneath the fuel carrying end of the locomotive commensurate with that maintained on the powered truck beneath the boiler, to the end that undesirable wheel slippage and rail burning are effectively prevented.

2

Other objects and attendant advantages will appear from the following detailed description of the attached drawings, wherein Fig. 1 is a view in side elevation of a steam locomotive conveniently embodying my invention.

Fig. 2 is a fragmentary view drawn to a larger scale and showing a portion of the front end of the locomotive in side elevation.

Figs. 3 and 4 are cross sections taken as indicated respectively by the angled arrows III—III and IV—IV in Fig. 1.

Fig. 5 is a fragmentary view in longitudinal section showing the means provided for automatically controlling directional flow of the ballast water between the tender and a water ballast compartment of the locomotive.

Figs. 6 and 7 are views like Fig. 5 with the parts differently positioned.

Fig. 8 is a detail cross section taken as indicated by the angled arrows VIII—VIII in Fig. 2.

Fig. 9 is a longitudinal section of a special valve means employed in connection with the water compartment of the tender and hereinafter more specifically referred to.

Fig. 10 is a view looking as indicated by the angled arrows X—X in Fig. 9.

Fig. 11 is a view in side elevation corresponding to Fig. 1 of a steam locomotive embodying an alternative form of my invention; and

Fig. 12 is a fragmentary sectional view at the region indicated at XII in Fig. 11 showing, on a larger scale, the details of a valve which automatically controls flow of water from the tender to the ballast compartment of the locomotive.

With more specific reference first more especially to Fig. 1 of these illustrations, the locomotive proper is comprehensively designated **20** and its tender **21**, these being connected by a suitable coupling means (not shown), at their juncture **22**. Within the rear end of the body **23** of the locomotive **20** is a horizontally-elongate boiler **24** which provides the steam for operating the engines (not shown) of separately-swiveled powered front and rear trucks **25** and **26** having multiple drive wheels **27** and **28**, and with which are associated smaller leading trucks **29** and **30** respectively. After common practice in the art, and as indicated in my prior patent hereinbefore referred to, spring suspensions are incorporated in the trucks **25** and **26** as conventionally indicated in Fig. 1. Within the front end of the body **23** of the main section **20** is a compartment or bunker **31** for fuel and flanking compartments

32 for ballast water; and between these grouped compartments and the fire box 33, which in this instance is at the front end of the boiler 24, is an enclosed space or cab 34 for the engine crew. Within the tender 21 is a relatively large reserve water compartment 35 which overlies a shallower bottom compartment 36 wherefrom leads a pipe 37 for conducting feed water to the boiler 24. By means of an automatic valve 38, which will be later on described in detail, a definite quantity of water is maintained in the compartment 36 between maximum and minimum levels indicated at L and L' in Figs. 1 and 9.

Extending between the ballast compartments 32 at the front end of the locomotive and the bottom water compartment 36 in the tender 21, is a pipe line 40, 41 in which is interposed a rotary pump 42 and a flow control cylinder valve 43, these latter being suitably supported on the car body at the level of the frame 44 of the powered front truck 25 adjacent the associated guide or pilot truck 29, as best shown in Fig. 2. The pump 42 is driven by a direct-connected turbine engine 45 which is supplied with steam from the boiler 24 through a pipe 46, the steam supply being controllable by a hand valve 47 with the aid of an indicator 48. From Figs. 5–7 it will be noted that the body of the control valve 43 has end ports 50 and 51 respectively in communication with the suction and pressure sides of the pump by way of pipes 52 and 53, and between said ports, a by-pass duct 54 which connects with the section 41 of the water transfer pipe line 41 through a short branch at 55. The check valve at 56 precludes reverse flow in the pipe 53. Opposite the by-pass duct 54, the body of the control valve 43 is provided with another by-pass duct 57 which is connected to the section 40 of the line conduit by a short branch at 58. In order that, at desired times, the ballast water may be diverted around the flow control valve 43 for a purpose later explained instead of passing through it, I have provided the shunt or circumventing pipe at 59 wherein is interposed a hand valve 60 which is normally kept closed. The piston 61 of the control cylinder 43 has spaced circumferential grooves 62 and 63 adjacent its opposite ends, and extending therefrom at one end through one end of the valve body is a rod 64 with a slotted head 65 which is engaged by the vertical extremity of a bell crank lever 66. This bell crank lever 66 is fulcrumed on a bracket 67 pendent from the locomotive body and is subject to the action of a toggle spring 68. With its lower end pivotally connected to one of the equalizer bars 69 (Figs. 2 and 8) of the front leading truck 29 is a vertical link rod 70 which passes through a guide projection 71 on the frame 72 of said truck, and which has a longitudinal slot 73 at its upper end whereinto extends the horizontal arm of the bell crank lever 66 aforesaid. Opposing helical springs 75 and 76 within the slot 73 form flexible connections between the link rod 70 and the bell crank lever 66. The toggle spring 68 aforementioned tends to yieldingly maintain the bell crank lever 66 in either of the positions in which it is shown in Figs. 5 and 7. At one side and adjacent its upper end, the link rod 70 affords pivotal connection at 77 for an angular stop 78 which normally occupies the position in which it is shown in Fig. 5 by virtue of having a flat surface 79 at its pivoted end to engage with the side of said rod, said stop being so yieldingly held by a spring 80.

