

Jan. 12, 1926.

C. L. A. M. LEBLANC

1,569,760

AIR EJECTOR

Filed Sept. 19, 1922

3 Sheets-Sheet 1

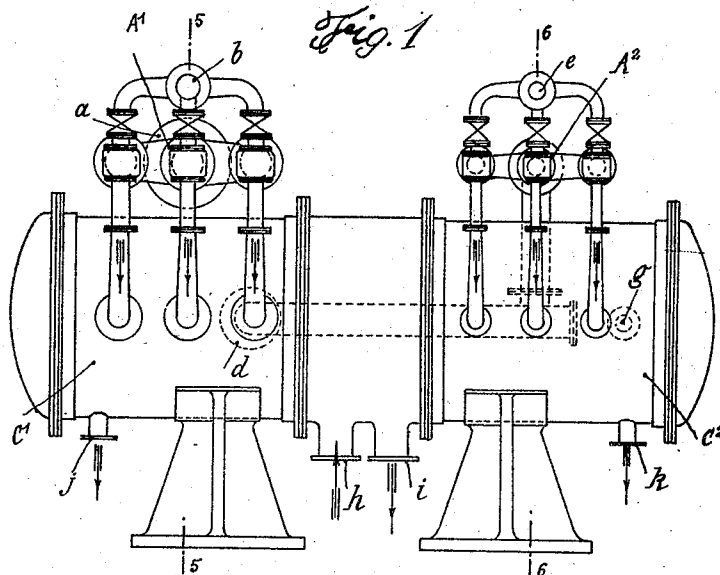
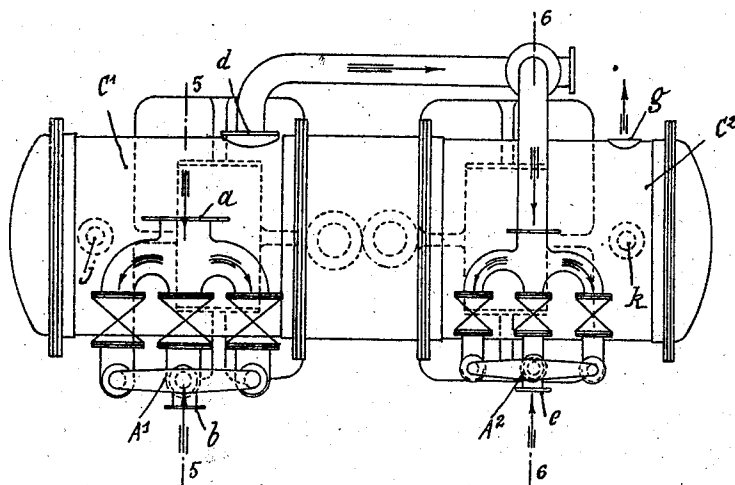


