No. 862,483. PATENTED AUG. 6, 1907.

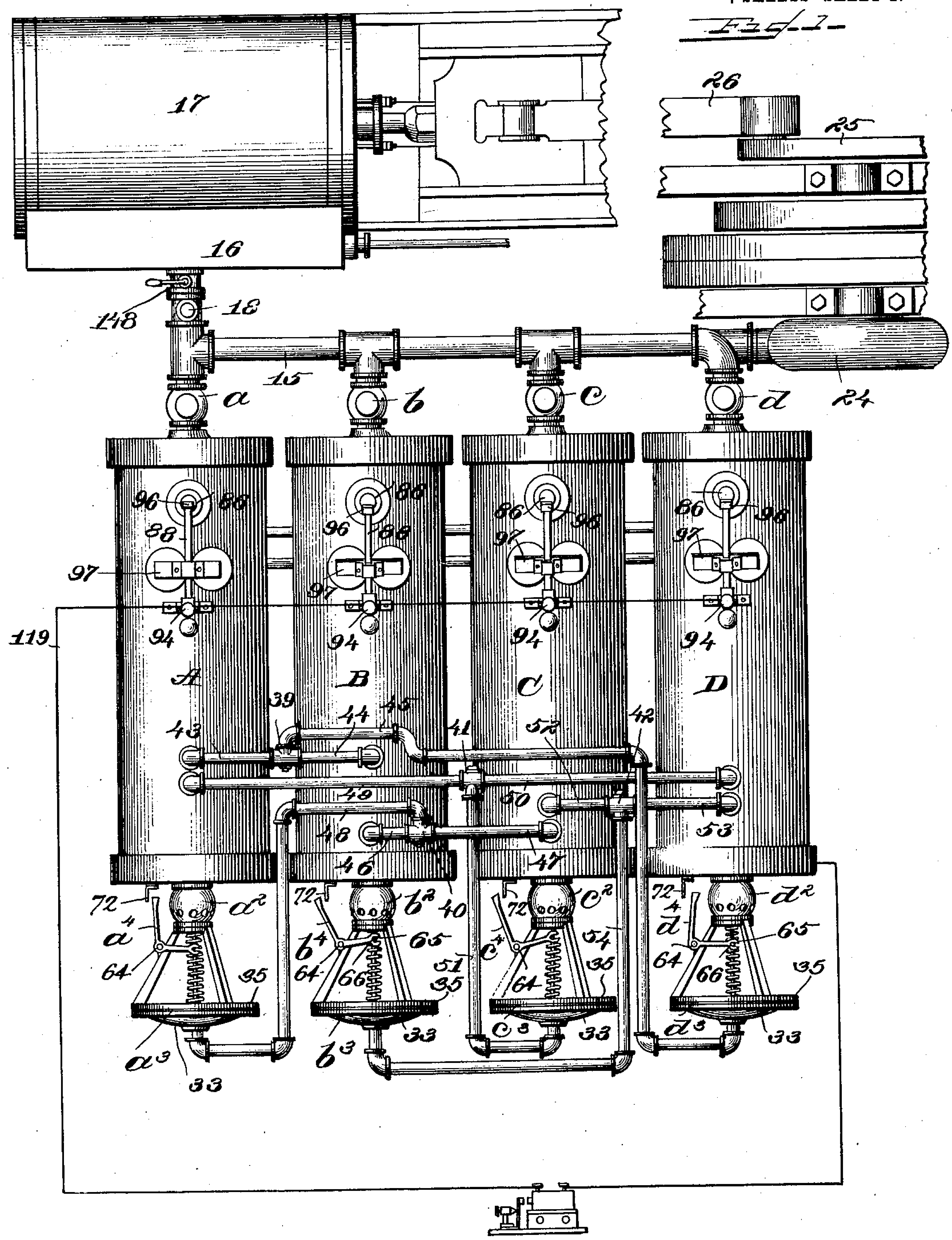
W. M. JEWELL.

GENERATOR.

APPLICATION FILED NOV. 24, 1900.

7 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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Fig. 2.

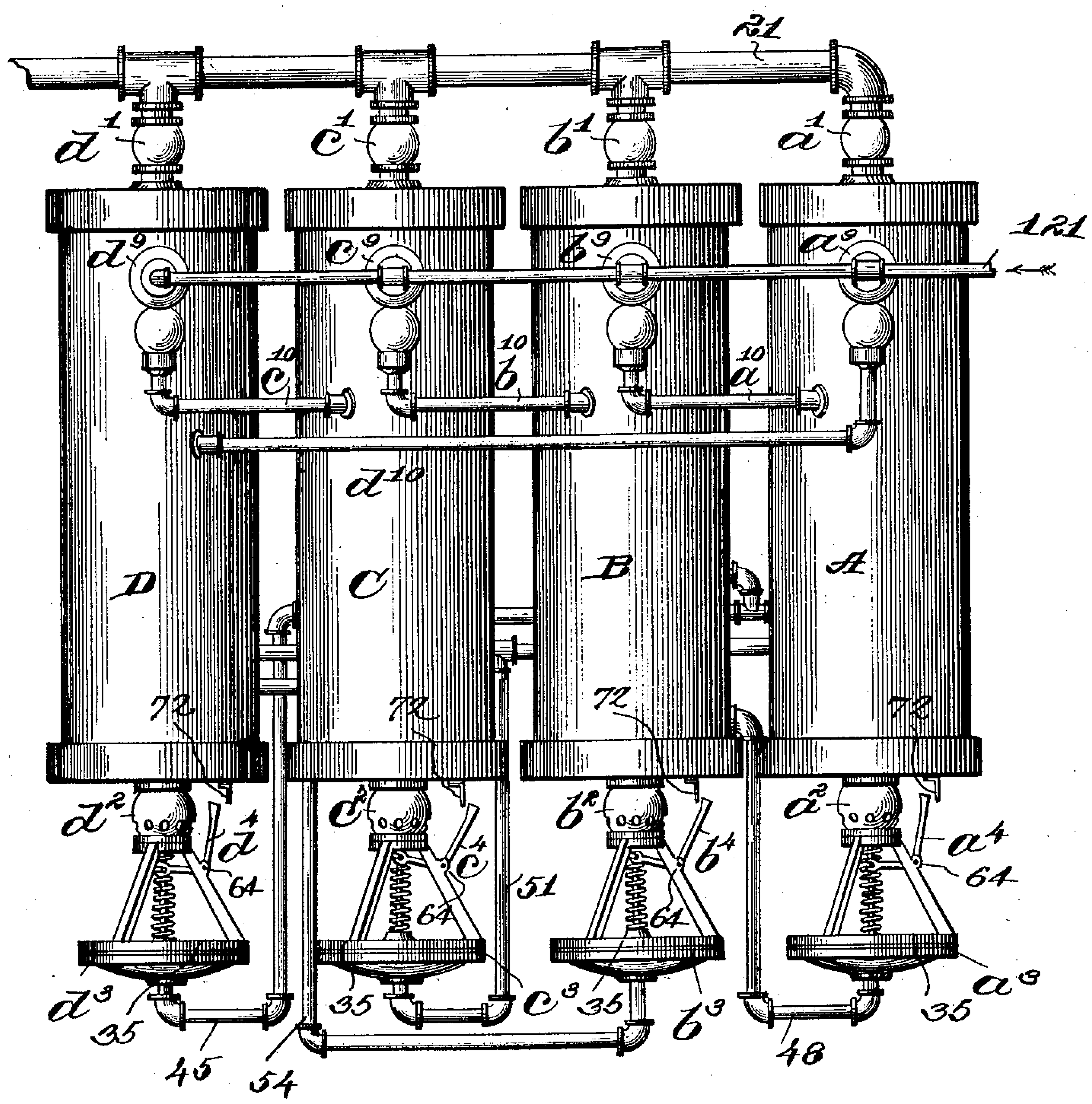

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Fig. 3.

