No. 812,825. PATENTED FEB. 20, 1906.

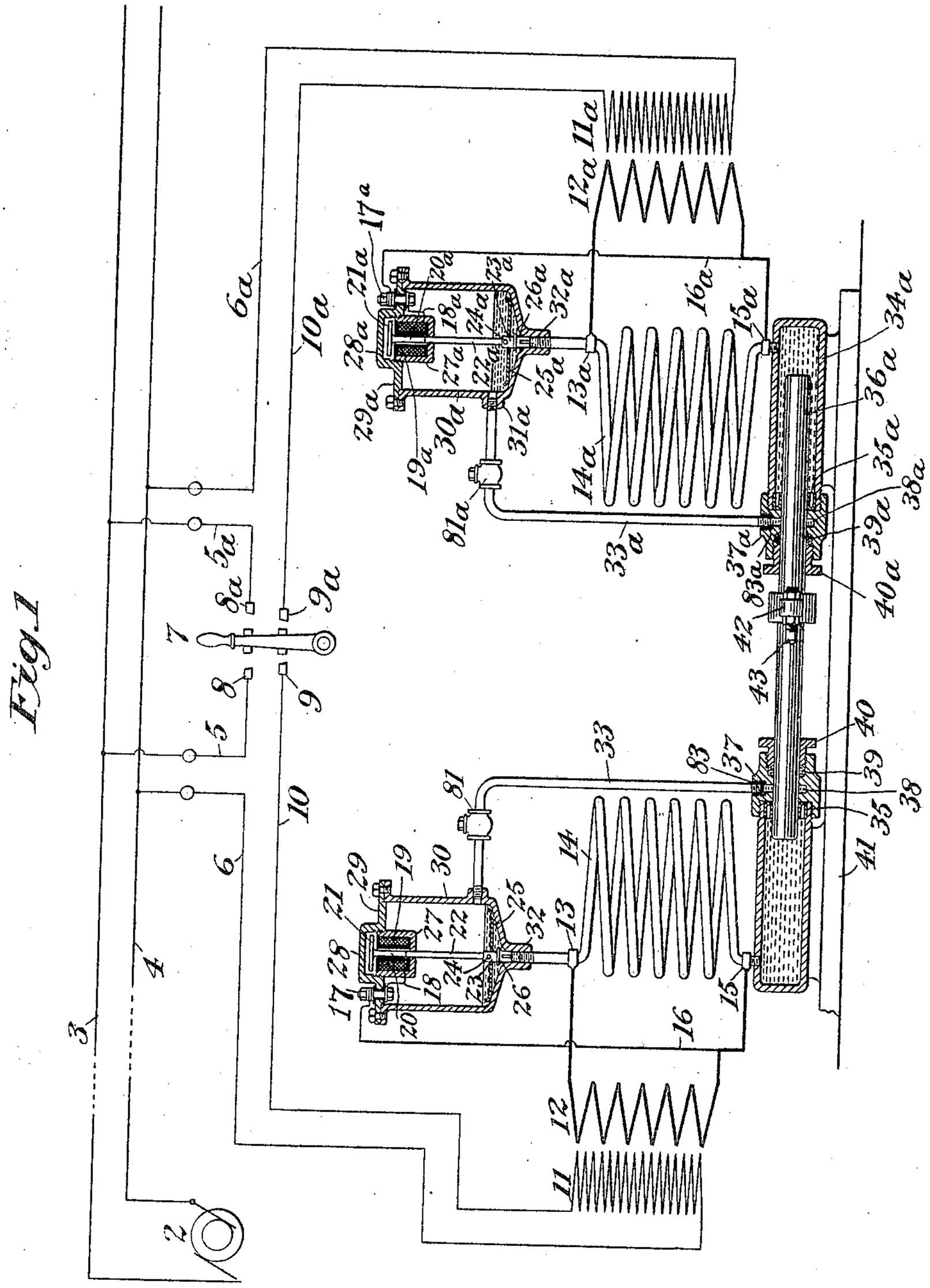
C. J. COLEMAN.

RAILWAY SWITCH OPERATING APPARATUS.

APPLICATION FILED FEB. 4, 1905.

2 SHEETS—SHEET 1.

Fig. 1



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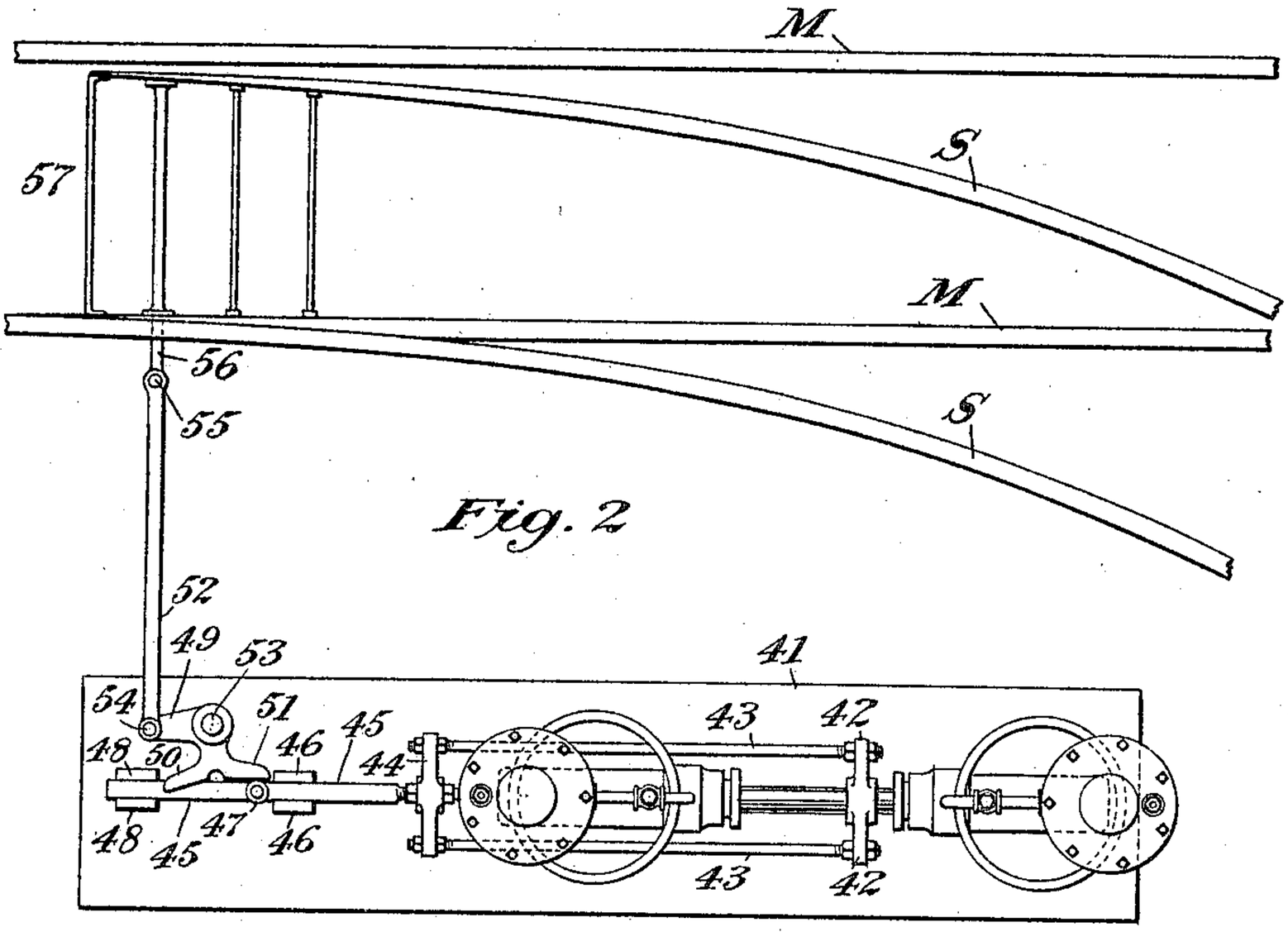

