J. KARRER.

STEAM TURBINE.

APPLICATION FILED MAR. 1, 1909.

930,766.

Patented Aug. 10, 1909.

3 SHEETS—SHEET 1.

Fig. 1.

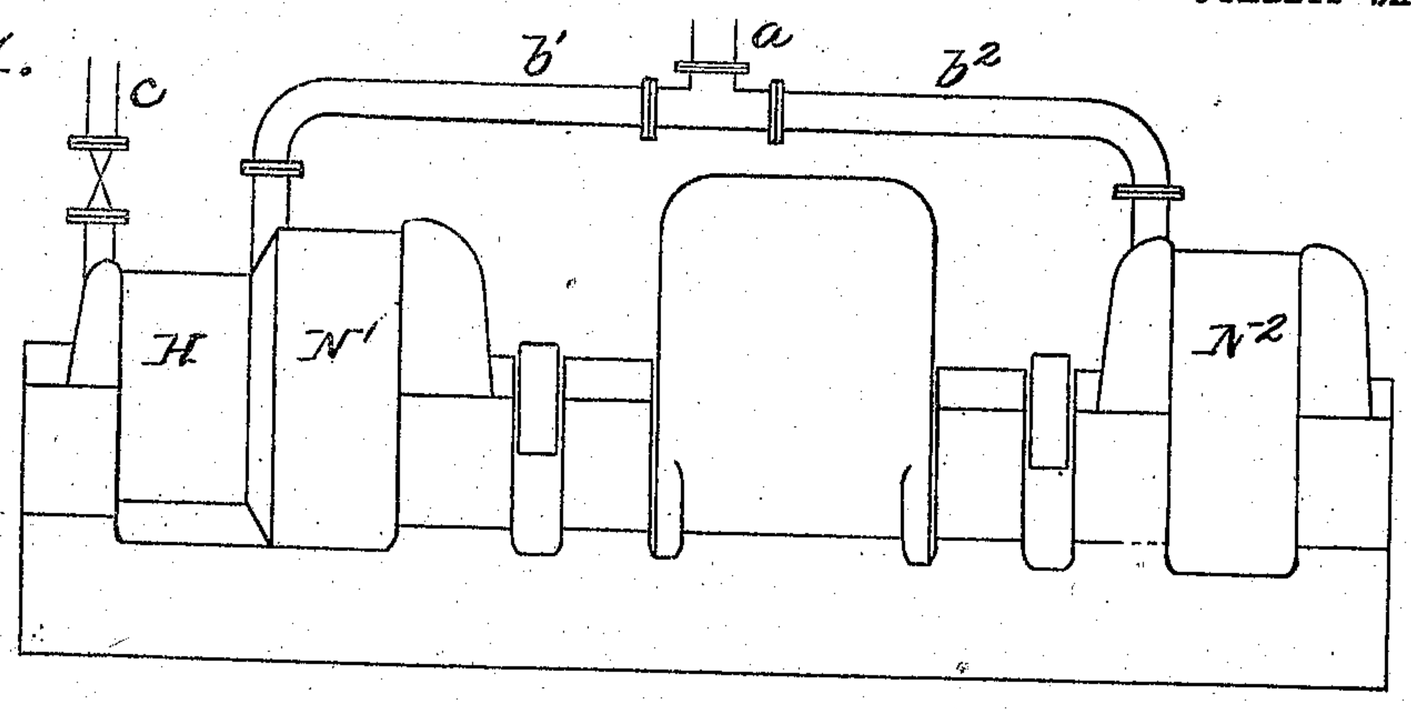

Fig. 2.