*Fig. 3*



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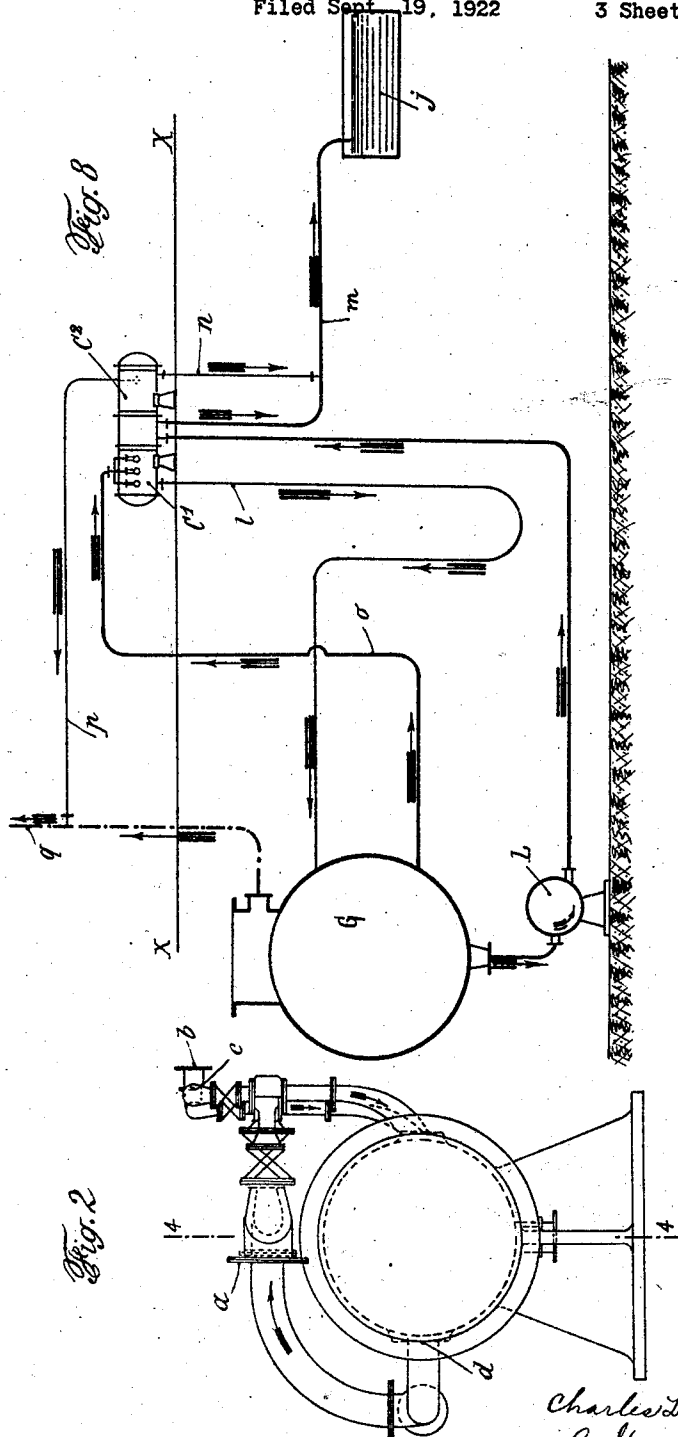
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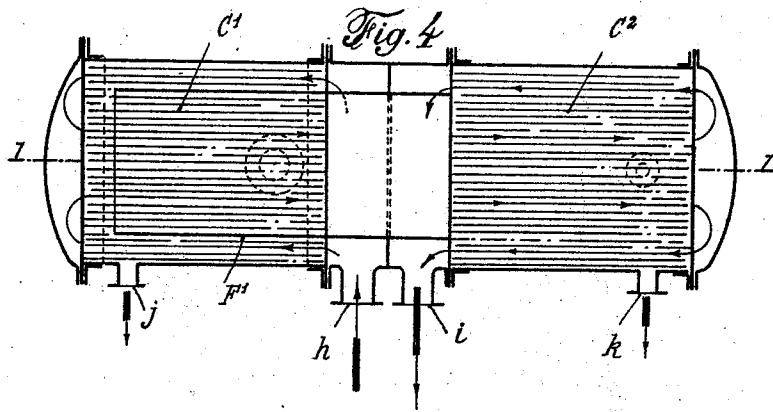
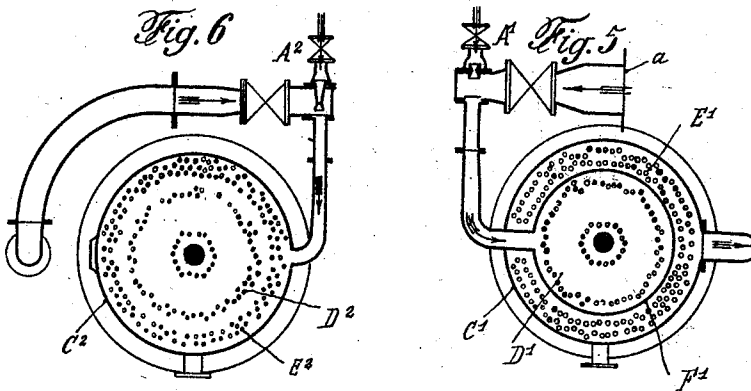
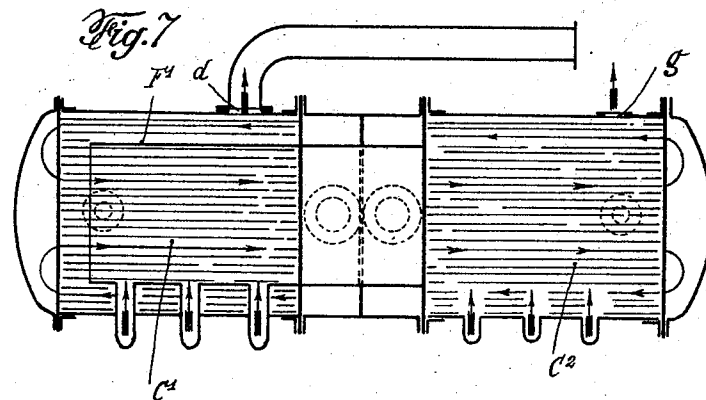
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AIR EJECTOR

