K. BAUMANN.

STEAM TURBINE.

APPLICATION FILED AUG. 17, 1920.

1,405,564.

Patented Feb. 7, 1922.

8 SHEETS—SHEET 1.

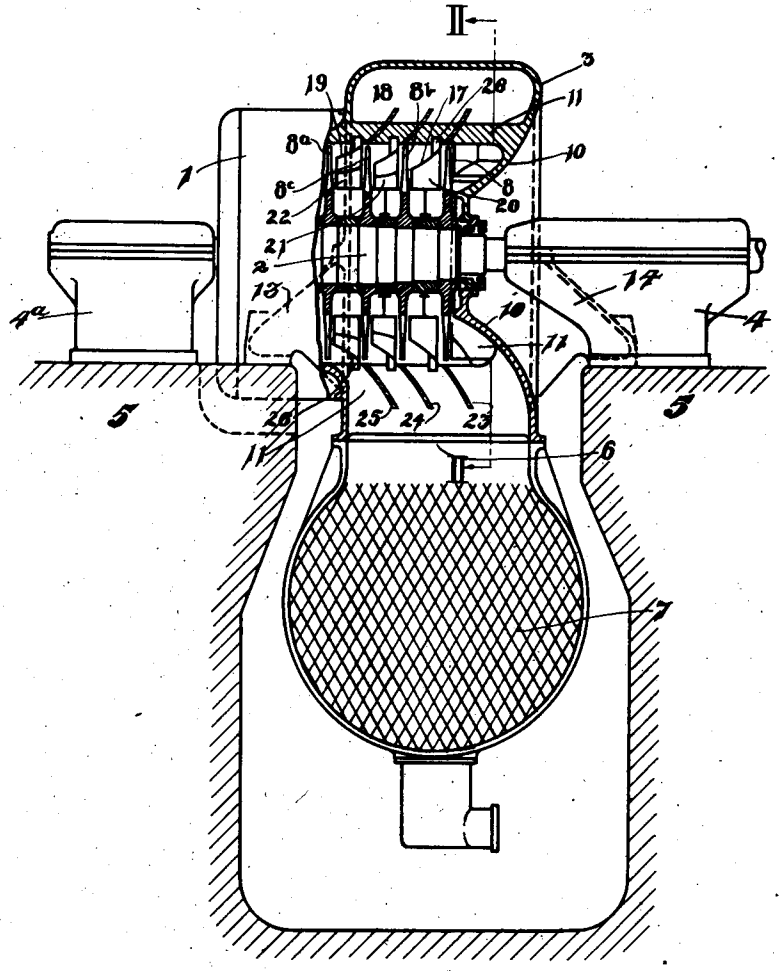


Fig. 1.

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8 SHEETS—SHEET 2.

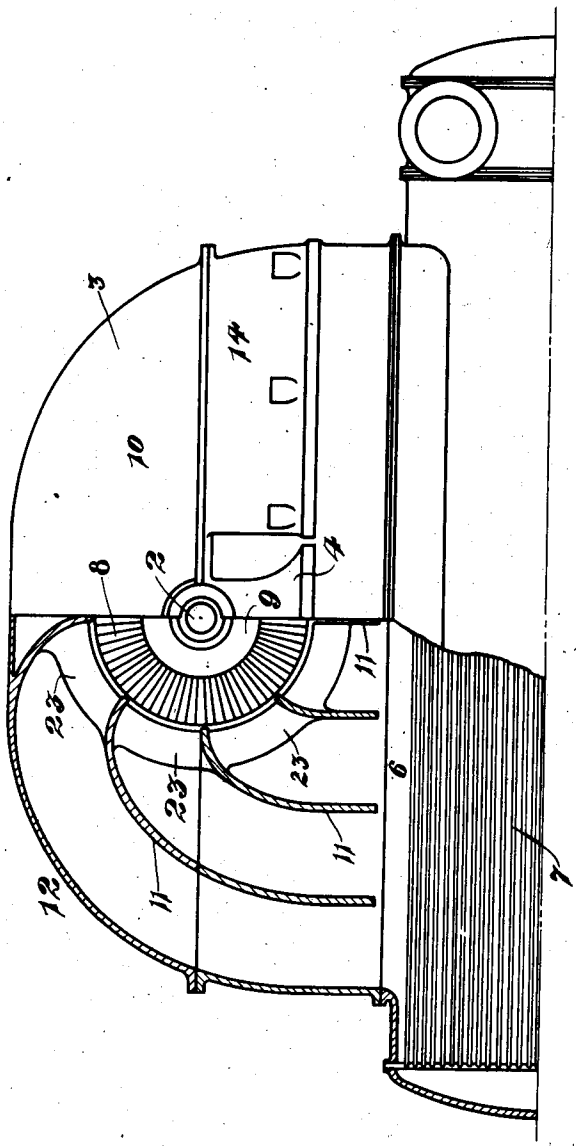


Fig. 2.

