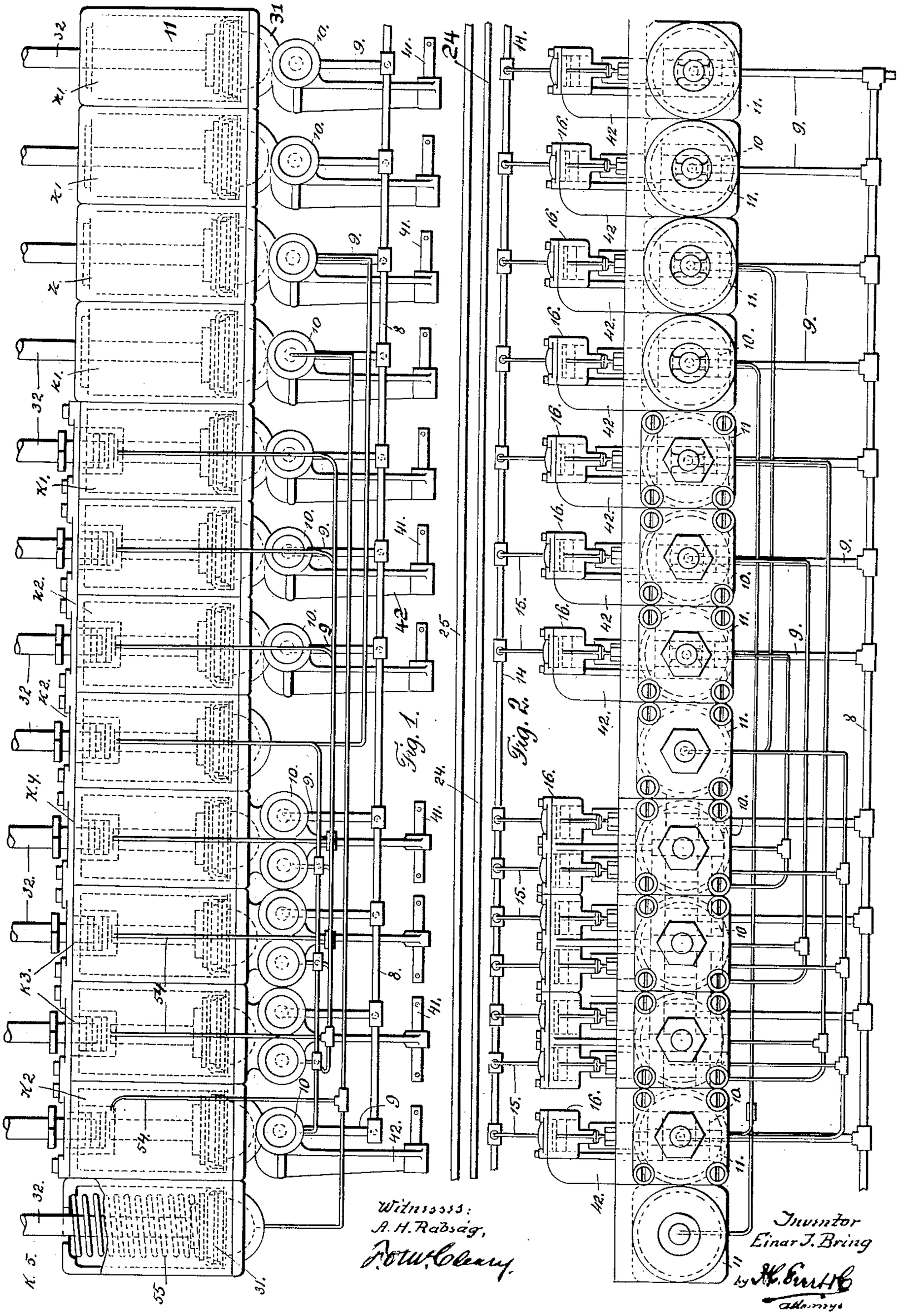
No. 842,619. PATENTED JAN. 29, 1907.

E. J. BRING.

SYSTEM OF PNEUMATIC CONTROL.

APPLICATION FILED JULY 25, 1906.

4 SHEETS—SHEET 1.



No. 842,619. PATENTED JAN. 29, 1907.

E. J. BRING.

SYSTEM OF PNEUMATIC CONTROL.

APPLICATION FILED JULY 25, 1906.

4 SHEETS—SHEET 2

Fig. 4.

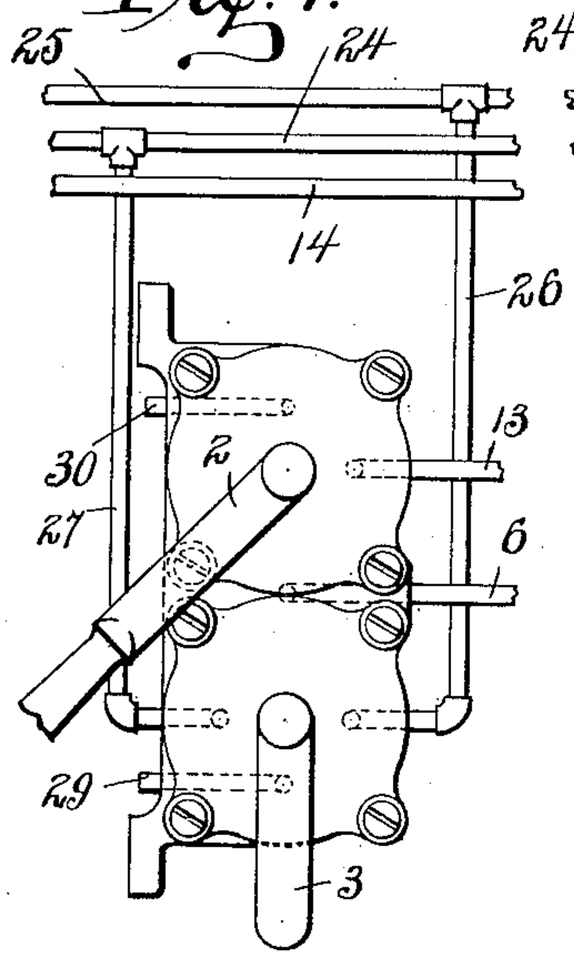


Fig. 3.

