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R. BERGMANS.

TRANSFORMING NOZZLE FOR OBTAINING KINETIC ENERGY FROM FLOWING GASES AND VAPORS.

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Fig. 1.

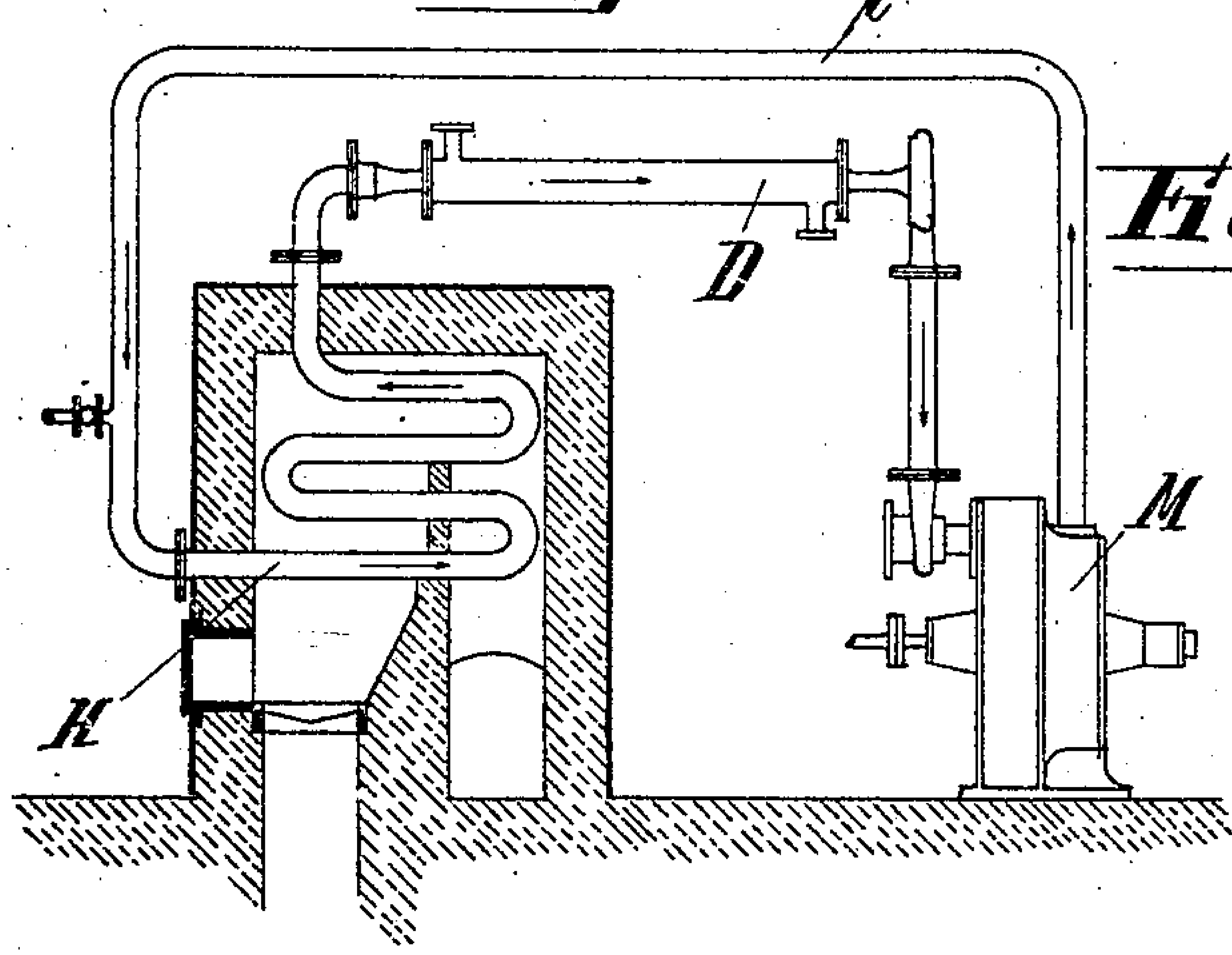


Fig. 3.

