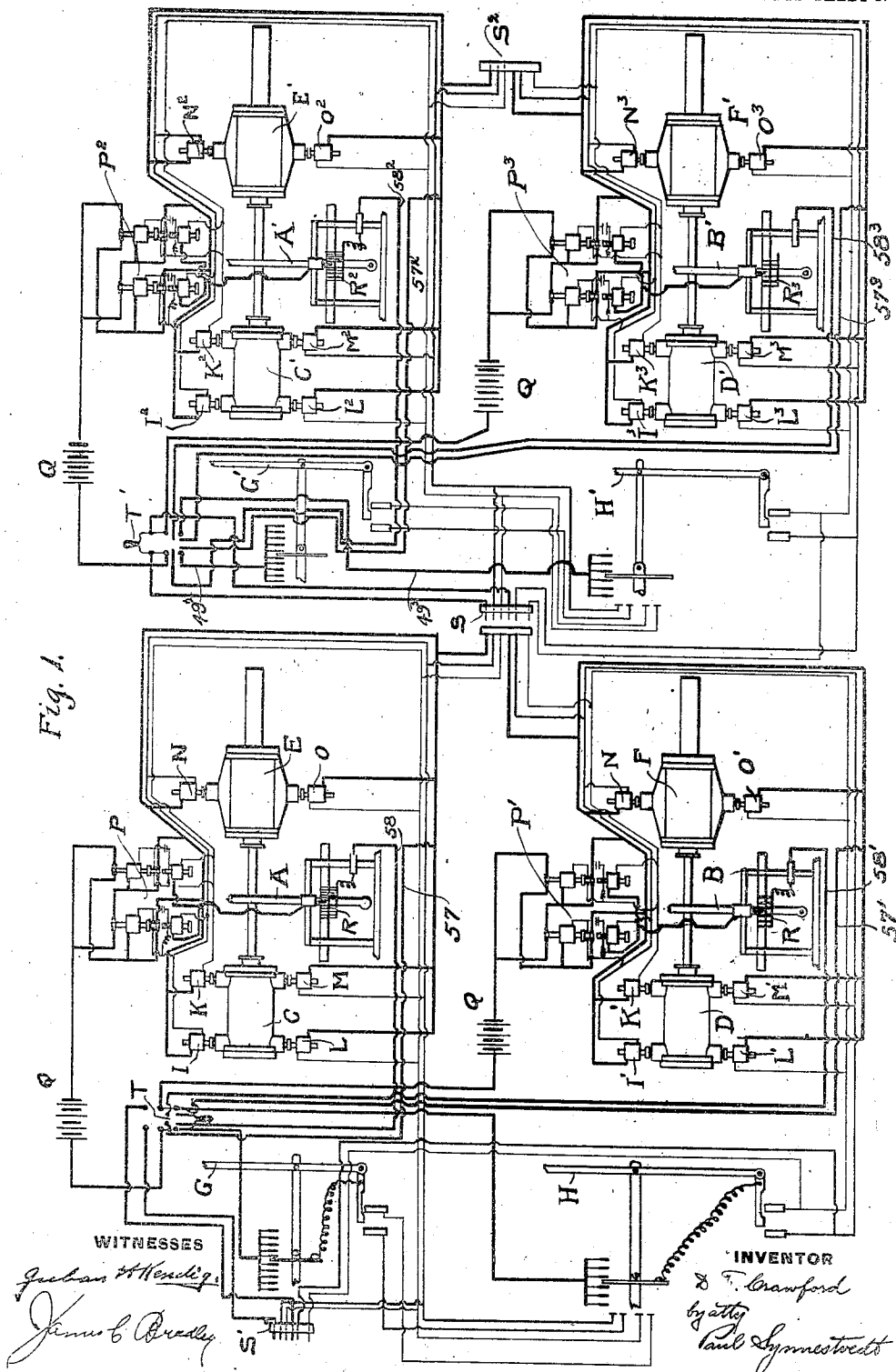


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