Fig. 2

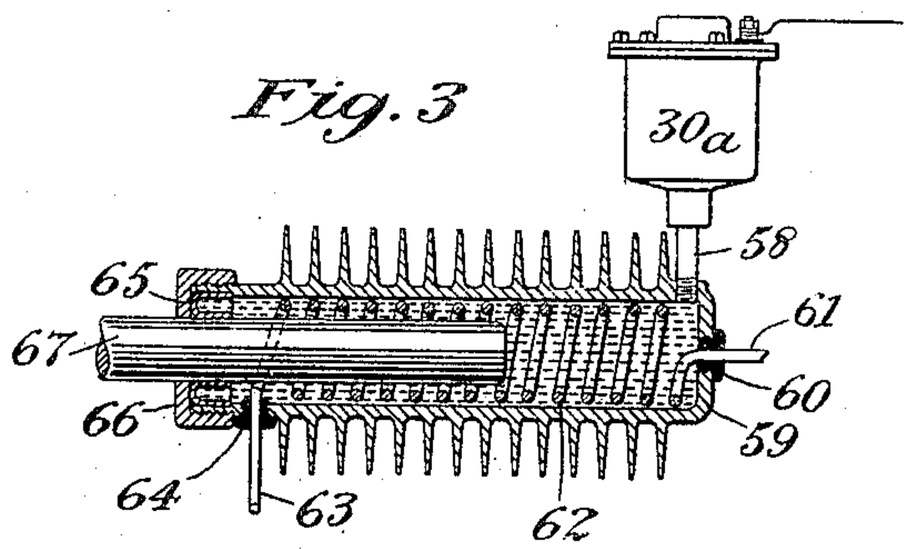

Fig. 3

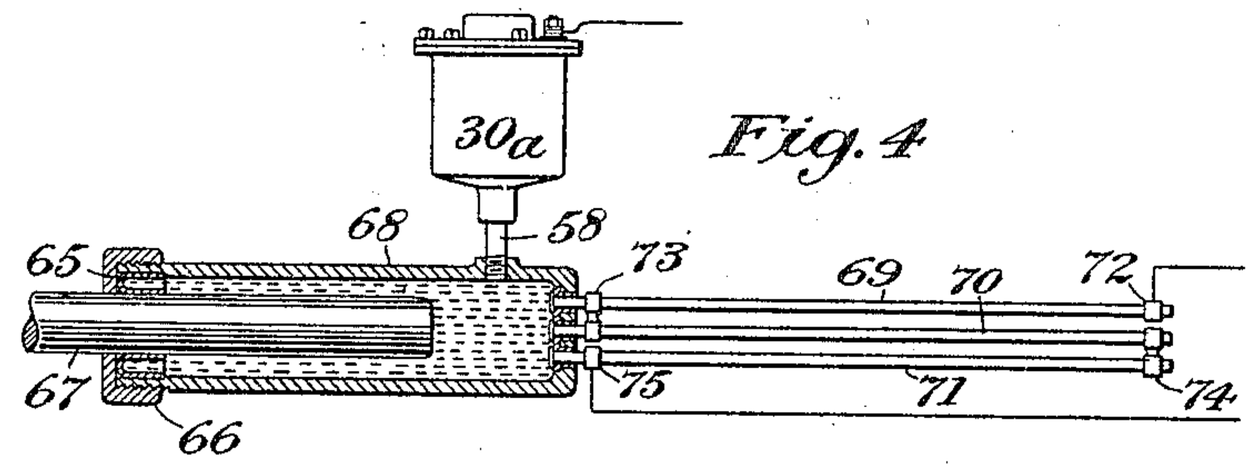

Fig. 4

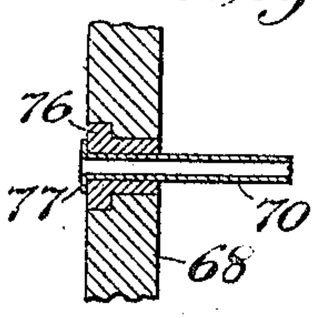

Fig. 5

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UNITED STATES PATENT OFFICE

CLYDE J. COLEMAN, OF ROCKAWAY, NEW JERSEY, ASSIGNOR OF ONE-HALF TO SIDNEY ARONSTEIN, OF NEW YORK, N. Y.

RAILWAY-SWITCH-OPERATING APPARATUS.

No. 812,825. Specification of Letters Patent. Patented Feb. 20, 1906.

Application filed February 4, 1905. Serial No. 244,225.

To all whom it may concern:

Be it known that I, CLYDE J. COLEMAN, a citizen of the United States, residing at Rockaway, in the county of Morris and State of New Jersey, have invented certain new and useful Improvements in Railway-Switch-Operating Apparatus, of which the following is a specification, reference being had therein to the accompanying drawings, forming a part thereof.