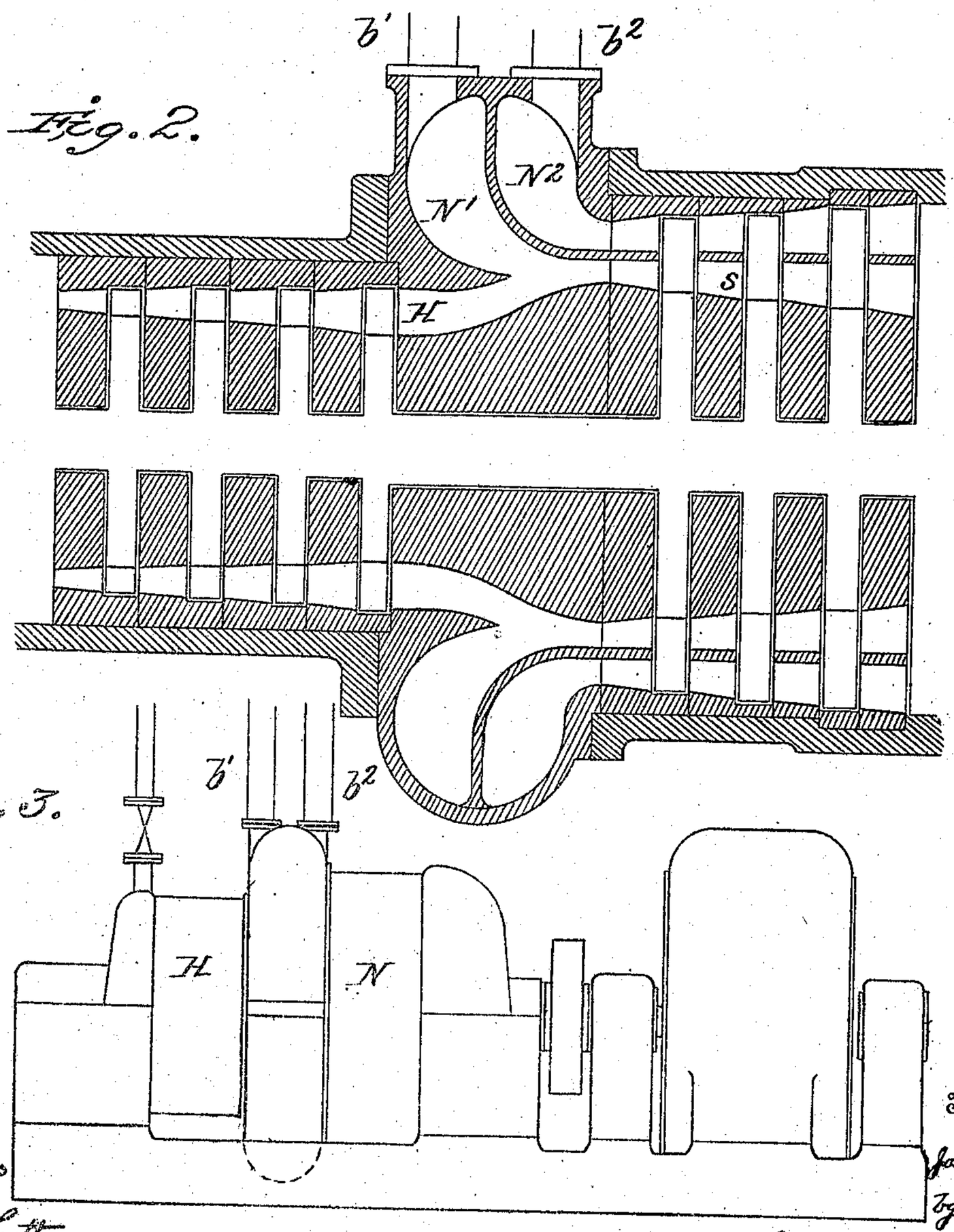

Fig. 3.

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3 SHEETS—SHEET 2.

Fig. 6.

