(No Model.)

5 Sheets—Sheet 1.

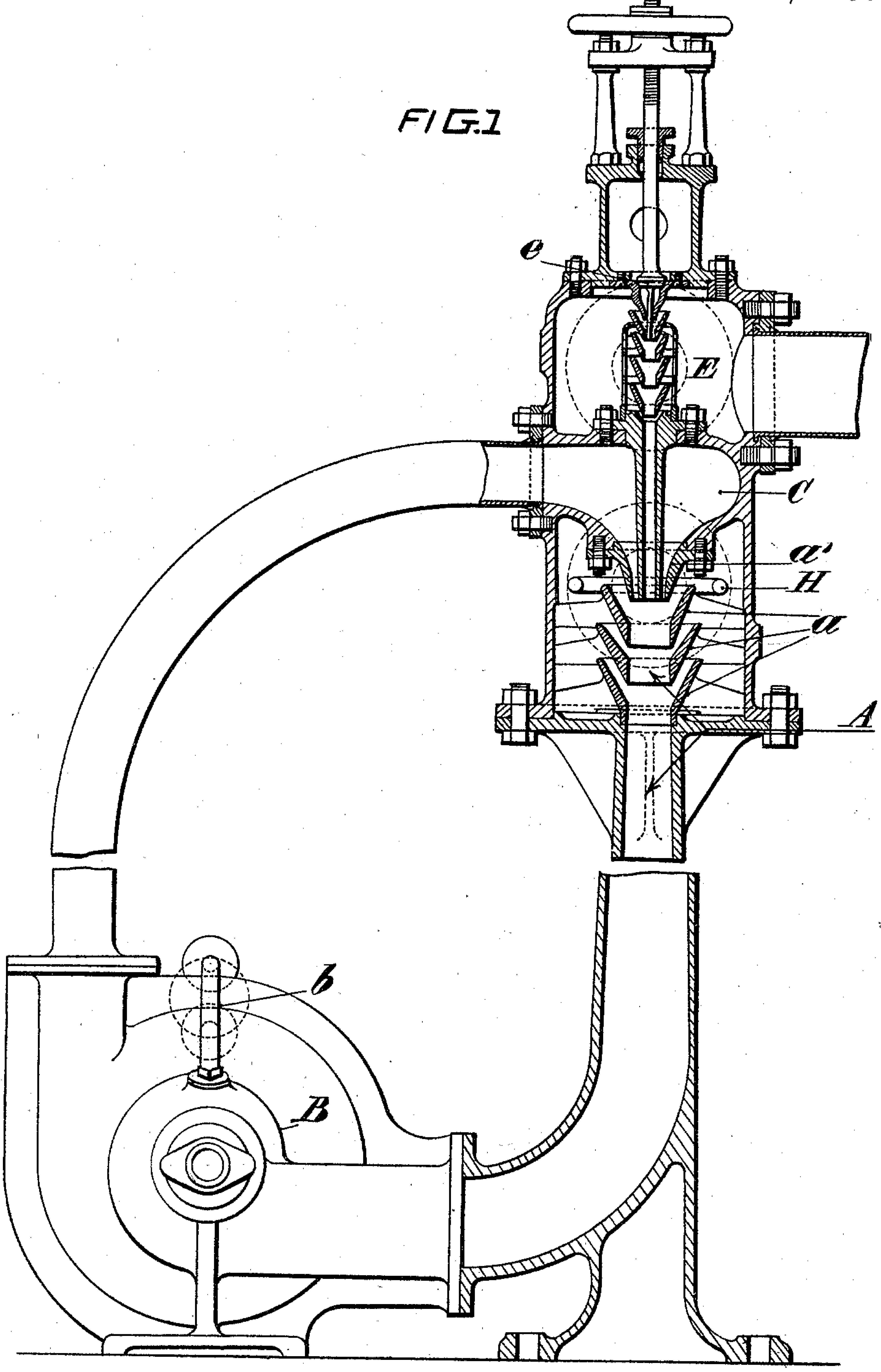
C. A. BOURDON.

EJECTOR CONDENSER EXHAUSTER.

No. 584,767.

Patented June 22, 1897.

FIG.1



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(No Model.)

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C. A. BOURDON.

EJECTOR CONDENSER EXHAUSTER.