My invention relates to railway-switch-operating apparatus and systems generally; and those embodiments of my invention which are illustrated in the accompanying drawings and particularly described hereinafter relate to apparatus and systems for operating railway-switches at a distance from the controlling operator or from the point of control.

Broadly stated, several objects of my invention are reliability of operation to insure safety and non-interruption of railway traffic, economy, simplicity, and compactness of construction, and economy and simplicity of maintenance.

My invention comprises various features and various further objects, some of which are subservient to the broad ends named above, but capable of more definite expression, and I will at this point enumerate several, but not all, of such features and further objects.

One object of my invention is to operate or control a railway-track switch located at a point distant from the operator or point of control.

Another object of my invention is to utilize electrical energy for the actuation or control of railway-track switches, this form of energy being best adapted for transmission from a source of operating energy to a distant track-switch or switch-actuating mechanism or apparatus; and it is also an object of my invention to convert such electrical energy or power into mechanical energy or power characterized by relatively great mechanical force capable of moving a track-switch quickly and with certainty of operation against impeding ice, snow, or other obstruction, and it is an object to attain this relatively great mechanical force with simple and compact mechanism and preferably with little or no force-multiplying gear mechanism or leverage.

Another object of my invention is to combine in one electrical circuit the function of a power-transmiting circuit to convey electrical power to a switch-operating apparatus and the function of an electric controlling-circuit to control the actuation of a track-switch by such a switch-operating apparatus.

My invention broadly comprehends caloric motive apparatus adapted to convert or transmute caloric energy into motive or mechanical energy and arranged to actuate a railway-track switch and in combination therewith an electrocaloric-energy-transmuting apparatus arranged to receive electrical energy from any suitable source and adapted to convert such electrical energy into caloric energy and to deliver the caloric energy to the caloric motive apparatus to cause the same to operate.

My invention also broadly comprehends the combination of a railway-track switch, an electrocaloric motive apparatus such as mentioned above in actuative coöperation with the switch, and an electric circuit arranged both to supply electrical energy to the electrocaloric motive apparatus and to control the operation of such apparatus which actuates the track-switch.

My invention also broadly comprehends fluid-pressure motive apparatus arranged to actuate a track-switch by motive expansion of its motive fluid or by an increase or other variation in pressure of such motive fluid and containing a motive fluid adapted to permit passage of electricity through it—for instance, by conductance as in one of the illustrated embodiments of my invention—and subject to expansion or increase or other variation in pressure by such passage of electricity—for instance, when the motive fluid is a liquid subject to expansion by conversion into gaseous form either by caloric volatilization or by other action. This fluid-pressure switch-actuating motive apparatus is combined with any suitable source of electrical energy or means for passing electricity through its motive fluid to effect therein the changes of volume or pressure necessary to actuate the track-switch, and in one of the illustrated embodiments of my invention this source of electrical energy is an electric circuit which not only supplies electricity to

control or vary the volume or pressure of the motive fluid, but also by such control of fluid volume or pressure governs or controls actuation of the track-switch by the motive apparatus.

My invention also broadly comprises electrocaloric fluid-pressure motive apparatus arranged to actuate a track-switch and including an electrical conductor provided with a receiving-space for motive fluid of the motive apparatus and adapted to be heated by conductive passage of an electric circuit and to transmit the heat thus generated to the motive fluid, so as to heat the same and effect a motive expansion or pressure variation therein. As one of the illustrated embodiments of such a heating-conductor my invention broadly comprises a tubular conductor arranged to receive in its tubular bore the motive fluid of the motive apparatus, and in one of the illustrated instances the tubular conductor is helical in form.

My invention further comprehends, broadly, the combination of the electrocaloric fluid-pressure switch-actuating motive apparatus defined above with cooling means for absorbing or dissipating the caloric energy of the motive fluid of the apparatus to permit or assist the condensation or contraction thereof after its motive expansion, and my invention broadly comprises an arrangement of such cooling means and the electrocaloric heating means whereby the motive fluid is alternately heated and cooled, and one illustrated embodiment of these features of my invention consists in a tubular heating-conductor helical in some instances and adapted to heat the motive fluid by the caloric energy of electrical resistance during passage of current through the conductor and also adapted to absorb and radiate or otherwise dissipate the heat of the motive fluid during cessation of current in such heating-conductor.

My invention also broadly comprehends electrocaloric fluid-pressure motive apparatus in actuative coöperation with a railway-track switch and comprising electrocaloric-energy-transmuting means arranged to supply caloric energy to the motive fluid of the apparatus, and also comprising a motive expansion-chamber operatable by a motive expansion or pressure variation in the motive fluid of the motive apparatus and consisting of a cylinder or other chamber variable in its fluid-containing volume or capacity either by movement of a fluid-displacing piston or by any suitable construction permitting the motive chamber to actuate the track-switch by the motive expansion or pressure variation of the motive fluid and a controllable relief-passage leading from the motive chamber and means for maintaining the relief-passage closed during the motive expansion of the motive chamber; and my invention also broadly comprehends as one of the illustrated embodiments of the foregoing feature an electrically-controllable relief-passage arranged to be maintained in closed condition by electrical energy from the same source which is employed to supply electricity to the electrocaloric-energy-transmuting apparatus.

My invention also comprehends various other features, too numerous, however, to be particularly mentioned in the foregoing enumeration, and these further features will clearly appear in the light of the following particular description of those embodiments of my invention which I have illustrated in the accompanying drawings.

In the accompanying drawings, Figure 1 is a partially-diagrammatic and partially-constructional view of a railway-switch-operating system and apparatus embodying my invention. It shows diagrammatically the electrical circuits which are employed to supply working and controlling energy to the motive apparatus which moves the track-switch and shows a longitudinal elevation, partially in middle section, of an electrocaloric fluid-pressure type of such motive apparatus. Fig. 2 is a plan view of the electrocaloric fluid-pressure motive apparatus shown in Fig. 1, together with a track-switch and a mechanism for transmitting power from the switch-actuating motive apparatus to the switch. Fig. 3 is a longitudinal elevation showing in middle section a fluid-pressure motive expansion-chamber different from those of Fig. 1 and provided with a different form of electrocaloric fluid-heating means and a different arrangement of the relief-passage, these features constituting other embodiments of my invention. Fig. 4 is a longitudinal elevation showing a motive expansion-chamber in middle section and showing in connection therewith still another form of electrocaloric fluid-heating means for supplying caloric energy to the motive fluid of the motive apparatus. Fig. 5 is an enlarged longitudinal middle sectional view of an end of one of the fluid-heating tubes of the construction of Fig. 4, together with one of the insulating-bushings employed to make insulated connections between such heating-tubes and the head of the motive chamber or cylinder with which the tubes have fluid communication.

