No. 879,397. PATENTED FEB. 18, 1908.

W. C. MAYO & J. HOULEHAN.

AIR BRAKE, LIGHTING, AND SIGNALING SYSTEM FOR RAILWAY TRAINS.

APPLICATION FILED JAN. 31, 1907.

7 SHEETS—SHEET 1.

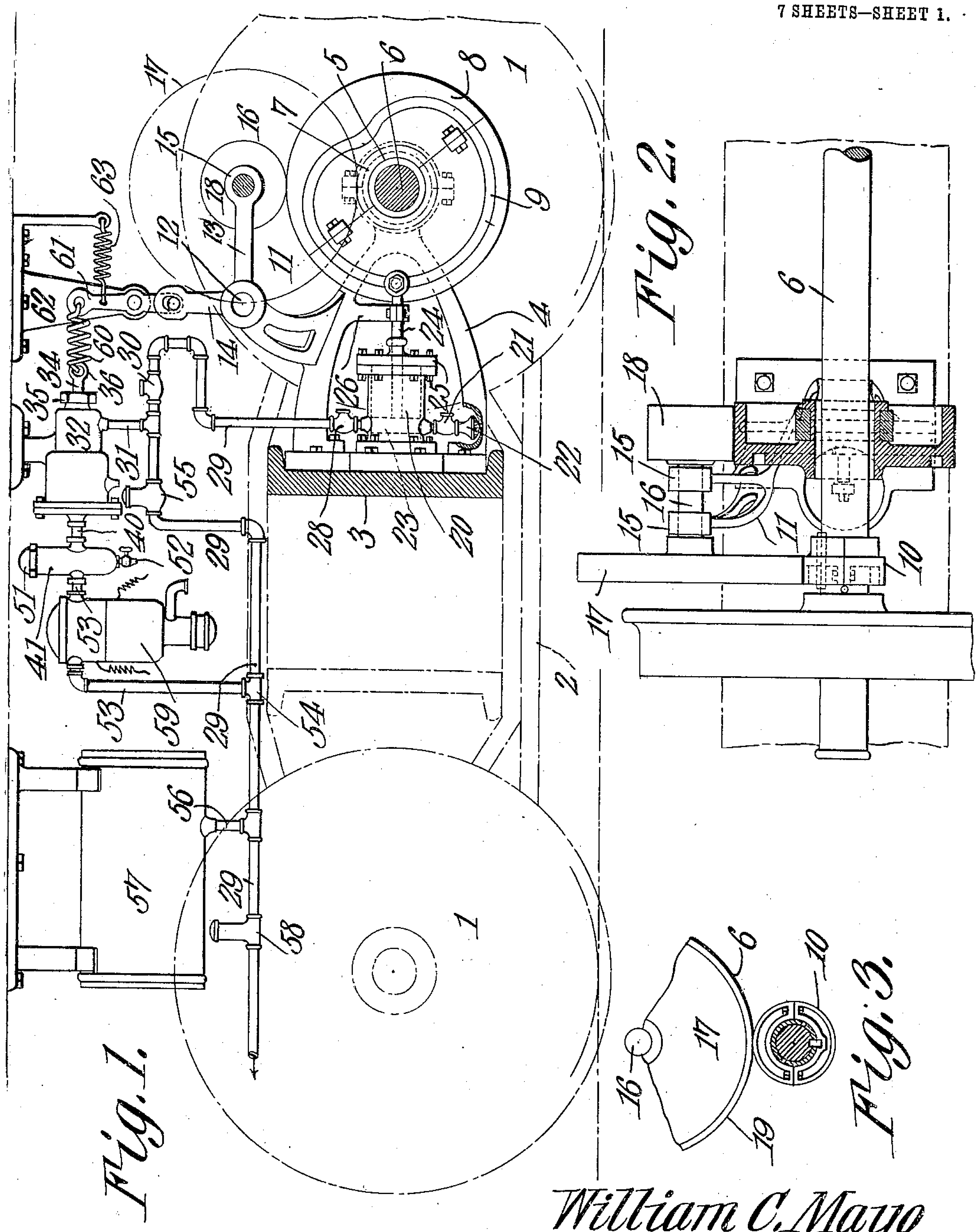

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Fig. 5.

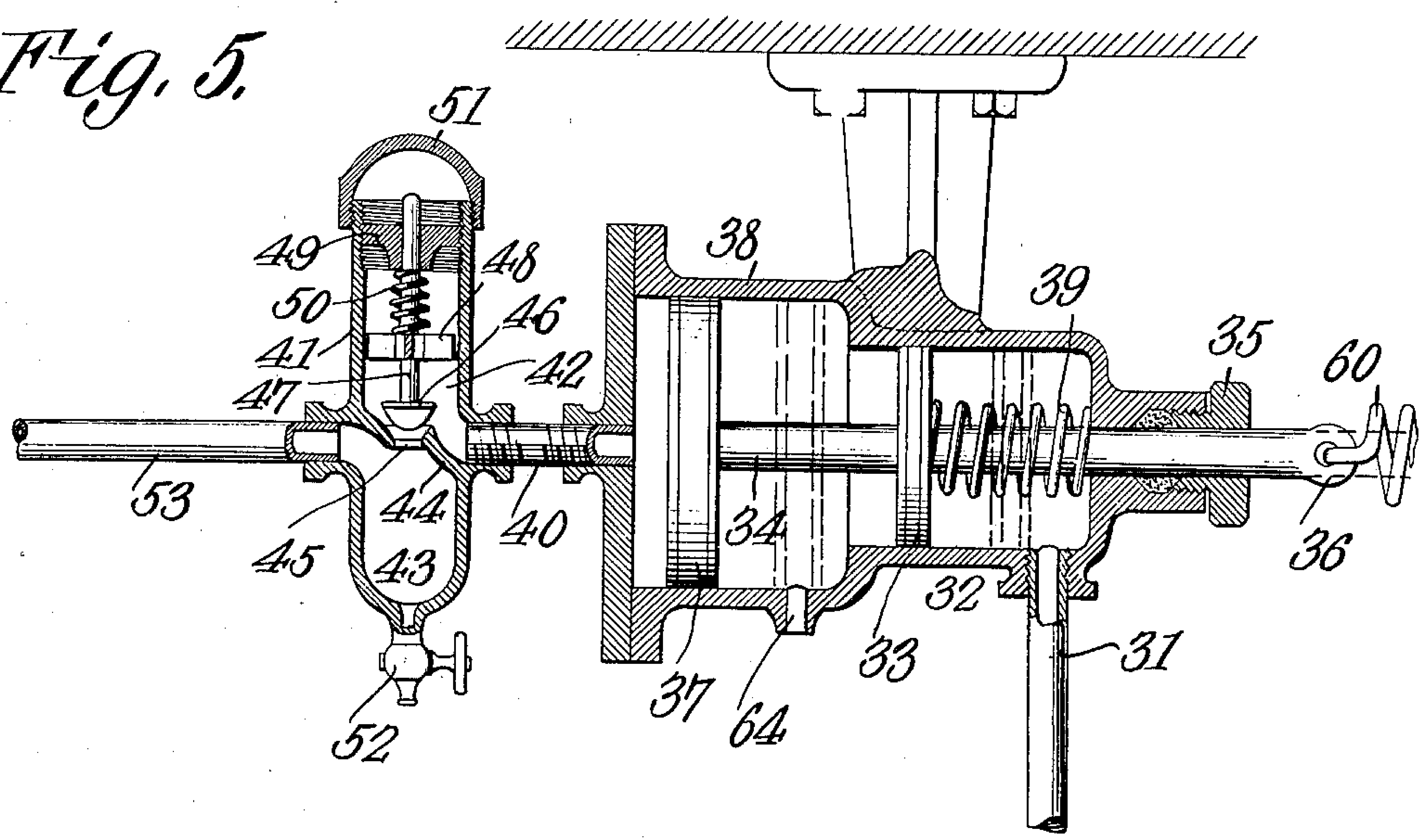
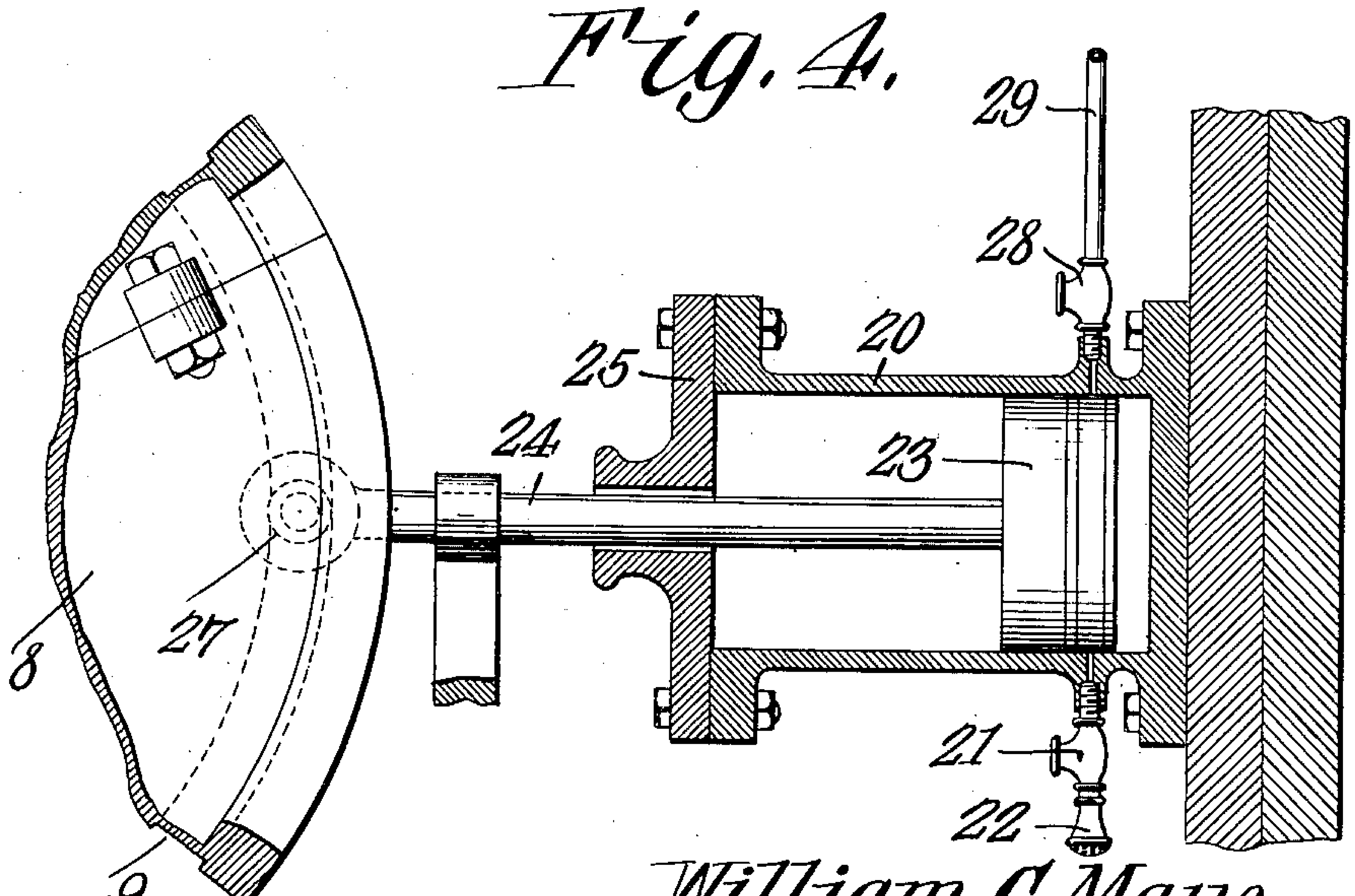


