J. F. GRACE.

CONDENSER SYSTEM AND VACUUM PUMP.

APPLICATION FILED MAY 26, 1919.

1,340,165. Patented May 18, 1920.

2 SHEETS—SHEET 1.

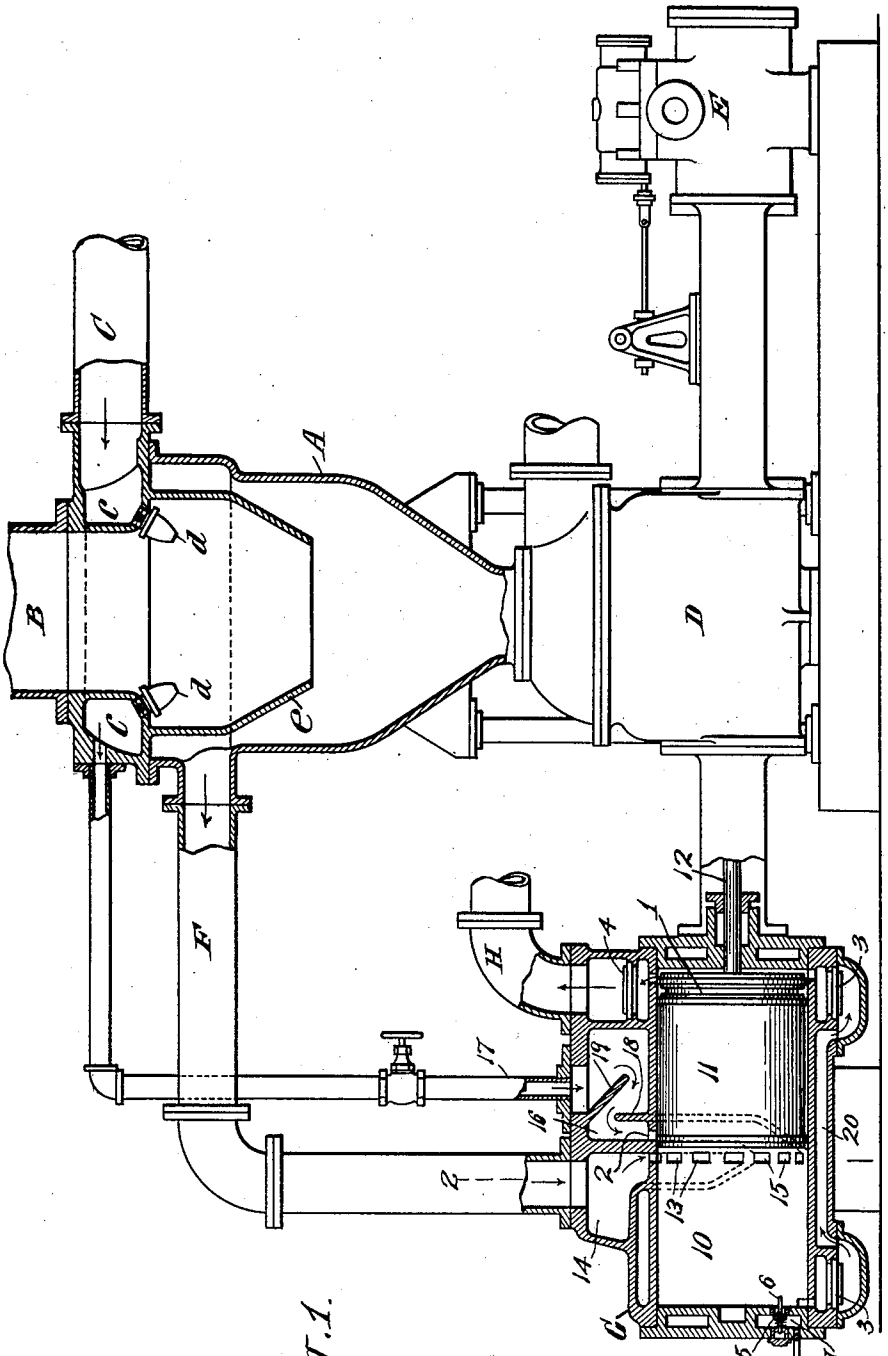

Fig. 1.

