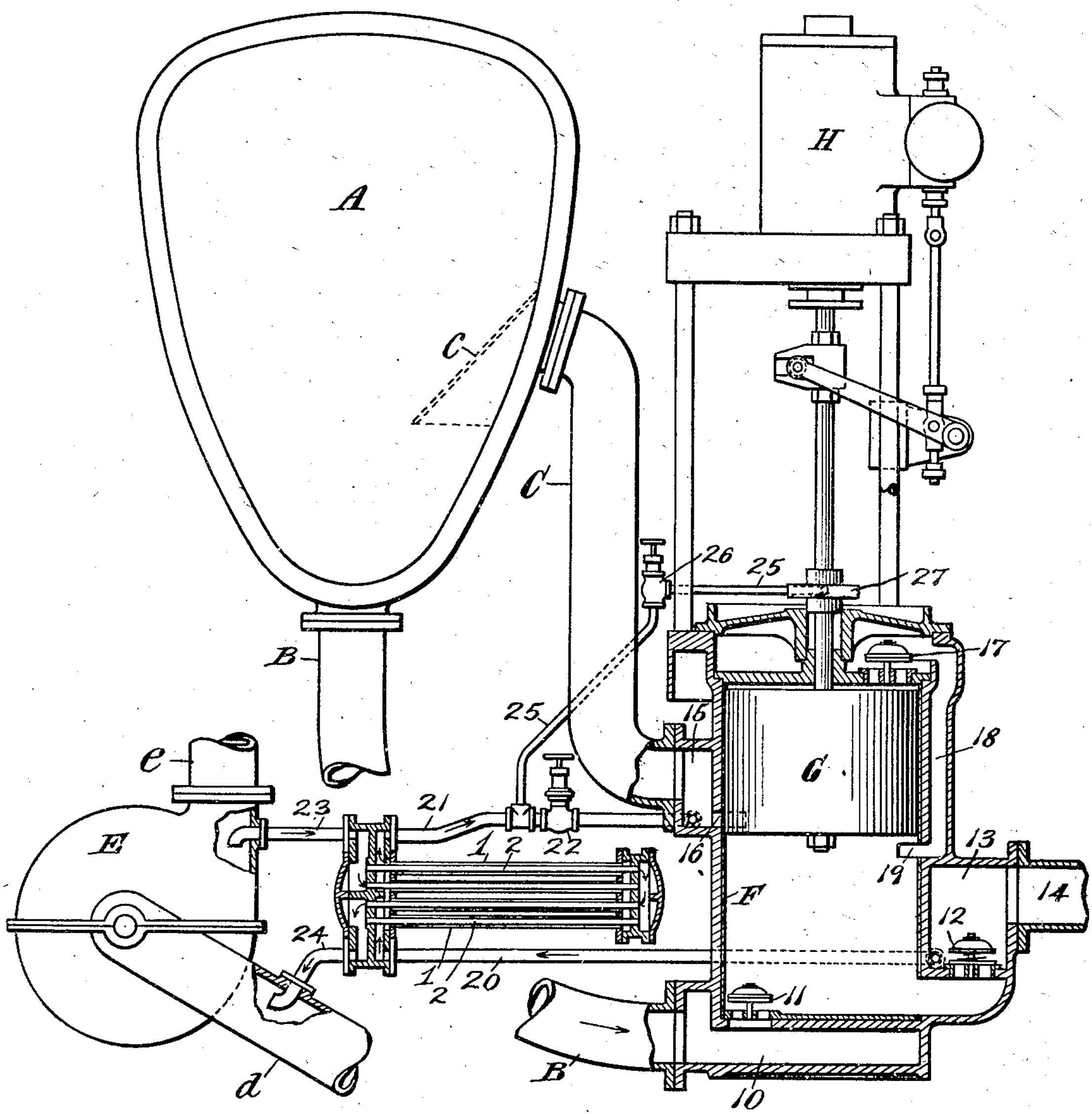
P. P. BOURNE.
CONDENSER SYSTEM AND VACUUM PUMP.
APPLICATION FILED MAY 23, 1919.

1,335,478. Patented Mar. 30, 1920.

2 SHEETS—SHEET 1.

Fig. 1.



