E. L. B. ZIMMER.

AIR PUMPING APPARATUS.

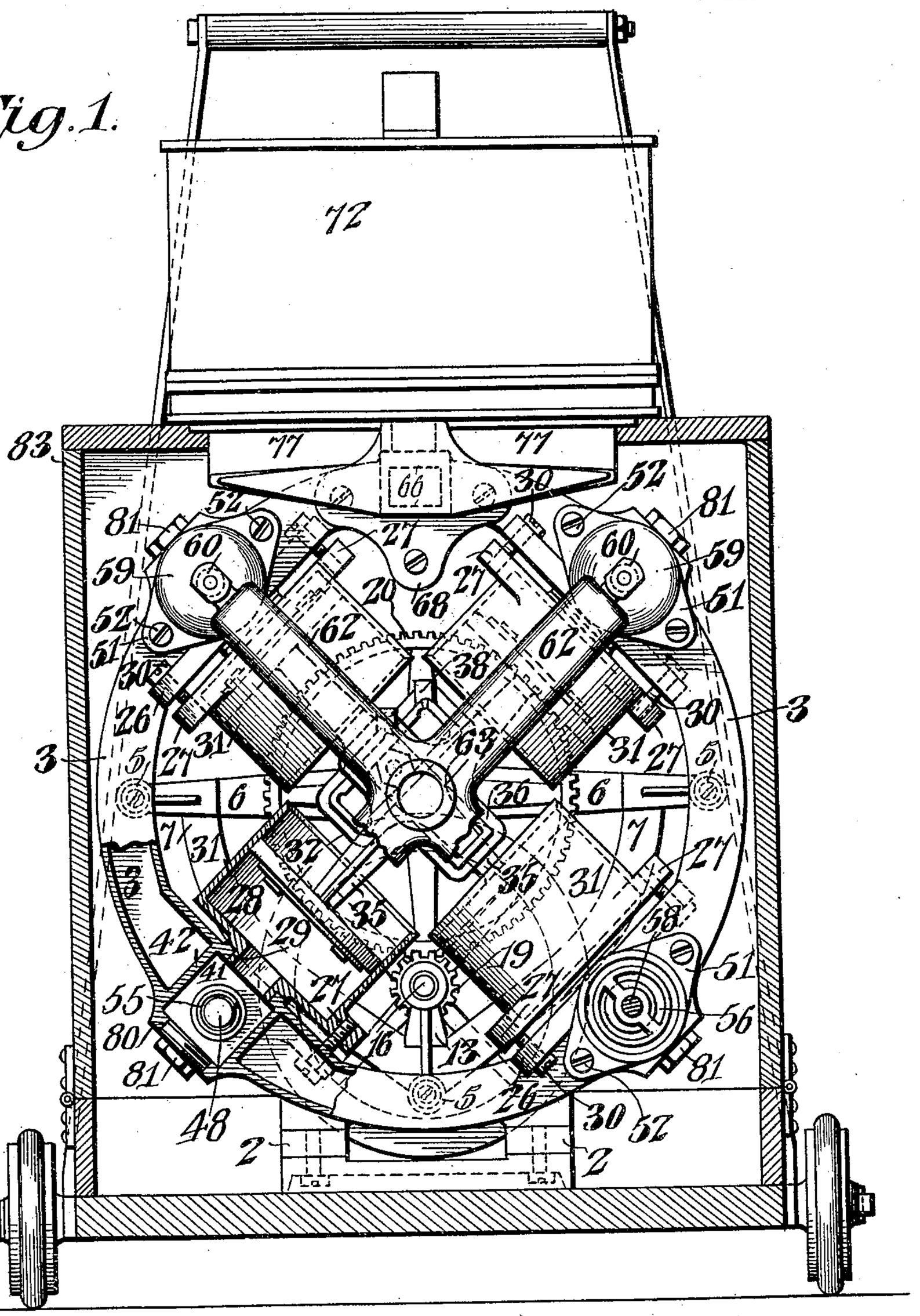
APPLICATION FILED FEB. 17, 1909.

978,258.

Patented Dec. 13, 1910.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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4 SHEETS—SHEET 2.

Fig. 3.

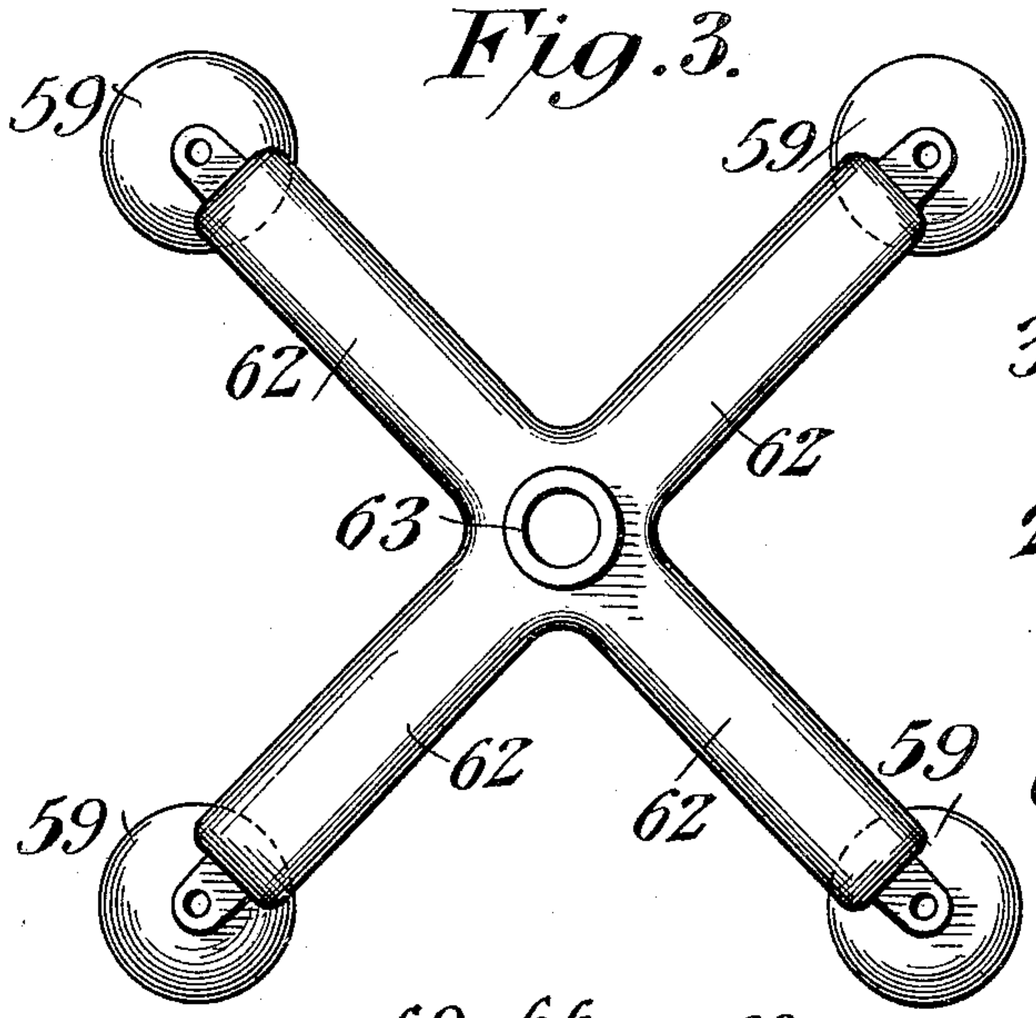


Fig. 5.

