No. 745,409. PATENTED DEC. 1, 1903.

G. ZAHIKJANZ.

TURBINE.

APPLICATION FILED DEC. 24, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.

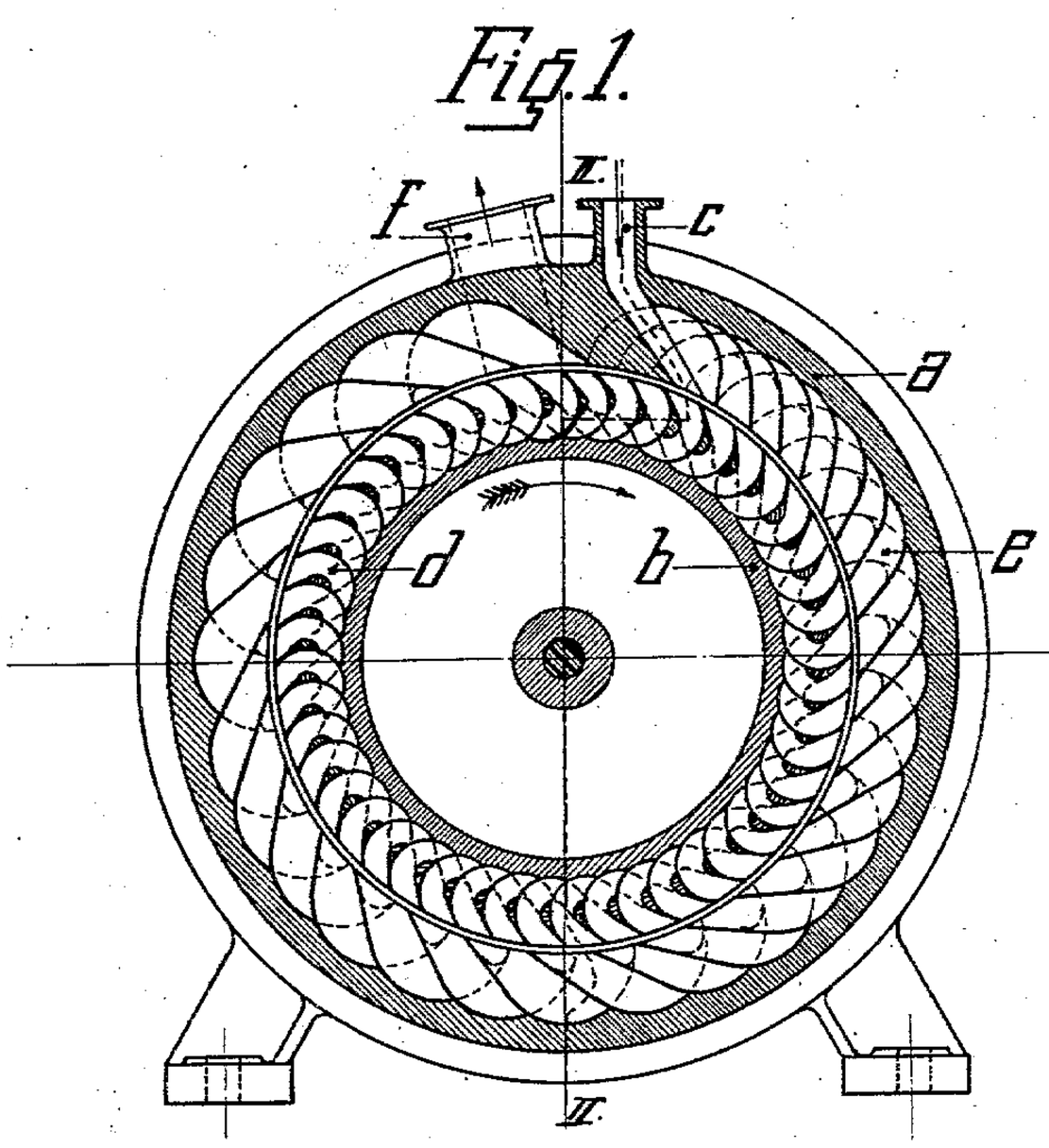


Fig. 2.

