No. 827,143. PATENTED JULY 31, 1906.

C. J. COLEMAN.

RAILWAY TRAFFIC CONTROLLING SYSTEM.

APPLICATION FILED MAR. 31, 1904.

5 SHEETS—SHEET 1.

Fig. 1.

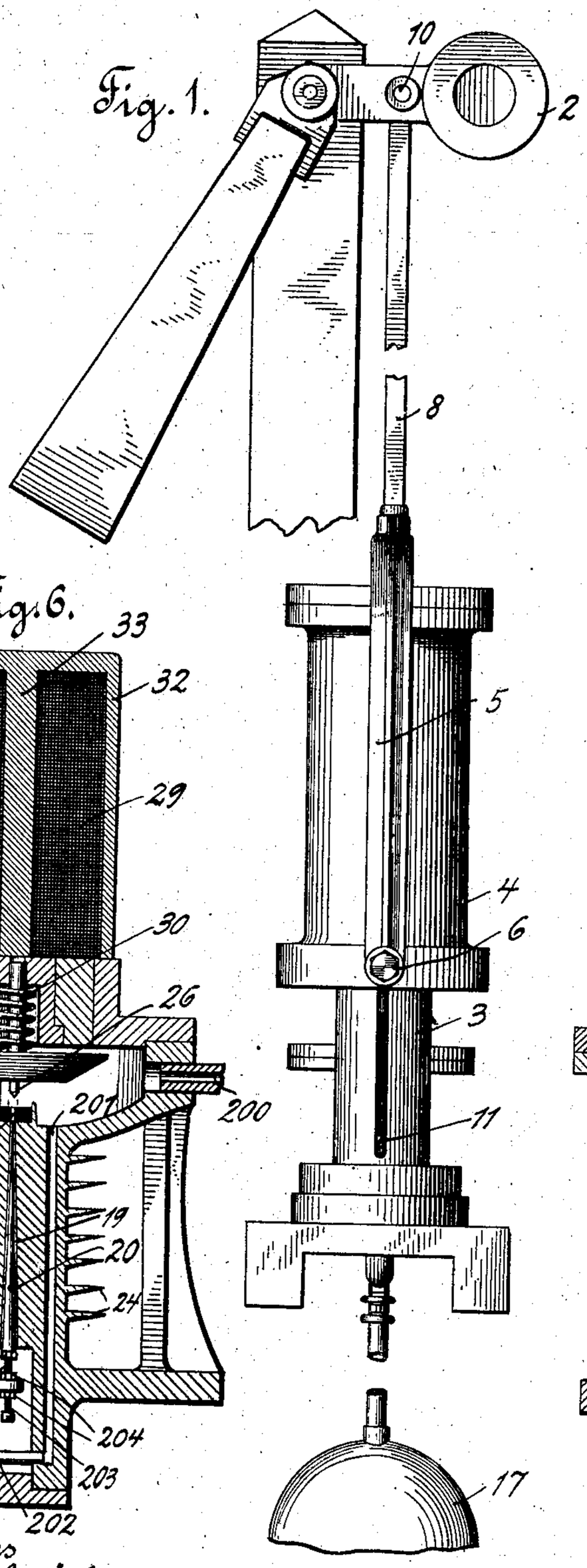
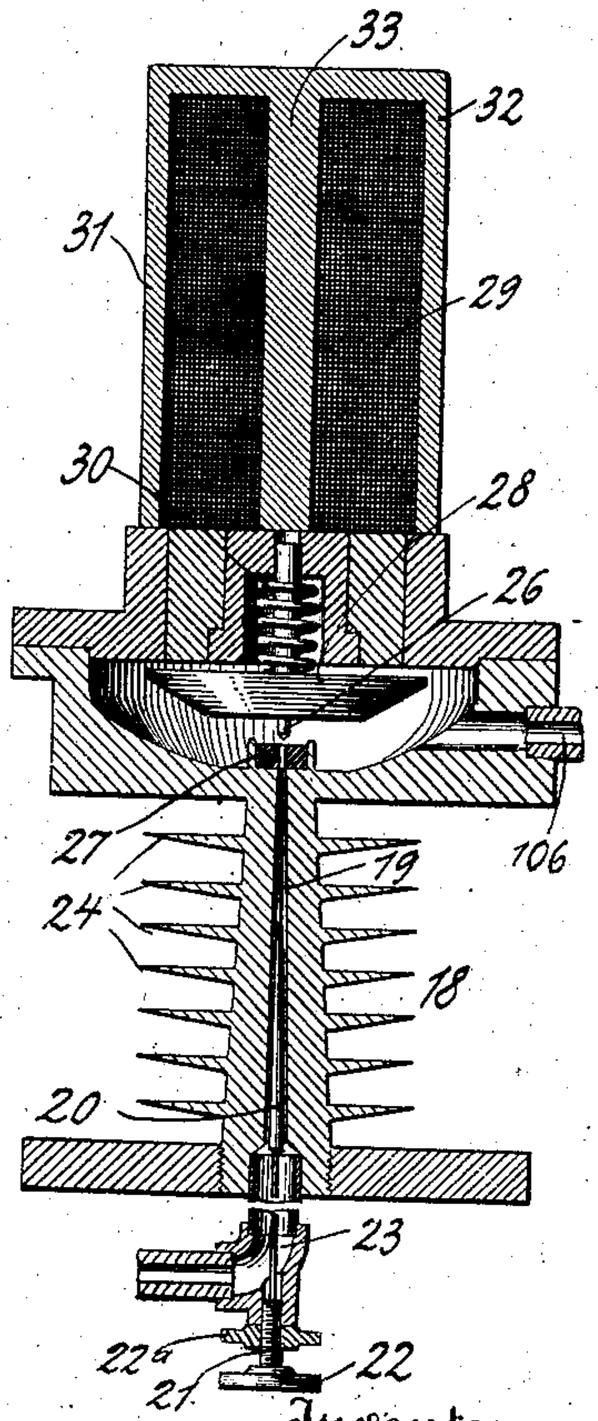


Fig. 6.

Fig. 7.



Witnesses
F. N. Roehrich
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5 SHEETS—SHEET 2.

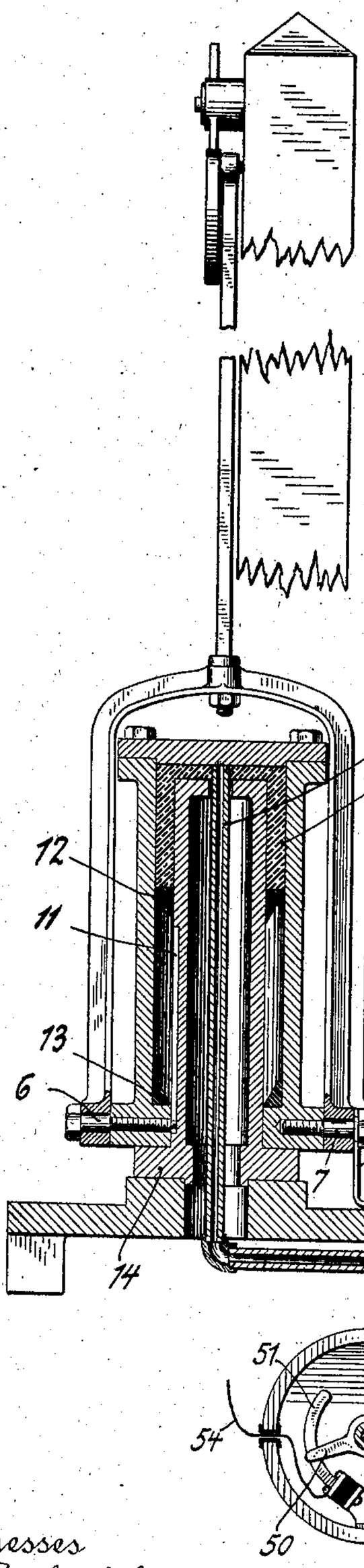

Fig. 2.

