May 31, 1932. C. H. FROELICH 1,860,929

CONTROLLING MECHANISM FOR ENGINES

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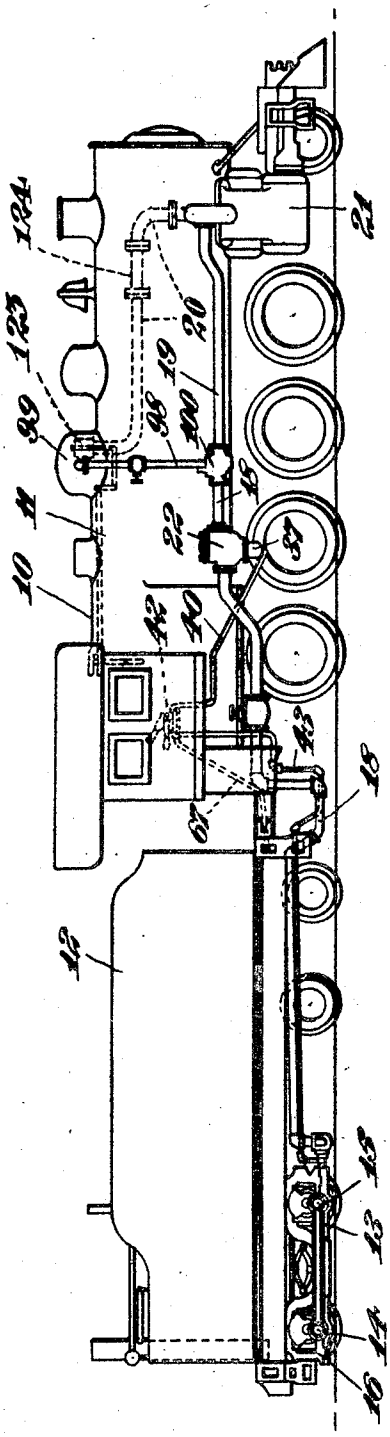


Fig. 1.

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Fig. 2.

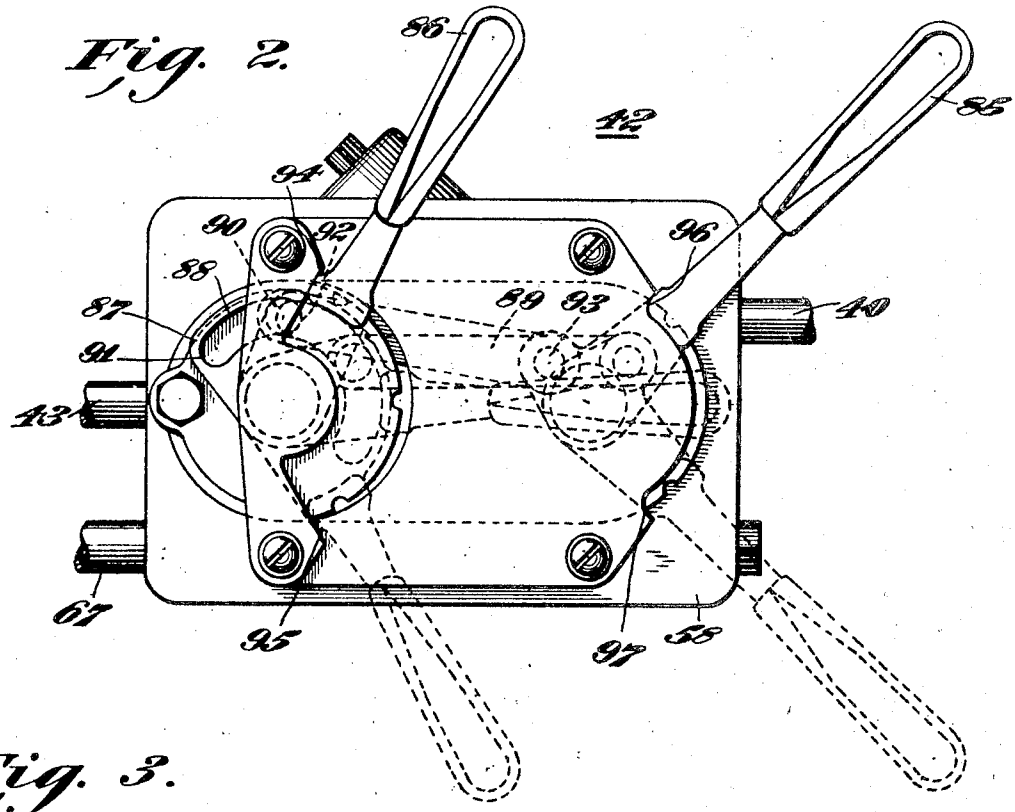
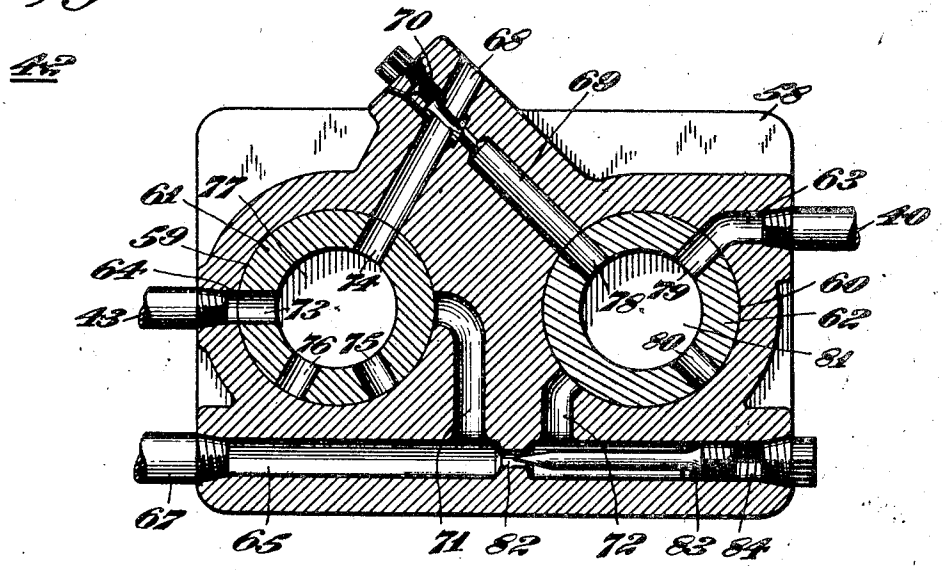


Fig. 3.



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Fig. 4.