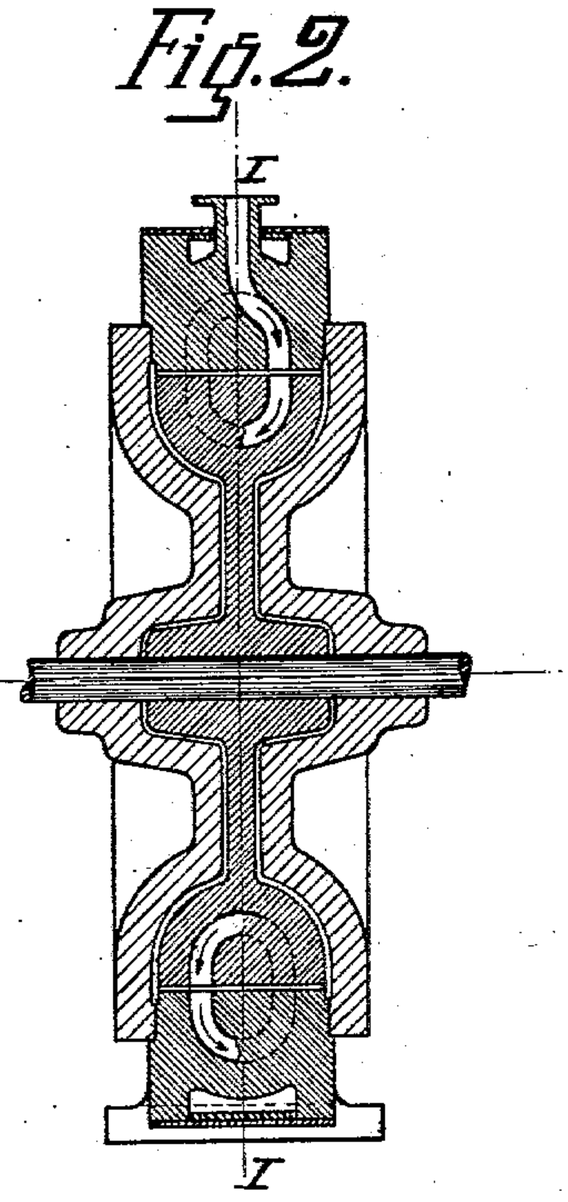
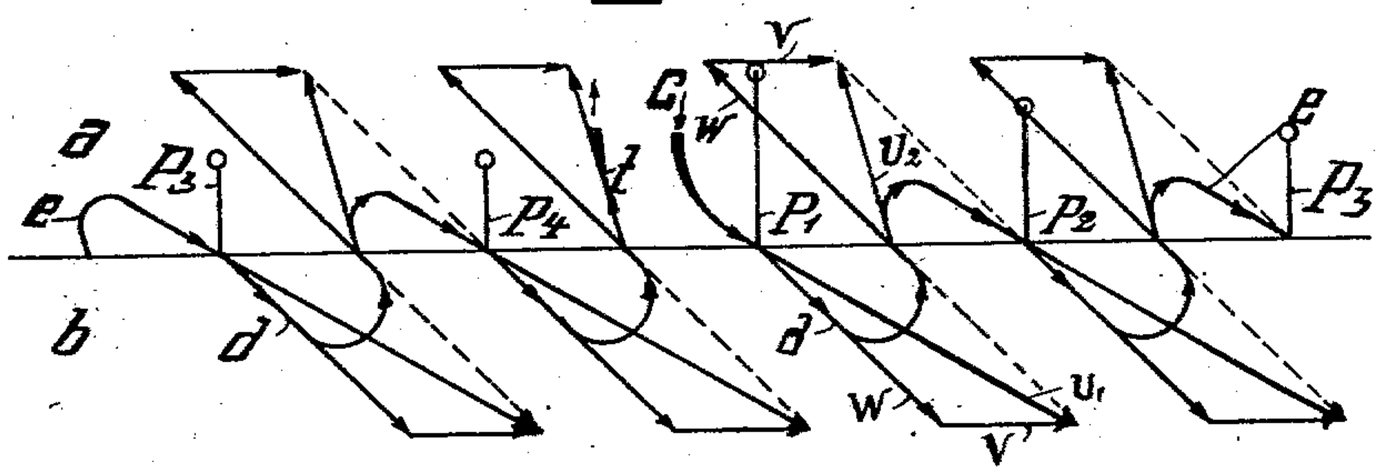


Fig. 3.



Witnesses:
Woldemar Haupt
Henry Hasper.

Gabriel Zahikjanz,
Inventor.

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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 4.

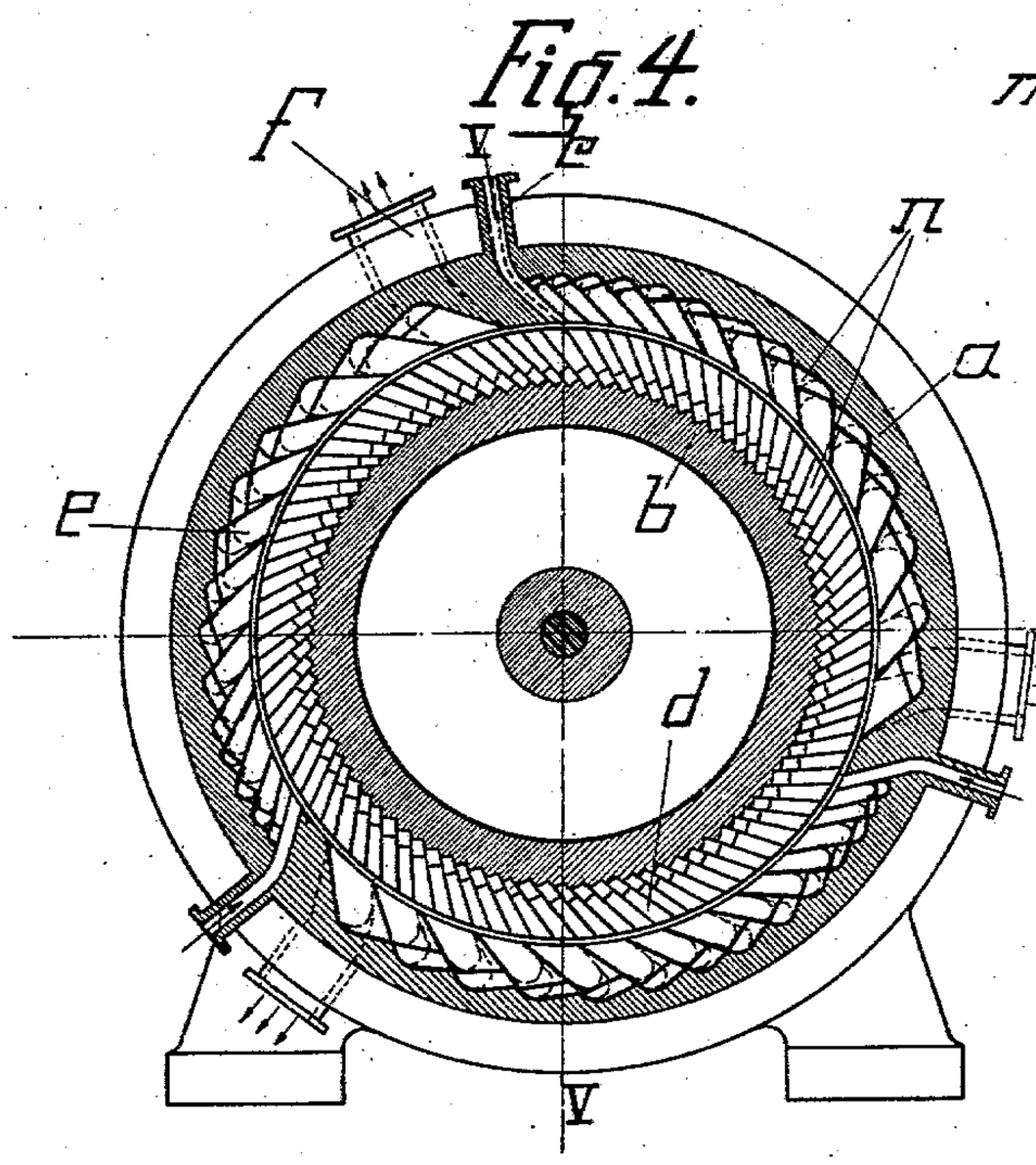


Fig. 5.