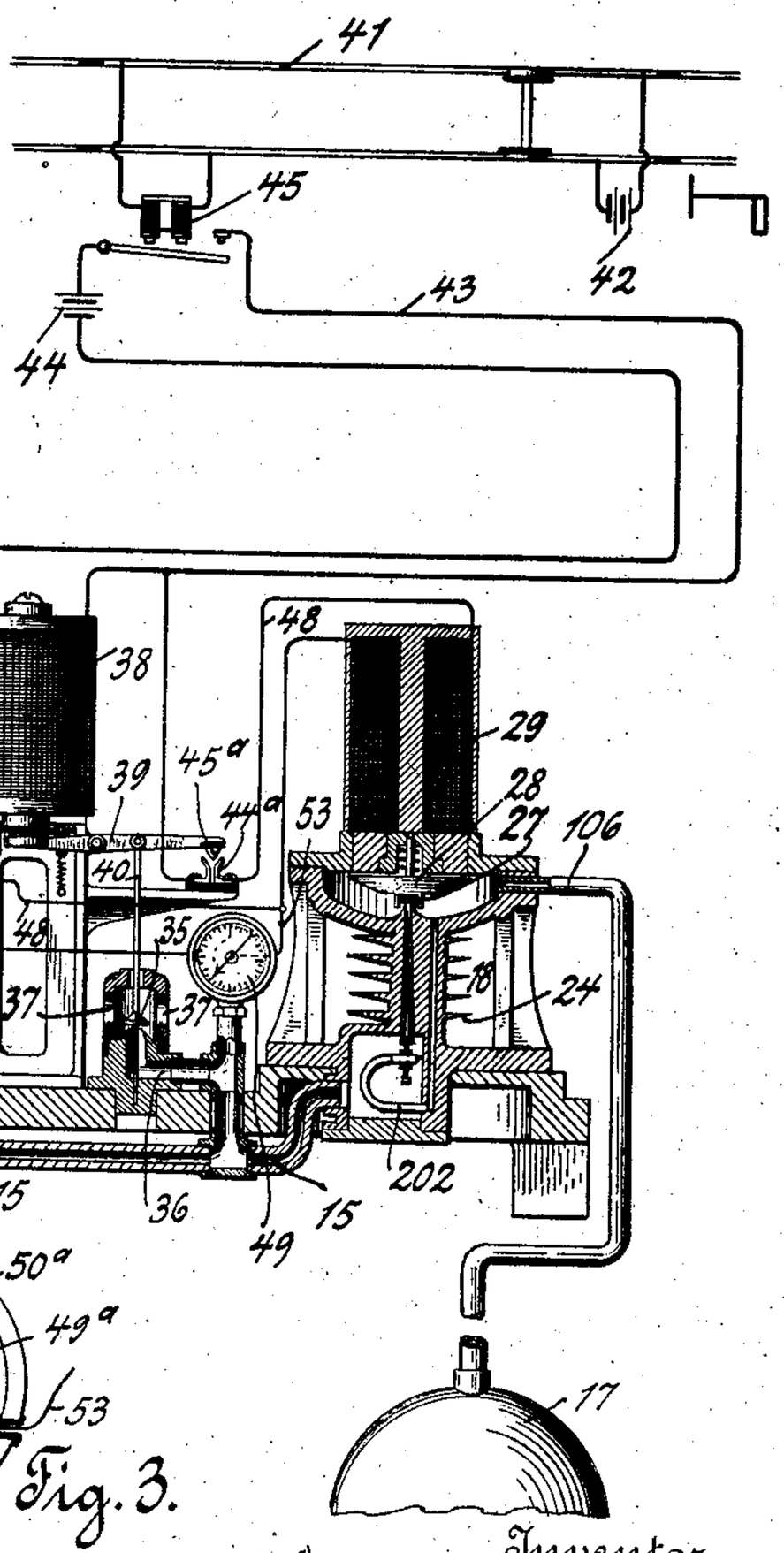

Fig. 3.

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5 SHEETS—SHEET 3.

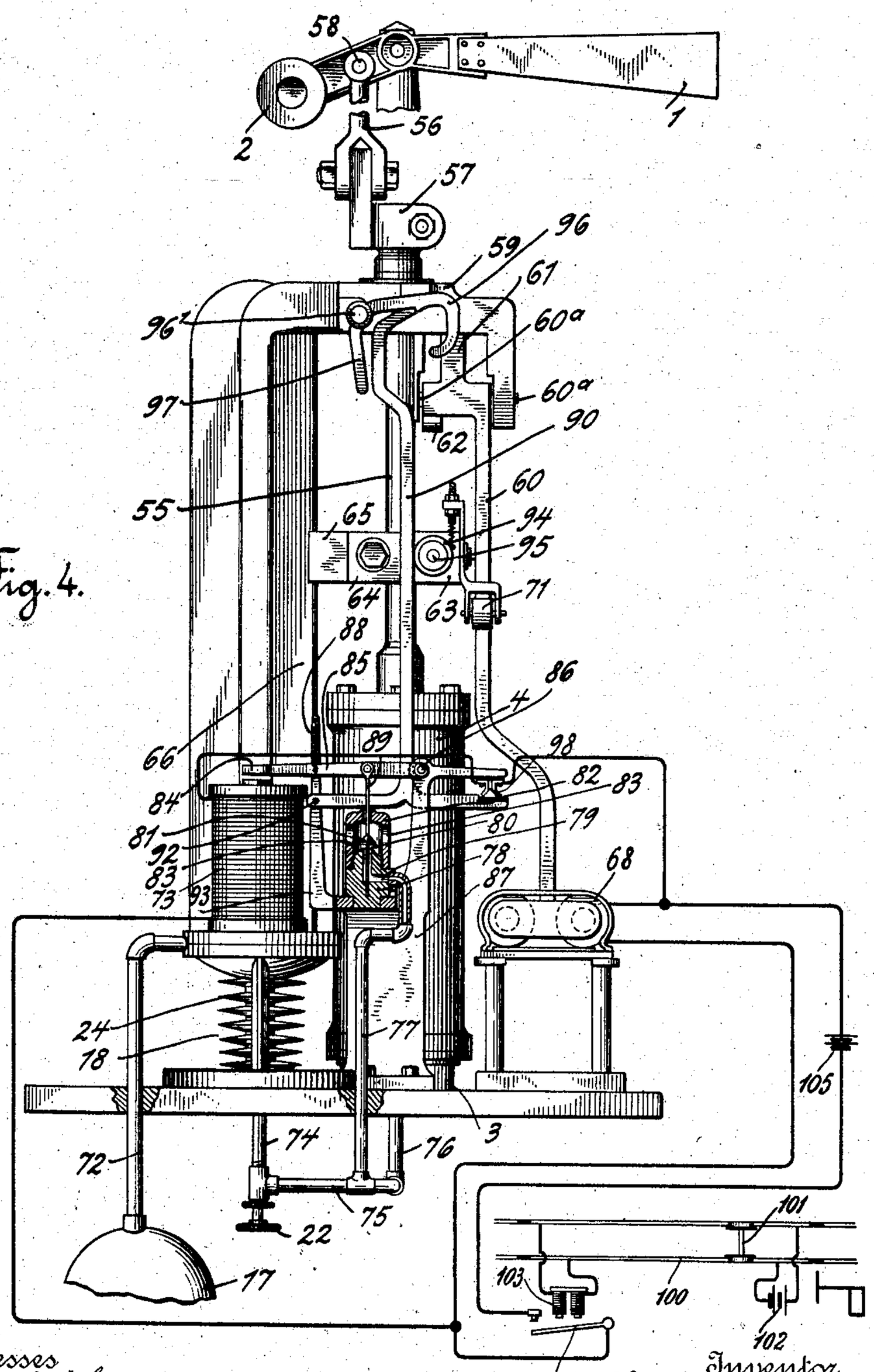

Fig. 4.

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5 SHEETS—SHEET 4.

Fig. 5.

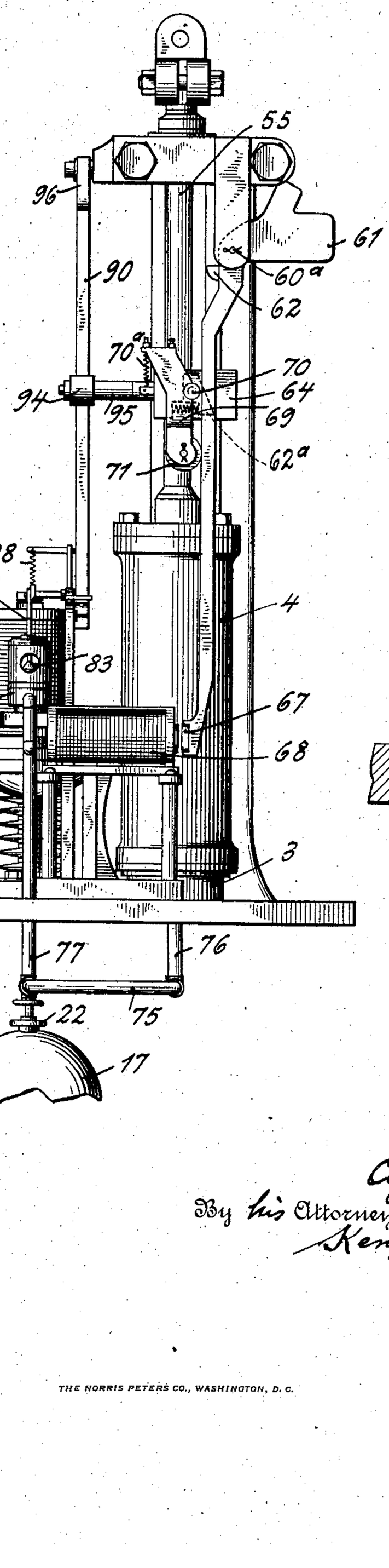
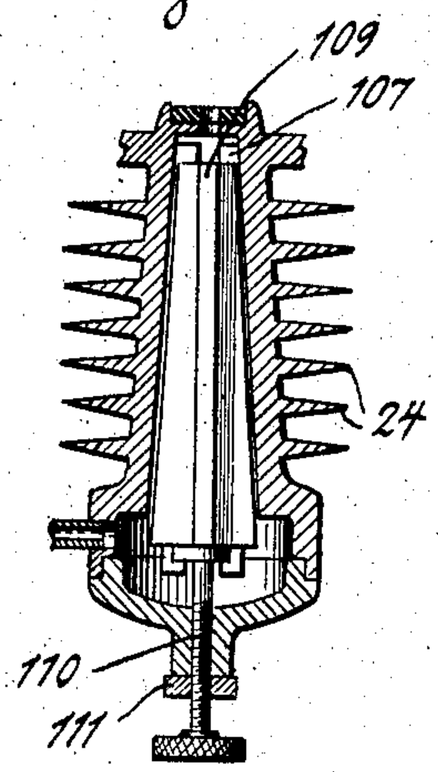


Fig. 9.