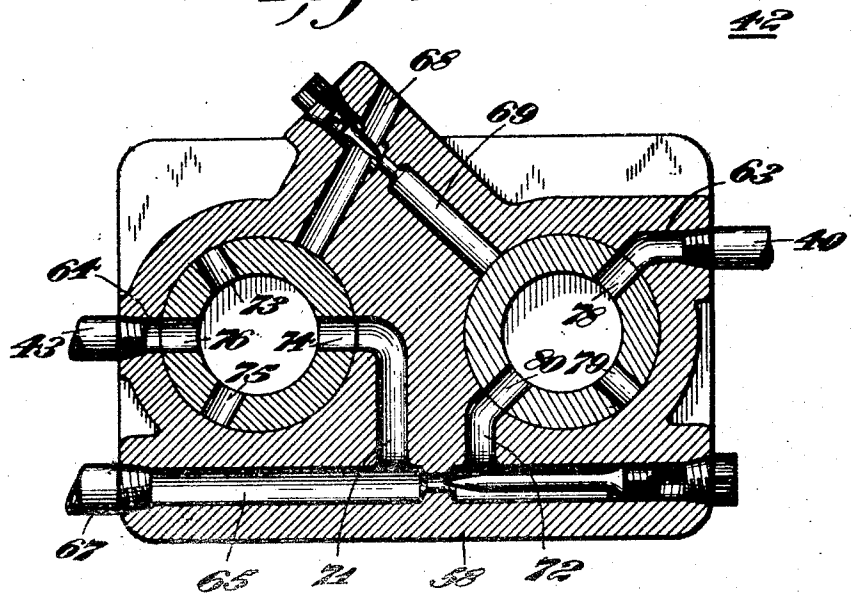
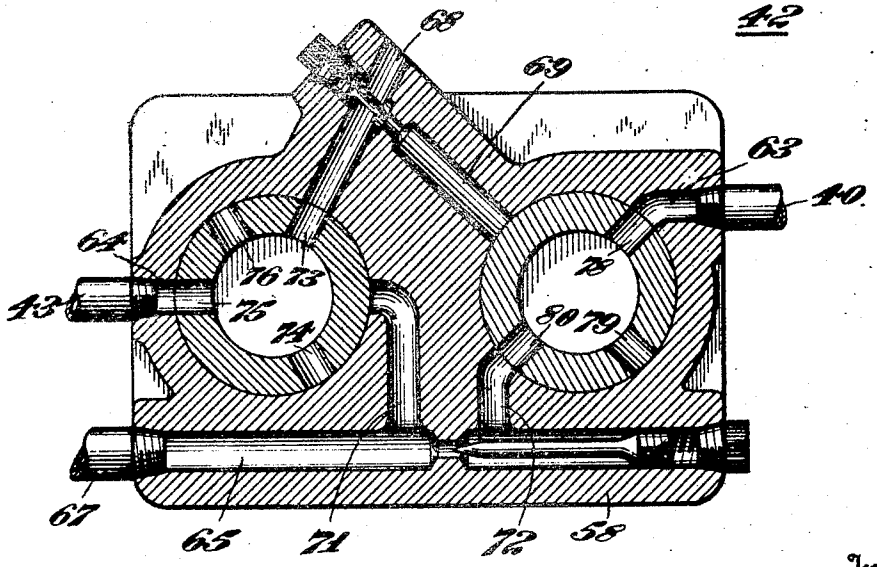


Fig. 5.



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Fig. 6.

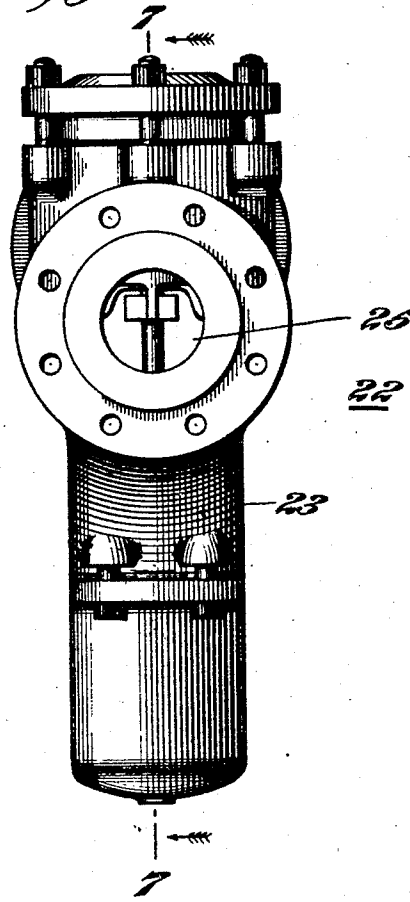


Fig. 7.

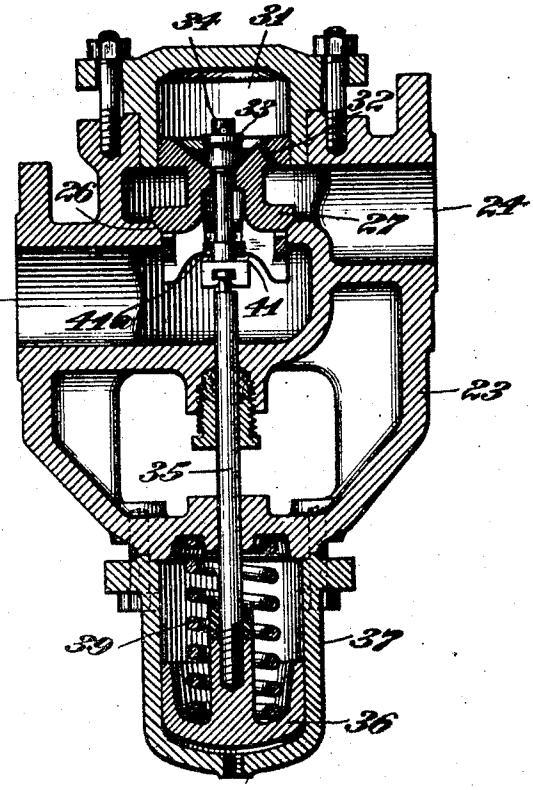
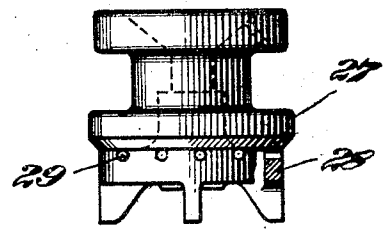


Fig. 8.