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3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE.

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SOCIÉTÉ ANONYME POUR L'EXPLOITATION DES PROCÉDÉS MAURICE LEBLANC-  
VICKERS, OF PARIS, FRANCE.

## AIR EJECTOR.

Application filed September 19, 1922. Serial No. 589,177.

*To all whom it may concern:*

Be it known that I, CHARLES LEONARD ARMAND MAURICE LEBLANC, a citizen of France, and a resident of Paris, France, have invented certain new and useful Improvements Relating to Air Ejectors, which is fully set forth in the following specification.

The present invention relates to a steam operated air ejector of high power and comprising a plurality of sections, more particularly applicable to condensers of large capacity, such as are used with high power steam turbines.

This compound ejector has the following essential characteristics:—

1. The grouping of several sections or elementary ordinary ejectors in two stages upon a single condenser.

2. The constitution of this single condenser by two elementary surface condensers interconnected in series and traversed by the current condensing water, and respectively intended to condense the exhaust steam issuing from the first stage, and that issuing from the second stage.

The compound ejector, object of the present invention, presents the following advantages:—

1. Regulation of the apparent expenditure of live steam in proportion to the weight of air to be extracted, which varies with the rate of working of the plant, and more particularly with the load on the turbine, if a turbine set is concerned.

2. Recovery of the whole of the heat contained in the exhaust steam.

3. Prevention of the carrying over of incondensable gases into the water tank, their admixture with the feed-water for the boilers, and the drawbacks resulting therefrom.

4. Simplification of the lay-out of pipes required for fitting up the plant, which is equivalent to several single apparatus working in parallel.

5. Reheating of the feed water by the twin intermediate condenser, owing to the fact that this latter is located on the delivery pipe from the extraction pump to the water tank.

The following description with reference to the accompanying drawings, which are given by way of example, will make clear the nature and the advantages of the invention.

Figs. 1, 2 and 3 show respectively a side elevation, an end view and a plan of a compound steam ejector with a plurality of sections, constructed in accordance with this invention.

Fig. 4 is a longitudinal section on the line IV—IV of Fig. 2.

Fig. 5 is a cross-section on the line V—V of Figs. 1 and 3.

Fig. 6 is a cross section on the line VI—VI of Figs. 1 and 3.

Fig. 7 is a horizontal section on the line VII—VII of Fig. 4.

Fig. 8 is a general diagram of a plant in which such a compound ejector is applied to the extraction of air from a condenser, for example, of a steam turbine.

As seen the apparatus, object of this invention, comprises essentially two groups  $A^1$  and  $A^2$  of elementary ejectors (three ejectors per group in the example shown) provided with intermediary surface condensers  $C_1$  and  $C_2$  respectively, which are interconnected.

The air is withdrawn, for example from the main condenser, through the connecting branch  $a$  common to the set of first stage ejectors  $A_1$ ; the operative steam is admitted at  $b$  to the ejectors of this stage; after having subjected the air into a first compression, it passes into the corresponding condenser  $C_1$ .

This condenser  $C_1$  is formed of two bundles of tubes  $D_1$  and  $E_1$ , through which the cooling water passes in succession and separated by a partition  $F_1$ , securing a systematic circulation of the steam to be condensed (Figs. 4, 5, 7).