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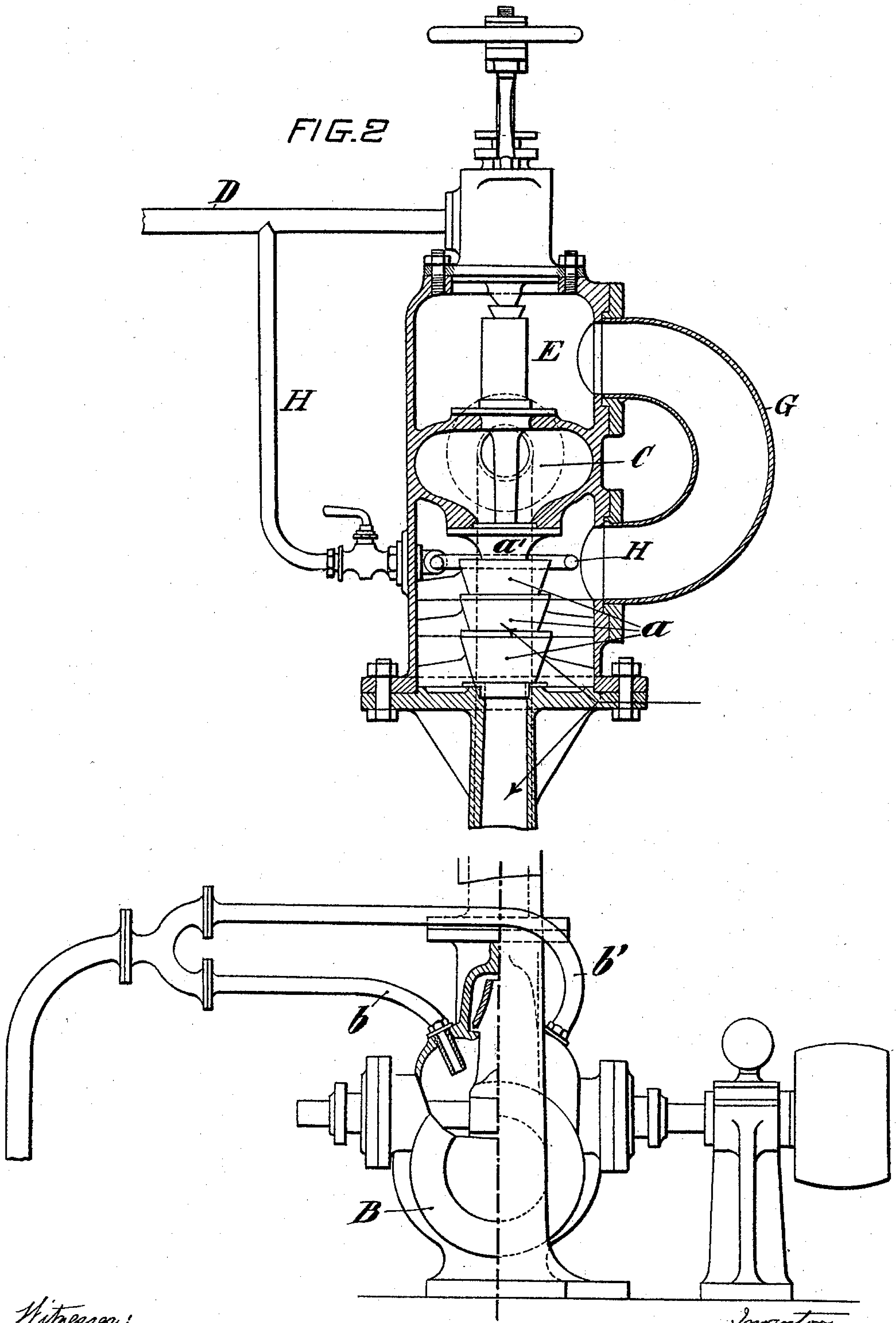
FIG. 2



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C. A. BOURDON.

EJECTOR CONDENSER EXHAUSTER.