Fig. 4.



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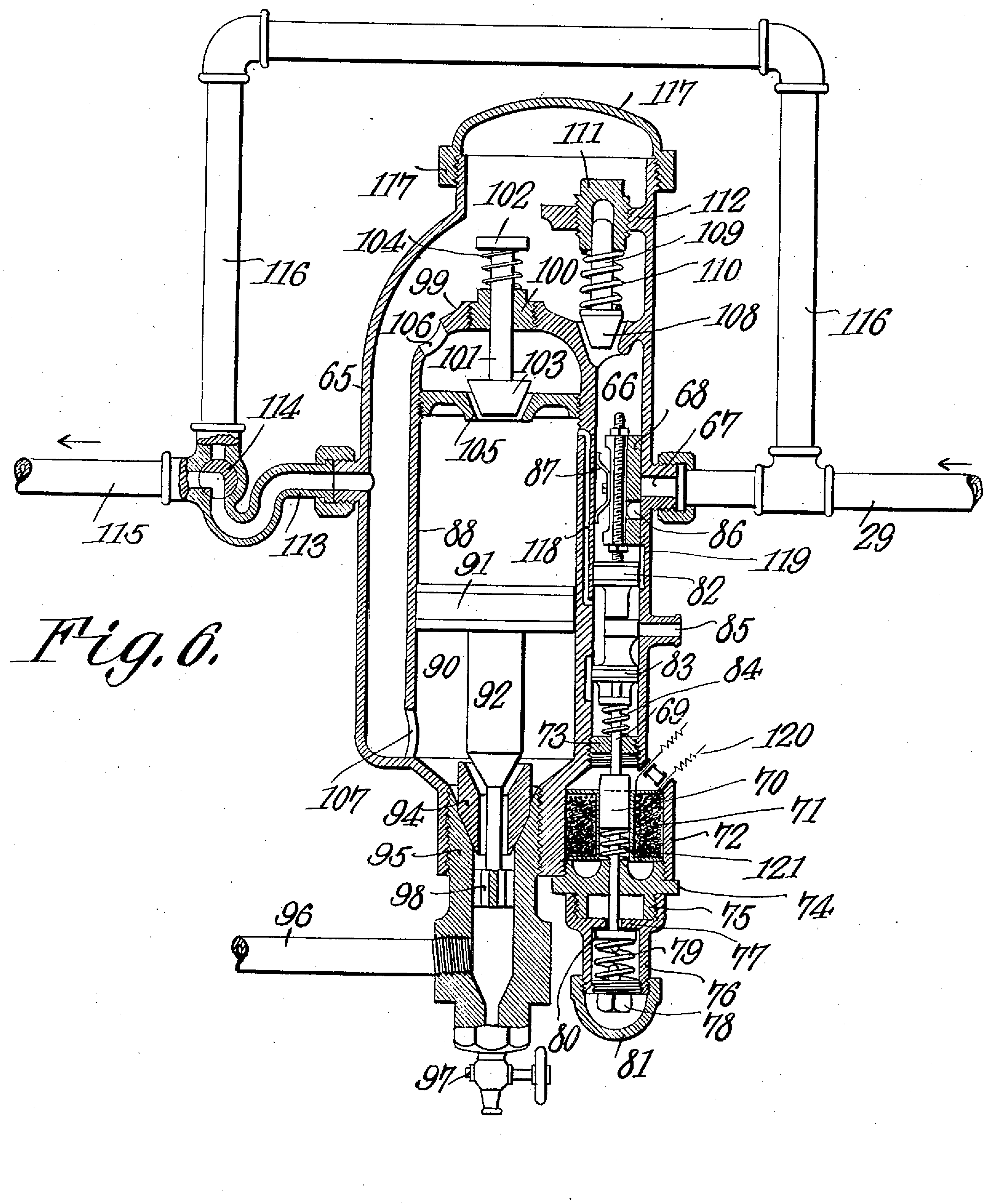

Fig. 6.

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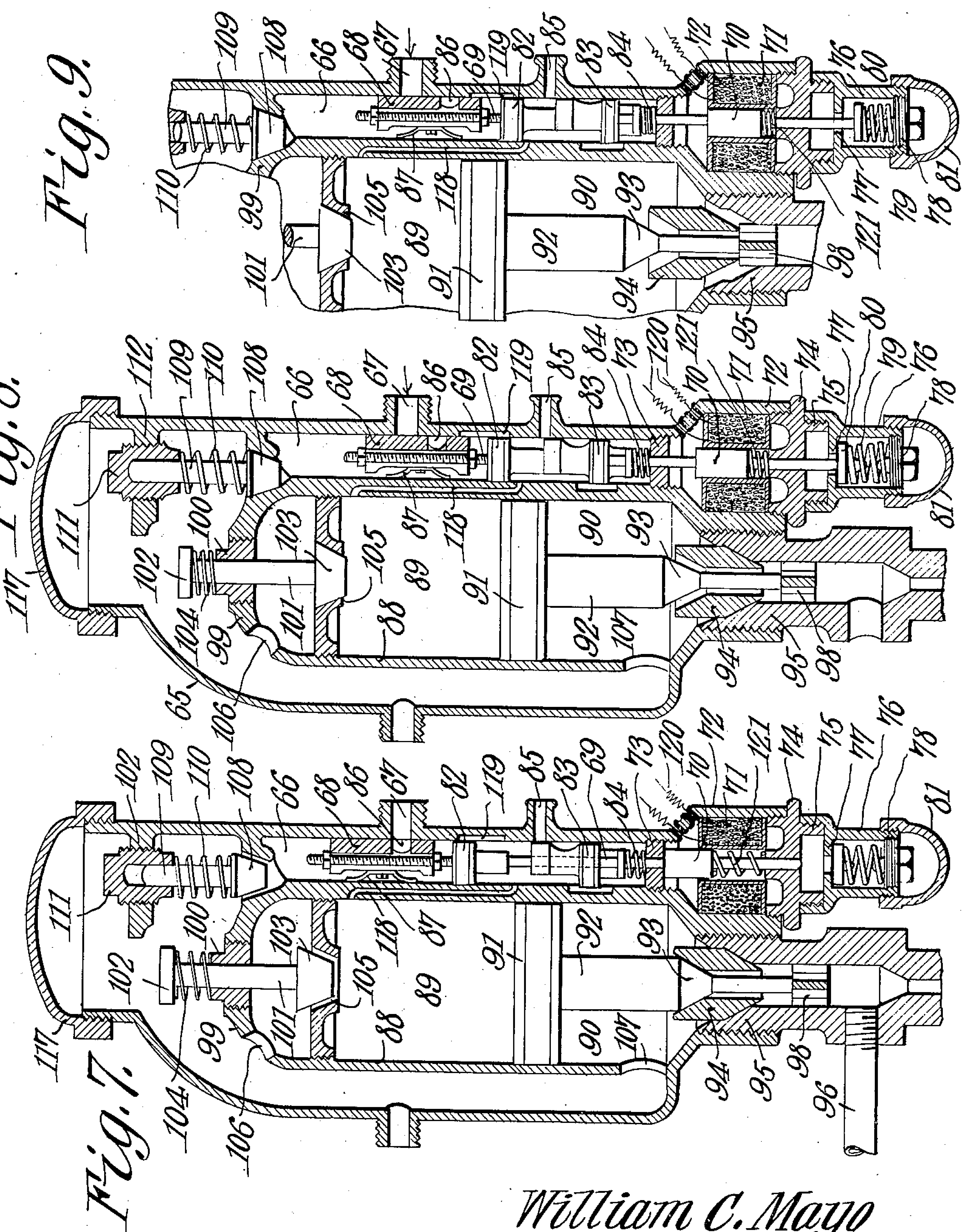

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7 SHEETS—SHEET 5.