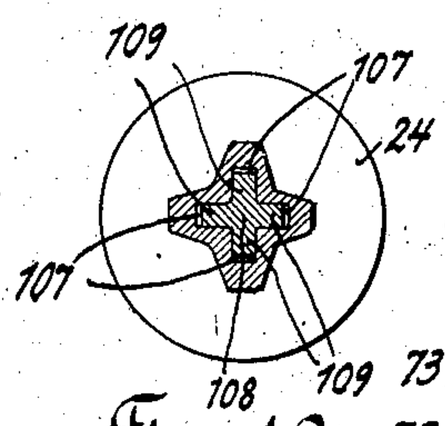
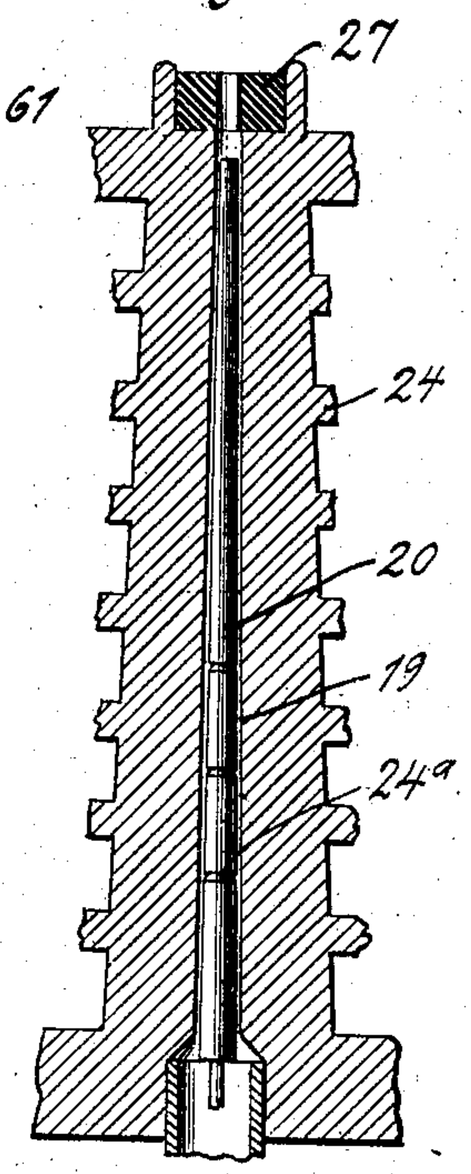


Fig. 10.

Fig. 8.



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5 SHEETS—SHEET 5.

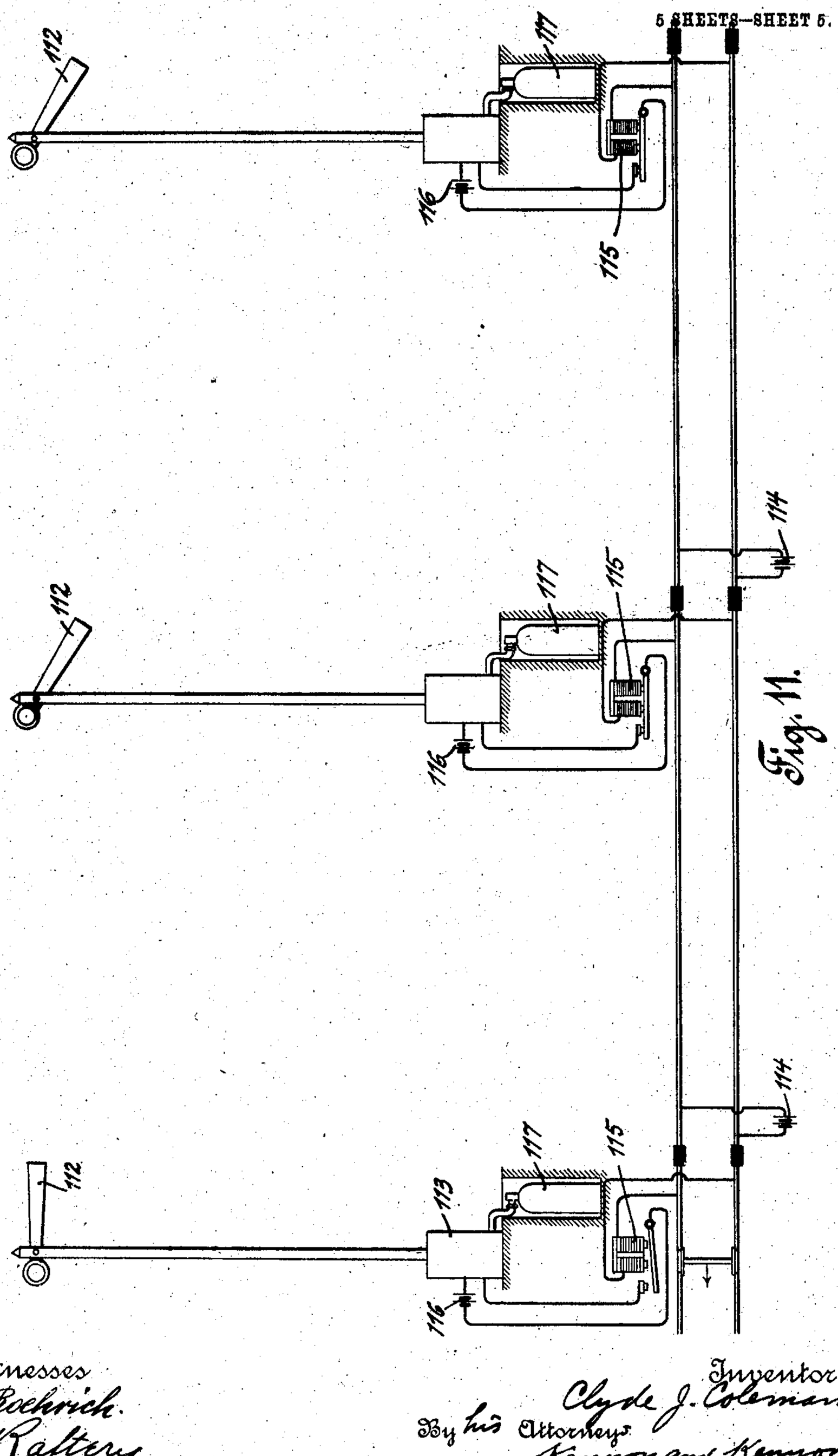

Fig. 11.

Witnesses
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UNITED STATES PATENT OFFICE.

CLYDE J. COLEMAN, OF ROCKAWAY, NEW JERSEY, ASSIGNOR TO THE HALL SIGNAL COMPANY, A CORPORATION OF MAINE.

RAILWAY TRAFFIC-CONTROLLING SYSTEM.

No. 827,143. Specification of Letters Patent. Patented July 31, 1906.

Application filed March 31, 1904. Serial No. 201,015.

To all whom it may concern:

Be it known that I, CLYDE J. COLEMAN, a citizen of the United States, and a resident of Rockaway, county of Morris, and State of New Jersey, have invented certain new and useful Improvements in Railway Traffic-Controlling Systems, of which the following is a specification.

My invention relates to a means for supplying gas in such a manner to the railway apparatus that utilizes it that the pressure of the gas is gradually reduced.

One object of my invention is to supply gas at a reduced pressure to the railway apparatus in which the gas is utilized.

A further object of the invention is to do away with the reducing-valve having intermittently-operating movable parts that is commonly used to reduce the pressure of the gas.

A further object of the invention is to do away with the expansion-chamber that has heretofore been used to avoid the troubles incident to the formation of gas snow.