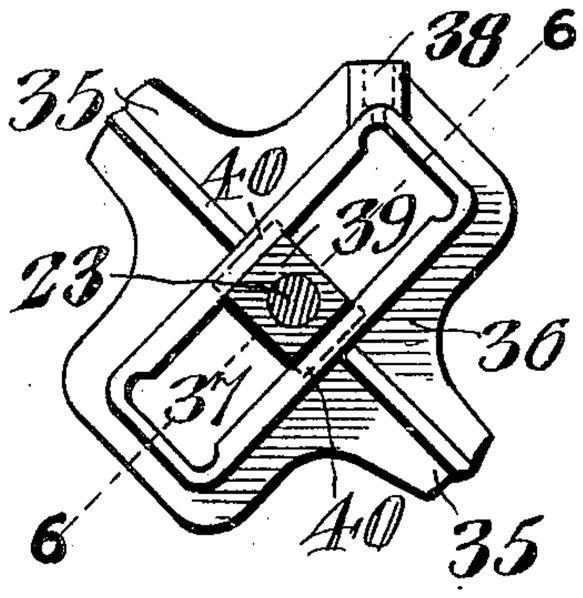


Fig. 4.

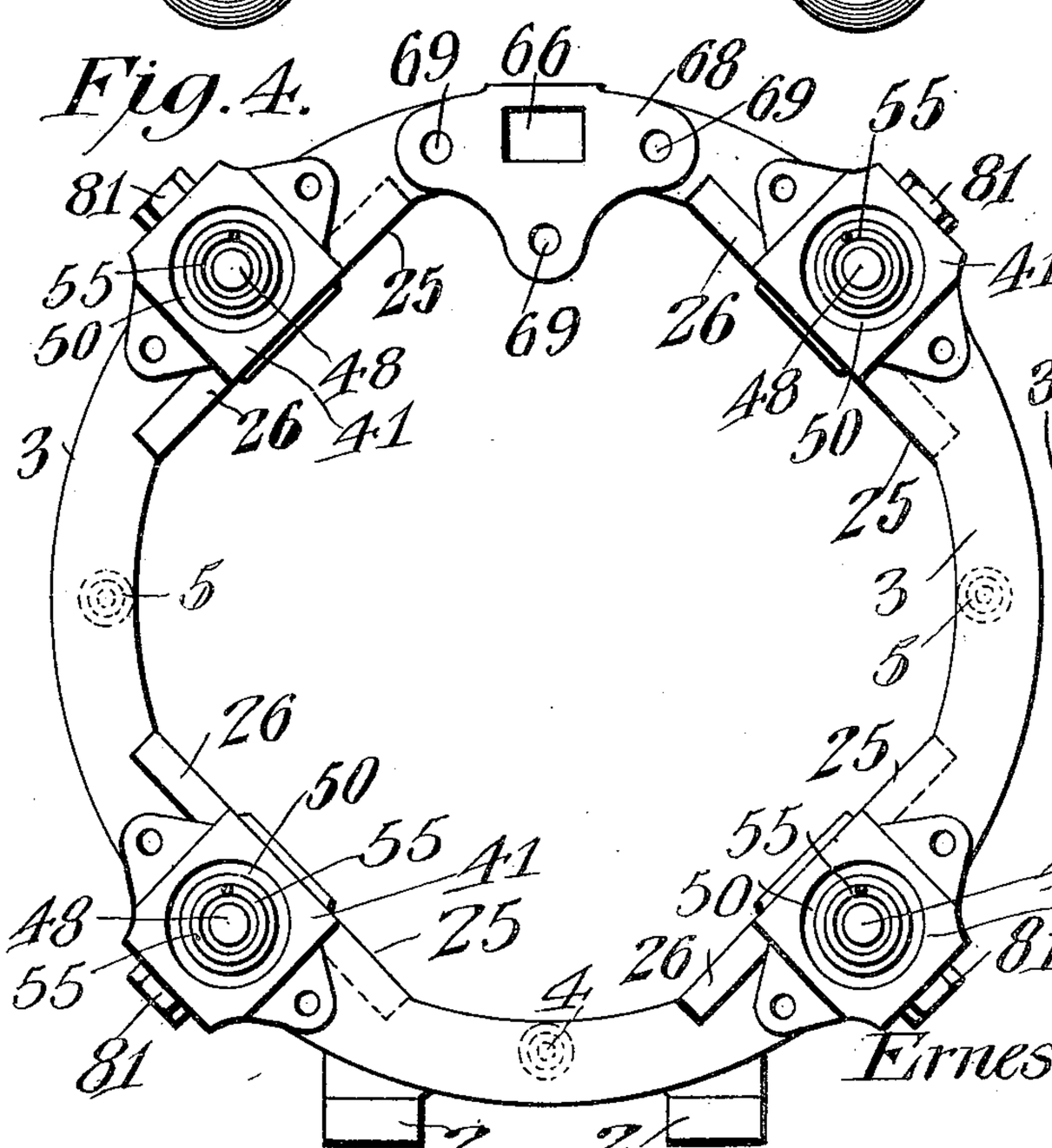
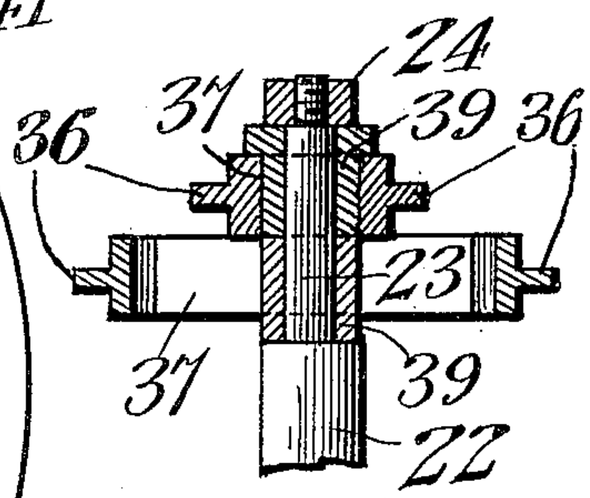


Fig. 6.



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4 SHEETS—SHEET 3.

Fig. 7.