Fig. 10.

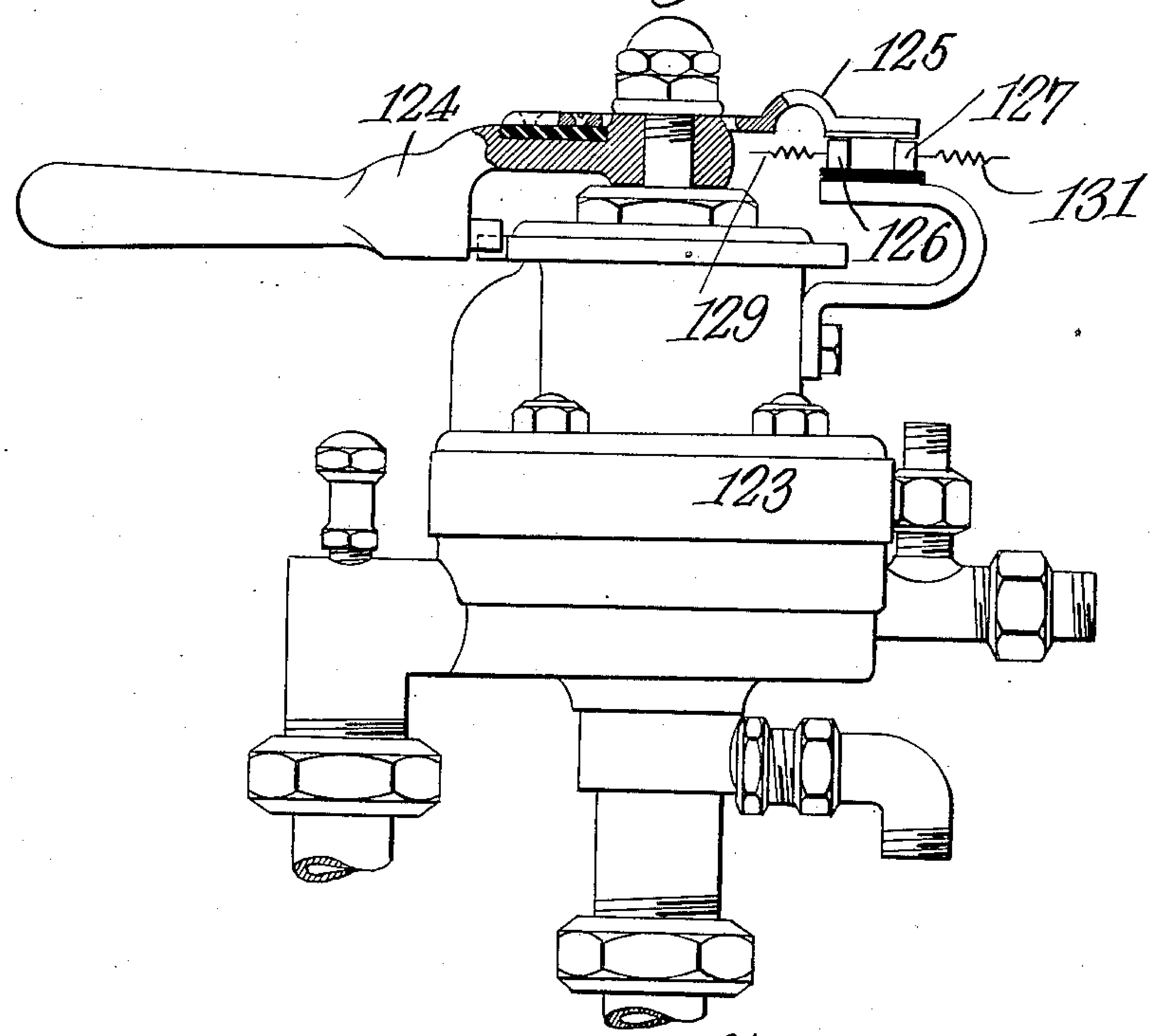
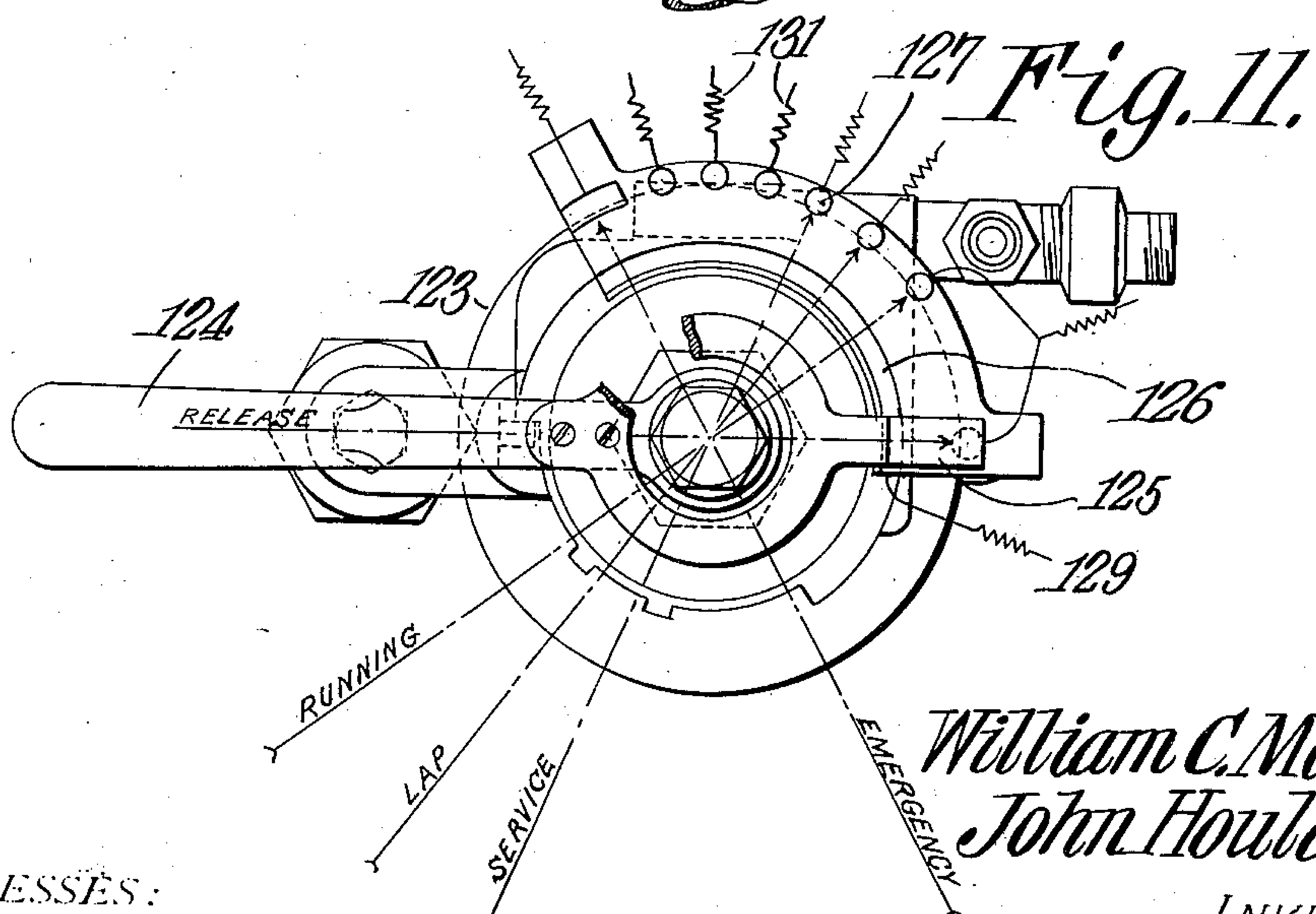


Fig. 11.