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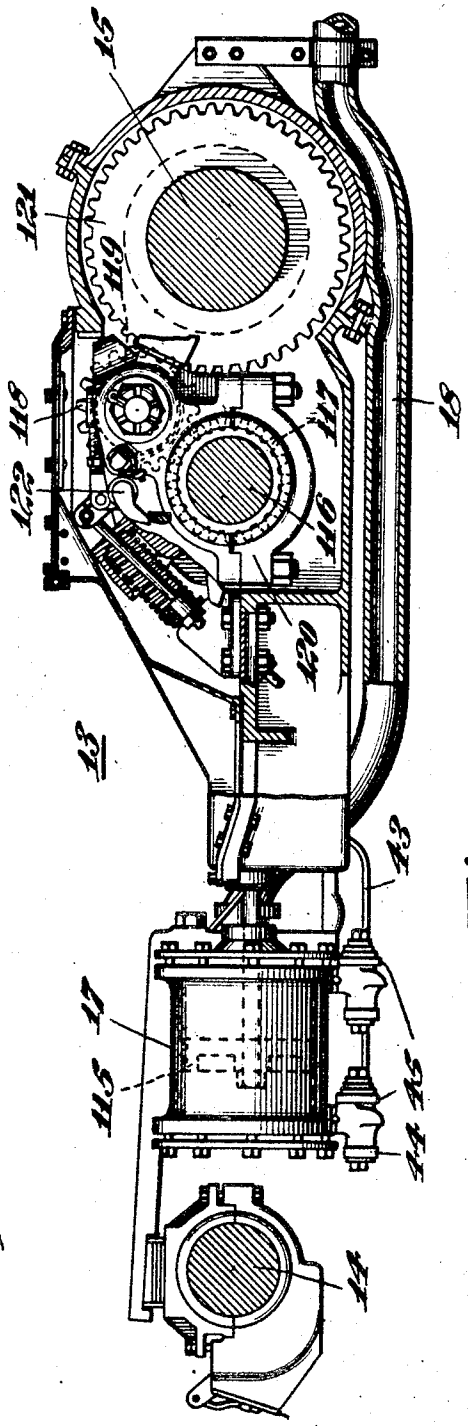


Fig. 9.

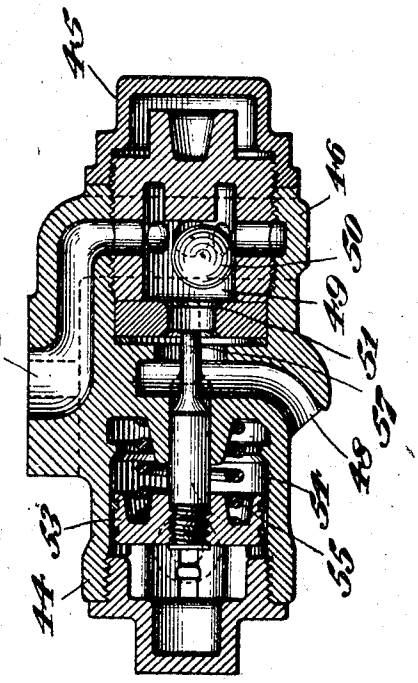


Fig. 10.

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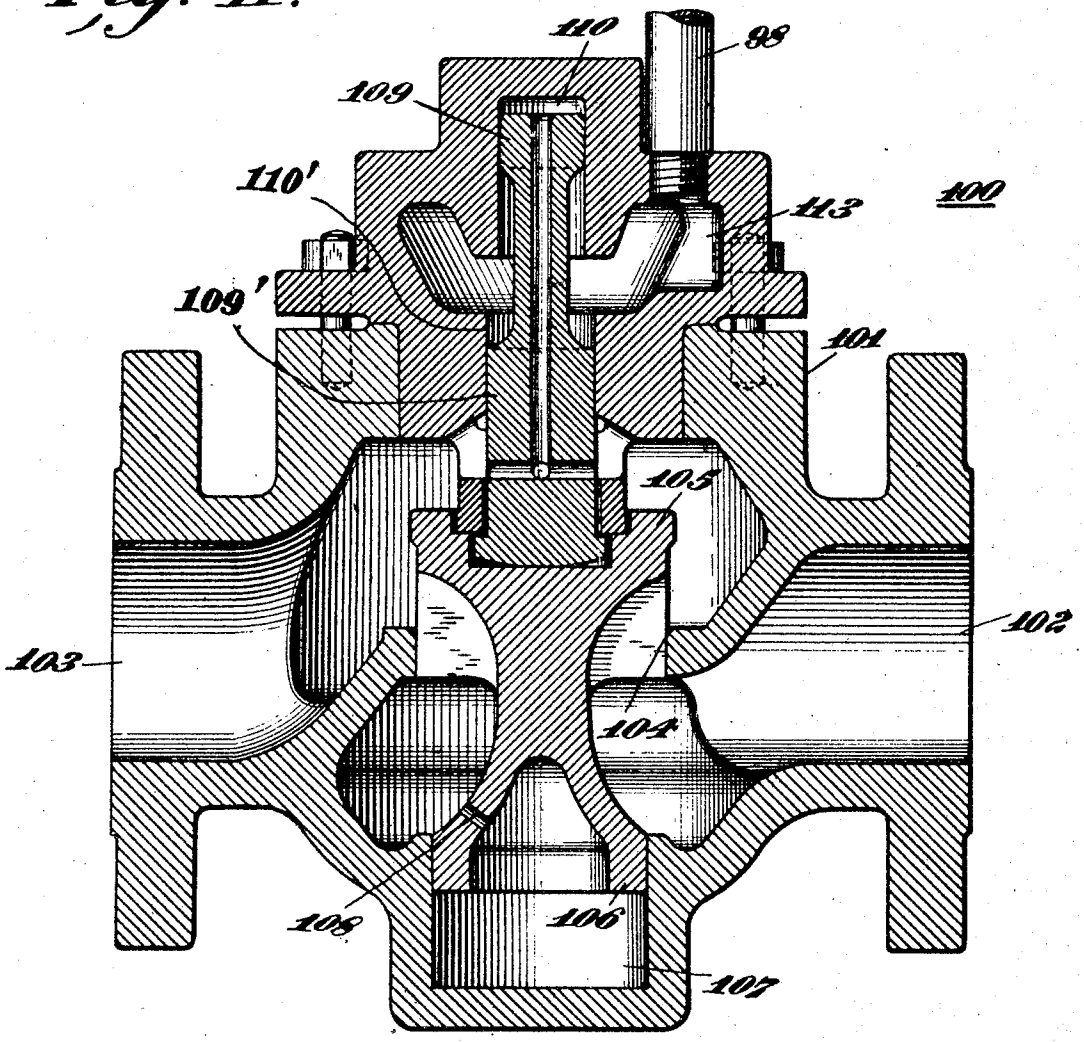
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CONTROLLING MECHANISM FOR ENGINES

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Fig. 11.



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Patented May 31, 1932 1,860,929

UNITED STATES PATENT OFFICE

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CONTROLLING MECHANISM FOR ENGINES

Application filed June 19, 1929. Serial No. 372,087.

My invention relates to controlling mechanism for steam engines, and particularly to controlling mechanism for engines used as propulsion units.

In connection with the problem of operating steam engines especially those used as propulsion units for railway vehicles it has heretofore been the practice to equip the cylinders with drain cocks which were either opened and closed by hand, or which are automatically opened and closed due to the absence of, or the presence of, steam pressure in the cylinders. In consequence, in one case the drain cocks were closed by the engineer before admitting steam to the cylinders and in the other case the cylinder cocks were automatically closed due to the pressure of the initial supply of steam to the cylinders. In both cases the cylinder cocks were closed while the cylinders were cold and in consequence thereof when steam was supplied to the cold cylinders considerable condensate formed in the cylinders before they became sufficiently warm to prevent a portion of the steam from becoming condensed and, as the cylinder cocks were in their closed position, the condensate in the cylinders could not escape and therefore caused damage to the engine.