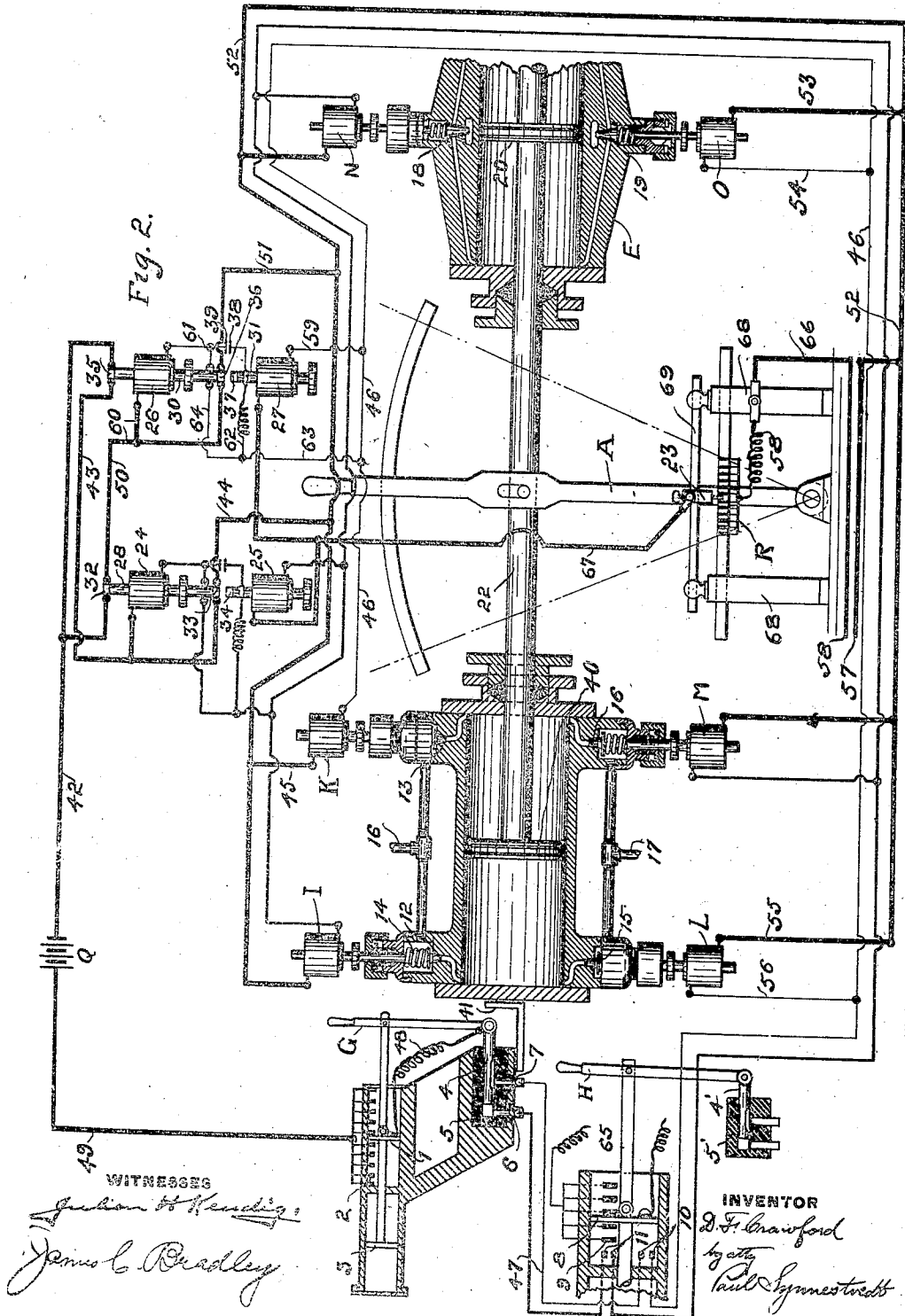