Inventor:
John F. Grace
By his Attys:
Philip Lauzer & Kennedy

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2 SHEETS—SHEET 2.

Fig. 2.

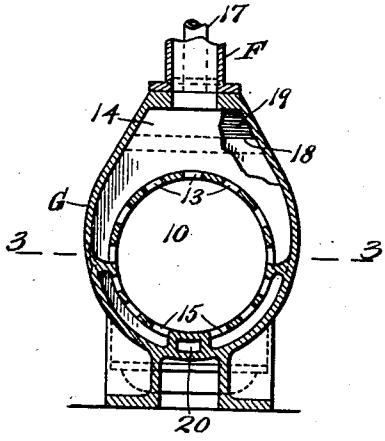


Fig. 3.

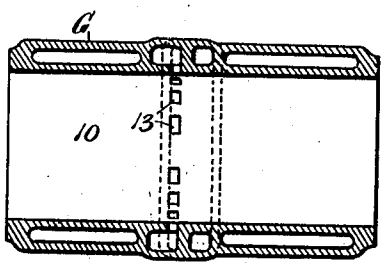


Fig. 5.

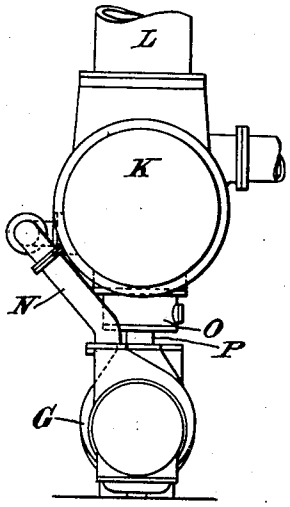
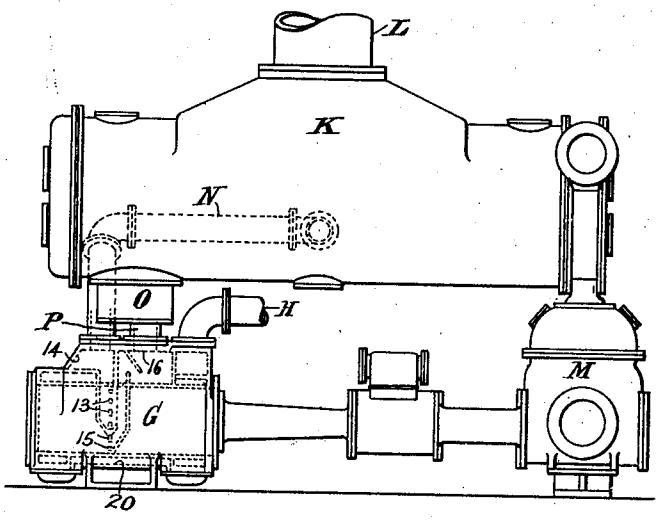


Fig. 4.



Inventor:

John F. Grace

by his Attys:

Philipp Sawyer Rice & Kennedy

UNITED STATES PATENT OFFICE.

JOHN F. GRACE, OF KEARNEY, NEW JERSEY, ASSIGNOR TO WORTHINGTON PUMP AND MACHINERY CORPORATION, A CORPORATION OF VIRGINIA.

CONDENSER SYSTEM AND VACUUM-PUMP.

1,340,165. Specification of Letters Patent. Patented May 18, 1920.

Application filed May 26, 1919. Serial No. 299,820.

To all whom it may concern:

Be it known that I, JOHN F. GRACE, a citizen of the United States, residing at Kearney, county of Hudson, and State of New Jersey, 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, and particularly to a system for discharging the air and uncondensed vapor from steam condensers and maintaining a high condenser vacuum.

The special object of the invention is to provide a vacuum pumping apparatus by which a high vacuum may be maintained in either surface or jet condensers with a low and compact construction, so that the total height of the condensing system and the horizontal space occupied by the vacuum apparatus may be reduced, while at the same time employing a simple, efficient and economical pumping apparatus.