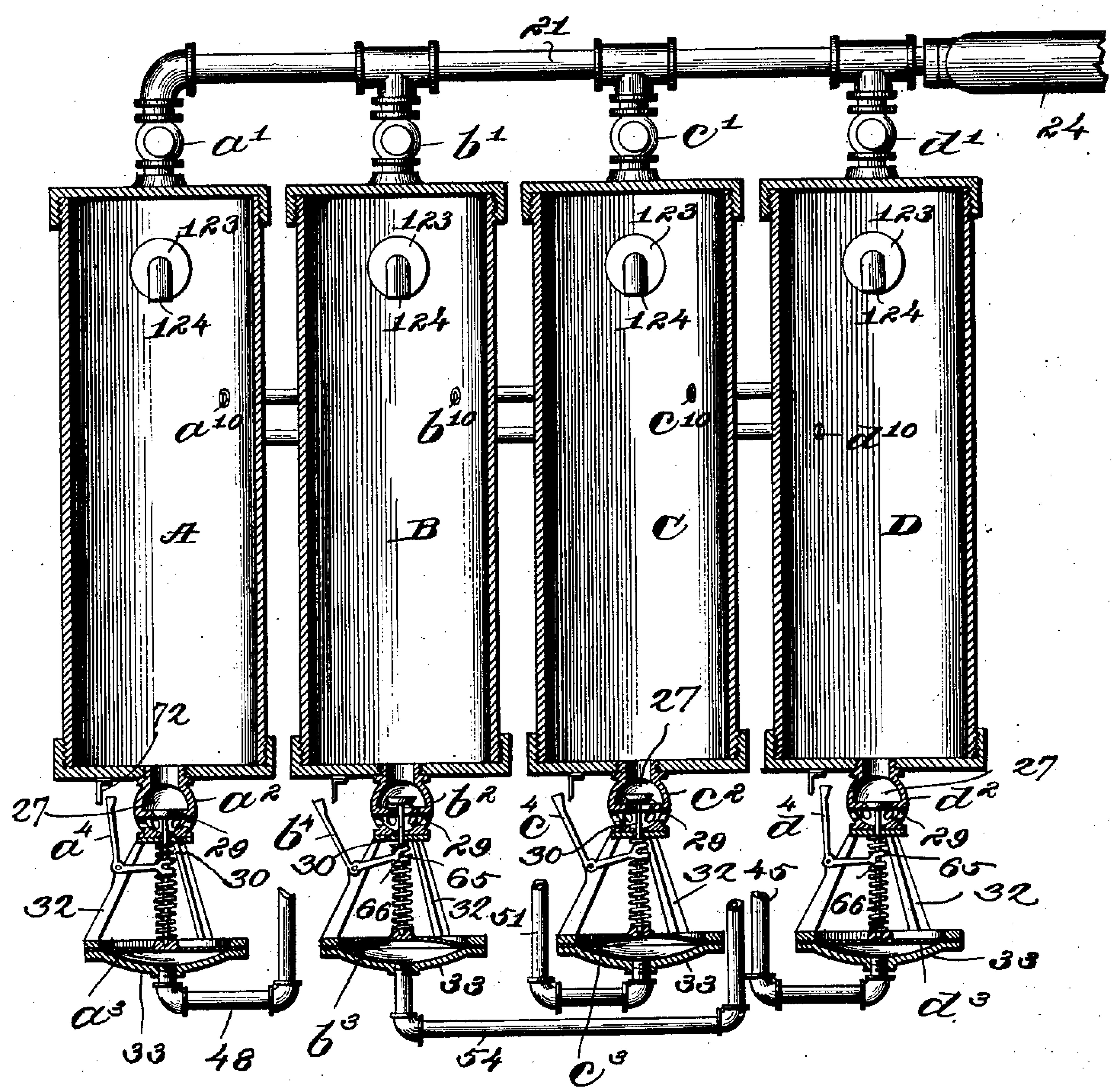

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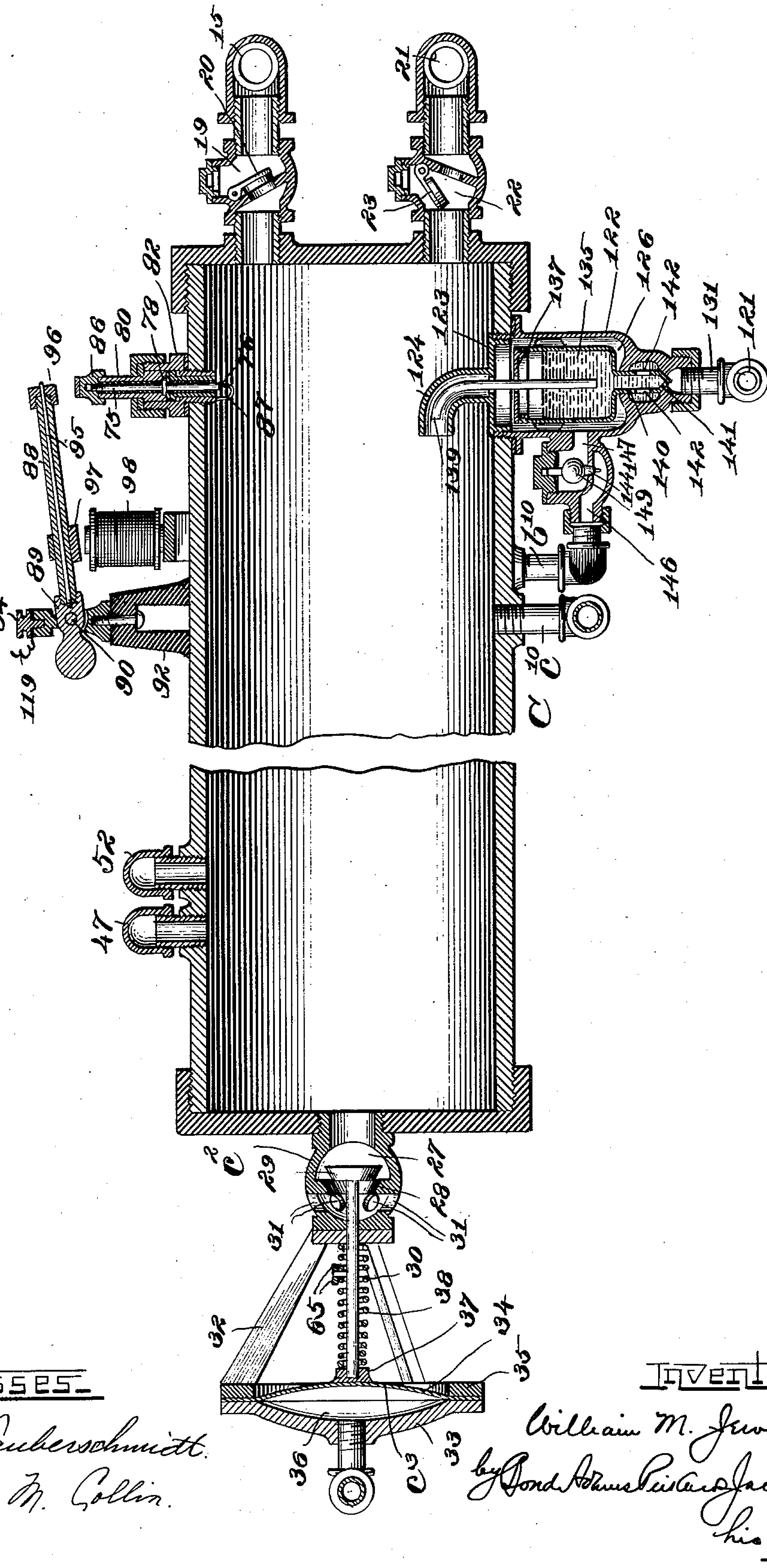
Fig. 4



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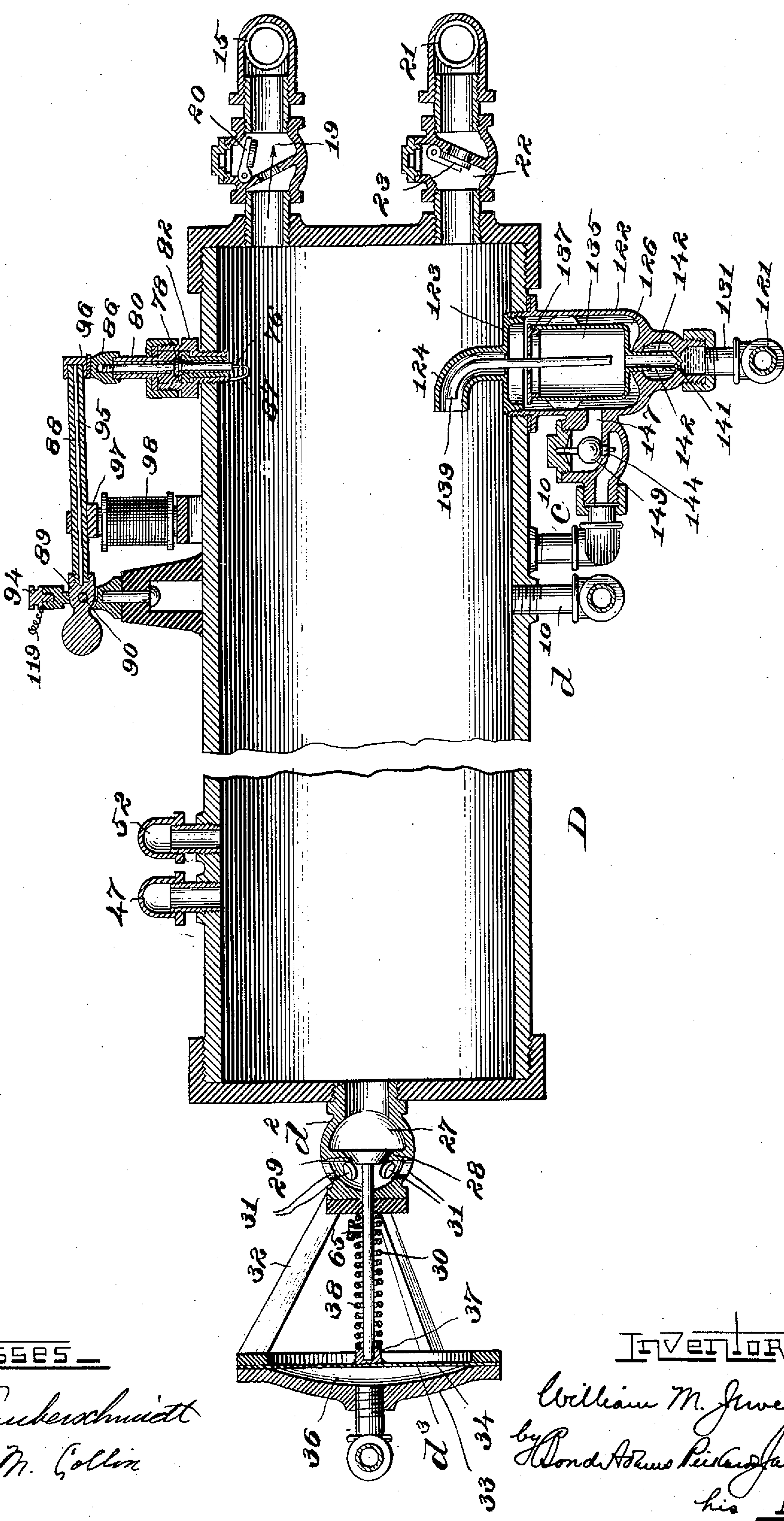

Fig. 5.

