

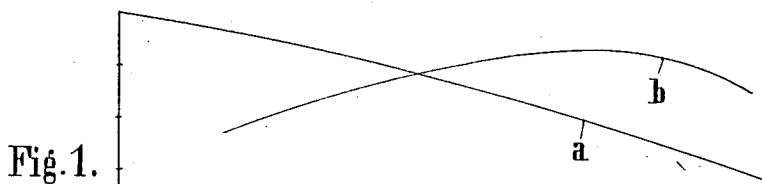
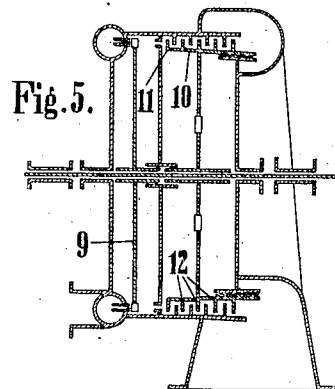
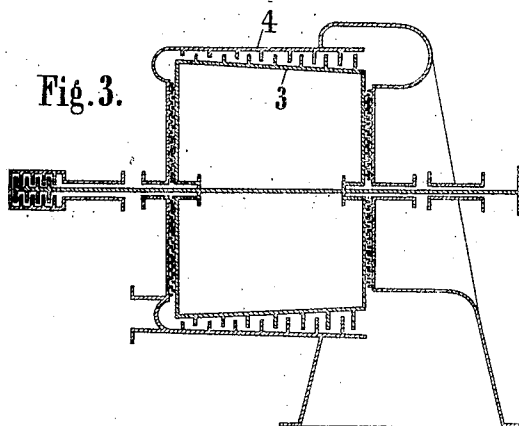
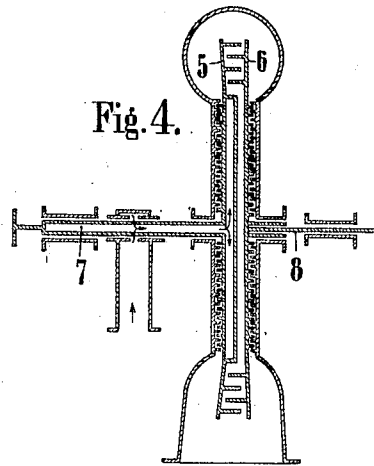
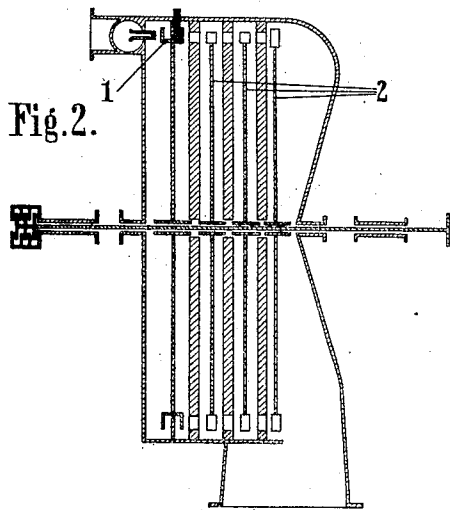
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MULTISTAGE TURBINE.

APPLICATION FILED APR. 15, 1911.

1,062,471.

Patented May 20, 1913.



Witnesses:

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UNITED STATES PATENT OFFICE.

EMIL JOSSE, OF BERLIN, AND PAUL CHRISTLEIN, OF CHARLOTTENBURG, GERMANY.

MULTISTAGE TURBINE.

1,062,471.

Specification of Letters Patent.

Patented May 20, 1913.

Application filed April 15, 1911. Serial No. 621,417.

To all whom it may concern:

Be it known that we, EMIL JOSSE and PAUL CHRISTLEIN, subjects of the German Emperor, residing at 157 Uhlandstrasse, Berlin, and at 1 Guerickestrasse, Charlottenburg, Germany, respectively, have invented certain new and useful Improvements in Multistage Steam or Gas Turbines with Axial or Radial Admission; and we 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.

It has been usual with multi-stage impulse, reaction or combined turbines; in which the steam admission was effected by ordinary passages with parallel walls, to so adjust the number of stages and the dimensions of the rotors, that the steam velocity produced at each step does not exceed the maximum of about 450 m. (the so-called critical velocity) owing to the belief that in this way loss by friction in the conducting and running blades was kept as low as possible. The view was held that the loss by friction in the turbine elements increased approximately as the third power of the velocity of the steam flowing through the engine. The efficiency curve based upon the foregoing assumption is shown at Figure 1 of the drawing in which the abscissa represents the steam velocity while the ordinates represent the efficiency shown by α . According to the current hypothesis the maximum efficiency is obtained when the steam velocity is zero.