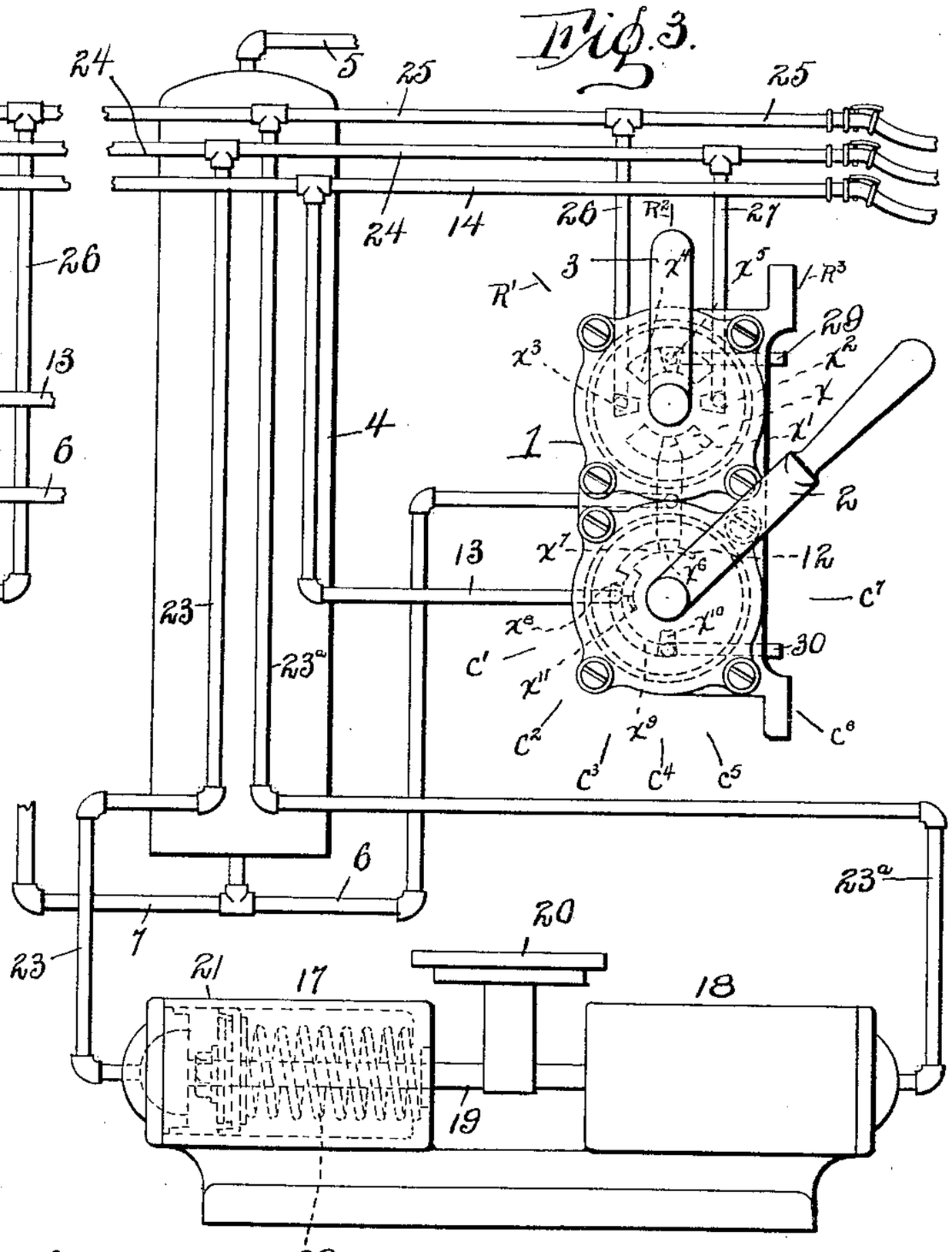
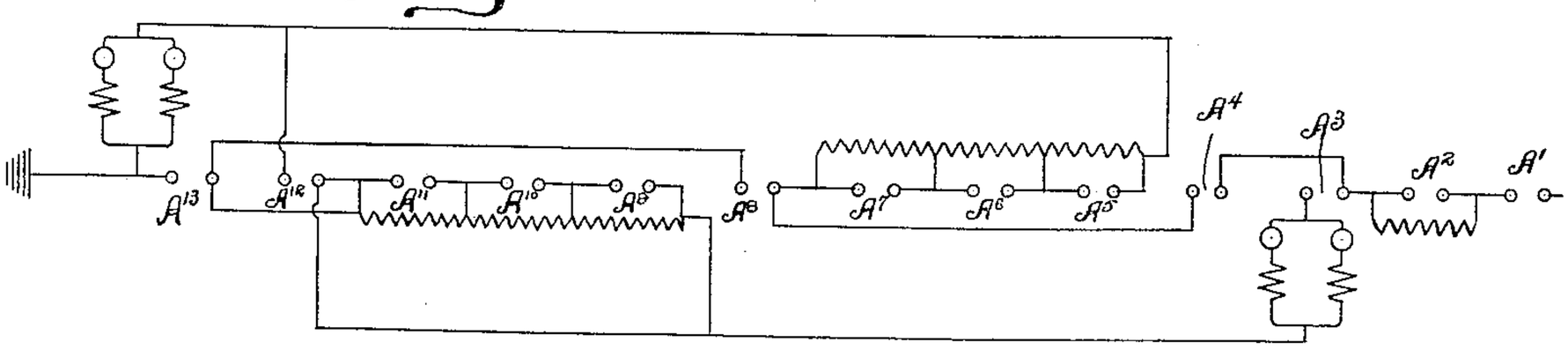


Fig. 5.



WITNESSES:
Jesse C. Miller.
F. D. McCleary.

INVENTOR
Einar J. Bring.

BY H. C. Evert & Co.

Attorneys

No. 842,619. PATENTED JAN. 29, 1907.

E. J. BRING.

SYSTEM OF PNEUMATIC CONTROL.

APPLICATION FILED JULY 25, 1906.

4 SHEETS—SHEET 3.

Fig. 6.