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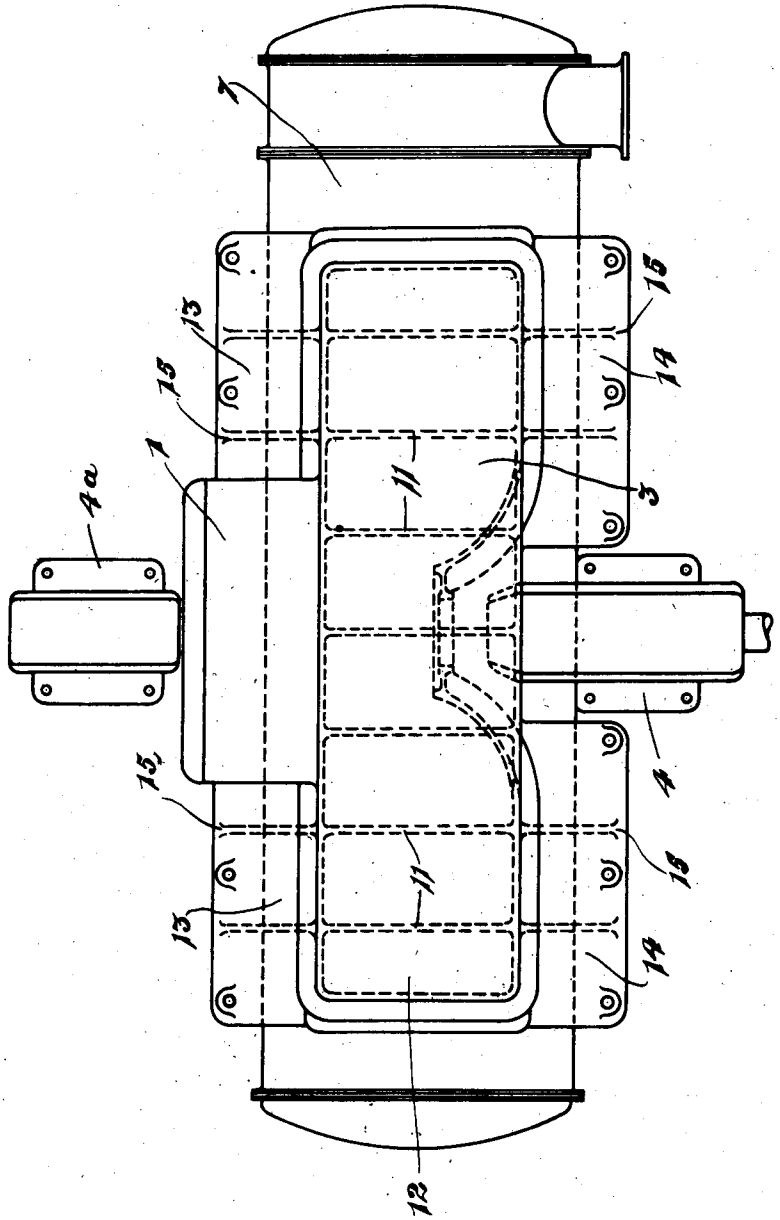


Fig. 3.

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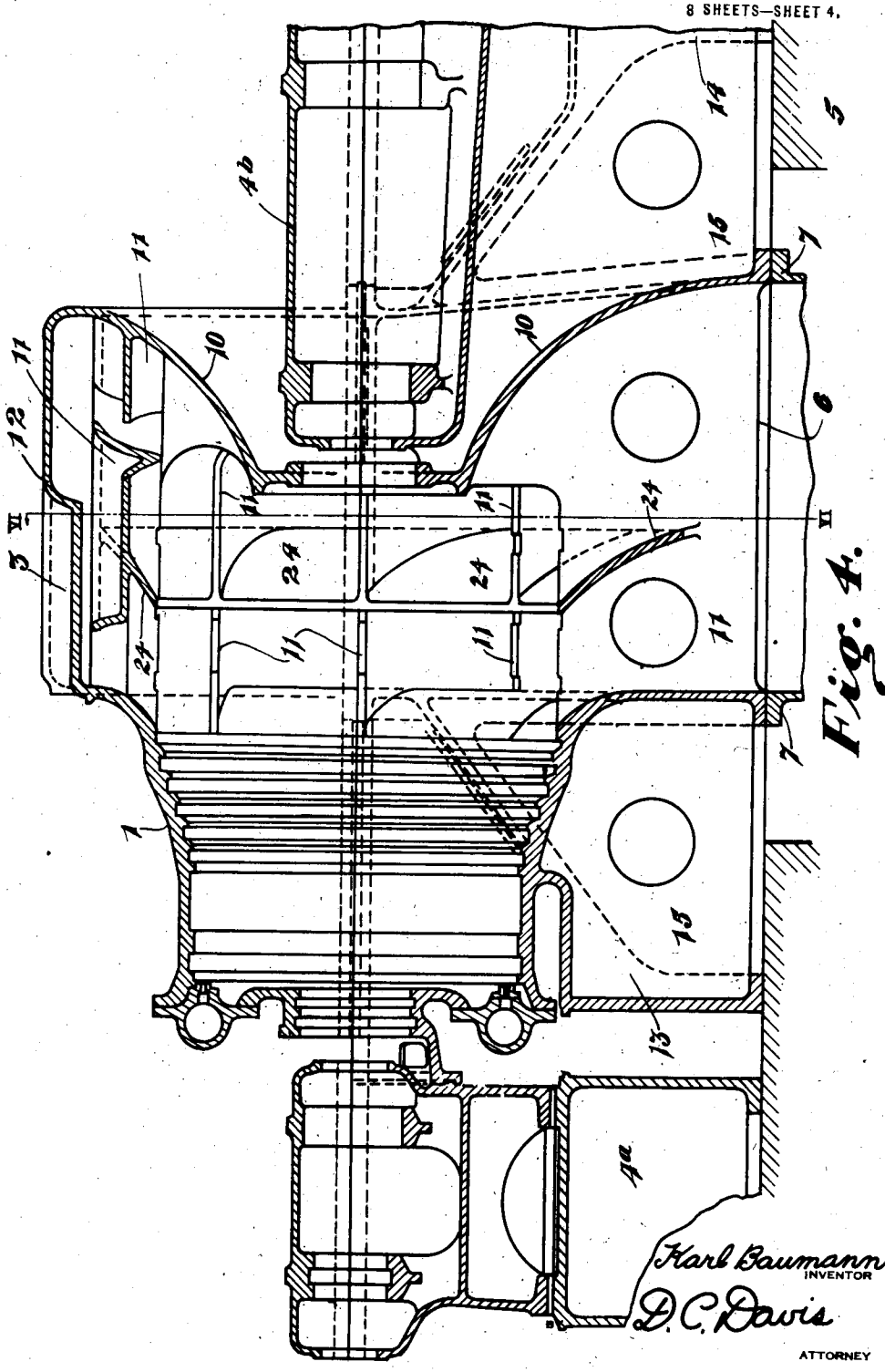