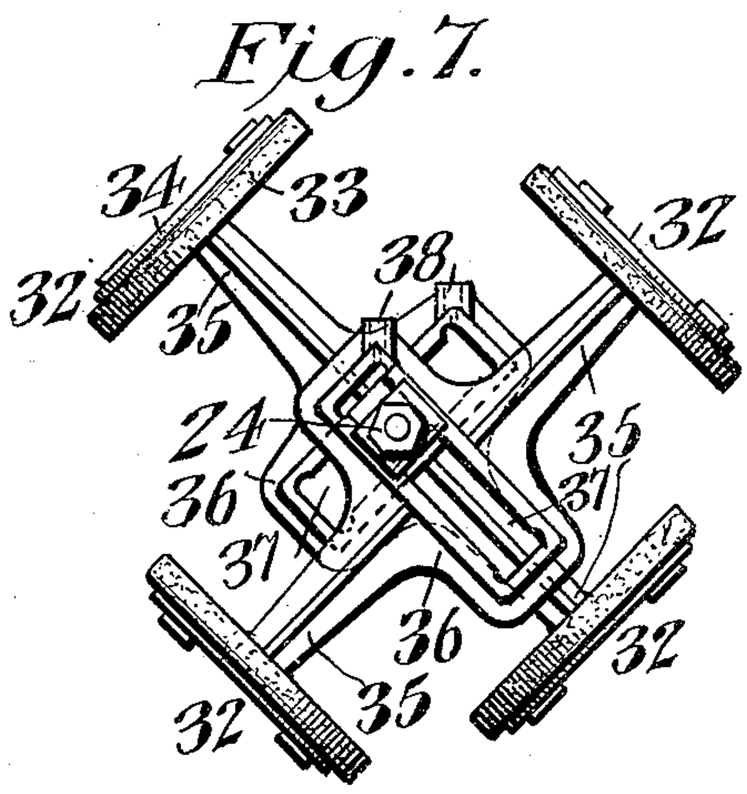

Fig. 8.

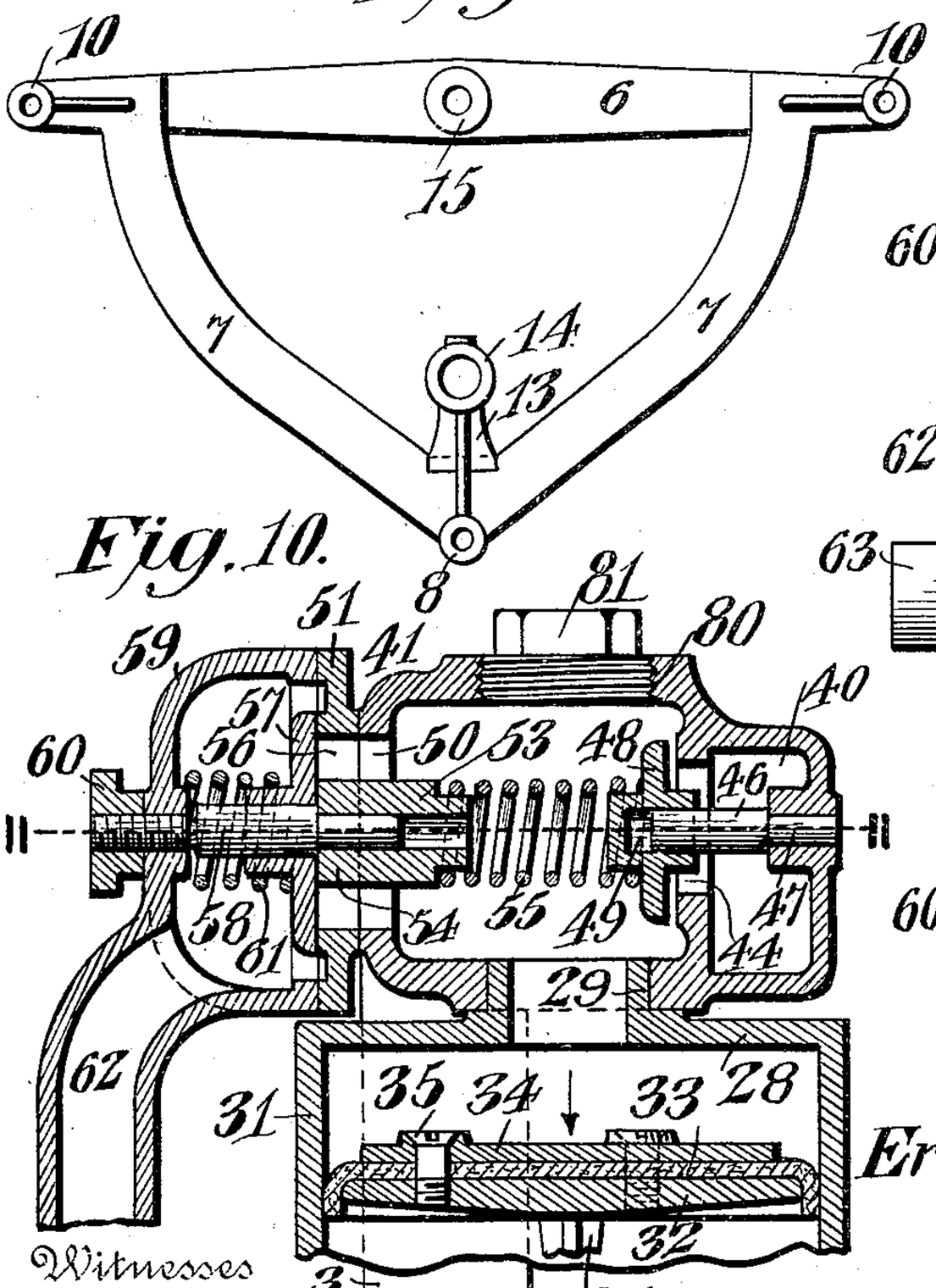

Fig. 10.

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Fig. 11.