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Fig. 6.

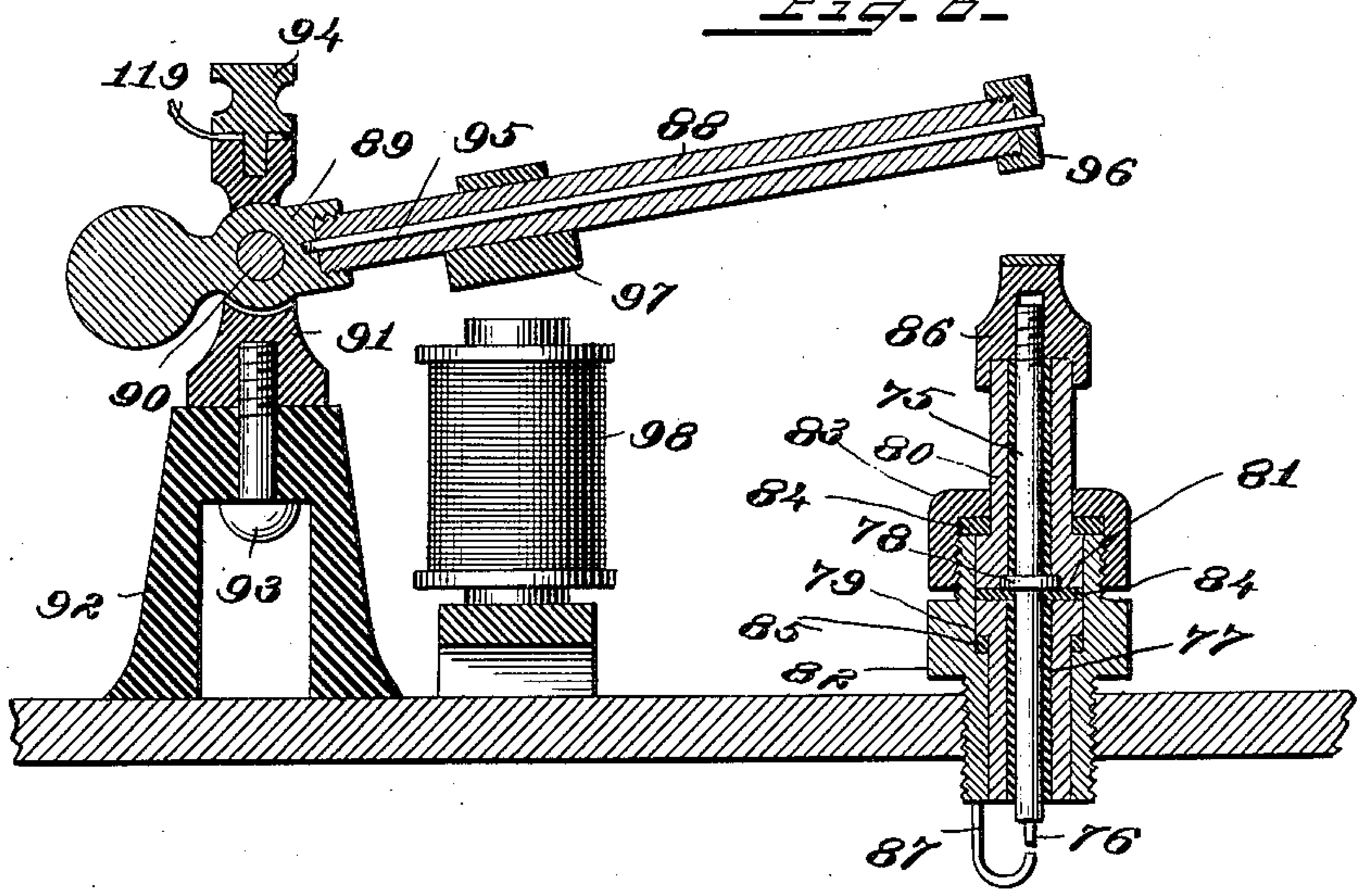


Fig. 7.

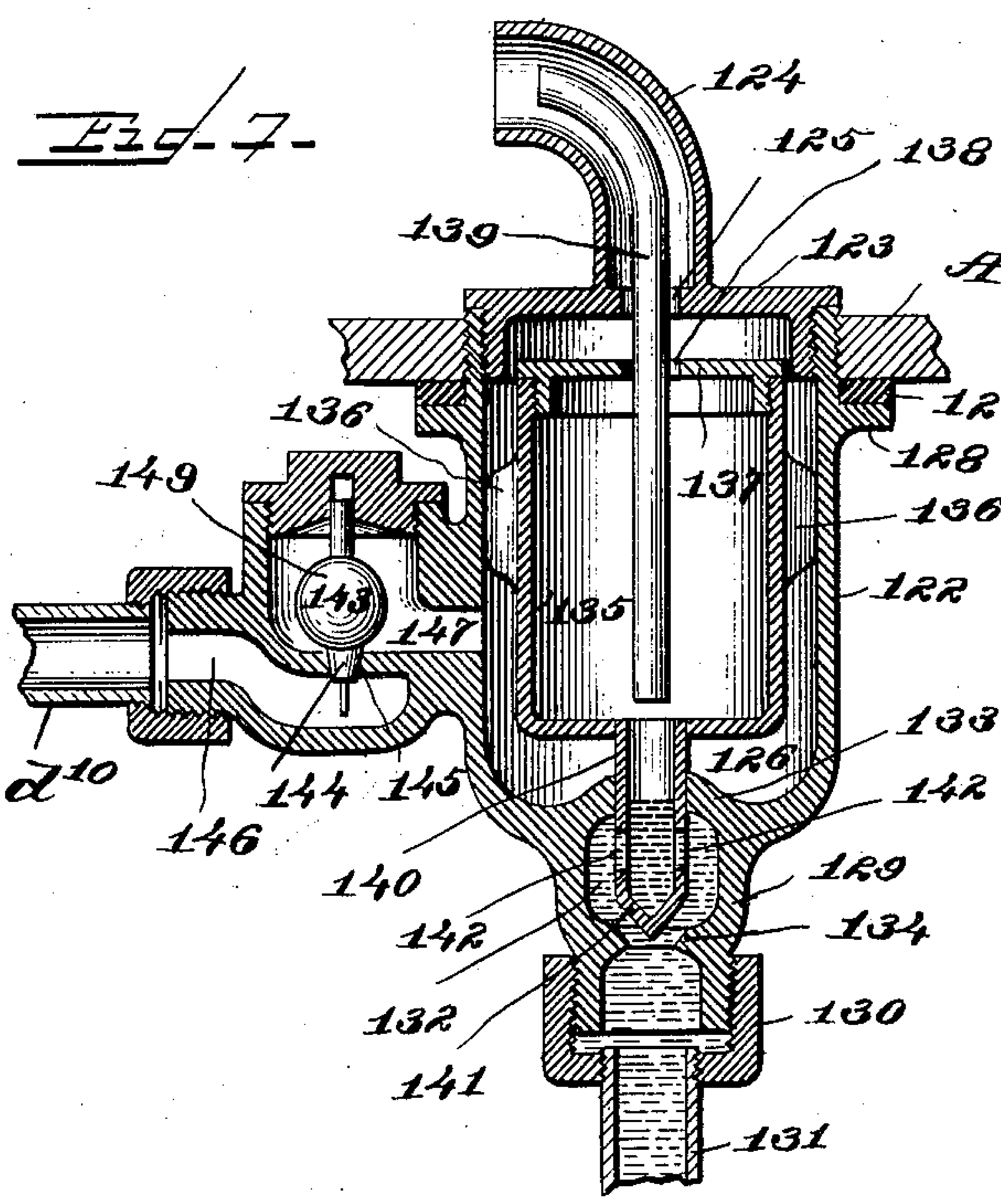


Fig. 8.

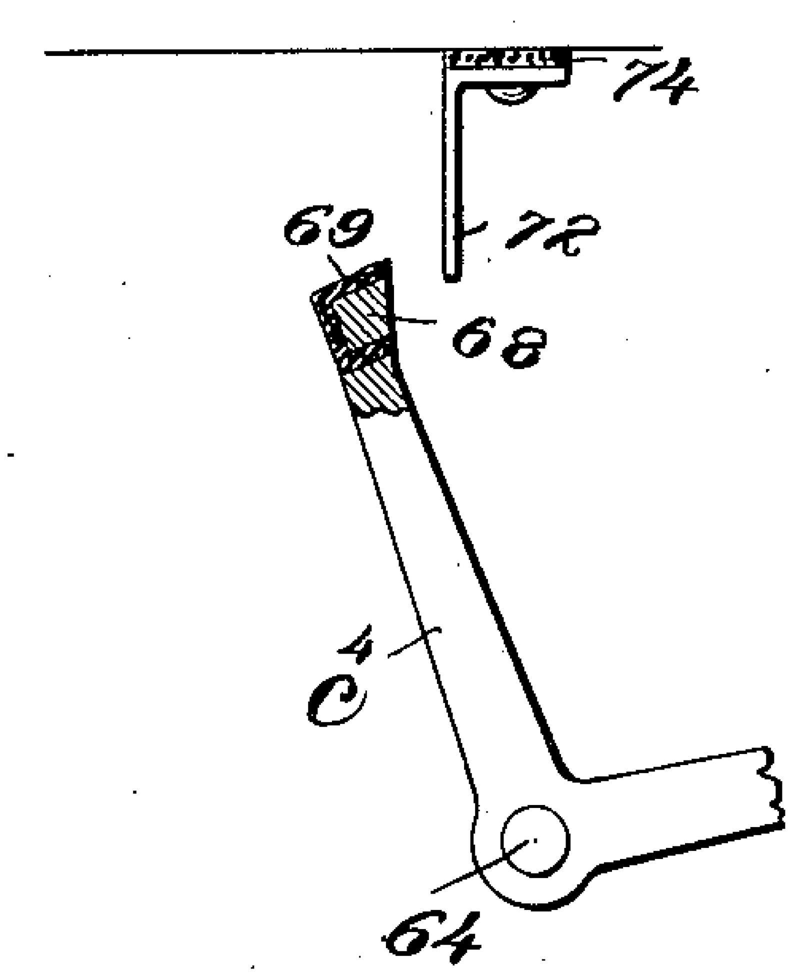


Fig. 9.