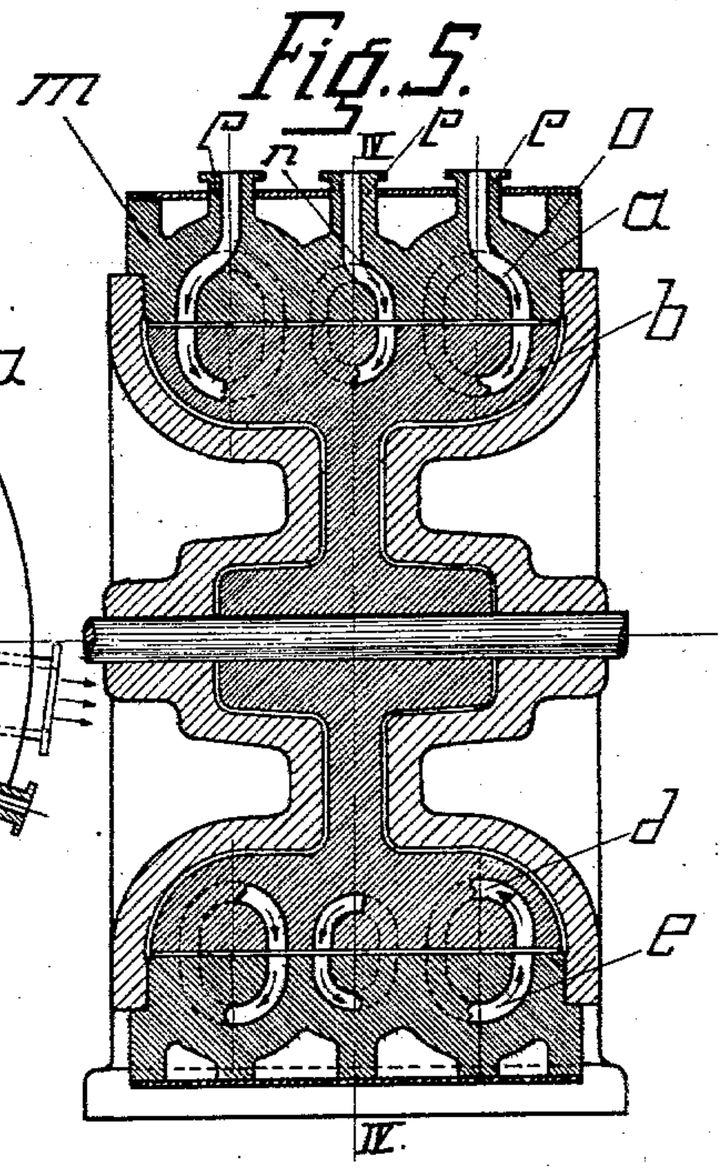
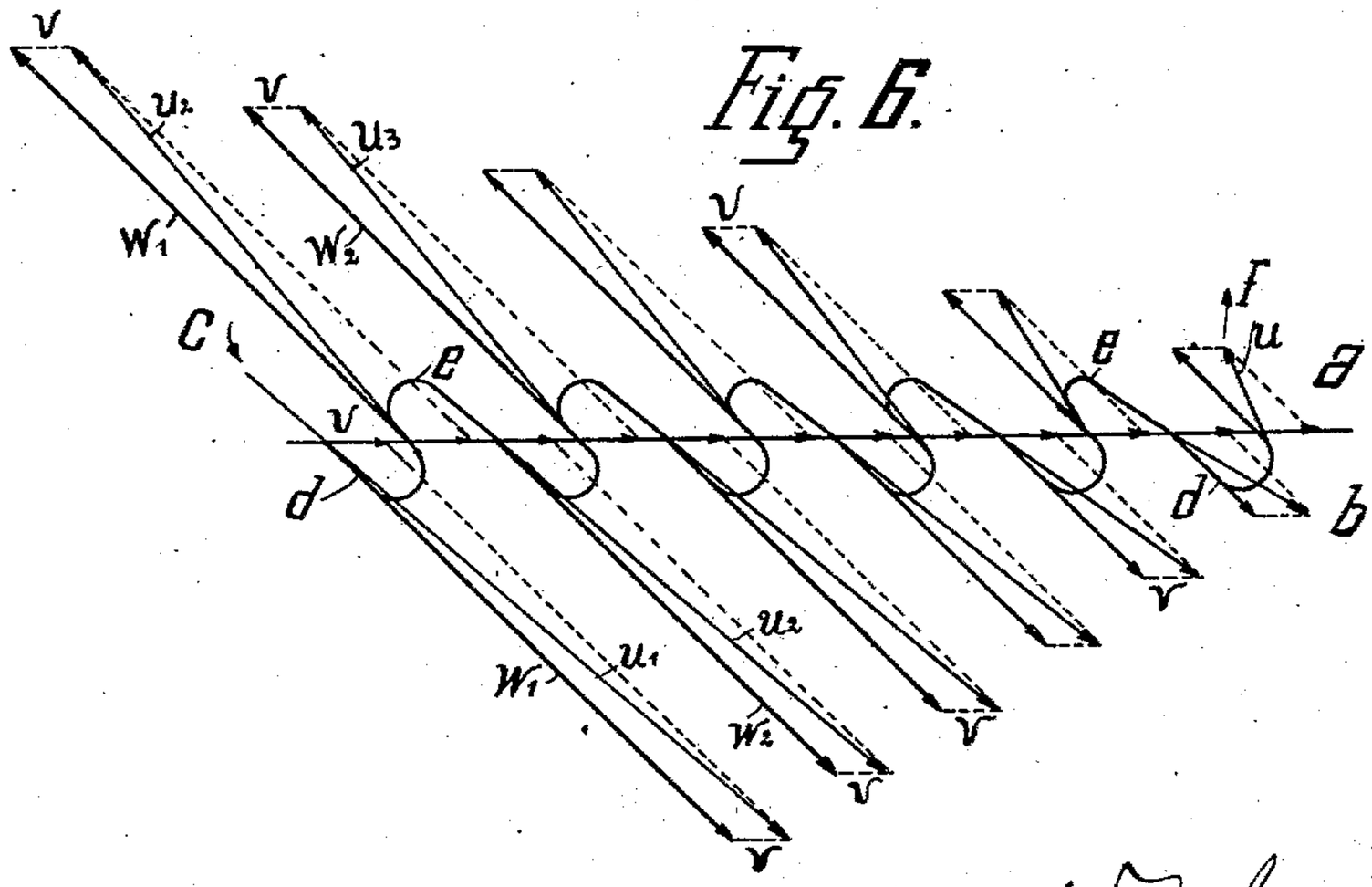