In connection with steam engines used as propulsion units for vehicles in which a train of gears is employed through which an axle of the vehicle is driven, and particularly of the type which has a driving gear mounted on the crankshaft of the engine and an idler gear constantly meshing with the driving gear which is capable of being entrained with a driven gear on the axle of the vehicle due to the turning over of the engine and which is retained in engagement with said gear solely by the resultant of the working forces set up between the teeth of these gears and which is disentrained from the driven gear when the speed of the engine is insufficient to create the necessary working forces between the teeth of the idler gear and the driven gear, it has heretofore been the practice for the cylinder cocks to be retained in a closed position as long as there was any pressure in the cylinders. In consequence thereof when the throttle was first closed the engine would continue to operate a short time due to the pressure then in the cylinders intermittently decreasing and building up sufficiently to cause the idler gear to be disentrained and entrained with the driven gear a number of times before the engine came to rest. This was very detrimental to the engine and especially to the gear mechanism.

It is therefore one of the objects of my invention to provide means whereby the cylinder drain cocks, which are preferably of the type which normally open automatically when there is no pressure in the cylinders and which normally close automatically when steam is admitted to the cylinders, will be retained in their open position during the opening of the throttle and until such time as they are closed by the operator, and which will be opened during the closing of the throttle even while there is pressure in the cylinders.

Another object of this invention is to provide a controlling mechanism for a fluid pressure system which is adapted to simultaneously control fluid under pressure for a plurality of fluid actuated motors and which is also provided with means whereby fluid under pressure may be controlled to one of the fluid motors without affecting the fluid supply of the other fluid motor.

Another object of this invention is to provide means for automatically controlling means for holding the cylinder cocks of a steam engine open when the throttle valve control is operated to either open or close the throttle valve regardless of whether or not there is pressure in the engine cylinder.

Another object of the invention is to provide adjustable means in the controlling mechanism for a fluid pressure system to regulate the flow of fluid under pressure to a fluid actuated motor so that a predetermined amount may be supplied thereto or exhausted therefrom upon the operation of the control mechanism.

Another object of the invention is to provide means, where the supply of steam for normally operating an auxiliary locomotive

in connection with the main locomotive is received from a source intermediate the main throttle and the main cylinders, for automatically controlling an auxiliary supply of steam from the boiler of the main locomotive to the auxiliary locomotive, when the auxiliary locomotive throttle is open, to prevent the gears from being disengaged when it becomes necessary to successively open and close the main throttle to overcome the slippage of the driving wheels of the main locomotive.

The novel features of my invention will be more fully understood from the following description and claims taken with the drawings in which:—

Fig. 1 illustrates diagrammatically a steam locomotive embodying my invention.

Fig. 2 is a top view of a valve embodying my controlling mechanism.

Figs. 3, 4 and 5 show a cross-section of the valve shown in Fig. 2 with the valve plugs in their different operating positions.

Fig. 6 is a side view of a throttle valve adapted to be used in connection with my invention.

Fig. 7 is a cross-section of the valve taken along line 7—7 of Fig. 6.

Fig. 8 is a side view of the valve plate of the throttle valve shown in Figs. 6 and 7.

Fig. 9 is a view of an auxiliary locomotive engine partially in cross section.

Fig. 10 is a sectional view of one of the cylinder drain cocks of the auxiliary locomotive engine shown in Fig. 9.

Fig. 11 is a sectional view of a combined automatic supply and check valve used in the steam lines to the auxiliary locomotive.

Referring to the drawings more in detail, wherein I show my controlling mechanism used in connection with a main locomotive and its auxiliary locomotive, 10 designates a locomotive having a boiler 11 of usual construction for generating steam and a tender 12 coupled thereto. An auxiliary engine 13 is suspended intermediate the axles 14 and 15 of the tender truck 16 and is adapted to be operatively connected to the axle 15 of said truck through suitable gearing when the auxiliary engine is turned over upon the admission of steam to its cylinders 17.

Pipes 18 and 19 are provided for conveying steam to the auxiliary engine 13. The pipe 19 is connected to the superheated steam pipe 20 intermediate the main throttle valve 123 and the cylinders 21 of the main locomotive. The superheated steam pipe 20 communicates with the superheater 124 and the main throttle 123. A throttle valve 22 is disposed in the pipe line 18 for controlling the steam supply to the cylinders 17. The throttle valve 22 may be of any well-known type but I prefer to use a valve similar to the type shown in Figs. 6 and 7.

The valve 22 comprises a casing 23, having an inlet opening 24 and an outlet opening 25. A valve seat 26 is provided intermediate the openings 24 and 25 and is adapted to receive a valve plate 27 for controlling communication between the inlet opening 24 and the outlet opening 25. The valve plate 27 is provided with a skirt 28 containing apertures 29. The function of this skirt is to baffle the steam and prevent its sudden rush to the engine when the valve 27 is initially raised from its seat and therefore allows the friction and inertia of the engine parts to be more or less gradually overcome and thus permits the engine to start smoothly.

The upper end of the valve 27 extends into an annular chamber 31 which receives fluid through the small bleeder opening 32. A pilot valve 33, having its seat in the center of the plate 27, is provided for admitting fluid from the chamber 31 to the underside of the valve 27. A stem 34, which is operatively connected to the pilot valve 33 at one end and to the spindle 35 at the other end, is provided with a shoulder 41 which is adapted to engage an abutment 41*a* on the valve 27 when the spindle 35 is moved vertically. The spindle 35 is operatively connected to the piston 36 of the fluid motor 37 which is adapted to move said spindle vertically when fluid under pressure is supplied thereto from any available source through the pipe 40. A spring 39 is provided to constrain the spindle 35 to its lower position. Fluid under pressure to the pipe 40 is controlled by the controlling mechanism 42 located in the engine cab.

The controlling mechanism 42 also controls the fluid under pressure to the pipe 43 for operating the fluid motors 44, which are provided for controlling the operation of the cylinder cocks 45 during the operation of the throttle valve 22.

In Fig. 9 I show one of the cylinders 17 of the auxiliary engine 13 equipped with two cylinder drain cocks 45 which are normally automatic in their operation. One of the cocks 45 is shown in detail in Fig. 10.

