(No Model.) 8 Sheets—Sheet 1.

P. I. SCHMALTZ.

COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

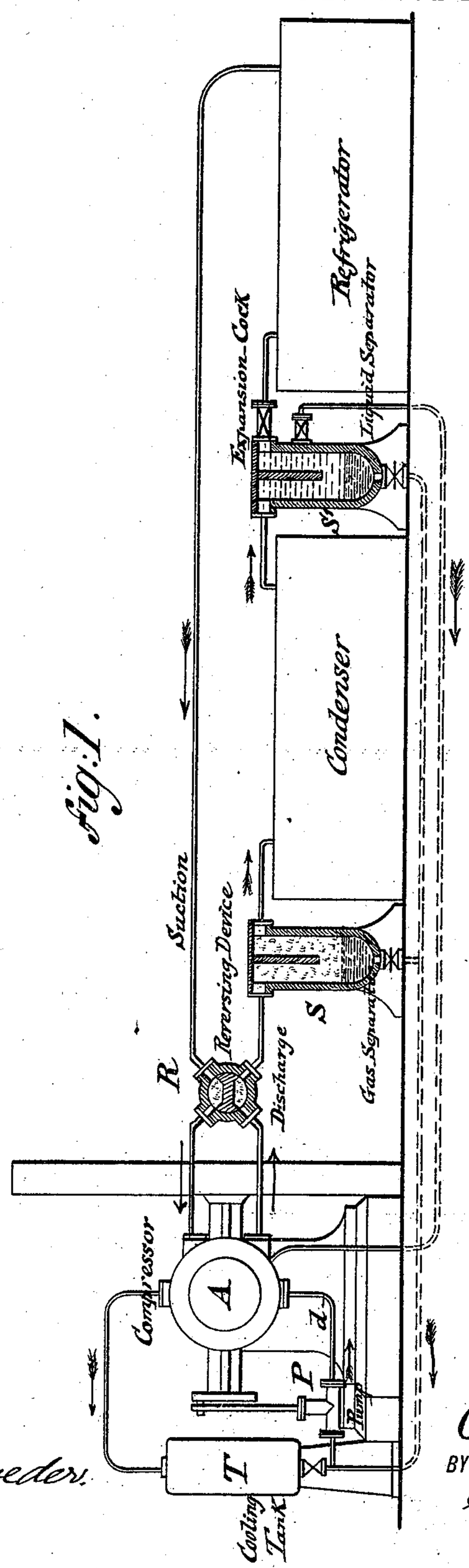

Fig. 1.

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(No Model.)

8 Sheets—Sheet 2

P. I. SCHMALTZ.

COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

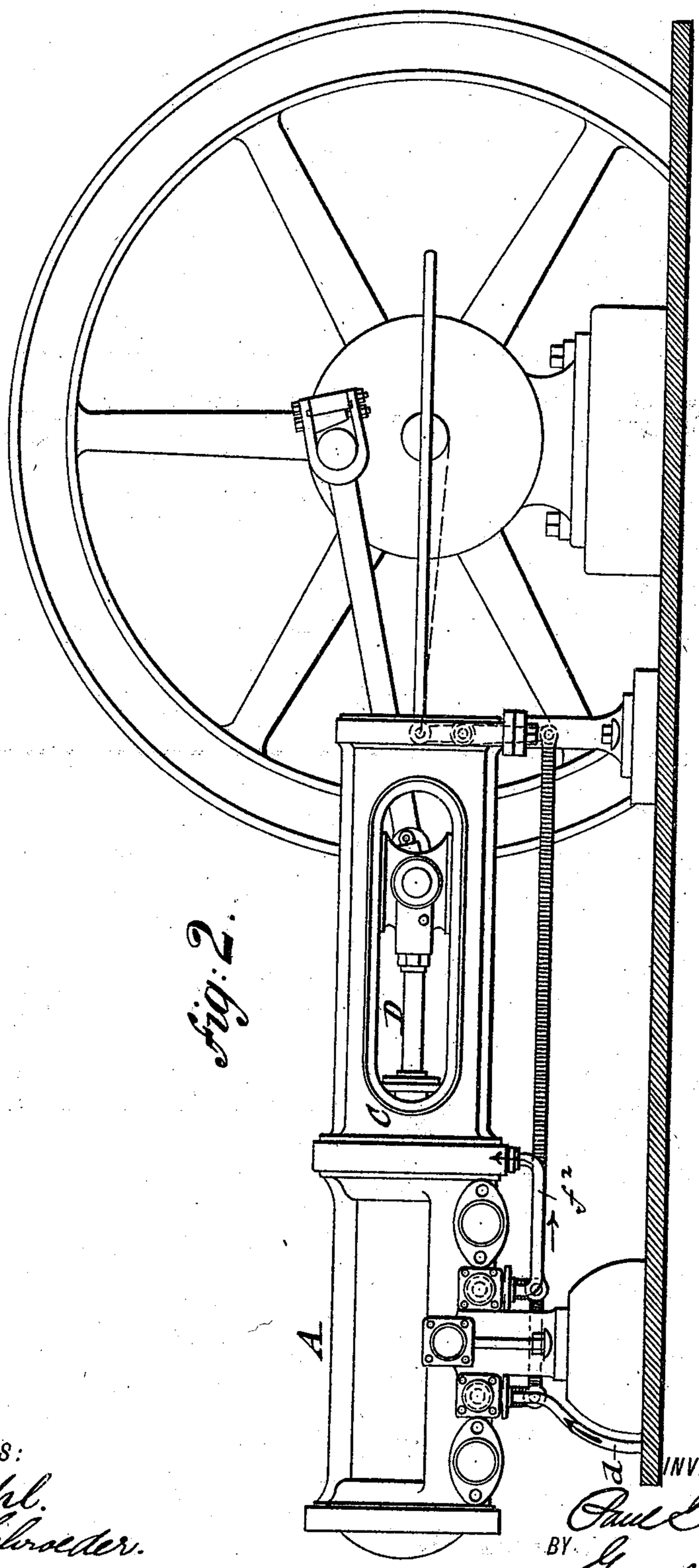

Fig. 2.

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(No Model.) 8 Sheets—Sheet 3.

