

No. 683,614.

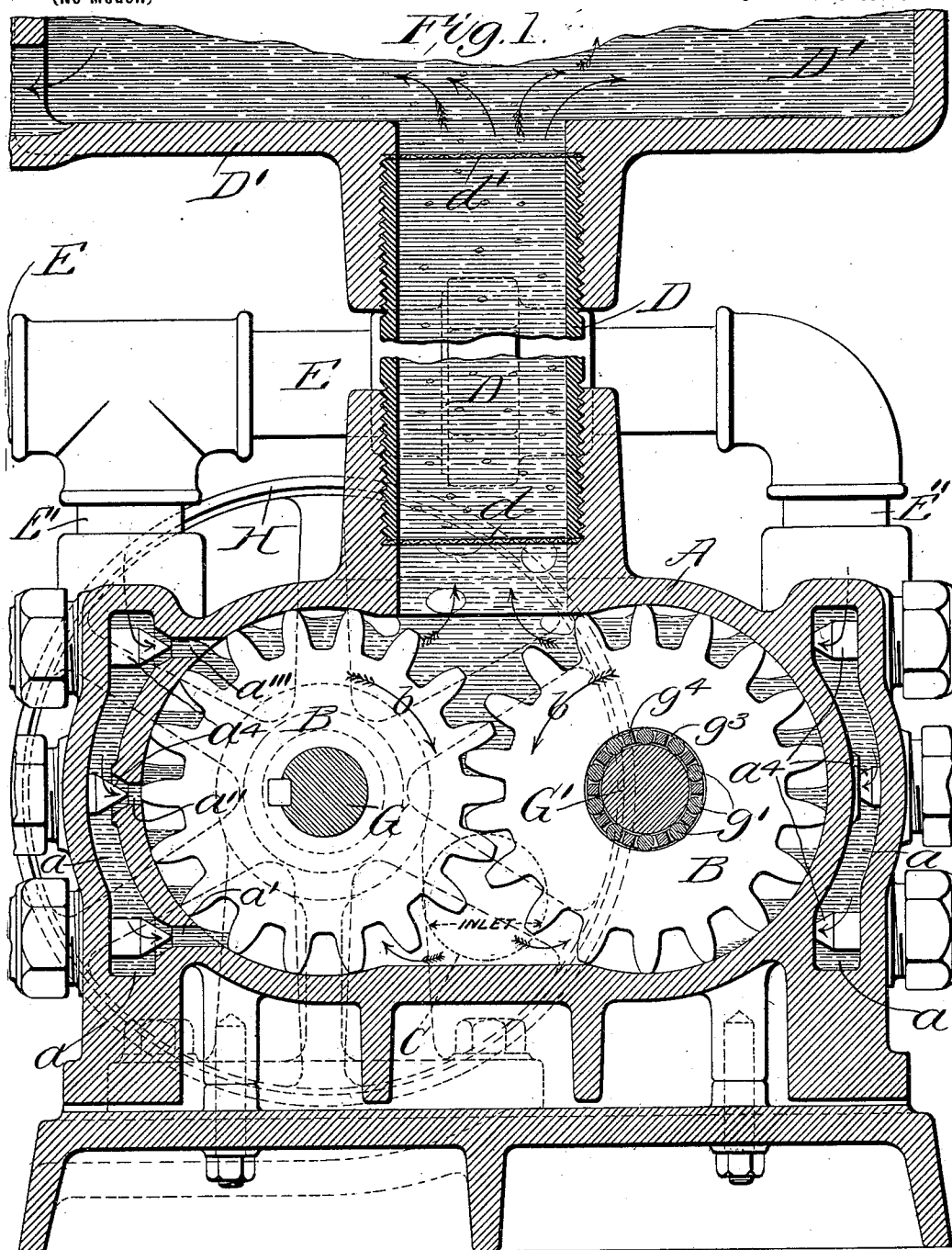
Patented Oct. 1, 1901.

C. R. MESTON.
AIR COMPRESSOR.

(Application filed Jan. 23, 1901.)

(No Model.)