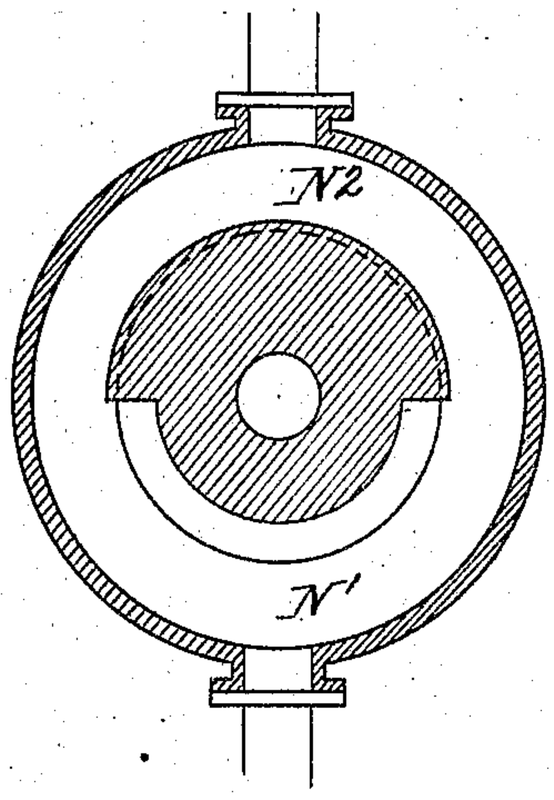


Fig. 7.

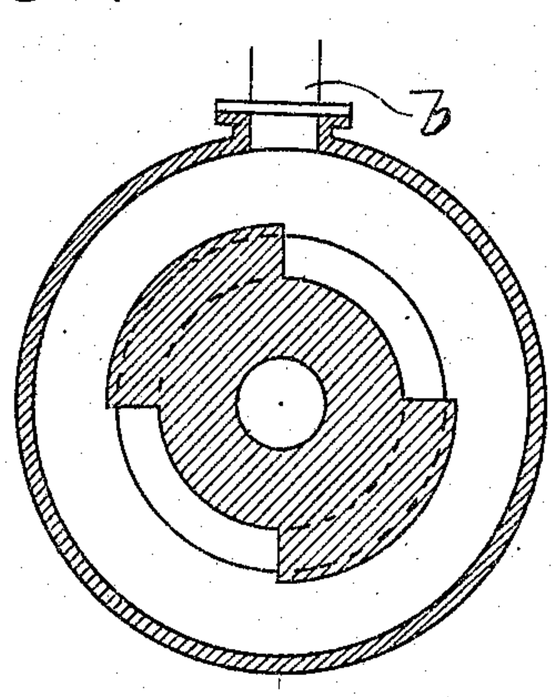
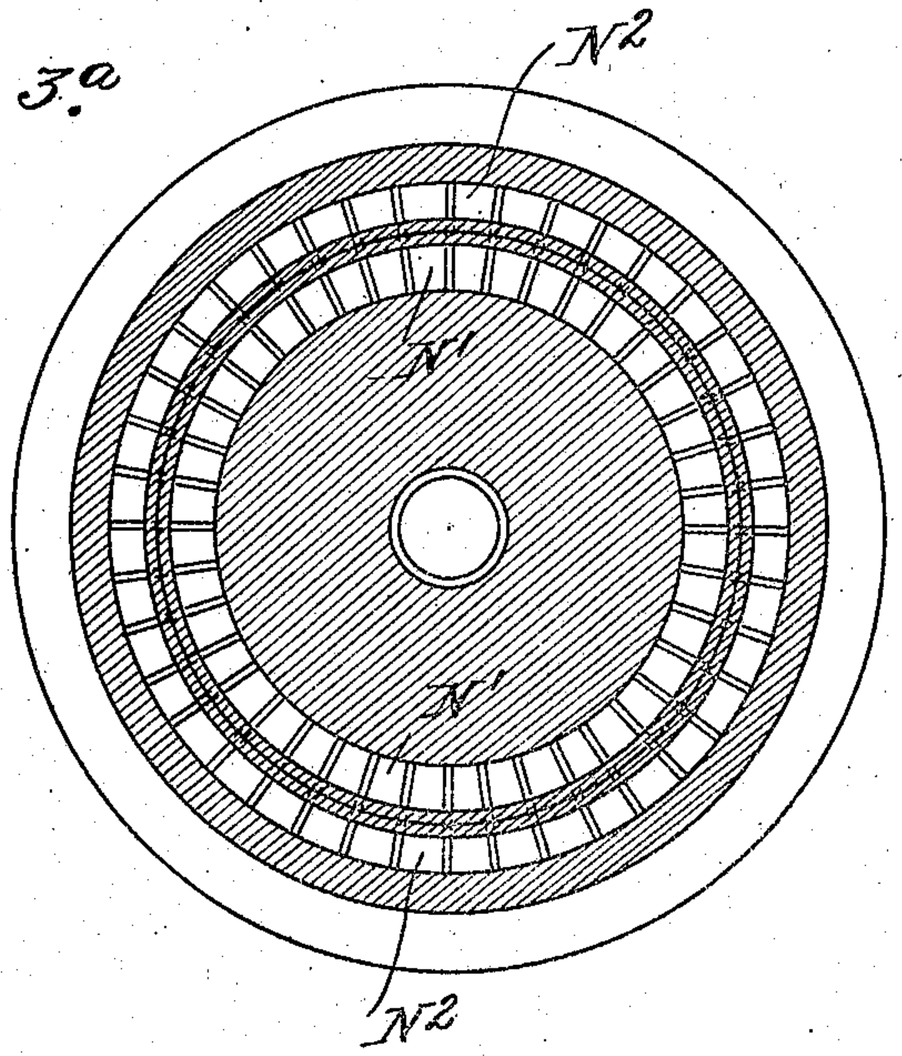