Accompanying the reduction of pressure I supply heat to the gas, and in the best embodiment of my invention I supply heat to the gas while it is being gradually reduced in pressure. In accomplishing this reduction in pressure of the gas I prefer to make use in part of the force of friction, a force that hitherto has been commonly regarded as deleterious when it affected the flow of gases, and I also make use of the heating effect due to the friction between the gas and the passage to help prevent the freezing of the passage.

My invention is particularly adapted to railway systems, and in the embodiment of my invention illustrated upon the drawings I have shown my invention applied to a motor of a railway traffic-controlling apparatus.

In the best embodiment of the invention the invention is adapted to be used for motors for controlling railway-signals. The parts of such motors and the parts moved thereby possess inertia; and it is one object of my invention to so construct the passage as to supply gas in such a manner to said motor that the pressure in the motor-cylinder remains at a low average working pressure while the motor is completing a movement.

My invention consists in the novel parts, improvements, and combinations herein shown and described.

Referring to the accompanying drawings, which are attached to the specification and form a part thereof, Figure 1 illustrates an elevation of one embodiment of the invention, the particular form illustrated being a railway-signal. Fig. 2 is a vertical section of the device shown in Fig. 1. Fig. 3 is a cross-section of a detail, showing a switch. Fig. 4 is an elevation of another form of signal. Fig. 5 is a side view of the parts shown in Fig. 4. Fig. 6 is a section of the pressure-reducing device shown in Fig. 2. Fig. 7 is a section of another form of pressure-reducing device. Fig. 8 is a section of the pressure-reducing passage on an enlarged scale. Fig. 9 is a section of a modification, showing a plurality of passages. Fig. 10 is a cross-section of Fig. 9. Fig. 11 is a view of a signal system embodying my invention.

Referring to the drawings, in which the same reference characters indicate the same parts in all the views, I will first describe the specific kind of railway traffic-controlling apparatus that I have illustrated.

The form of apparatus used may be widely varied. I have shown a railway-signal, and in the preferred embodiment of the invention the signal includes a weighted semaphore. The signals form part of any desired system. They may be normal safety or normal danger systems, as preferred. In normal safety systems the signal stands normally at "safety." In normal danger systems the signal stands normally at "danger."

The signal that I have illustrated includes a signal-blade 1. The operation of this blade may be controlled in any desired manner. I prefer to actuate it in one direction by fluid-pressure and in the other direction by a weight. This weight may be in the form of the weighted spectacle 2. The motor for controlling the movement of the signal in one direction may be of any desired character. I prefer to use a piston 3 and piston-chamber 4, relatively movable with respect to each other. I have shown the piston 3 as fixed and the piston-chamber 4 as movable, but the piston may be movable and the piston-chamber fixed. The motor may control the signal in any desired manner. In the best embodiment of the invention the motor actuates the signal, and in the best embodi-

ment of the invention as illustrated upon the drawings the motor under gas-pressure actuates the signal in one direction toward one position of indication, the weight 2 being used to return the signal.

The connections between the motor and the signal may be widely varied. In the embodiment of the invention illustrated in Fig. 2 the connections include a part which may be in the form of a yoke 5, pivoted at 6 and 7 to the moving element of the motor. The pivoted member 5 may be connected in any suitable way to the signal. I prefer to pivot the yoke on the piston-chamber and near the lower end thereof. As shown, the yoke is extended and pivoted at 10 to the semaphore. The pivots 6 and 7 may be screw-bolts, which are threaded into the cylinder 4 at the base of the cylinder. I prefer to guide the cylinder in its movement and to prevent its rotation. This may be accomplished by providing a recess 11 in the fixed element with which the bolt 6 engages. In order to seal the cylinder, if desired, against the escape of gas, I make use of elastic sealing-rings. These rings preferably consist of rubber and are beveled. The ring 12 is fixed in position and the ring 13 moves with the motor. When the rings 12 and 13 engage, they form a gas seal that prevents any leakage of gas to the atmosphere. The internal construction of the motor may be widely varied. I have shown a hollow pedestal 14, through which passes the pipe 15. The top of the pedestal is surrounded by a sleeve 16, through which the pipe 15 passes. The long sides of the sleeve, which terminate in the ring 12, interpose a long path to the gas if it should try to escape to the atmosphere. This insures a good gas-tight seal.

The motor that I prefer to use is adapted to be operated by fluid-pressure, and in the best embodiment of my invention I make use of a gas under pressure as the motive power. Any desired means for supplying gas under pressure may be used. I prefer to make use of a gas that can be liquefied at ordinary temperatures and to provide a means for containing a storage-supply of liquefied gas. The gas that I utilize in the best embodiment of my invention is carbonic-acid gas. I prefer to make use of a flask 17, which contains a storage-supply of liquefied carbonic acid.

It is very desirable in systems operated by fluid initially under high pressure to reduce the pressure of the fluid so as to enable it to actuate the motor smoothly and efficiently. The pressure of liquefaction of carbonic acid varies from six hundred to one thousand pounds per square inch with the ordinary variation in temperature. The chilling of the gas incident to its reduction in pressure may be sufficient to clog the passages and pipes through which the gas passes on its way to the motor largely by the solidification of the gas itself, thus preventing a further supply of gas to the motor. Hitherto it has been impossible to secure the requisite reduction in pressure of the gas necessary to operate a motor effectively without the use of a reducing-valve containing a movable member, which valve intermittently supplied a quantity of low-pressure gas to the motor. Attempts to reduce the pressure of the gas by a restricted passage have been failures both because such attempts failed to suitably reduce the pressure and because the passage froze and clogged.

In accordance with my invention I make use of means for reducing the pressure of the gas gradually before it enters the motor, and I prevent the freezing and clogging of the passage by means that I have devised which coöperate with the means for accomplishing the reduction in pressure. Since the motor and the parts connected therewith possess inertia, it is necessary to take account of the effect of inertia on the pressure of the gas in the motor. I have so constructed the means for reducing the pressure of the gas that the pressure in the motor-cylinder is maintained at a suitably low amount while the motor is operating. I accomplish this by regulating the rate of flow of the gas through the means for reducing the pressure, so that the pressure will not rise too much behind the piston of the motor when starting and moving the motor.

In accordance with my invention I reduce the pressure of the gas without interrupting its flow by retarding the flow of the gas. The nature of the means for retarding the flow of the gas may be widely varied. In the best embodiment of the invention the flow of the gas is retarded and controlled by providing a passage of sufficiently small effective cross-section. The effective cross-section may be reduced in a variety of ways. This may be accomplished by making one dimension of the passage much greater than another or by making the length of the passage very great as compared with the minimum dimension of its cross-section or by giving the passage an irregular form in the direction of its length or by utilizing any two or more of these features.

In the best embodiment of the invention the pressure of the gas is gradually reduced while in motion and flowing through the passage. This may be accomplished by a variety of means. The force of friction between the surfaces of contact of the passage and the gas may be utilized to gradually reduce the pressure. This permits, moreover, the use of a passage of larger cross-section than would be available if the force of friction were not utilized, since the force of friction has a similar effect to that of contracting the passage. In the best embodiment of the invention the force of friction is called into play instead of contracting the passage to

extremely fine dimensions. A gradual reduction in pressure may also be brought about by checking the flow of the gas and reducing its velocity along the passage, as by means of suitable enlargements in the passage. Both contact friction and the effect of enlargements may be utilized.

The pressure of the gas is preferably reduced to a predetermined amount that is independent of the variation in pressure on the high-pressure side of the system. This may be accomplished by a variety of means. In the best embodiment of the invention the section of the passage is varied automatically with the variation in pressure on the high-pressure side. In accordance with my invention also I prevent too great a reduction in temperature of the gas, especially such a reduction as would result in the clogging of the passage by the freezing of the fluid therein. This may be accomplished by supplying heat to the gas in any suitable way. As before stated, in the best embodiment of the invention the pressure of the gas is reduced gradually. The expansion of the gas therefore takes place over a long extent of passage and the cooling effect is gradual. In the best embodiment of the invention heat is supplied to the gas during the reduction in pressure. During the expansion of the gas which tends to produce a chilling of the gas heat is supplied so as to prevent the chilling.

Heat may be imparted to the gas either by supplying external heat or by developing internal heat in the gas or by the conjoint action of both ways. In the best construction the contact-surface of the passage in which the pressure is reduced is made a heating-surface, and heat is supplied to the gas by means of this heating-surface. When external sources of heat are made use of, a natural source of heat supply, such as the atmosphere, is utilized in the best embodiment of the invention. Internal heat may be developed in the gas in any suitable way. One way of generating it is to develop it by the friction between the flowing gas and the surface in contact with which the gas flows. Another way is to check its flow, and thus transform its kinetic energy into heat. In the best embodiment of the invention such transformation of energy is accomplished by giving the passage a varying section in the direction of its length, as by enlarging the passage at one or more intervals.