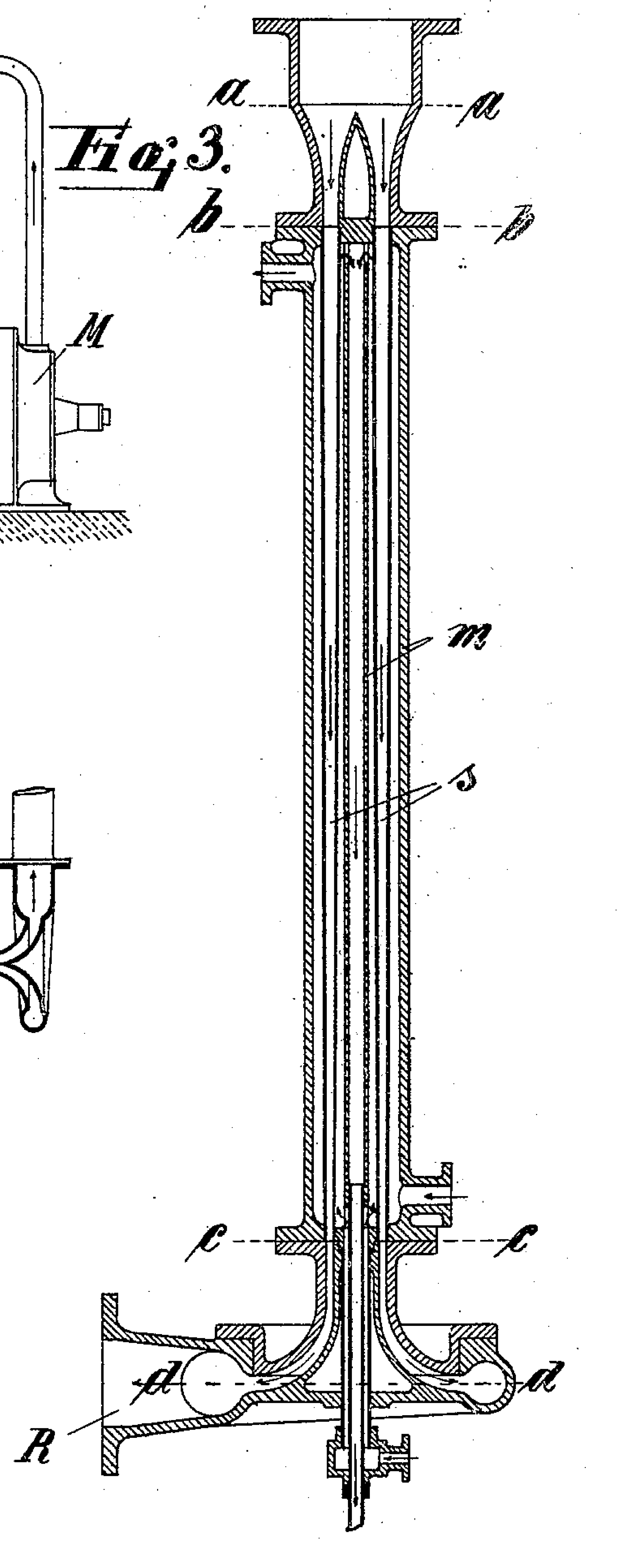
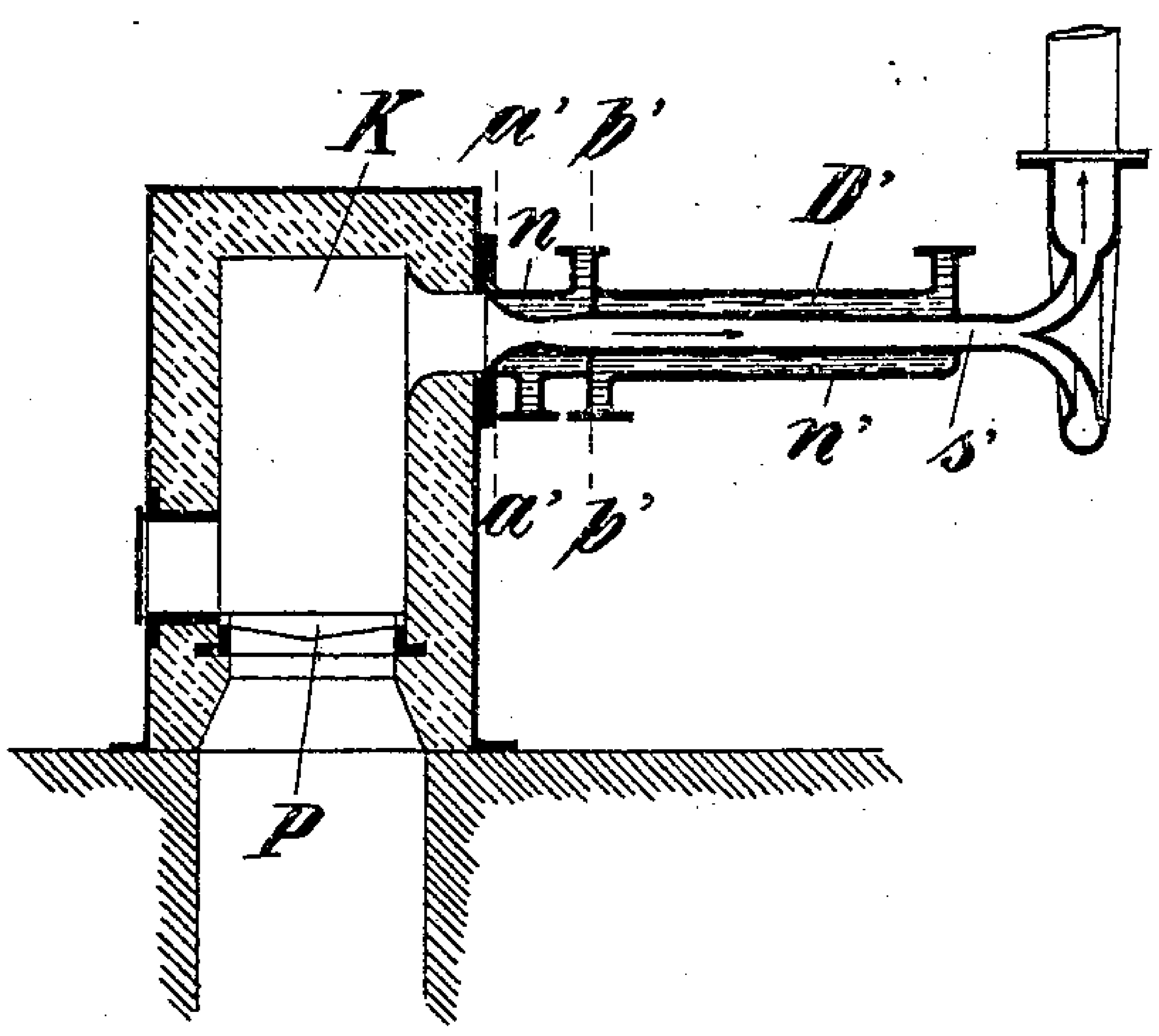


