E. S. G. REES.

ROTARY CONDENSER AND CONDENSING STEAM TURBINE.

APPLICATION FILED JUNE 22, 1907.

1,000,195. Patented Aug. 8, 1911.

3 SHEETS—SHEET 1.

Fig. 1.

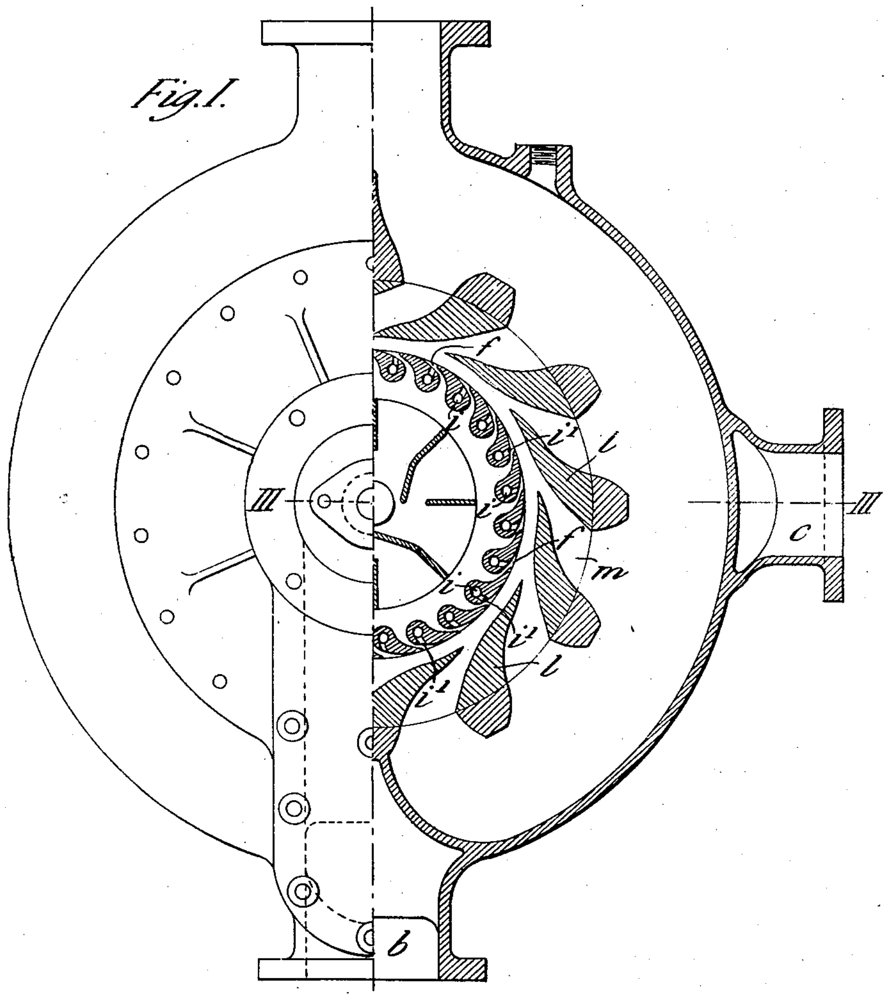
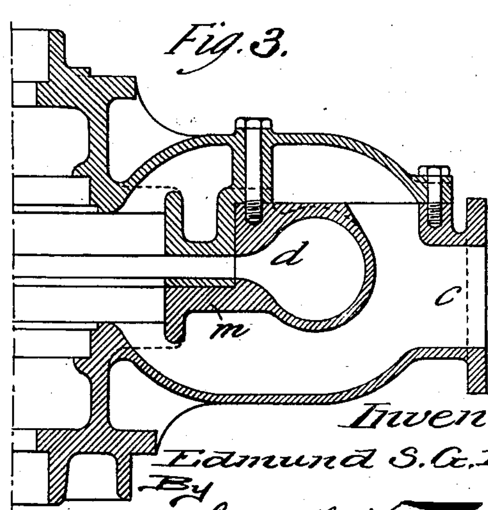


Fig. 3.



Witnesses:

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3 SHEETS—SHEET 2.

Fig. 4.

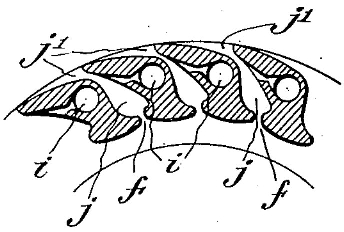


Fig. 5.