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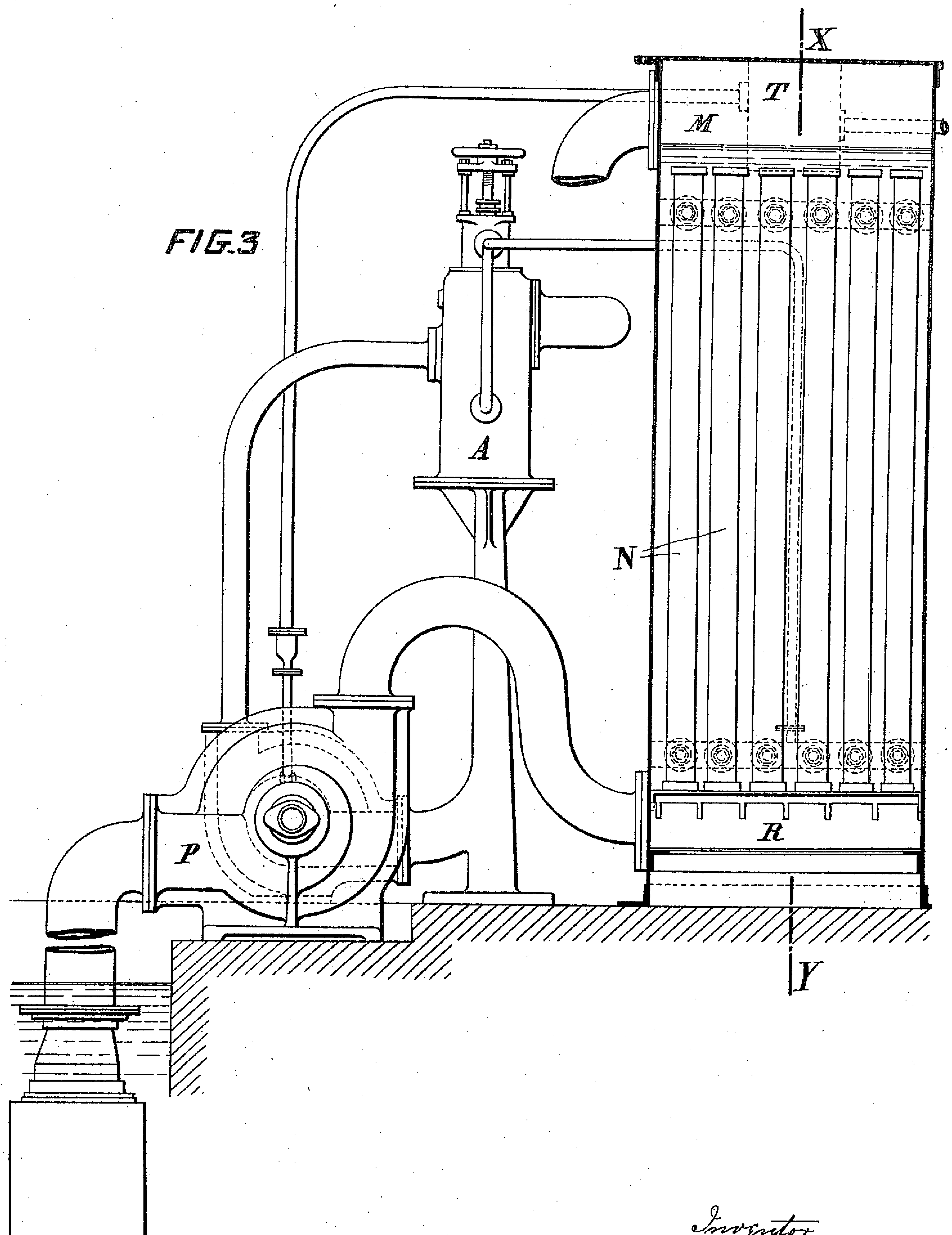
FIG. 3



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(No Model.)

5 Sheets—Sheet 4.

C. A. BOURDON.

EJECTOR CONDENSER EXHAUSTER.