Fig. 4.

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8 SHEETS—SHEET 5.

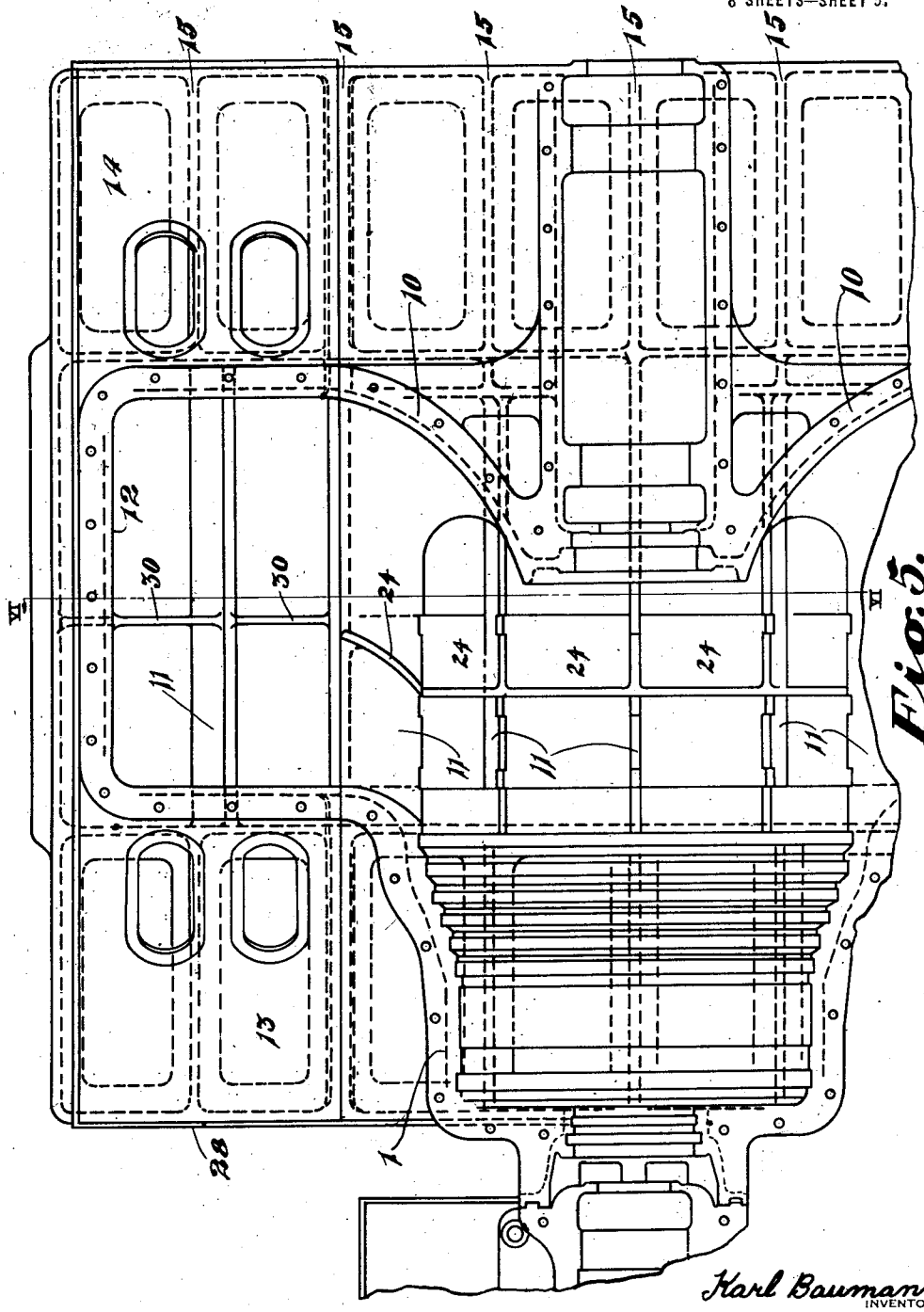


Fig. 5.

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8 SHEETS—SHEET 6.