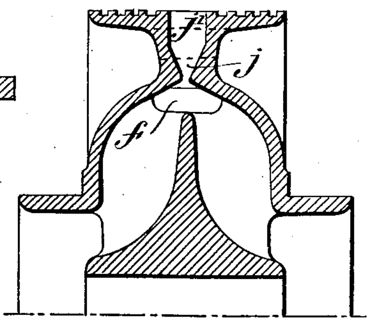


Fig. 2.

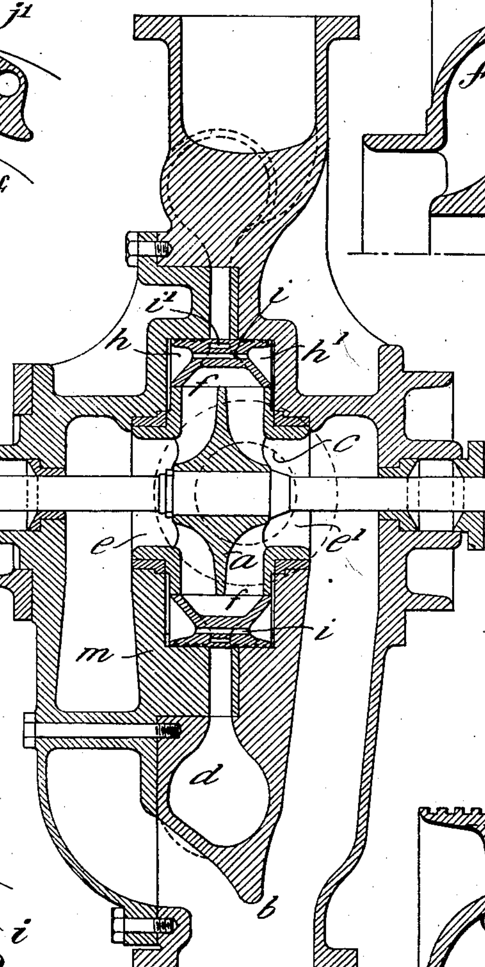


Fig. 6.

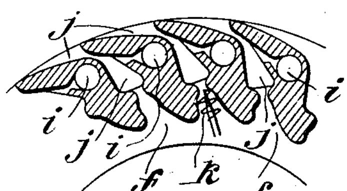
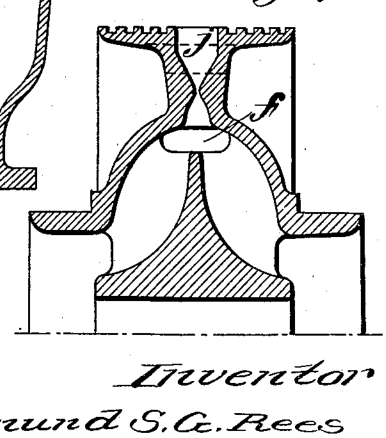


Fig. 7.



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3 SHEETS—SHEET 3.

Fig. 8.

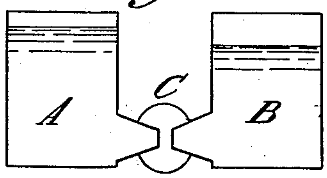


Fig. 9.

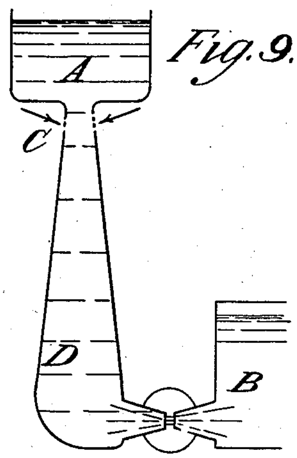


Fig. 10.

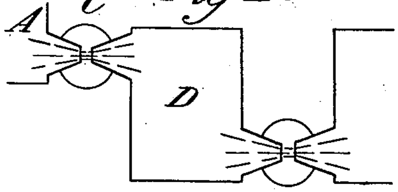


Fig. 11.

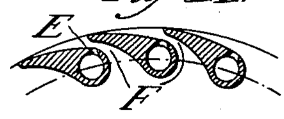


Fig. 12.

Fig. 11a.

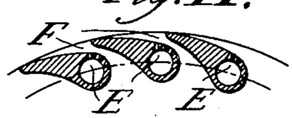


Fig. 12a.

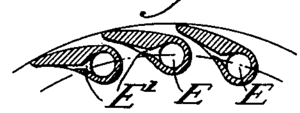


Fig. 13.