3 Sheets—Sheet 1.



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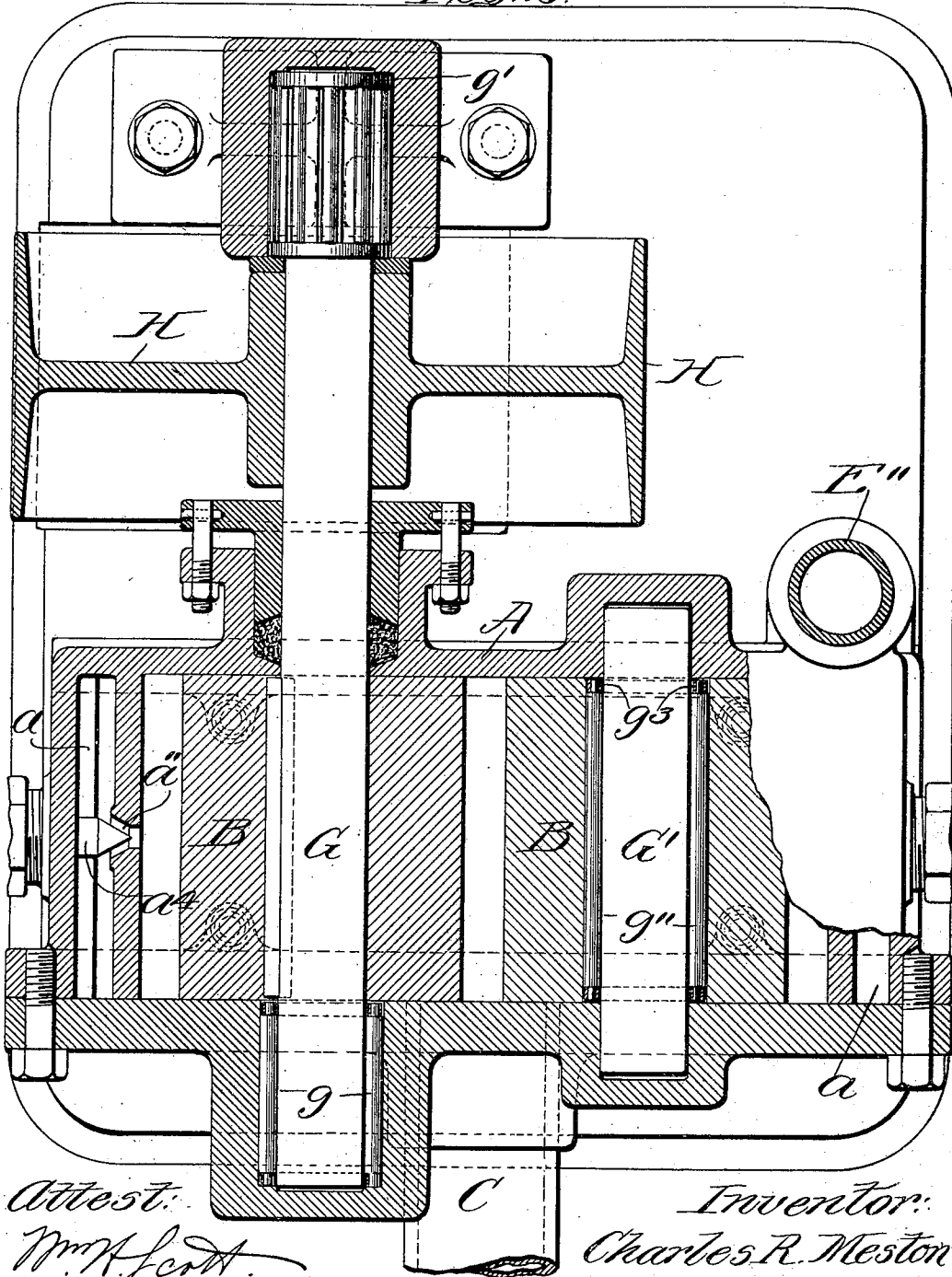
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3 Sheets—Sheet 2.

FIG. 2.