Fig. 2.



WITNESSES

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TRANSFORMING-NOZZLE FOR OBTAINING KINETIC ENERGY FROM FLOWING GASES AND VAPORS.

No. 868,397. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed November 4, 1905. Serial No. 285,950.

To all whom it may concern:

Be it known that I, RUDOLF BERGMANS, engineer, a subject of the Emperor of Germany, residing at 76 Friedrich Wilhelm strasse, Breslau, in the Empire of Germany, have invented new and useful Improvements in Transforming-Nozzles for Obtaining Kinetic Energy from Flowing Gases and Vapors, of which the following is a specification.

It is a known fact that the degree of thermic efficiency of a heat energy equipment, in which the working process is conducted according to the reversible cycle process will be so much the better the higher the temperature at which the heat is furnished to the working bodies and the lower at which it is withdrawn from them.

The employment of very highly superheated steam or gas as the working factor in heat power machines has nevertheless hitherto not proved practical, on account of the accompanying excessive heating of the machine parts.

With the aid of the transforming nozzle forming the object of the accompanying patent, it is, in the case of heat power machines, especially turbines, possible to use steam or vapor of high temperature, as the working factor.

The manner of operation of the transforming nozzle is such that with its aid, steam or vapor of low tension and the highest possible temperature, before admission to the heat power machine, will be transformed into the reverse condition, in such manner that the steam or vapor after transformation will have a higher tension and a lower temperature than before the transformation.

Figure 1 shows the application of the nozzle to a heat power apparatus working with superheated steam. Fig. 2 the employment of the nozzle in a heat power plant using hot vapors. Fig. 3 shows a special form of construction of the transforming nozzle.

The method of working of the arrangement shown in Fig. 1, in which superheated steam is supposed to be the power factor employed, is as follows:—The exhaust steam of the turbine M which has a low pressure and temperature flows uninterruptedly through the exhaust pipe *l* to the superheater H in which so much heat is conveyed to it at a constant pressure, that it receives a highest possible temperature. The highly heated steam passes from the superheater into the converter or interchanger D. By giving the latter suitable dimensions and form, the inflowing hot steam first receives a certain momentum in order afterwards to be compressed, by its own inertia or impetus, on the withdrawal of a certain amount of heat, to a higher pressure than the initial pressure.

The operations in the interchanger take place, in the form of construction of the nozzle shown in Fig. 3, in the following way:—An adiabatic expansion of the exhaust steam is produced in the part *a a*—*b b* of the interchanger by giving such part a suitable dimension and form. The steam attains in the nozzle section *b b* at the lowest density a certain speed and thus also a kinetic energy. The steam flows with this speed into the cooling part *b b*—*c c* of the nozzle, in which part heat is withdrawn from it, the pressure being maintained constant. For this object the part *b b*—*c c* of the nozzle is provided with a cooling jacket *m*. Through this jacket a colder body, for instance, water, flows, which absorbs and removes the quantity of heat which is to be withdrawn from the steam. By the withdrawal of heat and the cooling of the steam, the kinetic energy inherent therein on its entrance into the cooling part is increased to a certain amount corresponding to the amount of the cooling.