In the system and apparatus of Figs. 1 and 2 the motive or mechanical power for operating the track-switch is developed in two opposed horizontal single-acting fluid-pressure motive cylinders 34 and 34^a, mounted in axial alinement upon a suitable base or bed-plate 41. Single-acting pistons 36 and 36^a coöperate with these motive cylinders, respectively. The pistons are preferably made integrally with each other to constitute a single solid rod, and the pistons enter the

ends of their respective motive cylinders through tight hydraulic packings 35 and 35ª, surrounding the pistons and abutting the inner faces of suitable cylinder-caps 37 and 37ª, which are screwed over the ends of the cylinders 34 and 34ª, respectively. The cylinder-caps are provided with annular leakage-fluid-receiving chambers or grooves 38 and 38ª, respectively, through which the pistons pass and which serve to collect the motive fluid which leaks through the hydraulic packings. The entrance of the pistons into the leakage-fluid-receiving grooves is made tight by suitable stuffing-boxes 39 and 39ª, respectively, closed by suitable glands 40 and 40ª, respectively, which surround the pistons and are screwed firmly into their respective stuffing-boxes.

The electroconductive fluid-heating tubes 14 and 14ª, respectively, are bent in helical form about vertical axes and at their lower ends have fluid communication with the motive cylinders 34 and 34ª, respectively, and near the head ends thereof. At their upper ends these heating-tubes are secured in the connecting-lugs 32 and 32ª of the receiving-reservoirs 30 and 30ª, and the heating-tubes communicate with such reservoirs through the bores of these connecting-lugs, which constitute relief-passages controlled by suitable conical relief-controlling valves 26 and 26ª, guided at their lower ends in the bores of the lugs 32 and 32ª and seating in conical counter-bores formed at the upper or inner ends of the bores of the lugs.

The valves close downwardly, but are normally maintained in their open positions by means of substantially flat springs 25 and 25ª, which span or bridge the hollow conical bottoms of the reservoirs and are slotted to receive flattened enlargements 23 and 23ª, formed upon the valve-stems 22 and 22ª, which latter are preferably also integral with the relief-controlling valves 26 and 26ª. The flat springs support the valves and their attached parts upon pins 24 and 24ª, passing transversely over the springs and transversely through the flattened enlargements of their respective valve-stems. The valves are closed in opposition to the resisting bending moments of the springs by the magnetic attraction of iron-clad electromagnets, consisting in electromagnetic relief-controlling coils or spools 19 and 19ª, contained within cup-shaped iron casings 27 and 27ª and at their upper ends screwed into central recesses 28 and 28ª, formed in the non-magnetic cover-plates 29 and 29ª, suitably secured upon the upper ends of the reservoirs, so as to close and seal the same hermetically. The attraction of the magnets is exerted upon disk-shaped iron armatures 21 and 21ª, located in the central recesses 28 and 28ª and just above the annular poles of the magnetic casings 27 and 27ª. These disk-shaped armatures are mounted upon central integral stems or grooves 20 and 20ª, passing downward through the axes of the electromagnetic coils and at their lower ends suitably connected with the upper ends of the valve-stems 22 and 22ª, which are made of non-magnetic material and which pass through central guide-holes in the lower ends of the cup-shaped magnetic casings 27 and 27ª. The lower ends of the magnetic cores 20 and 20ª terminate just above the bottoms of the magnetic casings, so that a downward magnetic pull is also exerted upon such lower ends of the valve-stems by the central magnetic poles of the magnetic casings. One terminal of each of the electromagnetic relief-controlling coils 19 and 19ª is grounded upon its magnetic casing, while the other terminal is connected by a suitable wire 18 or 18ª to an insulated binding post or bolt 17 or 17ª, mounted in the cover of its respective reservoir and connected with a wire 16 or 16ª, leading from one terminal of the secondary coil 12 or 12ª of one of the transformers.

Suitable tubes 33 and 33ª are secured in lateral hollow connection-lugs 31 and 31ª, formed upon the reservoirs near their lower ends, and these tubes connect the reservoirs with the leakage-fluid-receiving grooves or chambers 38 and 38ª of the respective motive cylinders. Check-valves 81 and 81ª are interposed in the connecting-tubes 33 and 33ª and open in the direction of passage from the leakage-fluid-receiving grooves or chambers toward their respective receiving-reservoirs 30 and 30ª, and the connecting-tubes 33 and 33ª are connected with their respective leakage-fluid-receiving grooves through suitable insulating-bushings 83 and 83ª in order that such connecting-tubes may not constitute an electrical short-circuit across the terminals of the heating-tubes 14 and 14ª, respectively.

The secondary coils 12 and 12ª of the two transformers have their opposite terminals connected with opposite ends of the heating-tubes 14 and 14ª by means of suitable connecting-collars, such as 13 15 and 13ª 15ª. The grounded terminals of the relief-controlling-magnet coils are connected through their respective reservoirs with the upper ends of the heating-tubes, and thence are of course connected with given terminals of the secondary coils of the transformers, while the opposite terminals of the relief-controlling-magnet coils are connected through their respective binding-posts 17 and 17ª and their respective connecting-wires 16 and 16ª with the opposite terminals of their respective secondary coils. Thereafter each secondary coil will deliver alternating current to its respective electroconductive heating-tube and to its respective relief-controlling-magnet coil in parallel with each other.

The primary coils 11 and 11ª of the respec-

tive transformers are fed with primary current from an alternating-current generator 2 and through transmission line-wires 3 and 4, and thence through respective local branches leading from the transmission line-wires and separately and alternately closed by the manually or otherwise operated controlling-switch 7, which in its opposite positions close the circuit branches, including the primary coils of the opposite transformers. The branch including the primary coil 11 is traceable from the transmission line-wire 3 through the conductor 5, switch-contact 8, switch-lever 7, switch-contact 9, conductor 10, primary coil 11, and conductor 6 of the transmission line-wire 4. The branch which includes the primary coil 11^a is similarly traceable from the transmission line-wire 3 through the conductor 5^a, switch-contact 8^a, switch-lever 7, switch-contact 9^a, conductor 10^a, primary coil 11^a, and conductor 6^a to the transmission line-wire 4.