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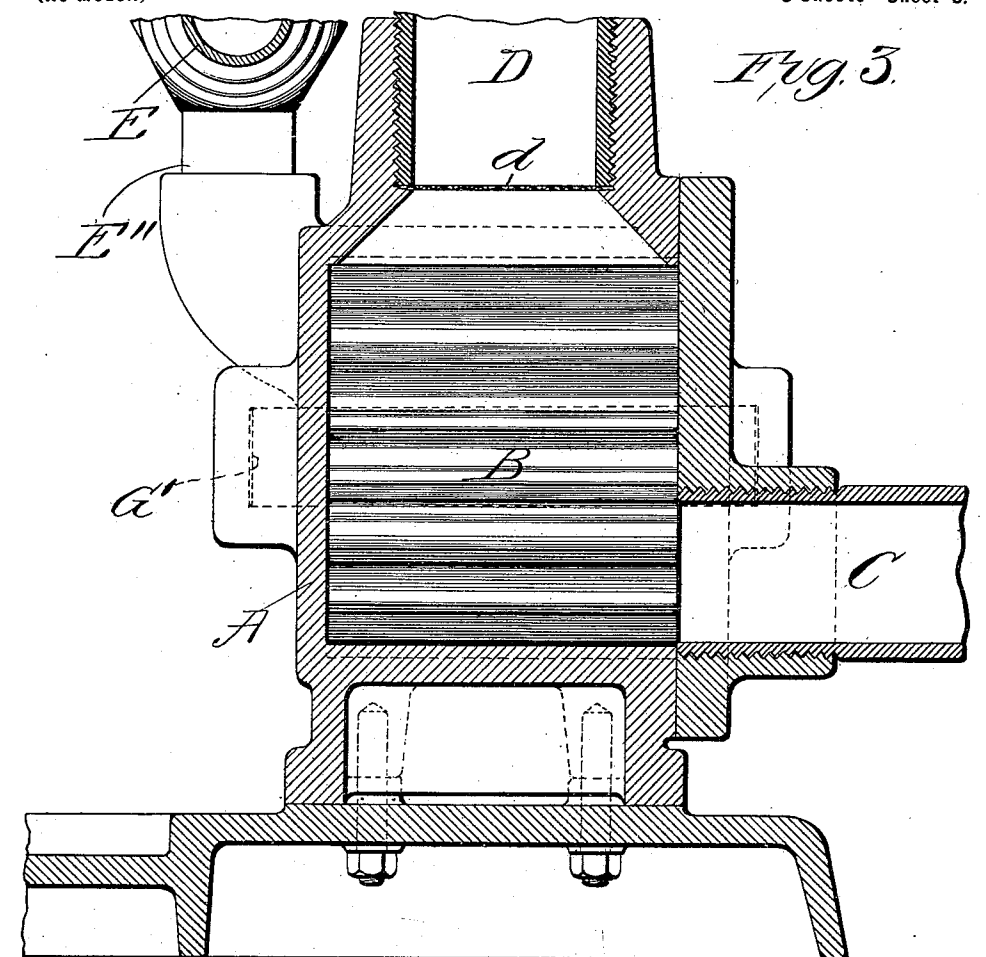
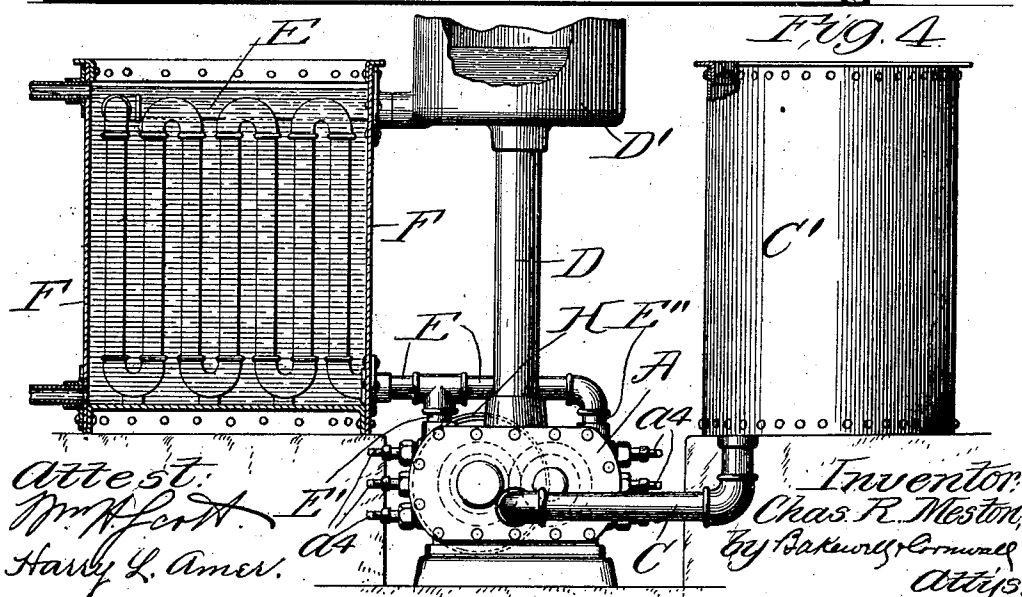
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3 Sheets—Sheet 3.