In order to obtain as intense a cooling in the part *b b*—*c c* of the interchanger as possible, the chamber *s* for the passage of the steam jet, is (as shown in Fig. 3) given the form of a ring which is cooled internally and externally. This annular space diminishes from *b b* toward *c c*, so that the pressure of the steam which touches the cooling surfaces remains approximately constant during its passage from *b b* to *c c*. In the nozzle section *c c* the steam has attained such a speed that it now is in a position by reason of its kinetic energy to compress to a higher pressure than its initial pressure. The compression that is to say the conversion of the kinetic energy into pressure takes place in the part of the nozzle *c c*—*d d* specially formed for this purpose.

The annular section of the passage channel *s* at the cooling part *b b*—*c c* of the interchanger, is prolonged into the condensing part *c c*—*d d* of the same, but in this part the diameter of the annular chamber is gradually increased in such a way that the annular chamber (as shown in Fig. 3) merges at the interchanger section *c c*—*d d* in a gentle curve into the collecting chamber R. Now the constant increase of the diameter of the annular chamber has for a consequence that the steam jet passes into a continually larger section, its speed is therefore slackened and thus a conversion of the kinetic energy of the same into pressure is produced. Now as the steam jet is diverted in a gentle curve from the original direction, and with a gradual diminution of speed conveyed to the collecting chamber, the compression takes place without shock and therefore without loss. The retarding of the steam jet in this nozzle part causes a slight increase in the temperature, however, on account of the high superheating of the steam entering in *a a*, this increase influences the efficiency of the entire apparatus but very imperceptibly. The steam passes from the interchanger D now at a higher pressure and at as low a temperature as is admissible for the working, into the turbine M in which it then executes certain work.

The present method of working allows of the gases of combustion being also employed directly as working medium in a heat power installation, and then the processes, described in a connection with Fig. 2, take place as follows:—On the grate P, the combustion of the material takes place at as high a temperature as possible and as low an atmospheric pressure. From the combustion chamber K the gas is directly conveyed into the interchanger D^1 in which the gas is converted into a reversed condition. In order at the high temperature of the combustion gases to prevent a burning away of the interchanger, the latter must be completely cooled. The cooling takes place by means of two separate cooling jackets n and n'. The cooling jacket n round the part a' b' of the nozzle, in which a certain momentum is produced, merely has for its object to prevent this part of the nozzle being rendered incandescent or red hot. The gas cooling required for the production of momentum is effected by the cooling jacket n'. In the interchanger D^1 shown in Fig. 2, the channel s' for the passage of the gas, is not of annular but of circular section. The interchanger D^1 might, however, be made like the nozzle D in Fig. 3. As some heat is withdrawn from the gas in the part a' b' of the interchanger, the expansion of the gas in this part does not take place adiabatically, but in a curve which is under the adiabatic; otherwise the course of the alterations of the condition of the gas in this interchanger takes place as hereinbefore described. The gas passes from the interchanger D^1, which gas now has a higher pressure and a lower temperature than before its entrance into the interchanger, as operating medium into the heat power engine. The conversion can also be effected by means of several interchangers erected one behind the other. The gas is then compressed, for instance, in the first interchanger to the pressure p', in the second to the pressure p'', and so forth, until the gas finally on emerging from the nth interchanger, has the desired pressure and temperature with which it then enters the heat power machine.

The operations of the flow in the interchanger may be arranged differently, but the formation of the interchanger and also the method of cooling must always be exactly suited to the actual condition of flow.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In an apparatus for obtaining mechanical work from flowing gases or vapors of high temperature and slight tension, a collecting chamber, a transforming nozzle having a diminishing cross-section, means for cooling the nozzle whereby heat is withdrawn, under a tension that remains approximately constant, from the engaging gases or vapors to which a high speed is thus imparted, and of a gradually widening annular passage canal through which the gases or vapors reach the collecting chamber, whereby the motion of the gases or vapors is retarded and their kinetic energy transformed into tension energy.

2. In an apparatus for obtaining mechanical work from flowing gases or vapors of high temperature and slight tension, a collecting chamber, a transforming nozzle having a diminishing annular space, means for cooling the inner and outer wall of the annular space whereby heat is withdrawn, under a tension that remains approximately constant, from the engaging gases or vapors to which a high speed is thus imparted, and of a gradually widening annular passage canal through which the gases or vapors reach the collecting chamber, whereby the motion of the gases or vapors is retarded and their kinetic energy transformed into tension energy.

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

RUDOLF BERGMANS.

Witnesses:
A. N. MAN,
LOUIS KATZ.