Experiments made by the inventors have demonstrated the fact that the loss of energy occasioned by the movement of the steam through the conducting passages and the vanes of the rotor, that is the loss of flow, does not in fact correspond with the curve α , but with the curve β Fig. 1, in such a way that when the velocity is small considerably greater losses are present than has hitherto been supposed. The reason of this phenomenon is that a greater density of steam corresponds to a small velocity and that the losses due to the greater density are relatively great in spite of the low velocity. Again, as experiment has shown, the efficiency curve β possesses a certain maximum which in the case of an ordinary conducting apparatus with parallel walls is far below the so-called critical velocity and moreover with the conception of the critical velocity (about 450 m.) hitherto accepted, to pass this

velocity meant extreme losses on account of the production of vibration, etc. The consequence has been that hitherto impulse and reaction turbines or combined impulse and reaction turbines have been provided with such a number of stages that in no case at any stage has the critical velocity of 450 m. been exceeded.

The present invention is based on the fact that by experiments with regard to the relation between loss of flow and the velocity of the working fluid (steam or gas) it has been established that the number of stages in the case of impulse, reaction or combined turbines, should be so diminished that the steam velocity at each stage considerably exceeds the critical velocity (by 10% to 60%) that is to say lies in the neighborhood of the maximum efficiency curve β , Fig. 1.

At Fig. 2 of the drawing is shown by way of example a combination multi-stage impulse turbine made according to the invention. Fig. 3 of the drawing shows a pure reaction turbine. Fig. 4 shows a radial admission turbine with nozzles and blades moving in opposite directions. Fig. 5 shows a combined impulse and reaction turbine.

At Fig. 2, 1 is a Curtis wheel (with pressure stages and velocity stages), 2 shows the rotors for three separate pressure stages, as an example, no velocity stages being shown. The three stages work according to the principles of this invention with practically the maximum efficiency and that in spite of the considerable excess over the critical velocity at each stage.

The result of the increased rate of motion of the fluid at the individual pressure stages and of the consequently lessened number of such stages, is that, besides increased efficiency other advantages are obtained, namely:—A decreased length of the whole turbine, in consequence of the reduced number of rotors. A smaller expenditure of material, especially of the more costly material, with consequent reduction in cost or use of better material. With equal admission passages a considerably increased output from the turbine is obtained up to 100%.

While retaining the maximum length of the blades, it is not necessary for controlling the volume of steam in the low pressure stages to increase the exit angles, a construction which would otherwise cause a reduction of efficiency at these stages.

According to Fig. 3 of the drawing which

shows a pure reaction turbine built for the greatest efficiency, 3 is the drum with several rings of blades and with full admission passages from the first stage onward, 4 are the conducting passages fitted with parallel walls.

In the method of carrying out the invention shown at Fig. 4, 5 and 6 are the oppositely moving rotors with radial admission, the channels having parallel walls so proportioned that as the working fluid passes through, the critical velocity is considerably exceeded by about 10% to 60%. 7 is the hollow shaft through which the steam admission is effected. 8 is a solid shaft for the other rotor 6.

In the method of carrying the invention into effect shown at Fig. 5, a combined impulse and reaction turbine is shown with a rotor 9 belonging to the first high pressure stage and a reaction drum 10, the first ring of blades on which, 11, belongs to the high pressure stage, while the further ring of blades 12 belongs to the reaction turbine.

In addition to the advantages already mentioned, multi-stage gas or steam reaction turbines made according to the present invention possess special advantages.

Reaction turbines as constructed up to the present are not suitable for use with high degrees of vacuum, as with the velocity at present in use of the steam blowing through the engine (150 m. to 350 m.) conducting and rotor blades of the necessary height cannot be employed. With the present invention the required result can be obtained without any difficulty, in consequence of the consid-

erably greater velocity. This for example is very important with steam exhaust turbines.

For instance, if a three-thousand K. W. turbine is built according to the preferred form of this invention, as an impulse turbine, it requires about six stages and, therefore, six separate rotors each with its ring of blades and five carefully made heavy separating partitions. If this turbine is built as a combined impulse and reaction turbine with two high pressure stages and a reaction drum, we require a rotor with one row of blades and a reaction drum with four rows of blades, the number of intermediate partitions being reduced to one, which is necessitated by the number of high pressure stages.

What we claim and desire to secure by Letters Patent of the United States of America is:—

A multi-stage turbine having impulse and reaction stages containing fixed blades and comprising a plurality of rotors having blades; pressure-fluid admitting means having parallel walls, said fluid admitting means and said rotors being so proportioned that at each stage a velocity exceeding 450 m. per second is attained whereby the loss of flow in the passages between the fixed and movable blades is reduced.

In testimony whereof, we affix our signatures, in presence of two witnesses.

EMIL JOSSE.

PAUL CHRISTLEIN.

Witnesses:

HENRY HASPER,

WOLDEMAR HAUPT.