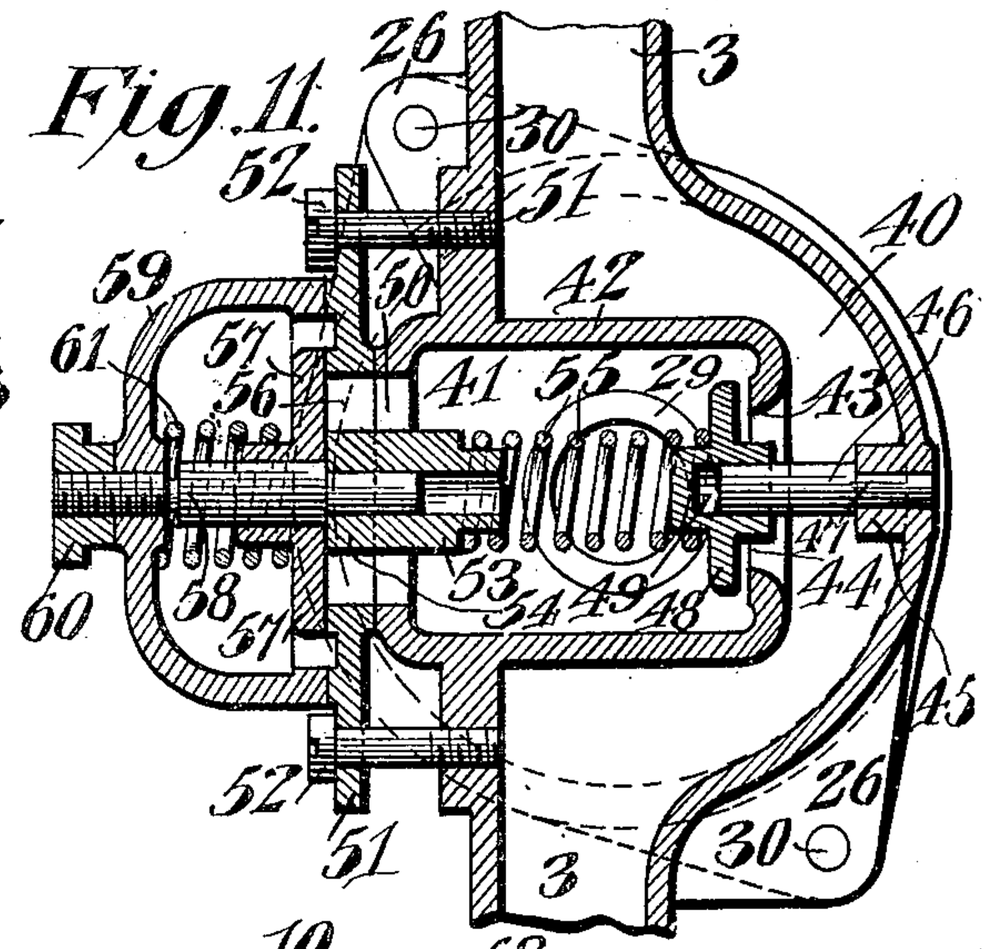
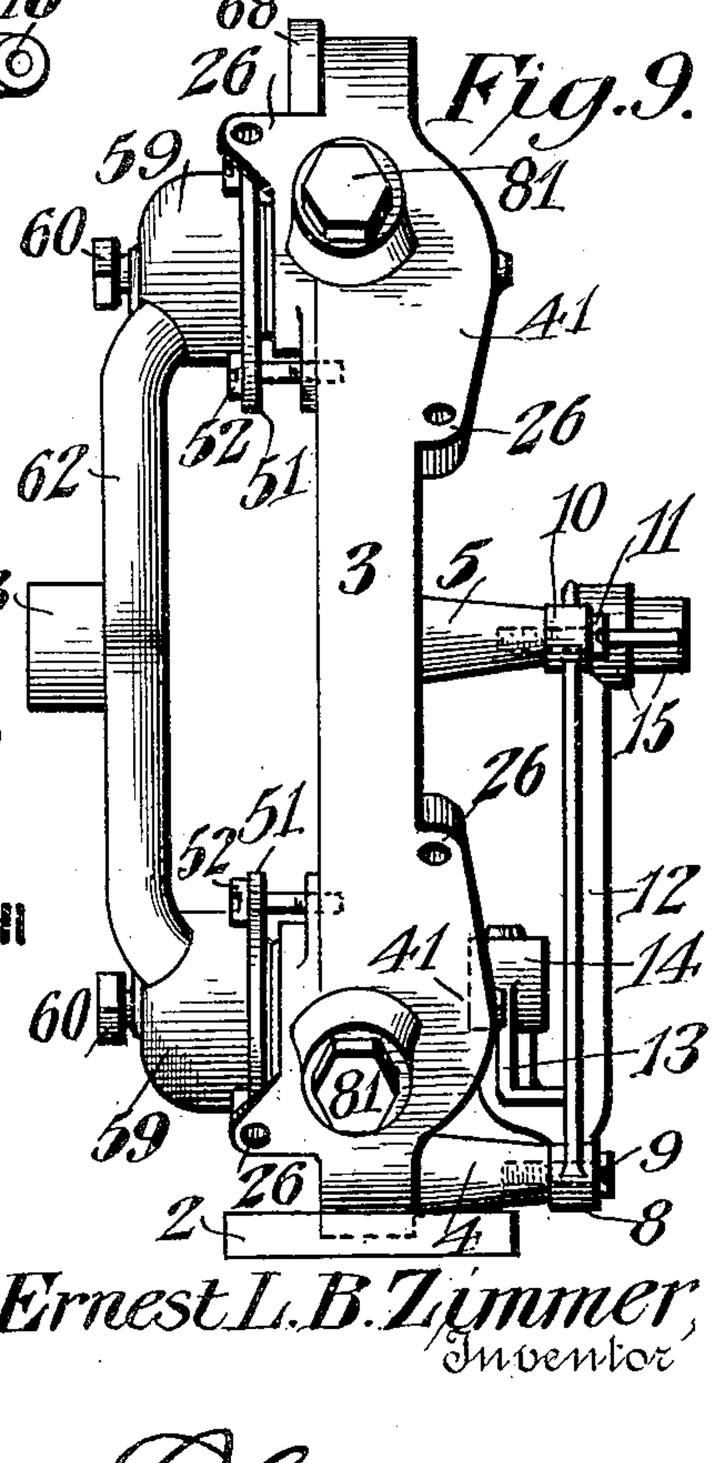


Fig. 9.



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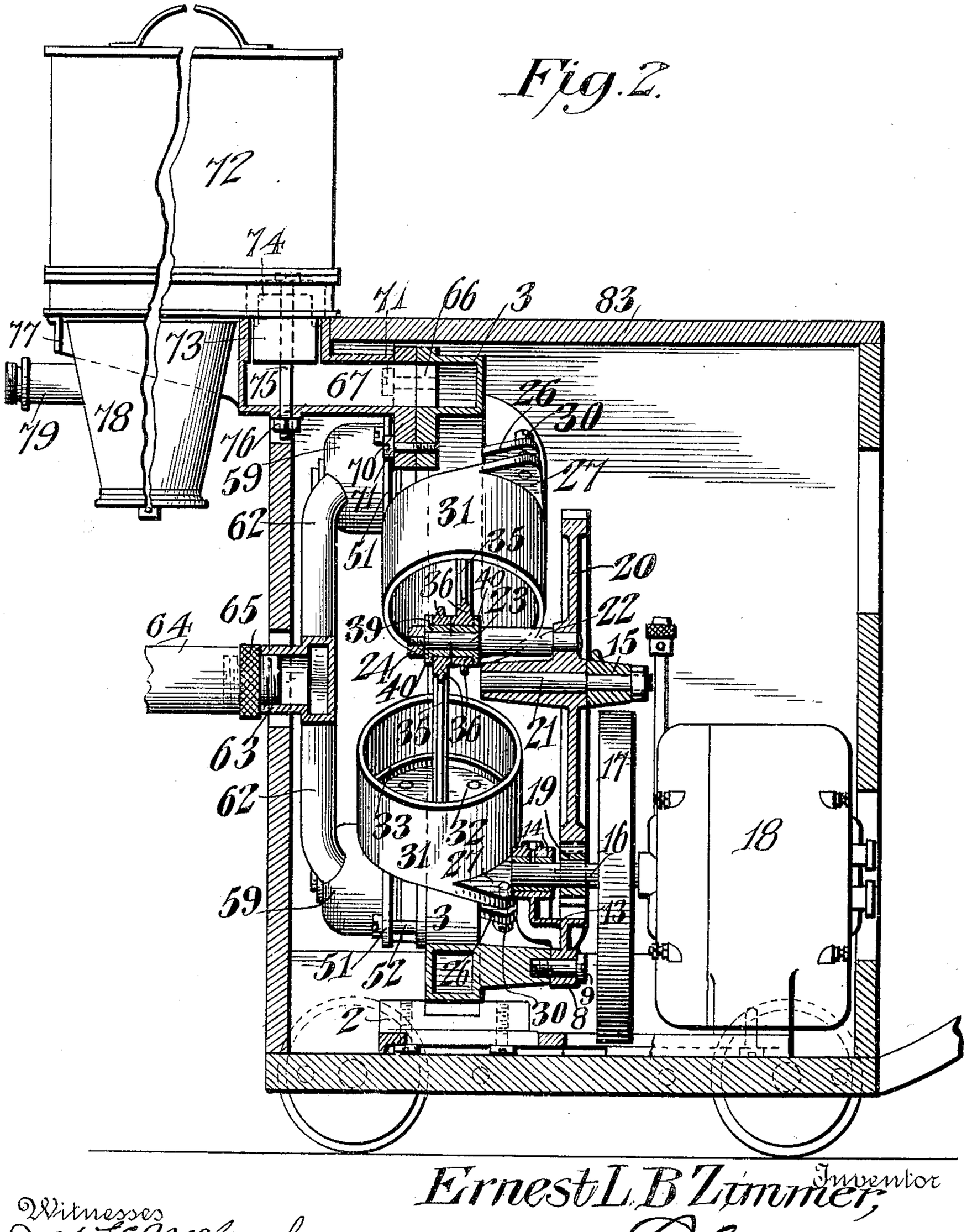
4 SHEETS—SHEET 4.