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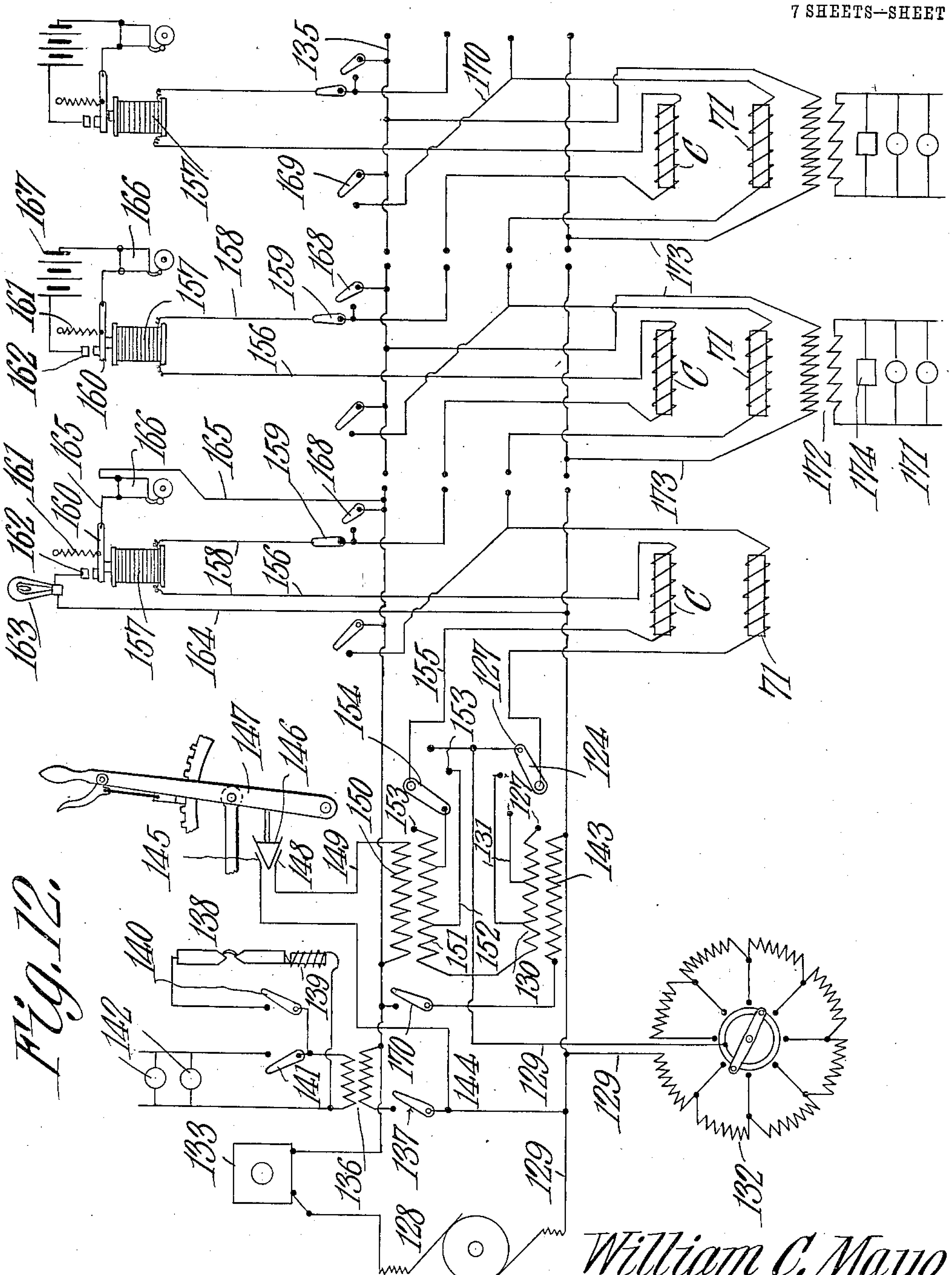

Fig. 12.

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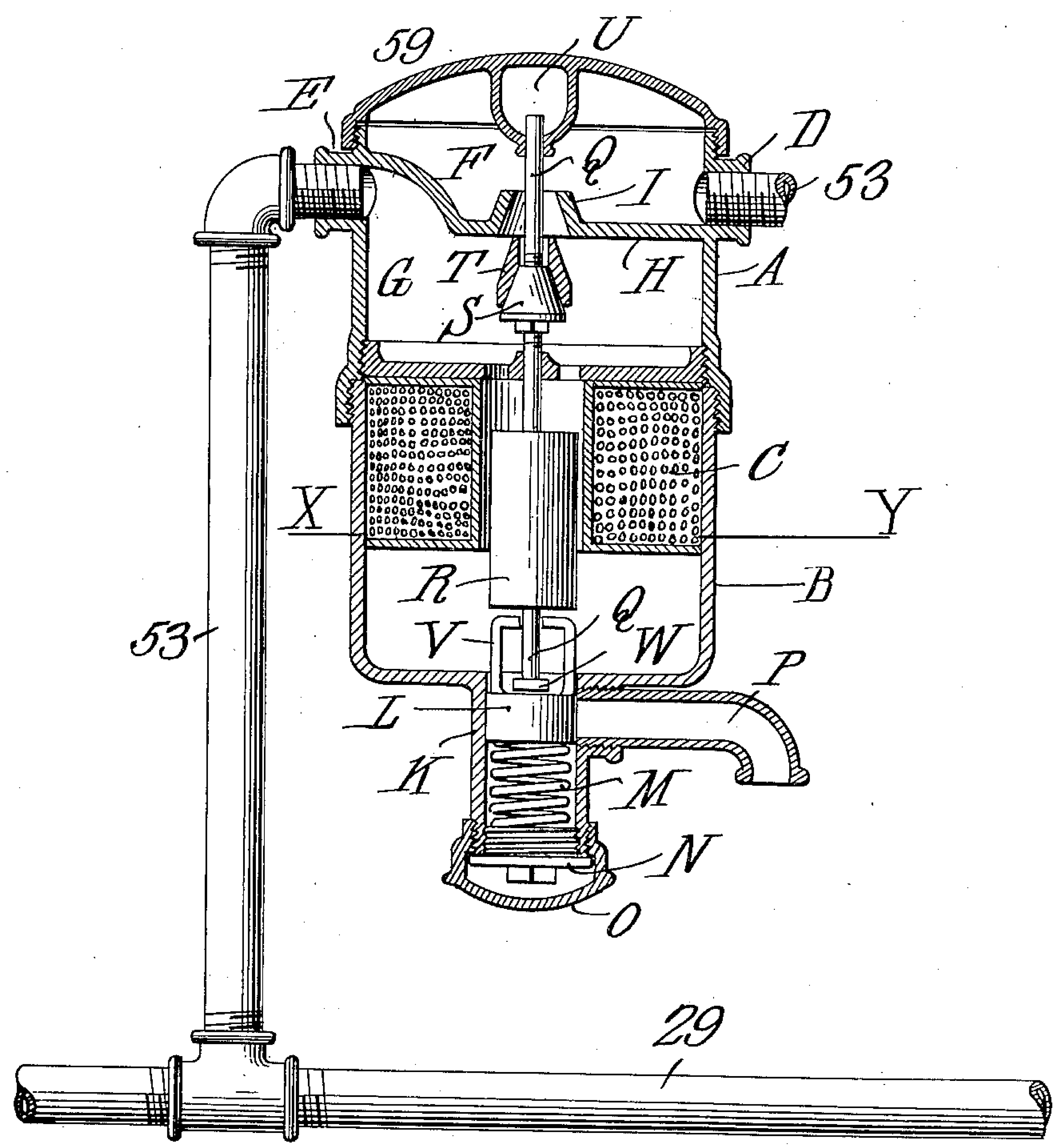
7 SHEETS—SHEET 7.

Fig. 13.



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UNITED STATES PATENT OFFICE.

WILLIAM C. MAYO AND JOHN HOULEHAN, OF EL PASO, TEXAS, ASSIGNORS OF ONE-THIRD TO GEORGE EDWIN BRIGGS, OF BARSTOW, TEXAS.

AIR-BRAKE, LIGHTING, AND SIGNALING SYSTEM FOR RAILWAY-TRAINS.

No. 879,397. Specification of Letters Patent. Patented Feb. 18, 1908.

Application filed January 31, 1907. Serial No. 355,148.

To all whom it may concern:

Be it known that we, WILLIAM C. MAYO and JOHN HOULEHAN, citizens of the United States, residing at El Paso, in the county of El Paso and State of Texas, have invented a new and useful Air-Brake, Lighting, and Signaling System for Railway-Trains, of which the following is a specification.

This invention relates to improvements in the electric control of the braking mechanism of railway trains and the lighting of said trains and also the signaling between the train crew and the engineer.

This invention relates particularly to a means whereby the braking of the train is under the direct control of the engineer without, however, the necessity of air connection between the engine cab and the several cars of the train.

One object of the invention is to provide each car with a braking unit controlled from the engine cab entirely by electric means, thus doing away with the usual air pipes, and in this connection means are provided whereby each car may be equipped with the Westinghouse or New York air-brake mechanism but will be independent of the usual air reservoir on the engine since by this invention each car will provide when running the requisite air supply automatically.

A further object of the invention is to provide each car with a means set into operation automatically by the closure of the throttle valve on the engine whereby the air-brake units upon each car will be put into operation to maintain the predetermined air pressure in the air reservoir upon each car at the maximum pressure, so that power usually allowed to waste is utilized for the purpose of maintaining the air pressure for the brakes at its maximum, and, incidentally, aiding in the braking of the train.

A further object of the invention is to provide each car with an automatic device whereby, should the car run away, the braking mechanism will be put into operation automatically and the air pressure brought to a maximum without the attention of an operator, whether trainman or engineer.

A further object of the invention is to provide a braking mechanism which can be applied to cars in such manner that they may be coupled to trains using the common Westinghouse or New York systems and operated without interference therewith.

A further object of the invention is to provide a train lighting system whereby the same general circuits and means of control utilized for the operation of the braking mechanism may be used for the production of electric lights; in this connection a further object of the invention is to provide a signaling means for use between the conductor and engineer whereby the same system of circuits is utilized by adding thereto the necessary mechanism to produce the signals, after the manner of using, in conjunction with the ordinary air-brake system, a system of signals for the use of the conductor and engineer.

In carrying out our invention along these various lines we provide each car with an ordinary Westinghouse or New York air-brake and provide the cars so equipped, with our invention, whereby each car becomes a unit and is provided with a main air reservoir into which air is pumped to the requisite pressure and there maintained by means of an air-pump operated from the car wheels, and automatically connected to and disengaged from the wheels to maintain a constant pressure in the reservoir. Combined with this pumping mechanism and pressure reservoir there is a valve mechanism for providing ordinary and emergency service, which valve mechanism is controlled by a closed electric circuit charged from a source of electric current from the engine and controlled as hereinafter described by a switching mechanism under the engineer's hand, which switching mechanism may be combined and used in conjunction with the ordinary air-brake valves now in use.