P. I. SCHMALTZ.

COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

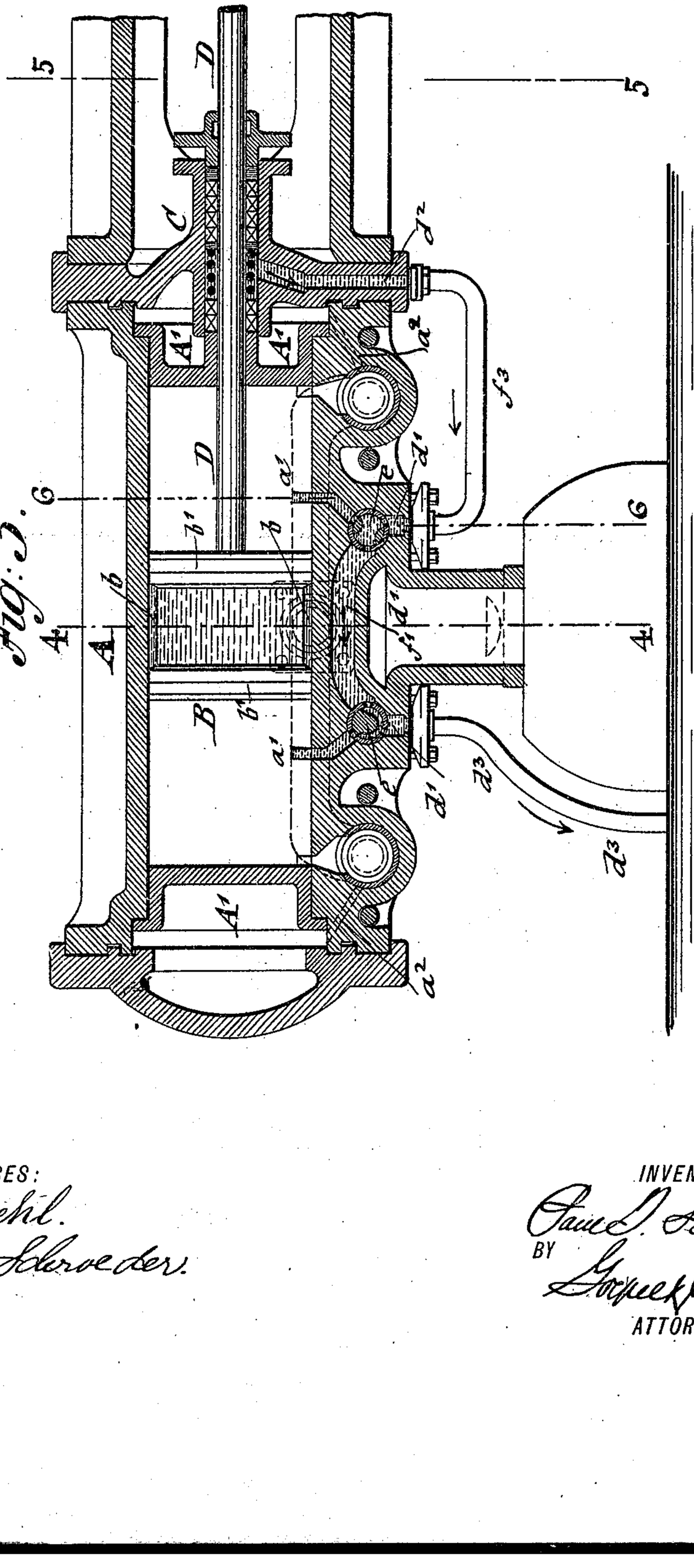

Fig. 3.

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(No Model.) 8 Sheets—Sheet 4.

P. I. SCHMALTZ.

COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

Fig. 6.

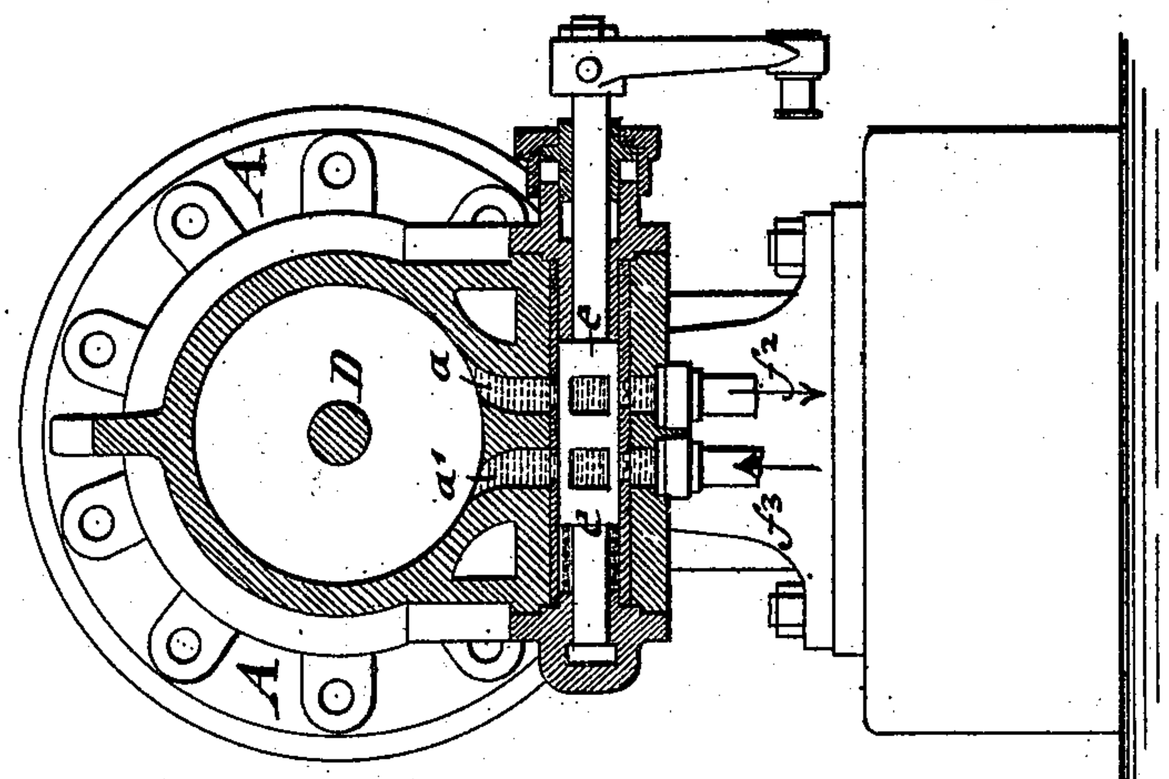


Fig. 5.