The valve 38, hereinbefore referred to and illustrated in detail in Figs. 9 and 10, has a vertically disposed body 82 with lateral ports 83 open into the upper water compartment 35 of the tender and with a circumferential flange 85 secured over an opening 86 in the bottom of said compartment, by headed screw bolts 87. The closure element 88 of the valve 38 is cylindric and hollow and open at its opposite ends. At the top, the closure element 88 has a beveled flange 89 which is adapted to engage a correspondingly beveled seat around a port 90 at the top of the body 82 which latter is surmounted by a separable dome 91. The lower end of the closure element 88 is in turn adapted to engage a seat around a port 92 in the lower part of the valve body. Extending axially through the closure element and secured by clamp nuts 93 engaging a medial screw threaded portion thereof is an actuating stem 95. At its bottom this stem 95 is provided with a cross pin 96 with the ends thereof coupled by drop links 97 with one extremity of a lever 98 fulcrumed at 99 on a pendent bracket extension 100 on the body 82 of valve 38, the other extremity of said lever being pivotally connected to a float 101. Also fulcrumed on the bracket extension 102 of the valve body is a bell crank 103 whereof the horizontal extremity is forked, as at 104, to engage between spaced laterally projecting lugs 105 on the valve stem 95 adjacent the lower end of the latter. The bell crank lever 103 is subject to a helical toggle spring 106 which functions in a manner presently explained. Likewise, for a reason later explained, the links 97 are slotted as at 97*a* at the region of their connection with the cross pin 96 on the valve rod 95.

Operation

Let it be assumed that the locomotive is prepared to get under way with its fuel compartment 31 filled to capacity and with the ballast water tanks 32 at the front end thereof substantially empty, with the hand valve 60 closed, and with the pump 42 in operation. Under these conditions the piston 61 of the control valve 43 will occupy its central or neutral position as shown in Fig. 5 with the downward arm of bell crank 66 engaging the stop 78, when the pump 42 will circulate water locally through said valve by way of the pipes 52 and 53 as indicated by the arrows, without transfer of any water between the locomotive and the tender in either direction. Upon decrease in the weight and attendant rise of the control valve 43 with the front end of the locomotive body incident to relaxation of the springs of the forward truck 25 as the fuel is consumed, the bell crank lever 66 will be moved to the position in which it is shown in Fig. 6 and be so temporarily held by the toggle spring 68, with attendant shifting of the valve piston 61 to its extreme left position. As a result, water will be delivered by action of the pump 42, from the bottom reservoir 36 in the tender 21 to the ballast compartments 32 in the locomotive (the flow being as indicated by the arrows in Fig. 6) to compensate for the loss in fuel weight. Upon re-establishment of normal conditions, the piston 61 of control valve 43 will again be restored to the neutral position of Fig. 5. The action just described recurs from time to time as the fuel is used up, with consequent maintenance of an unvarying load at all times on the powered front truck 25 equal substantially to that on the powered rear truck 36 which latter load remains practically uniform, since the boiler is constantly supplied by injector action, in a well known man-

ner, with feed water from the tender by way of the pipe 36 to replenish the water used in generating the steam from the engine. Spasmodic operation of the control valve 43 is prevented by reason of the flexible spring connections 75 and 76 between the vertical link rod 70 and the bell crank lever 66.

During re-fueling of the locomotive with attendant depression deflection of the springs of the front truck 25, the bell crank 66 is moved counter-clockwise and the piston 61 of control valve 43 thereby shifted to the extreme right as shown in Fig. 7. Thereupon the pump 42 will act to draw the water from the ballast compartments 32 on the locomotive and transfer it back to the tender 21, the flow in this instance being as indicated by the arrows in Fig. 7. The last described action will persist until the fuel compartment 31 is fully charged, whereupon the parts will automatically resume their neutral positions as in Fig. 5. In this connection it is to be observed that as the control valve 43 moves downward with the locomotive body, the outer end of the piston rod 64 clears the stop 78 to permit anti-clockwise movement of the bell crank lever 66 as described. Upon subsequent rise of the control valve 43, the stop 78, by reason of being pivoted and spring biased, will yield to temporary displacement until normal conditions are re-established. If desired or found convenient, transfer of water from the locomotive to the tender during fuel replenishment may be allowed to take place by gravity and without aid of the pump 42, simply by opening the hand valve 60, so that the water will by-pass the control valve 43 via the circumventing branch pipe 59.