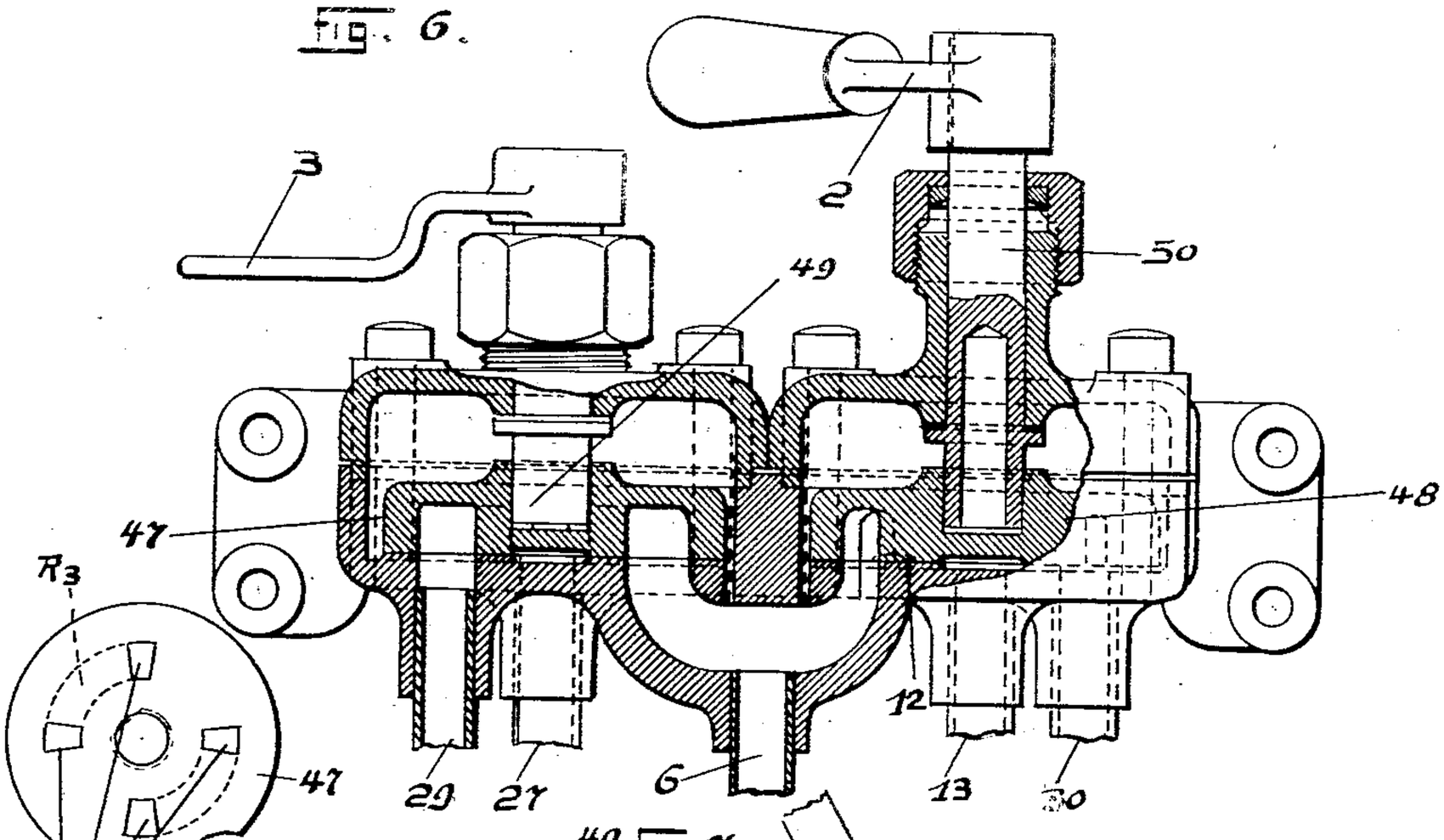


Fig. 8.

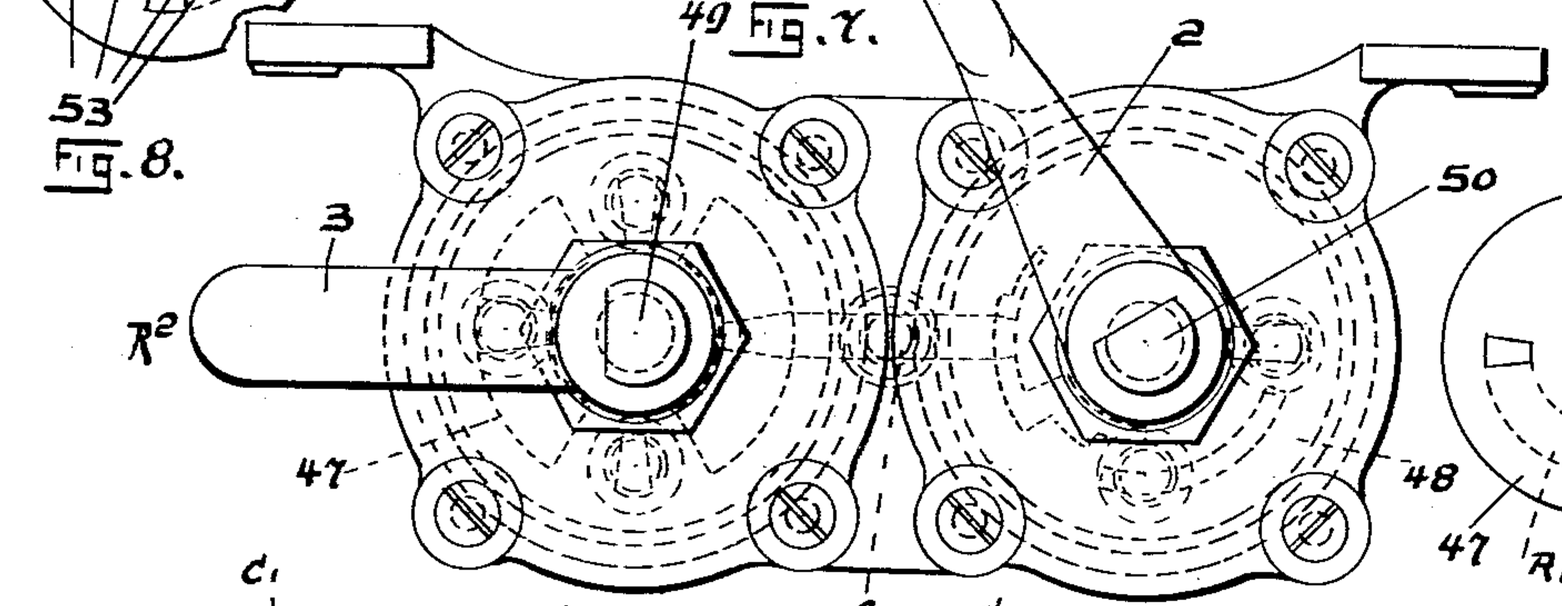


Fig. 9.