Inventor:
Phillips P. Bourne
by his Attys:
Philipp Sawyer Rice & Kennedy

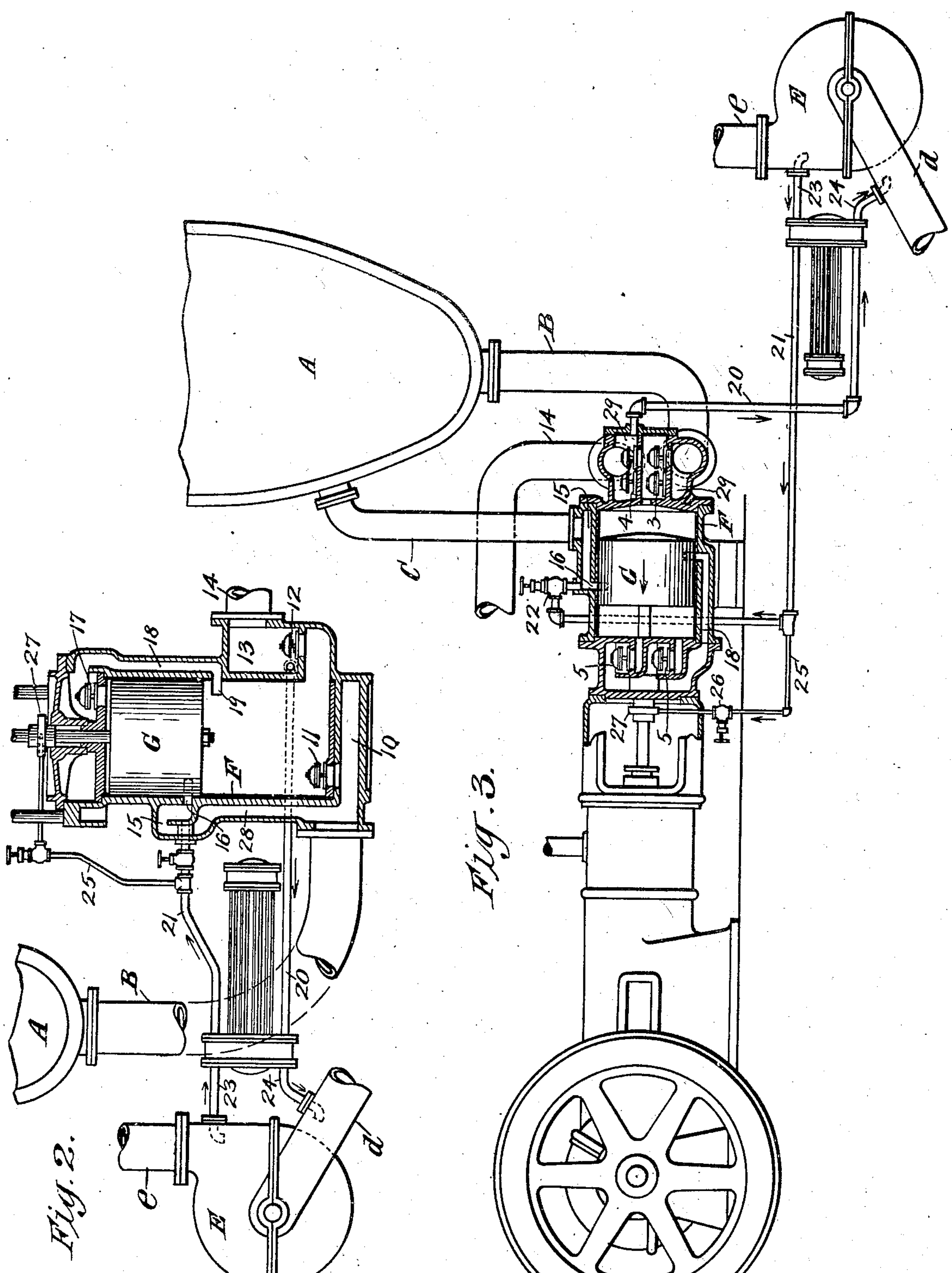
P. P. BOURNE.

CONDENSER SYSTEM AND VACUUM PUMP.

APPLICATION FILED MAY 23, 1919.

1,335,478. **Patented Mar. 30, 1920.**

2 SHEETS—SHEET 2.



Inventor.

Phillips P. Bourne

by his Attys:

Philipp Sawyer Rice & Kennedy

UNITED STATES PATENT OFFICE.

PHILLIPS P. BOURNE, OF WINCHESTER, MASSACHUSETTS, ASSIGNOR TO WORTHINGTON PUMP AND MACHINERY CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF VIRGINIA.

CONDENSER SYSTEM AND VACUUM-PUMP.

1,335,478. Specification of Letters Patent. **Patented Mar. 30, 1920.**

Application filed May 23, 1919. Serial No. 299,320.