Fig. 2.



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UNITED STATES PATENT OFFICE.

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AIR-PUMPING APPARATUS.

978,258. Specification of Letters Patent. Patented Dec. 13, 1910.

Application filed February 17, 1909. Serial No. 478,361.

To all whom it may concern:

Be it known that I, ERNEST L. B. ZIMMER, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented a new and useful Air-Pumping Apparatus, of which the following is a specification.

My invention relates to air pumps generally, but particularly to an air pumping structure designed for and peculiarly adapted to vacuum cleaning apparatus, though not limited to this use.

In its general features my apparatus includes, aside from the casing which would usually, but not necessarily, surround it, a series of radially arranged pumping cylinders fixed in an annular supporting tubular frame through which air is drawn from any desired source as, for instance, said vacuum cleaning apparatus.

A motor-actuated crank is arranged centrally of a series of pistons and their cylinders, said crank carrying yokes whereby the pistons are operated in the cylinders. The annular supporting frame is tubular, has an inlet at one portion, and each cylinder has outlet ports having suitable outlet valves, these parts being connected to a common discharge pipe.

Incidentally to the peculiar adaptation of my pump to vacuum cleaning apparatus, the tubular frame is connected to a dust collector to withdraw air from the same and the apparatus as a whole is mounted on a wheeled casing adapted to be readily transported to move the apparatus about a floor.

While in its broader feature my invention consists in a structure having a plurality of radially arranged pumping cylinders, whose pistons are actuated from a single shaft, these cylinders being connected to a common inlet conduit and a common discharge, yet it also consists in the general arrangement of parts and details of construction as set forth in the accompanying specification and specifically stated in the appended claims, these constructional details and arrangements conducing to the more perfect operation of the pumping apparatus and to the ease whereby it may be manufactured and assembled.

In the drawings, Figure 1 is a rear face view of the pumping mechanism, the casing being in section and certain of the interior parts being broken away to give a general idea of the construction; Fig. 2 is a vertical medial section transverse to Fig. 1; Fig. 3 is a face view of the outlet pipes detached from the supporting ring; Fig. 4 is an inside face view of the supporting ring detached from the parts supported thereby; Fig. 5 is an enlarged fragmentary detail showing a piston yoke, the crank pin and slide therefor being in section; Fig. 6 is a longitudinal section of Fig. 5, on the line 6—6, showing, however, the two superposed piston yokes; Fig. 7 is a face view of the two pairs of pistons and their yokes isolated from the coöperating mechanism; Fig. 8 is a front elevation of the frame supporting the driving gears of the apparatus; Fig. 9 is a side elevation of the cylinder supporting frame, the gear supporting frame and the air discharge or outlet pipes assembled; Fig. 10 is an enlarged detail axial section of a cylinder and one of the valve chambers of the tubular supporting frame and one of the connected discharge pipes; Fig. 11 is a section of the parts shown in Fig. 10 on lines 11—11.

In the embodiment of my invention shown in the drawings, 2 denotes a base supporting an annular tubular air conducting and supporting frame which, generically, is designated 3, and which, to a large extent, supports, the operating mechanism. The base 2 in the embodiment illustrated by me is supported on the flooor of a wheeled box or case, 83, adapted to be pushed about the floor, and which carries upon it a dust collector of any usual or desired character, such as is common in vacuum cleaning apparatus. One face of the tubular supporting frame 3 is formed with a projecting pillar, 4, at the lowest portion of the frame and two lateral pillars, 5, diametrically opposed to each other.

In Fig. 8 is shown a gear supporting yoke or frame of an approximately triangular form having an upper transverse bar 6 and opposed downwardly extending convergent arms 7. At the junction of the convergent arms is formed the hub 8, through which a stud bolt 9 extends into the pillar 4, while near the ends of the transverse bar 6 are also formed hubs 10 through which stud bolts 11 pass and engage the pillars 5. The inside face of the yoke is flat while the outer face is formed with the strengthening

flanges 12. Formed at the junction of the yoke frame arms 7 is the inwardly and upwardly extending bracket 13, carrying a journal bearing 14, and at the middle of the cross bar 6 is formed the hub 15. It will be seen from Fig. 2 that the middle portion of the cross bar 6 is in a plane offset outwardly from the arms 7 and that the hub 15 is therefore outward from the plane of the arms 7.

Journaled in the bearing 14 is a driving shaft 16 having a fly wheel 17, and shown as driven by an electric motor 18. This shaft 16 carries a pinion 19, which meshes with and drives a toothed gear wheel, 20, on the stub shaft 21, supported in the hub 15, and projecting inward therefrom. The gear 20 carries an inwardly projecting crank pin 22, which is reduced at its end as at 23, and has on its extremity a nut 24.

Referring now to Figs. 4, 10 and 11, it will be seen that the annular tubular frame, 3, at four points in its extent is formed with enlargements 40, inclosing a valve chamber 41, as will be later described. Each of these enlargements as shown in Fig. 4 is formed on the inside face of the ring with a seat 25, approximately elliptical in plan, the major axis of the ellipse extending diagonally across the plane of the annular support. The ends of the seat extend beyond the edge of the ring 3 in the form of wings or flanges 26. Each piston cylinder is formed at its outer end with opposed radially projecting wings or flanges, 27, whose plane is transverse to the axis of the cylinder. The center of the cylinder head 28 has the outwardly projecting nipple 29 which enters into an opening in the side of the valve chambers, said nipple forming a port through which air is first drawn into the cylinder during the suction stroke and then forced out during the discharge stroke. Stud bolts 30 passing through the flanges 26 and 27 hold the piston cylinders 31 in place. The inner ends of the cylinders 31 are open. There are four of these cylinders placed equidistant around the ring 3. The face of each of the pistons 32, as shown in Fig. 10, is covered with a disk 33 of leather, rubber or other packing material, larger in diameter than the piston head 32, and held in place by a plate 34 and screws 35. The margin of the packing disk 33 is turned inwardly as shown. Of course, I am not limited to this peculiar manner of packing the piston, but I have found it in practice to be an effective construction for this purpose.