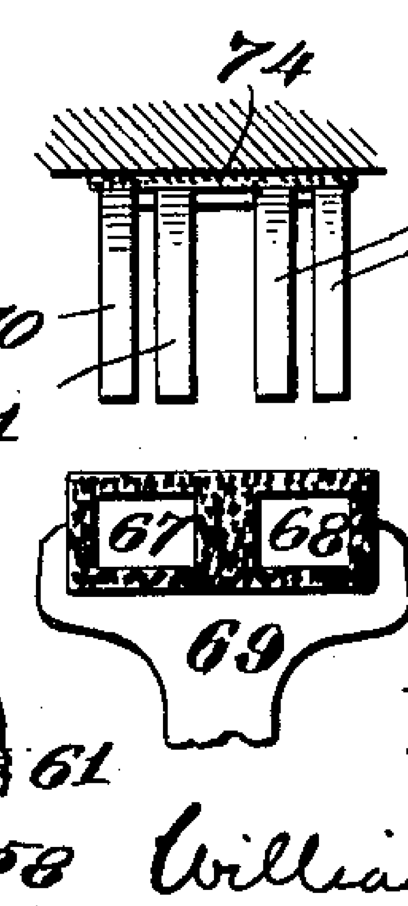
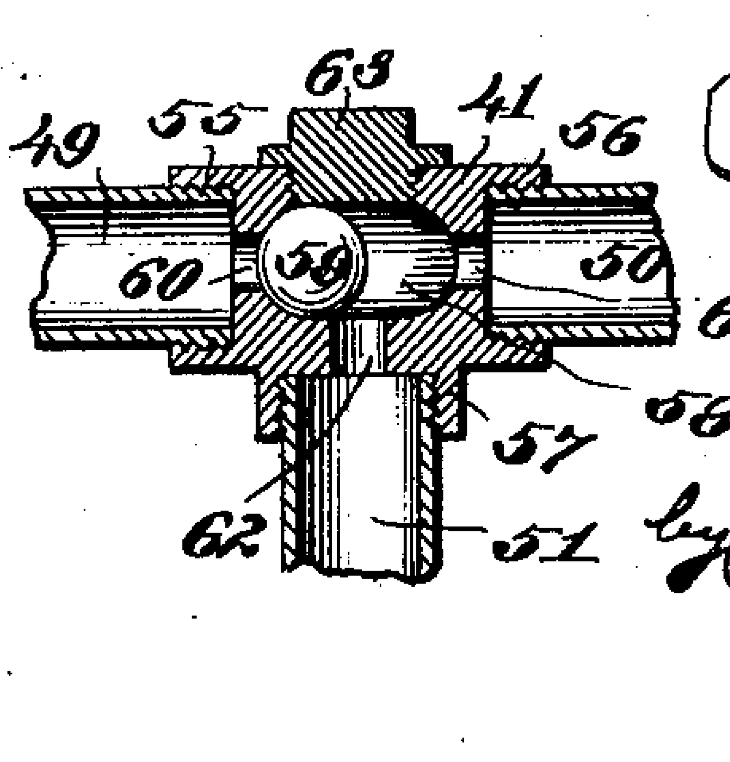


Fig. 10.



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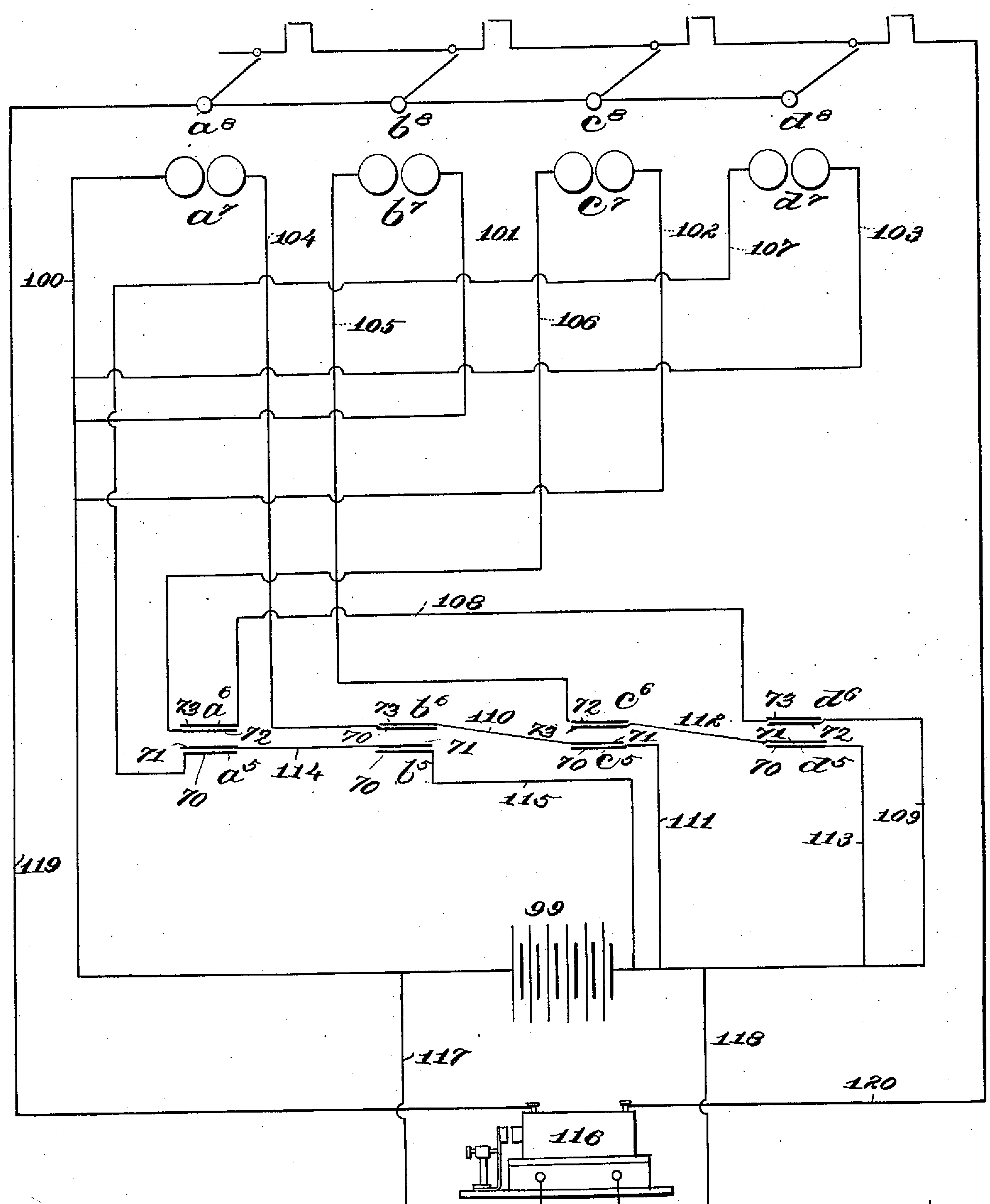
7 SHEETS—SHEET 7.

Fig. 11



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UNITED STATES PATENT OFFICE.

WILLIAM M. JEWELL, OF CHICAGO, ILLINOIS.

GENERATOR.

No. 862,483. **Specification of Letters Patent.** **Patented Aug. 6, 1907.**

Application filed November 24, 1900. Serial No. 37,699.

To all whom it may concern:

Be it known that I, WILLIAM M. JEWELL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Generators, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to generators, and has particularly to do with supplying a motive power to engines generally, including rotary, reciprocating, and other styles of engines. In fact, my invention may be employed for furnishing motive power to any type of engine operated by the expansive force of gases.

The primary object of my invention is to provide means for generating a gas, or gases, in a chamber or chambers separate from the engine, or other machine to be operated by the gas or gases produced, and afterwards conducting the live gases to the engine and utilizing them for motive purposes.

A further object is to provide for maintaining a practically constant pressure on the engine, by means of the gases generated as above described, so that the action of the engine will be constant and uniform, just as is the case where steam is employed as the motive force.

In the apparatus illustrated in the drawings and hereinafter described, it is designed to use gasolene, or equivalent substance, for generating the power, and my invention includes such apparatus; but it will be understood that it is not limited specifically to the apparatus illustrated and described or to the use of gasolene, except in so far as such features are specifically claimed, as many of the features which adapt the apparatus for use with gasolene are also well adapted for use when other substances are employed for generating the gases.