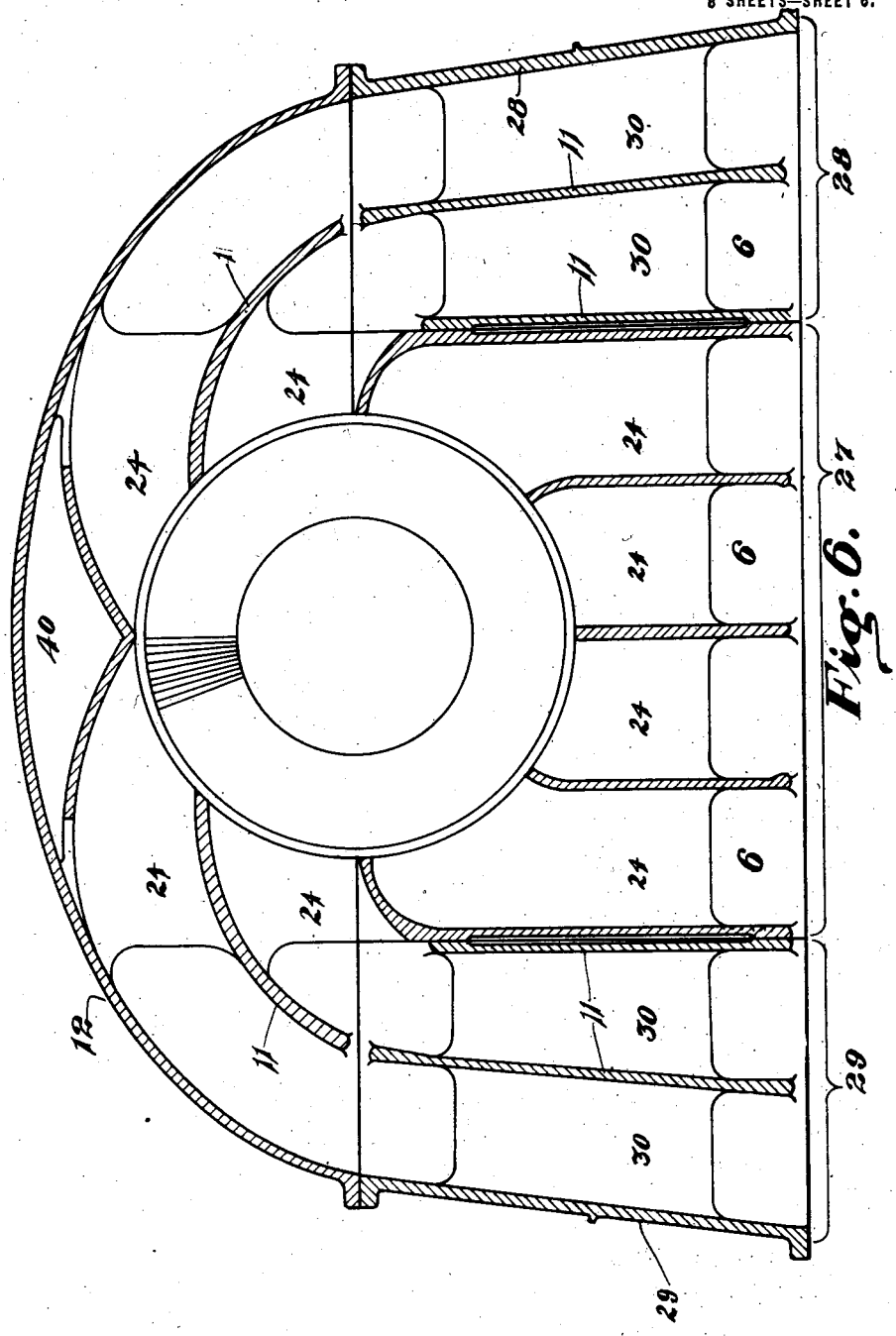


Fig. 6.

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APPLICATION FILED AUG. 17, 1920.

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8 SHEETS—SHEET 7.

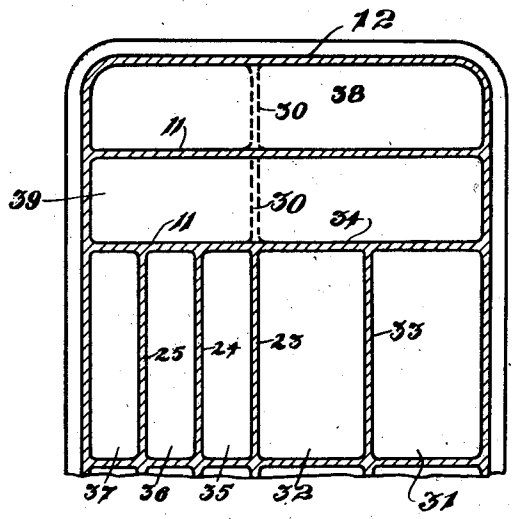


Fig. 10.