Fig. 6.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 8

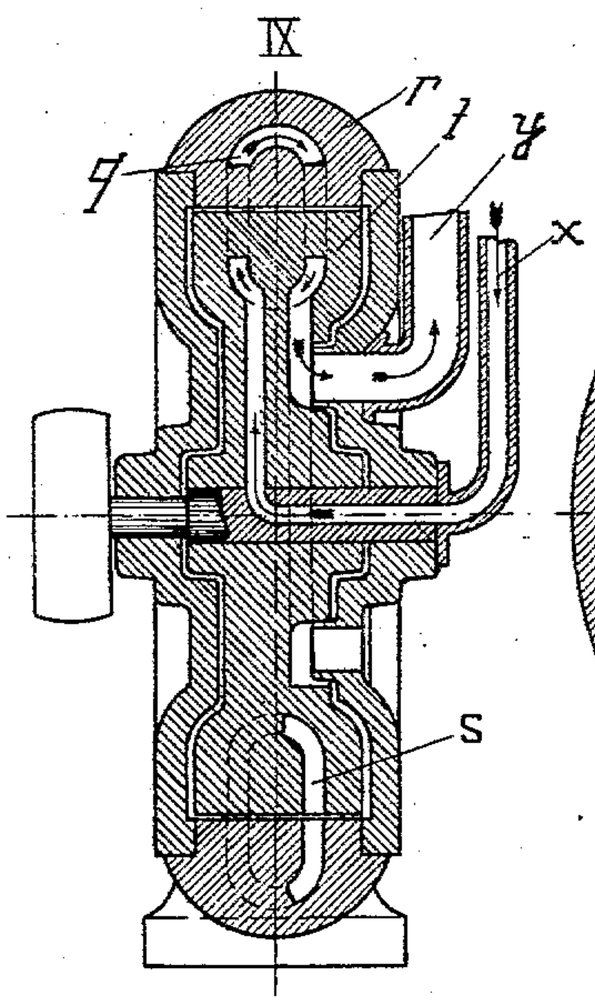
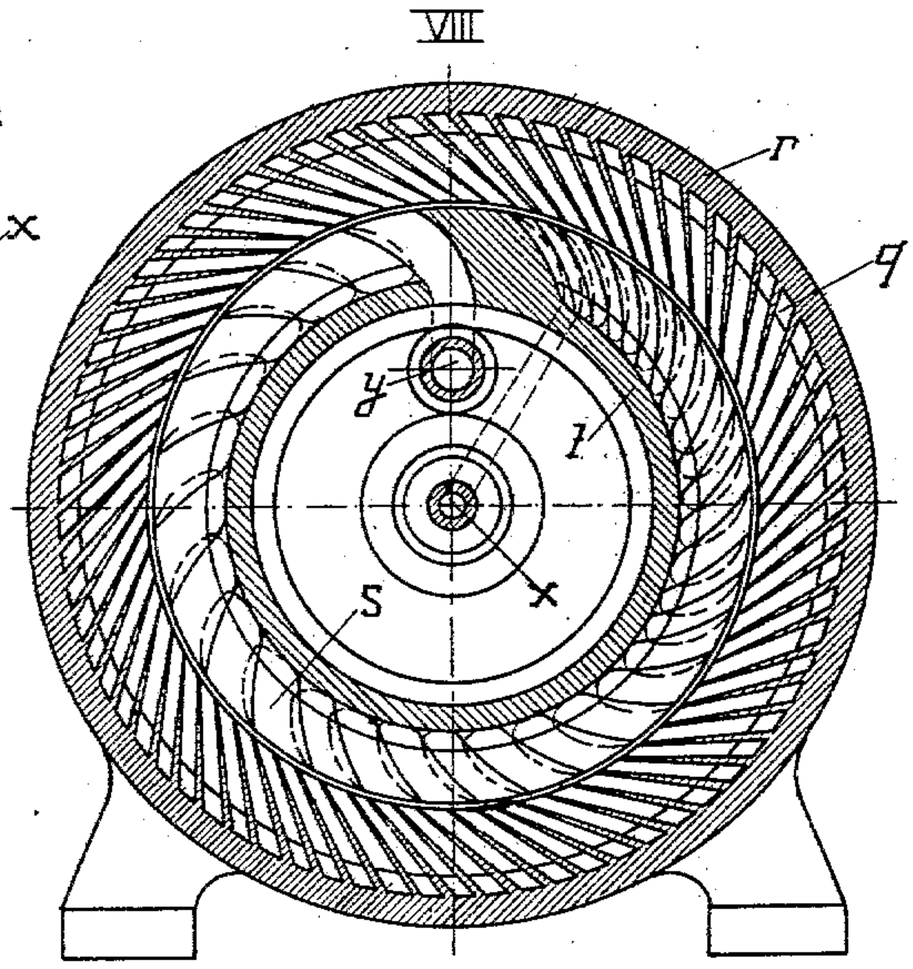
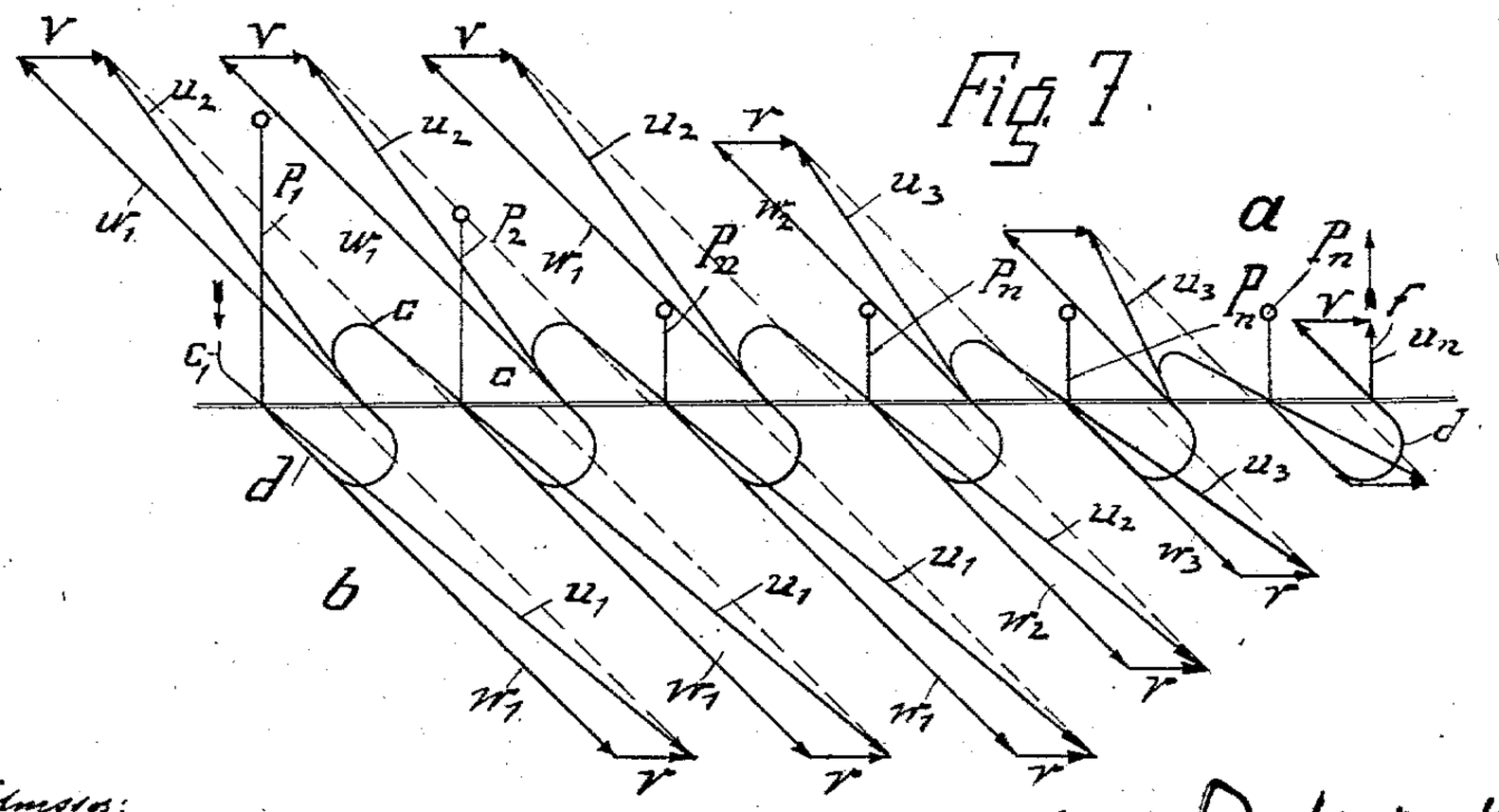


Fig. 9



IX VIII

Fig. 7



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APPLICATION FILED DEC. 24, 1902.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 10.