The apparatus illustrated in the drawings consists, generally, of a plurality of reservoir cylinders which are similar in construction and are arranged to coöperate in maintaining a practically constant pressure on the engine. I term the cylinders which compose the generator "reservoir" cylinders, in order to distinguish them from cylinders such as the cylinders of an ordinary explosive engine which communicate directly with the piston chamber, so that the force of the explosion is applied directly to the piston and the full force of the explosion is applied thereto immediately upon the taking place of the explosion. The cylinders of my improved generator, on the other hand, do not discharge completely as soon as the explosion takes place, but act as reservoirs to hold the exploded gases and to supply them for use as they are required, as will fully hereinafter appear. While the cylinders of my improved generator thus act as reservoirs, the period for which the gases are retained by them may vary to a considerable extent, as it will depend largely upon the number of cylinders employed; but whether it be for a very short time or for a long time, they nevertheless act as reservoirs. Said reservoir cylinders are arranged in series and operate in turn,—that is to say, if four cylinders are used, when the first one explodes the second and third will be preparing for the next explosion by receiving charges of air and gasolene, while the fourth will have exploded just previously. Furthermore, the different cylinders are so connected and arranged that their operation is interdependent, the operation of each cylinder being controlled entirely by the operation of the others in the series. The entire series of cylinders, constituting the generator, is connected to what is the equivalent of the steam chest of the engine, by means of a reducing valve which reduces the initial pressure of the gases as produced in the reservoir cylinders to a comparatively low point, thus conserving the energy and supplying power continuously during the intervals between the explosions in the different cylinders. By varying the number of cylinders in the series, the interval between explosions may, of course, be varied; but the principle is the same, whether the number of cylinders be two or more. It will be understood that the term "cylinder" is used generically, to describe a single generator of the series: the term "generator" being used to indicate the whole composed of the series of interdependent cylinders.

The foregoing is a statement of the general construction and operation of my improved generator, and I will now describe, in detail, the generator as illustrated and described in the accompanying drawings.

Referring to the drawings,—Figure 1 is a plan view of the generator, illustrating also part of an engine and a blower operated thereby; Fig. 2 is an underside view of the generator; Fig. 3 is a sectional view of the cylinders composing the generator and certain parts of the valve mechanism; Fig. 4 is an enlarged longitudinal section of one of the cylinders, and the various attachments operating in connection therewith; Fig. 5 is a similar view, showing the cylinder at a different stage of its operation; Fig. 6 is an enlarged detail, being a longitudinal vertical section of part of the circuit-closing mechanism; Fig. 7 is an enlarged sectional view of the injecting apparatus and its connections; Fig. 8 is an enlarged detail, partly in section, showing one of the circuit-closing devices in side elevation; Fig. 9 is a view of one of the circuit-closing devices; Fig. 10 is a sectional detail, illustrating one of the automatic valves between the different cylinders; and Fig. 11 is a diagrammatic view, illustrating the circuits.

In the drawings,—A, B, C and D indicate the four cylinders of the generator. Each of said cylinders is connected to a pipe 15 which communicates with a chest 16 which corresponds to the steam chest of an engine 17. Between the pipe 15 and the chest 16 is a reducing valve 18, of any approved type, operating to control the pressure of the gases admitted to said chest.

a, *b*, *c* and *d*, respectively, indicate stubs by which the heads of the cylinders A, B, C, and D are connected to the pipe 15. In each of them there is a valve chamber 19 in which is a check valve 20, said check valves operating to permit gases to pass from the cylinders A, B, C and D to the pipe 15 and to prevent reverse flow of the gases.

21 indicates an air-pipe, which, as shown, extends under the pipe 15 across the ends of the cylinders A—B—C—D. Said pipe is connected to said cylinders by stubs *a′*, *b′*, *c′* and *d′*, and in each of said stubs is provided a valve chamber 22 in which is a check valve 23 operating to admit air from the pipe 21 to the cylinders A—B—C—D and to prevent reverse flow thereof. The pipe 21 is connected with a blower 24 of any suitable construction, said blower being provided with a crank 25 connected to the pitman 26 of the engine 17, so that as the engine 17 operates, the blower 24 is also operated to force a current of air through the pipe 21 and into the cylinders A—B—C—D, as will be hereinafter described. Instead of operating the blower 24 from the engine 17 it may be otherwise operated.

At the end of each cylinder, opposite that to which are secured the stubs above described, there is provided an outlet valve, marked a^2, b^2, c^2, and d^2, respectively, each of said valves consisting of a valve chamber 27 communicating with the interior of the cylinder and having a valve-seat 28 on which is seated a disk 29 having a stem 30 which projects down through the valve casing, as best shown in Fig. 4; the arrangement being such that when the disk 29 is on its seat the escape of air or gas from the cylinder in that direction is prevented. In each valve, below the valve-seat 28, are perforations 31 through which the escaping air or gas passes out of the casing. Below each of the valves a^2, b^2, c^2 and d^2 is secured a frame 32, in the nature of a tripod, which carries a pressure chamber, said pressure chambers being marked, respectively, a^3—b^3—c^3—d^3. Each of said pressure chambers consists of a rigid plate 33, concave on its upper surface and having secured thereto a thin flexible disk or diaphragm 34, as shown in Fig. 4. The edges of the disk 34 are secured to the plate 33 by a ring 35. A chamber 36 is thus formed between the disk 34 and the plate 33, as shown. The lower end of each of the stems 30 rests upon the disk 34, being fitted in a suitable socket in a boss 37 provided for that purpose, as shown in Fig. 4; and around each of the stems 30, between the disk 34 and the valve-casing above it, is a spring 38 which normally tends to hold the disk 34 and valve-stem 30 down far enough to hold the disk 29 tightly in its seat and prevent the escape of gas or air through the valves a^2, b^2, c^2 and d^2, respectively. By raising the flexible disk 34, which is accomplished by introducing gas under pressure into the chamber 36, the stem 30 may be raised to carry the disk 29 off its seat and open the valve.

The pipe connections, by which the pressure-chambers a^3, b^3, c^3 and d^3 are operated, are best shown in Fig. 1, from an inspection of which it will be seen that four T-couplings are provided, marked, respectively, 39—40—41—42. The coupling 39 is connected by pipe 43 with the cylinder A and by pipe 44 with the cylinder B, which pipes are secured in opposite arms of said coupling. 45 indicates a pipe, which is connected to the stem of the coupling and runs to the plate 33 of the pressure chamber d^3. The coupling 40 is connected to cylinders B and C by pipes 46—47, respectively, which are secured in opposite arms of the coupling 40, as shown. The stem of the coupling 40 is connected by a pipe 48 with the plate 33 of the pressure chamber a^3. Similarly, the coupling 41 is connected by pipes 49—50, respectively, with the cylinders A and D, the stem of said coupling 41 being connected by a pipe 51 with the plate 33 of the pressure chamber c^3. In like manner, the coupling 42 is connected by pipes 52—53 with the cylinders C and D respectively; the stem of said coupling 42 being connected by a pipe 54 with the plate 33 of the pressure chamber b^3.

The construction of each of the couplings 39—40—41—42 is best shown in Fig. 10. The coupling shown in Fig. 10 is marked for convenience 41; but it will be understood that the others are identical in construction with it. From an inspection of Fig. 10 it will be seen that the couplings are provided with two oppositely-extending arms 55—56, and that the pipes 49—50 are screwed into said arms, respectively. It will also be seen that the stem 57 of the coupling is screw-threaded and receives the end of the pipe 51. The center of the coupling is provided with an elliptical valve-chamber 58, which carries a ball-valve 59 adapted to be seated in one or the other of the ends of the valve chamber 58, as shown. 60 indicates a port, opening from the valve-chamber 58 into the pipe 49; and 61 indicates a similar port opening into pipe 50. 62 indicates a port opening from the bottom of the valve-chamber 58 into pipe 51. The arrangement is such that when the valve 59 closes the port 60, ports 61 and 62 are open, while, when the valve 59 closes port 61, ports 60 and 62 are open. 63 indicates a screw-cap for the coupling 41, by the removal of which access may be had to the valve-chamber 58 for the removal or insertion of the ball valve.

The pressure chambers a^3—b^3—c^3—d^3, in addition to operating the valves 29 as already described, also operate the circuit-closing devices a^4—b^4—c^4—d^4 respectively, as shown in Figs. 1 and 8. Each of said circuit-closing devices consists of a bell-crank lever mounted on a pivot 64 suitably secured on the frame 32, one arm of each of said circuit-closing devices extending toward the end of the adjacent cylinder, the other arm thereof extending toward the adjacent valve-stem 30 and engaging a pin 65 carried by said stem, being provided with a fork 66 for that purpose, (see Figs. 4 and 5.) The end of each of the circuit-closing devices which extends toward the cylinder is provided with two metallic blocks 67—68, which are insulated from each other and from the arm on which they are carried, as shown in Fig. 9. One surface of each of the blocks 67—68 is exposed, as shown in Fig. 8; and the exposed surfaces of the two blocks 67—68, carried by each of the circuit-closing devices, are adapted to engage two pairs of spring brushes or contact points 70—71, 72—73 projecting from the end of the adjacent cylinder, as shown in Fig. 8. The springs 70—71 are insulated from each other, the insulation being indicated by 74 in Fig. 9; and said springs project in the path of the circuit-closing devices, so that when said circuit-closing devices are rocked on their pivots, they will strike said springs and deflect them temporarily in passing. The exposed contact surfaces of the blocks are so placed that when the valve-stems 30 move downward, carrying the contact blocks 67—68 inward, the exposed surfaces of said blocks will strike the springs and close the circuit through them.

In Fig. 11, I have illustrated the arrangement of the circuits in which the different contact brushes 70—71, 72—73 are placed; the switches carried by cylinder A being indicated by a^5—a^6, those carried by cylinder B by b^5—b^6, those carried by cylinder C by c^5—c^6 and those carried by cylinder D by d^5—d^6. The connections of the different switches will be hereinafter explained. The function of the switches a^5—a^6, b^5—b^6, c^5—c^6 and d^5—d^6 is to provide for the ignition of the gases in the different cylinders, at the proper time; and this is accomplished through electrically-operating devices which will now be described.