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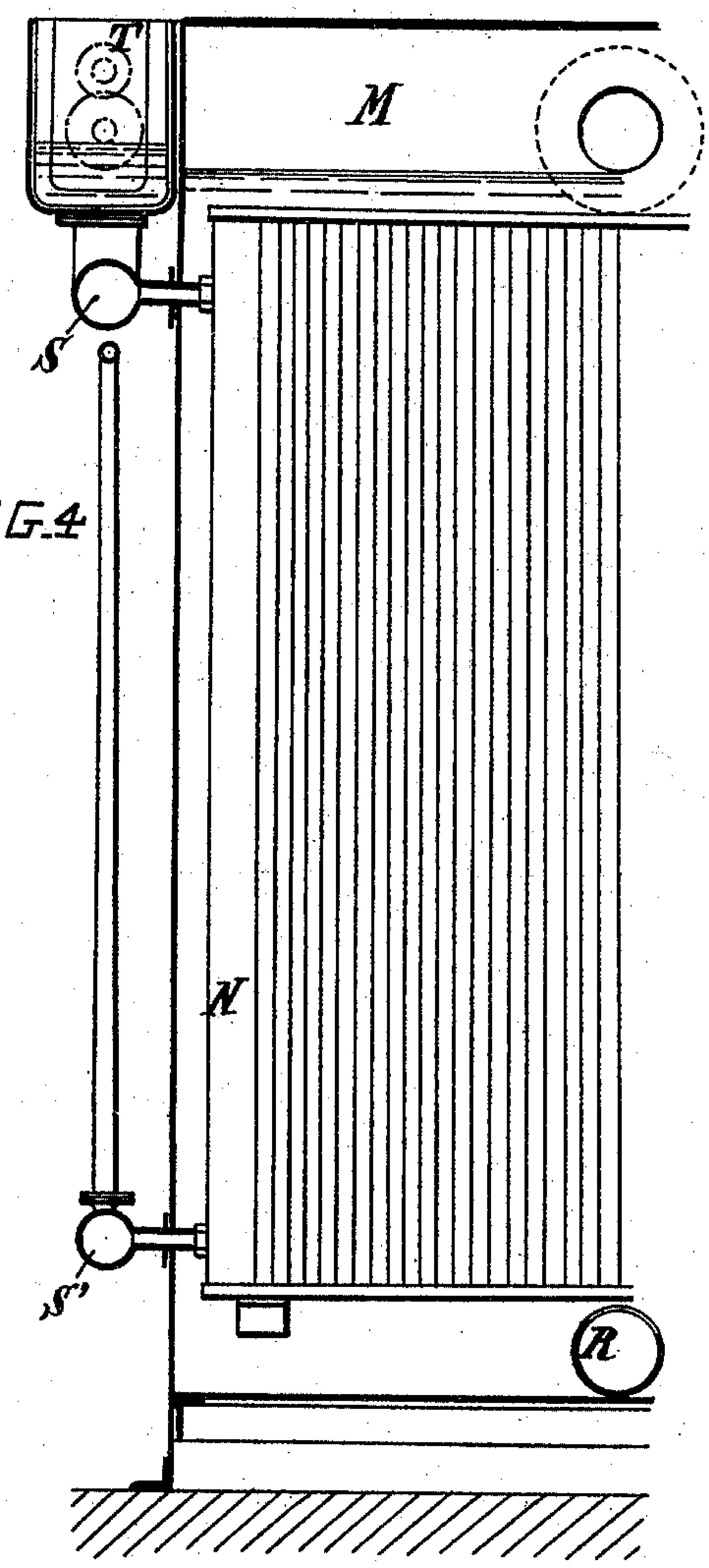

FIG. 4

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C. A. BOURDON.

EJECTOR CONDENSER EXHAUSTER.