The drain cock 45 comprises a casing 46 having a passage 47 communicating with the engine cylinder and an outlet passage 48 communicating with the atmosphere. A chamber 49 is provided intermediate these passages and is adapted to receive a ball valve 50, which is capable of movement, from the position shown in the drawings, to its seat 51 for closing communication between the passages 47 and 48 when pressure is admitted to the chamber 49 through the passage 47. The valve is prevented from seating by means of the plunger 57, when the latter is in its forward position as shown in broken lines in Fig. 10. The plunger 57 is operatively connected to the piston 53 which is slidingly mounted in the cylinder 54 of the motor 44. A compression spring 55 constrains the pis-

ton to its rearward position, shown in Fig. 10. When fluid under pressure is supplied to the cylinder the pressure on the piston 53 moves the plunger.

When there is no pressure being admitted from the cylinder 17 through the passage 47 the valve 50 assumes its normally idle position, as shown in Fig. 10 of the drawings, and the passages 47 and 48 are in communication with each other.

Referring to Figs. 2, 3, 4 and 5, the controlling mechanism 42 comprises a casing 58, having cylindrical openings or bores 59 and 60 formed therein for receiving valve disks or plugs 61 and 62, respectively. Ducts 63, 64 and 65 are provided in the casing 58 to which the pipes 40, 43 and 67, respectively, are connected. The casing 58 is also provided with ducts 68 and 69 which terminate in the bores 59 and 60, respectively, and communicate with the atmosphere. An adjustable needle valve 70 may be placed in the duct 69 for varying the size of the outlet thereof to any desired degree. The duct 65 is adapted to receive fluid under pressure from the pipe 67 from any available source of supply such as the air brake reservoir (not shown) for distribution to the branch ducts 71 and 72, respectively, where it is controlled by the valve plugs 61 and 62, respectively. The valve plug 61 is provided with ports 73, 74, 75 and 76, all of which communicate with its annular opening 77. The plug 62 is provided with ports 78, 79 and 80 all of which communicate with its annular opening 81. The duct 65, intermediate the branch ducts 71 and 72, is provided with a restricted portion 82. An adjustable needle valve 83, which is inserted through the opening 84, is capable of being adjusted to vary the size of the passage through the restricted portion 82 to any desired degree and therefore the correct amount of fluid under pressure required to effectively operate the throttle valve 22 will be supplied through the pipe 40 to the throttle valve motor 37 when the valve plug 62 is rotated so as to communicate the port 80 with the duct 72 and the port 78 with the duct 63. A handle 85 is operatively connected to the plug 62, as indicated in Fig. 2, for operating this plug.

The valve plug 61 is provided with a handle 86 having a sector 87 operatively connected thereto, which is provided with a slot 88. A link 89 is operatively connected to the sector 87 by the pin 90 which passes through the slot 88 and is capable of movement therein between the end walls 91 and 92 of the slot 88. The other end of the link 89 is pivotally connected to the handle 85 by means of the pin 93. This arrangement is provided so that the handle 86 of valve plug 61 will always be brought to its central position between the stops 94 and 95, as shown in Fig. 2, during the movement of the handle 85 to either of its extremities, that is, either against the stop 96 or 97, and also to permit the handle 86 being moved until it engages the stop 95 when the handle 85 is against its stop 97 and to permit the handle 86 being moved until it engages the stop 94 when the handle 85 is against its stop 96.

When the handles 85 and 86 are in the position shown in full lines in Fig. 2, the valve plugs 61 and 62 are in the positions shown in Fig. 3. When the handle 85 is moved to the position shown in dotted lines in Fig. 2, the handle 86 is automatically moved to its central position and the valve plugs 61 and 62 are positioned as shown in Fig. 4. When the handle 86 is manually moved to the extreme position shown in dotted lines in Fig. 2, that is against the stop 95, and the handle 85 remains in the position shown in dotted lines, the valve plugs 61 and 62 will be in the position shown in Fig. 5.

The superheated steam supplied through pipes 18 and 19 to the auxiliary engine 13 is received from the pipe 20 intermediate the main throttle valve 123 and the main engine cylinders 21. A pipe 98 which is connected with the pipes 18 and 19 receives saturated steam from the dome 99. In order to prevent the saturated steam from passing through the pipe 19 to the main cylinder 21 when the main throttle is closed, and in order to prevent the saturated steam mixing with the superheated steam when the main throttle is open I provide at the junction of the pipes 18, 19 and 98 a valve 100 which is automatic in its operation.

The valve 100 comprises a casing 101 having communicating inlet and outlet ports 102 and 103 which communicate with the pipes 19 and 18, respectively. A seat 104 is provided intermediate the ports 102 and 103 for receiving a valve plate 105 which is adapted to close communication between these two ports. The valve plate 105 has an extension forming a piston 106 which enters the cylindrical chamber 107 and is provided with an aperture 108 so as to allow steam to enter the chamber 107, when there is pressure in the pipe 19, to operate the piston 106 and raise the valve plate 105 from its seat and communicate the ports 102 with the port 103 and thus allow steam to be supplied from the pipe 19 to the pipe 18. To the upper end of the valve plate 105 is connected a piston having two diameters 109 and 109′ which operates within the cylinders 110 and 110′. An annular chamber 113 communicates with the cylinders 110 and 110′ and receives steam from the pipe 98. The difference in diameter between the piston portions 109 and 109′ results in a differential area subject to the steam pressure within the chamber 113. The area of the piston 106 is considerably greater than that of the piston portion 109 plus the differential area due to piston portion 109′

so that as long as there is pressure in the chamber 107 beneath the piston 106 the valve 105 will be held away from its seat, but when the pressure beneath the piston is relieved, due to the closing of the main throttle valve, then the pressure within the chamber 113 acting on the differential area due to piston portion 109′ will act to close the valve 105 and to cut off communication between the pipes 18 and 19 and to establish communication between the pipes 18 and 98.