The amount of the heat supplied to the gas is increased in the best embodiment of the invention by giving the gas a high velocity past the heating-surfaces, the high velocity being attained by the reduction of the cross-section of the passage adjacent to the heating-surfaces.

Referring to the drawings which illustrate one embodiment of the invention, 18 indicates the pressure-reducing passage. The shape, dimensions, and construction of the passage-way may be widely varied.

In the form of the invention shown I construct the passage with large surfaces of contact between the gas and the walls of the passage. I secure a great area of contact between the gas and the walls of the passage without increasing its sectional area by making one dimension of its cross-section much greater than the other. For convenience of construction the passage may be made annular, as shown. The exterior heating-wall of the annular passage is indicated at 19, and the interior heating-wall is formed by the plug 20. The cross-section of the passage, both longitudinally and transversely of its length, may be widely varied. In the embodiment of the invention illustrated upon the drawings I have shown a passage that expands toward the end of the passage nearest to the motor. The area of the transverse section of the passage is very small, and the area of the minimum cross-section is so small that the flow of the gas through it is thereby regulated, so as to prevent too great a rise in pressure in the working chamber of the motor.

In one form of apparatus that has been successfully used to carry out the invention the tapering plug 20 had a diameter of three thirty-seconds of an inch at the small end and three-sixteenths of an inch at the large end. The plug was one inch long. The plug fitted into a tapering chamber, with walls 19 of the same dimensions, so that when the part 20 was seated in the chamber it accurately fitted the tapering seat. The plug was then withdrawn until the depth or minimum dimension of the annular passage was about the one thousandth (.001) of an inch when reducing the gas from six hundred pounds per square inch to forty pounds per square inch. The pressure in the working chamber may be reduced to any desired amount. It is usually reduced to about forty pounds per square inch.

The form of the invention illustrated in Figs. 1 to 6 possesses certain inherent advantages. The pressure-reducing passage in Figs. 1 to 6 automatically compensates for a variation in pressure on the supply side of the system. This variation in pressure may be due to a number of causes, such as changes in diurnal temperature, changes in the temperature from season to season, in more or less complete exhaustion of the gas supply, and other causes. The high-pressure side of the system is connected at 200 to the reducing device. The supply of gas to the motor may be controlled in any desired manner. I prefer to make use of a valve, such as 26, described hereinafter. The means for compensating for the variation in pressure on the high-pressure side may be widely varied. In the best embodiment of the invention the de-

sired compensation is secured by varying the sectional area of the passage. The means for accomplishing the result may be widely varied. In the best embodiment of the invention one of the parts forming the passage is made relatively movable with relation to the other. In the form of the invention illustrated the passage comprises the exterior wall 19 and interior wall 20. The means for adjusting the plug 20 to compensate for variation in pressure on the high-pressure side may be widely varied. In the form illustrated a by-path 201 is provided for the gas, the path 201 leading into a closed flexible tube 202, preferably of metal. The tube is connected in any desired manner to the plug 20. In the best embodiment of the invention the connection is adjustable. The adjusting means may be widely varied. As shown, the plug has secured thereto an adjusting-screw 203 by means of the lock-nut 204. The screw 203 passes through an eye formed at the closed end of the tube 202. Two nuts 204 engage the threaded stem of the screw 203, so as to permit of a longitudinal adjustment of the screw, and consequently of the plug. The plug is first adjusted by hand by turning the screw 203. Any variation in pressure on the high-pressure side is then compensated by the automatic adjustment of the plug through the agency of the tube 202. Should the pressure rise, the tube will uncoil and thrust the plug inwardly, so as to contract the passage. The pressure of the gas at the low-pressure side 15, leading to the motor, will be kept the same, the high pressure being proportionately reduced. Should the pressure on the high-pressure side fall, the opening is increased and the reduction in pressure diminished, thus keeping the low pressure constant. As shown in the drawings, the passage may be given a varying section in the direction of its length. This is accomplished partly by enlarging the passage continuously and partly by providing a series of enlargements, such as 24ª. These may conveniently be produced by providing the core 20 with one or more annular grooves.

In the embodiment of the invention illustrated in Fig. 7 I have shown the plug 19 adjustable by hand. The means for effecting this adjustment may be widely varied. As shown, a screw 21 is provided which can be rotated by any desired means, such as a hand-wheel 22, connected to the plug by the stem 23. A rotation of the wheel 22 adjusts the plug 19 longitudinally, so as to vary the section of the passage. Suitable means are provided for locking the plug in its adjusted position. I have shown a lock-nut 22ª for this purpose. In the best embodiment of the invention the walls of the passage are made massive, so as to store up a large quantity of heat that is supplied when required to the gas. In the form of the invention illustrated heat is also transferred to the gas by means of projecting heat-conducting surfaces which conduct the heat to the heating-surfaces 19. I may utilize flanges, such as 24, for heat-conducting surfaces. The flanges may be of any desired shape or form, but I have shown a series of circumferential flanges in the embodiment of the invention illustrated in Fig. 2. Any desired means may be used to control the admission of the gas to the motor. In the best embodiment of the invention gas is supplied to the motor in small quantities and intermittently. The cooling effect incident upon the expansion of the gas and evaporation of the liquid is thereby reduced, and the parts are given time to heat between operations of the motor mechanism. In the best embodiment of the invention I use a valve 26 for controlling the admission of gas. This valve may be located at any desired point intermediate the source of supply of gas and the motor. In the best embodiment of the invention I locate the valve near the passage, so as to avoid condensing the gas by contact with cold pipes and to avoid the accumulation of high-pressure gas in the pipes between the valve and the reducing-passage. In the embodiment of the invention illustrated the valve is located near the inlet side of the passage. The valve may be of any desired character. I prefer to use a valve-seat 27 of rubber. In Fig. 2 the valve-seat is movable and in Fig. 7 the valve-seat is fixed. The valve may be controlled in any desired manner. I prefer to control the valve electrically. I make use of an iron armature 28 and an electromagnet 29 for moving the valve in one direction, the spring 30 being used to move the valve in the opposite direction. A stem 31 is used to guide the valve. The casing 32 and core 33 of the electromagnet preferably consist of iron. The circuits used to control the valve may be of any desired character, and the connection will be varied according as a normal danger or a normal safety system of signals is used. Before describing the circuits in detail I will describe the means for permitting the gas to exhaust from the motor. This means may be widely varied. In the particular embodiment of the invention illustrated upon the drawings a separate exhaust-valve 35 is used. The valve 35 controls the exhaust from the cylinder by means of the pipe 36 and escape-ports 37. Any desired means may be used to operate said valve. In the embodiment of the invention illustrated in Fig. 2 I make use of an electromagnet 38. Any desired means may be used to control said valve by means of said magnet. I have shown for this purpose suitable connections between the magnet and the valve, such as the pivoted armature-lever 39, connected to

the valve in any desired manner, as by means of the connecting-link 40. The electrical circuits and devices used to control the operation of the motor may be widely varied. The nature of the controlling-circuits used will, moreover, depend upon whether a normal danger system of signals or a normal safety system is to be operated.

In the embodiment of the invention illustrated in Fig. 2 I have shown a normal safety system and one form of electrical controlling means for controlling the system. 41 indicates a track-circuit energized by the track-battery 42. A local circuit 43 with local battery 44 is controlled directly or indirectly from a relay 45 in the track-circuit. The relay 45 is preferably controlled by the train. The local circuit 43 when closed energizes the magnet 38. This causes the magnet 38 to attract the armature-lever 39 and close the exhaust. The magnet 38 may also be used to close the circuit through magnet 28 by means of the circuit-closer at 44ª, contact being made in the form of mechanism illustrated in Fig. 2 by contact-maker 45ª. The valve 26 is thereby opened, gas flows into the motor, and the signal is moved to "safety." When the motor has nearly completed its stroke, in the embodiment of the invention illustrated in Fig. 2 a means is provided for sealing the gas within the working chamber of the motor. This means may be widely varied. I prefer to accomplish the result indicated electrically. I prefer to utilize a member, such as 46, attached to a moving part of the motor, which when the motor has made a complete movement will actuate the circuit-breaker 47, thus opening the circuit 48 of the magnet 28 and deënergizing the latter. The valve 26 drops to its seat and the gas is sealed between the valve 26 and the piston of the motor. When a signal or device is used that is held at one position by the pressure of the gas, I prefer to employ means for preventing the signal or device from leaving the position to which it has been moved on account of leakage of the gas. I have shown one form of means for accomplishing the result in Fig. 2, in which a device that may be in the form of a pressure-gage 49 acts as a circuit-closer. The pressure of the gas in the pipe moves the pressure-gage in any desired manner. This produces a rotation of the shaft 49ª, to which is attached the contact-arm 50, insulated at 50ª, that makes contact with the arc-shaped conductor 51. The branch circuit 53 54 is completed by this switch at 52. When the motor has reached the end of its stroke, the switch 50 is urged beyond the contact 51 by the pressure of the gas. The circuit of the magnet 28 is now opened at two points, one being the contact 47, the other the contact 50. Should the gas leak slightly out of the motor-cylinder, the pressure-gage, which is quite sensitive, would drop and close the contact 50 51, thus energizing the magnet 28 and supplying more gas to the motor. This preserves sufficient pressure in the motor-cylinder to retain the signal at the position desired. The contact 50 51 preferably acts so quickly that slight variations in pressure are at once counteracted without necessitating a return movement of the motor nor one sufficiently great to close the contact at 47. It will be observed that this feature of my invention may be used with any form of signal in which gas-pressure is utilized to hold the signal at one position.