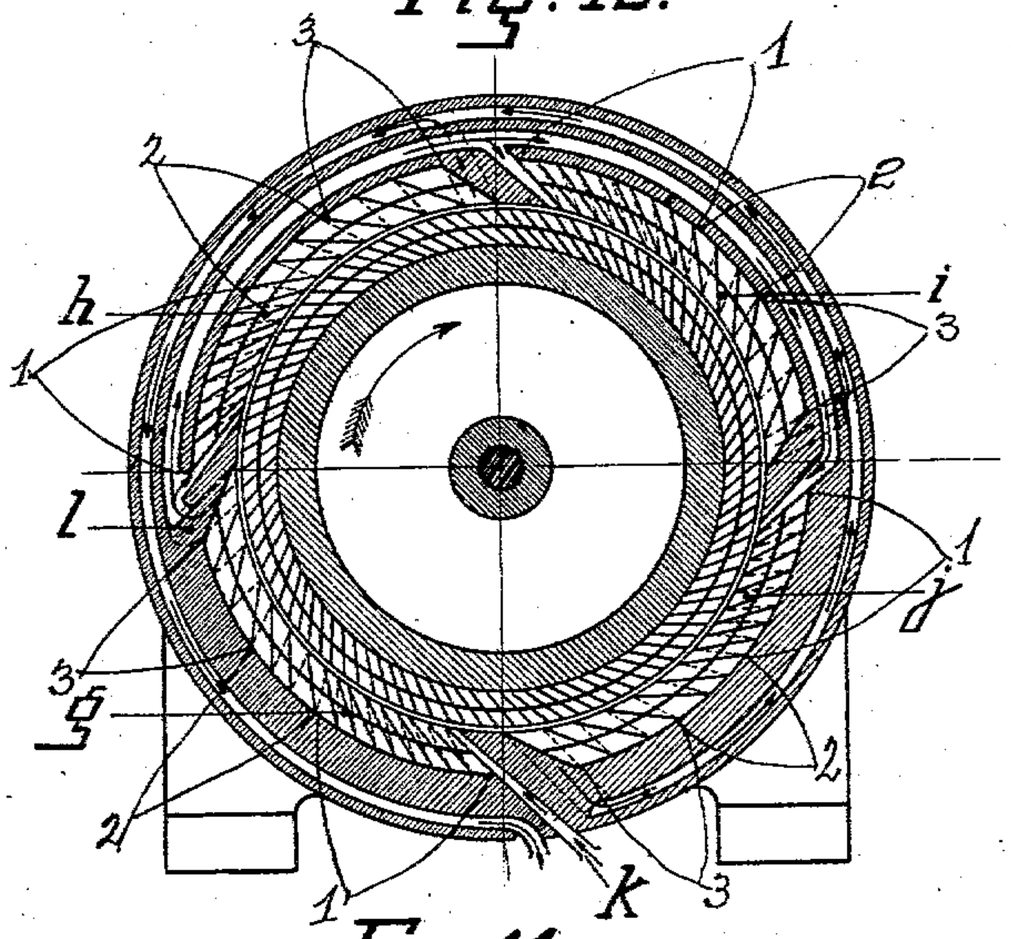


Fig. 11.

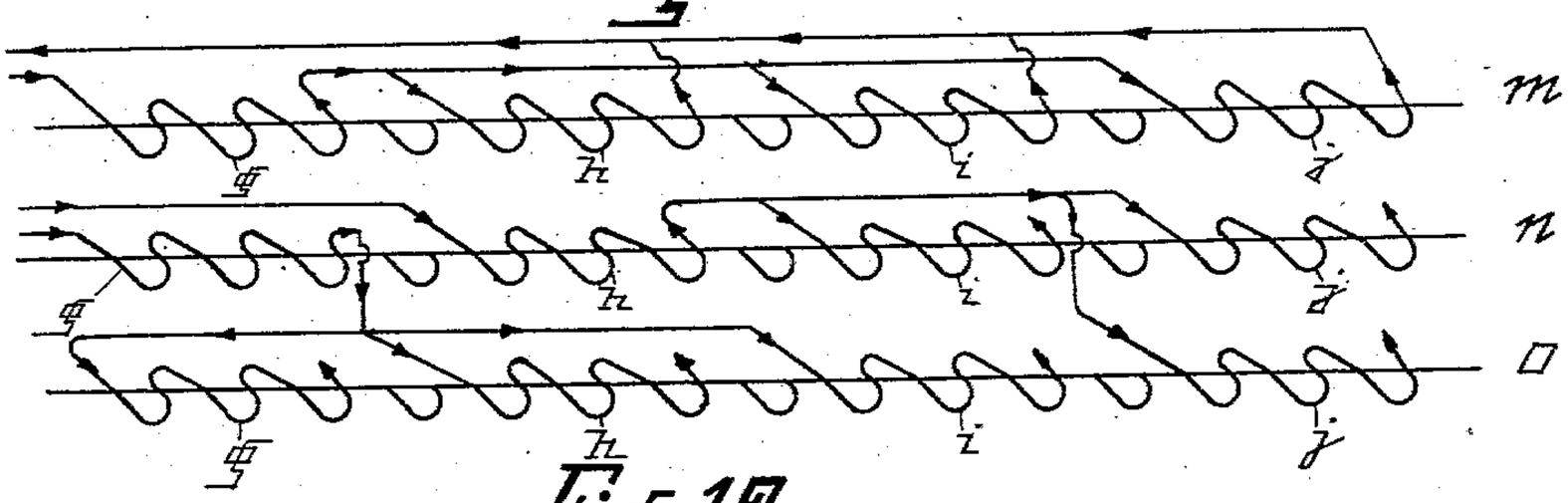
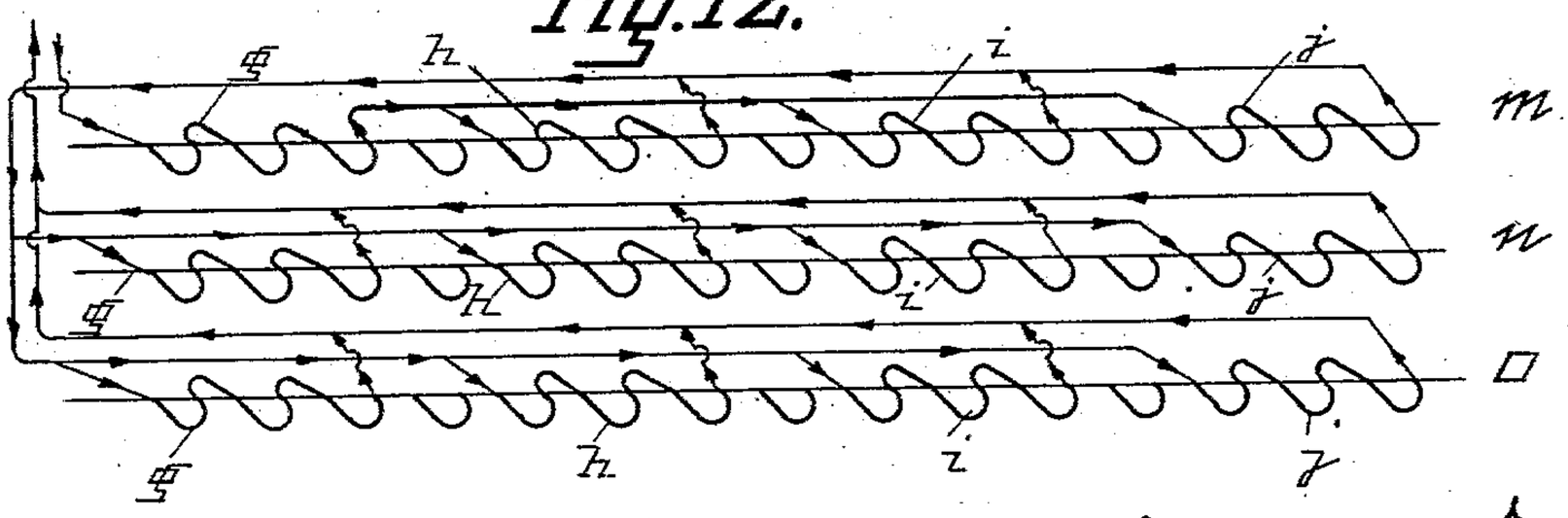