The valve 38 insures the maintenance of a predetermined amount of water in the bottom compartment 36 of the tender sufficient for both boiler feed and ballast purposes. When, by reason of withdrawal of feed water, the supply in the bottom compartment 36 of the tender recedes to the level indicated at L' in Fig. 9, the closure element 88 of the valve 38 will be automatically shifted upward by the action of float 101 to open position and thereby allow flow of water from the upper resorvoir 35 to take place, and be temporarily held in this position by action of the toggle springs 106 upon the bell crank lever 103. When the maximum level L of water is again attained in the lower reservoir 36 of the tender, the closure element 88 of the valve 38 is automatically returned to its normal closed position in which it is shown in full lines in Fig. 9 by rise of the float 101, being held in the latter position likewise by action of the toggle springs 106 upon the bell crank 103. Due to slotting of the links 98 at 97a, the required amount of lost motion is allowed the bell crank 103 to permit full end rise of the float 101 between the desired limits without influencing the valve except as these limits are reached, and also to allow for turbulence of the water incident to travel of the locomotive.

In the alternative embodiment of my invention illustrated in Figs. 11 and 12, ballast water to compensate for the loss of weight on the front truck 25a of the locomotive as the fuel is consumed, flows by gravity from a relatively high reservoir 35a in the tender 21a to the ballast compartment 32a by way of a conduit 40a, the flow being controlled by an automatically operative valve generally designated 43a. As best shown in Fig. 12, the body of this valve 43a is fitted over an opening 110 in the bottom of the ballast water compartment 32a and at its interior provides a seat 111 for a closure element 61a whereof the stem 64a passes downward through a stuffing box 112 at the bottom of the valve body. A bell crank lever 66a fulcrumed to a pendent bracket extension 113 on the valve body, has one of its arms engaging a circumferentially grooved head 65a on the stem 64a, and is subject to a toggle spring 68a which tends to yieldingly maintain the closure element 61a either in open or in closed position. At the bottom, the rod 64a is clevised for reception of a small link 114 by which it is coupled with a horizontal lever 115 fulcrumed on a lateral bracket projection 116 on one of the equalizer bars 69a of the small guide truck 29a at the front end of the locomotive. Intermediate its ends, the lever 115 is connected through a drop link 117, to the frame 72a of the guide truck 29a. Thus, with this construction and arrangement, when the front end of the locomotive rises as the fuel supply diminishes, the valve 43a will be opened to permit gravity flow of water, under head pressure from within the reservoir 35a in the tender 21a, to the ballast water tank 32a until the normal desired weight on the front powered truck 25a again obtains, whereupon said valve will automatically close with lowering of the locomotive front end. The above operation will recur from time to time as will be readily apparent, spasmodic functioning of the valve 43a as the guide truck 29a passes over track surface irregularities, being precluded by reason of the pin and slot connection at 118 (Fig. 12) between the valve stem 64 and the coupling link 114.

Return of the water from the ballast tank 32a on the locomotive to the tender 21a during refueling is effected through a separate connecting conduit 120 (Fig. 11) by action of a pump indicated at 42a which may be of the rotary type driven by a turbine 45a. Steam is conducted from the boiler 24a to the turbine 45a through a pipe 46a under the control of a hand valve 47a conveniently accessible within the cab 34a. The pump 42a is of course ordinarily idle, and flow through the conduit 120 is prevented by closure of a hand valve interposed therein at 121.

Having thus described my invention, I claim:

1. In a locomotive, a body with a boiler at one end, and with fuel storage and water ballast compartments at the other end; wheeled trucks with frames and spring suspensions whereby the body is yieldingly supported at opposite ends respectively beneath the boiler and beneath the fuel and water compartments; a coupled tender with a ballast water storage compartment; a conduit extending between the ballast water compartment of the locomotive and the storage water compartment on the tender; a valve and a pump interposed in the conduit; and a linkage means between the valve and the truck beneath the fuel storage and water ballast compartment on the locomotive automatically operative upon rise of the last mentioned end of the locomotive as fuel is consumed, to actuate the valve and thereby permit transfer of weight loss compensating ballast water by the pump, from the tender to the ballast water compartments on the locomotive for maintenance of a constant load on the last mentioned truck.