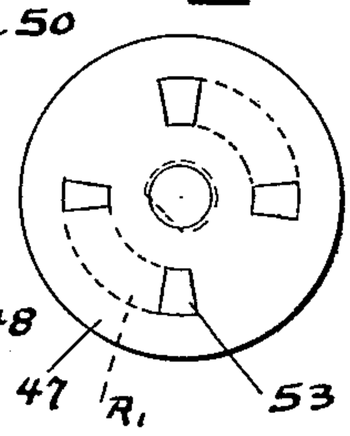
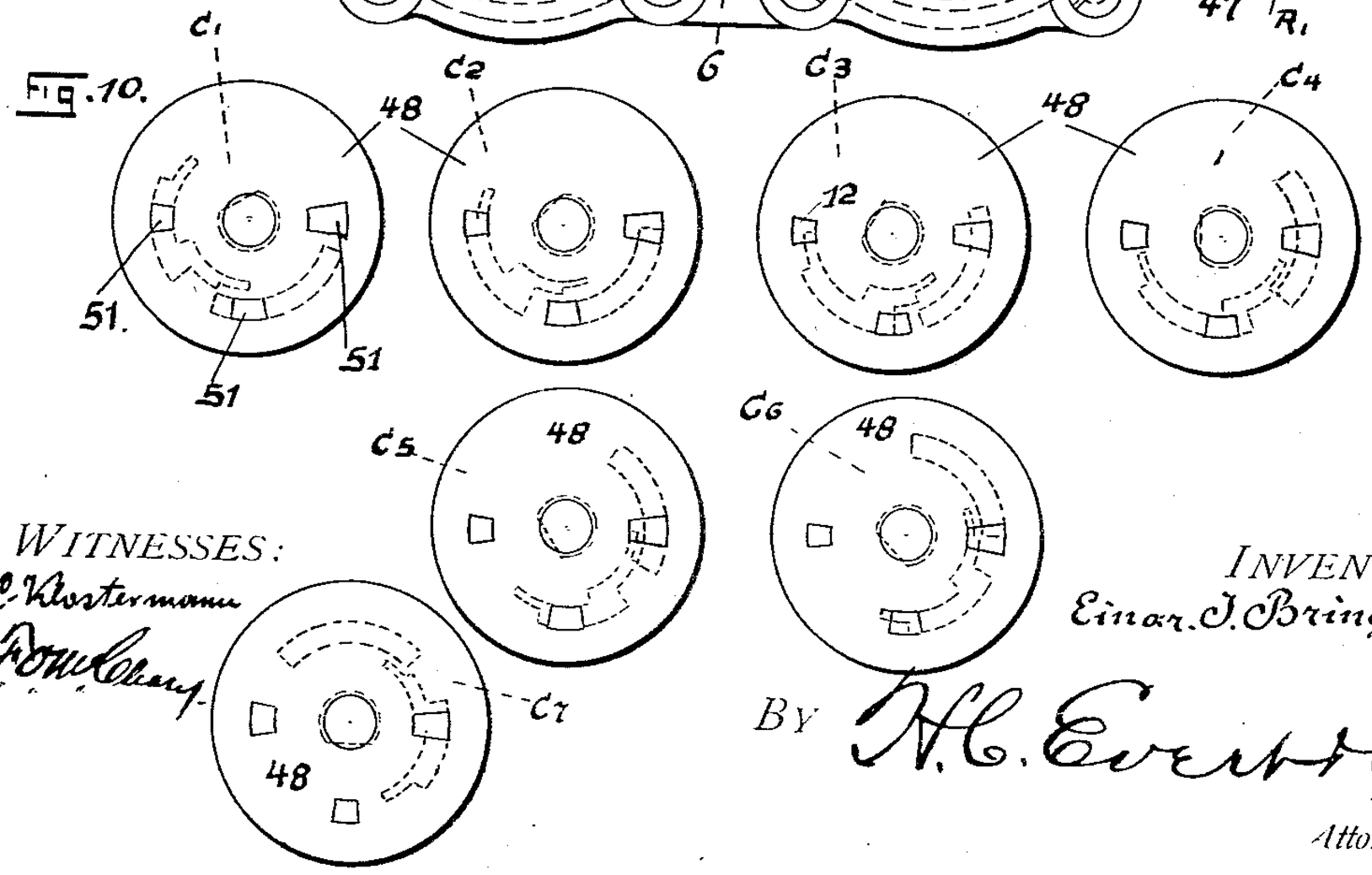


Fig. 10.



WITNESSES:

C. Klostermann

F. W. Cheney

INVENTOR

Einar J. Bring.

BY H. C. Evert & Co.

Attorneys

No. 842,619. PATENTED JAN. 29, 1907.

E. J. BRING.

SYSTEM OF PNEUMATIC CONTROL.

APPLICATION FILED JULY 25, 1906.

4 SHEETS—SHEET 4.

Fig. 11.