UNITED STATES PATENT OFFICE.

CHARLES R. MESTON, OF ST. LOUIS, MISSOURI, ASSIGNOR OF ONE-HALF TO
THE EMERSON ELECTRIC MANUFACTURING COMPANY, OF SAME PLACE.

AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 683,614, dated October 1, 1901.

Application filed January 23, 1901. Serial No. 44,444. (No model.)

To all whom it may concern:

Be it known that I, CHARLES R. MESTON, a citizen of the United States, residing at the city of St. Louis, in the State of Missouri, have
5 invented a certain new and useful Improvement in Air-Compressors, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a vertical sectional view through my improved air-compressor. Fig. 2 is a horizontal sectional view through the same. Fig.
15 3 is a vertical cross-sectional view through the compressor; and Fig. 4 is an elevational view, partly in section, showing my improved air-compressor combined with a system for cooling the liquid contained in the high-pressure side of the compressor.

This invention relates to a new and useful improvement in air-compressors, the object being to employ a rotary type of compressor in order to be economical with power, which
25 rotary type of compressor is also very simple and is highly efficient.

The invention consists in the construction, arrangement, and combination of the several parts, all as will hereinafter be described and
30 afterward pointed out in the claims.

In the drawings I have shown a well-known type of rotary pump, comprising a casing A, in which are mounted two compressing-disks B, having matching projections which gear
35 with each other, and power being applied to one the other will be rotated in the opposite direction, so that liquid or gas drawn in at one side of the casing will be forced out of the other. This well-known construction of
40 pump and its method of operation are well understood, and no detailed description thereof need be given here, except as the same pertains to the operation of such construction in carrying out my invention. It is well known
45 that this construction of pump, comprising the casing A and the matching disks B, will pump water or other liquid, taking the same from the inlet-pipe C, which for convenience will be designated as the "suction" or "low-
50 pressure" side of the pump, and forcing the liquid into and through the outlet-pipe D,

which I will term the "discharge" or "high-pressure" side of the pump. So far as I know this type of pump is efficient and economical of power in pumping liquids. However, when
55 the pump is operated and the pipe C disconnected from a source of water-supply the pump under ordinary conditions is not well adapted for compressing air. Experiments I have made show that the disks B will only
60 compress air in a reservoir to which the discharge-pipe D is connected to about two or three pounds pressure to the square inch. Where the interior of the casing was charged with liquid, preferably a lubricant, the air
65 was compressed to fifty or sixty pounds pressure per square inch in the reservoir. An outlet is provided for the liquid in the discharge-pipe and means provided for cooling the liquid, after which said liquid is returned
70 to the pump at various points, commencing at or near the suction-pipe and ending at or near the discharge-outlet.

As before stated, the casing A, with the matching disks B, is substantially in the form
75 of the well-known construction of a rotary pump on the market. The suction-pipe C, which leads into the bottom of casing A when the pump is in the position shown in the drawings, is preferably extended up above the
80 pump and provided at its upper end with a reservoir C', said reservoir being open at its top to admit air, and which reservoir is also employed for the purpose of taking care of any leakage of oil back through the suction
85 side of the pump when the pump is not in operation and there is pressure in the discharge-pipe above the liquid, which pressure tends to force the liquid back through the suction-pipe, as is well understood.