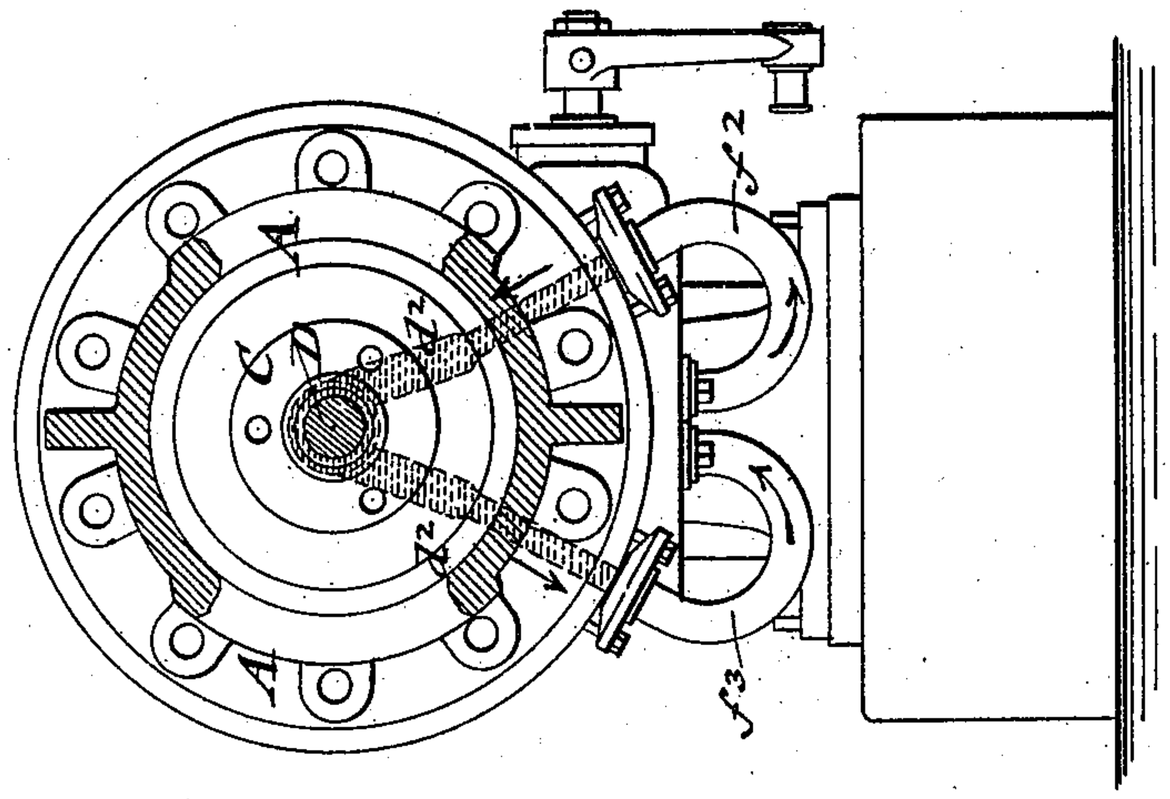
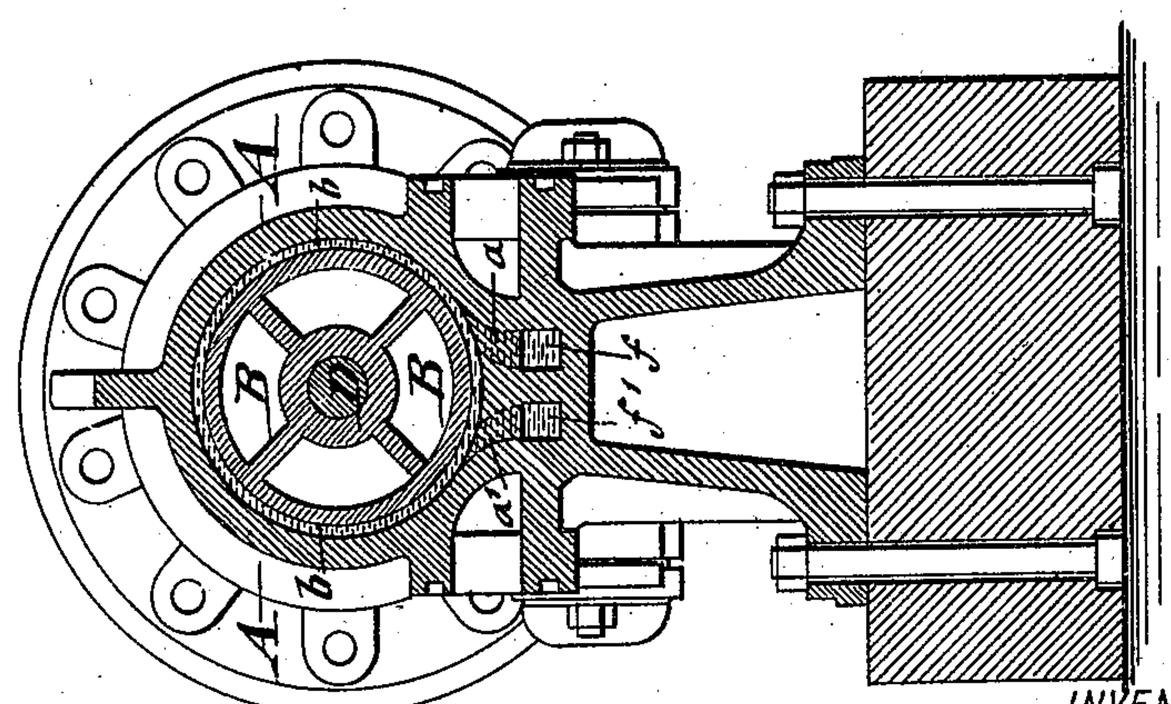


Fig. 4.