From an inspection of Figs. 4 and 5 it will be seen that each of the cylinders A—B—C—D is provided near one end with a sparking apparatus, consisting of an insulated rod 75, preferably of copper, the inner end of which projects into the cylinder and is provided with a platinum tip 76, as shown in Fig. 6. The rod 75 is insulated by being fitted into a sleeve 77, of porcelain or other suitable insulating material. Preferably, the sleeve 77 is in two sections, one being above and the other below a collar 78 carried by the rod 75 and located about midway thereof, as shown in Fig. 6. The sleeve 77 is in turn inclosed in vulcanite sleeves 79—80 fitted tightly thereon; and between said sleeves there is a disk 81, also of porcelain, said disk being inserted below the collar 78 of the rod 75. The sleeves 79—80 are fitted in a brass plug 82, screwed into the cylinder and provided with a cap 83, as shown. Suitable gaskets 84—85 are provided in the plug to secure the sleeves 79—80 firmly in position. The collar 78 prevents the rod 75 from moving down too far. The upper end of the rod 75 which projects above the cap 83, is provided with a cap 86, of brass or other suitable conducting material, which also incloses the upper ends of the sleeves 79—80, as shown. 87 indicates a platinum wire, which is secured to the plug 82 and terminates near the tip 76. By adjusting the position of the rod 75 the space between the tip 76 and the wire 87 may be adjusted, to vary the length of the spark. The adjustment of the rod 75 may be effected by using gaskets 84 of different thicknesses. 88 indicates a rod, of vulcanite or other non-conducting material, which is secured to a support 89 mounted on a pivot 90 carried by a suitable frame 91 mounted on a standard 92 of insulating material, which is secured on the surface of the cylinders in proximity to the sparking devices already described, as shown in Figs. 1 and 6. The frame 91 is secured to the standard 92 by a screw 93 which passes through the upper portion of the standard into the frame, as shown in Fig. 6. The frame 91, support 89 and pivot 90 are of conducting material; and said frame is provided with a binding-post 94. 95 indicates a rod, of copper or other conducting material, which extends from the support 89 through the rod 88 and connects with a cap 96 at the end of the rod 88; said cap 96 being arranged in position to strike the cap 86 of the sparking-device when the rod 88 is rocked sufficiently in the proper direction. 97 indicates an armature carried by the rod 88 over an electro-magnet 98 secured on the cylinder, as shown in Figs. 1 and 6. It will thus be seen that by energizing the electro-magnet 98 it will attract the armature 97, carrying the rod 88 downward and moving the cap 96 into contact with the cap 86, thereby closing the circuit from the binding-post 94 to the tip 76.

In Fig. 11 the electro-magnets 98 of the different cylinders A—B—C—D are respectively indicated by a^7—b^7, c^7 and d^7, and each of said magnets is connected with one pole of an electric battery 99; the magnet a^7 having a wire 100 which connects it with said battery, the other magnets being connected thereto, respectively, by wires 101, 102 and 103. The opposite pole of the magnet a^7 is connected by a wire 104 with the contact point 70 of the switch b^6. Similarly, the magnet b^7 is connected by a wire 105 with contact point 70 of the switch c^6, the magnet c^7 by a wire 106 with contact point 70 of the switch a^6, and the magnet d^7 by a wire 107 with contact point 70 of the switch a^5. 108 indicates a wire which connects the contact point 71 of the switch a^6 with contact point 71 of the switch d^6. 109 indicates a wire which connects contact point 70 of the switch d^6 with the opposite pole of the battery 99 from that to which the wire 100 is connected. 110 indicates a wire which connects contact point 71 of the switch b^6 with contact point 71 of switch c^5. 111 indicates a wire which connects contact point 70 of switch c^5 to wire 109. 112 indicates a wire which connects contact point 71 of switch c^6 to contact point 71 of switch d^5. 113 indicates a wire which connects contact point 70 of switch d^5 to wire 109. 114 indicates a wire which connects contact point 71 of switch a^5 to contact point 71 of switch b^5. 115 indicates a wire which connects contact point 70 of switch b^5 to wire 109. 116 indicates an induction coil, the primary coil of which is connected by wires 117—118 with the poles of the battery 99. 119 indicates a wire which connects one of the poles of the secondary coil of the induction coil with the binding-post 94 carried by the different cylinders. For convenience, in Fig. 11, the different binding-posts are indicated by letters a^8, b^8, c^8 and d^8. 120 indicates a wire by which the opposite pole of the secondary coil of the induction coil 116 is grounded in the cylinders A—B—C—D, thus securing electrical connection with the platinum wires 87 in the different cylinders.

From the foregoing it will be seen that when the rod 88 moves down far enough to bring its cap 96 into contact with the cap 86 of the sparking-devices, connections will be made extending from the tip 76 through rods 75 and 95, wire 119, and through the secondary coil of the induction coil 116, wire 120 and the body of the cylinder to the platinum wire 87, thereby causing a spark within the cylinder. The manner in which the different switches are operated to energize the different electro-magnets a^7, b^7, c^7 and d^7, to effect the result just described, will be hereinafter set forth.

The object of causing the sparks in the different cylinders is to ignite a mixture of air and vaporized gasolene therein. The air is introduced into the cylinders through pipe 21 by means of the blower 24: the gasolene is introduced through a pipe 121 and atomizers a^9, b^9,

c^9 and d^9, respectively. The term "atomizers" is applied to the gasolene-feeding devices in a generic sense, and, as herein used, it should be understood that it does not apply solely to the atomizing mechanism.

The construction of the atomizers is best shown in Fig. 7, in which a sectional view of the atomizer a^9 is shown in position on the cylinder A. The atomizers are all alike, so that a description of a single one will suffice for all. From an inspection of Fig. 7 it will be seen that there is an external cylinder or casing 122, one end of which is externally and internally screw-threaded, the external screw-thread screwing into the cylinder A. A cap 123 is screwed into the internal screw-threads, as shown, said cap being provided with a curved nozzle 124 which discharges into the cylinder, the opening being so turned as to direct the inflowing gasolene lengthwise of the cylinder and toward the end at which the valve 29 is placed; the object being to more thoroughly disseminate the atomized gasolene throughout the cylinder. A passage 125 is provided in the cap 123 within the nozzle 124 for the passage of gas from the chamber 126 formed by the casing 122 into said nozzle 124. 127 indicates a gasket placed between a circumferential flange 128 carried by the cylinder 122 and the cylinder A, so as to make a tight joint. The other end of the cylinder 122 is contracted, as shown at 129, and externally screw-threaded to receive a coupling 130 which secures thereto a stub 131 communicating with the pipe 121. The contracted portion 129 of the cylinder 122 contains a valve-chamber 132, partly separated from the chamber 126 by a diaphragm 133 having a central passage which affords communication between said chambers 126 and 132. At the opposite end of the chamber 132 from the diaphragm 133 is a valve-seat 134. 135 indicates a valve-cylinder which is placed within the cylinder 122 and is of somewhat less diameter, being held in position by wings 136 which radiate therefrom at suitable points, as shown. The inner end of the valve-cylinder 135,—that is to say, the end nearer the cylinder A,—is provided with a screw-cap 137 which has a central passage 138 which registers with the passage 125. A tube 139 extends through the passages 125 and 138, one end terminating in the lower portion of the valve-cylinder 135, the other end being curved and extending to near the discharge end of the nozzle 124, as shown. The tube 139 does not entirely close the passages 125 and 138, sufficient space being left around it to permit the action of the gases under pressure, as hereinafter described, on the liquid in the valve-cylinder and in the nozzle which projects therefrom, as shown in Fig. 7. The valve-cylinder 135 is closed at its outer end, except for a tube 140. Said tube 140 is closed and is conical in form, forming a valve 141 adapted to seat on the valve-seat 134, thereby controlling the flow of gasolene from the stub 131 into the valve-chamber 132. The tube 140 is also provided with one or more lateral passages 142 opening into the valve-chamber 132, through which passages the gasolene may flow from said valve-chamber 132 into the tube 140, and through it into the valve-cylinder 135.

The power which operates the atomizer of any given cylinder is derived from the explosion in one of the other cylinders. For example, the action of the atomizer a^9 depends upon the explosion in the cylinder D; that of atomizer b^9 on the explosion in cylinder A; that of atomizer c^9 on the explosion in cylinder B, and that of atomizer d^9 on the explosion in cylinder C. To this end, the cylinder D is provided with a pipe d^{10} extending from said cylinder to the atomizer a^9. Similarly, the cylinder A is provided with a pipe a^{10} which connects with the atomizer b^9; the cylinder B with a pipe b^{10} which connects with the atomizer c^9, and the cylinder C with a pipe c^{10} which connects with the atomizer d^9, (see Fig. 2). Between each of the pipes a^{10}, b^{10}, c^{10} and d^{10} and the atomizers to which they are respectively connected, are provided check-valves 143, as shown in Fig. 7. Said check-valves may be of any approved construction suitable for that purpose. In Fig. 7 I have illustrated them as consisting of a ball having a conical stem 144 seated on a seat 145 separating passages 146 and 147; the former leading, in the instance shown in Fig. 7, to the pipe d^{10} and the latter leading to the chamber 126, the arrangement being such that when there is pressure in the passage 146 the valve 143 is lifted from its seat, permitting the gases to flow through passage 147 into chamber 126, and thence through passages 125 and 138 to the nozzle 124 and valve-cylinder 135, respectively, the gases acting to atomize or spray the liquid in the valve-cylinder 135 into the cylinder A, as will be hereinafter described.