Diametrically opposed piston rods 35, are connected to move together by a yoke 36, formed integral with the piston rods. This yoke is formed with a slot 37, the axis of the slot (see Fig. 5) being at right-angles to the axis of the yoke. At one corner of the yoke is the oiling opening, 38. Reciprocating in the slot 37 of each yoke is a slide 39 having flanges at one end. Through both of these slides passes the reduced portion 23 of the crank pin 22. The complete arrangement of the pistons is shown in Fig. 7 and it will be obvious that the movement of the crank pin in a circle will reciprocate the pairs of pistons in the cylinder and that the pistons will move inward into their respective cylinders in series or successively one after the other. Thus when one of the pistons is at the limit of its inward stroke into the cylinder the opposed connected piston will be at the limit of its outward stroke, while the two pistons at right-angles thereto will be both at half stroke.

The enlargements 40 of the annular tubular support 3, as will be seen from Fig. 11, inclose a valve chamber, 41, or, rather, pass around the interior end of the valve chamber so as to form a by-pass. The walls 42 of each of the valve chambers are cylindrical, the plane of the valve chamber extending transversely to the axis of the tubular supporting frame and to the axis of the adjacent piston chamber.

The piston cylinders 31, as before explained, have each a nipple 29, projecting into the side wall of the adjacent valve chamber. One end of the valve chamber opens into the enlarged portion or by-pass 40 of the tubular frame, and the end of the chamber walls 42 inclosed by this by-pass is inwardly-turned, as at 43, to form a seat surrounding an inlet port 44. Directly opposite the opening in the enlargement or by-pass 40 is formed an inwardly projecting hub 45. A valve stem 46 having a reduced portion 47 is carried by the hub 45 and projects into the inlet opening 44. A valve 48 has a central socket 49, which receives the enlarged end of the spindle 46, and slides thereon. This valve 48 closes against the seat 43 and is held in place against this seat by a spring as will be later described. The outer end of the valve chamber is formed with an inlet opening 50, and supported against the ends of the walls 42 of the outer end of the valve chamber is a valve stem supporting plate, 51, shown very clearly in plan in Fig. 1. This valve stem supporting plate is elliptical in plan and has near the ends of the ellipse the stud bolts 52, which engage with the inner face of the tubular frame 3. A spider 53 is formed on this plate and the central portion thereof projects inwardly in the form of a hub 54, which is reduced at its inner end to project into the end of the coiled spring 55. The other end of this spring surrounds the projecting portion of the socket 49 and forces the valve 48 against the seat 43, as before described. Partially surrounding the central portion of the spider are the opposed ports 56, which coincide with the outlet

opening 50 formed at the end of the valve chamber 41. For the purpose of normally closing the outlet ports so formed I provide the disk valve 57, which contacts with the outer face of the plate 51, and covers the ports 56 therein. This valve is bored at its center to surround and move upon a spindle 58. The inner end of this spindle is reduced and is supported in the hub 54 as shown in Fig. 11, and the outer end of the spindle is reduced and screw threaded to engage with the wall of an eduction chamber 59. This chamber is cup-shaped in section, the edges of the cup fitting closely against the outer face of the plate 51. The nut 60 works upon the screw-threaded end of the spindle 58 so that the spindle may have a rigid engagement with the walls 59. A spring 61 surrounds the spindle 58 and bears against the valve 57, forcing it to its seat against the plate 51 and normally closing the outlet port 50 of the valve chamber 41. It will be seen that this construction provides for a very effective support for the valve 57, holds it positively in line with the valve 48 and prevents its shifting relatively to the outlet port of the chamber 41. Of course, it is to be understood that all of the valve chambers 41, with their inlet and outlet valves, are the same so that the description above applies to each and all of these valve chambers and valves.

Extending centrally from each of the chambers 59 are the discharge pipes 62. There are four of these pipes, of course, one for each of the four chambers 59, and they meet at the center of the machine and enter a common discharge chamber 63 to which a discharge pipe 64 is connected in any desirable manner as by the coupling 65. This discharge pipe may, of course, be conducted to the outer air, if desired, but ordinarily simply conducts the air discharged from the pumps into the room, inasmuch as this air has been thoroughly cleaned by passing through the dust collector prior to its entrance into the pumping cylinders.

The annular frame 3, as before stated, is tubular for the purpose of conducting air to the several pumping cylinders. As shown in Fig. 11 and as before described, each of the cylinders has connected to it the valve chamber 41, which by its inlet port 44, takes air from the interior of the tubular frame. At its uppermost portion this tubular frame is formed with an inlet port 66, as shown clearly in Figs. 2 and 4, which communicates with an inlet pipe 67. The inner face of the tubular frame at those portions surrounding the port 66 is formed with the flanged face 68 having bolt holes 69, while the conducting pipe 67 is also formed with flanges 70, having bolt holes through which bolts 71 enter the bolt holes 69, thus securing the pipe 67 to the tubular frame in the manner shown in Fig. 2. The outer end of the pipe 67 is upwardly-turned to the level of the upper face of the casing.

A dust collector 72 of any desired construction has projecting from its bottom the downwardly extending slip pipe, 73, which enters the upwardly-turned end of the pipe 67. In order to hold the dust-collector securely in place upon the upper face of the casing and its bracket and also to make a dust-proof joint between the dust-collector and the pipe, I provide the spider 74 having downwardly turned legs (this spider being shown in dotted lines in Fig. 2) engaging with the uppermost end of the slip pipe 73. A bolt 75 passes through the spider down through the center of the slip pipe and through the pipe 67 and is provided on its end with a nut 76, whereby the engagement between the under surface of the dust collector and the upper edge of the upturned end of the pipe 67 may be tightened so as to be dust-proof. This bolt 75 also holds the dust collector in place upon the supporting casing, yet is easily detached by unscrewing the nut 76. The front of the casing is provided with the outwardly-projecting curved bracket arms 77, whose extremities nearly abut, these bracket arms supporting the collector 72. A dust receptacle 78 is attached to the underside of the receptacle 72.

Inasmuch as the dust collector forms no part of the present invention I do not deem it necessary to go into an extended description thereof, and it is sufficient to say that from the dust collector or the dust receptacle 78 extends a pipe 79, which leads to any suitable vacuum cleaner head or nozzle. Of course, if the apparatus is to be used for pumping air for other purposes, the dust collector and its allied parts will be omitted and the parts 79 connected directly to the inlet pipe 67. It will also be obvious that while the pumping apparatus is drawing air or fluid through the pipe 79, or through the inlet pipe 67 it is ejecting air or fluid through the pipe 64, and that, therefore, my machine could be used for an air compressor, as well as an air exhauster, without departing from the principles of the construction which have been described.

The operation of my apparatus is obvious from what has gone before. The rotation of the motor shaft drives the gear wheel 20, which carries around the crank pin 22. The circular movement of the crank pin 22 causes a reciprocatory movement of the pistons each in turn. As each piston moves outward in its cylinder (that is, outward in relation to the valve mechanism but toward the center of the combined pistons) air will be drawn into the valve chamber and the cylinder through the port 44, the valve 48 lifting from its seat for this purpose against the force of the spring 55. Upon a return move-

ment of the piston inward into the cylinder and toward the valve chamber, the pressure of the air will close the valve 48 and force open the valve 57 against the pressure of the spring 61. The air will be forced outward into the chamber 59 and the passages 62 leading therefrom. As soon as the piston commences to move outward, however, the spring 61 will close the valve 57 against the outlet port and the cycle will be complete for that piston and valve chamber.