WITNESSES:
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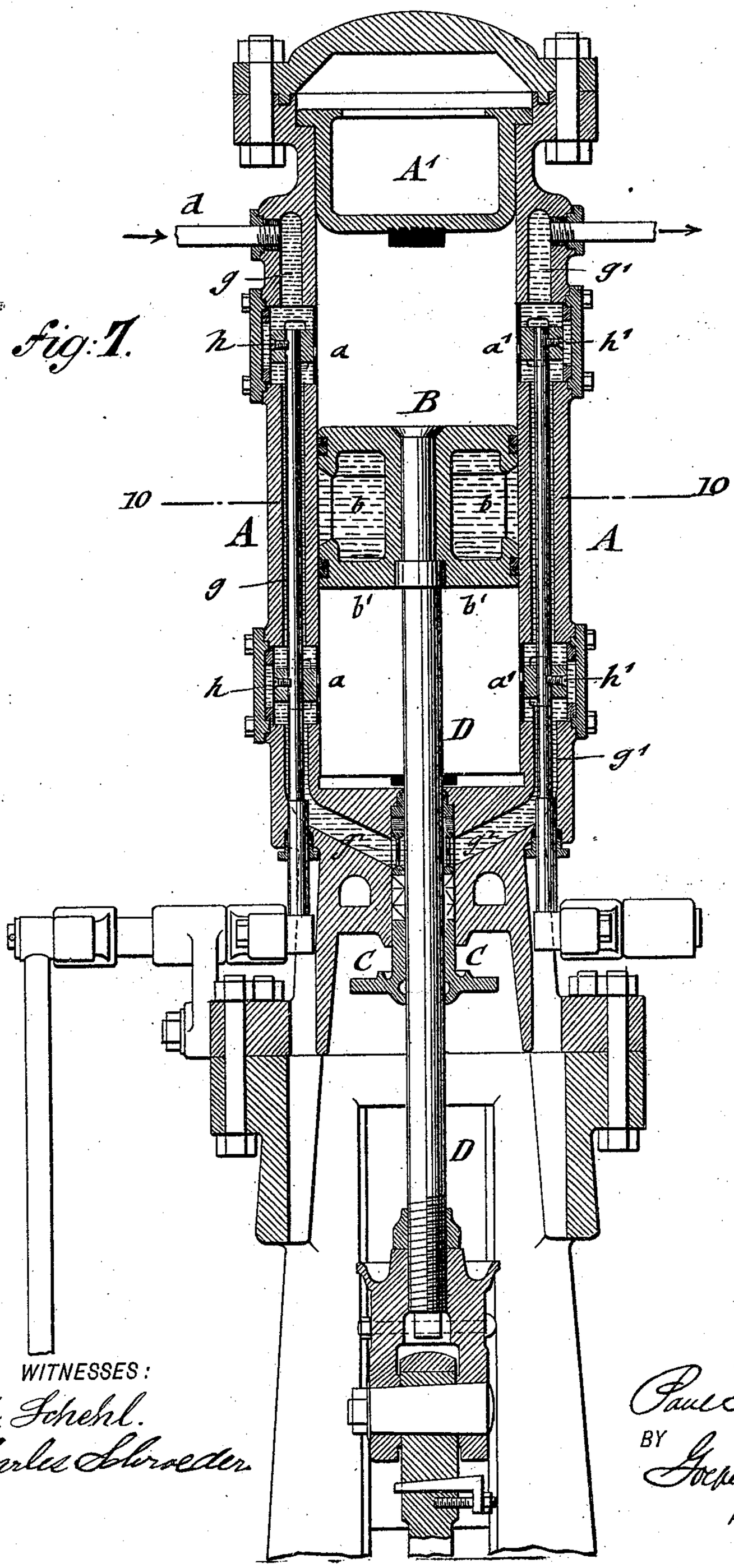
(No Model.) 8 Sheets—Sheet 5.

P. I. SCHMALTZ.

COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

Fig. 1.



WITNESSES:

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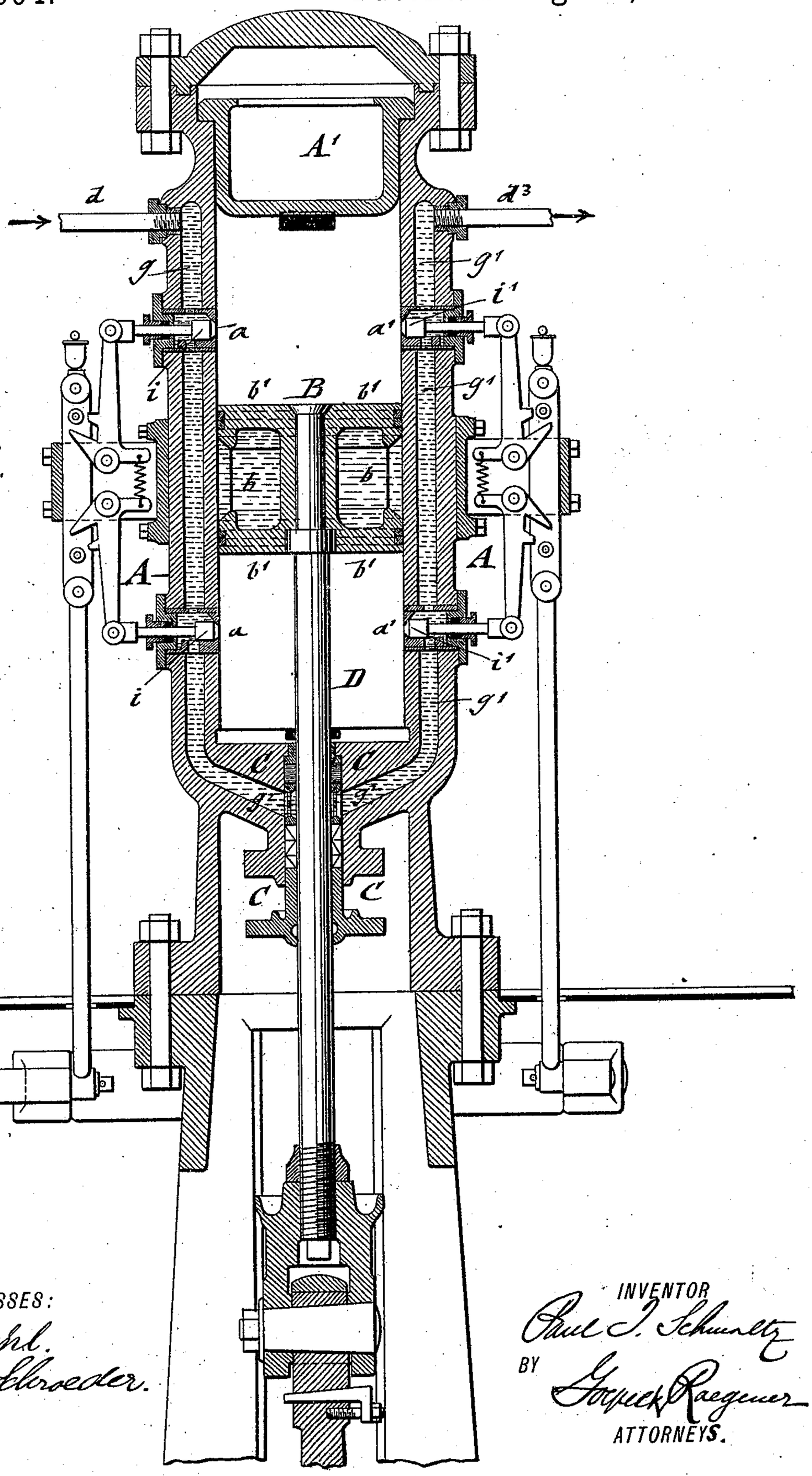
(No Model.) 8 Sheets—Sheet 6.

P. I. SCHMALTZ.

COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

Fig: 8.



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(No Model.) 8 Sheets—Sheet 7.