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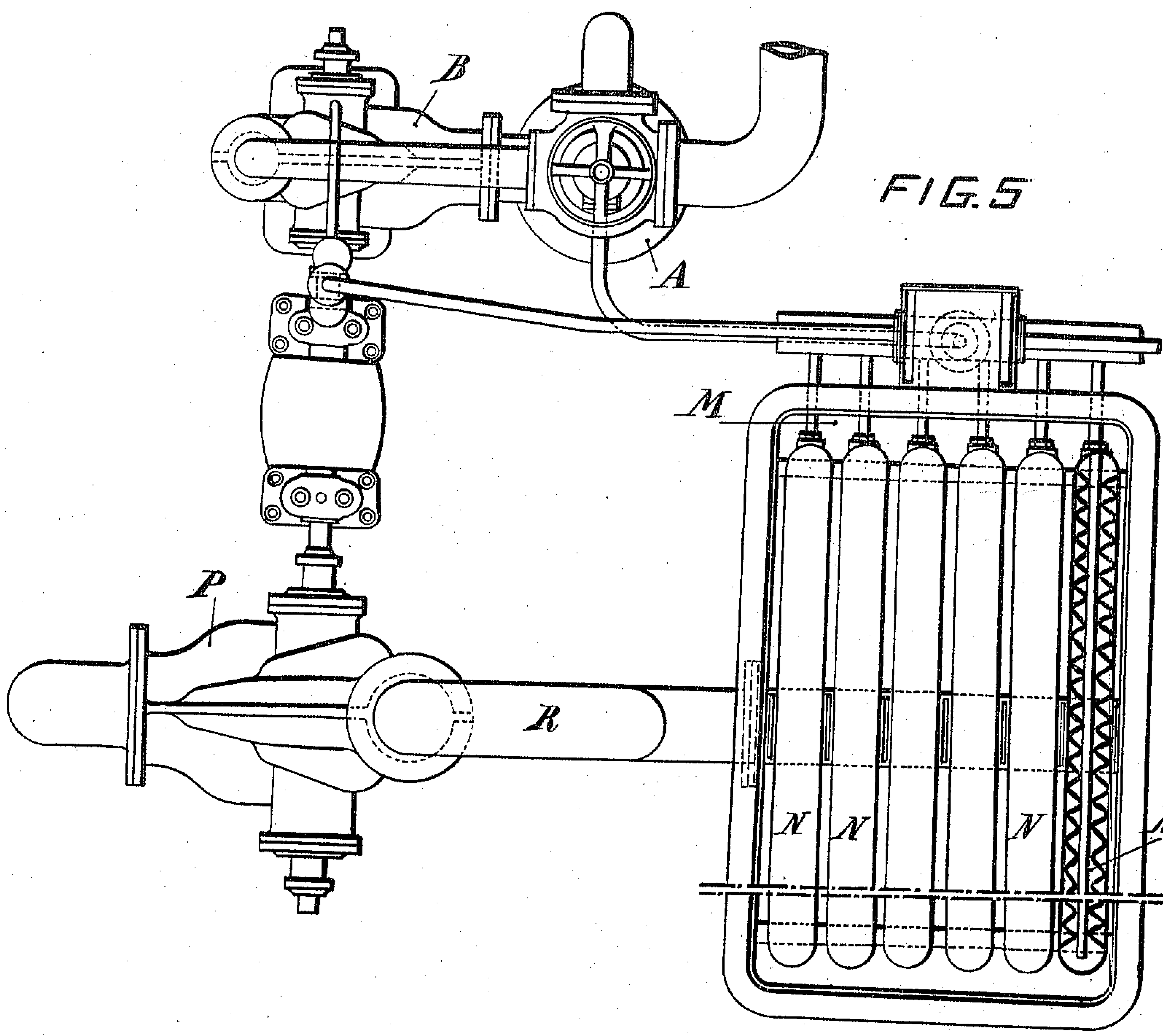
FIG. 5



Witnesses:
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UNITED STATES PATENT OFFICE.

CHARLES ALEXANDRE BOURDON, OF PARIS, FRANCE.

EJECTOR CONDENSER EXHAUSTER.

SPECIFICATION forming part of Letters Patent No. 584,767, dated June 22, 1897.

Application filed February 17, 1897. Serial No. 623,805. (No model.) Patented in France July 18, 1896, No. 258,173.

To all whom it may concern:

Be it known that I, CHARLES ALEXANDRE BOURDON, of the city of Paris, France, have invented an Improved Ejector Condenser Exhauster, (for which I have obtained Letters Patent in France for fifteen years, dated July 18, 1896, No. 258,173,) of which the following is a full, clear, and exact description.

This invention relates to what may be termed an "ejector condenser exhauster" for producing a vacuum in receivers or condensers, and possessing the following advantages: first, low consumption of power; second, reduced expenditure of water; third, absence of parts requiring adjustment or attention, and capability of being at once set in action at any moment, even after prolonged stoppage.

Exhausters and condensers in which the vacuum is produced by the passage at a high velocity of water through a converging and diverging conical nozzle are known, but heretofore the water, whether set in motion by a centrifugal pump or by the effect of the vacuum produced by the condensation of the steam, has always been lost on leaving the ejector. The volume expended is considerable and the water is ejected at a temperature much lower than that which it may without inconvenience attain.