For a full understanding of the invention, a detailed description of jet and surface condensing systems embodying the invention in the preferred form 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 sectional elevation of a jet condensing system, the condenser and air pump being shown in section;

Fig. 2 is a detail vertical section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 shows in elevation a surface condensing system with the pump of Fig. 1 delivering air and water of condensation, and

Fig. 5 is an end elevation looking to the right in Fig. 4.

Referring to the drawings, and now especially to Figs. 1 to 3, A is a jet condenser of a well-known type; B the exhaust inlet; C the injection water inlet delivering to chamber *c*, from which the water is sprayed through nozzles *d* into the condensing nozzle *e;* D the tail pump for the condenser discharge, shown as a well-known central suction discharge pump, similar to that of United States Letters Patent to Alberger & Sault, No. 318225, May 19, 1885, this pump being direct-acting and driven by a steam cylinder E.

The air and uncondensed vapor is withdrawn from the space about the upper portion of the condensing nozzle *e* through pipe F and delivered by the vacuum pump G, which pump in itself forms a part of the present invention, and the air and uncondensed vapor, with the cold water supplied to the pump, are delivered through the discharge pipe H.

The pump cylinder 10 has piston 11 carried by the plunger rod 12 of pump D, so as to be direct-acting and operated by steam cylinder E, and cylinder 10 is provided in its upper central portion with a series of ports 13 connected through chamber 14 with pipe F, and in its lower central portion with a series of ports 15 connecting with suction chamber 16, which is connected by pipe 17 with injection water chamber *c*, water being thus supplied to cylinder 10 for sealing and also lubricating and air cooling. Suction chamber 16 is provided with a trap for the water, shown as formed by weir 18 and shield 19, so that air will not be drawn through the pipe 17 and the water will pass to cylinder 10 only in accordance with the adjusted overflow of weir 18. The ports 13, 15 are uncovered by piston 11 in its extreme suction position and closed by the piston immediately upon reversal, the pump thus being a single-acting suction valveless pump, so far as the suction is concerned. The piston 11 also is preferably sealed and lubricated by a sealing groove 1 which, at the end of the first stage discharge stroke, receives water from the chamber 16 through small port 2, the liquid sealing of the piston between the suction end and the delivery end thus being secured.

The air and water admitted through the ports 13, 15 at the end of the suction stroke are discharged from the suction end of the cylinder 10 on the return stroke and transferred through light valves 3 and transfer passage 20 to the opposite or delivery end of the cylinder, from which delivery end the air and water are delivered to discharge pipe H through discharge valves 4 on the next stroke of the piston.

The air is preferably transferred without substantial compression from one end of

the pump to the other, the action preferably being the same as fully described in United States Letters Patent to Riesner, No. 1196742, Aug. 29, 1916. The valves 3, 4 may be of any suitable type, those in the transfer passage preferably being such as to afford substantially no resistance to the passage of the fluid, and all the valves are shown as automatic valves such as fully described in United States Letters Patent to Meyer, Reissue No. 13991, October 12, 1915. It will be understood, however, that these valves may be of any other suitable type, and either automatic or mechanically actuated. It will be understood, also, that the air may be initially compressed to any amount desired in the first stage within the broader features of the invention.

The suction end of cylinder 10 is preferably provided with means for admitting a small amount of cold water after the air and water having been discharged through the transfer passage 20, so as to avoid objectionable reëvaporation during the return or suction stroke of the piston. The means shown is a spring pressed spray valve 5 having its stem 6 projecting into the cylinder so as to be engaged by piston 11 as it approaches the end of its outward stroke, thus opening the cylinder for a spray from cold water chamber 7 supplied with water under pressure by the pipe 8.

The pump shown in Figs. 4 and 5 is the same in construction and operation as that of Figs. 1 to 3, but applied to a surface condenser and acting to deliver both the air and uncondensed vapor and the water of condensation. In this construction, K is a surface condenser having the steam inlet L and in which the condensing water is circulated by the circulating pump M, which is a direct-acting pump with its plunger on the same rod as the piston of pump G, so that the two pumps are operated together by the steam engine E. The air and uncondensed vapor are taken from the condenser or its usual internal air cooler through pipe N communicating with suction chamber 14 and air ports 13 of pump G, and the water of condensation is taken from condenser hot well O through pipe P connecting with chamber 16 and ports 15 of pump G, the same trap being employed in chamber 16 as shown in Fig. 1, so that air will not be drawn over into the liquid ports, but the air and uncondensed vapors must be drawn through the air cooler and pipe N.