The discharge-pipe D preferably connects with a reservoir D', and in the length of this discharge-pipe are arranged screens or perforated plates *d* and *d'* for breaking up the
90 air as it enters or passes through said discharge-pipe into small bubbles or particles in order that said small bubbles may the sooner lose their heat which is developed in the compression of the air.

The level of the oil in which the matching
100 disks B run is preferably above the bottom of the reservoir D'; but wherever the oil-level

may be I prefer to tap the discharge-pipe or the reservoir D' below the line of its oil-level for the purpose of connecting a pipe E, said pipe E being preferably cooled in a cooling vessel F, containing running cold water or other cooling medium. The lower end of pipe E is provided with two branches E' and E'', which open into chambers *a* at opposite ends of the casing A. These chambers *a* communicate with the interior of the casing A through openings *a'*, *a''*, and *a'''*, which are preferably controlled by needle-valves *a''* and so arranged that the rotating disks B will tend to induce a flow of liquid through said openings.

By referring to Fig. 2 it will be seen that one of the disks B, which may be designated as the "power-driven disk," is keyed to a shaft G, said shaft being received at one end into what I will term a "blind-pocket" bearing, in which pocket are arranged rollers *g*. The other end of this shaft G passes through the casing, being packed by a suitable stuffing-box, the protruding end carrying a pulley H, while the extreme end of shaft G is received in a roller-bearing *g'*. The driven disk B, meshing with the one just mentioned, is mounted upon a shaft G', whose ends are loosely received in blind pockets in opposite sides of the casing A. This shaft carries roller-bearings *g''*, upon which the disk B is mounted. This method of arranging the roller-bearings is highly desirable, because there is but one moving joint to pack, and the antifriction roller-bearings take up the side thrust of the disks, reducing the power required to drive them. By mounting the rollers *g''* within the casing the shaft *g'* may be received in shallow blind pockets of relatively small dimensions, and by loosely mounting the ends of this shaft *g'* in said pockets said shaft may rotate to some extent to present new wearing-surfaces for the rollers. These rollers are preferably mounted in rings *g'''*, which rings are spaced apart by rods *g''''*, (see Fig. 1,) whereby the rollers are separated and have a true rolling contact with their respective parts.

The operation of my improved apparatus is as follows: Assuming that the device is to be started for the first time, the oil to be used, which is preferably heavy lubricating-oil, is placed in the reservoir C'. Power is applied to the matching disks B to rotate them in the direction of their respective arrows *b*, and the first action will be to pump the oil from the reservoir C' into the casing A, thence through the discharge-pipe D and into the reservoir D'. From this reservoir the oil is carried back by the pipe E and its branches E' and E'' to the chambers *a*. When the oil is exhausted from the reservoir C', further rotation of the matching disks B will draw the air in through the suction side of the pump. However, the air entering the suction side of the pump is at atmospheric pressure and soon becomes confined in an inclosed space—such, for in-

stance, as the space marked 1 in the drawings. Then as the air in space 1 is carried around the opening *a'* connects therewith and during such communication admits oil or liquid into said space, slightly compressing the air therein—such, for instance, as shown at 2. As the space now registers with the opening *a''*, more liquid is admitted thereto, further compressing the air in said space. This operation is likewise true with respect to a liquid admitted through the opening *a'''*. Thus it will be seen that while the air originally confined in the recesses of the disks B was at atmospheric pressure the openings *a'*, *a''*, and *a'''* have admitted liquid to the chamber or space in which the air is confined and have gradually compressed the air, so that we have under these conditions what might properly be termed "gradual" or "stage" compression. By "stage compression" I mean that the air is subjected to pressure by stages or degrees. This is important, as the liquid is not permitted to enter the chamber coincident with the admission of air thereto, and therefore the notches in the disks B will receive the air at atmospheric pressure and the liquid cannot escape through the suction-pipe. However, when the chamber filled with air at atmospheric pressure is moved, so as to admit the liquid through the first opening *a'*, said liquid in entering said chamber will, depending upon the pressure thereabove and the length of time said opening *a'* communicates with the chamber, admit liquid to said chamber and compress the air therein to a certain extent. It will be noticed that before the chamber is in communication with the liquid-supply it is out of communication with the suction-pipe, and therefore the liquid is not permitted to run through. If when the same chamber under consideration reaches the next opening *a''* the pressure of the liquid exceeds the compression of air in said chamber, said liquid will compress the air to a further extent, depending upon the time that it has access to the chamber. So, likewise, will the liquid entering through the opening *a'''* further compress the air in said chamber, if it is susceptible of further compression. Of course the speed of the pump, the pressure upon the liquid, and the amount of liquid admitted are elements which control the amount of this stage compression, and it is obvious that these can be so regulated and proportioned that the air in any given chamber will be compressed to the same extent as the air in the reservoir D' before the air being compressed reaches the discharge side. However, if the pressure upon the liquid and the speed of the matching disks B are not regulated and proportioned to accomplish this the final compression of the air will be accomplished when the projections and recesses of the disks B match each other, and by so matching or meshing with each other the air is forced through the discharge-pipe D, together with any oil or liquid carried around in the