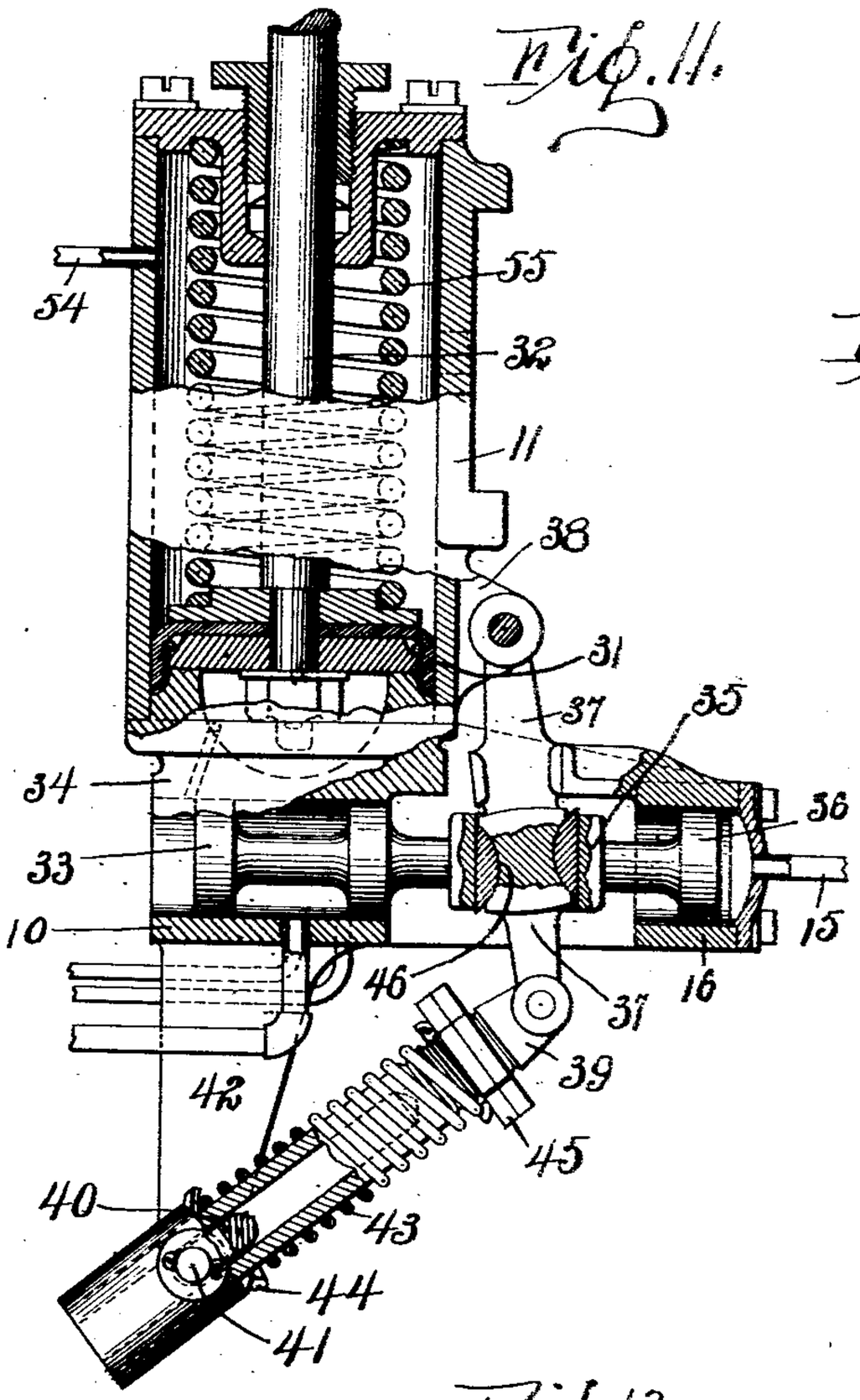


Fig. 12.

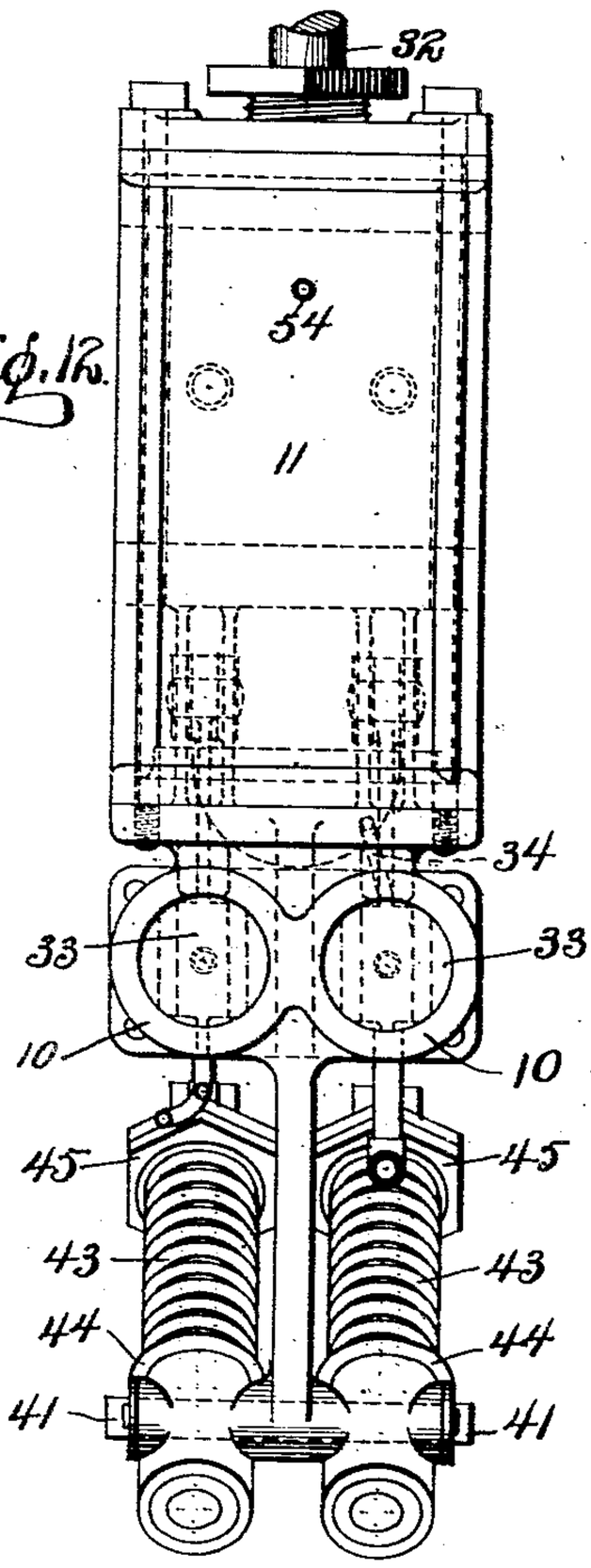
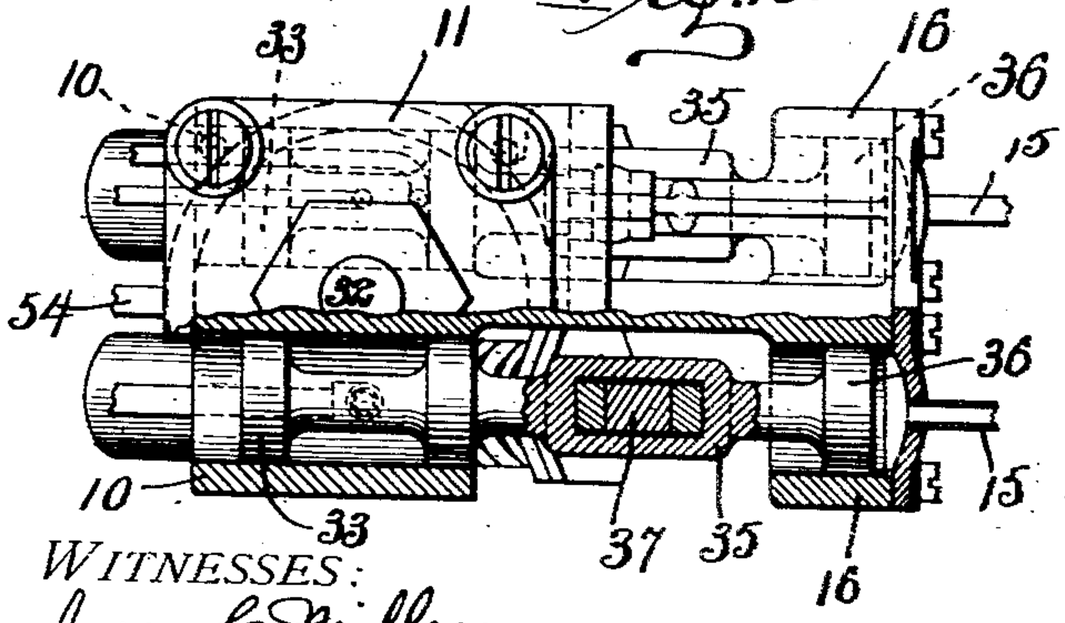


Fig. 13.