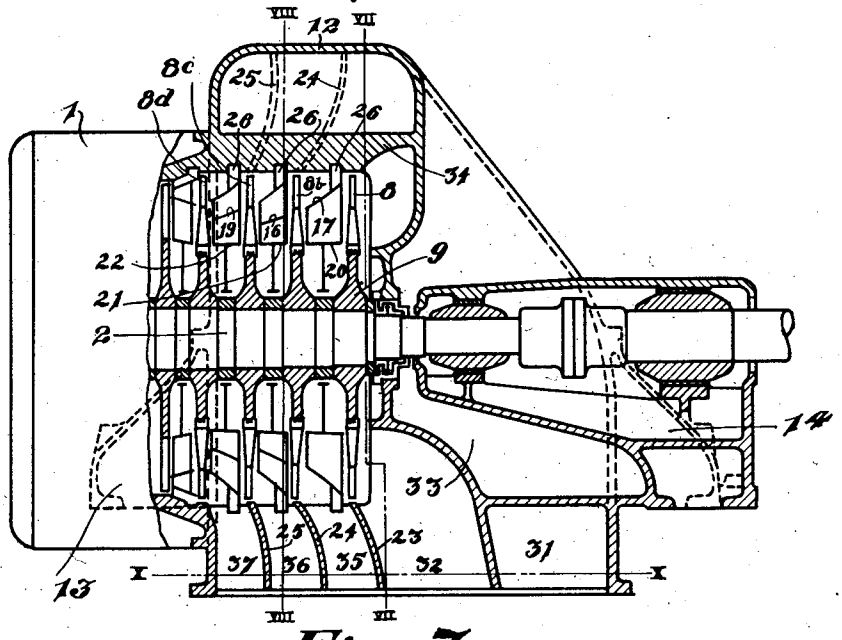


Fig. 7.

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8 SHEETS—SHEET 8.

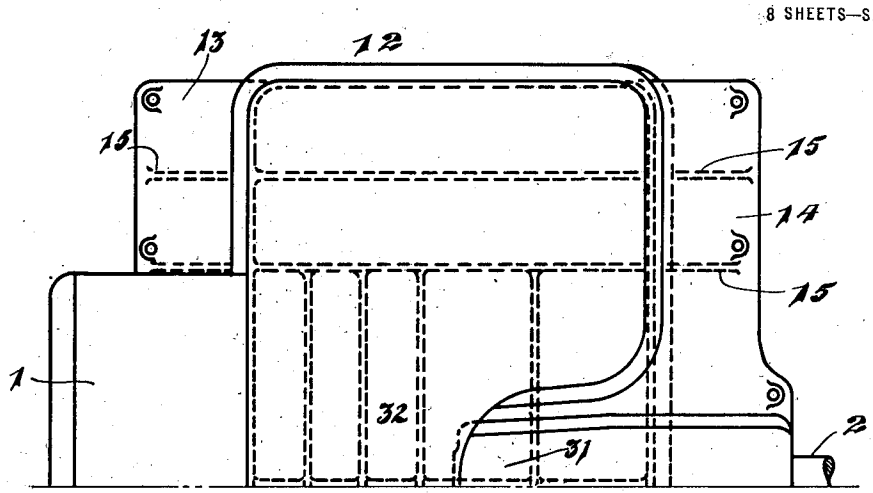


Fig. 9.

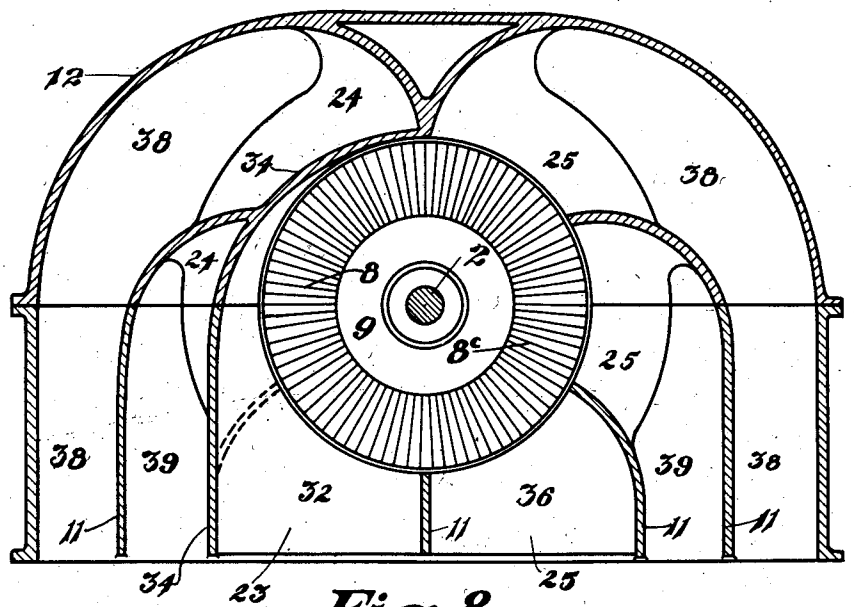


Fig. 8.

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UNITED STATES PATENT OFFICE.

KARL BAUMANN, OF URMSTON, ENGLAND, ASSIGNOR TO THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, A COMPANY OF GREAT BRITAIN.

STEAM TURBINE.

1,405,564. Specification of Letters Patent. Patented Feb. 7, 1922.

Original application filed October 4, 1916, Serial No. 123,697. Divided and this application filed August 17, 1920. Serial No. 404,147.

To all whom it may concern:

Be it known that I, KARL BAUMANN, a citizen of the Confederation of Switzerland and a resident of Urmston, in the county of Lancaster, England, have invented a new and useful Improvement in or Relating to Steam Turbines, of which the following is a specification, this application being a division of my application filed Oct. 4, 1916, Serial No. 123,697, and renewed Jan. 20, 1921, Serial No. 438,760.

This invention relates to steam turbines of the axial flow type, and although not limited in this respect, is especially applicable to turbines of this type in which the steam is led away to the exhaust outlet of the turbine from a plurality of rows of moving blades.