The motive cylinders and their heating-tubes are filled with motive fluid, preferably a liquid motive fluid, and in this instance a conductive motive fluid, which, as will be hereinafter explained, has certain advantages over a non-conductive motive fluid. Mercury is the conductive motive fluid which I prefer to employ in this particular embodiment of my invention, and in the present instance the mercury or other motive fluid will not only fill the motive cylinders and their respective heating-coils, but will also occupy the reservoirs up to a liquid-level a little above their relief-controlling valves.

When it is desired to actuate or change the position of the railway-track switch 57—for instance, when it is desired to move the switch from its position indicated in Fig. 2, affording direct passage along the rails M of the main-line track to its opposite position, giving passage from the main-line track to the rails S of the siding—the controlling electric switch 7 will be moved into its right-hand position, making conductive contact with its coöperating switch-contacts 8^a and 9^a, whereupon current will flow from the alternating-current generator 2 along the transmission-line and through the primary coil 11^a of the right-hand transformer. Current in this primary coil 11^a immediately gives rise to secondary electromotive force in the complementary secondary coil 12^a of the transformer, which thereupon immediately transmits current to and through the relief-controlling magnet 19^a in control of the motive fluid of the right motive cylinder 34^a, so as to immediately close its relief-controlling valve 26^a and cut off communication between the fluid-reservoir 30^a and its coöperating heating-tube and motive cylinder 14^a and 34^a, respectively. Current also flows simultaneously from the secondary coil 12^a through the conductive heating-tube 14^a and through the mercury contained therein, so as to heat the mercury not only directly by the caloric energy developed or generated in overcoming the electrical resistance of the mercury itself, but also by transmission of heat to the mercury from the heating-tube, which is likewise heated by the caloric energy of electrical resistance. When thus heated, the mercury at first expands in liquid form and then further expands by volatilization or vaporation. Both of such expansions constitute a motive expansion of the motive fluid of the apparatus and force the motive piston 36^a forward, so as to move the opposite piston 36 farther into its motive cylinder 34, thereby displacing a quantity of the motive fluid in such motive cylinder and causing a rise of the fluid-level in the fluid-reservoir 30 which at the moment is in free communication with the motive cylinder 34 through its heating-tube 14 and the relief-controlling valve 26. The same movement of the piston 36^a is transmitted through a suitable horizontal yoke 42 to two thrust-rods parallel with the piston and leading leftward along opposite sides of the motive cylinder 34 and to another yoke 44, similar to the yoke 42, and at its center connected with a reciprocating translating-slide 45, mounted in suitable right and left guides 46 and 48, respectively, and carrying between such guides a suitable roller 47, mounted upon a pin inserted in the upper side of the slide. The stud and roller reciprocate and engage suitable cam-surfaces upon the cam-arms 50 and 51 of a cam-lever bell-crank mounted upon a suitable stud 53 and comprising a rock-arm 49, pivotally connected with one end of a switch-actuating rod or link 52, which at its opposite end is also pivotally connected to the switch-bar 56, joining the movable rails S and M of the switch 57. As the piston 36^a thrusts forward or leftward upon the reciprocating translating-slide 45 the cam-actuating roller 47 is brought into contact with the cam-surface of the cam-arm 50 of the bell-crank 49, so as to swing such bell-crank rightward about its pivotal stud 53 and cause its rock-arm 49 to thrust the switch-actuating rod 52 toward the switch 57 and toward the switch-bar 56, so as to slide the switch-bar transversely and carry the ends of the movable switch-rails to their opposite positions. After the track-switch 57 has been reversed the controlling electric switch 7 may be moved to its midway or non-contacting position, whereupon current in the right-hand transformer and its secondary coil 12^a will cease, the electrocaloric supply of heat to the motive fluid will terminate, and the relief-controlling magnet 19^a will become immediately deënergized, so as to permit opening of its relief-controlling valve 26^a by its retractile spring 25^a and by fluid-pressure in the heating-tube 14^a. Should it now be desired to immediately reverse the position

of the track-switch 57, this may be accomplished by moving the controlling-switch 7 to its opposite position, making contact with its coöperating switch-contacts 8 and 9, so as to supply electrical energy to the left-hand transformer and to heating-tube and relief-controlling magnet of the left motive cylinder 34, whereupon the left motive cylinder will immediately force its piston 36 rightward, so as to restore the initial position of the right piston 36ª, while at the same time reversing the position of the track-switch 57 by an operation corresponding to its initial actuation and effected by engagement of the roller 47 with the cam-arm 51.

The comparatively small amount of motive fluid which leaks through the hydraulic packings 35 and 35ª is collected in the leakage-fluid-receiving grooves or chambers 38 and 38ª and rises in the connecting-tubes 33 and 33ª until it passes through the check-valves 81 and 81ª into the receiving-reservoirs 30 and 30ª. Since the receiving-reservoirs will be of such capacity that the fluid-pressures therein will not ordinarily rise much above normal and since the fluid-pressures in the leakage-receiving grooves or chambers 38 and 38ª cannot rise above such ordinarily low pressures in their respective receiving-reservoirs, the unrecovered leakage through the outer stuffing-boxes 39 and 39ª will generally be very small, and since the check-valves 81 and 81ª prevent return of fluid from the receiving-reservoirs to the leakage-receiving grooves, the greatest rate of unrecovered leakage from such receiving-grooves through their outer stuffing-boxes can only equal the leakage rate through the inner hydraulic packings.

After cessation of the heating-current in either of the heating tubes or coils 14 or 14ª the heat of the motive fluid is rapidly dissipated by conduction to the tube and by radiation therefrom, whereupon the motive fluid in the tube condenses and contracts, while its consequent reduction in volume is compensated by a return-flow from the receiving-reservoir to the tube. It is possible, and in some instances desirable, to dispense with the receiving-reservoirs and operate the motive cylinders without any relief-passages whatever, the condensation or contraction of the motive fluid subsequent to its motive expansion being in such cases solely relied upon to permit return movement of the motive piston.