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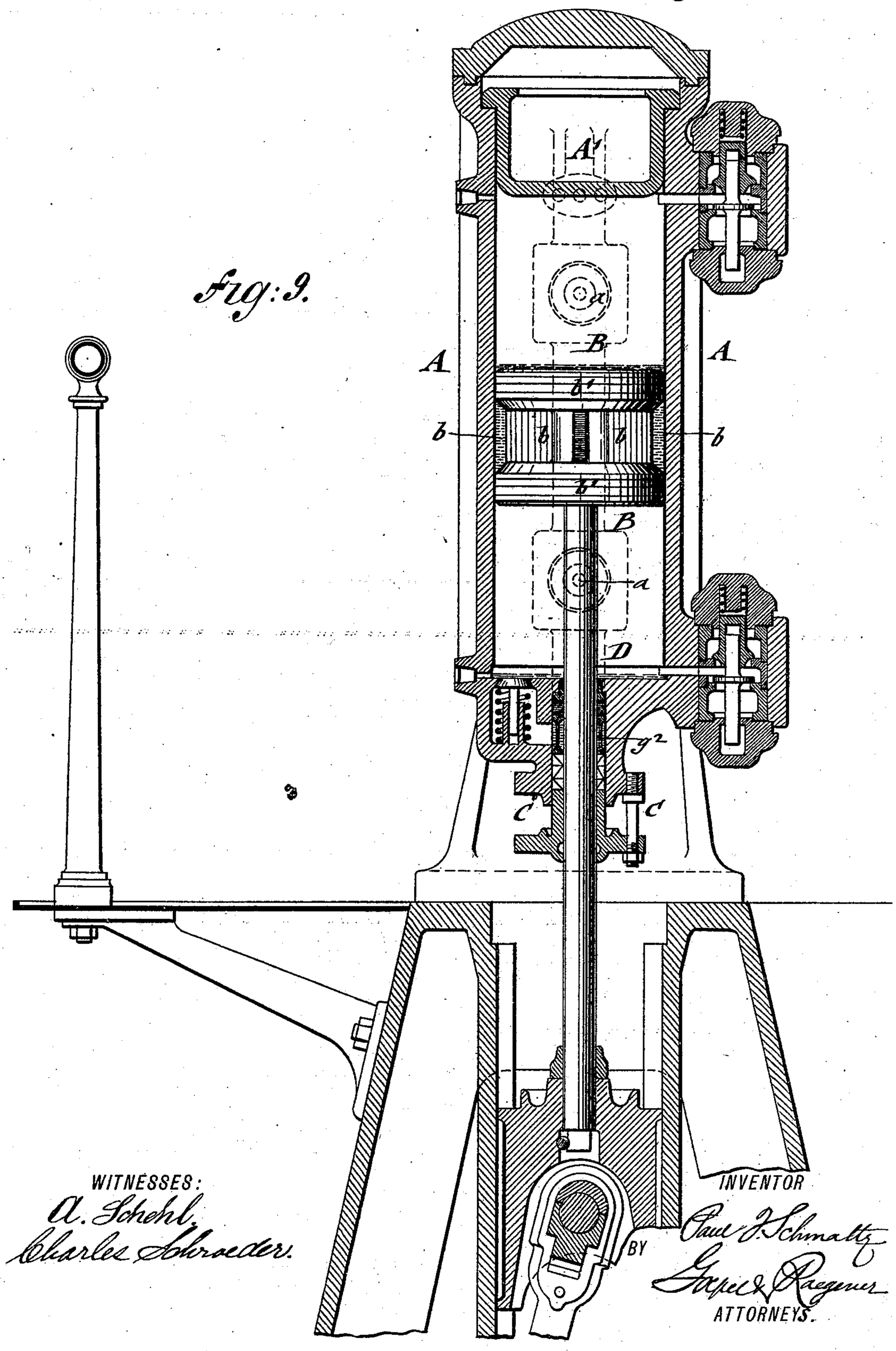
COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

Fig: 9.



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8 Sheets—Sheet 8.

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COMPRESSION AND VACUUM PUMP.

No. 504,094. Patented Aug. 29, 1893.

FIG. 12.

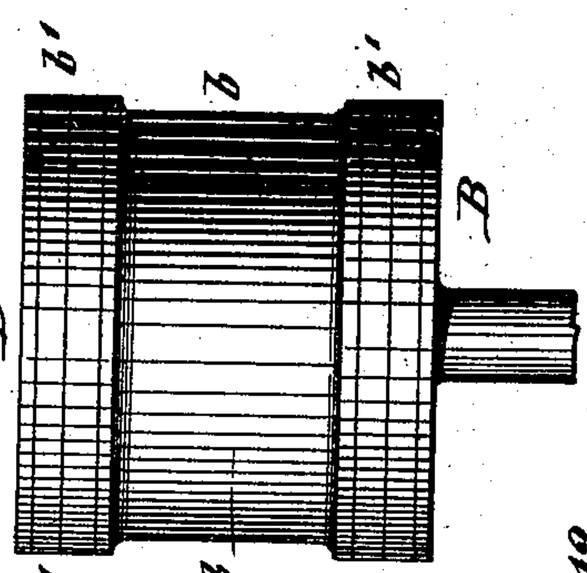


FIG. 11.

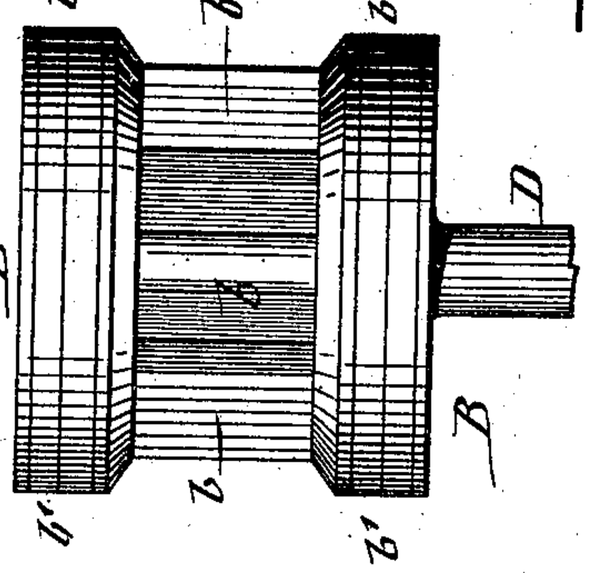


FIG. 13.