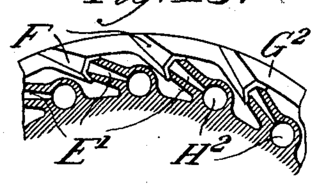
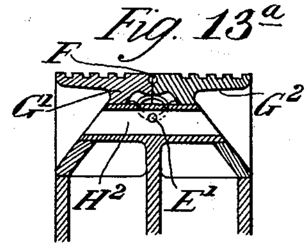


Fig. 13a.



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UNITED STATES PATENT OFFICE.

EDMUND SCOTT GUSTAVE REES, OF WOLVERHAMPTON, ENGLAND.

ROTARY CONDENSER AND CONDENSING STEAM-TURBINE.

1,000,195. Specification of Letters Patent. **Patented Aug. 8, 1911.**

Application filed June 22, 1907. Serial No. 380,347.

To all whom it may concern:

Be it known that I, Edmund Scott Gustave Rees, a subject of the King of Great Britain and Ireland, residing at Thomas Parker Limited and the Rees Roturbo Development Syndicate Limited, of Wolverhampton, in the county of Stafford, England, managing director, have invented certain new and useful Improvements in Rotary Condensers and Condensing Steam-Turbines, of which the following is a specification.

This invention relates to an improved construction of rotary condensers and self-condensing steam turbines which is characterized by the steam or other condensable gas and the condensing liquid being mixed or at any rate brought together in a common stream before leaving the impeller of the rotary pump or the turbine wheel, this admixture being effected by the action of an impeller of the kind described in the co-pending U. S. application Serial No. 334456 in which a mass of liquid contained in an internal reservoir in the impeller is maintained by the rotation of the latter at a considerable pressure which is utilized to impart a velocity to the streams of fluid issuing from the reservoir which is distinct from the tangential velocity due to the rotation of the impeller, this velocity being produced by means of a series of short peripheral nozzles, preferably rearwardly directed, leading from the reservoir to the periphery of the impeller, which nozzles are of small width transversely, that is, in the direction of the axis of the impeller, compared with the width of the latter, and also of small width in the circumferential direction at the point of maximum constriction, so that the sum of the areas of all the nozzles at this point is a small fraction of the circumferential area of the reservoir from which they lead. The steam is admitted to the stream or streams of liquid within the impeller at a point of reduced pressure, that is to say at a point at which the pressure of the liquid is reduced by conversion into velocity in suitably constricted channels, which may either be the peripheral discharge nozzles or other passages within the impeller. Finally the pressure of the mixed stream is raised to the pressure of discharge by leading it through suitable expanding passages usually formed partly in the impeller and partly in an external casing, or by leading the mixture to a part of the rotating vessel at a greater distance from the axis of rotation.

To these and other ends the invention consists in certain improvements and combinations and arrangements of parts, all as will be hereinafter more fully described and pointed out particularly in the claims at the end of the specification.

In the accompanying drawings, Figure 1 is a side elevation, partly in section of a complete condensing turbine constructed in accordance with the present invention. Fig. 2 is a vertical transverse section of the turbine shown in Fig. 1. Fig. 3 is a section on line III—III of Fig. 1. Figs. 4 and 5 are detail sectional views of impellers wherein the steam and water meet within chambers external to the common pressure reservoir but within the ring of the impeller discharge nozzles. Figs. 6 and 7 represent axial sections of the construction shown respectively in Figs. 4 and 5. Figs. 8, 9 and 10 are diagrams illustrating graphically the principles utilized in pumps and turbines constructed in accordance with the present invention. Figs. 11 and 11[a] are detail views in section, showing nozzles that are particularly adapted for use in condensers wherein the steam or other gas to be condensed is introduced to the water at a pressure not exceeding greatly that of the water. Figs. 12 and 12[a] are detail sectional views of nozzles especially adapted for use on condensing turbines. Figs. 13 and 13[a] are detail views in section showing a novel construction of nozzles adapted for use either on condensers or turbines.

It will be understood that an external casing with cut-waters and expanding passages, such as shown in Figs. 1, 2 and 3 is used in conjunction with the various modified constructions of impellers and nozzles herein described and illustrated, but that it has not been considered necessary to illustrate this casing in every figure of the drawings, some of which show no impeller or the impeller in part only.

The principles underlying the invention can be illustrated by reference to Figs. 8, 9 and 10 of the accompanying drawings, in which Fig. 8 shows a reservoir A containing condensing liquid under pressure due to gravity, which pressure is partially converted into velocity at the interrupted nozzle C and the velocity again converted into pressure in the chamber B. The condensable gas being usually at a higher pressure than the liquid at the interrupted nozzle is drawn into the liquid stream at that point, or it may be admitted thereto through suitable nozzles which impart a high velocity to the gas and direct it into the liquid stream so as to increase the velocity thereof.