The motive cylinder 59 of Fig. 3 is provided with a receiving-reservoir 30ª, directly connected to the motive cylinder near its head end and containing an electrically-controllable relief-controlling valve like those of Fig. 1. In lieu of the heating-tubes of Fig. 1 the construction of Fig. 3 employs a solid electrocaloric heating-conductor 62, coiled in helical form within the motive cylinder and coaxial therewith and with its piston 67. One end 61 of the heating conductor or coil 62 projects through an insulating-bushing inserted centrally in the head of the motive cylinder, while the other end 63 of the heating-coil projects laterally through the cylindrical wall of the motive cylinder near its opposite or packing end. Cooling of the motive fluid is effected in this instance by radiation from suitable annular radiating flanges or ribs integrally formed upon the outer cylindrical surface of the motive cylinder. A hydraulic packing 65 is employed to maintain a tight sliding joint between the piston and cylinder and is retained in place by a suitable retaining-cap 66, surrounding the piston and screwed over the open end of the motive cylinder.

The motive cylinder 68 of Fig. 4 is provided with a receiving-reservoir 30ª, communicating with the motive cylinder near its head end and including an electrically-controllable relief-controlling valve, such as those of Fig. 1. This construction comprises a number of electroconductive heating-tubes, such as 69, 70, and 71, disposed in parallelism with one another and with the motive cylinder and communicating with the motive cylinder through its cylinder-head, but hermetically sealed at their ends opposite to such connection. The connections between the cylinder-head and the open ends of the heating-tubes are made with insulating-bushings, such as 76, which surround the ends of the tubes and make a tight fluid-joint between such tube ends and the cylinder-head, while effectually insulating the tubes from the cylinder-head and from each other. The heating-tubes are electrically connected in series with one another by means of suitable conductive connecting-yokes, such as 73 and 74, brazed or otherwise fixed upon the ends of the tubes, and the series of tubes is connected with a suitable source of heating-current through suitable connecting-collars, such as 72 and 75, fixed upon the ends of the terminal tubes of the series.

It will be apparent that those embodiments of the fluid-pressure form of my invention which comprise an electroconductive heating-conductor distinct from or in addition to the motive fluid itself may be made to operate with an electrically-non-conductive motive fluid, which may be heated by the electric heating-conductor. For instance, as a modification a non-conductive oil or other non-conductive fluid may be employed in lieu of the mercury in the switch-actuating motive apparatus of Figs. 1 and 2, in which case the non-conductive motive fluid will be heated, expanded, and in some instances volatilized by the heat electrically developed in the electric heating-conductor. As another modification I may employ a mixture of fluids, such as a mixture of glycerin and al-

cohol, consisting, for instance, of two-thirds of glycerin and one-third of alcohol. This combination will make a saponaceous or partially-viscous mixture which will retain in suspension or in the form of a fine emulsion the small particles or quantities of alcohol vapor which will be generated when the temperature of the mixture is sufficiently raised by the electrocaloric heating means of my invention, so that in this instance the mixture will have the full expansive effect of volatilization or vaporization, while being at the same time substantially maintained as a homogeneous mixture, wherein the vapor is not considerably separated from the liquid. The maintenance of the vapor in this finely-divided state in admixture with the liquid motive fluid is advantageous in that it keeps each small particle of vapor in effectual heat-conductive connection with the electric heating-vapor through the intermediation of the liquid as a heat-conductive medium, thus permitting the small particles of vapor to be both heated and cooled more quickly than could be effected if they were united in one integral mass of vapor separate from the liquid.

It will be apparent that any one of the motive cylinders of the illustrated apparatus and its coöperating movable piston together constitute a completely-inclosed motive chamber, the motive cylinder comprising the side walls and one end wall of the motive chamber considered as a whole, while the movable piston constitutes a closure or end wall at the opposite end of the motive chamber. Thus by correlation of the motive cylinder and its motive piston is formed a motive chamber which is expansible by pressure of motive fluid therein—that is to say, a motive chamber having an expansible or variable fluid-containing volume and comprising elements movable relative to one another by pressure of motive fluid to effect such expansion or volume variation of the motive chamber as a whole.

It will be apparent that my broad invention and the various features thereof may be embodied in various forms of structure and arrangement and in various modifications of the forms which I have particularly illustrated and described, all such embodiments coming, however, within the spirit, scope, and principles of my broad invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination of a railway-track switch, caloric motive apparatus in actuative coöperation therewith, and electrocaloric-energy-transmuting apparatus arranged to supply caloric energy to the caloric motive apparatus.

2. The combination of a railway-track switch and electrocaloric fluid-pressure motive apparatus in actuative coöperation with the switch and including electrocaloric-energy-transmuting means arranged to heat the motive fluid of the motive apparatus.

3. The combination of a railway-track switch and electrocaloric motive apparatus in actuative coöperation with the switch and including an electric conductor adapted to be heated by electric current and to thereby develop caloric energy for operating the caloric motive apparatus.

4. Railway-track-switching means comprising, in combination, a track-switch, caloric fluid-pressure motive apparatus in actuative coöperation therewith, and an electric conductor arranged to be heated by electric current and to supply heat to the motive fluid of the motive apparatus.

5. The combination, with a railway-track switch, of electrocaloric fluid-pressure motive apparatus arranged to actuate the switch and comprising an electrical conductor provided with a receiving-space for the motive fluid of the motive apparatus and adapted to be heated by electric current and to transmit heat to the motive fluid.

6. The combination, with a railway-track switch, of caloric fluid-pressure motive apparatus arranged to operate the switch, and a tubular electrical conductor adapted to receive the motive fluid of the motive apparatus and to transmit to such motive fluid the heat generated in the tubular conductor by flow of electricity therein.

7. Railway-switch-operating apparatus comprising fluid-pressure motive apparatus in actuative coöperation with a track-switch and including an expansible motive chamber and a tubular electric conductor in fluid communication with the motive chamber and arranged to receive motive fluid and to heat and expand the same by caloric energy generated by passage of an electric current in the tubular conductor.

8. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative control of a track-switch and including a motive chamber expansible by pressure of motive fluid and provided with a relief-passage, electrocaloric-energy-transmuting means arranged to heat and expand the motive fluid of the motive apparatus so as to effect a motive expansion of the motive chamber, and means for opening the relief-passage from such motive chamber after occurrence of its motive expansion.

9. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative coöperation with a railway-track switch and including a motive chamber expansible by pressure of motive fluid and a relief-passage for such motive chamber, electrocaloric-energy-transmuting means arranged to supply caloric energy for effecting a motive expansion of the motive fluid and of the motive chamber, and means

for maintaining closure of the relief-passage during a given motive expansion of the chamber.

10. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative coöperation with a railway-track switch and including a motive chamber expansible by pressure of motive fluid and provided with a relief-passage, electrocaloric heating means arranged to heat the motive fluid of the motive apparatus so as to expand such motive fluid and thereby effect a motive expansion of the motive chamber, and means for maintaining the relief-passage in closed condition during the motive expansion of the chamber and for opening such relief-passage after such motive expansion.

11. Railway-switch-operating means comprising fluid-pressure motive apparatus including a fluid-pressure motive chamber expansible by pressure of the motive fluid of the motive apparatus and arranged in actuative coöperation with a track-switch and such motive apparatus including also an electrically-controllable relief-passage in communication with the motive chamber, electrothermal heating means arranged to heat and expand the motive fluid of the motive apparatus and thereby effect a motive expansion of the motive chamber, and a common source of electricity arranged to supply electrical energy both for the electrothermal heating means and for control of the electrically-controllable relief-passage.

12. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus including a motive expansion-chamber operatable by pressure of the motive fluid of the motive apparatus and arranged in actuative control of a track-switch, in combination with an electrically-controllable relief-passage communicating with the motive chamber, a relief-controlling electric circuit for the relief-passage and arranged to maintain closure of such relief-passage by flow of current in such relief-controlling circuit, electrothermal heat-producing means arranged to heat and expand the motive fluid and thereby actuate the motive chamber and operate the track-switch, and a common source of electricity arranged to supply electric current simultaneously to the electrothermal heating means and to the relief-controlling circuit.

13. A railway-switch-controlling system including, in combination, a railway-track switch, caloric motive apparatus in actuative coöperation with the track-switch, and an electric circuit in controlling relation to the caloric motive apparatus.

14. A railway-switch-controlling system comprising a railway-track switch, caloric motive apparatus in actuative coöperation therewith, electrocaloric-energy-transmuting means arranged to supply caloric energy to the caloric motive apparatus, and an electric circuit arranged both to supply electrical energy for the electrocaloric-energy-transmuting means and to control actuation of the track-switch by the caloric motive apparatus.

15. A railway-switch-controlling system comprising a railway-track switch, caloric fluid-pressure motive apparatus in actuative coöperation with the track-switch, electrocaloric heating means arranged to heat the motive fluid of the fluid-pressure motive apparatus, and an electric circuit arranged to supply electrical energy to the electrocaloric heating means and also arranged to control actuation of the track-switch by the caloric fluid-pressure motive apparatus.

16. Railway-switch-operating means comprising a fluid-pressure motive chamber expansible by pressure of motive fluid and arranged to actuate a track-switch by its motive expansion, an electrically-conductive fluid-heating tube having fluid communication with the motive chamber and adapted to expand the motive fluid by heat of an electric current so as to effect a motive expansion of the motive chamber, a fluid-relief passage leading from the heating-tube, and means for maintaining closure of the relief-passage during the motive expansion of the motive chamber.

17. Railway-switch-operating means comprising fluid-pressure motive apparatus including a motive chamber expansible by pressure of motive fluid and arranged to actuate a track-switch by its motive expansion and such motive apparatus including also a reservoir and a relief-passage leading from the motive chamber to the reservoir, electrocaloric-energy-transmuting means arranged to supply caloric energy to the motive fluid of the fluid-pressure motive apparatus to effect motive expansion of its motive chamber, and means for maintaining closure of the relief-passage during such motive expansion of the motive chamber.

18. Railway-switch-operating means including a fluid-pressure motive expansion-chamber, a leakage-fluid-receiving chamber, a power-transmitting rod passing through the leakage-fluid-receiving chamber and into the motive expansion-chamber, a tight sliding joint through which the rod enters the leakage-fluid-receiving chamber, a second tight sliding joint through which the rod passes from the leakage-fluid-receiving chamber into the motive expansion-chamber, a conduit connecting the leakage-fluid-receiving chamber with a receiving-reservoir, a relief-passage affording fluid communication between the motive expansion-chamber and the reservoir, means for increasing the pressure of the motive fluid in the motive expansion-chamber whereby to move the power-transmitting rod, means for maintaining closure of the relief-passage during such move-

ment of the rod, and means for transmitting the movement of the power-transmitting rod to a track-switch.

19. Railway-switch-operating means comprising fluid-pressure motive apparatus in actuative connection with a railway-track switch and including a fluid-pressure motive expansion-chamber arranged to move the track-switch by its motive expansion, an electroconductive fluid-heating tube in fluid communication with the motive expansion-chamber, a fluid-reservoir, a controllable relief-passage affording controllable fluid communication between the electroconductive fluid-heating tube and the relief-reservoir, means for passing an electric current through the electroconductive fluid-heating tube whereby to heat the tube and the motive fluid contained therein and effect a motive expansion of such fluid and of the motive chamber, and means for maintaining closure of the relief-passage during the motive expansion of the motive chamber.

20. Railway-switch-operating means comprising fluid-pressure motive apparatus in actuative connection with a railway-track switch and including, in a closed motive-fluid-containing system, a fluid-pressure motive expansion-chamber arranged to move the track-switch by its motive expansion, an electroconductive fluid-heating tube in fluid communication with the motive expansion-chamber, a fluid-reservoir permanently closed against communication with the outer atmosphere, a controllable relief-passage affording controllable fluid communication between the electroconductive fluid-heating tube and the closed relief-reservoir, means for passing an electric current through the electroconductive fluid-heating tube whereby to heat the tube and the motive fluid contained therein and effect a motive expansion of such fluid and of the motive chamber, and means for maintaining closure of the relief-passage during the motive expansion of the motive chamber.

21. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative connection with a track-switch and including a motive expansion-chamber operatable by pressure of the motive fluid of the apparatus to actuate the track-switch, and a tubular electric conductor of helical form in fluid communication with the motive expansion-chamber and adapted to be heated by an electric current and to heat and expand the motive fluid of the motive apparatus so as to effect a motive expansion of the motive chamber and thus actuate the track-switch.