Fig. 12.



Witnesses:
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Henry Hasper.

Gabriel Zahikjanz
Inventor.

No. 745,409. Patented December 1, 1903.

UNITED STATES PATENT OFFICE.

GABRIEL ZAHIKJANZ, OF BERLIN, GERMANY, ASSIGNOR TO BERGMANN ELEKTRICITÄTS WERKE, AKTIENGESELLSCHAFT, OF BERLIN, GERMANY, A CORPORATION.

TURBINE.

SPECIFICATION forming part of Letters Patent No. 745,409, dated December 1, 1903.

Application filed December 24, 1902. Serial No. 136,459. (No model.)

To all whom it may concern:

Be it known that I, GABRIEL ZAHIKJANZ, a subject of the Emperor of Russia, and a resident of Berlin, Germany, have invented certain new and useful Improvements in Turbines, of which the following is a specification.

My invention relates to turbines for steam and other agents, and has particular reference to turbines in which guide and rotary channels form windings in the turbine-rim.

The invention consists in a novel construction by means of which I may obtain successive increase of the cross-section of the steam-path, according to the gradual expansion in expansion-turbines or to the gradual decrease of the current velocity in turbines without expansion.

Various ways of carrying out my present invention will now be described with reference to the accompanying drawings, and the novel features of my invention will then be pointed out in the appended claims.

In the drawings, Figure 1 is one form of my turbine in section on line I I of Fig. 2. Fig. 2 is a sectional elevation on line II II of Fig. 1. Fig. 3 is a diagram illustrating the action in expansion-turbines. Fig. 4 shows another form of my turbine in section on line IV IV of Fig. 5. Fig. 5 is a sectional elevation on line V V of Fig. 4. Fig. 6 is a diagram illustrating the action in turbines without expansion. Fig. 7 is a diagram illustrating the action in combined turbines with decreasing pressure and velocity of steam. Fig. 8 is a reversal of the turbine represented by Figs. 1 and 2 in section on line VIII VIII of Fig. 9. Fig. 9 is a sectional elevation on line IX IX of Fig. 8. Fig. 10 is a cross-sectional elevation of still another form of my invention, and Figs. 11 and 12 are diagrams showing the action of steam in various forms of my invention.

My turbine, as shown in Figs. 1 and 2, consists of a guide-wheel *a*, preferably stationary and surrounding the rotary wheel *b*, the arrangement being reversible. The stationary member *a* is provided with the inlet *c* for steam or other driving medium. The rotary member *b* is provided in its rim with motive or rotary channels *d*, each being curved toward the direction of rotation and having both its openings on the surface of the rim either side by side in an axial line or one way precede the other. The stationary member *a* is provided with guide-channels *e*, which are so arranged as to admit the steam from the outlet of a rotary channel and to convey it into the inlet of a further rotary channel, all the inlets being separated by a general partition from the outlets. For avoiding shocks the outlet of every channel builds with the wheel-periphery an acuter angle than that formed therewith by the inlet of the channel opposite to it, while the respective inclinations are all alike from winding to winding. The channels, preferably rectangular in their cross-section, thus form a system of windings in which the steam gradually converts its pressure into useful work and escapes at the exhaust *f* in the stationary member. Now in order to increase gradually the cross-section of the steam-path in accordance with its continual expansion I provide the following device: The rotary channels *d* are all alike and receive the smallest cross-section needed, according to the initial density of steam. The guide-channels *e*, however, increase progressively in cross-section from channel to channel toward the outlet *f*, so that the guide-channels admitting the steam expand the same and convey it to further rotary channels. Fig. 3 illustrates the operation of this device diagrammatically. w' represents the absolute velocity of the steam entering the rotary wheel *b*. v is the peripheral velocity of the rotating wheel. w is the relative velocity of the steam in the rotary channel *d*, and w^2 is the absolute velocity of the steam at the moment it leaves the rotary channel *d*. This velocity is smaller than the initial velocity w'; but the steam in expanding at its passage through the guide-channel *e* restores its original velocity w', with which it flows into a further motive channel *d*. The action of the steam is practically the same from channel to channel, owing to the widening of the steam-path in accordance with the progressive expansion due to the gradual decrease of the steam-pressure, as in-

dicated by p' p^2 p^3 p^4. At the exhaust f the steam leaves the turbine after having converted its pressure into useful work.