Fig. 3a.



Witnesses

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3 SHEETS—SHEET 3.

Fig. 5.

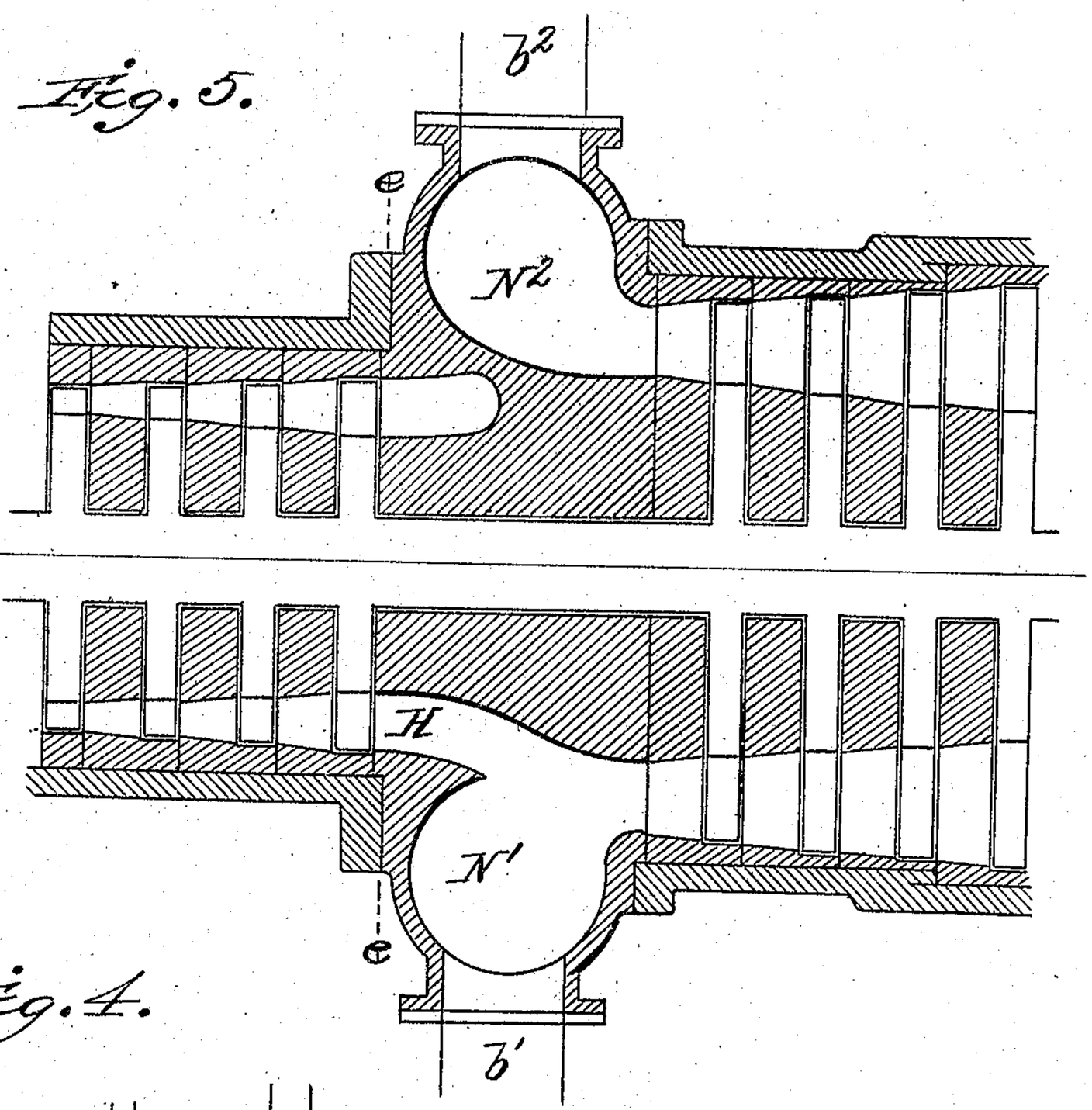
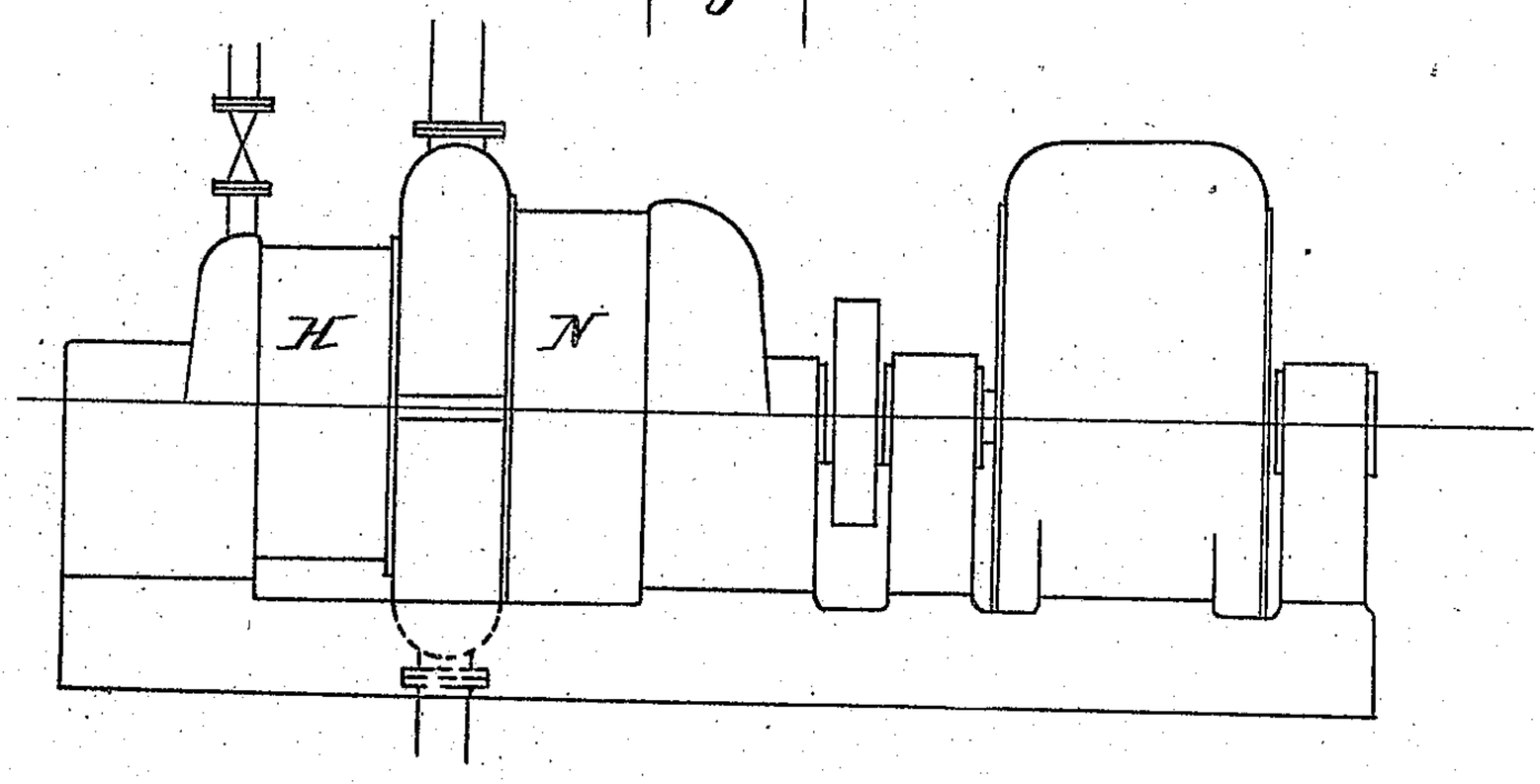