In the embodiment of the invention illustrated in Figs. 4 and 5 I have shown a retaining device for holding the signal at one position of indication. In the particular embodiment of the invention illustrated the signal-blade 1 is urged in one direction by the weighted spectacle 2. Any desired means may be used to move the signal in the opposite direction. I have shown a piston 3 and the piston-chamber 4 for this purpose. Any desired means may be used to connect the motor with the signal. I prefer to use a thrust-rod 55, attached to the cylinder at one end and to the connecting-rod 56 at the other end. The connection between the thrust-rod and the connecting-rod 56 is made by a clamp 57. The connecting-rod 56 is pivoted at 58 to the signal-arm. The rod 55 is preferably guided at its upper end in a bracket 59. The means that are used to hold the signal at one position of indication may be widely varied. I prefer to utilize the form of mechanism illustrated in Figs. 4 and 5. In these views a pivoted member 60, pivoted at 60ª, is urged in one direction by any suitable device, such as a weight 61. A detent 62, connected with the member 60, engages under a shoulder 62ª (shown in dotted lines in Fig. 5) on the bracket 63 when the motor has completed its movement. The bracket 63 is attached to a moving part of the system—as, for example, to the rod 55—by the clamp 64. The bracket 63 is guided by the lugs 65, which embrace the guiding-rib 66. The armature 67 when attracted by the electromagnet 68, as will appear more fully hereinafter, holds the detent in position under the shoulder on the bracket 63. When the magnet is deënergized, the pivoted arm 69, pivoted at 70 to bracket 63, said arm being spring-pressed by spring 70ª, attached to the arm 69 and bracket 63 and carrying the roller 71, urges the member 60 away from the electromagnet, so as to prevent sticking of the armature 67.

I will now describe the means for reducing the pressure and controlling the admission of gas to the motor. These means may be widely varied. In the best embodiment of the invention I use a supply of fluid under pressure in the tank 17. Gas from said fluid passes through pipe 72 to the reducing de-

vice 18. The form of the reducing device may be widely varied. I have shown in Figs. 4, 5, and 6 one form of pressure-reducing passage that may be utilized. This is illustrated in section in Fig. 6. The electromagnet 73 controls the admission-valve, (not shown in Fig. 4,) and when the valve is opened gas flows through the reducing-passage into the pipe 74, then through pipes 75 and 76 to the motor. The exhaust and the means for controlling it may be widely varied. I have shown a branch pipe 77 leading into the valve-chamber 78 by the inlet 79. The valve-seat 80 seats the valve 81. A cap 82, screwed to the chamber 78, is provided with exhaust-ports 83. The form of the valve 81 may be widely varied, as well as the means for operating the valve. In the form of mechanism illustrated I utilize the same magnet for operating both admission and exhaust valves. The magnet 73 is provided with an armature 84, the movement of which is communicated to the exhaust-valve in any desired manner. I prefer to utilize a lever 85, pivoted at 86 to bracket 87 and pulled in one direction by means such as spring 88. The connecting-rod 89 communicates the movement of the lever 85 to the valve 81. When the magnet 73 is energized, the admission-valve 26 is opened and the exhaust-valve 81 is closed, thus admitting gas to the motor. In the best embodiment of my invention I prefer to close the admission-valve and open the exhaust-valve when the motor has completed its stroke and to hold the parts in position by the retaining device. The means for accomplishing this result may be widely varied. In the embodiment of the invention illustrated this is accomplished electrically. A pivoted lever 90 is made use of, the lever being pivoted at 92 to bracket 93 and urged in one direction by any suitable means, such as the weight of the lever. The roller 94, mounted on the stud 95, carried by the bracket 63, unhooks the latch 96, pivoted at 96′, when the motor has completed its stroke. The return movement of the roller resets lever 90. The lever 90 falls to one side when the latch is unhooked, and this movement is insured by the contact of the tail 97 of the latch 96 with the lever. The movement of the lever 90 controls a circuit-breaker 98, which in turn controls the circuit through the magnet 73. When the lever drops, the circuit of the magnet 73 is opened, the admission-valve closes, the exhaust opens, and the parts settle down on the retaining-detent 62. It will be noted that the magnet 68 is energized at this time, so as to hold the detent in place. I will not describe the circuits and controlling mechanism illustrated in Figs. 4 and 5. These circuits and means may be widely varied. They may be varied so as to operate normal danger or normal safety systems of signals and for other purposes.

In the embodiment of the invention illustrated in Fig. 4 I have illustrated the circuits as controlled by a train 101 on track 100. The track-battery 102 normally energizes relay 103. The relay may be used to control a local circuit in any desired manner. I have shown an armature 104, actuated by the relay, the armature closing the circuit through battery 105. Two circuits are arranged to be energized by battery 105. One circuit passes through magnet 68 and then back to armature 104. The other circuit passes through magnet 73 and back to armature 104. When the relay 103 is deënergized, as by the presence of a train on the track, the circuit of magnet 73 is opened and the signal goes to "danger," as shown. When the train leaves the track, the relay 104 is closed. This energizes magnets 68 and 73, the exhaust-valve 81 is closed, the admission-valve 26 is opened, the piston-chamber 4 rises, the roller 94 strikes the latch 96, the lever 90 moves to the right, thus opening the circuit of the magnet 73 at 80, but leaving magnet 68 energized. This closes the admission-valve and opens the exhaust-valve, and the piston-chamber returns slightly, the parts being held by the retaining device at 62. The signal then stands at "safety." When the next train enters the block, it deënergizes magnet 68, releases the detent, and the parts drop to the danger position.

In the form of the invention illustrated in Figs. 9 and 10 a plurality of passages 107 are utilized. The cross-section of each passage may be widely varied. As shown, it is rectangular. A plug 108, provided with a plurality of wings 109, forms the inside walls of the passages. The means for adjusting the cross-section of the passages may be widely varied. In Fig. 9 an adjusting-screw 110, secured in place by a lock-nut 111, is utilized.

The application of the invention to a series of signals forming part of a railway signaling system is illustrated in Fig. 11. The signals are indicated at 112. The casing which contains the parts of the apparatus for actuating and controlling the signals in a gas-tight box is indicated at 113. The track-batteries are designated 114, track-relays 115, and local batteries 116. The flasks for gas are indicated at 117. The operation of the system will be evident from the previous description.

My invention is not limited to a particular theory of operation nor to the particular forms of apparatus illustrated in the drawings. Wide departures may be made in the construction of the apparatus without departing from the principle of the invention.

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

1. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying fluid under pressure to actuate said means, and means whereby frictional resistance is opposed to the passage of the fluid utilized to actuate said means, substantially as described.

2. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure to actuate said means, and means whereby frictional resistance is opposed to the passage of the gas utilized to actuate said means, substantially as described.

3. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor adapted to actuate said railway traffic-controlling means, means for supplying gas under pressure to actuate said motor, and means whereby frictional resistance is opposed to the passage of the gas, substantially as described.

4. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor adapted to actuate said railway traffic-controlling means, means for supplying carbonic-acid gas under pressure to actuate said motor, and means whereby frictional resistance is opposed to the passage of the gas, substantially as described.

5. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor adapted to actuate said railway traffic-controlling means, means for containing a storage supply of liquefied gas to actuate said motor, and means whereby frictional resistance is opposed to the passage of the gas derived from said liquid, substantially as described.

6. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor adapted to actuate said railway traffic-controlling means in one direction, means for supplying gas under pressure, means other than said supply means for returning said railway traffic-controlling means, and means whereby frictional resistance is opposed to the passage of the gas, substantially as described.

7. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means in one direction, a weight for returning said railway traffic-controlling means, means for supplying gas under pressure to actuate said motor, and means whereby frictional resistance is opposed to the passage of the gas, substantially as described.

8. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means in one direction, a weight for returning said railway traffic-controlling means, means for supplying carbonic-acid gas under pressure to actuate said motor, and means whereby frictional resistance is opposed to the passage of the gas, substantially as described.

9. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means in one direction, a weight for returning said railway traffic-controlling means, means for containing a storage supply of liquefied gas to actuate said motor, and means whereby frictional resistance is opposed to the passage of the gas, substantially as described.

10. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means, means for supplying gas under pressure to actuate said motor, means whereby frictional resistance is opposed to the passage of the gas, and means for intermittently admitting gas at a reduced pressure to said motor, substantially as described.

11. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means in one direction, means for supplying gas under pressure, means other than said supply means for returning said railway traffic-controlling means, means whereby frictional resistance is opposed to the passage of the gas, and means for intermittently admitting gas at a reduced pressure to said motor, substantially as described.

12. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means in one direction, a weight for returning said railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and means for intermittently admitting gas at a reduced pressure to said motor, substantially as described.

13. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, means for admitting gas at a reduced pressure to said motor, and means controlled by a train for intermittently controlling said gas-admitting means, substantially as described.

14. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means, means for supplying carbonic-acid gas under pres-

sure, means whereby frictional resistance is opposed to the passage of the gas, means for admitting gas at a reduced pressure to said motor, and means controlled by a train for intermittently controlling said gas-admitting means, substantially as described.

15. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means, means for containing a storage supply of liquefied gas, means whereby frictional resistance is opposed to the passage of the gas derived from said liquid, means for admitting gas at a reduced pressure to said motor, and means controlled by a train for intermittently controlling said gas-admitting means, substantially as described.

16. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means in one direction, means for supplying gas under pressure, means other than said supply means for returning said railway traffic-controlling means, means whereby frictional resistance is opposed to the passage of the gas, means for admitting gas at a reduced pressure to said motor, and means controlled by a train for intermittently controlling said gas-admitting means, substantially as described.

17. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor adapted to actuate said railway traffic-controlling means in one direction, a weight for returning said railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, means for admitting gas at a reduced pressure to said motor and means controlled by a train for intermittently controlling said gas-admitting means, substantially as described.

18. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and means for supplying heat from an external source to said gas, substantially as described.

19. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying carbonic-acid gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and means for supplying heat from an external source to said gas, substantially as described.

20. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for containing a storage supply of liquefied gas, means whereby frictional resistance is opposed to the passage of the gas derived from said liquid, and means for supplying heat from an external source to said gas, substantially as described.

21. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas and means whereby heat is supplied from the atmosphere to said gas, substantially as described.

22. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying carbonic-acid gas under pressure, means whereby frictional resistance is opposed to the passage of the gas and means whereby heat is supplied from the atmosphere to said gas, substantially as described.

23. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for containing a storage supply of liquefied gas, means whereby frictional resistance is opposed to the passage of the gas derived from said liquid, and means whereby heat is supplied from the atmosphere to said gas, substantially as described.

24. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and metallic means for conducting heat to said gas, substantially as described.

25. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and metallic means for supplying heat from the atmosphere to said gas, substantially as described.

26. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and heat-conducting flanges for supplying heat from the atmosphere to said gas, substantially as described.

27. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and means for supplying heat from an external source to said last-named means, substantially as described.

28. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and means whereby heat is supplied from the atmosphere to said last-named means, substantially as described.

29. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying carbonic-acid gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and means for supplying heat from an external source to said last-named means, substantially as described.

30. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for containing a storage supply of liquefied gas, means whereby frictional resistance is opposed to the passage of the gas derived from said liquid, and means whereby heat is supplied from the atmosphere to said last-named means, substantially as described.

31. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and metallic means for conducting heat to said last-named means, substantially as described.

32. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, means for supplying gas under pressure, means whereby frictional resistance is opposed to the passage of the gas, and heat-conducting flanges for supplying heat from the atmosphere to said last-named means, substantially as described.

33. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for supplying gas under pressure, and a pressure-reducing passage in the path of the gas used for actuating said motor, said passage having a small cross-section and a large superficial area, substantially as described.

34. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for supplying gas under pressure, and a pressure-reducing passage in the path of the gas used for actuating said motor, said passage being small in cross-section, but great in length, and having a large superficial area in contact with the gas, substantially as described.

35. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for supplying gas under pressure and a pressure-reducing passage in the path of the gas used for actuating said motor comprising a plurality of surfaces in contact with the gas, substantially as described.

36. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for supplying carbonic-acid gas under pressure and a pressure-reducing passage in the path of the gas used for actuating said motor comprising a plurality of surfaces in contact with the gas, substantially as described.

37. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for containing a storage supply of liquefied gas and a pressure-reducing passage in the path of the gas used for actuating said motor comprising a plurality of surfaces in contact with the gas, substantially as described.

38. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for supplying gas under pressure and a pressure-reducing passage in the path of the gas used for actuating said motor comprising adjacent surfaces in contact with the gas, substantially as described.

39. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for supplying gas under pressure and a pressure-reducing passage in the path of the gas comprising an exterior surface and an interior surface in contact with the gas, substantially as described.

40. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a gas-operated motor for actuating said means, means for supplying carbonic-acid gas under pressure and a pressure-reducing passage in the path of the gas comprising an exterior surface and an interior surface in contact with the gas, substantially as described.

41. In a railway traffic-controlling apparatus, the combination of means for containing a storage supply of liquefied gas and a pressure-reducing passage in the path of the gas derived from said liquid comprising an exterior surface and an interior surface in contact with the gas, substantially as described.

42. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, and means for supplying heat to said passage, substantially as described.

43. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, and means for supplying heat to said passage, substantially as described.

44. In a gas-operated railway-signal, the combination of a signal, a motor for control-

ling said signal, means for containing a storage supply of liquefied gas, a passage in the path of the gas derived from said liquid for reducing the pressure of the gas, and means for supplying heat to said passage, substantially as described.

45. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, and means for supplying heat from the atmosphere to said gas, substantially as described.

46. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, and means for supplying heat from the atmosphere to said gas, substantially as described.

47. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage in the path of the gas derived from said liquid for reducing the pressure of the gas, and means for supplying heat from the atmosphere to said gas, substantially as described.

48. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, said passage having a small cross-section and a large surface in contact with the gas, substantially as described.

49. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, said passage having a small cross-section, a large surface in contact with the gas and a length many times the depth of its cross-section, substantially as described.

50. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, said passage having a small cross-section, a large surface in contact with the gas and a length many times the depth of its cross-section, substantially as described.

51. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage in the path of the gas derived from said liquid to the motor for reducing the pressure of the gas, said passage having a small cross-section, a large surface in contact with the gas and a length many times the depth of its cross-section, substantially as described.

52. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, and a passage for gradually reducing the pressure of the gas used to operate the motor, substantially as described.

53. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, and a passage for gradually reducing the pressure of the gas used to operate the motor, substantially as described.

54. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, and a passage for gradually reducing the pressure of the gas derived from said liquid and used to operate the motor, substantially as described.

55. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas, and means for supplying heat to the gas, substantially as described.

56. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage for gradually reducing the pressure of the gas, and means for supplying heat to the gas, substantially as described.

57. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid, and means for supplying heat to the gas, substantially as described.

58. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas, and means for supplying heat to the passage during the gradual reduction of pressure of the gas, substantially as described.

59. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage for gradually reducing the pressure of the gas, and means for supplying heat to the passage during the gradual reduction of pressure of the gas, substantially as described.

60. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid, and means for supplying heat to

the passage during the gradual reduction of pressure of the gas, substantially as described.

61. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, means for supplying heat to said passage and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

62. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, means for supplying heat to said passage and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

63. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage in the path of the gas derived from said liquid for reducing the pressure of the gas, means for supplying heat to said passage and a valve for intermittently controlling the admission of gas to the motor, substantially as described.

64. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, means for supplying heat from the atmosphere to said gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

65. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, means for supplying heat from the atmosphere to said gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

66. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage in the path of the gas derived from said liquid for reducing the pressure of the gas, means for supplying heat from the atmosphere to said gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

67. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, said passage having a small cross-section and a large surface in contact with the gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

68. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, said passage having a small cross-section and a large surface in contact with the gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

69. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage in the path of the gas derived from said liquid for reducing the pressure of the gas, said passage having a small cross-section and a large surface in contact with the gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

70. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage in the path of the gas to the motor for reducing the pressure of the gas, said passage having a small cross-section, a large surface in contact with the gas and a length many times the depth of its cross-section, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

71. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas before it enters the motor, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

72. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage for gradually reducing the pressure of the gas before it enters the motor, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

73. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid before it enters the motor, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

74. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas, means for sup-

plying heat to the gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

75. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to the passage during the gradual reduction of pressure of the gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

76. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to the passage during the gradual reduction of pressure of the gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

77. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid, means for supplying heat to the passage during the gradual reduction of pressure of the gas, and a valve for intermittently controlling the admission of the gas to the motor, substantially as described.

78. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for reducing the pressure of the gas, means for supplying heat to said passage and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

79. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage for reducing the pressure of the gas, means for supplying heat to said passage and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

80. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage for reducing the pressure of the gas derived from said liquid, means for supplying heat to said passage and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

81. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for reducing the pressure of the gas, means for supplying heat from the atmosphere to said gas, and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

82. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for reducing the pressure of the gas, said passage having a small cross-section and a large surface in contact with the gas, and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

83. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for reducing the pressure of the gas, said passage having a small cross-section, a large surface in contact with the gas and a length many times the depth of its cross-section, and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

84. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas before it enters the motor, and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

85. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to the gas, and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

86. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to the passage during the gradual reduction of pressure of the gas, and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

87. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for reducing the pressure of the gas, means for supplying heat to said passage, and a valve located at the high-pressure side of said passage for intermittently admitting gas to said motor, substantially as described.

88. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying carbonic-acid gas under pressure, a passage for reducing the pressure of the gas, means for supplying heat to said passage, and a valve lo-

cated at the high-pressure side of said passage for intermittently admitting gas to said motor, substantially as described.

89. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage for reducing the pressure of the gas derived from said liquid, means for supplying heat to said passage, and a valve located at the high-pressure side of said passage for intermittently admitting gas to said motor, substantially as described.

90. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to the passage during the gradual reduction of pressure of the gas, and a valve located near said passage for intermittently admitting gas to said motor, substantially as described.

91. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for supplying gas under pressure, a passage for reducing the pressure of the gas, means for supplying heat to said passage and a valve located at the high-pressure side of said passage for intermittently admitting gas to said motor, substantially as described.

92. In a gas-operated railway-signal, the combination of a signal, a motor for controlling said signal, means for containing a storage supply of liquefied gas, a passage for reducing the pressure of the gas, means for supplying heat to said passage and a valve located at the high-pressure side of said passage for intermittently admitting gas to said motor, substantially as described.

93. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying gas under high pressure, a passage for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high pressure side of the system, substantially as described.

94. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying gas under high pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to said gas during the gradual reduction in pressure, and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

95. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying gas under high pressure, a passage provided with large surfaces in contact with the gas for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

96. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying gas under high pressure, a passage for gradually reducing the pressure of the gas, means for manually adjusting the section of the passage and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

97. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying gas under high pressure, a passage having large surfaces in contact with the gas and having a length many times the depth of its cross-section for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

98. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying gas under high pressure, a passage for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

99. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying gas under high pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to said gas during the gradual reduction in pressure and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

100. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying gas under high pressure, a passage provided with large surfaces in contact with the gas for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-

pressure side of the system, substantially as described.

101. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying gas under high pressure, a passage for gradually reducing the pressure of the gas, means for manually adjusting the section of the passage, and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

102. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying gas under high pressure, a passage having large surfaces in contact with the gas and having a length many times the depth of its cross-section for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

103. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying carbonic-acid gas under high pressure, a passage for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

104. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying carbonic-acid gas under high pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to said gas during the gradual reduction in pressure, and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

105. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying carbonic-acid gas under high pressure, a passage provided with large surfaces in contact with the gas for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

106. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying carbonic-acid gas under high pressure, a passage for gradually reducing the pressure of the gas, means for manually adjusting the section of the passage and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

107. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for supplying carbonic-acid gas under high pressure, a passage having large surfaces in contact with the gas and having a length many times the depth of its cross-section for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

108. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying carbonic-acid gas under high pressure, a passage for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

109. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying carbonic-acid gas under high pressure, a passage for gradually reducing the pressure of the gas, means for supplying heat to said gas during the gradual reduction in pressure and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

110. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying carbonic-acid gas under high pressure, a passage provided with large surfaces in contact with the gas for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

111. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for supplying carbonic-acid gas under high pressure, a passage for gradually reducing the pressure of the gas, means for manually adjusting the section of the passage, and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

112. In a railway signaling apparatus the

combination of a railway-signal, a motor for actuating said signal, means for supplying carbonic-acid gas under high pressure, a passage having large surfaces in contact with the gas and having a length many times the depth of its cross-section for gradually reducing the pressure of the gas and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

113. In a railway traffic-controlling apparatus, the combination of railway traffic-controlling means, a motor for actuating said means, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

114. In a railway traffic-controlling apparatus, the combination of a railway traffic-controlling means, a motor for actuating said means, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid, means for supplying heat to said gas during the gradual reduction in pressure, and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

115. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for containing a storage supply of liquefied gas, a passage provided with large surfaces in contact with the gas for gradually reducing the pressure of the gas derived from said liquid and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

116. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid, means for manually adjusting the section of the passage and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

117. In a railway traffic-controlling apparatus the combination of railway traffic-controlling means, a motor for actuating said means, means for containing a storage supply of liquefied gas, a passage having large surfaces in contact with the gas and having a length many times the depth of its cross-section for gradually reducing the pressure of the gas derived from said liquid and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

118. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

119. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid, means for supplying heat to said gas during the gradual reduction in pressure and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

120. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for containing a storage supply of liquefied gas, a passage provided with large surfaces in contact with the gas for gradually reducing the pressure of the gas derived from said liquid and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

121. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for containing a storage supply of liquefied gas, a passage for gradually reducing the pressure of the gas derived from said liquid, means for manually adjusting the section of the passage, and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

122. In a railway signaling apparatus the combination of a railway-signal, a motor for actuating said signal, means for containing a storage supply of liquefied gas, a passage having large surfaces in contact with the gas and having a length many times the depth of its cross-section for gradually reducing the pressure of the gas derived from said liquid and means for automatically varying the sectional area of the passage so as to compensate for variations in pressure on the high-pressure side of the system, substantially as described.

123. In a signal apparatus, the combination of a signal, and means for reducing the pressure of a gas in motion without interrupting its flow comprising a passage having a small cross-section and a large surface in contact with the gas, substantially as described.

124. In a signal apparatus, the combination of a signal, and means for reducing the pressure of a gas in motion without interrupting its flow, comprising a passage having a small cross-section, a large surface in contact with the gas and a length many times the depth of its minimum cross-section, substantially as described.

125. In a signal apparatus, the combination of a signal, means for reducing the pressure of a gas in motion without interrupting its flow, comprising in combination a passage having a small cross-section and a large heating-surface in contact with the gas, and means for supplying heat to said heating-surface, substantially as described.

126. In a signal apparatus, the combination of a signal, means for reducing the pressure of a gas in motion without interrupting its flow, comprising in combination a passage having a small cross-section, a large heating-surface in contact with the gas and a length many times the depth of its minimum cross-section, and means for supplying heat to said heating-surface, substantially as described.

127. In a signal apparatus, the combination of a signal, means for reducing the pressure of a gas in motion without interrupting its flow, comprising in combination a passage having a small cross-section and a large heating-surface in contact with the gas, and means for supplying heat from the atmosphere to said heating-surface, substantially as described.

128. In a signal apparatus, the combination of a signal, means for reducing the pressure of a gas in motion without interrupting its flow, comprising in combination a passage having a small cross-section, a large heating-surface in contact with the gas, and a length many times the depth of its minimum cross-section, and means for supplying heat from the atmosphere to said heating-surface, substantially as described.

129. In a signal apparatus, the combination of a signal, means for reducing the pressure of a gas in motion without interrupting its flow, comprising in combination a passage having a small cross-section and a large heating-surface in contact with the gas, and one or more surfaces for conducting heat from the atmosphere to said heating-surface, substantially as described.

130. In a signal apparatus, the combination of a signal, means for reducing the pressure of a gas in motion without interrupting its flow, comprising in combination a passage having a small cross-section, a large heating-surface in contact with the gas, and a length many times the depth of its minimum cross-section, and one or more flanges for conducting heat from the atmosphere to said heating-surface, substantially as described.

131. In a signal apparatus, the combination of a signal, and means for reducing the pressure of a gas in motion comprising a passage having outer and inner heating-walls, substantially as described.

132. In a signal apparatus, the combination of a signal, and means for reducing the pressure of a gas in motion, comprising a passage having a small cross-section, and a length many times the depth of its minimum cross-sections, said passage having outer and inner heating-walls, substantially as described.

133. In a signal apparatus, the combination of a signal, means for reducing the pressure of a gas in motion, comprising in combination a passage having a small cross-section, said passage having outer and inner walls, and heat-transferring means for supplying heat from the atmosphere to said walls, substantially as described.

134. The combination of a pivoted semaphore, a motor comprising a piston and a piston-chamber, said piston-chamber being provided with a recess, a link pivoted to said semaphore at one end and to one of said parts of said motor at the other end for transmitting the movement of said motor to said semaphore, and a pin engaging said recess for preventing relative rotation between the piston and piston-chamber, substantially as described.

135. The combination of a pivoted semaphore, a motor comprising a piston and a piston-chamber, said piston-chamber being provided with a recess, a yoke provided with an extension, said extension being pivoted to the semaphore at one end and said yoke being pivotally connected to one of said parts of said motor, and a pin engaging said recess for preventing relative rotation between the piston and piston-chamber, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CLYDE J. COLEMAN.

Witnesses:
EDWIN J. MATTHEWS,
MAE MORRELL.