In the construction illustrated by Figs. 4 and 5 the steam enters the rotary wheel b with the whole velocity due to the available pressure. Owing to the high rate of velocity of the steam the coils are disposed in a plurality of segments or systems. There are three systems in each of the three coils m n o shown. Each system has its own inlet c and outlet f. For the purpose of progressive widening the steam-path in accordance with the gradual decrease of its velocity the rotary channels of the rotary wheel are all alike and dimensioned in accordance with the initial highest velocity of the steam, and the guide-channels of each system progressively increase in cross-section, corresponding to the gradual reduction in the velocity of the steam toward the outlet. Fig. 6 illustrates this diagrammatically. Through the inlet c the steam enters with the initial velocity u' into the channel d of the rotary wheel revolving with the peripheral velocity v. The steam traverses the channel with the relative velocity w', with a diminished absolute velocity u^2 enters the guide-channel e, increases its cross-section, and flows to a further rotary channel. The same action is repeated from channel to channel until the steam, having converted the greatest part of its velocity into work, escapes through the exhaust f with the velocity u^2. In order to avoid shocks and losses from channel to channel at the passage of the steam gradually decreasing its velocity, the rotary channels d are all given the same inclination, while the guide-channels e are inclined in accordance with the decrease of the steam velocity.

The two arrangements for the utilization of the steam hereinbefore described may be combined by causing the steam to first work with constant speed at a gradually-decreasing pressure, so as to reduce the dimensions of the machine and then with constant pressure at decreasing speed in order to reduce the *vis viva* of the exhaust-steam. Such a combination is diagrammatically represented in Fig. 7.

Figs. 8 and 9 illustrate a reversal of the construction shown in Figs. 1 and 2. In this case the guide-wheel r has channels g of equal cross-sections, while the channels s of the rotary member t gradually increase in cross-section. The first channel s of the rotary member communicates with the steam-supply pipe x and the last channel g of the rotary member with the exhaust-pipe y.

For the sake of simplifying the construction the progressive widening of the steam-path may be effected from group to group instead of from channel to channel—*i. e.*, the channels are divided in groups of equal cross-section, which progressively increases from group to group. The action will not be so steady in this case, but will be sufficient for practical requirements. Thus, for instance, the channels may consist of groups whose cross-sections relate to each other as one to one and one-third, to one and two-thirds, to two, to three, to four, to five, to six.

For practical reasons it is not convenient to carry the increase of cross-section beyond a certain limit. In order, however, to gradually widen the steam-path to any extent, I cause the steam to first pass through a system of channels increasing in cross-section from channel to channel or from group to group. Then at a point where a further increase of the cross-section would be inconvenient I cause the steam to pass from the last or widest channel of this first system into a plurality of similar systems connected in parallel, and in each of these the steam is caused to expand further.

Fig. 10 shows a steam-turbine in which the coil of channels consists of four systems g h i j, each of which is subdivided into three groups 1, 2, and 3, the respective cross-sections of which are as one to one and one-half to two. The steam enters at k into the first system g. While passing through this system the steam works first with single expansion, then with one and one-half fold expansion, and finally with double expansion. Then the steam leaves the system g at l and is subdivided into three streams, which then pass simultaneously through the three systems h i j, which are connected in parallel, the cross-sectional area and therefore the expansion increasing progressively from three multiplied by one equal threefold expansion to three multiplied by one and one-half equal four and one-half fold expansion, and finally to three multiplied by two equal sixfold expansion.

When the turbine consists of several coils of channels arranged side by side or one over the other, each of these coils may be subdivided into systems, and the systems of the several coils may be connected with each other in parallel or in series in various manners to secure a further expansion or to cause a large amount of steam to perform work.

Fig. 11 represents diagrammatically a steam-turbine with three coils m n o, each having four systems of channels g h i j. The four systems g h i j of the first coil are connected with each other in the manner described with reference to Fig. 10. The systems of channels of the other coils are connected with each other in any way desired, just as if they belonged to the same coil or as if they were independent steam-turbines.

Fig. 12 represents diagrammatically the connection of channels in a steam-turbine having three coils m n o, each with four systems of channels g h i j. With this construction the increase of cross-section may be carried very far. For instance, if each system of channels consists of three groups, the cross-sections of which are in the proportion of one to one and one-half to two, the steam will be

caused to expand sixteenfold, and such high rate of expansion may be required when the initial pressure of the live steam is very high or when a condenser is used in connection with the turbine.

What I claim as new, and desire to secure by Letters Patent, is—

1. A turbine comprising two members, one rotatable relatively to the other and each provided with channels arranged to register with those of the other member and to form a path for the driving medium, the channels of one member being arranged in groups, all the channels of one group being equal in cross-section while the channels increase in cross-section progressively from group to group.

2. A turbine in which the channels of the guide and rotary member form windings, the channels of one member being of constant cross-section, while the channels of the other member increase in cross-section progressively, the steam-outlet being more inclined than the opposite inlet toward the periphery, while the respective inclinations are all alike from winding to winding.

3. A turbine in which the channels of the guide and rotary member form windings, the channels of one member being of constant inclination, while the channels of the other member vary in inclination progressively.

4. A turbine in which the channels of the guide and rotary member form windings, the channels of one member being of constant cross-section and inclination, while the channels of the other member increase progressively in cross-section and also vary progressively in inclination.

5. A turbine in which the channels of the guide and rotary member form windings arranged in a plurality of coils, each coil being subdivided into systems of windings.

6. A turbine in which the channels of the guide and rotary member form windings arranged in a plurality of coils, each coil being subdivided into systems of windings, these systems being connected together.

7. A turbine in which the channels of the guide and rotary member form windings arranged in a plurality of coils, each coil being subdivided into systems of windings, these systems progressively increasing in the cross-section and being connected together.

8. A turbine comprising two members, one rotatable relatively to the other and each provided with channels for the driving medium, said channels being arranged to register with each other and to form a spiral path, the channels in one of said members increasing in cross-section toward the outlet of the driving medium.

9. A turbine comprising two members, one rotatable relatively to the other and both provided with channels adapted to register and to form a path for the driving medium, said channels forming one series through which the driving medium is adapted to pass first, and a plurality of series connected in parallel with the outlet of the first-named series.

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

GABRIEL ZAHIKJANZ.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.