recesses or spaces of the disks B, which will not leak around the side edges and peripheries thereof. Furthermore, the air has a tendency and will rise through the column of liquid in the discharge-pipe D, the heat developed in compressing the air being readily absorbed by the liquid when the air is broken up into small particles by the screens d and d' . When the air finally escapes above the column of liquid, the liquid acts as a seal and prevents the air escaping by leakage back around the disks B. Furthermore, the admission of liquid at the points a' , a^2 , and a^3 establishes a circulation of liquid up through the discharge-pipe and down through the cooling vessel, which not only gives the liquid an opportunity to give up the heat it has absorbed from the compressed air, but to be cooled and in readiness to absorb heat from air to be compressed, with which in its cooled state it is in actual contact at the time of final compression and also during the stage compression before referred to. The general direction of the air in its passage to and from the compressor is indicated by the feathered arrows, and the circulation of the liquid is indicated by the featherless arrow.

In connection with the cooling of the air or gas being compressed, so as to deprive it of its high temperature resulting from compression, I will mention the advantage of so proportioning the pressure of the liquid entering through the openings a' , a^2 , and a^3 (and in calculating the pressure of the liquid at this point it is well to consider the hydrostatic pressure in addition to the actual pressure on the surface of the liquid in the reservoir) and the amount of liquid passing through said openings, so that the air or gas will be fully compressed before reaching the discharge-opening: First the disks have imposed upon them the work of elevating the liquid, the compression of the gas or air having been accomplished by the liquid; second, the power required to rotate the disks is applied uniformly, because the disks are pumping liquid, an incompressible fluid, against the compressible gas in the reservoir, from which reservoir there is a constant egress of the liquid, (that being returned to the pump;) third, the liquid having absorbed the heat from the air or gas during compression and during its passage through the column of liquid in its efforts to reach the reservoir on the high-pressure side of the pump is cooled in readiness to again absorb the heat when it enters the pump-chamber; fourth, if means be provided to cool the liquid below the temperature of the external atmosphere the compressed air or gas in the reservoir will be approximately at the temperature of the external atmosphere, and therefore not having any heat to lose will not sacrifice any pressure; fifth, the liquid which is incompressible, but having a certain pressure, will occupy a relative space in the chamber containing the air being compressed—that is, if there are two atmospheres

of pressure on the surface of the liquid and the air in the chamber originally at atmospheric pressure and occupying the whole of said chamber is compressed one-half its volume plus the hydrostatic pressure of the liquid there is approximately the same volume of liquid in the chamber as there is of air, and while the temperature of the air is theoretically double there is approximately an equal volume of liquid in readiness to absorb the surplus heat in the compressed liquid—say of five atmospheres—the volume of air will be reduced approximately one-fifth, the remaining four-fifths of the chamber being occupied by liquid at or below atmospheric temperature, and while the temperature of the compressed air is theoretically five times as great as it was originally there is present a volume of liquid at or less than the external temperature exceeding the volume of air four to one, so that the heat of the compressed air is ready to be absorbed by the incompressible liquid whose temperature is theoretically one-fifth of that of the compressed air, and which incompressible liquid has a greater capacity for heat than the air with which it is in actual contact. Furthermore, in rising through the column of liquid in the discharge-pipe the air is first divided into small particles by the screen d , so that it is in the best condition to have its heat dissipated, the liquid being on all sides of the small air-bubbles, and thus more readily assimilating or absorbing the heat from the air.