The air, freed from steam, is carried off again at  $d$  and withdrawn by the ejectors  $A_2$  of the second stage group; the operative steam for which is admitted at  $e$ . After doing its work this steam passes into the condenser  $C_2$ , similar to the first condenser  $C_1$  except that it has no partition. The air carried over and compressed a second time escapes into the atmosphere through the connecting branch  $g$ .

The bundles of tubes of the condensers  $C_1$  and  $C_2$  are cooled by the water coming from the extraction pump  $L$  of the main condenser  $G$  (Fig. 8). The stream of water enters at  $h$  and escapes at  $i$ . It traverses the twin condensers  $C_1$  and  $C_2$  in a system-

atic way, being heated first in  $C_1$  by contact with the steam from the first stage, and then in  $C_2$  by contact with the steam from the second stage (Figs. 1 to 7).

5 The condensation of the steam in the condensers  $C_1$  and  $C_2$  is systematic, and effected on the contraflow principle. The steam coming from the ejectors thus reaches the tubes traversed by the least cold water; this is why the escape from the first stage elementary ejectors  $A_1$  enter the inner tubes  $D_1$  of the condenser  $C_1$  whilst the escape from the second stage elementary ejectors  $A^2$  enters the outer tubes  $E^2$  of the condenser  $C_2$ .

10 The condensate in  $C_1$  returns to the main condenser  $G$  (Fig. 8) through a  $U$  tube  $l$ , attached to the branch  $j$ ; the steam condensed in  $C_2$  is drawn off through the branch  $k$  which is connected to the lowest point of the delivery pipe  $m$  to the water tank  $J$ .

Owing to the plurality of members it is possible, once the turbine has been started up and reached its normal working, to shut the steam admission valves on one or more members of the compound ejector, and thus to obtain an economy in consumption.

25 It is to be noted, in fact, that the quantity of air to be extracted decreases on load, and consequently also the strictly necessary expenditure of steam.

The arrangements made on the other hand allow of the complete recovery of heat units since both the exhaust steam of the second stage  $A_2$  and of the first stage  $A_1$ , is condensed by heat exchange through the tubes of the twin condenser  $C_1$   $C_2$ , and since the cooling water carries off the water tank  $J$  the whole of the heat contained in this steam.

40 The only loss is that caused by the return to the main condenser  $G$  of the condensate from the exhaust steam from the first stage  $A_1$ . This loss is unimportant, since it is numerically equal, per kilogramme of steam used in the first stage, to the difference of temperature between the main condenser  $G$  and the intermediate condenser  $C_1$  of the ejector, and thus amounts to about 15 calories.

The surface condensation of the exhaust steam from the second stage  $A_2$  of the tubes prevents the carrying over of the extracted air to the water tanks and consequently the serious drawbacks which are caused for the boilers by this carrying over.

55 Finally the compound ejector with a plurality of sections serves the same purpose as several ordinary apparatus working in parallel, in particular it completely assures the working of the plant to which it is attached in the case of the breakdown of any one of the sections.

This advantage is obtained by means of a simple lay-out for erection as shown in

the diagram, Fig. 8, which permits of obviating the complicated system of pipes necessitated by the usual plan.

In Fig. 8,  $X-X$  is the floor line of the engine room,  $G$  the main condenser,  $L$  the extracting pump,  $l$  the  $U$  tube acting as draw off for the first stage condenser  $C_1$ ,  $J$  the feed water tank,  $m$  the feed water return pipe,  $n$  the draw off for the second stage condenser  $C_2$ ,  $o$  the air suction pipe into the main condenser  $G$ ,  $p$  the air escape pipe from the twin condenser  $C_1$   $C_2$  and  $q$  the escape to the atmosphere.

The operation of the compound ejector with a plurality of sections as applied for example to a steam turbine condenser is as follows:—

1. Admission of live steam to all the second stage ejectors  $A_2$ . During this period, the steam exhausts to the atmosphere.

2. When the vacuum in the main condenser  $C$  reaches about 600 mm. the turbine is started up, and then the condensing plant i. e., the pump  $L$ . The twin condenser  $C_1$   $C_2$  of the ejector is then traversed by the cooling water.