WITNESSES:
Jesse C. Miller.
F. D. McCleary.

INVENTOR
Einar J. Bring

BY H. C. Evert & Co.

Attorneys

UNITED STATES PATENT OFFICE.

EINAR J. BRING, OF WILKINSBURG, PENNSYLVANIA.

SYSTEM OF PNEUMATIC CONTROL.

No. 842,619. Specification of Letters Patent. Patented Jan. 29, 1907.

Application filed July 25, 1906. Serial No. 327,672.

To all whom it may concern:

Be it known that I, EINAR J. BRING, a subject of the King of Sweden, residing at Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Systems of Pneumatic Control, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to pneumatic control systems for electric motors, and it is especially adapted for use in connection with electrically-propelled vehicles or trains.

The improved system employs a series of pipes for conveying compressed air or other fluid under a constant pressure, which will be called in the following description the "constant-pressure" circuit, and a series of pipes for compressed air or other fluid under variable pressure, which will be hereinafter referred to as the "variable-pressure" circuit.

A series of cylinders and pistons is provided for each of said circuits, the pistons of the constant circuit being connected to electric switches and being operated through valves actuated by the pistons of the variable circuit, the operation of said variable-circuit pistons being controlled by the admission or exhaustion of compressed fluid thereto by a master-valve under control of the motorman or operator.

The invention also includes improved means for moving the pistons of the variable circuit with a snap action, means for gradually increasing the pressure in the variable circuit, means for equalizing the pressure on each side of the pistons connected with the constant-pressure circuit, and means whereby the pistons of the variable-pressure circuit are operated by predetermined pressures thereon.

The invention also covers operation of the reversing-switch by means of two single-acting air-cylinders and various combinations of parts and details of construction, all of which will be specifically described hereinafter in connection with the accompanying drawings, which form a part of this specification.

In the drawings, Figure 1 is a side elevation of a plurality of cylinders and pipe connections employed in carrying out the invention. Fig. 2 is a top plan view of the same. Fig. 3 is a top plan showing the controller or master-valve and its pipe connections at one end of a car or train and the reverser and its connecting pipes. Fig. 4 is a similar view of the controller-valve at the opposite end of the car or train. Fig. 5 is a diagram of an electric-motor circuit, selected for the purpose of illustrating the invention. Fig. 6 is a vertical section of the controller-valve. Fig. 7 is a top plan thereof with parts shown in dotted lines. Fig. 8 is a diagrammatic view showing the relations between the ports in the valve-seat and cavities in the rotary disk. Fig. 9 is a similar view showing the reverser-valve disk in a position opposite to that shown in Fig. 8. Fig. 10 is a diagrammatic view showing different positions of the controller-valve disk. Fig. 11 is a central vertical section of one of the constant-circuit cylinders, one of the variable-circuit cylinders, one of the valves, and their contained mechanism and connections. Fig. 12 is a front elevation of the same; and Fig. 13 is a view, partly in plan and partly in horizontal section, of variable-circuit cylinder and valve.

The reference-numeral 1 designates a controller adapted to be located on a car-platform and provided with a controller-valve operated by a handle 2 and a reverser-valve operated by a handle 3. Only one of these controllers is employed for single end operation, but where a car is to be operated from either end two controllers will of course be employed, one on each of the car-platforms.

A tank or reservoir 4 for compressed air is provided (which may be the brake-reservoir or a separate one, as preferred) having a pipe connection 5 with a compresser, a pipe connection 6 with the controller, and a pipe connection 7 with the constant-circuit pipe 8. The pipe 8, constituting the main supply-pipe of the constant circuit, has a pipe connection 9 with the valve-chamber 10 of each of the constant-pressure cylinders 11. The port x^8 of the controller is connected by a pipe 13 with the main pipe 14 of the variable-pressure circuit, said pipe 14 having a pipe connection 15 with each of the cylinders 16.

A reverser is employed comprising two alined cylinders 17 and 18, a piston-rod 19 extending into both cylinders, a reversing-switch 20, pistons 21 on said piston-rod, and springs 22, encircling the piston-rod within each cylinder. The ends of the reverser-cylinder 17 and 18 are each connected by a pipe (23 and 23^a) with the reverser-pipes 24 and 25, thus establishing a reverser-circuit. The reverser-pipes 25 and 24 are connected by pipes 26 and 27 with ports x^3 and x^2, re-

spectively. Communication between ports x, x^2, and x^3 and also between ports x^5, x^2, and x^3 is effected through cavities x' and x^4 in the rotary disk. Port x^5 has an exhaust 29 to atmosphere. The port x^{10} is also provided with an exhaust-pipe 30. Within each of the constant-circuit cylinders 11 is a piston 31, connected to a piston-rod 32, the outer ends of said rods being adapted to be secured to an electric switch. (Not shown.)

Each of the constant-circuit or switch cylinders is provided with a valve-chamber 10, within which is supported a valve 33, controlling an air-inlet port 34. The valve 33 is connected by a stem 35 with a piston 36 within the variable-circuit cylinder 16. Extending through the stem 35 is a lever 37, pivotally secured at its upper end to a lug 38, projecting from the cylinder 11, and at its lower end to an arm 39, formed with an elongated slot 40, through which extends a cross-pin 41, supported by a bracket 42, depending from the valve-chamber 10. The arm 39 is encircled by a coil-spring 43, one end of which bears against a shoulder 44 on said arm, while the opposite end bears against lock-nuts 45, fitting the threaded upper portion of said arm. This spring-arm connection is an important adjunct of the variable-circuit piston, as it insures a snap action of the piston. The construction is such that, the power the spring exerts upon the piston in its line of motion diminishes as the tension of the spring is increased. This is due to the inclined position of the spring-arm 39 and its pivotal connection with the lever 37. This lever 37 has a ball-and-socket connection with the stem 35, as shown at 46 in Fig. 11.