In operation, the auxiliary locomotive being in its inoperative condition and the main throttle valve being opened and supplying steam through the pipe 20, the auxiliary throttle valve 22 being in its closed position, the cylinder drain cocks 45 are in their open position, due to the absence of pressure in the cylinders of the auxiliary locomotive. Assuming that the control valve handles 85 and 86 are in the position shown in full lines in Fig. 2; that is, with the ports 73 and 74 in the valve plug 61 communicating with the ducts 64 and 68 respectively, and the ports 78 and 79 of the valve plug 62 communicating with the ducts 69 and 63, respectively, as shown in Fig. 3. The engineer moves the handle 85 in a clockwise direction to the position shown in dotted lines in Fig. 2 thus rotating the valve plug 62 and bringing the ports 78 and 80 into communication with the ducts 63 and 72, respectively. As the handle 85 is operatively connected to the sector 87 of the handle 86 through the link 89 the movement of the handle 85 to this position causes the handle 86 to be moved to its central position shown in Fig. 2 and thus rotates the valve plug 61 and brings the ports 74 and 76 into communication with the ducts 71 and 64, respectively, as indicated in Fig. 4. With the valve plug 61 in this position fluid under pressure is delivered from the duct 71 through the ports 74 and 76, the duct 64 and the pipe 43 to the cylinder drain cock motor 44 which causes the piston 53 to be operated to compress the spring 55, and the plunger 57, which is operatively connected to the piston 53, to move forward to such a position that the valve 50 is unable to be seated by the pressure of the steam supplied to the cylinders upon the opening of the throttle valve as hereinafter explained. At the same time fluid under pressure is being delivered from the duct 72, through the ports 78 and 80, the duct 63 and the pipe 40, to the throttle valve operating motor 37 to cause the piston 36 to be operated. The initial operation of the piston 36 opens the pilot valve 33 and allows steam to enter beneath the throttle valve 27, thus balancing this valve. The further movement of the piston 36, due to the shoulder 41 engaging the abutment 41*a* on the valve 27, will cause the valve 27 to commence to open. As the fluid under pressure for operating the piston 36 is received through the restricted opening 82, which has been so adjusted by the needle valve 83 that the supply of motive fluid is more or less restricted gradually builds up in pressure to gradually overcome the opposition of spring 39. Thus the opening of the throttle valve will be gradual, and therefore the supply of steam to the auxiliary locomotive cylinders 17 will be in a gradually increasing quantity, especially as the valve skirt 28 baffles the steam and prevents its sudden rush to the engine cylinders 17 when the valve 27 is initially raised from its seat. The gradual supply of steam to the auxiliary locomotive cylinders permits the friction and inertia of the engine parts to be more or less gradually overcome and thus allows the engine to start smoothly. The admission of fluid to the cylinders 17 will cause the pistons 115 to reciprocate and thus rotate the crank shaft 116 and the driving gear 117, which is operatively connected thereto, which in turn tends to drive the idler gear 118 which is rotatively mounted in the bracket 120, but as the idler gear 118, in the construction shown in the drawings, is held against rotation by the friction band 119 the bracket 120 is caused to rotate about the axis of the driving gear 117 until the idler gear 118 commences to mesh with the gear 121 which is keyed to the axle 15. As soon as the gear 118 commences to mesh with the gear 121 the cam 122 releases the friction band 119 and allows the gear 118 to rotate and the auxiliary locomotive engine 13 is now in driving relation with the axle 15 of the tender 12 and will remain in this relation as long as sufficient steam is supplied to the cylinders 17 to cause the engine unit to transmit power to the driven gear 121.

After steam has been supplied to the cylinders 17 for a sufficient period to warm the cylinders so that the steam will not become condensed, the engineer operates the handle 86 in a clockwise direction until he brings it up against the stop 95 as shown in Fig. 2. The operation will bring port 75 into communication with the duct 64 and the port 73 into communication with the exhaust duct 68 as shown in Fig. 5, thus shutting off the supply of fluid under pressure to the motor 44 and also allowing the fluid in the pipe 43 to be exhausted to the atmosphere. The relief of pressure in the pipe 43 will allow the piston 53 to be returned to its inoperative position due to the expansion of the spring 55, and the plunger 57 which is operatively connected to the piston 53 to be withdrawn from the valve seat 51, therefore allowing the valve 50 to automatically seat itself due to the pressure which is now in the cylinders 17. If the wheels of the auxiliary locomotive have a tendency to slip the drain cocks 45 are opened for a short period by turning the

handle 86 to its central position. The cocks are then closed by bringing the handle 86 back against its stop 95.

When it is necessary for the engineer, due to the slipping of the wheels of the main locomotive, to successively open and close the main throttle valve to overcome this slippage, the normal supply of superheated steam through the pipes 18 and 19 to the auxiliary locomotive is also cut off when the main throttle is closed, as it is supplied from a source intermediate the main throttle valve and the cylinders of the main locomotive. This will cause the pressure beneath the piston 106 of the valve 100 to be relieved and the valve 105 is carried to its seat 104 due to the differential pressure effect in the cylinders 110 and 110′ acting upon the piston portions 109 and 109′ as hereinbefore described, thus closing communication between the pipes 18 and 19 and establishing communication between the pipes 18 and 98 and allows sufficient saturated steam to be supplied to the cylinders 17 to retain the auxiliary locomotive gearing in entrainment. As soon as the main throttle is again opened the pressure beneath the piston 106 will cause the valve 105 to be raised from its seat 104 and open communication between the pipes 18 and 19 and simultaneously close communication between the pipes 18 and 98, thus cutting off the supply of saturated steam and permitting the superheated steam to be supplied to the auxiliary locomotive.

When the engineer desires to put the auxiliary locomotive out of operation he turns the handle 85 in a counterclockwise direction until it abuts the stop 96. This will cause the handle 86 to be moved to its central position as shown in Fig. 2 due to the pin 90 engaging the end wall 92 of the slot 88. The valve plug 62 will now be in the position shown in Fig. 3 and the valve plug 61 will be in the position shown in Fig. 4. With the plugs in these positions the fluid under pressure will be exhausted from the motor 37 through the pipe 40, the ports 79 and 78 in the plug 62 out through the ducts 69 and 68 to the atmosphere, thus allowing the throttle valve 22 to close, the required speed of the closing of the throttle valve being governed by the size of the exhaust opening in the duct 69 which is adjusted by the valve 70 and shut off communication to the auxiliary locomotive engine 13, and fluid under pressure will be supplied through the valve plug 61, and the pipe 43 to the cylinder cock motors 44 to operate the plungers 57 and unseat the valves 50 and thus relieve the pressure in the engine cylinders 17. As soon as the pressure in the cylinders 17 is relieved the engine 13 ceases to turn over and therefore the idler gear 118 disentrains from the gear 121 and the auxiliary locomotive assumes its normally idle position and remains in this position until the engineer desires to again put it into operation.

After the auxiliary locomotive assumes its idle position the engineer moves the handle 86 up against its stop 94 thereby rotating the valve plug 61 to the position shown in Fig. 3, thus cutting off the supply of fluid under pressure to the pipe 43 and allowing the fluid therein to exhaust through the duct 68 to the atmosphere.

It will be seen from the foregoing that I have devised novel and simple controlling mechanisms for steam engines, which are particularly adaptable for controlling auxiliary locomotive engines.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

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

1. In combination with a fluid operated engine and its cylinders, cylinder cocks which are adapted to close when the cylinders are receiving motive fluid, a motor operated throttle for controlling the fluid supply to the cylinders, fluid actuated means for governing the cylinder cocks, and a controlling mechanism for said motor operated throttle and for said fluid actuated means comprising a valve casing having a plurality of bores and ducts therein, a valve plug for each of said bores for governing the operation of said motor operated throttle and said fluid actuated means respectively, said plugs having ports capable of registering with said ducts, controlling means for each of said plugs, and connecting means between said controlling means adapted to simultaneously operate the plugs upon the operation of one of said controlling means.