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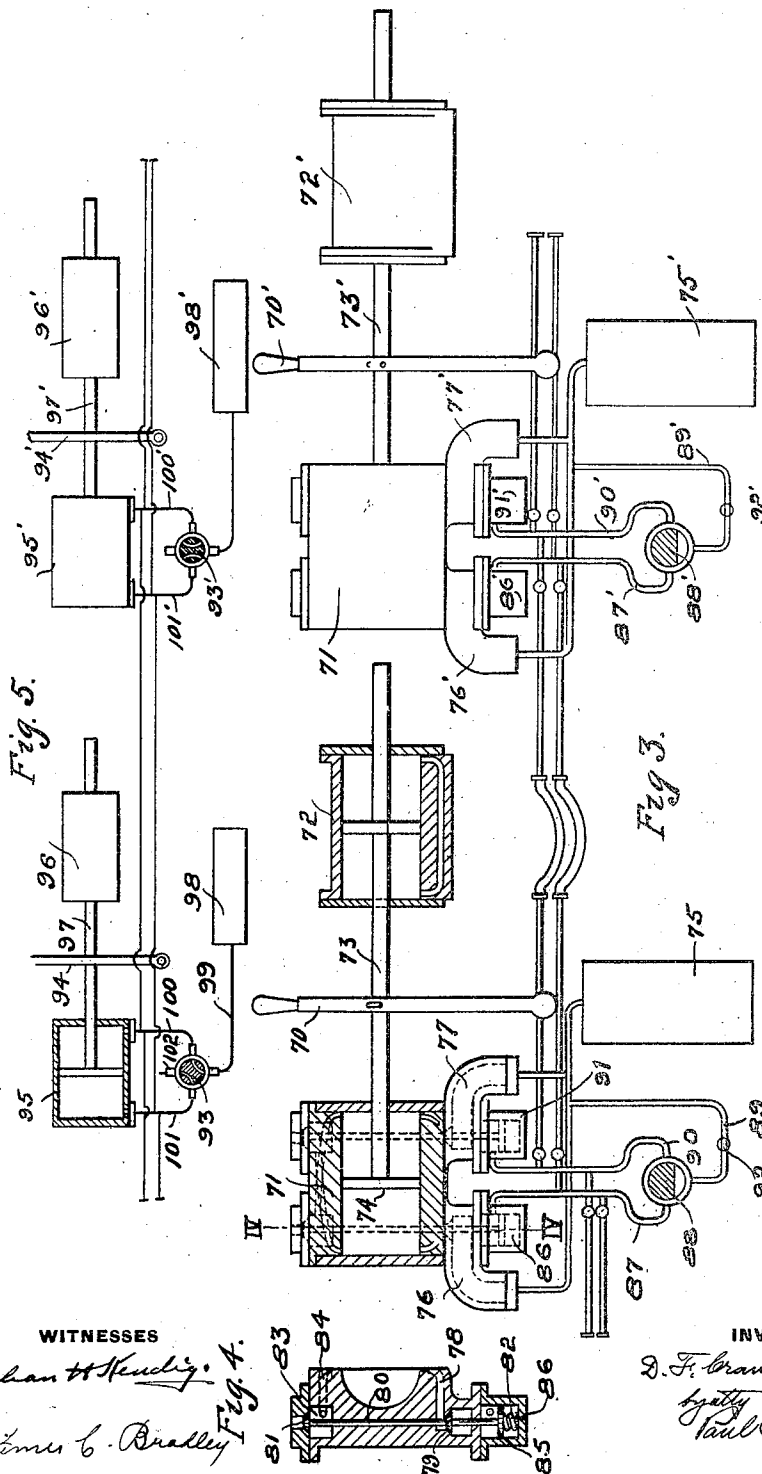


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3 SHEETS-SHEET 3.



WITNESSES

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MULTIPLE-CONTROL MECHANISM FOR STEAM-LOCOMOTIVES.

1,057,941.

Specification of Letters Patent.

Patented Apr. 1, 1913.

Application filed July 6, 1910. Serial No. 570,673.

To all whom it may concern:

Be it known that I, DAVID F. CRAWFORD, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Multiple-Control Mechanisms for Steam-Locomotives, of which the following is a specification.

The invention relates to mechanism for controlling the operation of a plurality of steam engines, particularly locomotives, from a single point, so that the number of operators may be reduced and the operation of the engines synchronized. The invention has its primary application to use with two or more locomotives operated in tandem, and, as so applied, the system contemplates the control of both throttle levers from a single controlling element or handle on one of the locomotives, and similarly the control of both reversing levers from another element or handle preferably adjacent the first, so that the operator by shifting these two elements or handles can control the operation of both throttle levers and valves, and both reversing levers and the valves controlled thereby. One embodiment of the invention is illustrated in the accompanying drawing wherein,

Figure 1 is a diagrammatic view of the apparatus and wiring connections therefor, Fig. 2 is an enlarged diagrammatic view of one portion of the apparatus, Fig. 3 is a diagrammatic view of a modified form of apparatus in which the electrical control is dispensed with, Fig. 4 is a section on the line IV—IV of Fig. 3, and Fig. 5 is a diagrammatic view illustrating still another form of apparatus.