As to the valve mechanism forming part of the present invention, it will be described in detail further on, but it may be here stated that provision is made for its operation by electric means so that the braking of the train is under the same control of the engineer as is found in the ordinary air-brake systems; and provision is also made whereby the breaking of the electric circuit, and, therefore, the loss of control of this valve mechanism, will cause the setting of the brakes, and should the car continue to run the air pressure will be brought to normal even under the conditions of low air pressure when the brakes were first set.

In the practice of our invention on a train supplied with air-brakes controlled by electric means which we have devised, there is mounted upon the engine a dynamo driven by steam from the engine boiler and supplying current constantly to the circuit controlling the various car systems, and there being suitable couplings for the main conductors between the several cars. This dynamo also is used to charge various lighting circuits which may be branched from the main circuit, and also other circuits which are utilized for the transmission of signals from the conductor to the engineer, and to apprise the engineer of breakages of the circuit or other conditions that may exist in the system. All this will more fully appear from the fully detailed description taken in connection with the accompanying drawings forming part of this specification, in which,—

Figure 1 is a side elevation, partly in section and partly diagrammatic, of a car truck showing the pumping and storage mechanism; Fig. 2 is a cross section, partly in elevation, of the car axle driving mechanism; Fig. 3 is a detail view of the same; Fig. 4 is a sectional view of the pump and driving mechanism therefor; Fig. 5 is a sectional view of the equalizing valve connected with the pump delivery; Fig. 6 is a central longitudinal section, with parts in elevation, of the electric valve operating mechanism; Figs. 7, 8 and 9 are similar views of the valve operating mechanism in different positions; Fig. 10 is an elevation, partly in section, of an ordinary air-brake controlling valve with an electric switch attached; Fig. 11 is a plan view of the same; and Fig. 12 is a diagram of the electric circuits; and Fig. 13 is a detail sectional view through the valve mechanism for controlling the car air reservoir pumping mechanism.

Since the braking mechanism *per se* forms no part of the present invention, it has been omitted from the drawings, and the train is represented by a single car truck, which latter is shown largely diagrammatic.

As shown in Fig. 1, the car truck is represented by two wheels 1—1 and a portion 2 of the yoke connecting the same, this being sufficient for the understanding of the present invention. Bolted to one of the cross-beams 3 of the car truck is a yoke-shaped frame 4 having at its free end a journal bearing 5 encircling and concentric with one of the car axles 6. The journal bearing 5 has journaled in it the hub 7 of a cam wheel 8 which is split for application to the journal and around the car axle this cam wheel 8 has formed in one face a cam groove 9, the purpose of which will be hereinafter described. The hub 7 of the wheel 8 is of greater internal diameter than the car axle 6 so as to at all times remain out of contact therewith.

Adjacent to the cam wheel 8 there is securely fixed upon the axle 6 a small pulley 10 splined to the axle and split for easy application thereto. In practice the bore of this pulley will be made large enough to fit any car axle and bushings will be used to reduce the internal diameter sufficiently for various sizes of car axles.

Upon the frame 4 there is formed an offset 11 formed with a bearing 12 for a bell-crank lever 13—14, the member 13 of which has formed in its outer end the journal boxes 15 for a short shaft 16 carrying upon one end a large pulley 17 and upon the other end a small pulley 18. The pulley 17 may be faced with some friction material such as leather or wood, as indicated at 19, and the pulley 18 may be likewise provided on its periphery. The purpose of the pulley system 10—17—18 is to transmit motion from the car axle to the cam wheel 8, and this motion is to be transmitted intermittently as will hereafter appear.

Secured to the cross-beams 3 is a pump cylinder 20, shown in Fig. 1 and on a larger scale in Fig. 4. This pump is of the ordinary single acting type and is designed to compress air. For this purpose it is provided near one end with an inlet opening controlled by a check valve 21 and communicating through the latter and through a strainer 22 with the external air. Air is drawn into the cylinder 20 through the check valve 21 by means of a piston 23 carried by a piston rod 24 guided by the pump head 25 and an arm 26 on the frame 4, and this piston-rod terminates in an anti-friction roller stud bearing 27 engaging in the cam groove 9 in the cam wheel 8. The cam groove is so shaped as to impart a motion to the pump piston through the greater part or only during a small portion of the rotation of the cam wheel. When the piston has been moved to draw air into the cylinder 20 and is then returned, the check valve 21 closes and another check valve 28 in a pipe 29 leading from the pump cylinder opens and allows the air to pass into the said pipe 29. In the pipe 29 is another check valve 30 and beyond this check valve is connected to the pipe 29 the branch pipe 31 leading into a cylinder 32 to one side of the piston 33 (see Fig. 5), which, in turn, is mounted upon a piston-rod 34 which extends in one direction outwardly to a gland 35 and terminates in an eye 36. The piston-rod 34 passes through and beyond the piston 33 and at its end there is another and larger piston 37 moving in an enlarged portion 38 of said cylinder 32. Between the piston 33 and the end of the smaller portion of the cylinder 32 there is a helical spring 39 surrounding said piston-rod and serving to drive said piston 33 away from the gland end of the cylinder 32. The other and large end of the cylinder 32 is connected by a pipe 40 with a casing 41 divided into two compartments 42—43 by a diaphragm 44 in which is formed a valve seat 45 for a valve 46 contained in the compartment 42 and having its stem 47 guided by a spider 48 and a head 49, between which latter and the spider the valve stem is surrounded by a helical spring 50. The upper end of the casing 41 is threaded both internally and externally and the head 49 is threaded to screw into the upper end of said casing 41 and compress the spring 50 to a greater or less extent. The spider 48 is fast upon the valve stem but loose within the casing so that the spring 50 is free to act upon said valve. Screwed on to the upper end of the casing 41 is a cap 51 to protect the valve from harm or malicious manipulation.

The lower chamber 43 of the casing 41 is provided with a drain-cock 52 and also communicates by a branch pipe 53 with the pipe 29 coming from the pump 20 by means of a T-coupling 54. The pipe 29 extends between the branch pipe 31 and the coupling 54 and contains a check valve 55. Beyond the coupling 54 the pipe 29 extends ultimately to the air-brake mechanism, not shown, but between said mechanism and the coupling 54 the pipe 29 connects by a branch pipe 56 with a reservoir 57 and contains beyond said reservoir a check valve 58. The reservoir 57 constitutes the compressed air reservoir for the particular car which carries it and takes the place of the main reservoir always situated on the engine with the usual brake mechanism heretofore used, an auxiliary reservoir being always provided on each car.

In the pipe 53 between the check valve contained within the casing 41 and the connection of the pipe 53 with the pipe 29 at the coupling 54 there is included a valve mechanism 59.

The structure 59 consists of a two-part cylindrical casing A—B, the part B screwing into the part A, at which point the casing carries a solenoid C to be hereinafter referred to. The pipe 53 coming from the check valve casing 41 is screwed into a suitable nut D formed at the upper end of the chamber, and the other branch of the pipe 53 is screwed into a similar nut E also formed in the upper part of the chamber opposite the nut D. Between the two connections D and E the upper part A of the casing is divided into two chambers F and G by a diaphragm H in which is formed a valve seat I.

The lower portion of section B of the casing is formed into a central neck K in which is a valve L resting normally by gravity upon a spring M of the compression type held within said neck K by a screw-plug N which, in turn, is protected by a screw-cap O threaded on to the exterior of the neck K. The valve L normally closes an exhaust port P.

Normally resting by gravity upon the valve L is a stem Q carrying a solenoid armature R, and above the solenoid is a small fixed valve S upon which is seated a larger valve T movable longitudinally on said stem and having a seat formed for the valve S. Said valve T is adapted to seat in the valve seat I. The stem Q at its upper end fits snugly in an opening formed in a small chamber U within the chamber F, and around this valve stem where it passes through the opening in the chamber U is a loose packing so that the chamber U will operate after the manner of a dash-pot when the stem Q is moved into the same.

The valve L has formed on it fingers V in the path of a stop W on the stem Q.

The solenoid C is connected by conductors X—Y to an electric circuit to be hereinafter described, it sufficing at this point to say that the circuit may be so connected to and controlled by the throttle valve on the engine that the solenoid will be energized sufficiently to cause it to draw its armature R to the desired extent when steam is shut off at the engine, as, for instance, when the engineer desires either to slow up or to stop the train.

Reverting, now, to the piston rod 34, this latter piston-rod is connected by means of a spring 60 to a short lever 61 of the first order mounted upon a bracket 62 depending from the car frame or other portion of the car, and this lever is connected at its other end to the arm 14 of the bell crank lever 13—14. The lever 61 is constrained to move, by means of a spring 63, in such manner as to draw the piston 34 outwardly and through the bell-crank lever 13—14 lift the pulleys 17 and 18 away from the pulley 10 and cam wheel 8.