To all whom it may concern:

Be it known that I, Phillips P. Bourne, a citizen of the United States, residing at Winchester, county of Middlesex, and State of Massachusetts, have invented certain new and useful Improvements in Condenser Systems and Vacuum-Pumps, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to vacuum pumping apparatus of the class employed in connection with steam condensing systems, and especially to that type of apparatus known as dry and wet air pumps, in which one end of the cylinder receives the air and uncondensed vapor and the other end the discharge water, that is, the water of condensation in surface condensing systems, for which the invention is especially intended, although applicable also to jet condensing systems.

The especial object of the invention is to provide a condensing system of this class in which the pump shall be simple, reliable, and economically operated, and a system by which a high volumetric efficiency and vacuum may be maintained, with a vacuum pumping apparatus of small size and low cost.

For a full understanding of the invention, a detailed description of condenser systems in preferred forms as applied in connection with surface condensers, will now be given, in connection with the accompanying drawings forming a part of this specification, and the features forming the invention then specifically pointed out in the claims.

In the drawings—

Figure 1 is a side elevation of a surface condenser system, with the pump and cooler in section, showing a preferred construction in which the air and uncondensed vapor are taken off the condenser separately from the water of condensation;

Fig. 2 is a similar partial view showing a construction in which the air and uncondensed vapor are taken off the condenser with the water of condensation, and

Fig. 3 is a view similar to Fig. 1, showing the invention applied in connection with a horizontal pump.

Referring to the drawings, and especially to Fig. 1, A is a surface condenser shown as of a well-known type; B the tail pipe for the water of condensation, and C the air pipe through which the air and uncondensed vapor are drawn off from the usual internal cooler *c*, which is preferably used. E is the usual centrifugal circulating pump by which the condensing water is circulated through the condenser, *d*, *e* being, respectively, the suction and discharge pipes of the circulating pump. The dry and wet air pump F, having the piston G, is shown as a vertical direct-acting pump of a common type, having the steam cylinder H operating the piston in a manner well-known. The pump cylinder F receives the water of condensation from tail pipe B through base suction chamber 10, and the usual suction valves 11, and discharges below the piston through force valves 12, discharge chamber 13 and discharge pipe 14. The cylinder F also receives above the piston G the air and uncondensed vapor from pipe C through inlet chamber 15 and inlet ports 16, this air and vapor inlet preferably being valveless and adapted to be opened by the piston G at the end of its downward stroke for suction and closed by the piston on reversal for discharge on the upward stroke, such discharge being through valves 17 in the cylinder head.

This condensing system and vacuum pump, so far as above described, is well known, so that no further description of its construction or operation, except so far as concerns features added in accordance with the present invention, is required.

Referring now to these features, the air and uncondensed vapor from the condenser is not discharged to the atmosphere by the piston on its upward stroke, but is discharged from the ports controlled by valve 17 to a head discharge chamber closed to the atmosphere and through a passage 18, shown as cast in the cylinder but which may be formed by a pipe or in any other suitable manner, to ports 19 opening into the cylinder below the piston so as to be opened by the piston at or near the end of its upward stroke and closed by the piston at or near the beginning of its downward stroke. The air and uncondensed vapor, therefore, are not delivered against atmospheric pressure by the piston on its upward stroke, but are delivered only against the reduced suction pressure in cylinder F below the piston. The discharge chamber above valves 17 and passage 18 are made of such capacity as to avoid large compression before the port 19 is opened. The air and uncondensed vapor thus transferred to the cylinder below the piston are compressed and discharged with the water of condensation through valves 12 on the downward stroke of the piston.

It is desirable that the temperature of the air in the upper end of the cylinder should be kept low, as cooled by the air cooler in the condenser, for the purpose of reducing the air volume and aiding in the condensation of the vapor, and for this purpose the water, preferably injected into the air end for the purpose of filling the clearance spaces and sealing the piston and air discharge valves, should be cold water of the required temperature. This cold water is preferably delivered to the cylinder through ports 16 above the piston at the end of the downward stroke of the piston and preferably taken from the discharge of pump F, in which case, because of its temperature as water of condensation, it is important to cool it to the required temperature before it is delivered above the piston. In the construction shown, this liquid is taken from the discharge chamber 13 of pump F by pipe 20 and passed through a cooler and then supplied through pipe 21 to air suction chamber 15, the amount of water supplied preferably being regulated by cock 22. The cooler may be of any suitable construction, but as shown the water from pipe 20 passes through outer tubes 1 which are cooled by inner tubes 2 supplied with cold circulating water by the pump E through pipe 23 connecting with the circulating pump delivery *e*, this water returning to the suction *d* of pump E through pipe 24. As shown, this cooled water of condensation is used also for sealing and cooling the gland of the pump piston rod, water being supplied through pipe 25 controlled by cock 26 to the gland ring 27.