2. In combination with a fluid operated engine and its cylinders, cylinder cocks which are adapted to close when the cylinders are receiving motive fluid, a motor operated throttle for controlling the fluid supply to the cylinders, fluid actuated means for governing the cylinder cocks, and a controlling mechanism for said motor operated throttle and for said fluid actuated means comprising a casing having a plurality of cylindrical openings and ducts therein, a valve plug rotatably mounted in each of said openings for governing the operation of said motor operated throttle and said fluid actuated means respectively, each of said valve plugs having ports therein capable of registering with ducts in the valve casings and means adapted

to rotate said plugs simultaneously, and means adapted to operate one of said plugs independently of the other.

3. In combination with a fluid operated engine and its cylinders, cylinder cocks which are adapted to close when the cylinders are receiving motive fluid, a motor operated throttle for controlling the fluid supply to the cylinders, fluid actuated means for governing the cylinder cocks, and a controlling mechanism for said motor operated throttle and for said fluid actuated means comprising a valve casing having a pair of cylindrical openings and ducts therein, a valve plug for each of said openings for governing the operation of said motor operated throttle and said fluid actuated means respectively, said plugs having ports capable of registering with said ducts, controlling means for each of said plugs, connecting means between said controlling means adapted to simultaneously operate the plugs upon the operation of one of said controlling means, and means associated with said controlling means adapted to permit the operation of one plug independently of the other.

4. In combination with a fluid operated engine and its cylinders, cylinder cocks which are adapted to close when the cylinders are receiving motive fluid, a motor operated throttle for controlling the fluid supply to the cylinders, fluid actuated means for governing the cylinder cocks, and a controlling mechanism for said motor operated throttle and for said fluid actuated means comprising a valve casing having a plurality of bores and ducts therein, a valve plug rotatably mounted in each of said bores for governing the operation of said motor operated throttle and said fluid actuated means respectively, said plugs having ports capable of registering with said ducts, a handle operatively connected to each plug, a slotted sector mounted on one handle, a link, means slidably mounted within said slotted sector for operatively connecting said link to said sector, and means for pivotally connecting the link to the other handle, whereby one handle will be operated to an intermediary position upon the manipulation of the other handle to either of its extreme positions.

5. In combination with a fluid operated engine and its cylinders, cylinder cocks which are adapted to close when the cylinders are receiving motive fluid, a motor operated throttle for controlling the fluid supply to the cylinders, fluid actuated means for governing the cylinder cocks, and a controlling mechanism for said motor operated throttle and for said fluid actuated means comprising a valve casing having a plurality of bores and ducts therein, a valve plug rotatably mounted in each of said bores for governing the operation of said motor operated throttle and said fluid actuated means respectively, said plugs having ports capable of registering with said ducts, a handle operatively connected to each of said plugs, a slotted sector mounted on one handle, a link pivotally mounted on the other handle, and connecting means for said handles comprising said link and means operatively connected thereto slidably mounted within the slotted sector.

6. In combination with a fluid operated engine and its cylinders, cylinder cocks which are adapted to close when the cylinders are receiving motive fluid, a motor operated throttle for controlling the fluid supply to the cylinders, fluid actuated means for governing the cylinder cocks, and a controlling mechanism for said motor operated throttle and for said fluid actuated means comprising a valve casing having a plurality of cylindrical openings and ducts therein, a valve plug for each of said openings for governing the operation of said motor operated throttle and said fluid actuated means respectively, said plugs having ports capable of registering with said ducts, adjustable varying means for one of the ducts and controlling means for each of the valve plugs.

7. In combination with a steam engine and its cylinders, cylinder cocks which are adapted to normally close when the cylinders are receiving steam, a motor operated throttle for controlling the steam supply to the cylinders and fluid actuated means adapted to render the cylinder cocks inoperative in their opened position while the cylinders are receiving steam.

8. In combination with a steam engine and its normally automatically operated cylinder cocks, fluid actuated means adapted to oppose the closing of said cylinder cocks, a throttle valve for controlling the steam to said engine, a motor for said valve, a fluid pressure system, and controlling means adapted to simultaneously control the operating fluid for the fluid actuated means and the throttle valve motor.

9. In combination with a steam engine and its throttle valve, a motor for operating said valve, a fluid pressure system, piping connecting said fluid pressure system to said valve motor, controlling mechanism in said piping for controlling the fluid to said motor, said controlling mechanism comprising a valve casing having a bore, and inlet and outlet ducts, a valve plug rotatably mounted within said bore, said plug having ports therein capable of registering with the ducts in the casing, an operating handle for said plug, and an adjustable varying means mounted in one of the ducts adapted to supply fluid at a predetermined rate of flow to the throttle valve motor upon the operation of the valve plug.

10. In combination with a steam engine and its throttle valve, a motor for operating said valve, means for opposing the opening of

the throttle valve, a fluid pressure system, piping connecting said fluid pressure system to said valve motor, controlling mechanism in said piping for controlling the fluid to said motor, said controlling mechanism comprising a valve casing having a bore, and inlet and outlet ducts, a valve plug rotatably mounted within said bore, said plug having ports therein capable of registering with the ducts in the casing, an operating handle for said plug, adjustable means mounted in one of the ducts for varying the area thereof, whereby upon the operation of the valve plug fluid at a predetermined rate of flow necessary to overcome the means opposing the opening of the throttle valve will be supplied to the throttle valve motor to gradually open the throttle valve.

11. The combination with a railway vehicle axle, a normally inoperative steam engine adapted to drive said axle, normally open cylinder cocks for said engine adapted to close when steam is being supplied to the cylinders, a motor operated throttle valve for controlling the steam supply to the cylinders, motor operated means for holding said cylinder cocks open when steam is being supplied to the cylinders and controlling means adapted to simultaneously control the operation of the afore-mentioned motors.

12. The combination of a vehicle axle, a normally idle engine adapted to drive said axle, means for supplying operating steam to said engine, cylinder cocks which are normally open and which are adapted to close when steam is supplied to the cylinders, fluid actuated means for rendering said cylinder cocks inoperative in their opened position while steam is being supplied to the cylinders, a fluid actuated throttle valve for controlling the supply of steam to said cylinders, a fluid pressure system, and controlling mechanism for the fluid pressure system comprising manually operated means adapted to simultaneously control fluid under pressure to the aforementioned fluid actuated means and the fluid actuated throttle valve.

13. The combination of a vehicle axle, a normally inoperative steam engine adapted to drive said axle, a fluid actuated throttle valve for controlling the operation of said engine, engine cylinder cocks adapted to close upon the admission of steam to the engine cylinders, fluid actuated means adapted to prevent the steam pressure in the cylinders from closing said cocks, a fluid pressure system, and controlling means adapted to simultaneously control the fluid pressure for said fluid actuated means and the fluid actuated throttle valve, and means adapted to control the fluid pressure for the fluid actuated means independently.