The check valve 55 is set to open at some predetermined pressure, say fifty pounds. Before this pressure is reached the pump 20 will deliver air through the pipe 29 and branch pipe 31 to the cylinder 32 in front of the piston 33. Now, assuming that the spring 39 has a normal expansive force of fifty pounds, the piston 33 will be held in a position away from the gland end of the cylinder with a pressure of one hundred pounds. This pressure will act through the lever 61 and bell crank lever 13—14 to maintain the pulleys in operative contact and keep the pump in working condition. After a pressure of fifty pounds in the pipe 29 has been reached, the air will pass the check valve 55 and ultimately reach the reservoir 57 and the pumping will continue until a pressure of, say one hundred and fifty pounds has been reached in the reservoir. This pressure will also be maintained in that portion of the cylinder 32 in front of the piston 33 in addition to the initial pressure of one hundred pounds. Now, however, the reservoir pressure will react through the pipe 53 upon the valve 46 in the cylinder 41. If this valve has been set to open at a pressure of, say one hundred pounds, the excess of pressure in the reservoir 57 will open this valve and compressed air will reach the cylinder 32 back of the piston 37. This piston is larger in diameter than the piston 33 and the parts are so proportioned that the excess of pressure which forces the air to the rear of the piston 37 will ultimately balance the pressure in the small end of the cylinder 32 and the spring 63 will draw the piston forward and cause the lever 61, acting through the bell crank lever 13—14, to lift the pulleys 17 and 18 out of engagement with the pulley 10 and cam wheel 8. Air will leak past the piston 33 into the space between the two pistons 33 and 37 and escape through the open outlet 64. This will reduce the pressure in front of the piston 33 and piston 37 will ultimately move sufficiently to cover the outlet 64, though a very small leakage is always purposely present. Now air from the reservoir will pass to the braking mechanism necessarily and ultimately the pressure will be reduced. When this occurs and the pressure drops to one hundred pounds the check valve 46 will close and the leakage past piston 37 will reduce the pressure in the large end of the cylinder 32. The excess of pressure in the small end of cylinder 32 will cause the latter to return to its first position, thus again bringing the pulleys 17 and 18 into contact with the pulley 10 and cam wheel 8 and again operating the pump to compress air. The spring 39 has sufficient force to bring the pump-operating parts into operative connection when the pump is started and this is quickly supplemented by the increased air pressure. The pistons 33 and 37 will ultimately return to their first position because of the leakage past them when the air pressure in the reservoir 57 has reached a point which permits the valve 46 to close but this air pressure is even then greater than that required for the operation of the air-brakes, which latter pressure is usually about seventy pounds, so that when the air pressure in the reservoir 57 is reduced to approximately one hundred pounds the pumping will be resumed and the pressure again raised to one hundred and fifty pounds. This operation is performed automatically from time to time as required.

Suppose, now, that the structure included in the casing 59 were absent. The operation just described would take place as described, but if the brakes had been applied and the pressure in the reservoir 57 had been reduced partly, that is, not enough to cause the pump to be put into operation, the next time the brakes were operated, as, for instance, when the train was brought to a standstill, the pressure in the reservoir 57 might be reduced much below that necessary to maintain the brake-operating pressure. Then while the train was starting and getting up speed there would be the additional work imposed upon the engine of not only starting the train but of operating the several pumps for the several reservoirs 57 and this at a time when the engine is under greatest load. By means of the structure 59 the pumps are automatically set in operation when the train is slowing down, either from temporarry shut-offs or when preparing to make a full stop, and even though the brakes are being or have been applied the pumping will proceed as long as the train is moving or until the maximum pressure has been reached in the reservoirs 57.

The arrangement is such, as will hereinafter appear, that when the engineer closes the throttle to shut off the steam sufficient current reaches the solenoids C to cause each of them to attract its armature R. The valve stem Q fast on said armature R will be moved in a direction to cause the valve T to be seated in the valve seat I where the final movement of seating will be effected by the back pressure from the reservoir 57, and this pressure will hold the valve T in place. A sudden motion of the valve stem Q is prevented by the dash-pot action of the chamber U. When the armature or core R has reached the limit of its travel within the solenoid C the stop W will be just in engagement with the fingers V on the valve L, and the valve L in this position closes the exhaust passage P. The armature or core R being relieved of the weight of the valve T and being firmly held by the solenoid C, will maintain the small valve S in its seat in the valve T. Now, the leak past the piston 37 reduces the pressure on that piston until the valve 46 will be closed by the spring 50 since no air can pass the valve T. The spring 39 behind the piston 33 and also the air pressure reaching the same through the pipe 31 will move the piston 33 so as to bring the pump into action, as heretofore explained, and this action is maintained until the reservoir has been pumped up to the predetermined pressure. When this pressure is reached it will act through the valve L upon the spring M until the said valve is moved to open the exhaust or blow-off passage P, at the same time compressing the spring M and also by the fingers V pulling down the valve stem Q and unseating the valve S from the valve T, which valve S is purposely made very small. This operation permits the pressure to accumulate under valve 46 and raises the same, whence pressure reaches the piston 37 and moving the same cuts out the pump. As soon as the pressure is equalized the valve T falls by gravity, fully opening the passage to piston 37.

It will be seen that every time that steam is shut off at the engine the pump is put in operation and the momentum of the train is utilized for the purpose of operating the pumps. Thus not only are the pumps operated by power usually wasted but the resistance of the pumps also serves to brake the train to the extent to which they offer resistance to the turning of the wheels propelling them.

Should the pressure in the reservoirs 57 be reduced at times when the steam is not shut off, then the pump-operating mechanism extraneous to the mechanism included in the casing 59 will serve to cause the pumping of air into the reservoirs 57 until the maximum pressure is attained.

Between the main power reservoir and the regular triple (which latter is required only on cars equipped with hose couplings for the regular air-brakes as well as with the present invention) the auxiliary reservoir and the brake cylinder, there is located a reducing valve operated electrically from the engineer's cab to assume the positions of "running", "service" and "emergency". This reducing valve or electric triple, as it may be called, is shown in section in Fig. 6 and in the several operative positions in Figs. 7, 8 and 9. It consists essentially of a casing 65 having formed in one side a chamber 66 communicating through a port 67 with the supply pipe 29 coming from the main pressure reservoir 57. Within the chamber 66 is a valve system comprising a slide valve 68 on one end of a valve stem 69 and near the other end of this valve stem there is secured an armature 70 for a solenoid 71 located in an enlargement 72 of the casing 65 in line with the chamber 66. The valve stem 69 passes through an adjustable guide nut 73, and a cap 74 below the solenoid and holding the latter in place is screwed to a threaded stud 75. Formed on said cap 74 is a sleeve 76 having one end closed by a perforated diaphragm 77 and the other end closed by a nut 78. Between the diaphragm 77 and nut 78 there is confined a helical spring 79 and disk 80 which is normally pressed by the spring 79 against the diaphragm 77. This diaphragm 77 is centrally perforated for the passage of the lower end of the valve stem 69 and the disk 80 acts as an abutment for the valve stem 69, which latter, under conditions hereinafter set forth, projects through the perforated diaphragm 77 and compresses spring 79 to a greater or less extent. The lower end of the sleeve 76 is closed by a cap 81.

Fixed upon the valve stem 69 below the slide valve 68 there is a piston 82, and carried by said valve stem 69 but not fixed thereon is another piston 83 between which and the nut 73 is a spring 84.

The chamber 66 has an exhaust port 85 within the range of travel of the piston 83, as hereinafter described.

The slide valve 68 is provided with a port 86 which may be moved into and out of communication with the pipe 29, and this slide valve is held in contact with the side of the casing into which the pipe 29 opens by a bow-spring 87.

Centrally located within the casing 65 is a cylinder 88 divided into two chambers 89—90 by a piston 91, the stem 92 of which is formed into a valve 93 seated on an auxiliary valve 94 which is, in turn, seated in one end of a casting 95 screwed into the lower end of the casing 65 and having tapped therein the exhaust pipe 96 and a drip valve 97. The lower end of the stem 92 passes through the seat 94 of the valve 93 loosely and is guided at its lower end within the casting 95 by a spider 98 free to move up and down within said casting 95 with the stem 92.

The upper end of the cylinder 88 is closed by a dome 99 tapped centrally to receive a bushing 100 for the passage of a stem 101, the upper end of which receives a fixed nut 102 and the lower end of which carries a valve 103. Between the nut 102 and the bushing 100 the valve stem is surrounded by a spring 104, purposely of little tension. Within the cylinder 88 there is a valve seat 105 dividing the chamber 89 into two parts, and this valve seat receives the valve 103 under certain conditions, but normally this valve is open. Through the dome 99 there is a permanent opening 106 and at the bottom of the cylinder 88 there is another permanent opening 107. The interior of the casing 65 is thus in constant communication with the portion of the chamber 89 above the valve seat 105 and also with the chamber 90 through the port 107. The chamber 66 and interior of the casing 65 are put into communication from time to time through a valve 108, the stem 109 of which is surrounded by a spring 110 and enters a hollow nut 111 capped into an extension 112 on the interior of the casing 65 above the chamber 66. This valve 108 is set to open at a pressure of, say thirty pounds. The interior of the casing 65 communicates through a coupling 113 and three-way valve 114 to a pipe 115 which leads to a regular triple, auxiliary reservoir and brake cylinder (not shown) of an ordinary air-brake system. It will be understood that the regular triple is used only when the system of the present invention is to be operated in connection with other systems, for otherwise the ordinary triple is omitted since the electric valve takes the place of the triple usually employed, but the regular triple will usually be present so that the system of the present invention may be combined with the ordinary system. The pipe 29 and pipe 115 may be put into communication by means of a shunt pipe 116 bridging the casing 65 and valve mechanism therein, the three-way valve 114 being utilized for this purpose when it is desired to cut out the system of the present invention and use the brake mechanism in the usual way.

Access to the interior of the casing 65 for the adjustment of the valves 103 and 108 is had through the upper end of the casing 65 which is normally closed by a cap 117.

The chamber 66 and chamber 89 are in communication through a by-pass 118 which is opened and closed at intervals in the operation of this mechanism, as will presently appear, and in the side of the chamber 66 opposite the by-pass 118 is another by-pass 119, the purpose of which will appear further on.

The solenoid 71 is in communication with the engineer's cab through the leads 120, and between the armature 70 and cap 74 the valve stem 69 is surrounded by a spring 121.