3. Admission of live steam to all the ejectors of the first stage  $A_1$ .

4. When the vacuum in the main condenser  $G$  reaches its maximum, simultaneous closing of first stage and second stage steam valves of one or more sections of the ejector, according to the weight of air to be extracted.

As follows from the explanation already given, the compound steam operated ejector the object of this invention conduces to the following advantages:—

1. Regulation of the apparent expenditure of live steam in proportion to the weight of air to be extracted, which varies with the rate of working of the plant, and more particularly with the load on the turbine, if a turbine set is concerned.

2. Recovery of the whole of the heat contained in the exhaust steam.

3. Prevention of the carrying over of uncondensable gases into the water tank, their admixture with the feed water for the boilers, and the drawbacks resulting therefrom.

4. Simplification of the lay-out of pipes required for fitting up the plant, which is equivalent to several single apparatus working in parallel.

5. Reheating of the feed-water by the twin intermediate condenser, owing to the fact that this latter is located on the delivery pipe from the extraction pump to the water tank.

It is to be understood that the arrangements which have been given by way of example in no way limit the invention, and that modifications may be made therein without going outside its ambit.

Especially it is obvious that the funda-

mental principle underlying the invention may be applied to a plant the exhaust steam from which would be condensed at the second stage by mere bubbling through the water tank, and at the first stage by admixture in an injector condenser. However, in the former case the benefit of eliminating air would be lost, and in the latter case that of complete recovery.

What I claim is:—

1. The combination with a main condenser of an air extractor including two stages of steam ejectors mounted in series, each of said stages including a plurality of ejectors mounted in parallel, means for supplying steam to either or both of said ejector stages, a first auxiliary condenser associated with one of said ejector stages and comprising concentric bundles of water tubes, a partition separating said bundles of tubes, means for directing water from said main condenser through the outer bundle of water tubes and thence through the inner bundle of water tubes, means for directing steam from said first stage of ejectors into the inner bundle of water tubes and thence to the outer bundle of water tubes, a second auxiliary condenser associated with the other of said ejector stages and comprising two concentric bundles of water tubes, means for directing water from said first condenser to the inner bundle of tubes of said second condenser and thence to the outer bundle of tubes of said second condenser and means for directing steam from the other stage of steam ejectors into the outer bundle of water tubes of said second condenser.

2. The combination with a main condenser of an air extractor including two stages of steam ejectors mounted in series, each of said stages including a plurality of ejectors mounted in parallel, means for supplying steam to either or both of said ejector stages, a first auxiliary condenser associated with one of said ejector stages and comprising concentric bundles of water tubes, a partition

separating said bundles of tubes, means for directing water from said main condenser through the outer bundle of water tubes and thence through the inner bundle of water tubes, means for directing steam from said first stage of ejectors into the inner bundle of water tubes and thence to the outer bundle of water tubes, a second auxiliary condenser associated with the other of said ejector stages and comprising two concentric bundles of water tubes, means directing water from said first condenser to the inner bundle of tubes of said second condenser and thence to the outer bundle of tubes of said second condenser, means for directing steam from the other stage of steam ejectors into the outer bundle of water tubes of said second condenser, the tubes of said second auxiliary condenser forming prolongations of the tubes of the first condenser and a common casing surrounding said auxiliary condensers.

3. The combination in an air extractor of two steam ejector stages connected in series, two sets of condenser tubes disposed in line within a common casing, and plates for each of said sets of tubes, a cylindrical partition separating one of said sets of tubes into two bundles and extending from a point adjacent the outer end plate of said set of tubes to the inner end plate of the other set of tubes, an annular partition between said sets of tubes, a water inlet between said first set of tubes and said annular partition, a water outlet between said second set of tubes and said annular partition, means for directing steam from one of said ejector stages to the bundle of tubes within said cylindrical partition, an outlet for uncondensed gases from said first set of tubes, means for admitting steam from said second ejector stage to the other set of tubes and an outlet for said steam.

In testimony whereof I have signed this specification.

CHARLES LEONARD ARMAND MAURICE LEBLANC.