In order to remedy these objections, I have connected the extremity of the diverging cone of the ejector with the suction of a mechanical means of imparting to the mass of water the velocity with which it should pass through the nozzle in order to produce the suction required. By this means the work of aspiration is performed by means of this mass of water, which is caused to circulate mechanically with a considerable velocity in a closed circuit in which the nozzle is situated. The liquid mass therefore returns with its acquired velocity to the mechanical apparatus, which maintains its motion, but which has only to compensate for the loss of pressure produced during one passage through the circuit, so that the motive power absorbed by the apparatus is reduced as far as possible.

It is to be observed also that, this mechanical work of aspiration being performed as efficiently by a current of hot as of cold water, the temperature of the water circulating in the closed circuit may be allowed to rise to a tolerably high degree and absorb a large quantity of steam, and consequently the expenditure of water is less than with the ordinary kind of ejector condenser.

If motion is imparted to the water by means of a centrifugal pump, the mixture of water and aspirated air is, so to speak, turbined in passing through the pump. By the effect of centrifugal force the air tends to remain at the center of the pump while the water is projected to the circumference, so that in order to get rid of the air it is only necessary to connect the central part of the pump with the exterior by means of two pipes opening into the pump at a short distance from the shaft of the pallet-wheel.

If the apparatus is a condenser, a certain quantity of cold water is added continually to the circulating-column by means which will be described in order to prevent the temperature rising beyond to a point at which a sufficiently-high vacuum could not be obtained. The addition of cold water may be effected by injecting it at any suitable point in the delivery-pipe of the centrifugal pump. In working thus a volume of water equal to that added must flow out of the circuit, which it may do by the air-escape pipes.

In the drawings, Figure 1 is a broken-away side elevation of a condenser embodying my invention, the operating parts being shown partly in section. Fig. 2 is a broken-away end elevation of the same, also partly in section. Fig. 3 shows the condenser apparatus and a surface-condenser apparatus in elevation. Fig. 4 is a broken-away detail side elevation of the surface condenser, and Fig. 5 is a plan of the apparatus shown in Fig. 3, partly in section.

Referring now to the accompanying drawings, forming part of this specification, in which Figs. 1 and 2 are sectional views showing in detail the construction of condenser, it will be seen that it consists, essentially, of the converging and diverging conical ejector A and the centrifugal pump B, driven either by a belt or motor at a speed suited to the vacuum to be obtained. The delivery of the pump is connected to the inlet of the converging cone of the ejector, while the mouth of the diverging cone is directly connected to the suction-pipe of the pump.

The double-conical ejector A may be placed either vertically or horizontally, preferably in the former position. From each of the suction-chambers of the pump lead the discharge-pipes b b'. Between the converging cone a' and the inlet to the diverging cone of the ejector A there is a series of conical rings a projecting the one into the other, but with intervening annular spaces at which the steam which condenses in the water and the air to be carried along by the water are drawn in.

The water is delivered by the pump into the chamber C, from the bottom of which leads the converging cone a' of the ejector A. Cold water is supplied to the apparatus by a tube D and may enter into circulation in two ways, either by a second doubly-coned ejector E or by an injection-tube H, from which the cold water is rained down on the chamber of the ejector A, the simultaneous supply in both ways being favorable to the condensation of the steam. E, like A, is a doubly-coned ejector having between the converging and diverging cones a number of conical rings projecting into each other and separated by spaces producing successive aspirations. The supply of water thereto may be intercepted or regulated by means of a valve e, operated by a hand-wheel, the valve being provided with a regulating-needle. The diverging cone of this ejector opens at the center of the smaller end of the converging cone a'—that is to say, at the point where the suction produced by this ejector is greater. The cold water thus enters E at a high velocity due in part to the vacuum produced by the condensation of the steam and in part to the suction produced in the ejector E by the passage into A of the water delivered by the centrifugal pump. From this it will be seen how greatly the aspirating power of the ejector E is increased relatively to that of A by reason of the high velocity of the cold water which traverses it. In this way cold water is caused to enter the circulation of the closed circuit while utilizing the very powerful suction which it is capable of producing and by causing it to condense a large quantity of steam of which its low temperature enables it to absorb the heat. The suction-chambers of the two ejectors are shown as being connected by a tube G.

Thus constructed the ejector condenser may be considered as being formed of two ejectors, whereof A absorbs the air which enters the condenser and all the steam permitted by the temperature of the water passing through the suction-rings of the ejector, while E completes the condensation of the steam to a temperature which is determined by the greater or less quantity of cold water supplied to this second ejector and the temperature of this water.