The construction as illustrated is such that there will always be two pistons exhausting and two pistons drawing in the air. One of each of the two pistons will be at the extreme end of its movement, while the other will be at its middle. The exhausting and discharging action of the pistons is, therefore, practically continuous, the cycles of the cylinders overlapping. The supporting tubular frame it will be noted, performs two functions, that of supporting the cylinders in their proper position relative to the crank actuating the pistons, and also forming the conduit whereby air is drawn from a common source. The peculiar arrangement of the discharge chambers 59 permits them to be readily detached from the interior face of the tubular supporting frame so that the valve mechanism may readily be inserted, removed or repaired, the removal of the plate 51, of course, further permitting the repair of parts within the valve chamber 41. This construction is a simple one mechanically speaking, provides for a rigid guiding of the valves, a ready removal of the valves and the ready repair of the valves as above referred to. In order to provide for further access into the valve chambers, however, I form the exterior walls of the exterior frame with hand holes, 80, as shown in Figs. 9 and 10, these hand holes being closed by screw plugs 81.

While I have shown what I believe to be the preferable details of construction and arrangement of parts which I have found to be extremely effective, I do not wish, however, to be limited to the precise details of these parts or the precise arrangement shown, inasmuch as the apparatus is capable of considerable modification without the principle of the invention being departed from. It is obvious also that many minor details of construction may be somewhat modified in order to suit it to other purposes than that of a vcauum cleaner pump.

In place of the dust collector which I have illustrated, I might use the dust collector which forms the subject of my companion application for patent, Serial No. 439,052, filed June 17, 1908.

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

1. In a pumping apparatus, the combination of an annular tubular frame having a fluid inlet port, valve chambers disposed transversely within said frame, each having inlet and outlet ports at its opposite ends and an intermediate combined inlet and outlet port, a series of radially arranged cylinders supported on the frame and having communication with the valve chambers through the combined inlet and outlet ports, a series of pistons successively moving in the cylinders, a common means for operating all said pistons, outlet conduits leading from each of the valve chambers to a common discharge, and valves within the said chambers controlling the inlet and outlet ports thereof.

2. In a pumping apparatus, a tubular frame having a fluid inlet port, a series of piston cylinders supported on the frame and having inlet ports communicating with the interior thereof, a series of pistons successively moving in the series of cylinders, a discharge conduit leading from each of the cylinders, said cylinders and pistons being removable together as a unit in a lateral direction from the tubular frame, and inlet and outlet valves controlling the admission and discharge of fluid to and from said cylinders.

3. In a pumping apparatus, an annular tubular frame having a fluid inlet port, a series of cylinders radially supported on the frame and extending toward the center of the same, pistons in the cylinders, piston rods extending to the center of the frame, a gear supporting frame mounted adjacent to the tubular frame, a crank shaft supported on the gear supporting frame, and having crank mechanism engaging with all the piston rods of the several cylinders, a motor, driving gear mounted on the gear frame and engaging with the crank shaft to drive the same, outlet conduits leading from each of the cylinders to a common discharge, and valves for controlling the inlet and outlet of fluid to and from the cylinders.

4. In a pumping apparatus, a base, an annular tubular frame vertically supported on said base, a vertical gear supporting frame mounted adjacent to the annular frame, a series of radial inwardly-extending cylinders supported on the annular frame and extending toward the center thereof, a crank shaft mounted on the gear supporting frame and extending into the space between the inner ends of the cylinders, connections between the crank shaft and the pistons in said cylinders, a motor, means for driving the crank shaft from the motor, outlet conduits connected to each of the cylinders and extending therefrom to a common discharge, and valves for controlling the inlet and outlet of fluid to and from the cylinders.

5. In a pumping apparatus, a base, an annular tubular vertically disposed frame

mounted upon said base and having an inlet port connected to a source of fluid supply, a series of radially arranged cylinders mounted on the annular frame and having connections to the interior thereof, said cylinders projecting inwardly toward the center of the frame, a gear supporting frame mounted on the annular frame in a plane parallel therewith, driving gears supported on the gear supporting frame and having connection with a motor, a crank shaft on the gear supporting frame driven by said driving means, pistons in the cylinders, connections between the crank shaft and said pistons, outlet conduits leading from the cylinders to a common discharge, and valve mechanism controlling the inlet and outlet of fluid to or from the cylinders.

6. In a pumping apparatus, the combination of an annular tubular frame having a series of transverse valve chambers formed in its interior, said chambers having at one end an inlet opening and at the other end an outlet opening, a series of pumping mechanisms removably supported on the frame and connected to said valve chambers, a single port intermediate the ends of each valve chamber forming a communication between the valve chamber and a pumping mechanism, a valve controlling the inlet opening to each valve chamber, a valve controlling the outlet opening from each valve chamber, a discharge conduit connected to each of the outlet openings of the chambers and leading to a common discharge, and common means for operating the pumping mechanisms consecutively.

7. In a pumping apparatus, a tubular annular frame having a fluid inlet port connected to a source of supply, a series of valve chambers extending transversely into the interior of the tubular frame, each having an inlet opening at its inner end communicating with the interior of the frame, outlet conduits connected to the outer end of each of said valve chambers, pumping chambers mounted on the inner side of the tubular frame and communicating through the side of the same with the valve chambers between the ends thereof, pumping mechanisms operating in said pumping chambers, and valves located in said valve chambers controlling the inlets and outlets of the same.

8. In a pumping apparatus, an annular tubular frame having a fluid inlet port connected to a source of fluid supply, the internal passage of said frame having a series of expanded portions along its extent, a series of valve chambers, one located in each of the expanded portions of the frame, said valve chambers having at one end an inlet opening into the interior of the frame, the other end having an outlet opening, outlet conduits leading from the outlet openings of all of the valve chambers to a common discharge, valves controlling the outlet and inlet openings of the valve chambers, a series of radially arranged inwardly extending pumping cylinders each connected at its outer end to one of said valve chambers, pistons in the cylinders, a crank shaft centrally arranged with regard to the cylinders, connections between said shaft and the pistons, and mechanism for operating the shaft to actuate the pistons consecutively.

9. In a pumping apparatus, a vertically arranged annular tubular frame having a fluid inlet port connected to a source of supply, said frame having a series of enlargements formed around its length, a valve chamber contained within each one of the enlargements, one end of said valve chamber opening into the interior of the frame, the other opening to the exterior thereof, an outlet conduit connected to the exterior end of each of the valve chambers and leading to a discharge common to all of the outlet conduits, puppet valves arranged within the valve chambers and controlling the inlet and outlet openings thereof, a series of radially arranged inwardly projecting pumping cylinders supported on said annular frame and connected at their outer ends to the interior of the valve chambers, a gear supporting frame mounted adjacent to the cylinder supporting frame and carrying driving gears, a crank shaft projecting into the space between the inner ends of the cylinders, pistons in the cylinders connected to said crank shaft, and driving mechanism for operating the crank shaft.