2. In a locomotive, a body with a boiler at one end, and with fuel storage and water ballast compartments at the other end; wheeled trucks with frames and spring suspensions whereby the body is yieldingly supported at opposite ends

respectively beneath the boiler and beneath the fuel and water compartments; a coupled tender with a ballast water storage compartment; a conduit extending between the ballast water compartment of the locomotive and the storage water compartment on the tender; a valve and a pump interposed in the conduit; and a linkage means between the valve and the truck beneath the fuel storage and water ballast compartment end of the locomotive automatically operative upon rise of the last mentioned end of the locomotive as fuel is consumed, to actuate the valve and thereby permit transfer of weight loss compensating ballast water by the pump, from the tender to the ballast water compartment on the locomotive and to reversely actuate the valve upon fall of the last mentioned end of the locomotive as the fuel in the fuel compartment is replenished, to permit transfer of water by the pump, to the storage compartment on the tender from the ballast water compartment on the locomotive for maintenance of a constant load on the truck at said last mentioned end of the locomotive.

3. A locomotive according to claim 1, wherein the tender is also provided with a boiler feed water compartment; and further including automatic valve means interposed between the two water compartments of the tender for maintaining definite maximum and minimum levels of water in the storage compartment.

4. In a locomotive, a body with a boiler at one end, and with a fuel compartment and a water ballast compartment at the other end; separately-powered driving wheel trucks with spring suspensions yieldingly supporting the body respectively beneath the boiler and beneath the fuel and water ballast compartments; a pilot truck in advance of the forward powered truck; a coupled tender with a water storage compartment; a conduit extending between the tender and the water ballast compartment on the locomotive; a valve and a pump interposed in the conduit; and linkage means between the valve and the pilot truck automatically operative upon easement of the springs of the forward powered truck as the fuel is consumed, to permit transfer, by the pump, of water from the tender to the ballast compartment on the locomotive to compensate for the fuel weight loss, so that a constant load is maintained on the front driving wheels.

5. In a locomotive, a body with a boiler at one end, and with a fuel compartment and a water ballast compartment at the other end; separately-powered driving wheel trucks with spring suspensions yieldingly supporting the body respectively beneath the boiler and beneath the fuel and water ballast compartments; a pilot truck associated with the forward powered truck; a coupled tender with a water storage compartment; a conduit extending between the tender and the water ballast compartment on the locomotive; a valve and a pump interposed in the conduit; and linkage means between the valve and the pilot truck automatically operative upon easement of the springs of the forward powered truck as the fuel is consumed, to permit transfer of weight-compensating water from the tender to the ballast water compartment on the locomotive to compensate for the fuel weight loss and

to reversely actuate the valve upon compression of the springs of the forward powered truck to permit transfer of water from the ballast water compartment on the locomotive to the tender by way of the conduit during replenishment of the fuel so that a constant load is at all times maintained on the front driving wheels.

6. In a locomotive, a body with a boiler at one end, and with a fuel compartment and a water ballast compartment at the other end; separately-powered driving wheel trucks with spring suspensions yieldingly supporting the body respectively beneath the boiler and beneath the fuel and water ballast compartments; a coupled tender with a water storage compartment; a pilot truck in advance of and associated with the forward powered truck; a conduit extending between the ballast water compartment on the locomotive and the tender; a continuously running pump and a control valve interposed in the conduit, said valve having ports by way of which water is normally circulated idly through the pump; and connections whereby the valve is automatically operated periodically from the pilot truck upon easement of the springs of the forward truck as the fuel is consumed, to permit transfer by the pump of water from the tender to the ballast water compartment on the locomotive in compensation for the fuel weight loss and maintenance of a constant load on the front driving wheels.

7. In a locomotive, a body with a boiler at one end, and with a fuel compartment and a water ballast compartment at the other end; separately-powered driving wheel trucks with spring suspensions yieldingly supporting the body respectively beneath the boiler and beneath the fuel and water ballast compartments; a pilot truck in advance of and associated with the forward powered truck; a coupled tender with a water storage compartment; a conduit extending between the ballast water compartment on the locomotive and storage compartment on the tender; a continuously running pump and a control valve interposed in the piping, said valve having ports by way of which water is normally circulated idly through the pump; and linkage means between the valve and the pilot truck automatically operative, upon easement or compression of the springs of the forward truck as the fuel is consumed or replenished, to permit transfer, by the pump, of water in the proper direction between the ballast water compartment on the locomotive and the storage compartment on the tender for maintenance at all times of a constant load on the front driving wheels.

CARLETON K. STEINS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,413,119	Steins	Dec. 24, 1946
2,467,703	Steins	Apr. 19, 1949

FOREIGN PATENTS

Number	Country	Date
740,452	France	Jan. 26, 1933
269,608	Germany	Jan. 26, 1914