The second arrangement described for introducing cold water into the ejector condenser consists in projecting the water in the form of rain in the suction-chamber of the ejector A. For this purpose a tube, such as H, may be used, and the water so injected condenses the steam, and the whole is drawn through the ejector A, which at same time draws in the air contained in the condenser. In this case the cold water surrounds, so to speak, the hot water put in circulation by the pump, while in the previous case the cold water after having passed through E entered the center of the jet of hot water circulating in A. This last condition is favorable to condensation, but has the objection of introducing the injection water, as in an ordinary condenser, into the midst of a vacuum, so that the air held in solution becomes disengaged and disseminated in the condenser, from which it must be extracted by the ejector A. As this has a low output, it is of advantage to give it as little work as possible. With the first-described arrangement this disengagement of air from the injection water does not take place in the ejector E. It will be seen that it is easy to utilize simultaneously the two modes described so as to profit by the advantages of both.

It will be seen that with this new apparatus an important economy of motive power is effected, as it will be obvious that the centrifugal pump working in the manner described absorbs less power than the air-pump of an ordinary condenser of which the piston is exposed to atmospheric pressure. The expenditure of water, whether for the simple or compound condensation, is also very much reduced relatively to that required for ordinary condensation.

In order to prevent the return of water to the cylinder when the engine is stopped, it is only necessary to provide on the exhaust-pipe an air-inlet cock which is opened at same time that the steam is shut off from the engine, and as the momentum of the fly-wheel causes the engine to make a few revolutions after the steam-valve is shut the continued exhaustion of the condenser prevents the water entering the cylinder. The action of the condenser commences at the same time as the engine is set in motion.

I will now describe the application of the ejector condenser exhauster to surface condensation.

The reduction which is rendered possible by the ejector condenser in the consumption of water required for the purpose of condensation and the rise of temperature of this water permit of a new combination possessing the advantages of surface condensation—namely, avoiding contact of the condensed steam with the cold water by which the heat of condensation is absorbed.

This apparatus, which I will now describe, is not, properly speaking, a surface condenser, but a mere refrigerating apparatus. It consists, essentially, of a nest of tubes or a series of chambers presenting a large area of surface and into which, by one of their ends, enters the water delivered through the discharge-tubes *b b'* by the centrifugal pump of the ejector condenser above described. Their other end is connected to a pipe whose prolongation is the supply-pipe D of the ejector condenser. The water before entering the chambers has been delivered into a tank which forms a fresh-water reservoir, the transfer of the water thereto permitting the disengagement of the air. These chambers are immersed in a sheet-iron tank, through which a current of cold water is circulated in accordance with the principles of methodical cooling by a centrifugal pump or other means.

The advantages of the arrangement are as follows: The construction of tubular condensers now in use is costly, the tube-plates being of copper and the tubes of tinned brass, the joints between the tubes and plates being expensive and requiring to be made with great care. They are so numerous that it is difficult to insure their being perfectly tight at the pressure of one atmosphere which they are required to withstand when the condenser is under vacuum, and the condenser-shell itself must be of suitable construction to enable it to withstand this pressure.

With the arrangement which I have referred to the chambers and the tank in which they are immersed are merely filled with water and do not support any pressure, so that the joints, if any, are not liable to leak, since there is equilibrium of pressure throughout. The construction of a refrigerator of this kind is very simple and inexpensive, and as regards the condensation it takes place in exactly the same way as was described in respect of the previously-described arrangement, except that the water supplied to the ejector E is always the same and is never in contact with the water used for cooling. This very simple arrangement can hardly be used with jet condensers now in use because the volume of water required for effecting condensation is too great and because this water being ejected at a low temperature the difference of temperature available for the transmission of heat-units is too small. This objection is the more weighty because the coefficient of the transmission of heat from water to water is less than that which corresponds to the transmission from steam to water. For these reasons with ordinary condensation the cooling-surfaces must necessarily be of large area as ultimately to be almost impracticable, whereas with the ejector condenser the dimensions of the apparatus are considerably reduced because the volume of water to be cooled is smaller at the same time that the available difference of temperature between the hot and the cold water determines a more rapid transmission of the heat-units.