Assuming that the solenoid 71, which is included in a constantly closed electric circuit, is but weakly energized so as to be inoperative, the spring 121 will lift the valve stem and slide valve 68, together with the piston 82, until the port 86 is in communication with the pipe 29. Within this pipe 29 is an air pressure of, say one hundred pounds, coming from the main reservoir 57 through the reducing valve 58. This air pressure is at once established in the chamber 66 and opens the valve 108, which is set at thirty pounds. Therefore, within the casing 65 a pressure of seventy pounds is established through the coupling 113 and pipe 115 to the air-brake mechanism. At the same time this pressure will be established in the upper end of the chamber 89 and will flow past valve 103 into the lower portion of the chamber 89. It will also be established in the chamber 90, the piston 91 under these conditions being in such position that the valve 93 is closed. The compressed air entering through the port 86 will also pass around the piston 82 through the leak passage 119 and by-pass 118 into the chamber 89, so that under these conditions the valve 103 will not be closed by any inrush of air through the opening 106 since the pressure on each side thereof is equalized. Now, by this time the air pressure on each side of the piston 82 has become equalized and the spring 121 will lift the slide valve 68 until the port 86 fully matches the opening coming from the pipe 29 and at the same time the piston 82 has closed the upper end of the leak by-pass 119. Now, let it be assumed that the solenoid 71 is more strongly energized, but not to its full extent. The armature 70 will be drawn down partially into the solenoid against the action of the spring 121. This will draw down the slide valve 68 and piston 82 so that the port 86 is out of communication with the pipe 29 and the piston 82 has closed the lower end of the by-pass leak 119. However, the pull of the solenoid is unable to draw the piston 83 past the exhaust port 85, so that the latter remains closed. Now, by energizing the solenoid to a greater extent, the armature is drawn still further into the solenoid and the piston 83 is lowered until the port 85 is open to a small extent. This permits air to leak through the passage 118 from the chamber 89 to the external air and the pressure in the said chamber 89 is therefore reduced, whereupon the valve 103 closes and the piston 91 is raised, thus opening the valve 93 and permitting the pressure in the casing 65 and in the brake mechanism to be reduced, thus setting the brakes in the ordinary manner for a service application. This position of the parts is shown in Fig. 8. When the solenoid is again weakened to normal condition the parts once more assume the position shown in Fig. 7, which is the condition necessary for running.

When the solenoid is fully energized the armature is pulled down to the greatest extent, not only compressing the spring 121 but also the spring 79. This will fully open the exhaust port 85, allowing a quick reduction of pressure in chamber 89 and the piston 91 will then quickly rise sufficiently to not only open the valve 93 but the spider 98 will also lift the auxiliary valve 94, allowing a large out-flow of air through the exhaust pipe 96 and a correspondingly quick reduction of pressure in the air-brake apparatus, thus providing for the emergency application of the brakes.

In Figs. 10 and 11 is shown an ordinary engineer's controlling valve 123 for an air-brake system, and no description of this valve is necessary. On the handle 124 of this valve, but insulated therefrom, is a switch-arm 125 arranged to pass over and make contact with a continuous contact plate 126 and also with a series of contacts 127, the switch-arm itself acting as a bridge between the two contacts 126 and 127. The switch-arm should be wide enough to bridge two contacts 127 without breaking the circuit through the solenoids.

Upon the engine is located an alternating current dynamo 128, driven continuously by steam from the boiler through the intermediary of any approved small steam engine or turbine (not shown). One terminal of the dynamo is connected through a conductor 129 with the continuous contact plate 126 on the engineer's valve, while the series of contacts 127 are connected respectively to the terminals of booster coils 130 by means of the conductors 131. The arrangement is such that when the engineer's air-brake valve is on "release" or on "running" no booster coils are inserted, but when the valve is on "lap", "service" and "emergency" the booster coils are placed successively in circuit. The purpose of these booster coils is to increase the voltage of the dynamo for a purpose which will presently appear.

The electric circuits of the system are shown diagrammatically in Fig. 12, which includes the engine circuits and that of two cars equipped with the brake mechanism. In this figure the engineer's operating valve is indicated by a switch-arm 124. The circuit from the dynamo 128 may be traced through an equalizing rheostat 132, to be hereinafter described, one or more sections 130 of a booster coil to the switch-arm 124, thence to the solenoids 71 in series, and finally returning by the return conductor 135 to the dynamo 128. The solenoids 71 are in this diagram representative of the electric valve-operating mechanism of the car. The sections 130 of the booster constitute the secondary thereof, while the primary coil of this booster is indicated at 143, and this primary coil 143 may be branched between the main out-going conductor from the dynamo to the return conductor 135 and may include a switch 170, as indicated.

Account must be taken of the fact that each solenoid 71 develops certain counter electromotive force, and when a number of these solenoids are in circuit they serve to cut down the voltage of the dynamo; therefore, since the pull of each solenoid must be carefully adjusted, there is placed upon the engine in the circuit including the solenoids the equalizing rheostat 132 which is, in fact, but a series of cho ing coils each matching in effect the respective solenoids of the train. Thus a train made up of a number of cars will develop in the solenoids a certain counter electro-motive force and the engineer will then adjust the equalizing rheostat 132 in such manner that the voltage of the dynamo will be raised to the normal condition which would prevail if but one solenoid were used so that a pull of the solenoid predetermined upon may be always established, no matter how many solenoids there may be added to the train.

The adjusting rheostat is of the ordinary character and need not be described.

Assuming that the system is adjusted for a predetermined voltage with a certain number of solenoids 71, when the switch-arm 124 is placed upon "release" or "running" contact the solenoids will be inoperative, their pull being too weak to overcome the springs 121. Now, when the switch-arm is placed upon the next contact it will cut in one of the booster coils and the solenoid will be more strongly energized, pulling its armature in a distance in opposition to the spring 121 and thereby moving the slide valve 68 and piston 82 to the position of "lap". By a further movement of the switch-arm the other contacts will cut in more of the booster coils and thereby successively increase the dynamo voltage and thus more strongly energize the solenoids and draw the armatures thereof to move the slide valves 68 and pistons 82 to the "service" and "emergency" positions as the case may be.

The dynamo circuit may have a transformer 136 branching therefrom and controlled by a switch 137 and in the secondary of this transformer may be arranged an arc light 138 under the control of the reactance coil 139 and switch 140, and from this same secondary circuit may be branched another circuit controlled by a switch 141 and containing incandescent lamps 142 in multiple arc. This lighting circuit just described is to be located upon the engine, the arc light serving as an electric headlight.

Branched off from the conductor 129, and which may include a portion of the conductor leading to the switch 137, there is another conductor 144 leading to a terminal 145 in the path of a bridging contact 146 carried by the throttle lever 147 on the engine cab. In the path of the bridging contact 146 there is another terminal 148 connected by a conductor 149 to one end of the primary coil 150 of a booster, the other end of this coil 150 being connected to the return conductor 135. The secondary of this booster is made up of a coil 151 tapped at intervals by conductors 152 leading to terminals 153 in the path of a switch-arm 154 coupled by a conductor 155 to one terminal of the first of the series of solenoids C. The other terminal of the first solenoid C is connected by a conductor 156 to a magnet 157, and the return conductor 158 of this magnet includes a switch 159 and connects to one terminal of the next solenoid C, the other terminal of which is connected by a conductor 156 to another magnet 157 having its other terminal connected by a conductor 158 through a switch 159 to the third solenoid C, and so on throughout the train. The first magnet 157 is mounted upon the engine while the other magnets 157 are mounted upon the several succeeding cars of the train. Each magnet 157 has in operative relation thereto an armature 160 under the control of a retractile spring 161, and arranged to be held away from a contact 162 by the attractive force of the magnet 157 but to make contact therewith under the action of the spring 161 when the magnet 157 is deënergized. The contact 162 opposite the armature 160 of the magnet 157 upon the engine is connected to one terminal of an incandescent lamp 163, the other terminal of which is connected by a conductor 164 to the main out-going conductor coming from the dynamo 128, while the armature 160 is connected by a conductor 165 through a bell or other audible signal 166 to the return conductor 135.

Upon each car the armature 160 is connected as before to a bell 166 but the contact 162 is connected to one side of a battery 167 and the other side of this battery is connected to the bell 166 and the lamp 163 is omitted. Thus, each bell 166 on a car will ring automatically should the cars become uncoupled and the electric connections from the engine be broken, while the bell on the engine will ring from the current supplied by the dynamo should, from any cause, a train be broken in two and the continuity of the electric circuits be thus destroyed. It will be understood, of course, that the bell 166 and lamp 163 on the engine may be so adjusted as to operate with the current furnished by the dynamo, the lamp acting as a non-inductive resistance.

Each conductor 158 may be coupled directly to the return conductor 135 by a switch 168 so that the magnets 157 and solenoids C may be coupled up to the return conductor through the switch 168 on the last car of the train. Similar provision is made by means of a switch 169 and conductors 170 leading to the solenoids 71 so that the circuit may be completed to the return conductor 135 on the last car of the train.

In the return circuit near the dynamo 128 there may be included an adjusting rheostat 133 or the field of the dynamo may also be provided with an ordinary field rheostat.

It will be observed that on the closing of the throttle valve by means of the throttle lever 147 so as to shut off steam, the bridging contact 146 will close the circuit through the coil 150. Now, by a suitable adjustment of the switch 154 the booster coil consisting of the coil 150 and so much of the coil 151 as may be included in the circuit by the switch 154, will cause a stronger current to be generated in the signal circuit; and the solenoids C, which are constructed to be inoperative to the normal current of the signal circuit, will now be rendered active by the stronger current and will therefore operate as before described through the controlling device 59. The momentary opening and closing of the signal circuit by the switches 159 for the purpose of transmitting signals will be insufficient to affect the solenoids C to an extent to cause them to operate.