It is one of the objects of this invention to provide an improved construction of turbine exhaust casing by means of which the exhaust steam is conducted from the last row of moving or exhaust blades, or where there is more than one row, from some or all the rows of exhaust blades, to the exhaust outlet or outlets or the condenser or condensers.

Another object of the invention is so to improve the construction of the exhaust casing of a turbine that the steam leaving the turbine is uniformly distributed over a large area of the condensing surface of the condenser. In the case of a surface condenser for example, the steam may be distributed over the greater part, in some cases substantially the whole of the perimeter of the tube nest. In this way the utilization of the condensing surface of the condenser to the greatest possible advantage is ensured.

A further object of the invention is to increase the strength and rigidity of the exhaust casing so that the turbine may be supported on its foundations from the two ends only of the exhaust casing. With turbines having large exhaust outlets, as at present constructed, it is generally found necessary to support the turbine not only from the ends but also partly from both sides necessitating the employment of a bed-plate supported on girders between the two main foundation blocks. With a turbine having its exhaust casing constructed in accordance with the present invention a complete bed-plate is unnecessary as the turbine may be supported on soleplates on foundations provided for the ends only of the exhaust casing. With the improved rigid construction of turbine exhaust of this invention the condenser may in many cases advantageously be suspended direct from the turbine exhaust, no other support therefor being provided, and in this way the use of expansion pieces between the turbine and the condenser is obviated. In some cases, however, the condenser may in addition be provided with a resilient support.

Still another object of the invention is to reduce the cost of the construction of the exhaust casing of turbines in which the steam is led away to the exhaust from a plurality of rows of moving blades.

In a turbine exhaust casing constructed in accordance with this invention a suitably curved guide or guides are provided which deflect the whole of the steam leaving the exhaust blades outwardly into an approximately radial direction of flow. The enclosing walls of the exhaust casing are so formed as to conduct the steam, which has been deflected by the guide or guides aforementioned into an approximately radial direction of flow, to the exhaust outlet or outlets of the turbine or to the condenser or condensers outwardly in a direction substantially transverse to and away from the turbine axis. Guide walls are preferably also provided which divide the steam leaving one or more rows of moving exhaust blades into separate segmental portions. Said guide walls in conjunction with the enclosing walls of the exhaust casing of the turbine form passages which conduct the several segmental portions of steam to the exhaust outlet or outlets of the turbine or to the condenser or condensers where more than one is used.

In the drawings, Fig. 1 is a view, partly in section and partly in elevation, of a turbine installation including a turbine of the "multiple exhaust" type with my improvement applied thereto; Fig. 2 is a view partly in end elevation and partly in section along the line II—II of Fig. 1 viewed from the right; Fig. 3 is a plan view of the apparatus shown in Fig. 1; Fig. 4 is a longitudinal sectional view of a turbine cylinder showing a modified form of my improvement applied thereto; Fig. 5 is a plan view of a portion of the lower half of the cylin-

der shown in Fig. 5; Fig. 6 is a sectional view taken along the lines VI—VI of Figs. 4 and 5; Fig. 7 is a view partly in elevation and partly in section of a turbine showing a further modified form of my improvement applied thereto; Fig. 8 is a transverse sectional view, the left-hand portion of the section being taken along the line VII—VII and the right-hand half section being taken along the line VIII—VIII of Fig. 7; Fig. 9 is an half plan view of the apparatus shown in Fig. 7, and Fig. 10 is an half sectional view taken along the line X—X of Fig. 7.

Referring now to the drawings for a more detailed description of my invention, I show an axial-flow turbine wherein the elastic fluid or steam is led away to a condenser from a plurality of rows of moving exhaust blades. The turbine includes a cylinder 1, a shaft 2, and an exhaust casing 3, the shaft being supported in bearings 4 and 4^a. The bearings are carried by suitable pedestals supported by the foundations 5 as may be seen from Fig. 1, or one of the bearings may be supported by the exhaust casing structure, as may be seen from Fig. 4. The exhaust casing is supported upon the foundations 5 by means of feet 13 and 14, the latter being preferably provided with strengthening ribs 15.

One way in which the invention may be applied to a turbine of this description is illustrated in Figs. 1, 2 and 3. In Fig. 1 steam flows to the exhaust from the whole area of the moving blades 8 and from the upper portions of the rows of moving blades 8^b 8^c and 8^d. The curved guide which changes the direction of the flow of steam leaving the final row of moving blades 8 is constituted by a portion 10 of the rear wall of the exhaust casing 3 of the turbine. Curved guides for changing the direction of steam flowing from rows of moving blades 8^b 8^c and 8^d are constituted partly by the outer walls or shroudings 17, 18 and 19 respectively of the rows of stationary guide blades 20, 21 and 22, which are held in position by lugs 26 in the guide walls 11, and partly by curved guides 23, 24 and 25 also supported in the position shown by the guide walls 11. The guides 23, 24 and 25 are curved and flaring as shown and will be seen to resemble somewhat in shape the bell of a trumpet.

With this construction the steam leaving the row of moving blades 8 will be deflected by the curved portion 10 of the rear wall of the exhaust casing from an axial into an approximately radial direction. The steam leaving the outer portion of the row of blades 8^b will be deflected by the shrouding 17 and curved guide 23 from an axial into an approximately radial direction of flow whilst the steam leaving the outer portions of the rows of moving blades 8^c and 8^d will be deflected respectively by the shroudings 18 and 19 and curved guides 24 and 25 into a similar direction of flow.