Briefly stated the apparatus comprises in the first embodiment of the invention illustrated, an air operated power mechanism on each locomotive connected to the throttle lever; a switch lever and electrical controlling means operated therefrom whereby the operation of both power mechanisms is controlled from one of the locomotives; an air operated power mechanism on each locomotive connected to the reversing lever, and another switch and electrical controlling means operated therefrom whereby the operation of both such last power mechanisms is also controlled from the one locomotive, the two switches being placed conveniently close together so that the engineer

by merely throwing these two switches can secure the synchronous operation of both throttle levers and both reversing levers. The switches are preferably arranged to move over a series of contacts, and for each step of the movement of a switch the power mechanisms move the throttle or reverse levers a corresponding step. The controlling connections for the throttle levers and reverse levers are so arranged that the switch controlling the throttle levers must be thrown to position to cut off the supply of steam before the reverse levers can be operated from their switch. Each air operated power mechanism is also preferably controlled by a throttling cylinder and piston which serve to maintain the air operated mechanism fixedly in any position to which it may be moved.

Referring first to the general arrangement of parts as indicated diagrammatically in Fig. 1, the principal parts shown may be enumerated as follows:—A is the reversing lever on the forward locomotive; B is the throttle lever on the forward locomotive; A' is the reversing lever on the rear locomotive; B' is the throttle lever on the rear locomotive; C and D are the air cylinders constituting the power means from which the levers A and B are operated respectively; C' and D' are the air cylinders from which the levers A' and B' respectively upon the rear locomotive are operated; E and F are throttling cylinders whose pistons are carried by the same piston rods as those carrying the pistons of the air cylinders C and D, which throttling mechanism serves to maintain the levers A and B fixedly in any position to which they may be moved, in a manner to be hereinafter more particularly described; E' and F' are throttling cylinders upon the rear locomotive corresponding to the throttling cylinders E and F upon the front locomotive and corresponding thereto in function; G and H are switch levers upon the front locomotive arranged to control respectively the operation of the air cylinders C and D and the reversing and throttling levers controlled thereby; G' and H' are similar levers for controlling corresponding parts on the rear locomotive; I and K are solenoids electrically controlled from the switch G for governing the admission of air to the opposite ends of the cylinder C; L and M are similar solenoids controlled from the switch G for governing the exhaust of

air from the opposite ends of the cylinders C; N and O are solenoids also controlled from the switch G for governing the flow of liquid from one side to the other of the piston in the throttling cylinder E; P is what may be termed a relay system for assisting in the automatic control of the solenoids I, K, L, M, N and O in a manner to be hereinafter described; I', K', L', M', N', O', and P' are parts controlled from the switch lever H and corresponding to the parts just above described for operating in conjunction with the lever G; I², K², L², M², N², O² and P² are means controlled from the switch lever G' upon the rear locomotive and corresponding to the parts heretofore enumerated as controlled from the lever G upon the front locomotive; I³, K³, L³, M³, N³, O³ and P³ are controlling means governed by the switch lever H' upon the rear locomotive and to the parts as above enumerated for the front locomotive as controlled by the lever H; Q, Q, Q, Q are batteries for supplying current for operating the electrical mechanism; R, R', R² and R³ are switches controlled by the movement of the reversing levers A, A' and throttling levers B, B'; S is a plug connection whereby the leads from the rear locomotive may be detachably connected to those of the front locomotive; S' and S² are similar plug connections upon the front and rear locomotive respectively whereby the leads from these locomotives may be connected to the leads of other locomotives in case the position of the locomotives is reversed or in case more than two locomotives are used in tandem; T and T' represent knife switches upon the front and rear locomotives respectively, which switches are varied in position depending upon which locomotive is in front position and which is in rear position. In the wiring diagrams the heavy lines indicate positive outgoing circuits, the light lines indicate one of the return circuits, and the medium weight lines indicate the other return circuit.

A comparison of the sets of mechanism as shown in Fig. 1 will indicate that the arrangement of mechanism upon the front locomotive is precisely the same as that upon the rear locomotive, the intention being that the position of the locomotives may be reversed if desired, and that the mechanism and circuits for controlling the reversing levers is precisely the same as that for controlling the throttling levers. A study of one of these sets of mechanism will therefore serve to make clear the construction and operation of all of the sets, and such construction of one of the sets of mechanism will now be discussed in connection with Fig. 2 which shows in enlarged diagrammatic form, partly in section, the arrangement of the mechanism for controlling the reversing lever upon the front locomotive.