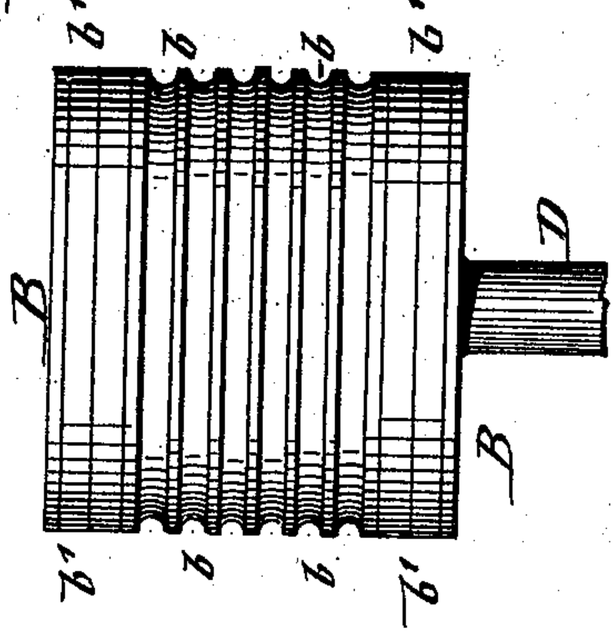
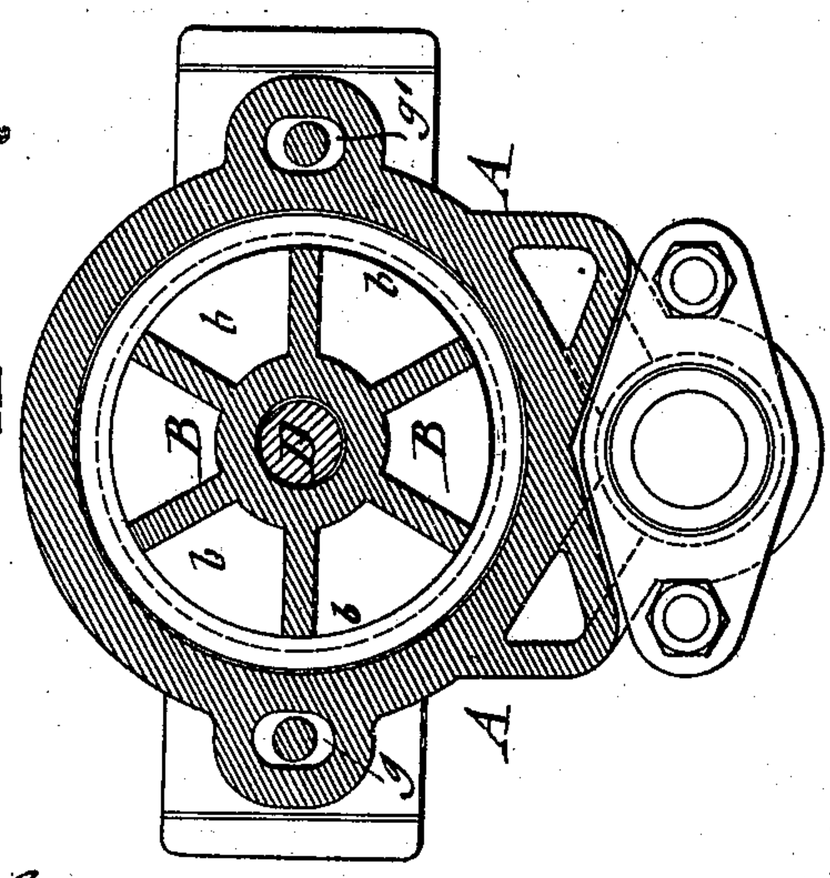


FIG. 10.



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ATTORNEYS.

UNITED STATES PATENT OFFICE.

PAUL I. SCHMALTZ, OF HAMBURG, GERMANY.

COMPRESSION AND VACUUM PUMP.

SPECIFICATION forming part of Letters Patent No. 504,094, dated August 29, 1893.

Application filed December 29, 1891. Serial No. 416,456. (No model.) Patented in Germany June 14, 1891, No. 61,104, and February 6, 1892, No. 64,656.

To all whom it may concern:

Be it known that I, PAUL I. SCHMALTZ, a subject of the German Emperor, residing in Hamburg, in the Empire of Germany, have invented certain new and useful Improvements in Compression and Vacuum Pumps, (for which I have obtained Letters Patent of Germany, No. 61,104, dated June 14, 1891, and No. 64,656, dated February 6, 1892,) of which the following is a specification.

This invention relates to certain improvements in the lubricating and sealing of compression and vacuum-pumps. Heretofore different methods were used for removing the heat of compression in such pumps, namely, first, the circulation of a lubricating liquid of low temperature with the gases through the cylinder of the pump; secondly, the injection and evaporation of some portion of a liquefied refrigerating medium at the inside of the compressor; thirdly, the cooling of the outside of the compressor by water, which is sometimes assisted by the cooling of the interior of the piston that is closed toward the walls of the compressor.

This invention is designed to effect the sealing and lubricating of the walls of the compressor-cylinder and of the piston and piston-rod, and it consists in arranging the piston with one or more chambers which are open toward the walls of the compressor but incased by the piston-rings, and in keeping the space in these chambers filled with the cooled lubricating liquid and renewing the latter while the piston passes over one or more ports in the walls of the compressor. The lubricating liquid absorbs, during the up and down stroke of the piston, the heat of compression which has been transmitted to the walls of the compressor-cylinder and affords ample lubrication while it cannot detract from the efficiency of the compressor as very little of the lubricating liquid is carried off with the gases so as to exert an injurious influence in its further passage through the refrigerating plant. The lubricating and cooling of the piston-rod is effected by a circulating portion of the lubricating liquid through one or more chambers in the stuffing-box of the piston-rod.

The invention consists next of certain details of construction which will be fully described hereinafter and finally pointed out in the claims.

In the accompanying drawings, Figure 1 represents a side-elevation, partly in section, of a refrigerating plant, which shows also the connection of the compressor with the cooling-tank for the lubricating liquid. Fig. 2 shows a side-elevation of a horizontal compression or vacuum-pump with my improved means for lubricating and sealing the piston and piston-rod of the same. Fig. 3 is a vertical longitudinal section of the pump, shown in Fig. 2. Figs. 4, 5 and 6 are vertical transverse sections, respectively on lines 4, 4, 5, 5 and 6, 6, Fig. 3; and Figs. 7 and 8 are vertical transverse sections of a vertical gas-compressor, taken on planes at right-angles to each other. Fig. 9 is a vertical central section of an upright gas-compressor, showing a modified arrangement of the liquid-supply valves. Fig. 10 is a horizontal section through the compressor-cylinder and piston, on line 10, 10, Fig. 7; and Figs. 11, 12 and 13 are detail side-views showing different forms of pistons.

Similar letters of reference indicate corresponding parts.

C in the drawings represents a compressor, which may be of the horizontal or vertical type, P a circulating-pump for the lubricating liquid, which pump is connected with the compressor-cylinder and with a cooling-tank T for the lubricating liquid, the upper end of the tank being connected by a pipe with the compressor.

S S′ represent separators which are interposed respectively between the compressor and the condenser and refrigerator, one of said separators serving for collecting the liquid carried along with the gases, the other for collecting the liquid deposited on the inside of the coils of the refrigerator, which is produced by means of a reversing-device R, shown in Fig. 1. This reversing-device is fully described and claimed in a separate application, Serial No. 411,863, filed November 14, 1891. The separators S S′ are connected with the tank T for the lubricating liquid by means of valved connecting-pipes, so as to conduct the liquid from time to time to said tank, or they may be emptied directly by drawing

off the lubricating liquid collected in the same at proper intervals of time.