10. In a pumping apparatus, the combination of an annular tubular frame having a fluid inlet port connected to a source of fluid supply, the internal passage of said frame having a series of expanded portions along its extent, a series of valve chambers, one located in each of the expanded portions of the frame, said valve chambers having at one end an inlet opening into the interior of the frame, the other end having an outlet opening, outlet conduits leading from the outlet openings of all the valve chambers to a common discharge, valves controlling the outlet and inlet openings of the valve chambers, a series of pumping mechanisms mounted on the inner side of the tubular frame and each connected to one of said valve chambers, and mechanism for operating the pumping mechanisms consecutively.

11. The combination of an annular tubular frame, a series of pumping mechanisms secured on the inner side of the tubular frame and communicating with the interior thereof to be supplied therefrom, valve chambers projecting into the frame and communicating with the pumping mechanisms, valves at the inner ends of the valve chambers controlling the flow from the tubular frame to the pumping mechanisms, valves at the outer

ends of the valve chambers controlling the flow from the pumping mechanisms, discharge conduits leading from the outer ends of the valve chambers, a supply conduit leading into the tubular frame, and operating means common to all the pumping mechanisms.

12. In a pumping apparatus, a pumping chamber, a valve chamber connected to the pumping chamber, said valve chamber having an inlet opening at one end and an outlet opening at the other end, a plate closing the outlet end of the valve chamber but having outlet openings through it, a valve spindle passing through said plate, rigidly connected thereto and projecting on both sides thereof, an outlet valve mounted on said valve spindle exterior to the plate and controlling the openings through the plate, an inlet valve located in the interior of the valve chamber and controlling the inlet opening thereof, and a spring surrounding the inwardly projecting end of said valve spindle and engaging with the inlet valve to hold it closed.

13. In a pumping apparatus, a pumping chamber, a valve chamber connected to the pumping chamber, said valve chamber having an inlet opening at one end and an outlet opening at the other end, a plate closing the outlet end of the valve chamber but having outlet openings through it, a valve spindle passing through said plate, rigidly connected thereto and projecting on both sides thereof, an outlet valve mounted on said valve spindle exterior to the plate and controlling the openings through the plate, a cap fitting the exterior of said plate and connected to an outlet conduit, said cap being engaged and held in place by the outer end of the spindle, a valve controlling the inlet opening of the chamber, and a spring mounted at one end on the inwardly projecting end of the valve spindle and engaging with the inlet valve to hold it closed.

14. In a pumping apparatus, a tubular member having a fluid inlet port and an enlarged portion, a valve chamber projecting into said enlarged portion of the tubular member, the inner end of the chamber having an inlet opening and the outer end an outlet opening, a plate closing the outlet end of the chamber but having outlet passages therefrom, a spindle mounted in the plate and projecting on one side into the interior of the valve chamber and at the other extending out beyond the plate, a spindle mounted in the wall of the tubular member opposite to the inlet opening of the valve chamber and extending into the same, a valve mounted on said spindle and controlling the inlet opening, a spring engaging with the inlet valve, and at its other end with the spindle projecting through the outlet opening of the chamber, and a cap engaging over the outlet end of the chamber and the plate thereon and connected to a discharge conduit, the outlet valve spindle extending through said cap and being provided with means whereby the cap is held in place.

15. In a pumping apparatus, the combination of a tubular annular frame having a fluid inlet port connected to a source of fluid supply, a series of inwardly projecting pumping cylinders mounted on the inner side of said frame and having inlet ports communicating with the interior thereof, a series of outlet conduits leading laterally from the cylinders and supported on one side of the frame independently of the cylinders, a series of pistons in the cylinders having inwardly projecting piston rods, and means for reciprocating the said piston rods supported on the tubular frame independently of the cylinders at the side of the frame opposite from the outlet conduits.

16. In a pumping apparatus, a base, a vertically arranged annular tubular frame mounted on said base and having an inlet port at its uppermost portion, a tubular connection leading from the inlet port to a source of air supply, a plurality of pairs of inwardly projecting pumping cylinders supported on the inner face of the annular frame, said cylinders having connection with the interior of said frame, outlet conduits connected to each of said cylinders and leading to a common discharge, pistons and piston rods in the cylinders, the piston rods of diametrically opposed cylinders being connected to each other by a yoke, said yoke having a slot transverse to the axis of said rods, a gear supporting frame mounted on said base and extending vertically in a plane parallel to the annular frame, driving gears mounted on the gear supporting frame, and a shaft mounted on the gear supporting frame and connected to the driving gears, and a crank pin on said shaft engaging with the yokes of all of said pistons.

17. In a pumping apparatus of the class described, a base, a vertically extending annular tubular supporting frame having an air inlet opening in its uppermost portion and a connection leading from the inlet opening to a source of air supply, valve chambers located within the tubular frame, said chambers communicating at one end with the interior of the frame and at the other with the exterior thereof, valves in said valve chambers controlling the inlets and outlets thereof, outlet pipes connected to the outlet ends of the valve chambers and leading to a common discharge pipe, a series of cylinders mounted on the inner face of the frame and connected to said valve chambers, pistons in the cylinders, inwardly projecting piston rods, a pillar projecting out from

the lowest portion of the annular frame, pillars projecting from the side portion of the frame, an approximately triangular gear supporting frame carried by said pillars, a bracket on said gear supporting frame forming a bearing for a driving shaft, a pinion on the driving shaft, a gear wheel mounted upon the upper face of the gear supporting frame and engaging with the pinion, a wrist pin projecting from said gear wheel into the space between the cylinders, and a transversely slotted yoke rigidly connecting each pair of diametrically opposed piston rods, said wrist pin projecting into said yokes and having a sliding engagement therewith.

18. In a pumping apparatus, the combination with a plurality of pumping devices, of a tubular frame supporting said devices and disposed in a common plane therewith, and valve chambers projecting into the interior of the tubular frame with which said pumping devices are connected.

19. In a pumping apparatus, the combination with a plurality of pumping devices, of a tubular supporting frame supporting said devices and forming an inlet pipe common to all of them, said devices being carried on the inner face of said frame and projecting toward the center thereof, the devices and frame being disposed in a common plane and outlet connections from said frame extending radially inward to a common discharge pipe.

20. In a pumping apparatus, the combination of an annular tubular frame having a fluid inlet port and provided with expanded portions at intervals along its extent, valve chambers projecting into said expanded portions, pumping cylinders mounted on the inner side of the tubular frame and communicating directly with the valve chambers between the ends thereof, axially alined spring-controlled valves arranged to open and close the ends of the valve chambers, and discharge conduits leading from the outer ends of the valve chambers.

21. The combination of an annular tubular frame having ports at intervals on its inner side, pumping cylinders having open inner ends and provided at their outer ends with central nipples engaging the said ports, pistons mounted in the cylinders, operating mechanism common to all the pistons, means for detachably securing the cylinders to the tubular frame, valve chambers formed within the tubular frame around the port at the end of the cylinder, a valve-controlled connection through one end of the said valve chamber with the interior of the tubular frame, and a valve at the opposite end of the chamber controlling the flow therefrom.

In testimony, that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

ERNEST L. B. ZIMMER.

Witnesses:

J. S. POMERON,

FRED S. JOHNSON.