In addition to breaking up the air into small bubbles, in order that it may be more quickly deprived of heat acquired at the time of compression, the screens d and d' also serve as scrubbing-surfaces, and when the air is broken up into small bubbles dust or foreign particles which may have been in the air at the time of its introduction into the compressor are liable to be absorbed by the liquid, and thus the air will be freed from impurities. Where it is desired to have air free from odor which might be acquired from contact with the heavy lubricating-oil in the compressor, glycerin or other suitable substance which would serve as a lubricant as well as a seal can be used.

While I have shown a construction in the drawings wherein there are no valves (except the valves a^4) or other moving parts except the rotating disks B, it is obvious that an inwardly-opening check-valve can be placed in the suction-pipe C for the purpose of holding the air and liquid in the casing A and the reservoir connected therewith in the event that the disks cease rotating or an outwardly-opening check-valve (outwardly opening with respect to the casing A) can be placed in the discharge-pipe D for the same purpose, although in this latter instance the valves a^4 should be closed to take care of the leakage going through pipe E when the engine is not running.

The discharge-pipe D contains a column

of liquid on the high-pressure side of the compressor, and said liquid being available at all times will flow back into the chamber near the low-pressure side of the casing to take
 5 care of the variable displacements due to the moving projections on the disks B. In other words, an important feature of my improved compressor is the liquid seal in the high-pressure or discharge side of the compressor,
 10 which, due to the weight of the column of said liquid and the pressure in the reservoir on top of said liquid, is constantly seeking to flow back into the casing, and in so doing will force the air which has access to the discharge-pipe to flow into this discharge-pipe,
 15 and this air or gas being lighter than the liquid will rise through the liquid, and thus the liquid materially assists in the compression. Furthermore, the liquid occupying the discharge or high-pressure side of the casing due to the pressure on this side of the compressor will seek to pass from the high-pressure to the low-pressure or suction side of the compressor, and in so doing will seal the leaks
 25 around the disks and of course occupy any space wherein pressure is less than that which is impelling the liquid onward to make its escape. Finding a path of less resistance, the liquid will flow into the spaces containing
 30 the air to be compressed, and thus the leakage in the compressor is taken advantage of in effecting the stage compression before referred to. In fact, peripheral grooves leading from the discharge-opening of the compressor and located in the inner faces of the casing may be employed to offer paths for the liquid to effect the stage compression before referred to, which by-passes would practically amount to no more than an increase of
 40 leakage around the moving parts which ordinary leakage effects the same result, but perhaps not to such a degree as could be accomplished by the use of by-passes. These by-passes are of course equivalent to the openings a^1 , a^2 , and a^3 , except that they are connected directly with the discharge-opening of the pump rather than indirectly to said discharge-pipe through the medium of pipes E, E', and E². These by-passes would not be connected with the suction-pipe, as it is necessary
 50 to keep the liquid out of the suction-pipe, and this effort is made notwithstanding the inevitable leakage which will occur in this type of pump, and so the walls adjacent the inlet-opening, as shown in the drawings, are made slightly higher to prevent the liquid from flowing back into the suction-pipe. The discharge-pipe D of course is large enough where the pipe E and its associate parts are omitted to readily accommodate the passage
 60 of the air or gas in an upward direction and also to accommodate the passage of the liquid in a reverse or downward direction in order to keep the discharge side of the compressor filled. Where the pipe E is not used, there is a constant circulation of the liquid in the casing, due to the leakage from the high-pres-

sure to the low-pressure side of the casing and the return by mechanical means of said liquid from the low-pressure to the high-pressure side, and there is also constant movement of the liquid in the discharge-pipe D, due to the displacement of said liquid and the action of the liquid in filling spaces resulting from the movement of the disks B.
 75 It will also be obvious that any suitable device may be introduced into the system for purifying the liquid and removing any foreign particles which may be collected thereby from the gas which is compressed. In fact, 80 well-known filtering-screens with suitable mechanism for cleaning the same can be used in pipe E, as is well understood.