The lubrication of the compressor-walls is produced by arranging in the piston B a chamber or chambers *b*, which are open toward the walls of the compressor, but which are inclosed toward the interior of the compressor-cylinder A by piston-rings *b'*. The chambers in the piston B are supplied with a lubricating liquid by the circulating-pump P, or by gravity if the cooling-tank is arranged at a higher elevation than the compressor. The pump P is connected by a supply-pipe *d* with oil-channels *d'* that communicate with the interior of the compressor-cylinder by means of ports *a a* which are arranged with or without valves according to the length of the chambers in the piston B. The oil-channe's *d'* are also connected by channels d^2 with one or more chambers arranged in the stuffing-box C of the piston-rod D, the cylinder A having also outlet-ports *a'* through which the lubricating-liquid leaves the chamber or chambers in the piston, it being then returned by a suitable pipe d^3 into the cooling-tank by the circulating-pump or by pressure, as the case may be. When the ports are not provided with valves, the piston-chambers have to be long enough so as to establish the regular supply of the lubricating liquid during the strokes of the piston, while when the ports are valved, they are made to open for the period during which the chambers of the piston are opposite the ports, the ports being kept open as long as the piston is in connection with them. It is evident that this arrangement may be used with single-acting or double-acting compressors, both of the vertical and horizontal type, also with single-acting compressors of the box-type in which latter type the lubricating liquid is conducted from the piston-chambers through an overflow-channel into the crank-pit or into a special collecting chamber.

The compressor-cylinder A is preferably provided with cushioned safety-heads A' near the outlet-valves for the compressed gas, so as to prevent accidents which might be caused by drippings of the lubricating liquid passing between the walls of the compressor-cylinder and the piston-rings, said safety-heads yielding sufficiently to permit the accumulations to escape. In a horizontal compressor the safety-heads A' are arranged at both ends of the cylinder A and cushioned by means of high pressure gas which is conducted into the hollow safety-heads by suitable ducts a^2 connected with the pressure-side of the compressor, as shown in Fig. 3. The safety-head A' adjacent to the stuffing-box of the piston-rod is not effected by the spring in the latter, which spring serves merely for exerting a pressure on the packing of the stuffing-box, as the cushioning of the safety-head is entirely accomplished by the high pressure gas in the same.

The gas inlet and outlet valves are arranged, whenever possible, in one casing with one port in common, which arrangement permits the drippings to fill this port on the discharge-stroke, and empty back into the compressor during the suction-stroke of the piston, as shown in Fig. 9. Some of the drippings pass by, even with the best of constructions, and this quantity will be sufficient to stop the clearances effectively.

The lubrication of the piston-rod is effected by introducing a portion of the liquid from the cooling-tank into a chamber of the stuffing-box, or by introducing the liquid after it has passed through the chambers of the piston where it has become heated to some extent and most of the gases have been driven off from the liquid by such heat, into the chambers of the stuffing-box. The latter arrangement is to some extent a safety-guard against the escape of gases which are absorbed by the lubricating liquid and of which a small portion always escapes through the stuffing-box of the piston-rod. The lubrication of the piston-rod can also be effected by a chamber which communicates with the inside of the compressor, whereby a portion of the liquid will always surround the piston-rod.

In the compressor shown in Figs. 2 to 6, the cylinder A is arranged in a horizontal position and provided with two inlet-ports *a* and two outlet-ports *a'* for the lubricant, two on each side of the vertical plane of the cylinder, which ports communicate with a circumferential chamber at the middle part of the piston B as the same passes over said ports. The supply of liquid to the ports and piston is regulated by means of oscillating valves *e e* that are operated by a suitable valve-gear connected with an eccentric on the driving shaft, as shown in Fig. 2. The cold liquid is supplied from the cooling tank to the supply-port *a* at one side of the center of the cylinder and into the annular circumferential chamber of the piston as the same passes over said port. The liquid by the action of the pump passes then around the piston, takes up the heat of compression and passes out through the discharge-ports *a'* at the other side of the center of the cylinder to the return-pipe d^3 for the heated liquid. When the piston arrives at the other end of the cylinder A, the liquid passes through the longitudinal channel *f* and the second inlet-port *a* of the piston and into the chamber of the same, passing out through the port *a'*, a second longitudinal channel *f'* and the discharge-pipe d^3 to the tank T. The liquid passes through the connecting-pipe f^2 to the channel d^2 that communicates with the annular chamber in the stuffing-box C of the piston-rod D, as shown clearly in Figs. 3 and 5, whenever the piston is not in position over the inlet and outlet-ports *a a'*. The liquid is returned through a second channel d^2, pipe

f^3, longitudinal channel f' and return-pipe d^3 to the cooling-tank. The oscillating motion of the liquid supply-valves is so timed that the ports of one valve are open so as to supply oil to the piston when the same arrives at one end of the cylinder, during which time the ports of the second valve are closed, while when the piston-rod is at the other end of the cylinder the ports of the valve at that end are open so as to supply cold liquid, in which position the ports of the first valve are closed toward the cylinder but open toward the ports of the second valve.

The connecting-channels and valves for supplying the liquid to the annular chamber of the piston and to the chamber of the piston-rod are clearly shown in Figs. 3, 4, 5 and 6, the liquid in said chambers taking up the heat of compression from the walls of the compressor-cylinder and the piston while simultaneously lubricating and sealing the piston and the piston-rod.

In compressors of the vertical type, such as are shown in Figs. 7, 8, and 9, the liquid is supplied and discharged through vertical channels $g\,g'$ in the wall of the compressor-cylinder, one of said channels being connected at its upper end with the pipe d that conducts the cold liquid from the cooling-tank to the piston, while the other channel is connected with the pipe d^3 that conducts the heated liquid back to the cooling tank. The lower ends of the channels $g\,g'$ are connected with a chamber g^2 in the stuffing-box of the piston-rod, as shown clearly in Figs. 7 and 9. The inlet and outlet-ports $a\,a'$ are arranged at diametrically opposite points in the cylinder, which ports are either closed by means of slide-valves $h\ h'$ that are operated by a suitable valve-gear operated by an eccentric on the driving-shaft, or by puppet-valves $i\,i'$, as shown respectively in Figs. 7 and 9. In either case the lubricating liquid is supplied to the chamber b arranged at the interior of the piston B, the cold liquid being injected at one side into the piston, while the heated liquid is ejected at the opposite side of the same and then returned to the cooling-tank. The course of the lubricating liquid is indicated by arrows in the different figures, the liquid moving in a continuous current from the supply-pipe through the main-channel, it being intermittently deflected in its course first through the chamber of the piston, then forced through the chamber in the stuffing-box, then through the piston when it arrives at its second position, then again through the stuffing-box, &c. As the liquid is conducted from the cooling-tank under pressure through the oil-channels, it effects a sudden but forcible action on the comparatively small quantity of liquid in the piston so as to eject the same and produce thereby the quick exchange of the cooled liquid with the heated liquid, which would otherwise not be possible owing to the short duration of the connection of the piston with the supply and discharge-ports a a' in the cylinder. As the liquid is moved by the circulating-pump under pressure and under exclusion of the atmosphere through the supply and discharge-channels of the compressor-walls and through the chambers of the piston and stuffing box of the piston-rod, the effective cooling, lubricating and sealing of the compressor-walls, safety-heads, piston and piston-rod are accomplished. The heat of compression is therefore effectually taken up and the loss of liquid considerably decreased, as a much smaller quantity of the same is carried along by the gases to the other parts of the refrigerating-machine, while there is a comparatively smaller loss of gas by leakage to the atmosphere. Whatever liquid is carried along by the gases is collected in the separators S S' and returns by pipe-connections to the compressor and cooling-tank, as shown in Fig. 1. In this connection it may be stated that by "lubricating liquid" any suitable lubricating-oil or a mixture of oil with other lubricants, or with a refrigerating-liquid, which latter would expand in the piston and would be pumped off by an auxiliary pump, is meant.