In Fig. 9 the liquid passage is not completely interrupted at the point C where the steam is admitted, and the velocity of the mixed stream is converted into pressure by being led through an expanding passage to a lower part D of the same reservoir. The mixed stream is delivered through discharge nozzles to suitable expanding ducts leading to the discharge tank or reservoir B.

In the diagram of Fig. 10 the increased flow of condensing liquid and the consequently increased vacuum at the nozzle C is obtained by means of a second chamber D which is closed and is at a lower level than the chamber A, which chamber D in conjunction with the expanding ducts into which it discharges acts by suction so as to increase the flow of liquid past the first constriction and consequently reduce still further the pressure at that point.

In the case of a condenser or condensing turbines operating in accordance with the present invention, instead of producing the pressure in the condensing liquid by gravitation, as in the above illustration, the pressure is created by means of a rotary pressure producing chamber or impeller of the character described in the specification above referred to, in which the discharge outlet of the impeller consists of a series of peripheral nozzles preferably rearwardly directed.

In the case of a condenser, when the condensable gas is at a pressure which does not greatly exceed that of the water at the mixing point, the gas passage or passages E would contract to the point of junction with the liquid passage F, as shown diagrammatically in Figs. 11, 11ª, and in the case of a condensing turbine when the pressure of the gas is considerable, its potential energy is extracted by conversion into kinetic energy on its passage through the discharge nozzles, and for this purpose the steam passages E are made after the well known Delaval type and are directed with the water stream and against the direction of rotation of the pressure chamber as shown in Figs. 12, 12ª and 13.

Fitting a steam nozzle of this character into the water discharge nozzles, it will be seen that for a condenser the steam discharge nozzle will be cut off at the point of maximum constriction as shown diagrammatically in Fig. 11 at E, and will be directed substantially toward the point of maximum constriction of the water channel F, while in the case of a turbine the steam expansion nozzle will include a greater or less length of outwardly flaring passage E′ which is directed rearwardly into the water stream as shown diagrammatically in Figs. 12 and 12ª.

Instead of a single duct nozzle as shown at Fig. 11 the nozzle may be subdivided into a number of ducts as in the ordinary ejector condenser fed from a tank, as shown in Fig. 11ª.

In Figs. 13, 13ª, a constructional form of steam and water nozzle is shown which may be applied either to condensers or turbines, and the advantage of which is that, being circular in section, both the water nozzles F and the steam nozzles E may be drilled out, the water nozzles being formed in two half rings G′, G^2 which are afterward bolted together and are arranged to be held in position partly by the laterally extending steam ducts H^2 in which the steam nozzles are formed. As shown in the drawings the steam nozzles E are expanding nozzles adapted for a turbine and are coaxial with the water nozzles.

The above mentioned or other suitable arrangements of nozzles may be applied to the various forms of improved apparatus hereinafter described, the drawings illustrating which are for the most part to be regarded merely as diagrammatic and not as exhibiting the actual constructional details.

Figs. 1, 2 and 3 are respectively a transverse sectional elevation, a longitudinal section, and a part section on line III—III of Fig. 1 of a complete rotary condenser constructed according to the present invention in which the pressure producing chamber which is of large capacity, that is to say, the area of the body of the impeller is large compared with the area of the outlet therefrom, so that the velocity of the fluid entering at its eye or inlet is less than that of the fluid issuing at its outlet or nozzle, is equally divided into two compartments by a central partition *a* and the water and steam are both admitted to the two sides of the partition so as to balance end thrust of the shaft in the known manner. The water from the suction pipe *b* enters the two compartments of the impeller at the two opposite inlets or eyes *e e′* while the steam is taken through the pipe *c* to two opposite annular steam spaces or chambers *h h′* which are connected by transverse ducts *i* in the peripheral blades which form the water discharge nozzles *f* of the impeller, and the walls of which are pierced to form nozzles as shown at *i′* to connect the ducts *i* with the discharge nozzles *f* at or about the point of maximum constriction of the latter. From this point the water and steam more or less completely condensed pass on together in a common stream which is discharged through the expanding passages formed by the cut waters *l* of the fixed casing *m* into the common delivery chamber *d*.