While I have shown in the drawings a well-known form of rotary pump or compressor 85 having two matching disks cooperating with each other to effect the compression, it is obvious that types of pumps or compressors wherein oppositely-rotating twin screws are used could as well be operated in connection 90 with my invention, or those forms of pumps or compressors wherein a single rotating disk or cylinder carrying movable piston-heads could also be used.

I am aware that there are many minor 95 changes in the arrangements, construction, and combination of the several parts of my device which can be made and substituted for those herein shown and described without in the least departing from the nature and 100 principle of my invention.

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

1. In a device of the character described, 105 the combination with a casing, of a rotary element therein provided with notches or recesses forming air-chambers, said casing having inlet and discharge openings, and means for introducing liquid into the casing adjacent to the inlet-opening; substantially as described. 110

2. In a device of the character described, the combination with a casing, of a rotary element therein provided with notches or recesses forming air-chambers, said casing having inlet and discharge openings, and means for introducing liquid into the casing at different points between the inlet and discharge openings; substantially as described. 120

3. In a device of the character described, the combination with a casing, of a rotary element therein provided with notches or recesses forming air-chambers, said casing having inlet and discharge openings, and means 125 for introducing liquid under pressure into the casing at different points between the inlet and discharge openings, whereby said liquid flows into the chambers in the rotary element to compress the gas or air contained 130 therein; substantially as described.

4. In a device of the character described, the combination with a casing provided with inlet and outlet openings and ducts in its pe-

riphery connected with the outlet-opening, said ducts not being in communication with the inlet-opening, and a discharge-pipe leading from the outlet-opening and containing a liquid; substantially as described.

5. In a device of the character described, the combination with a casing provided with inlet and outlet openings, of a rotary element having independent air chambers or spaces, a discharge-pipe connected to the outlet-opening and containing a column of liquid, a pipe for conveying liquid from said discharge-pipe to a chamber adjacent to said casing, and openings connecting said chamber with the interior of the casing, said openings being located in such position as not to communicate with the inlet-opening of the casing; substantially as described.

6. In a device of the character described, the combination with a casing provided with inlet and outlet openings and having ducts or passages in its interior communicating with the outlet-opening and terminating short of the inlet-opening, a rotary element provided with recesses or chambers for receiving air to be compressed, from the inlet-opening, said chambers receiving liquid through the ducts or passages before mentioned before they register directly with the outlet-opening, and means for cooling said liquid; substantially as described.

7. In a device of the character described, the combination with a casing provided with inlet and outlet openings, a rotating disk mounted in said casing and having recesses forming air-chambers, a discharge-pipe leading from the outlet-opening of the casing and containing a column of liquid, a pipe for conveying the liquid from said discharge-pipe back to the casing at a point intermediate

the inlet and outlet openings, and a cooling-coil arranged in the length of said last-mentioned pipe; substantially as described.

8. In a device of the character described, the combination with a casing provided with inlet and outlet openings, and having ducts or passages in communication with the outlet-opening only, a discharge-pipe connected to the outlet-opening and containing a column of liquid, a rotary element mounted in the casing having recesses forming air-chambers which are placed in communication with the ducts or passages before mentioned after said recesses are out of communication with the inlet-opening, whereby the liquid from said ducts or passages entering said chambers will compress the air or gas therein, and means across the outlet-opening for dividing the compressed air or gas into small particles as it enters the column of liquid in the discharge-pipe; substantially as described.

9. In a device of the character described, the combination with a casing, of a rotary element therein provided with notches or recesses forming air-chambers, said casing having inlet and discharge openings, and openings through which liquid under pressure is introduced into the casing at different points between the inlet and discharge openings, and means for controlling the amount of liquid admitted through said last-mentioned openings, substantially as described.

In testimony whereof I hereunto affix my signature, in the presence of two witnesses, this 17th day of January, 1901.

CHARLES R. MESTON.

Witnesses:

F. R. CORNWALL,
WM. H. SCOTT.