In connection with the cooling-action of the liquid, a liquid-refrigerant may be injected into the compression-space of the cylinder, so as to produce the cooling of the vapors, and it may also be injected intermittently or continuously in the suction-space of the cylinder, so as to reduce the pressure on the valves and cool off the heated gases in and near the compressor.

The term "chamber or chambers" of the piston is intended to comprise the interior chamber or chambers and the exterior annular chamber, or a number of smaller annular chambers, as shown respectively in the detail Figs. 11, 12 and 13.

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

1. The combination, in a compression or vacuum-pump, of a pump cylinder having supply and discharge channels, inlet ports for the lubricating liquid on one side and outlet ports for the lubricating liquid on the reverse side thereof, a piston having a chamber which is open toward the walls of the pump, and a stuffing-box for the piston-rod having a chamber connected with the supply and discharge channels, whereby the lubricating liquid is supplied to the piston, pump and piston-rod, substantially as set forth.

2. The combination in a compression or vacuum-pump of a pump cylinder having inlet ports for the lubricating liquid on one side and outlet ports for the lubricating liquid on the reverse side thereof, a piston having a chamber open toward the walls of the cylinder, supply and discharge channels for the lubricating liquid arranged respectively on each side of the pump, longitudinal channels

connecting the ports on one side with each other and with the channels on that side, and valves for opening and closing said ports intermittently, substantially as set forth.

3. The combination, in a compression or vacuum-pump, of a pump cylinder having inlet ports for the lubricating liquid on one side, outlet ports for the lubricating liquid on the reverse side thereof, a piston having one or more chambers open toward the walls of the cylinder, supply and discharge channels for the lubricating liquid arranged respectively on each side of the pump, longitudinal channels connecting the ports on one side with each other and with the channels on that side, valves for intermittently opening and closing the ports, and a valve gear for operating said valves, substantially as set forth.

4. The combination, in a compression or vacuum pump, of a pump cylinder having inlet ports for the lubricating liquid on one side, outlet ports for the lubricating liquid on the reverse side thereof, a piston having one or more chambers open toward the walls of said cylinder, supply and discharge channels for the lubricating liquid, a chamber in the stuffing-box of the piston-rod, channels for connecting said chamber with the supply and discharge channels of the liquid supplied to the piston, valves for said ports, a cooling tank for said liquid, and pipes for connecting the tank with the supply and discharge channels of the pump, substantially as set forth.

5. The combination, in a compression or vacuum-pump, of a pump cylinder, inlet ports for the lubricating liquid on one side, outlet ports for the lubricating liquid on the reverse side thereof, a piston having one or more chambers open toward the walls of said cylinder, supply and discharge channels for the lubricating liquid, hollow cushioned safety heads at the ends of said cylinder, and ducts, as a^2, leading from the pressure side of the compressor to the hollow safety heads.

6. In a compression or vacuum pump, the combination of a piston having closed ends and provided with a circumferential chamber, a receptacle for a lubricating medium provided with a cooling device for said lubricating medium, a channel or port in the compressor wall through which said lubricating medium is supplied to said circumferential chamber, and adjunctive connections whereby said lubricating medium is supplied to said circumferential chamber.

7. In a compression or vacuum pump, the combination of a piston having closed ends and provided with a circumferential chamber, a receptacle for a lubricating medium, means for circulating said lubricating medium, a separator for separating said lubricating medium from the gas of the pump, channels or ports in the compressor walls through which said lubricating medium passes to and from said circumferential chamber, and adjunctive connections whereby said lubricating medium is supplied to and returned from said circumferential chamber.

8. In a compression or vacuum pump, the combination of a piston having closed ends and provided with a circumferential chamber, a receptacle for a lubricating medium, a stuffing box for the rod of the piston provided with a chamber for the lubricating medium, a channel or port in the compressor wall through which said lubricating medium is supplied to said circumferential chamber, and adjunctive connections whereby said lubricating medium is supplied to the chamber of the stuffing box and to the circumferential chamber.

9. In a compression or vacuum pump, the combination of a piston provided with a circumferential chamber, channels or ports in the compressor walls through which a lubricating medium is supplied and discharged to and from the chamber of said piston, and valves by which said channels or ports are intermittently opened and closed as said piston is moved.

10. In a compression or vacuum pump, the combination of a piston with closed ends and provided with a chamber opening to the wall of the compressor, inlet and outlet ports in the compressor for a lubricating medium, supply and discharge channels for said lubricating medium, a stuffing box for the rod of the piston provided with a chamber, channels for connecting said chamber of the stuffing box with the channels of the lubricating medium supplied to the piston chamber, valves for said inlet and outlet ports of the compressor, a cooling tank for said lubricating medium, and pipe connections between said cooling tank and the supply and discharge channels of the pump.

11. The combination, of a compression or vacuum pump, a piston having a chamber in the same, said chamber being open toward the walls of the cylinder, inlet ports for the lubricating liquid on one side of the cylinder, outlet ports for the lubricating liquid on the reverse side thereof, supply channels for conducting the liquid to the inlet ports, discharge channels for the outlet ports, longitudinal channels for connecting the ports and channels on one side, a stuffing-box around the piston-rod, a chamber therein, channels leading to said chamber, and connecting pipes connecting the channels leading to said chamber, with one of the supply and discharge channels, respectively, substantially as set forth.

12. The combination, of a compression or vacuum-pump, a piston having a chamber in the same, said chamber being open toward the walls of the cylinder, inlet ports for the lubricating liquid on one side of the cylinder, outlet ports for the lubricating liquid on the reverse side thereof, supply channels for conducting the liquid to the inlet ports, discharge channels for the outlet ports, longitudinal

channels for connecting the ports and channels on one side, a stuffing-box around the piston rod, a chamber therein, channels leading to said chamber, connecting pipes connecting the channels leading to said chamber with one of the supply and discharge channels, respectively, and valves for opening and closing said ports intermittently, substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

PAUL I. SCHMALTZ.

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