The operation of my improved generator is as follows: Assuming that the cylinder D has just exploded, the cylinder A, which will be the next to explode will be preparing therefor, and the cylinders B and C will be receiving a charge of fresh air, to clear out the gases remaining after the explosion and to supply a requisite amount of air for mixture with the gasolene, prior to the next explosion. At this time, as shown in Fig. 3, the valves 29 in valve-chambers a^2 and d^2 will be closed, while the valves in the chambers b^2 and c^2 will be open. This will be due to the fact that, as the pressure in cylinder D will be greater than in any other cylinder owing to its just having exploded, such pressure will force the ball valves 59 in couplings 41 and 42 against the seats at the ports 60, permitting the gases in cylinder D to act through pipes 53 and 54 on diaphragm b^3, and also through pipes 50 and 51 on diaphragm c^3, thereby forcing the disks 34 of said diaphragms upward, and opening their respective valves 29. The valve 29 in valve-chamber a^2 will be closed at the time of the explosion in cylinder D by the springs 38, since there will be no opposing pressure in the diaphragm a^3, as will hereinafter appear. When the explosion occurs in the cylinder D, pressure will be transmitted through pipe d^{10} to atomizer a^9, the valve 143 being raised thereby so that the gases under pressure enter the chamber 126. Prior to this action, the valve-cylinder 135 will have received a charge of gasolene in the following manner: The gasolene reservoir being placed on a higher level than the cylinders A—B—C—D, gasolene will flow therefrom through pipe 121 to the different atomizers; and when there is no pressure in a given cylinder, as, for example, the cylinder A, the pressure of the gasolene will be sufficient to raise the valve 141 from its seat, so that the gasolene can enter the valve-chamber 132, and passing through it and through the pipe 141 enter the valve-cylinder 135. As illustrated in Fig. 4, the atomizers are on the under side of their respective cylinders.

As soon as the valve-cylinder 135 is filled so full that the weight of the contained gasolene overcomes the pressure from the gasolene reservoir, the valve-cylinder 135 drops, carrying the valve 141 on to its seat and preventing the admission of further gasolene. The parts of the atomizer will then be in the position shown in Fig. 4, so that when the gases under pressure are admitted to the chamber 126 they enter valve-cylinder 135 through passage 138 and exert downward pressure on the surface of the gasolene therein contained, forcing the gasolene up through pipe 139 and out through the nozzle 124. At the same time, the gases pass upward through the passage 125, and act externally on the gasolene escaping from pipe 139; the result being that the gasolene is atomized and sprayed through the cylinder into which it is discharged. The check-valve 143 is provided with a large ball 149 which prevents it from rising from its seat except under the greatest pressure, so that the gasolene is supplied to the cylinders only immediately after the explosion in the cylinders which exploded next previously. Waste of pressure is by this means avoided. A spring could be used instead of the weight 149, if desired. The atomizers b^9 and c^9 of cylinders B and C, respectively, will not supply gasolene to their respective cylinders at this time, although their valve-cylinders 135 will be full or be filling with gasolene, because there will be no pressure in cylinder A, which operates atomizer b^9, or in cylinder B, which operates atomizer c^9. It will, of course be understood that cylinder A was cleared of gases and provided with a charge of fresh air prior to its receiving a charge of gasolene, the air being supplied to said cylinder at the time of the explosion in cylinders B and C.

As has already been explained, the pressure chamber a^3 of cylinder A, by which its valve 29 in valve-chamber a^2 is opened, is connected by pipe 46, coupling 40 and pipe 48 with cylinder B, and by pipe 47, coupling 40 and pipe 48 with cylinder C, so that pressure in either of said cylinders B and C sufficient to compress spring 38 operates to raise the disk 34 in pressure chamber a^3 and open valve 29 in valve-chamber a^2. Since the cylinders A—B—C—D explode in rotation, prior to the explosion in cylinder D the explosion in cylinder C will, therefore, have opened valve 29 in valve-chamber a^2, and until shortly before the explosion in cylinder D said valve will have remained open. As soon, however, as the pressure in cylinder C is reduced to such an extent that it is unable to hold the spring 38 of pressure chamber a^3 under compression, said spring acts to depress the disk 34 and valve-stem 30, closing said valve 29 and putting the cylinder A into condition to receive its charge of gasolene. This occurs shortly before the explosion in cylinder D. Immediately upon the taking place of the explosion in cylinder D gasolene is sprayed into cylinder A, as already described, and at the same time the pressure chamber disks 34 of the pressure chambers b^3 and c^3 are raised, pressure being applied to the pressure chamber b^3 from cylinder D through pipe 53, coupling 42 and pipe 54, and to the pressure chamber c^3 through pipe 50, coupling 42 and pipe 51, opening the valves 29 in the valve-chambers b^2 and c^2, respectively, and at the same time rocking the circuit-closing devices b^4 and c^4 out beyond their respective contact-points 70—71—72—73, into the position shown in Fig. 1. When the pressure in cylinder D is reduced by consumption to such a point that it is insufficient to compress the springs 38 of the pressure chambers b^3 and c^3, said springs act to close the valves in the valve-chambers b^2 and c^2, moving their respective valve-stems 30 downward, rocking the circuit-closing devices b^4 and c^4 to the right, as shown in Fig. 1, and moving them temporarily into engagement with the springs 70—71 and 72—73 as they pass. This closes the circuit at switches b^5, b^6 and c^5, c^6, so that there is then a circuit from battery 99 through the magnet a^7 as follows: from battery 99 over wire 100 to magnet a^7, thence over wire 104, switch b^6, wire 110, switch c^5 and wires 111 and 109 back to the battery. While the switches b^5 and c^6 are closed by this operation no current passes through them, since these circuits are broken at other points, as, for example, at a^5 and d^5.

The closing of the circuit through magnet a^7 causes the rod 88 to move toward the cap 86 of the sparking devices of cylinder A until the cap 96 strikes said cap 86, thereby making connection between the induction coil 116 and the tip 76 in one direction, and between the induction coil and the wire 87 in the other direction, thereby causing a spark to pass from the tip 76 to the wire 87 within the cylinder A. The connections between the induction coil and the tip 76 are as follows: over wire 119 to binding-post a^8, thence through rod 95 to cap 96, thence to cap 86 and through rod 75 to tip 76. From the induction coil to wire 87 the current passes over wire 120 to the frame of the machine, and through said frame to the wire 87. The closing of the circuit in cylinder A will ignite the mixed air and gasolene therein, which will explode, the greater portion of the power being directed through pipe 15 to the chest. At the same time the pressure in cylinder A will act through pipe 49, coupling 41 and pipe 51 upon pressure chamber c^3, raising the disk 34 thereof and again opening the valve 29 in chamber c^2. It will also act through pipe 43, coupling 39 and pipe 45 upon pressure chamber d^3, raising the disk 34 thereof and opening valve 29 in valve-chamber d^2. It will also act through pipe a^{10} upon atomizer b^9 of cylinder B, and effect the discharge thereinto of the gasolene in its valve-cylinder 135. The valve 29 in the valve-cylinder b^2 will, however remain closed, since it is not acted upon by pressure in cylinder A, so that the gasolene supplied to cylinder B will not pass out. When the valve 29 in the valve-chamber d^2 of cylinder D is opened, as above described, there being no pressure in said cylinder, check-valve 23 which controls the air discharged from the blower will open, admitting a supply of fresh air which will enter and fill said cylinder, passing out through valve 29 and passages 31 until said valve is again closed.

The operation of the different cylinders continues in rotation; the gases in cylinder B exploding as soon as the pressure in cylinder A becomes reduced to a point where it is insufficient to compress the springs 38 of pressure chambers d^3 and c^3, when said springs will rock the circuit-closing devices d^4 and c^4, respectively, closing the circuit through switches c^5 and c^6 and d^5 and d^6, thus establishing a closed circuit through magnet b^7 as follows: from battery 99 over wires 100 and 101 to magnet b^7, thence back over wire 105, switch c^6, wire 112, switch d^5 and wires 113 and 109 to the battery. This energizes magnet b^7 and causes a spark in cylinder

B, as already described, in connection with cylinder A. In like manner an explosion in cylnder B opens valves 29 in valve-chambers d^2 and a^2, and the consequent reduction of pressure in cylinder B closes the circuit by means of circuit-closing devices d^4 and a^4, respectively, through switches d^5—d^6 and a^5—a^6, establishing a current through magnet c^7 from the battery 99, as follows: over wires 100 and 102 to magnet c^7, thence back over wire 106, switch a^6, wire 108, switch d^6 and wire 109 to the battery, making a spark in cylinder C and causing an explosion therein. It will thus be seen that the different cylinders explode in rotation, and that in the construction shown three cylinders are being cleansed and charged for subsequent explosions while the fourth is under pressure, so that practically a continuous pressure is maintained on the chest. It will further be seen that by regulating the tension of the springs 38, the minimum pressure in the cylinders can be accurately regulated.

Obviously, the number of cylinders A—B—C—D employed may be varied in number, from two up being used; but it is desirable that the number employed be sufficient to allow ample opportunity for the cleansing and charging of the cylinders between explosions. It is further obvious that the different cylinders may be arranged to explode in any desired order by appropriately arranging the connections; but, for convenience, it is desirable that they be arranged in the order illustrated.

The engine is stopped and started by means of a throttle valve 148 placed between the pipe 15 and the chest 16 of the engine, and preferably between the reducing valve 18 and the chest, as indicated in Fig. 1. When the valve 148 is opened the gases under pressure may enter the chest 16 and operate the engine; and by closing said valve pressure may be cut off from the chest. When the throttle valve is closed, the cylinder in which the last explosion took place will retain its gases under pressure, since the different valves are made tight enough to prevent leakage. The result is that the engine may be started at any time by simply opening the throttle valve, and the generator will commence its operation at once, the different cylinders operating as hereinbefore described.

The term "engine", as used herein, should be understood to mean a machine, of whatever character, operated by power derived from the generator.

While I have described the generator illustrated specifically, it will be understood that my invention is not limited to the specific details of construction, except in so far as such details are particularly claimed.