The steam leaving all the rows of blades 8, 8^b, 8^c, and 8^d is divided circumferentially into segmental portions by the guide walls 11 and conducted away to the exhaust outlet 6 of the turbine, at which point, as will be clear from the left-hand portion of Fig. 2, all the segmental portions of steam will be flowing towards the condenser 7 in a similar direction.

Figs. 4, 5 and 6 show in somewhat greater detail than Figs. 1, 2 and 3 the improved exhaust casing of this invention adapted for use with a multiple exhaust turbine, the constructional details also being modified somewhat from those illustrated in the preceding figures. In Figs. 4 and 5 the turbine cylinder and exhaust casing only are shown, the rotor with its moving blades and the fixed diaphragms containing the guide blades being omitted. As in the turbine illustrated in Figs. 1, 2 and 3, the steam in the turbine shown in Figs. 4, 5 and 6, passes from four separate rows of moving blades to the exhaust. Curved guides 23 and 25 as shown in Fig. 1 are, however, not provided, only the central guide 24 being retained. If desired, however, the guide 24 may also be omitted.

The exhaust casing is increased in width as it approaches the exhaust outlet 6 and is also increased in length towards the exhaust outlet, enabling the width of the casing to be still further reduced whilst at the same time providing passages of suitable, preferably increasing, area for the steam on its way to the condenser. The lower half of the exhaust casing is, for convenience in manufacturing, preferably constructed in three portions as shown, a middle portion 27 and two outer portions 28 and 29. The curved guide 24 is extended some distance along the passages formed by the exhaust casing and the guide walls 11 and additional stiffening webs 30 are provided in the outer end portions 28, 29 of the casing. The supporting feet 14 also provide the necessary support for the bearing 46 at the exhaust end of the turbine, as the bearing is carried by the casing, thus obviating the necessity of providing a separate pedestal for this purpose. The supporting feet 13 are continued under and formed integrally with the lower portion of the turbine cylinder as clearly seen in Figures 4 and 5. The supporting feet 13 are not, however, connected to any portion of the turbine cylinder, subjected to high temperatures in order to avoid excessive expansion of said feet which might tend to throw the cylinder out of line with the turbine shaft. The overhung portion of the high pressure end of the cylinder is con-

nected with the bearing pedestal by an extension of the lower half of the cylinder so as to ensure said overhung portion of the cylinder being maintained central with the turbine shaft.

The passages which conduct the segmentally divided portions of steam from the rows of exhaust blading to the exhaust outlet or the condenser may be constructed and arranged in various ways as may be found most desirable. Various factors will determine which is the most advantageous way in which such passages should be arranged. For instance, one factor to be considered is the shape and dimensions of the condenser as it is desirable, as hereinbefore stated, so to arrange the exhaust outlet of the turbine that the steam may be distributed as uniformly as possible over the greatest possible area of the condensing surface. In some cases it will be found beneficial to increase the length rather than the width of the passages, and also to extend the passages in a direction towards the rear end of the turbine as they approach the exhaust outlet, which will reduce the width of the exhaust outlet and enable a compact outlet to be arranged.

In the case of a turbine having three or four separate rows of moving exhaust blades, the passages conducting the steam from the final row of exhaust blades may be so arranged that when they reach the exhaust outlet they are more or less centrally located at the rear end of the outlet, whilst the passages conducting the steam away from the earlier and penultimate rows of exhaust blades may be arranged at the exhaust outlet in various ways in front of and at both sides of the first mentioned exhaust passages.

In a multiple exhaust turbine of the kind hereinbefore mentioned one of the types of exhaust casing heretofore usualy adopted may be utilized to conduct away the steam flowing from the final row of exhaust blading, the steam flowing from the earlier rows of exhaust blading being conducted away by an exhaust constructed in accordance with the present invention.

A multiple exhaust turbine having an exhaust casing consisting of a combination of the two types above mentioned is shown in Figs. 7 to 10. In the arrangement illustrated in these figures the steam from the upper half of the final row of moving exhaust blades 8 is led away through the passage 31, and the steam from the lower half of such blades through the passage 32, the steam flowing from the blades 8 being divided into two valves by a diaphragm 33 of a well known kind. The passages 31 and 32 which conduct the steam leaving the upper and lower halves of the final row of exhaust blades 8 are formed by the rear wall of the exhaust casing, the diaphragm 33, the curved guide 23 and an additional internal division wall 34, which is a continuation of one of the guide walls 11 and forms the end wall of the passages 31 and 32.

The steam leaving the other rows of moving blades 8^b, 8^c and 8^d is deflected by the curved guides 17, 18, 19 and 23, 24 and 25, and the guide walls 11 in the manner hereinbefore described with reference to Figs. 1 to 3. In the arrangement described in Figs. 7 to 10 it will be observed that a less number of guide walls 11 is employed than is provided in the construction shown in Figs. 1 to 3, and these form passages which terminate in exhaust outlets arranged as shown in Fig. 10. The steam from the lower portions of the rows of exhaust blades 8^b, 8^c, and 8^d flows through the passages 35, 36 and 37 respectively. The steam from the upper portions of these rows of blades flows through the passages 38 whilst the steam from the remaining portions of these rows of blades flows through the passages 39 to the exhaust. As Fig. 9 is a half plan only and Fig. 10 a half section it will be understood that passages corresponding to the passages 31, 32 and 35 to 39 inclusive are located in the other half of the exhaust casing not shown.