It will be seen that the dry suction and the wet suction of the surface condenser are thus kept separated until the air and condensate have entered the cylinder 10 simultaneously through the upper and lower ports 13, 15, and they are then trapped in the cylinder immediately by the return of the piston on reversal, before the warm condensate has time to substantially increase the vapor pressure.

It will be seen also that, in both the constructions shown, the pumping apparatus will have an even movement, notwithstanding the fact that compression in the vacuum pump may be only in one direction on each revolution, because of the connected discharge pump or circulating pump in which the amount of power required by the water cylinder on each stroke will steady the action of the unit. It is thus entirely practicable to secure a steady movement of this vacuum pump with a direct-acting engine. It will be understood, however, that this vacuum pump may be used otherwise than direct driven, and that the claims on the pump itself are not to be limited to the character of the drive, although the preferred construction is single, horizontal, direct-acting, combined with the condenser circulating pump or tail pump.

This vacuum pump will maintain a very high vacuum with great economy, and it will be seen that the combined unit provides a condensing apparatus occupying much less space vertically and horizontally than the usual jet condenser with centrifugal discharge pump and hydraulic vacuum pump, and is much smaller and more desirable than the usual combination of surface condenser with circulating pump and hot well pump of centrifugal type, and reduces largely the vertical space as compared with a hot well pump of centrifugal type, and still more as compared with the well known hydraulic vacuum pump unit.

What is claimed is:

1. In a condensing system of that class in which the air and uncondensed vapor are drawn off separately from the water, the combination with the condenser, of a horizontal pump having a central valveless air inlet in the upper part of the cylinder connected with the air discharge of the condenser, a central valveless water inlet in the lower part of the cylinder connected with a water supply, a piston adapted to uncover the inlet ports on its movement in one direction and to close the ports on its stroke in the opposite direction, a discharge outlet at the other end of the cylinder, and a transfer passage and valve mechanism for transferring fluid from the inlet end of the cylinder to the discharge end.

2. In a condensing system of that class in which the air and uncondensed vapor are drawn off separately from the water, the combination with the condenser, of a horizontal pump having a central valveless air inlet in the upper part of the cylinder connected with the air discharge of the condenser, a central valveless water inlet in the lower part of the cylinder connected with a water supply receiving water from the con-

denser and water sealed to prevent withdrawal of air or vapor from the condenser through the water ports, a piston adapted to uncover the inlet ports on its movement in one direction and to close the ports on its stroke in the opposite direction, a discharge outlet at the other end of the cylinder, and a transfer passage and valve mechanism for transferring fluid from the inlet end of the cylinder to the discharge end.

3. In a condensing system of that class in which the air and uncondensed vapor are drawn off separately from the water, the combination with the condenser, of a horizontal pump having a central valveless air inlet in the upper part of the cylinder connected with the air discharge of the condenser, a central valveless water inlet in the lower part of the cylinder connected with a water supply, a piston adapted to uncover the inlet ports on its movement in one direction and to close the ports on its stroke in the opposite direction, a discharge outlet at the other end of the cylinder, a transfer passage and valve mechanism for transferring fluid from the inlet end of the cylinder to the discharge end, a make-up water supply connected to the inlet end of the cylinder, and a piston-actuated valve controlling the inlet of make-up water to the cylinder.

4. In a condensing system of that class in which the air and uncondensed vapor are drawn off separately from the water, the combination with the condenser, of a horizontal pump having a central valveless air inlet in the upper part of the cylinder connected with the air discharge of the condenser, a central valveless water inlet in the lower part of the cylinder connected with a water supply, a piston adapted to uncover the inlet ports on its movement in one direction and to close the ports on its stroke in the opposite direction, a discharge outlet at the other end of the cylinder, a transfer passage and valve mechanism for transferring fluid from the inlet end of the cylinder to the discharge end, a sealing chamber around the discharge end of the piston, and a port connecting said chamber to the water supply at the end of the transfer stroke.