Fig. 4.



Witnesses

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STEAM-TURBINE.

No. 930,766. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed March 1, 1909. Serial No. 480,776.

To all whom it may concern:

Be it known that I, JOSEF KARRER, a citizen of the Republic of Switzerland, residing at Sihlstrasse 48, Zurich, Switzerland, have invented certain new and useful Improvements in Steam-Turbines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

The exhaust steam from intermittently working sources such as winding engines, has been used in supplying heat-accumulators and thence to exhaust steam turbines. The disadvantages of such plants are that when the supply of exhaust steam stops for a considerable time, especially when the condensation of the exhaust steam turbines fails to act, the plants become incapable of working. For this reason live steam turbines, which obviate the above disadvantage, have recently been placed ahead of and arranged to discharge into the exhaust steam turbines, so that the live-steam turbines may be placed in operation when the exhaust-steam supply fails. Such an arrangement of combined live- and exhaust steam turbines possess, however, the disadvantage that they have a low efficiency when operated as live steam turbines, only because the sectional areas for the flow of the steam through the low pressure (exhaust steam) turbine is much too large for the case when the plant is operated with live steam only. Supposing for example, that a combined live and exhaust steam turbine plant has a maximum output of 1000 kw. If such a plant is supplied by exhaust steam only, it works economically. If we assume for example that the available quantity of heat of the live steam is twice that of the exhaust steam, the cross sections of the steam passages or nozzles for the high pressure turbines would have to be dimensioned for 500 kw., as the low pressure turbine also furnishes 500 kw. If now the supply of exhaust steam fails completely, so that live steam only has to be used for a shorter or longer time, this high pressure steam works very badly in the low pressure part, and does not yield its maximum of available work as the cross sections of the steam passages in the low pressure turbine are calculated for 1000 kw., that is to say they are twice as large as they ought to be. Now it is true that the cross sections of the steam passages in the high pressure parts might also be calculated for 1000 kw., so that they would correspond to those in the low pressure part, but in such case the whole plant would be twice as large at 1000 kw. out-put as it ought to be, that is to say, it would again work very badly.

The object of the present invention is to obviate the above disadvantages.