To maintain the condenser vacuum, the water may, as shown in Figs. 4, 5, 6 and 7, be projected in jets or sprayed into the various mixing compartments of an external chamber *j* within which it encounters the steam from the steam nozzles *i* and by condensation produces and maintains the condenser vacuum, the mixed streams of condensed and uncondensed steam and water being discharged through common peripheral discharge nozzles *j'* into the expanding ducts of the outer casing not shown in these figures. In Figs. 5, 7, the water passages *f* are fitted with spiral distributers *k* to give a rotary motion to the issuing jets of water in the known manner so as to facilitate the admixture of the water with the steam in the mixing compartments *j*.

In each of the constructions above described whether in the case of a rotary condenser pure and simple or in the case of a condensing turbine, it will be noted that a mass of condensing liquid is raised to a considerable pressure by rotation of a containing reservoir, and this pressure is in part converted into velocity by means of a suitably formed outlet or outlets from the pressure producing chamber or reservoir thereby reducing the pressure locally by what may be called the Venturi effect in the manner well known in connection with the Venturi water meters so as to enable the condensable or uncondensable gases to be efficiently discharged into and mixed with the condensing liquid, and the reduction of pressure necessary for this purpose may be assisted by preliminary jet condensation in steam and water mixing chambers in front of the Venturi constriction or nozzles.

Having thus described the nature of my said invention and the best means I know of carrying the same into practical effect, I claim:

1. In a rotary condenser or condensing turbine, the combination with a casing, of an impeller of large capacity so that the area of its body is large compared with the area of its outlets, the said impeller having an inlet connected with a supply of liquid and an outlet consisting of a series of constricted peripheral nozzles of small width both transversely and circumferentially at the point of maximum constriction adapted to reduce pressure of the liquid locally and to discharge the liquid into the casing in directed streams, a chamber within the casing and external to the impeller connected with a supply of condensable fluid, and ducts connecting said chamber with the interior of the peripheral discharge nozzles, substantially as described.

2. In a rotary condenser or condensing turbine, the combination with a casing, of an impeller of large capacity so that the area of its body is large compared with the area of its outlets, the said impeller having an inlet connected with a supply of liquid and an outlet consisting of a series of constricted rearwardly directed peripheral nozzles of small width both transversely and circumferentially at the point of maximum constriction adapted to reduce the pressure of the liquid locally and to discharge the liquid into the casing in directed streams, a chamber within the casing and external to the impeller connected with a supply of condensable fluid, and ducts connecting said chamber with the interior of the peripheral discharge nozzles, substantially as described.

3. In a rotary condenser or condensing turbine, the combination with a casing, of an impeller of large capacity so that the area of its body is large compared with the area of its outlets, the said impeller communicating with a supply of liquid and having a series of peripheral discharge nozzles provided with intermediate constricted portions adapted to reduce the pressure of the liquid locally, a steam chamber inside the casing and external to the impeller, and steam discharge nozzles communicating with the said steam chamber and leading into the liquid at the region of reduced pressure, substantially as described.

4. In a rotary condenser or condensing turbine, the combination with a casing, of an impeller of large capacity so that the area of its body is large compared with the area of its outlets, the said impeller being connected to a supply of condensing liquid and having a series of constricted and rearwardly directed peripheral discharge nozzles of small width both transversely and circumferentially at the point of maximum constriction and adapted to reduce the pressure of the liquid locally, a steam chamber external to the impeller, and steam nozzles communicating with the said chamber and discharging into the liquid at the region of reduced pressure and substantially in the same direction as the liquid stream.

5. In a rotary condenser or condensing turbine, the combination with a casing, of an impeller of large capacity so that the area of its body is large compared with the area of its outlets, the said impeller being connected to a supply of condensing liquid and having a series of constricted peripheral discharge nozzles adapted to reduce the pressure of the liquid locally, mixing chambers in front of the discharge outlets of the nozzles, means for admitting steam to the said mixing chambers, and means for projecting the condensing liquid in jets into the said chambers.

6. A rotary condenser or condensing turbine, comprising an impeller having an in-

ternal reservoir of large capacity in which a body of condensing liquid is maintained under pressure by centrifugal force, discharge outlets leading from the said reservoir to the impeller rim, said outlets having constricted portions which are small in width both transversely and circumferentially, a fixed casing surrounding the impeller and inclosing a steam space external to the impeller, and steam ducts connecting the said steam space with the interior of the impeller discharge outlets, whereby the steam is mixed with the condensing liquid within the impeller and is discharged therewith through the impeller outlets into the fixed casing.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

EDMUND SCOTT GUSTAVE REES.

Witnesses:
JOSEPH MILLARD,
WALTER J. SKERTEN.