Referring now to Figs. 6 to 10, inclusive, the numerals 47 and 48 designate disk-valves centrally mounted, respectively, upon the handle-shafts 49 and 50 of the controller. It will be understood that the specific construction of the disks 47 and 48 and the area of the leakage-groove and cavities in the same and ports controlled by said disks will vary according to the work required, the function of said disks being to control the admission of air to the variable-pressure-circuit cylinders and to the reverser, the size and relative location of the ports 51 and 53 in the valve-seats and the leakage-groove and cavities in the disks 47 and 48, communicating between ports, will be so regulated as to provide for an admission of air suitable to the particular condition of service required. The cavities x' and x^4 in the reverser-disk 47 are disposed at equal distances apart, as shown in Figs. 8 and 9, and as the function of this disk is to control the supply of air to the reverser-cylinders 17 and 18, it has three positions only—viz., one which admits air to the cylinder 17 and simultaneously discharges air from the cylinder 18, one which admits air to the cylinder 18 and discharges air from the cylinder 17; and one which cuts off air from both of said reverser-cylinders when the reverser at the opposite end of the car is to be operated. These positions are indicated in Fig. 3, as follows: the forward position at R′, the off position R^2, and the reverse position R^3.

The handle controlling the supply of air to the variable-pressure circuit has (in the construction here shown) seven different positions, (illustrated by the diagram in Fig. 10 and dotted lines in Fig. 3 as follows): the closed or "off" position C′, a quick-discharge position C^2, a gradual-application position C^3, intermediate off position C^4, gradual-discharge position C^5, quick-discharge position C^6, and off position C^7.

To illustrate the application of the system to switch-controlling cylinders of different construction, I have shown in the drawings, Figs. 1 and 2, thirteen cylinders embodying five different constructions as follows: The cylinders K′, open at their upper ends; cylinders K^2, closed at their upper ends; cylinders K^3, closed on top and having two piston-valves and two control-cylinders 16; cylinder K^4, closed at its upper end and having neither piston-valve nor control-cylinder, and cylinder K^5, open at its upper end and having neither piston-valve nor control-cylinder. Various combinations of these several types of cylinders may be employed, it being apparent that the type of cylinder to be used for a certain switch depends on the number of times this switch has to be closed or opened and also on its relation to the closing or opening of the other switches during one cycle of application. With certain of these cylinders shown in Figs. 1 and 2 I employ pipe connections 54, connecting the upper ends of the cylinders with the valve-chambers 10 to equalize the pressure on opposite sides of the pistons in said cylinders, thereby causing spring 55 to force piston down, and thus opening the switch.

The operation of the apparatus constructed as above set forth will now be described; but before specifically following the course of the air-circuits in one cycle of application it may be stated that after the reverser-valve has been operated to determine the direction of movement of the car the controller-valve is manipulated to start and accelerate the car by gradually admitting air to the variable-circuit cylinders to operate the electric switches through the movement of the pistons of the constant-circuit cylinders.

It should be noted that all of the piston-springs 43 are of the same tension and all of said pistons of such diameter that they will compress said springs when subjected to a predetermined air-pressure, or else all of the control-pistons are of the same diameter and the springs so tensioned that they will yield only to a predetermined pressure, so that it

will be understood that certain of the control-pistons will yield to a pressure which would not operate other control-pistons, and consequently certain of the electric switches are operated by a certain pressure of air in the variable-pressure circuit, while others of said switches are not operated until additional pressure is applied.

One cycle of operation will now be specifically explained by reference to the drawings, including the diagram shown in Fig. 5.

For forward movement, pressure being maintained in the reservoir 4, the reverser-handle 3 is moved to the position R′, which applies pressure to the reverser-cylinder 17 through port x, cavity x', port x^2, pipes 27, 24, and 23, and at the same time opens a discharge to the atmosphere for the cylinder 18 through pipes 23^a, 25, and 26, port x^3, cavity x^4, port x^5, and discharge-pipe 29. On the master-valve at the other end of the car the reverser-handle 3 should be in the position R^2 and the control-handle 2 in the position C′ or C^7. This determines the direction of motion.

The leakage groove or nozzle 12 is of such cross-sectional area that it will increase the pressure in pipe 14 from atmospheric pressure to the pressure in the reservoir in a certain predetermined time, this time being approximately the same time required to bring the car from a standstill to full speed.

The switches establishing the combination of connections here described should be closed and opened in the following order: First, close switch A′, next switches A^3 and A^8, then switch A^2, then switch A^9, and then the switches A^7, A^{10}, A^6, A^{11}, and A^5 successively in the order named. Full series is now attained. The next switching step is to close switch A^{12} and open switches A^5 A^6 A^7 A^8 A^9 A^{10} A^{11}. The next step closes switches A^4 and A^{13} and opens switch A^{12}, at which point the connections change from series to parallel. Further steps close first switches A^9 and A^7, then switches A^{10} and A^6, and the final step closes switches A^{11} and A^5, establishing full parallel.

The movement of the controller-handle to the position C^3 applies pressure to all of the control-cylinders 16, through the port x^6, leakage-groove 12, cavity x^7, port x^8, and pipes 13, 14, and 15. The pressure now increases in the pipe 14 at a rate governed by the cross-sectional area of the leakage-groove 12 and the pressure in the pipe 8, and during this gradual increase each of the control-pistons actuates its piston-valve at the instant a certain predetermined pressure is attained. In other words, the pistons are constructed and piped in such a manner that they will cause the operation of the switches in the order above stated.

To cut out the switches, move the control-handle into the position C^2, which will open a discharge for the pipe 14 through the port x^8, cavity x^9, port x^{10}, and discharge-pipe 30. When the pressure in the pipe 14 is exhausted, all of the switches are cut out.

If it is desired to run on any particular switch, move the control-handle into the position C^3, leaving it there until the desired switch is closed, which can be noted either by the speed of the car or by a pressure-gage piped into the pipe 14. Then move the controller-handle into the position C^4, thus cutting out any further admission of compressed air to the pipe 14. Should it then be desired to cut out some switches before full parallel is attained, move the control-handle into the position C^5, which will discharge pressure from the pipe 14 through the cavity x^7, leakage-groove x^{11}, port x^{10}, and discharge-pipe 30 to atmosphere gradually. If a rapid discharge is desired, move the control-handle into the position C^6.

If the control-handle has been brought as far as C^4 and it is then desired to cut all of the switches out, move the control-handle to the C^6 position instead of to C^2 and leave it there until the next application, then bringing the control-handle to the C^3 position.

It will be apparent that the invention is susceptible of embodiment in a great variety of combinations of cylinders, valves, and pistons, together with the required pipe connections, and I would therefore have it understood that the invention is not restricted to the construction of apparatus here shown and described, but includes all such modifications and variations in the details and relative arrangement of parts as may be resorted to without departing from the spirit of the invention as defined in the claims.

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

1. In a pneumatic-control system for electric motors, the combination with electrical apparatus, of a series of pipes for fluid under pressure constituting a circuit of variable pressure, a second series of pipes for fluid under pressure, constituting a circuit of constant pressure, a plurality of pistons in said variable-pressure circuit, of such diameter as to adapt them to compress a spring of known tension when acted upon by a predetermined pressure, and a plurality of valves in said constant-pressure circuit, each controlling the admission of fluid to or the discharge of fluid from a cylinder in said constant-pressure circuit.