In order to avoid confusion, the switch T, shown in Fig. 1, is omitted from Fig. 2, as well as certain of the wiring connections leading to the other sets of mechanisms, the function of the switch and the arrangement of the connections (not shown) being subsequently reviewed in connection with Fig. 1. The principal parts as shown in Fig. 2 and not hitherto enumerated in connection with Fig. 1, may be enumerated as follows; 1 is a sliding switch member in the form of a piston connected to the handle G and operating over the contacts 2; 3 is the piston of a dash pot construction fitting its cylinder so as to permit a flow of air from one side of the piston to the other when it is moved in either direction; 4 is a contact member connected to the switch G and mounted in an insulated block 5 which also carries the contact members 6 and 7; 8 is the sliding switch for controlling the throttling lever, which switch is in the form of a piston working over the contacts 9 and connected to the handle H; 10 and 11 are pairs of contact plates which are connected when the piston 8 is moved to its extreme left hand position; 12 and 13 are air admission valves carried by the solenoid rods and held in their lower position by means of the springs 14; 15 and 16 are the exhaust valves operated from the solenoid L and M and normally held in closed position by means of the springs shown; 16' and 17 are the air inlet and exhaust pipes respectively; 18 and 19 are the valves for controlling the flow of liquid, preferably oil, from one side of the throttling piston 20 to the other, such valves being operated from the solenoids N and O; A is the reversing lever carrying at its lower end, by means of a pin and slot connection shown, the contact switch R, which is slidably mounted on the standards 68; 23 is a contact brush, adjustably mounted on the stationary bar 69, and which slidably engages the contact points of the switch R; 24, 25, 26 and 27 are solenoids provided with the metal rods 28, 29, 30 and 31, which rods are provided with an insulating covering except at the contact points marked 32, 33, 34, 35, 36 and 37; 38 is a contact plate carried by the rod 31 and adapted to contact with the plate 39 when the rod 31 moves upward; and the black circles arranged along the line of movement of the contact 32, 33, 34, 35, 36 and 37 and constituting the terminals of the wires indicated are contact members with which the said contacts on the rods engage when such contact come opposite such contact member.

The apparatus just described will best be understood from a description of the operation involved in moving the reversing lever A one step in either direction. Assuming that it is desired to move the reversing lever one step to the left, such movement

will require that the lever G be moved to the left so that the contact member 1 bears upon the next contact 2, which movement will secure an opening of the valve 13 to admit air to the right hand side of the piston 40, the corresponding and simultaneous opening of the valves 15 and 19 to permit an exhaust of air from the left hand side of the piston 40 and a movement of oil in the throttling cylinder E from the left hand end of the cylinder to the right hand end thereof, the automatic closing of the valve 13 when the piston 40 and reversing lever A have been moved a fraction of their total movement to the left, and the closing of the valve 19 to positively stop the movement of the piston rod 22 and holding the lever A fixedly in the position to which it has been moved. Before the lever G is moved however, in order to secure the above operations, it is necessary to move the handle H, which controls the throttle lever to its extreme left hand position in order that the piston 8 contact with the pairs of points 10 and 11 and connect such points, as the circuit which is controlled by the operation of the lever G would otherwise be broken at this point. In other words this arrangement requires that the throttle valve be moved to closed position in every case before the operation of the reversing lever, which requirement renders the operation of the reversing lever easy and safe. If now the upper end of the handle G is moved to the left, the member 1 will not at first move because of the air resistance to the front of the plunger 3, and because of the resistance at this point the lower end of the lever G will first move over against the plate 41, so that the left hand end of the rod 4 comes in contact with the end of the member 7. A further movement of the upper end of the lever G will then cause the member 1 to contact with the member 2, thus completing the circuit at this point. Commencing with the battery Q the circuit thus completed will be as follows; wire 42, contact 35, wire 43, contact 33, wire 44, wire 45, winding of solenoid K, wire 46, contact 10, piston 8, contact 10, wire 47, contact members 7 and 4, wire 48, piston 1, contact 2, and wire 49, thus completing the circuit. At the same time the solenoid O is energized from the following circuit, wire 42, contact 32, wire 50, contact 36, wire 51, wire 52, wire 53, winding of solenoid O, wire 54, and wire 46. The solenoid L is also energized by means of its connections 55 and 56 to the wires 52 and 46 respectively. The operation of the solenoids K, O and L permits the admission of air to the right hand side of the piston 40, the exhaust of air from the left hand side of such cylinder, and the passage of oil from one side of the piston 20 to the other side thereof. It will also be