22. Railway-switch-operating means comprising a fluid-pressure motive expansion-chamber, means for transmitting the power of a motive expansion of the motive chamber to a track-switch, an electroconductive fluid-heating tube of helical form in fluid communication with the motive chamber and adapted to be heated by electric current and to heat the motive fluid of the motive apparatus and effect a motive expansion of such fluid and of the motive chamber, a controllable relief-passage leading from the heating-tube, and means for maintaining closure of the relief-passage during the motive expansion of the motive chamber.

23. Railway-switching means comprising a railway-track switch, caloric fluid-pressure motive apparatus arranged in actuative relation thereto and including a motive-fluid-containing system closed from communication with the outer atmosphere, and electro-caloric-energy-transmuting means arranged to supply caloric energy to the motive fluid of the caloric fluid-pressure motive apparatus.

24. Railway-switch-operating means comprising switch-actuating motive apparatus operatable by caloric energy and including an electrical heating-conductor adapted to be heated by electric current and to supply the caloric energy for operating the motive apparatus, in combination with a transformer arranged to deliver its secondary current to the heating-conductor, and a current-transmitting circuit arranged to deliver primary current to the transformer.

25. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative connection with a track-switch and including a motive chamber expansible by pressure of the motive fluid of the motive apparatus and arranged to move the track-switch in one direction by its motive expansion, electrocaloric heating means arranged to heat the motive fluid of the motive apparatus so as to increase its pressure and effect a motive expansion of the motive chamber, and means for returning the motive chamber and the track-switch to initial condition and position after the motive expansion of the motive chamber.

26. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative connection with a track-switch and including two motive expansion-chambers arranged to move the track-switch into opposite positions by their respective motive expansions and each motive chamber being also arranged to restore the other motive chamber to its normal or unexpanded condition, and the caloric fluid-pressure motive apparatus also including separate motive-fluid-containing systems for the motive fluids of the separate motive expansion-chambers, and means for independently heating and expanding the motive fluids of the independent containing systems.

27. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative connection with a track-switch and including two motive expansion-

chambers arranged to move the track-switch into opposite positions by their respective motive expansions and each motive chamber being also arranged to restore the other motive chamber to its normal or unexpanded condition, and the caloric fluid-pressure motive apparatus also including separate motive-fluid-containing systems for the motive fluids of the separate motive expansion-chambers, and independent electrocaloric-energy transmuters arranged to heat and expand the motive fluids of the independent motive-fluid-containing systems.

28. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus arranged to actuate a track-switch by motive expansion of the motive fluid of the motive apparatus, electrocaloric-energy-transmuting means arranged to supply caloric energy to the motive fluid to effect motive expansion of the same, and cooling means arranged to dissipate the caloric energy of the motive fluid.

29. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus arranged to actuate a track-switch by motive expansion of its motive fluid, an electrocaloric-energy transmuter, and cooling means, the electrocaloric-energy transmuter and the cooling means being arranged to alternately supply and dissipate caloric energy to and from the motive fluid of the motive apparatus to effect motive expansion of the motive fluid and to permit a contraction of such motive fluid between successive motive expansions thereof.

30. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus arranged to actuate a track-switch by motive expansion of its motive fluid and including an electric heating-conductor provided with a motive-fluid-receiving space arranged to contain motive fluid of the motive apparatus and such conductor being adapted to heat the motive fluid by caloric energy of an electric current flowing through the conductor and also to cool the motive fluid by absorption of heat therefrom.

31. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus arranged to actuate a track-switch by motive expansion of its motive fluid and having a motive-fluid-containing system including a tubular electric conductor arranged to be heated and to heat the motive fluid by passage of an electric current whereby to effect motive expansion of the motive fluid and also arranged to absorb and dissipate heat of the motive fluid so as to permit a contraction thereof subsequent to its motive expansion.

32. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus in actuative coöperation with a track-switch and including a motive expansion-chamber arranged to actuate the track-switch by motive expansion of the motive fluid of the apparatus, and a helical electroconductive tube in fluid communication with the motive chamber and arranged to contain motive fluid and to heat and expand the same by caloric energy of an electric current passing through such electroconductive tube, and such tube being also arranged to absorb and dissipate the heat of the motive fluid.

33. Railway-switch-operating means comprising caloric fluid-pressure motive apparatus arranged to move a track-switch into a given position by motive expansion of the motive fluid of the apparatus, electrocaloric-energy-transmuting means arranged to supply caloric energy to the motive fluid of the caloric fluid-pressure motive apparatus, an electric circuit arranged to supply electrical energy to the electrocaloric-energy-transmuting means and also arranged to control actuation of the track-switch by the motive apparatus, a second caloric fluid-pressure motive apparatus arranged to move the track-switch into another position by motive expansion of the motive fluid of such second motive apparatus, a second electrocaloric-energy-transmuting means arranged to supply caloric energy to the motive fluid of the second motive apparatus, and a second electric circuit arranged to supply electrical energy to the second electrocaloric-energy-transmuting means and also arranged to control actuation of the track-switch by the second motive apparatus.

34. Railway-switch-operating means comprising switch-actuating caloric motive apparatus, electrocaloric-energy-transmuting means arranged to supply caloric energy to the caloric motive apparatus, an electric-current transformer arranged to deliver its secondary current to the electrocaloric-energy-transmuting means, and an electric transmission-circuit arranged to deliver primary current to the transformer.

35. Railway-switch-operating means comprising fluid-pressure motive apparatus arranged to actuate a track-switch by motive expansion of its motive fluid and including electroconductive motive fluid expansible by passage of an electric current through it, and means for conducting electricity through the motive fluid of the motive apparatus so as to effect a motive expansion thereof.

36. Railway-switch-operating means comprising fluid-pressure motive apparatus arranged to actuate a track-switch by pressure variation in its motive fluid and including a liquid motive fluid adapted for conversion into gaseous form by passage of electricity through such liquid, and means for passing electricity through the liquid so as to convert the same to gaseous form and thereby vary its pressure to actuate the track-switch.

37. Railway-switch-operating means comprising fluid-pressure motive apparatus ar-

ranged to actuate a track-switch by motive expansion of its motive fluid and including a motive fluid expansible by passage of electricity through it, and means for passing electricity through the motive fluid of the motive apparatus to effect a motive expansion thereof and actuate the track-switch.

In testimony whereof I have affixed my signature in presence of two witnesses.

CLYDE J. COLEMAN.

Witnesses:
HENRY D. WILLIAMS,
HENRY BARNES.