The construction shown in Fig. 2 is the same as that shown in Fig. 1, except that the air and uncondensed vapor pass from the condenser through tail pipe B with the water of condensation, and are separated at the suction chamber 10, the water of condensation passing into cylinder F below the piston through valves 11, as in Fig. 1, and the air and uncondensed vapor passing upward through passage 28 to suction chamber 15, as common in this class of dry and wet air pumps.

As shown in Fig. 3, the air and uncondensed vapor are taken off through pipe C and the water of condensation through tail pipe B, as in Fig. 1, but the pump is made horizontal and is shown as driven by an engine of the rotative type but which may be direct-acting as in the other constructions. In this construction, the air suction chamber 15 and ports 16 are shown as placed on the upper side of the pump, which usually is preferable, and the delivery passage by which the air is transferred to the water side of the piston is shown as on the lower side of the pump, but it may be on the side or top to avoid collection of water if this is found preferable in any case. The suction valves 3, and force valves 4, at the water end of the pump, are preferably placed horizontally in valve chamber 29, and the air discharge valves 5 are placed horizontally in valve chambers on the opposite head of the cylinder.

It will be seen that the invention provides a vacuum pumping apparatus by which a high volumetric efficiency is secured and a high vacuum may be maintained with a comparatively small and cheap single cylinder pump. The two stage air compression not only increases the pump capacity largely, but avoids the objectionable high compression in the dry end of the pump and reduces the power required.

What is claimed is:

1. In a condenser system, the combination with the condenser, of a pump having its cylinder connected to the condenser for receiving and discharging air and uncondensed vapor at one end of the cylinder and liquid at the other end of the cylinder, and a passage connecting the outlet of the air end of the cylinder with the water end of the cylinder whereby the air is delivered from the air end of the cylinder against a reduced pressure in the water end and finally delivered with the water.

2. In a condenser system, the combination with the condenser, of a pump having its cylinder connected to the condenser for receiving and discharging air and uncondensed vapor at one end of the cylinder and liquid at the other end of the cylinder, a passage connecting the outlet of the air end of the cylinder with the water end of the cylinder whereby the air is delivered from the air end of the cylinder against a reduced pressure in the water end and finally delivered with the water, and connections for supplying sealing water to the air end of the cylinder.

3. In a condenser system, the combination with the condenser, of a pump having its cylinder connected to the condenser for receiving and discharging air and uncondensed vapor at one end of the cylinder and liquid at the other end of the cylinder, a passage connecting the outlet of the air end of the cylinder with the water end of the cylinder whereby the air is delivered from the air end of the cylinder against a reduced pressure in the water end and finally delivered with the water, and a by-pass through which water from the water end is delivered to the air end on the air suction stroke of the piston.

4. In a condenser system, the combination with the condenser, of a pump having its cylinder connected to the condenser for receiving and discharging air and uncondensed vapor at one end of the cylinder and liquid at the other end of the cylinder, a passage connecting the outlet of the air end of the cylinder with the water end of the cylinder whereby the air is delivered from the air end of the cylinder against a reduced pressure in the water end and finally delivered with the water, a by-pass through which water from the water end is delivered to the air end on the air suction stroke of the piston, and a cooler on said by-pass.

5. In a condenser system, the combination with the condenser, of a pump having its cylinder connected to the condenser for receiving and discharging air and uncondensed vapor at one end of the cylinder and liquid at the other end of the cylinder, a passage connecting the outlet of the air end of the cylinder with the water end of the cylinder whereby the air is delivered from the air end of the cylinder against a reduced pressure in the water end and finally delivered with the water, a by-pass through which water from the water end is delivered to the air end on the air suction stroke of the piston, a surface cooler on said by-pass, and connections for supplying cooling water to said cooler from the condenser cold water pump.

6. In a condenser system, the combination with the condenser, of a vertical pump having its upper end connected to the condenser by a valveless piston controlled inlet for receiving air and uncondensed vapor, a valved air outlet at the top of the cylinder, a valved water inlet in the lower end of the cylinder connected to the condenser, a valved water outlet, and a passage connecting the air outlet with the water end of the cylinder and having its cylinder port controlled by the piston and opened at or near the end of its upward stroke.