seen that the circuits just described include the outgoing circuits represented by the heavy black lines and the return circuit indicated by the very light lines, but that the other return circuit indicated by the lines of intermediate heaviness is not completed for the reason that the contact members 4 and 6 are not in engagement so that the winding of the solenoids I, M and N which are on such other uncompleted circuit are not energized. As the lever A continues to move to the left, a contact member of the said switch R, to the right of the contact brush 23, engages the said brush. This movement completes the following circuit, wire 52, wire 57, switch T (not shown on Fig. 2 but indicated diagrammatically on Fig. 1), wire 58, wire 66, switch R, contact member or brush 23, wire 67, winding of solenoid 27, wire 59, and wire 46, thus energizing the solenoid 27 and causing its rod 31 to move upward, and causing the connections of the contact members 38 and 39. This secures the energization of the solenoid 26, the current flowing thereto through the wire 60 and therefrom to the wire 46, by the wire 61, contact members 39 and 38, wire 62, and wire 63. This causes the bar 30 to move upward so that circuit at the contact 35 is broken and the contact 36 is shifted, the contact 37 taking its place. One circuit leading to the solenoid K is thus broken, but another circuit including the contact 32, wire 50, contact 37, wire 51, and wire 45 continues. The circuits through the winding of the solenoids O and L also continue. These latter circuits are broken however when the contact member of the switch R moves so that a blank space engages the brush 23, thus interrupting the circuit through the wire 67. The bar of the solenoid 27 is thus permitted to drop breaking the circuit between the wires 50 and 51 so that the valves 15 and 19 controlled by the solenoids L and O are permitted to close. This downward movement of the bar 31 breaks the contact between the members 38 and 39, but the current still flows through the winding of the solenoid 26 by reason of the circuit through the wires 60, 61, contact 36, wire 64, and wire 63. The bar 30 therefore remains in its upper position until the piston 1 controlled by the lever G is moved off of a contact plate and on to a blank space, at which time the circuit through the winding of the solenoid 26 is broken so that the bar 30 moves to its original position as shown in Fig. 2, and the contact 35 completes the circuit between the wires 42 and 43. The parts are now all in their original position, and a further movement of the lever G one step to the left secures another movement of the piston 40 and the lever A controlled thereby another step to the left.

When it is desired to move the reversing

lever in the other direction, the handle G is moved to the right, and the contact member 4 is first moved to the left engaging the contact member B, and the piston 1 is then moved to the right engaging one of the contact plates 2. By this operation the circuit including the fine line return is broken and the circuit including the return circuit represented by the lines of intermediate weight is completed. This circuit operates the solenoids I, M and N, and the circuit and operation will be obvious from the description hitherto given of the operation of the solenoids K, L and O.

The foregoing description relates to the mechanism for operating one of the reversing levers A, but by reference to Fig. 1 it will be seen that the mechanism for operating the throttling levers B and B' is precisely the same, the control of the operation being secured from the handles H and H', the handle H being connected to the piston 8 moving over a series of contacts 9 as indicated in Fig. 2. The operating handle H is provided with a contact member 4' working over contact members 6' and 7' and corresponding in construction and function to the members 4', 6' and 7' heretofore described.

It will be seen from the foregoing that the relay mechanisms P and P' and the controlling levers G and H with their switches are necessary only on the leading locomotives, as all that is necessary insofar as the succeeding locomotives are concerned is that the current through the solenoids I², K², L², M², N², O², and I³, K³, L³, M³, N³, O³ be made and broken to correspond with the making and breaking of the circuits on the leading locomotives, but in view of the fact that the locomotives may be reversed in position it is desirable that the rear locomotive be provided with precisely the same controlling mechanism as the forward locomotive so that it may be placed in front if so desired, and as shown in Fig. 1 the front and rear locomotives are shown as provided with precisely the same equipment so that they may be shifted in position. It is desirable however that means be provided so that the relays P² and P³ and the mechanism operated by the controlling handles G' and H' may be entirely cut out of operation, and in order to do this the knife switch T' is provided, which switch is duplicated in the front apparatus in the switch T. It will be seen that when the switch T' is in the position illustrated the wires 57² and 58² and the wires 57³ and 58³ are disconnected thus cutting out the operation of the relays P² and P³, and that the circuit leading through the switches controlled by the handles G' and H' and including the wires 49² and 49³ are disconnected so that these switches are cut out of operation and there

is no possibility of the operator on the rear locomotive interfering with the operation from the front locomotive by manipulating the levers G' and H'. The switch T on the front locomotive is shown in the reverse position, and in this position the wires 57 and 58 and 57' and 58' are connected and the switches controlled by the levers G and H are thrown into operative connection with the pistons.