From the construction illustrated in these figures it will be seen that an exhaust outlet is provided of a very compact shape.

It should be understood that the diaphragm 33 may, if desired, be omitted and will of course not exist when an exhaust for the final row of moving blades of the construction heretofore usually employed is adopted.

In some forms of turbine exhaust casing constructed in accordance with this invention, certain portions of the guide walls may be omitted as these are not necessary for the guidance of the steam when adjacent portions thereof are flowing in substantially the same direction. On the other hand, for the purpose of strengthening the construction of the exhaust casing so that the support of the turbine may be simplified and the condenser or condensers hung directly from the exhaust casing, additional stiffening webs may be added, such for instance as the webs 30 (see Figs. 5, 6, and 10), care being taken that they are so shaped and located that they do not interfere with the flow of steam.

In order that the exhaust casing near its outlet may have the maximum strength and rigidity the several passages therein are preferably so arranged and located with respect to one another that the walls forming the several passages are so far as possible continuations one of the other. Where the turbine is supported at the ends only of the exhaust casing the guide walls con-

ducting away the segmental portions of steam should be continuations one of the other. In some cases it may be desired to support the turbine by feet located at the sides only or at the sides as well as at the ends of the exhaust casing. In such cases the exhaust casing may be given the necessary strength by providing additional stiffening webs such as the web 30 for example. In many cases the desired continuity of the guide walls can be secured by suitably changing the shape and disposition of the various passages as they approach the exhaust outlet.

While I have shown my invention in a plurality of forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. A low-pressure section for an elastic-fluid turbine comprising a plurality of rows of moving exhaust blades, means for changing the direction of flow of the elastic fluid from the direction in which it flows between the blades, and means for segmentally dividing the elastic fluid discharged from said blades into a plurality of portions and conducting it away in separate streams.

2. In an elastic-fluid turbine, a low-pressure section comprising a plurality of rows of moving exhaust blades, an exhaust casing having an exhaust outlet and including means for changing the direction of flow of elastic fluid discharged from said blades from an axial to approximately a radial direction and means for segmentally dividing the elastic fluid discharged from said blades into a plurality of portions and for guiding the portions for discharge from the outlet in a like direction.

3. In combination with an axial-flow turbine having a pulrality of rows of moving exhaust blades, an exhaust casing having a plurality of circumferentially extending guiding surfaces for directing the fluid discharged from said rows from an axial to approximately a radial direction of flow, and a plurality of partitions within said casing for dividing the fluid passing therethrough into a plurality of segmental portions.

4. In a power-plant installation, the combination with a condenser, of an axial-flow turbine including a low-pressure section having a plurality of rows of moving exhaust blades and a plurality of passages associated with said rows of blades for leading exhaust elastic fluid to and distributing it along the condenser.

5. In a power-plant installation, the combination of an axial-flow turbine and a condenser, said turbine including a low-pressure section having a plurality of exhaust blades, means for changing the direction of flow of elastic fluid discharged from said exhaust blades from an axial to approximately a radial direction, and means for segmentally dividing the elastic fluid discharged from said rows of blades and for distributing the exhausted elastic fluid along the condenser.

6. In a power-plant installation, the combination with a condenser of the surface type, of an axial-flow turbine having its axis extending transversely to the major axis of the condenser and including a plurality of moving rows of exhaust blades and means for changing the direction of flow of elastic fluid discharged from each of said rows from an axial to approximately a radial direction, for dividing the elastic discharged from said rows of blades segmentally with respect to the latter, and for distributing said exhaust fluid along the condenser.

7. In an axial-flow turbine, the combination of an exhaust casing, a plurality of rows of stationary and moving blades in which the steam is divided into a plurality of annular portions for discharge to the exhaust casing from the moving blades, means carried by the stationary blades and the exhaust casing for changing the direction of flow of each annular portion from an axial to approximately a radial direction, and a plurality of partitions carried by the exhaust casing for dividing the radially-flowing annular portions into a plurality of segmental portions.

8. In an axial-flow turbine, the combination of an exhaust casing having an exhaust outlet, a plurality of rows of stationary and moving blades in which the steam is divided into a plurality of annular portions for discharge to the exhaust casing from the moving blades, circumferentially extending means carried by the stationary blades and by the exhaust casing for changing the direction of flow of each annular portion except the last from an axial to approximately a radial direction, said casing having means for changing in a like manner the direction of flow of the annular portion of steam discharged from the last row of moving blades, curved partitions carried by the casing for dividing the radially-flowing annular portions into segmental portions, for maintaining the latter in separate streams, and for controlling the direction of flow thereof so that all of said portions pass from the outlet in a like direction.

9. In an axial-flow turbine, the combination of an exhaust casing having an outlet,

a plurality of rows of moving blades discharging to the exhaust casing, means for changing the direction of flow of the exhaust discharged from said moving rows of blades from an axial to approximately a radial direction, curved partition means carried by said casing for segmentally dividing the radially-flowing steam, maintaining the divisions in separate streams, and for controlling the direction of flow so that the steam is discharged in a like direction with the discharge streams of the last row of blades arranged centrally and at the rear of the outlet and the discharge streams of the other rows arranged at the sides and in front of the last row discharge streams at the outlet.

In testimony whereof, I have hereunto subscribed my name this twenty second day of June, 1920.

KARL BAUMANN.