7. In a condenser system of that class in which the air and uncondensed vapor are withdrawn from the condenser separately from the discharge water, the combination with the condenser, of a vertical pump cylinder, an air passage connecting the upper end of the cylinder with the condenser and having a valveless piston-controlled inlet, a water passage connecting the lower end of the cylinder with the condenser and having a valved inlet, a valved air outlet at the top of the cylinder, a valved water outlet at the bottom of the cylinder, and a passage connecting the air outlet with the water end of the cylinder and having its cylinder port controlled by the piston and opened by the latter at or near the end of its upward stroke.

8. In a condenser system of that class in which the air and uncondensed vapor are withdrawn from the condenser separately from the discharge water, the combination with the condenser, of a vertical pump cylinder, an air passage connecting the upper end of the cylinder with the condenser and having a valveless piston-controlled inlet, a water passage connecting the lower end of the cylinder with the condenser and having a valved inlet, a valved air outlet at the top of the cylinder, a valved water outlet at the bottom of the cylinder, a passage connecting the air outlet with the water end of the cylinder and having its cylinder port controlled by the piston and opened by the latter at or near the end of its upward stroke, and a by-pass from the liquid discharge of the cylinder to the air inlet.

9. In a condenser system of that class in which the air and uncondensed vapor are withdrawn from the condenser separately from the discharge water, the combination with the condenser and its air cooler, of a vertical pump cylinder, an air passage connecting the upper end of the cylinder with the air cooler and having a valveless piston-controlled inlet, a water passage connecting the lower end of the cylinder with the condenser and having a valved inlet, a valved air outlet at the top of the cylinder, a valved water outlet at the bottom of the cylinder, a passage connecting the air outlet with the water end of the cylinder and having its cylinder port controlled by the piston and opened by the latter at or near the end of its upward stroke, a by-pass from the liquid discharge of the cylinder to the air inlet, and a cooler on said by-pass.

10. A vacuum pump having its cylinder provided with inlets and outlets at opposite ends for receiving and delivering air at one end of the cylinder and liquid at the other end of the cylinder, and a passage connecting the air outlet at the air end of the cylinder with the water end of the cylinder, whereby the air is delivered from the air end against the reduced pressure of the water end and finally delivered with the water.

11. A vacuum pump having its cylinder provided with inlets and outlets at opposite ends for receiving and delivering air at one end of the cylinder and liquid at the other end of the cylinder, a passage connecting the air outlet at the air end of the cylinder with the water end of the cylinder, whereby the air is delivered from the air end against the reduced pressure of the water end and finally delivered with the water, and a by-pass connecting the water delivery with the air end.

12. A vacuum pump having its cylinder provided with inlets and outlets at opposite ends for receiving and delivering air at one end of the cylinder and liquid at the other

end of the cylinder, a passage connecting the air outlet at the air end of the cylinder with the water end of the cylinder, whereby the air is delivered from the air end against the reduced pressure of the water end and finally delivered with the water, a by-pass connecting the water delivery with the air end, and a cooler on the by-pass.

13. A vacuum pump having its cylinder provided with a suction valveless piston-controlled air inlet and valved air discharge at one end of the cylinder, a valved water inlet and valved water discharge at the opposite end of the cylinder, and a passage connecting the air outlet with the water end of the cylinder, said passage having its cylinder inlet controlled by the piston and positioned to be opened by the piston at or near the end of the water suction stroke of the piston.

14. A vacuum pump having its cylinder provided with a suction valveless piston-controlled air inlet and valved air discharge at one end of the cylinder, a valved water inlet and valved water discharge at the opposite end of the cylinder, a passage connecting the air outlet with the water end of the cylinder, said passage having its cylinder inlet controlled by the piston and positioned to be opened by the piston at or near the end of the water suction stroke of the piston, and a by-pass connecting the liquid discharge with the air inlet for supplying water to the air end when the air inlet is opened by the piston.

15. A vacuum pump having its cylinder provided with a suction valveless piston-controlled air inlet and valved air discharge at one end of the cylinder, a valved water inlet and valved water discharge at the opposite end of the cylinder, a passage connecting the air outlet with the water end of the cylinder, said passage having its cylinder inlet controlled by the piston and positioned to be opened by the piston at or near the end of the water suction stroke of the piston, a by-pass connecting the liquid discharge with the air inlet for supplying water to the air end when the air inlet is opened by the piston, and a cooler on the by-pass.

In testimony whereof I have hereunto set my hand.

PHILLIPS P. BOURNE.