The construction as shown in Fig. 3 is a simplified one, the apparatus being operated entirely by air and the electrical mechanism being dispensed with. The arrangement is shown as applied only to the operation of the reversing levers 70 and 70' on the front and rear locomotives respectively, but it will be understood that the arrangement for operating the throttle levers is substantially the same as that indicated for the reversing levers. As in the former arrangement the levers 70 and 70' are operated by means of air cylinders 71 and 71', and the levers are steadied and maintained in position by means of throttling cylinders 72 and 72', which cylinders carry pistons mounted upon the connecting rods 73 and 73' carrying at their front ends the pistons 74. 75 and 75' are air reservoirs from which air for operating the pistons is supplied to the chambers 76, 77, 76' and 77', the construction of the ports and valve mechanism upon the rear locomotive being precisely the same as that upon the front locomotive. As indicated in Fig. 4 the left hand end of the cylinder is provided with an admission port 78 governed by a valve 79 carried on the rod 80 which rod also carries the exhaust valve 81, and these valves 79 and 81 are normally held in closed position by means of the spring 82. The chamber 83 below the valve 81 connects with the right hand end of the cylinder 71 by means of the passage 84, and it will be seen from the arrangement just described that when the valve 79 is open permitting admission to the left hand side of the piston 74 the exhaust valve 81 which controls the passage of air from the right hand end of the cylinder is open, so that as air is admitted to one side of the piston 74 it is permitted to exhaust from the other side. The operation of the valves 79 and 81 is controlled from the piston 85 mounted in the cylinder 86, which cylinder is provided with an air pipe 87 leading to the valve 88. The valve is supplied with air from the reservoir 75 by means of the pipe 89, and when the valve is rotated clock wise a short distance the pipe 89 is brought into communication with the pipe 87 admitting air to the upper side of the piston 85 and securing the opening of the valves 79 and 81. The arrangement of valves and passages at the right hand end of the cylinder 71 is pre-

cisely the same as that just described for the left hand end, so that when the valve 88 is shifted in the other direction the pipe 89 is brought into communication with the pipe 90 leading to the cylinder 91. The pipes 87 and 90 are connected respectively to the pipes 87' and 90' leading to the cylinders 86' and 91', so that when air is admitted to either of the cylinders 86 and 91 it is also admitted to one of the cylinders 86' or 91' and the actuation of the valve parts and pistons in the cylinder 71' corresponds to that in the cylinder 71. The valves 92 and 92' serve as a means to cut out the valves 88 or 88' depending upon which locomotive is in advance, so that the danger of a different operation at these valves is avoided, the valve 92' on the rear locomotive being closed to prevent the actuation of the parts controlling the reversing lever 70' independent of the operation of such parts from the front locomotive.

In Fig. 5 still another arrangement of parts is shown, and the four way valves 93 and 93' are substituted for the valve mechanism shown in the arrangement of Figs. 3 and 4. In this construction 94 and 94' are the reversing levers, 95 and 95' are the operating cylinders, 96 and 96' are the throttling cylinders, 97 and 97' are the piston rods, and 98 and 98' are the air reservoirs. When the valve 93 is in the position shown, air is admitted from the reservoir 98 to the front end of the cylinder 95 through the pipes 99 and 100 and is exhausted from the other end of the cylinder through the pipes 101 and 102. If the valve is shifted 90° the operation is reversed, and air is admitted to the left hand end of the cylinder through the pipes 99 and 101 and exhausted from the right hand end of the cylinder through the pipes 100 and 102. The pipes 100' and 101' respectively are connected to the pipes 100 and 101, so that the actuation of the valve 93 secures the operation of the piston in the cylinder 95', all of the air in such case exhausting through the pipe 102. If desired the valve 93' may be locked in the position illustrated so as to prevent the possibility of the operation of the system from this point.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is the following:—

1. In mechanism for controlling the operation of a plurality of engines each provided with a throttling device, a power means for operating each of said throttling devices, and a controlling means having connection with each of said power means and including a manually operable member and arranged to secure a simultaneous actuation of all of the power means and the

throttling devices operated thereby proportional to the movement of the manually operable member.