If it be found that the solenoids C develop a counter electro-motive force to cut down the current when cars containing them are added to the train, a suitable equalizing rheostat may be included in the signal circuit in order to take care of the solenoids C in the same manner that the equalizing rheostat 132 is arranged to take care of the solenoids 71.

The dynamo will be of sufficient size, when used on passenger trains, to provide lights for the train. These lights, which are indicated as incandescent lamps arranged in multiple-arc, may be included in circuit with the secondary coils of transformers 172, the primary coils of which are included in multiple-arc branches through conductors 173 from the main out-going conductor leading from the dynamo and the common return conductor 135. The secondary circuits of the transformers 172 may also include electric fans, indicated at 174.

The present invention will not necessitate the fitting of trains with a complete new system of air-brakes, since the cars next to the engine may be supplied with the ordinary air-brakes controlled by air supplied from the engine, and cars may be added to such a train with the electric equipment constructed in accordance with this invention, the only thing necessary being the source of current on the engine and the addition to the air-brake engineer's valve of the switch and regulating means herein set forth, which will in no wise interfere with the operation of the ordinary air-brakes, and the necessary conducting wires under the cars. Our system can therefore be installed on all cars very cheaply and without interference with existing air-brakes equipments.

We claim:—

1. An air-brake operating system for railway trains comprising an operating unit in each car consisting of a main air reservoir, an air pump communicating therewith operated by the running gear of the car and controlled by the back-pressure from the reservoir, and an electric valve-controlling device constructed to apply the brakes in direct proportion to the current supplied thereto, in combination with a source of electricity located on the locomotive, conductors therefrom to the valve mechanism upon the car, and controlling means for the electric circuit also located on the engine.

2. An air-brake operating system for railway trains comprising an operating unit on each car consisting of a main air reservoir, an air pump communicating therewith, a driving mechanism for the pump operated by the running gear of the car and controlled by the back-pressure from the reservoir, and a valve movable to different operative positions for operating the brake mechanism and electrically actuated from the locomotive.

3. In an air-brake operating system for railway trains, an operating unit on each car, an electrically operated valve for the brake mechanism movable to different operative positions, electric circuits leading from the valve-operating mechanism to the engine cab, and means on the engine cab for charging the valve circuit with currents of a strength directly proportioned to the desired extent of movement of the valve.

4. In an air-brake operating system for railway trains, an operating unit on each car, an electrically operated valve for the brake mechanism movable to different operative positions, electric circuits leading from the valve-operating mechanism to the engine cab, a source of energy on the engine cab for constantly charging said circuit with currents of insufficient strength to operate the valve

mechanism, and means on the engine cab for increasing the current in the circuit to a degree commensurate with the desired extent of operation of the valves.

5. An air-brake operating system for railway trains comprising an operating unit on each car including a main air reservoir for supplying compressed air to the brakes, an air pump, a driving mechanism for the pump operated by the running gear of the car and controlled by the back-pressure from the reservoir, an electrically controlled valve movable to different operative positions for controlling the brake mechanism, a source of current on the engine, circuits therefrom including an electric valve-operating mechanism, and means on the engine for charging said circuits with currents of different strengths sufficient to move the valve to its different operative positions.

6. In an air-brake operating system for railway trains, an electrically operated air valve, on each car movable to different operative positions, an electric circuit including the several air valve operating mechanisms upon the different cars of the train, a source of electric current for normally charging said circuit to an extent insufficient to operate the valve mechanisms, and means under the control of the engineman for increasing the current supplied to an extent sufficient to operate said valve mechanisms.

7. The combination with an air pump of means for driving the same consisting of a cam wheel having a cam groove coacting with the pump piston, a train of friction gear between said cam wheel and the prime mover, and means for putting the friction gear into and out of communication with the prime mover.

8. In an air-brake operating system, the conbination with an air reservoir and a pump for supplying air under pressure thereto, of controlling mechanism for the pump consisting of check valves in communication with the pump and air reservoir adjustable to open at a predetermined pressure, and a differential controlling device for putting the pump into and out of action, controlled by the back-pressure from the reservoir.

9. In an air-brake operating system, the combination with an air reservoir and a pump for supplying air under pressure thereto, of back-pressure check valves arranged to open under predetermined pressure, and a differential controlling device for putting the pump into and out of operation comprising a cylinder containing two pistons of different areas, one in communication with the pump and the other in communication with the air reservoir.

10. In an air-brake operating mechanism, a car unit for supplying compressed air to the air-brake mechanism consisting of an air reservoir, a pump for supplying air thereto, gearing for transmitting motion from the car axle to the pump, back-pressure check valves between the pump and the air reservoir, a cylinder containing pistons of different sizes communicating with the pump and air reservoir, and connections between said piston and the driving gear for the pump for putting said gear into and out of action.

11. In an air-brake system for railway trains, a brake-controlling valve situated upon each car, an electric controlling device coupled to said valve, an electric circuit including all the valve-controlling devices and extending to the engine cab, and means for adjusting the circuit to the number of valve-controlling devices included therein.

12. In an air-brake operating system for railway trains, an operating valve mechanism situated upon each car comprising a casing having chambers formed therein, one chamber containing a valve controlling the main compressed air supply and operated by an electric actuating device controlled from a distance, another chamber containing a piston controlling an exhaust valve, said chamber being in free communication with the part leading to the air-brakes on the exhaust side of the chamber and in intermittent communication therewith on the other side of the piston, a reducing valve between the chamber communicating with the air reservoir and the chamber communicating with the air brakes, and means for reducing the pressure on the side of the aforesaid piston remote from the exhaust valve.

13. In an air-brake operating system for railway cars, a brake-operating valve located upon a car and comprising a casing having therein a chamber connected to the main air reservoir and containing a series of valves controlled in one direction by springs and in the other direction by electric attraction; another chamber communicating with the first named chamber by an adjustable loaded reducing valve and also in communication with the air-brakes, and a third chamber containing a piston controlling an exhaust valve, the said third chamber being in free communication with the second named chamber on the exhaust side of the piston and on the other side of the piston in intermittent communication with the said second chamber and also with the external air.

14. In an air-brake system for railway trains, the combination with an air-brake valve located on the locomotive, of an electric switch having circuit terminals corresponding to the operative positions of the air-brake valve, said switch being mechanically connected to the air-brake valve operating lever and adapted to be put in communication with electrically operated air-brake units upon cars having no air connection with the locomotive, whereby the simultaneous application of the brakes upon cars

having air connection with the locomotive and cars having electrically operated air-brake units, may be effected.

15. In an air-brake system for railway cars, electrically-operated brake-controlling valves situated upon each car and constructed to cause the application of the brakes by and in accordance with an increased current supply, a source of electric current carried by the locomotive, and circuits under the control of the engineer for operating the electrically-operated valves from the locomotive cab.

16. The combination with an electrically-operated system of air brakes comprising an air-brake operating unit upon each car and a source of current and controlling means upon the locomotive connected to each air-brake unit, of signal circuits connected to the brake-operating source or current for the communication of signals to the engine cab.

17. In an air-brake system for railway trains, electrically-operated air-brake units upon each car, a source of current upon the engine, and circuits between the source of current and the air-brake units controlled from the engine cab, in combination with signal circuits receiving current from the same source of energy on the engine, and lighting and power circuits for the train also energized from the same source of current upon the engine.

18. An air-brake system for railway trains, comprising an operating unit on each car consisting of a main air reservoir, an air pump communicating therewith, a driving mechanism for the pump operated by the running gear of the car and controlled by the back pressure from the reservoir, a means for operating the air pump irrespective of the pressure at the reservoir, and an electric controlling circuit for the said operating means leading therefrom to the engine cab and closed on the shutting off of steam from the engine.

19. An air-brake operating system for railway trains, comprising an operating unit on each car consisting of a main reservoir air, an air pump communicating therewith, a driving mechanism for the pump operated by the running gear of the car and controlled by the back pressure from the reservoir, and means for setting the pump into action independent of the pressure from the reservoir electrically controlled from the locomotive.

20. An air-brake operating system for railway trains, comprising a main air reservoir on each car, an air pump communicating therewith, a driving mechanism for the pump operated by the running gear of the car and controlled by the back pressure from the reservoir, and means on each car interposed between the reservoir and pump-operating mechanism for closing the latter to the back pressure of the reservoir and electrically controlled from the locomotive.

21. An air-brake operating system for railway trains, comprising an operating unit on each car consisting of a main air reservoir, an air pump communicating therewith, a driving mechanism for the pump operated by the running gear of the car and controlled by the back pressure from the reservoir, an electrically controlled valve between the pump and reservoir, an electric circuit leading therefrom to the engine cab, circuit terminals therefor in the path of the throttle valve mechanism on the engine cab, and a terminal bridging means closing said circuit when the throttle is closed.

22. In an air-brake operating system for railway trains comprising a main air reservoir, an air pump and a driving mechanism for the latter operated by the running gear of the car and controlled by the back pressure from the reservoir, a means for controlling the air pump irrespective of the back pressure of the reservoir consisting of a valve interposed between the reservoir and pump mechanism, an electric operating means for the valve energized by the closing of the throttle valve on the engine, and a check valve also controlling the electrically operated valve and itself controlled by the maximum back pressure of the reservoir.

In testimony that we claim the foregoing as our own, we have hereto affixed our signatures in the presence of two witnesses.

WILLIAM C. MAYO.
JOHN HOULEHAN.

Witnesses to signature of Mayo:
HENRY P. STROH,
W. A. WARNOCK.

Witnesses to signature Houlehan:
A. M. WALKER,
H. G. CLUNN.