5. In a condensing system of that class in which the air and uncondensed vapor are drawn off separately from the water, the combination with the condenser, of a horizontal pump having a central valveless air inlet in the upper part of the cylinder connected with the air discharge of the condenser, a central valveless water inlet in the lower part of the cylinder connected with a water supply, a piston adapted to uncover the inlet ports on its movement in one direction and to close the ports on its stroke in the opposite direction, a discharge outlet at the other end of the cylinder, a transfer passage and valve mechanism for transferring fluid from the inlet end of the cylinder to the discharge end, a water pump on the condenser having its piston connected to the vacuum pump piston, and a direct-acting steam engine operating the water pump and vacuum pump pistons.

6. In a surface condensing system of that class in which the air and uncondensed vapor are drawn off separately from the water of condensation, the combination with the condenser, of a horizontal pump having a central valveless air inlet in the upper part of the cylinder connected with the air discharge of the condenser, a central valveless inlet in the lower part of the cylinder connected to the water of condensation discharge and trapped to prevent withdrawal of air or vapor from the condenser with the water of condensation, a piston adapted to uncover said ports on its movement in one direction and to close the ports on its stroke in the opposite direction, a discharge outlet at the other end of the cylinder, and a transfer passage and valve mechanism for transferring the fluid from the inlet end of the cylinder to the discharge end.

7. In a surface condensing system of that class in which the air and uncondensed vapor are drawn off separately from the water of condensation, the combination with the condenser, of a horizontal pump having a central valveless air inlet in the upper part of the cylinder connected with the air discharge of the condenser, a central valveless inlet in the lower part of the cylinder connected to the water of condenser discharge and trapped to prevent withdrawal of air or vapor from the condensation with the water of condensation, a piston adapted to uncover said ports on its movement in one direction and to close the ports on its stroke in the opposite direction, a discharge outlet at the other end of the cylinder, a transfer passage and valve mechanism for transferring the fluid from the inlet end of the cylinder to the discharge end, a water circulating pump for the condenser, and a direct-acting steam engine having its piston connected to the pistons of the circulating pump and vacuum pump.

8. In a condensing system, the combination with the condenser, of a pump having its cylinder provided with a valveless air and water inlet, a piston adapted to uncover said inlet on its movement in one direction and close the inlet on its stroke in the opposite direction, whereby one end of the cylinder forms the inlet end, a valved discharge at the opposite end of the cylinder, and a transfer passage connecting the inlet end of the cylinder with the discharge end.

9. A vacuum pump having a central valveless air inlet, a central valveless water inlet, a piston opening the inlet ports on its movement in one direction whereby one end

of the cylinder forms the inlet end, a valved discharge at the opposite end of the cylinder, and a transfer passage connecting said inlet end and discharge end.

10. A horizontal vacuum pump having a central valveless air inlet, a central valveless water inlet, a piston opening the inlet ports on its movement in one direction whereby one end of the cylinder forms the inlet end, a valved discharge at the opposite end of the cylinder, a transfer passage and valve mechanism connecting said inlet end and discharge end, and an inlet water chamber connected with said liquid inlet ports and provided with means for trapping the water to seal the ports against admission of air.

11. A horizontal vacuum pump having a central valveless air inlet in the upper part of the cylinder, a valveless water inlet in the lower part of the cylinder, a piston opening the inlet ports on its movement in one direction whereby one end of the cylinder forms the inlet end, a discharge at the opposite end of the cylinder, a transfer passage and valve mechanism connecting said inlet end and discharge end, an inlet water chamber at the top of the pump connected with said liquid ports and provided with means for trapping the water to seal the ports against admission of air, a sealing chamber around the discharge end of the piston, and a port connecting said water chamber with the piston sealing chamber at the end of the transfer stroke of the piston.

In testimony whereof, I have hereunto set my hand.

JOHN F. GRACE.