That which I claim as my invention and desire to secure by Letters Patent is,—

1. A generator, consisting of a plurality of generating chambers, each of said chambers having a contracted outlet through which the pressure generated therein is transmitted therefrom, means operated by increase of pressure in one of said chambers for charging another of said chambers with an explosive mixture, and means operated by diminution of pressure in one of said chambers for exploding the mixture in another chamber.

2. A generator, consisting of a plurality of reservoir cylinders, means for charging said cylinders with an explosive mixture of gases, means for igniting the mixed gases in said cylinders, to cause an explosion, means for exploding the gases in the different cylinders in rotation, means operated by increase of the pressure in each cylinder for charging another cylinder of the series, and means operated by reduction of the pressure of one cylinder for exploding the charge in another cylinder of the series, substantially as described.

3. A generator, consisting of a plurality of cylinders, means for supplying air to said cylinders, means for supplying gasolene to said cylinders, valves controlling the admission of air and gasolene, respectively, to said cylinders, means operated by increase of the pressure of the gases in each of said cylinders for controlling the admission of air and gasolene to another cylinder of the series, means for igniting the mixed gases in said cylinders, and means operated by reduction of the pressure of the gas in one of said cylinders for controlling the operation of the igniting-devices in another cylinder, substantially as described.

4. A generator, consisting of a plurality of cylinders, means for forcing air through said cylinders, means for supplying gasolene to said cylinders subsequently to their receiving the charge of air, valves controlling the admission of the air and gasolene, sparking-mechanism for igniting the gases in said cylinders, means operated by reduction of the pressure of the gas in one of said cylinders for controlling the operation of said sparking-mechanism of another cylinder, and means operated by increase of pressure of the gas in one of said cylinders for controlling the operation of the air and gasolene supplying mechanism of another cylinder, substantially as described.

5. A generator, consisting of a plurality of cylinders, means for forcing air through said cylinders, means for supplying gasolene to said cylinders subsequently to their receiving the charge of air, valves controlling the admission of the air and gasolene, sparking-mechanism for igniting the gases in said cylinders, means operated by reduction of the pressure of the gas in one of said cylinders for controlling the operation of the sparking-mechanism of another cylinder, and means operated by increase of pressure of the gas in one of said cylinders for controlling the operation of the air and gasolene supplying mechanism of another cylinder, the different cylinders being arranged to operate in rotation, substantially as described.

6. A generator, consisting of a plurality of cylinders, each of said cylinders having an outlet for the discharge of the gases under pressure, a check valve for said outlet, an inlet passage for air communicating with each of said cylinders, a check valve in each of said inlets, a discharge passage for waste gases communicating with each of said cylinders, each of the latter passages having a valve to prevent the escape of gases under pressure, the latter valve of each cylinder being operated by the explosion in one of the other cylinders of the series, means for supplying said cylinders with gasolene, and means for igniting the mixed gases therein, substantially as described.

7. In a generator, the combination of a plurality of reservoir cylinders arranged to operate in rotation, means for supplying an explosive mixture to said cylinders, in rotation, one of said cylinders being supplied while another is under pressure, and means operated by the reduction of the pressure in one of said cylinders for igniting the mixed gases in a charged cylinder, substantially as described.

8. In a generator, the combination of three or more cylinders, means for charging each of said reservoir cylinders with an explosive mixture, and means for igniting the explosive mixture in said cylinders in rotation, the charging mechanism of each cylinder being operated by pressure in one of the other cylinders and the igniting mechanism of the charged cylinder being operated by diminution of the pressure in one of the other cylinders, substantially as described.

9. A generator, consisting of a plurality of reservoir cylinders, means for charging said cylinders with an explosive mixture, and means operated by diminution of the pressure in one of said cylinders for exploding the mixture in another cylinder, substantially as described.

10. A generator, consisting of a plurality of reservoir cylinders, means for charging said cylinders with an explosive mixture, and means operated by diminution of the pressure in one of said cylinders for exploding the mixture in another cylinder, the several cylinders being connected to operate in rotation, substantially as described.

11. In a generator, the combination of cylinders as A—B—C—D, arranged to operate in rotation, each of said

cylinders having an escape valve for the escape of spent gases therefrom, means operated by sufficient pressure in each of said cylinders for opening the escape valves of the two cylinders which exploded next before it, said escape valves being arranged to close automatically when the pressure in the cylinder by which they were opened diminishes beyond a certain point, means operated by the explosion of gas in each cylinder for supplying gasolene to the cylinder next to operate, and electric sparking-devices operated by diminution of the pressure in any cylinder for operating said sparking mechanism to cause a spark in the cylinder next to operate, substantially as described.

12. In a generator, the combination of cylinders as A—B—C—D, arranged to operate in rotation, each of said cylinders having an escape valve for the escape of spent gases therefrom, means operated by sufficient pressure in each of said cylinders for opening the escape valves of the two cylinders which exploded next before it, said escape valves being arranged to close automatically when the pressure in the cylinder by which they were opened diminishes beyond a certain point, means operated by the explosion of gas in each cylinder for supplying gasolene to the cylinder next to operate, electric sparking-devices operated by the diminution of the pressure in any cylinder for operating said sparking mechanism to cause a spark in the cylinder next to operate, and means for forcing air into each of said cylinders when their exhaust valves are open, substantially as described.

13. In a generator, the combination of four cylinders as A—B—C—D, each of said cylinders having an exhaust valve, pressure chambers a^3, b^3, c^3 and d^3 for operating said exhaust valves, means for operating the pressure chamber a^3 from cylinders B and C, means for operating the pressure chamber b^3 from cylinders C and D, means for operating the pressure chamber c^3 from cylinders A and D, means for operating the pressure chamber d^3 from cylinders A and B, sparking-devices in each of said cylinders, means for operating the sparking-devices of cylinder A by the operation of pressure chambers b^3 and c^3, means for operating the sparking-devices of cylinder B by the operation of pressure chambers c^3 and d^3, means for operating the sparking-devices of cylinder C by the operation of pressure chambers a^3 and d^3, means for operating the sparking-devices of cylinder D by the operation of pressure chambers a^3 and b^3, means for supplying gasolene to each of said cylinders, the gasolene-supplying devices of cylinder A being operated by pressure in cylinder D, those of cylinder B being operated by pressure in cylinder A, those of cylinder C by pressure in cylinder B, and those of cylinder D by pressure in cylinder C, substantially as described.

14. In a generator, the combination of four cylinders as A—B—C—D, each of said cylinders, having an exhaust valve, pressure chambers as a^3, b^3, c^3 and d^3 for operating said exhaust valves, means for operating the pressure chamber a^3 from cylinders B and C, means for operating the pressure chamber b^3 from cylinders C and D, means for operating the pressure chamber c^3 from cylinders A and D, means for operating the pressure chamber d^3 from cylinders A and B, sparking-devices in each of said cylinders, means for operating the sparking-devices of cylinder A by the operation of pressure chambers b^3 and c^3, means for operating the sparking-devices of cylinder B by the operation of pressure chambers c^3 and d^3, means for operating the sparking-devices of cylinder C by the operation of pressure chambers a^3 and d^3, means for operating the sparking-devices of cylinder D by the operation of pressure chambers a^3 and b^3, means for supplying gasolene to each of said cylinders, the gasolene-supplying devices of cylinder A being operated by pressure in cylinder D, those of cylinder B being operated by pressure in cylinder A, those of cylinder C by pressure in cylinder B, and those of cylinder D by pressure in cylinder C, and means for forcing air into each of said cylinders when its exhaust valve is open, substantially as described.

15. In a generator, the combination of cylinders as A—B—C—D, each of said cylinders having an exhaust valve, pressure chambers a^3, b^3, c^3 and d^3 operating, respectively, the exhaust valves of the cylinders A, B, C and D, the pressure chamber a^3 being connected by pipes 46 and 48 and coupling 40 with cylinder B and by pipes 47 and 48 and coupling 40 with cylinder C, the pressure chamber b^3 being connected by pipes 52 and 54 and coupling 42 with cylinder C and by pipes 53 and 54 and coupling 42 with cylinder D, the pressure chamber c^3 being connected by pipes 49 and 51 and coupling 41 with cylinder A and by pipes 50 and 51 and coupling 41 with cylinder D, and the pressure chamber d^3 being connected by pipes 43 and 45 and coupling 39 with the cylinder A and by pipes 44 and 45 and coupling 39 with cylinder B, each of said couplings having an automatic valve which opens for the gases from the cylinder having the greater pressure, means for admitting air into said cylinders when their exhaust valves are open, a sparking device for each of said cylinders, and an atomizer for each of said cylinders for supplying gasolene thereto, a pipe connecting the atomizer of cylinder A with cylinder D, a pipe connecting the atomizer of cylinder B with cylinder A, a pipe connecting the atomizer of cylinder C with cylinder B, and a pipe connecting the atomizer of cylinder D with cylinder C, whereby the pressure in each cylinder operates the atomizer of the cylinder next to operate, substantially as described.

16. A generator, consisting of a plurality of cylinders, means for charging said cylinders with an explosive mixture, means operated by diminution of the pressure in one of said cylinders for effecting an explosion of the mixture in another cylinder, and valves between the different cylinders, substantially as described.

17. A generator, consisting of a plurality of generating chambers, means for charging said chambers successively with an explosive mixture, each of said chambers having a contracted outlet through which the pressure generated therein is transmitted therefrom, and means operated by the diminution of pressure in one of said chambers for effecting an explosion of the mixture in another chamber.

18. A generator, consisting of a plurality of generating chambers, means operated by the explosion of an explosive mixture in one chamber for charging another of said chambers with an explosive mixture, and means operated by the diminution of pressure in one of said chambers for exploding the mixture in another chamber.

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Witnesses:
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HELEN M. COLLIN.