2. In a pneumatic-control system for electric motors, the combination with a series of electric switches, of a series of pipes constituting a constant-pressure circuit, a second series of pipes constituting a variable-pressure circuit, a series of cylinders in said constant-pressure circuit, pistons in said cylinders connected to said switches, the movement of said pistons being governed by the pressure in said variable-pressure circuit.

3. In a pneumatic-control system for electric motors, the combination with a series of electric switches, of a series of pipes for compressed air, constituting a circuit of variable pressure, a second series of pipes for compressed air constituting a circuit of constant pressure, a series of cylinders, pistons and valves, in said constant circuit, and a pipe connection between any of said valves and cylinders in said constant circuit whereby pressure on each side of said pistons is equalized, or the pressure on one side exhausted simultaneously with the admission of air to the cylinder operated by a valve from which pipe connection is drawn.

4. In a pneumatic-control system for electric motors, the combination with a series of electric switches, of a series of pipes for compressed air constituting a circuit of constant pressure, a series of pipes for compressed air constituting a circuit of variable pressure, a piston in the variable-pressure circuit and a spring connected to said piston in such relation that the force it exerts upon the piston in its line of movement diminishes as the tension of the spring is increased thereby causing the piston to move with a snap action.

5. In a pneumatic-control system for electric motors, the combination with a series of electric switches, of a series of pipes for compressed air constituting a circuit of constant pressure, a series of pipes for compressed air constituting a circuit of variable pressure, the movement of parts in said constant circuit being controlled by the increase or decrease of pressure in said variable circuit, and a valve controlling the admission of compressed air to the variable circuit thereby permitting any desired pressure to be maintained.

6. In a pneumatic-control system for electric switches, the combination with a series of pipes for compressed air constituting a circuit of constant pressure, and a series of pipes for compressed air constituting a circuit of variable pressure, a series of cylinders and pistons in said constant circuit, and means whereby the movement of said pistons in the constant circuit will depend upon the degree of pressure in the variable circuit, the existence of a certain pressure in the variable circuit actuating a certain piston in the constant circuit.

7. In a pneumatic-control system for electric switches, the combination with a series of pipes for compressed air constituting a constant circuit and a series of pipes for compressed air constituting a variable circuit, pistons in said constant circuit controlled by the pressure in said variable circuit, and means for effecting a gradual increase of pressure in said variable circuit.

8. In a pneumatic-control system for electric switches, the combination with a series of pipes for compressed air constituting a constant circuit and a series of pipes for compressed air constituting a variable circuit, pistons in said constant circuit controlled by the pressure in said variable circuit, and means for effecting a gradual increase of pressure in said variable circuit, comprising a nozzle or leakage-groove of predetermined cross-sectional area.

9. In a pneumatic-control system for electric switches, the combination with a series of pipes for compressed air, constituting a constant circuit, and a series of pipes for compressed air constituting a variable circuit, a series of valves and pistons in the constant circuit, a series of pistons in the variable circuit, a series of springs of predetermined tension, each adapted to be compressed by its piston when said piston is subjected to a certain pressure to actuate one of the valves controlling the motion of one of the pistons in the constant circuit.

10. In a pneumatic-control system for electrically-driven vehicles or trains, the combination with a series of pipes constituting a circuit of constant pressure, and a series of pipes constituting a circuit of variable pressure, and means for increasing or decreasing the supply of compressed air, whereby the acceleration of the vehicle or train depends primarily upon the rate of admission of air into said variable circuit.

11. In a pneumatic-control system for electric switches, the combination with a compressed-air circuit of constant pressure, and a compressed-air circuit of variable pressure, means for gradually increasing the supply of air to the variable circuit, and a series of pistons in said variable circuit so arranged as to cause certain switches to be closed at predetermined pressures during the gradual increase of pressure in the variable circuit.

12. In a pneumatic-control system for electric motors, the combination with a plurality of vertically-disposed pneumatic cylinders, of valve-chambers adjacent to said cylinders, horizontally-disposed pneumatic cylinders adjacent to said valve-chambers, pistons in said horizontal cylinders, piston-rods for said pistons, and valves within said valve-chambers connected to said piston-rods.

13. In a pneumatic-control system for electric motors, the combination with a series of cylinders, of switch-controlling pistons, and piston-rods in said cylinders, a valve-chamber for each of said cylinders, a control-cylinder adjacent to each of said valve-chambers, valves within said chambers connected to the piston-rods of said control-cylinders, and pipe connections for supplying air under a constant pressure to said first-mentioned cylinders, and air under variable pressure to said control-cylinders.

14. In a pneumatic-control system for electric motors, the combination with a plurality of switch-cylinders, of a valve-chamber and

valve for each cylinder, control-cylinders having a piston, and a piston-rod for operating said valves, means for supplying air under a constant pressure to said switch-cylinders, and air under variable pressure to said control-cylinders, and equalizing-pipes connecting said valve-chambers and switch-cylinders.

15. In a pneumatic-control system for electric motors, the combination with a plurality of switch-cylinders, of a valve-chamber and valve for each of said cylinders, a plurality of control-cylinders and a plurality of spring-controlled pistons within said control-cylinders for operating said valves.

16. In a pneumatic-control system for electric motors, the combination with a switch-cylinder and its piston and piston-rod, of a valve-chamber and valve, a control-cylinder, a piston within said control-cylinder, and a device for regulating the movement of said control-cylinder piston comprising a lever connected to said piston, an inclined arm pivotally secured at one end to said lever, and at its opposite end to a suitable support, and a spring encircling said arm, and means for compressing said spring by the movement of said lever.

17. In a pneumatic-control system for electric motors, the combination with a series of switch-cylinders, of a valve-chamber and valve for admitting air to said cylinders, a control-cylinder for each of said valve-chambers, pistons and piston-rods within said control-cylinders, and springs connected with said piston-rods whereby said pistons will be actuated by the admission of air to the control-cylinders under a predetermined pressure.

18. In a pneumatic-control system for electric motors, the combination with a series of switch-operating cylinders, pistons and piston-rods, of a series of control-cylinders each having a spring-controlled piston, means for admitting air to said switch-operating cylinders under a constant pressure, and air to said control-cylinders under a variable pressure, a series of pipe connections between said cylinders and an air-supply, and a controller-valve for regulating the supply of air through said pipes.

In testimony whereof I affix my signature in the presence of two witnesses.

EINAR J. BRING.

Witnesses:
MAX H. SROLOVITZ,
F. O. MCCLEARY.