2. In mechanism for controlling the operation of a plurality of engines each provided with a throttling device, a power means for operating each of said throttling devices, a controlling means having connection with each of said power means and including a manually operable member and arranged to secure a simultaneous step by step actuation of all of the power means and the throttling devices operated thereby proportionate to the movement of the manually operable member, and stop means also operated from the said controlling means and arranged to hold the throttling devices fixedly in any position to which they may be moved.

3. In mechanism for controlling the operation of a plurality of engines each provided with a means for reversing the valves of the engine, a power means for operating each of said reversing means, and a controlling means having connection with each of said power means and including a manually operable member and arranged to secure the simultaneous actuation of all of the power means and the reversing means operated thereby proportionate to the movement of the manually operable member.

4. In mechanism for controlling the operation of a plurality of engines each provided with a means for reversing the valves of the engine, a power means for operating each of said reversing means, a controlling means having connection with each of said power means and including a manually operable member and arranged to secure a simultaneous step by step actuation of all of the power means proportionate to the movement of the manually operable member, and stop means also operated from the said controlling means and arranged to hold the reversing means fixedly in any position to which they may be moved.

5. In mechanism for controlling the operation of a plurality of engines each provided with a throttling device and a reversing device, a power means for operating each of said devices, a controlling means having connection with each of the power means for operating the throttling devices, and arranged to secure the simultaneous actuation of all of such power means, and a controlling means having connection with each of the power means for operating the reversing devices and arranged to secure the simultaneous actuation of all of such reversing means and a switch connection between the controlling means for operating the power means for operating the throttling devices and the controlling means for operating power means for operating the

reversing devices, whereby the throttling devices must be thrown to closed position before the reversing devices can be moved.

6. In mechanism for controlling the operation of a plurality of engines each provided with a throttle valve, mechanism for each engine for controlling the throttle valve comprising a cylinder provided with a piston connected to the throttle valve, means for supplying air under pressure to the cylinder to move the piston valve mechanism for controlling the flow of air to the cylinder, a second piston and a cylinder therefor carrying a liquid, a communication between the two sides of the piston, a valve mechanism for controlling the flow of liquid through the said communication, and means for connecting the two pistons, and a single manually operable means having operative connection to all the said valve mechanisms whereby such mechanisms may be simultaneously operated.

7. In mechanism for controlling the operation of a plurality of engines each provided with a reversing member, mechanism for each engine for controlling the reversing member comprising a cylinder provided with a piston connected to the reversing member, means for supplying air under pressure to the cylinder to move the piston valve mechanism for controlling the flow of air to the cylinder, a second piston and a cylinder therefor carrying a liquid, a communication between the two sides of the piston, a valve mechanism for controlling the flow of liquid through the said communication, and means for connecting the two pistons, and a single manually operable means having operative connection to all the said valve mechanisms whereby such mechanisms may be simultaneously operated.

8. In mechanism for controlling the operation

of a plurality of engines, each provided with a controlling member, mechanism for each engine for controlling the said member comprising a cylinder provided with a piston connected to the said member, means for supplying air under pressure to the cylinder to move the piston, air valve mechanism for controlling the flow of air, a cylinder carrying a piston connected to the first mentioned piston, a throttling passage connecting the opposite sides of the piston, a valve controlling such passage, and a single means having operative connection to all the said valves whereby such valves may be simultaneously operated.

9. In mechanism for controlling the operation of a plurality of engines each provided with a throttling device, a power means for operating each of said devices, a controlling means for each power means including a manually operable member each arranged to control all of the power means simultaneously, and means whereby any one of such controlling means may be cut out of operative connection with the system.

10. In mechanism for controlling the operation of a plurality of engines each provided with a reversing device, a power means for operating each of said devices, a controlling means for each power means including a manually operable member each arranged to control all of the power means simultaneously, and means whereby any one of such controlling means may be cut out of operative connection with the system.

In testimony whereof I have hereunto signed my name in the presence of the two subscribed witnesses.

DAVID FRANCIS CRAWFORD.

Witnesses:

L. A. MYERS,
I. M. BLAINE.