The invention consists in supplying exhaust steam from an intermittently operating engine or the like and dividing it up into two or more parts, to supply one or more exhaust steam turbines or two or more parts of an exhaust turbine and adding a high pressure turbine, the sectional areas of the nozzles or passages for the flow of the steam of which high pressure turbines are so dimensioned, that they suit the sectional areas of that part of the exhaust steam turbine, into which the high pressure turbine empties.

Referring to the drawings illustrating my invention in which like parts are similarly designated, Figure 1 is an elevation of a turbine plant showing two exhaust steam turbines in conjunction with a high pressure steam turbine for driving an electric generator. Fig. 2 is a vertical longitudinal section of a portion of Fig. 3 showing the junction of the high pressure and the exhaust-steam turbines. Fig. 3 is an elevation similar to Fig. 1 of a modification. Fig. 3[a] is a vertical cross section of Fig. 2 through lines *d*, *d*. Fig. 4 is an elevation of a further modification. Fig. 5 is a vertical longitudinal section of Fig. 4 similar to Fig. 2. Fig. 6 is a vertical cross section of Fig. 5 through lines *e*, *e*. Fig. 7 is a vertical cross section similar to Fig. 6 of a modification.

Referring to Fig. 1, in which I have shown a 1000 kw. combined live and exhaust steam turbine plant. The exhaust steam from any suitable source is supplied to two separate exhaust steam turbines N_1 and N_2 to develop the full power of 1000 kw. to drive an electrical generator or the like; the exhaust steam flows from a main pipe *a* through the pipes b_1 and b_2 to the exhaust steam turbine. Ahead of the exhaust steam turbine N_1 is placed a high pressure turbine

H, the sectional areas of the nozzles or steam passages of which are calculated for the same volume of steam, as the sectional areas of the steam passages of the turbine N_1 and adjoin the latter. The high pressure turbine H receives live steam from the pipe *c* which is provided with an inlet or cut off valve. As the available quantity of heat of the live steam is about twice as great as that of the exhaust steam, the live steam yields 500 kw. in the turbine H and 500 kw. in the exhaust steam turbine N_1. Consequently, if for any reason the supply of exhaust steam should fail, the turbine H N_1 may be fed with live steam and can give the full power with the best efficiency, as the cross sections are calculated accordingly. This plant works economically therefore with both live and exhaust steam. A further advantage may be obtained by conducting the exhaust steam first through the turbine N_2 and only at a load of over 500 kw. through the cylinder N_1. The turbine then works economically even under half load.

Referring now to Fig. 2, which shows a simplification of structure from that shown in Fig. 1, the exhaust steam turbines N_1 and N_2 which are shown in Fig. 1, as separate are combined into a single turbine N in Fig. 3, the exhaust steam is nevertheless supplied separately, through the pipes b_1 and b_2; the fixed blade rings of the turbine N are so constructed that the passages for the steam from two concentric zones, are separated from one another; (see Fig. 2) the outer passages correspond to those of the turbine N_2 and the inner ones with those of the turbine N_1. The exhaust steam flowing through N_1 and N_2 acts upon the blades of the same rotor. The cross section of the passages of N_1 correspond in their turn to the cross section of the passages of the high pressure turbine H, see Fig. 3. If, therefore, for any reason live steam has to be used, this may be done here in an economical manner. The live steam flows through the high pressure turbine H. and afterward through the passages N_1 of the low pressure turbine N. The turbine H N therefore possesses all the advantages of the turbine H N_1 and N_2 of Fig. 1, but is considerably cheaper and occupies considerably less room. The loss by leakage in the low pressure steam exhaust steam turbine N, from the passages N_1 to the passages N_2 is very small, because the width *s* of the gap is very small compared with the height or radial length *h* of the blades of the rotor and this loss of efficiency is at all events considerably smaller than the gain secured by doing away with the idle running of the rotor of turbine N_2 of Fig. 1.