Figs. 3, 4, and 5 of the drawings show different views of the arrangements which may be adopted in the construction of a surface condenser according to the principle above set forth. The principal element of this installation is the ejector condenser, as above described, comprising the ejector A and the centrifugal pump B, M being the cooling-tank, in which are immersed a number of chambers N, of galvanized sheet-iron or corrugated copper, presenting a very extended surface sufficient in area for producing the cooling required.

A vigorous and continuous current of the water available for cooling may be maintained through the tank M by a centrifugal pump P, which may be mounted on the same shaft as that of the ejector condenser and driven by the same pulley. This mode of condensation being especially applied to marine engines it may be supposed that a certain quantity of sea-water proportional to the number of heat-units to be absorbed is kept circulating through the tank. It is evident that the area of the cooling-surface and the quantity of water in circulation are two factors which may be varied inversely within wide limits to obtain the same result. Thus the cooling-surface may be small in area and the water in circulation large in quantity, or the area of surface may be large and the quantity of water in circulation small, practice alone showing which are the best proportions to adopt.

In order to insure a good distribution of the cooling-water through tank M, the delivery-pipe R from the pump enters the tank and is provided at its upper side with a number of slits, through which the water is projected into the spaces intervening between the chambers N.

In order to produce a methodical cooling, the water discharged from the ejector condenser enters the chambers N by branch connections at their upper ends and passes out by similar connections at their lower ends.

The inlets and outlets are connected to receiving and distributing pipes S S'. On the pipe S is mounted a tank T, which receives the water discharged by the ejector condenser and allows the contained air drawn in by the ejector to become disengaged while the pipe S' is connected to the fresh-water injection apparatus within the condenser.

The construction of the cooling apparatus may be varied indefinitely, that described being inexpensive and illustrating well the advantages to be gained by this mode of working, which does not necessitate the use of a nest of tubes presenting a multitude of joints.

The ejector condenser exhauster constructed and operating as described in the first part of this specification may be used not only for condensing steam and extracting air from a condenser, but also for merely exhausting air or a gas, or for the propulsion of a liquid.

One of the numerous possible applications is the use for producing a more or less high vacuum in a receiver. In this case it is necessary that the circuit in which the liquid circulates should always be completely full, and it will therefore be necessary to make a small addition of water through a pipe, such as H, or by means of an ejector, such as E, in order to replace that carried off along with the air or gas in escaping at the discharge-pipes b b' of the centrifugal pump.

If only a small volume of gas is required to be carried off under a very diminished pressure, I may profit by the increased suction produced by the ejector E, which would in this case alone be utilized for producing the vacuum, while the ejector A would only serve to increase the velocity of the water which passes through the other. This would enable the velocity of circulation of the closed circuit to be reduced, but it would be necessary to supply at E a considerable quantity of water which would be lost.

The apparatus may be used as an exhauster in gas-works, with the advantage that it would also wash and cool the gas which would pass out at the discharge-pipes b b' of the centrifugal pump.

If the exhaustion is performed in a space in which it is not required to maintain a high vacuum, the forcing power of the apparatus may be utilized to force the gas through the discharge-pipes of the centrifugal pump under a pressure corresponding to the speed of rotation of the pump.

The setting in motion of gaseous masses may also be effected by this apparatus, but less effectually, by causing a constant portion of the gas itself to circulate in the closed circuit by means of a fan.

For the forcing of liquids the construction of the apparatus would be unaltered, and the liquid forced would be that arriving by the tube H or by the ejector E, and the forcing would be produced by a constant mass of this same liquid, which would be put in motion by the centrifugal pump and would circulate continuously in the closed circuit, the discharge or forcing taking place through the tubes b b' of the centrifugal pump.

When using the apparatus as an ejector condenser, it is utilized for forcing air and water simultaneously.

I claim—

The herein-described ejector condenser exhauster for effecting the condensation of steam in jet or surface condensers or for forcing gases and liquids, the said apparatus consisting essentially of an ejector formed of a converging and diverging cone through which a liquid column is by mechanical means kept continuously circulating in a closed circuit provided with discharge-orifices for the evacuation of the gases or liquids exhausted.

The foregoing specification of my improved ejector condenser exhauster signed by me this 5th day of February, 1897.

CHARLES ALEXANDRE BOURDON.

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MAURICE H. PIGNET.