14. The combination of a vehicle axle, an engine adapted to drive said axle, means for supplying operating steam to said engine, cylinder cocks which are normally open and which are adapted to be closed when steam is supplied to the cylinders, fluid actuated means for rendering said cylinder cocks inoperative in their opened position when steam is supplied to the cylinders, a fluid actuated throttle valve for controlling the supply of steam to said cylinders, a fluid pressure supply system, manually operated means for simultaneously controlling the fluid for operating the aforementioned fluid actuated means and the fluid actuated throttle, and means adapted to control the fluid pressure for the fluid actuated means without effecting the control of the fluid pressure for the fluid actuated throttle.

15. In combination with a steam actuated locomotive engine and its cylinder cocks which are normally automatic in their operation, a motor controlled throttle valve, fluid actuated means for preventing the automatic operation of the cylinder cocks, means for supplying fluid under pressure to the fluid actuated means and the throttle valve motor, a controlling mechanism comprising controlling means for controlling fluid under pressure to the fluid actuated means and the throttle valve motor, respectively, operating means for each of said controlling means and a connecting means between said operating means adapted to simultaneously operate both controlling means upon the manipulation of one of the operating means.

16. In combination with a steam actuated locomotive engine and its cylinder cocks which are normally automatic in their operation, a motor controlled throttle valve, fluid actuated means for preventing the automatic operation of the cylinder cocks, means for supplying fluid under pressure to the fluid actuated means and the throttle valve motor, a controlling mechanism, comprising controlling means for controlling fluid under pressure to the fluid actuated means and the throttle valve motor, respectively, operating means for each of said controlling means, a connecting means between said operating means, said connecting means being so arranged that the manipulation of one of the operating means simultaneously operates both controlling means and the manipulation of the other operating means operates one of the controlling means independently.

17. In combination with a railway vehicle axle, an auxiliary steam engine adapted to drive said axle, a fluid pressure actuated throttle for controlling the operation of said auxiliary engine, controlling means for said throttle, cylinder cocks for said engine, which are normally open and which close automatically when the cylinders are receiving steam, fluid pressure actuated means for holding the cylinder cocks in their opened position, and controlling mechanism for the

latter means operatively connected to the first mentioned controlling means.

18. In combination with a main locomotive and its throttle, an auxiliary locomotive, a valve casing having a single outlet communicating with the auxiliary locomotive, a pair of independent inlets, one of which is adapted to communicate with the main locomotive steam supply and the other inlet communicating with an auxiliary steam supply for supplying steam to the auxiliary locomotive when the main steam supply is cut off, and means automatically operable by the main steam supply for controlling the auxiliary steam supply to the auxiliary locomotive.

19. In combination with a main locomotive and its throttle of a normally idle auxiliary locomotive and its throttle, means for automatically entraining the auxiliary locomotive with an axle to be driven upon admission of steam to its cylinders, means adapted to supply steam from one source to the auxiliary locomotive cylinder when the main locomotive and the auxiliary loccmotive throttles are open and controlling means adapted to automatically supply steam from another source to the auxiliary locomotive cylinder upon the closing of the main throttle.

20. In combination with a main locomotive and its throttle, of an auxiliary locomotive and its throttle, means for supplying steam to the auxiliary locomotive from a source intermediate the main locomotive throttle and its cylinders, when the auxiliary and the main locomotive throttles are open, and controlling means adapted to automatically supply steam to the auxiliary locomotive from an auxiliary source upon the closing of the main throttle.

21. In combination with a main locomotive and its throttle, of an auxiliary locomotive and its throttle, means for supplying superheated steam to the auxiliary locomotive when its throttle and the main throttle are open, and controlling means adapted to automatically supply saturated steam to the auxiliary locomotive upon the closing of the main throttle.

22. In combination with a main locomotive and its throttle, an auxiliary locomotive and its throttle, means for supplying steam to the auxiliary locomotive from a main source when the main locomotive throttle and the auxiliary throttle are opened, means for supplying steam from an auxiliary source when the main throttle is closed, and an automatically operated valve adapted to control the steam supply from the different sources to the auxiliary locomotive when the auxiliary locomotive throttle is in its open position.

23. In combination with a main locomotive and its throttle, an auxiliary locomotive and its throttle, means comprising piping for supplying steam to the auxiliary locomotive from a main source when the main locomotive throttle and the auxiliary throttle are opened, means comprising piping for supplying steam from an auxiliary source to the auxiliary locomotive and an automatically operated valve within the piping adapted to establish communication between the auxiliary source and the auxiliary locomotive upon the closing of the main throttle.

24. In combination with a main locomotive and its throttle, an auxiliary locomotive and its throttle, means comprising piping for supplying steam to the auxiliary locomotive from a main source when the main locomotive throttle and the auxiliary throttle are open, means comprising piping for supplying steam from an auxiliary source, and an automatically operated valve adapted to close communication between the piping of the main source and the piping of the auxiliary locomotive upon the closing of the main throttle and to establish communication between the auxiliary source and the auxiliary locomotive.

25. A control mechanism for an engine, a throttle valve, a cylinder drain cock, normally idle means for preventing the closing of said drain cock, means for controlling said throttle valve, and means actuated by the last mentioned means for rendering the first mentioned means effective.

26. A control mechanism for an engine, a throttle valve, a cylinder drain cock, means for opening said throttle valve, and means for positively maintaining said drain cock in its open condition actuated by said opening means.

27. A control mechanism for an engine, a throttle valve, a cylinder drain cock, means for closing the throttle valve, means for opening the drain cock, and a control device for operating both of said means simultaneously.

28. The method of starting an auxiliary locomotive engine comprising the steps as follows; supplying saturated steam to the engine, maintaining the engine cylinder drain cocks in their open condition, supplying the engine with superheated steam, and closing the drain cocks.

29. In an engine, means to generate saturated steam, means to generate superheated steam, a conduit for communicating the latter means with the engine, a main throttle control for said conduit, an auxiliary conduit for communicating the first mentioned means with the engine past said throttle, an auxiliary throttle for controlling both of said conduits, a cylinder drain cock, means for positively maintaining the latter in its open condition, means for opening said auxiliary throttle, and means actuated by the latter means for rendering the third mentioned means effective.

30. In a control mechanism for an engine, a throttle valve, a cylinder drain cock, a device for operating said throttle, an element to prevent the closing of said cock, a device for operating said element, and a lost motion means connecting said devices.

31. In a control mechanism for an engine, a throttle valve, a cylinder drain cock, a throttle control member, an element for preventing the closing of said cock, a control member for said element, and a link member connecting said control members.

32. In a control mechanism for an engine, a throttle valve, a cylinder drain cock, a throttle control member, an element for preventing the closing of said cock, a control member for said element, and a link member pivoted to one of said members and slidably mounted in the other member.

33. In combination with a steam engine and its cylinder, a cylinder cock which is adapted to normally close when the cylinder is receiving steam, a throttle valve for controlling the steam supply to the cylinder, a control for said throttle valve, and means operated by said control to render the cylinder cock inoperative while the cylinder is receiving steam.

In testimony whereof I hereunto affix my signature.

CLARENCE H. FROELICH.