Figs. 4 to 6 show another arrangement. The rotors of the turbines N_1 and N_2 of Fig. 1 are again combined into a single cylinder N. The guide passages are however, not arranged in two concentric zones: the steam traverses them on their entire height *h*, Fig. 5. Nevertheless, the steam in the part N_1 works separately from the steam in the part N_2; this is obtained by transforming for instance the upper half of the turbine N into the part N_2 and the lower half into N_1. The guide passages in the upper half are suitably separated from those in the lower half. b_2 leads the steam to the upper half and b_1 to the lower half of the exhaust steam turbine N. When the turbine is worked by exhaust steam, the whole rotor of turbine N is in operation; if there is no exhaust steam available, then live steam flows through the high pressure turbine H and thence through the low pressure part N_1 of the exhaust steam turbine N. The guide passages in the low pressure exhaust steam turbine N may, of course, be divided up into more parts, or segments say four, for example (see Fig. 7). The exhaust steam enters through the pipe *b* and flows through all four segments of the low pressure exhaust steam turbine; and live steam flows through the high pressure turbine and afterward through only two segments of the low pressure turbine. Other combinations may also be made, in all of which the essential feature will be, that a high pressure turbine is placed ahead of the low pressure or exhaust steam turbine, the sectional areas of such high pressure turbine being calculated for the same volume of steam as those parts of the low pressure turbine, through which live steam also passes.

I claim:—

1. The combination with a turbine operating by live steam of a plurality of turbines operating by exhaust steam, said live steam turbine discharging into less than the whole number of said exhaust steam turbines.

2. The combination with a turbine operating by live steam of a turbine operating by exhaust steam and divided into a plurality of parts, said live steam turbine discharging into less than the whole number of parts of said exhaust steam turbine.

3. In combination a high pressure live steam turbine and a plurality of exhaust steam turbines, said high pressure turbine discharging into less than the whole number of said exhaust steam turbines, and that exhaust steam turbine or those exhaust steam turbines into which the high pressure turbine exhausts being designed to accommodate the steam entering from the high pressure turbine.

4. In combination a high pressure live steam turbine and an exhaust steam turbine divided into a plurality of parts, said high pressure turbine discharging into less than the whole number of parts of the exhaust

steam turbine, and that part or parts into which the high pressure turbine exhausts being designed to accommodate the steam entering from the high pressure turbine.

5. In combination a high pressure live steam turbine and an exhaust steam turbine divided into a plurality of parts, said high pressure turbine discharging into less than the whole number of parts of the exhaust steam turbine, and that part or parts into which the high pressure turbine exhausts being designed to accommodate the steam entering from the high pressure turbine, the steam passages or nozzles of the exhaust steam turbine being divided into concentric zones by suitable partitions, so that the parts form a plurality of co-axial cylinders.

6. In combination a high pressure live steam turbine and an exhaust steam turbine divided into a plurality of segmental parts, said high pressure turbine discharging into less than the whole number of said segmental parts of the exhaust steam turbine, and that or those segmental parts into which the high pressure turbine exhausts being designed to accommodate the steam entering from the high pressure turbine.

7. In combination a high pressure live steam turbine, and exhaust steam turbine parts operating and separately supplied with exhaust steam, said live steam turbine discharging into less than the whole number of parts of said exhaust steam turbine, and that part or parts into which the live steam turbine exhausts being designed to accommodate the steam from the live steam turbine.

8. In combination a high pressure live steam turbine, and an exhaust steam turbine divided into a plurality of parts, a single casing for both of said turbines, means to separately supply the several parts of the exhaust steam turbine with exhaust steam, said live steam turbine discharging into less than the whole number of parts of the exhaust steam turbine and that part or those parts of the exhaust steam turbine into which the live steam turbine discharges being designed to accommodate the steam entering from said live steam turbine.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

JOSEF KARRER.

Witnesses:
E. C. REDINGER,
JOSEPH SIMON.