No. 869,773. PATENTED OCT. 29, 1907.

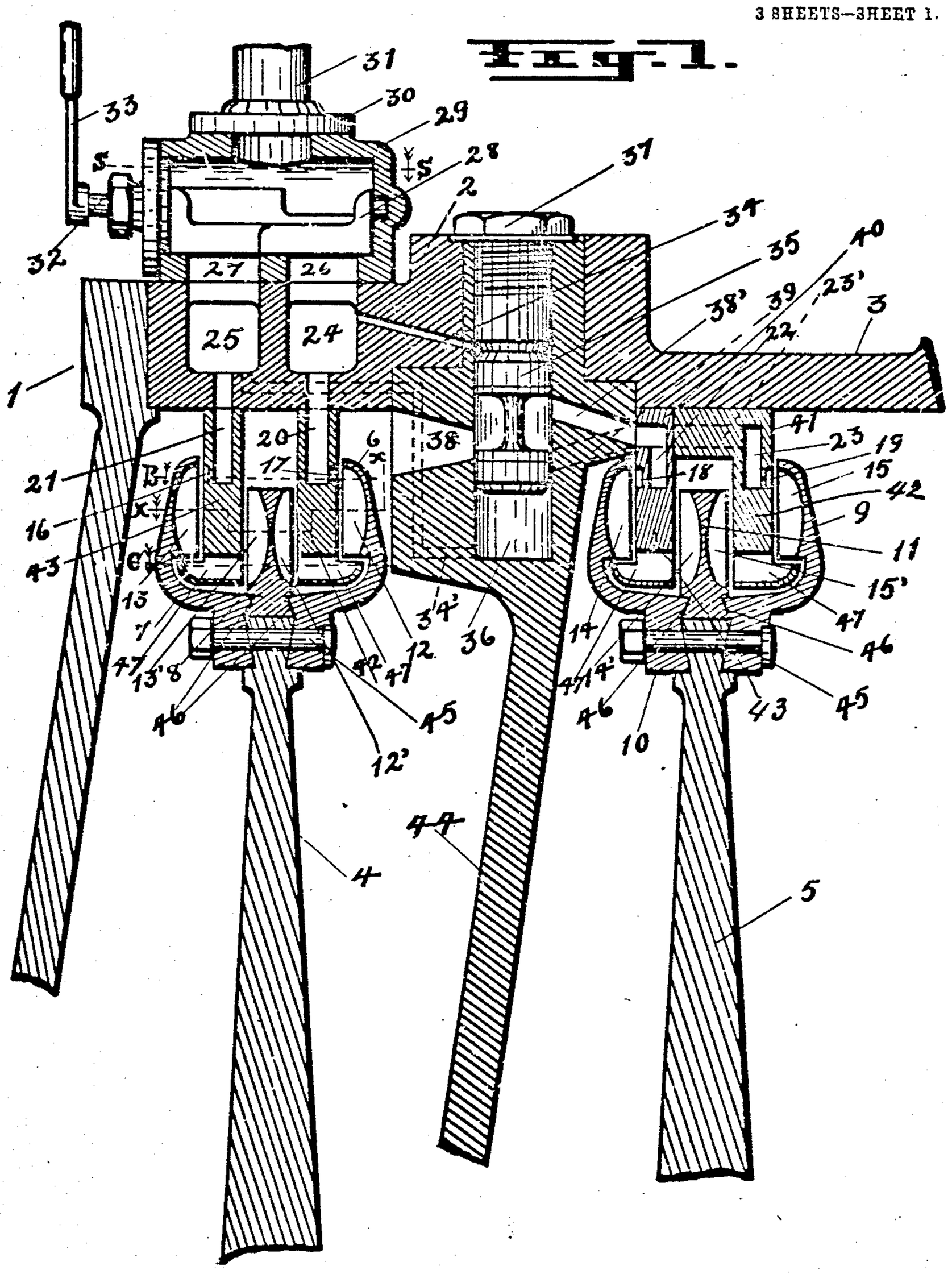
C. W. DAKE.

REVERSIBLE ELASTIC FLUID TURBINE.

APPLICATION FILED JAN. 10, 1907.

3 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

Gertrude Tallman

O. J. [illegible]

INVENTOR.

Charles. W. Dake.

BY Chappell & Earl

ATTORNEYS

No. 869,773. PATENTED OCT. 29, 1907.

C. W. DAKE.

REVERSIBLE ELASTIC FLUID TURBINE.

APPLICATION FILED JAN. 10, 1907.

3 SHEETS—SHEET 2.

Fig. 2.

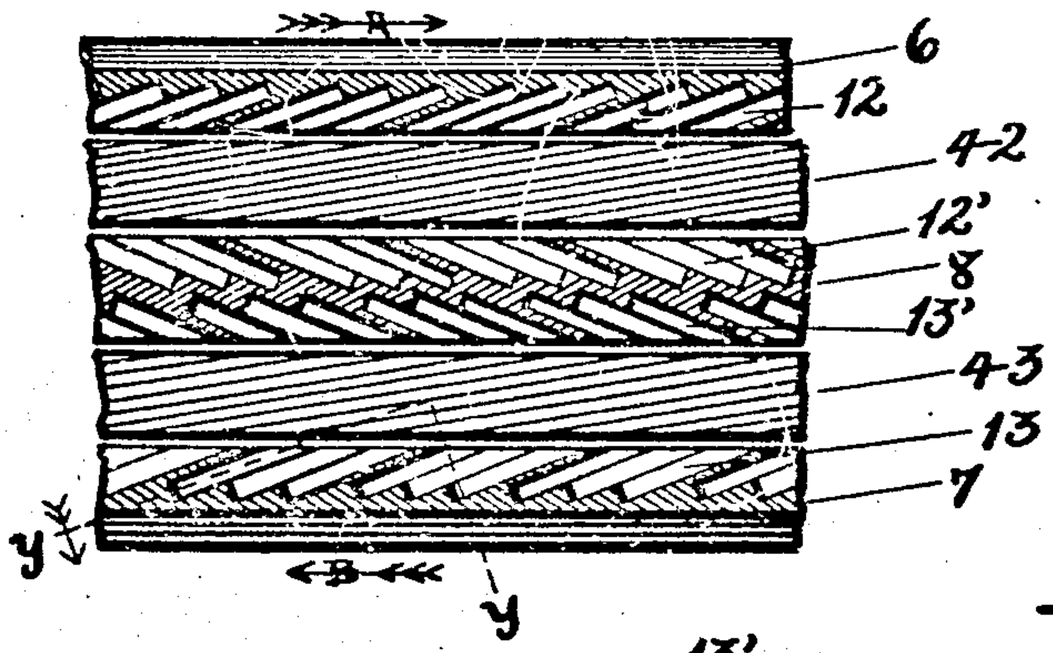


Fig. 3.

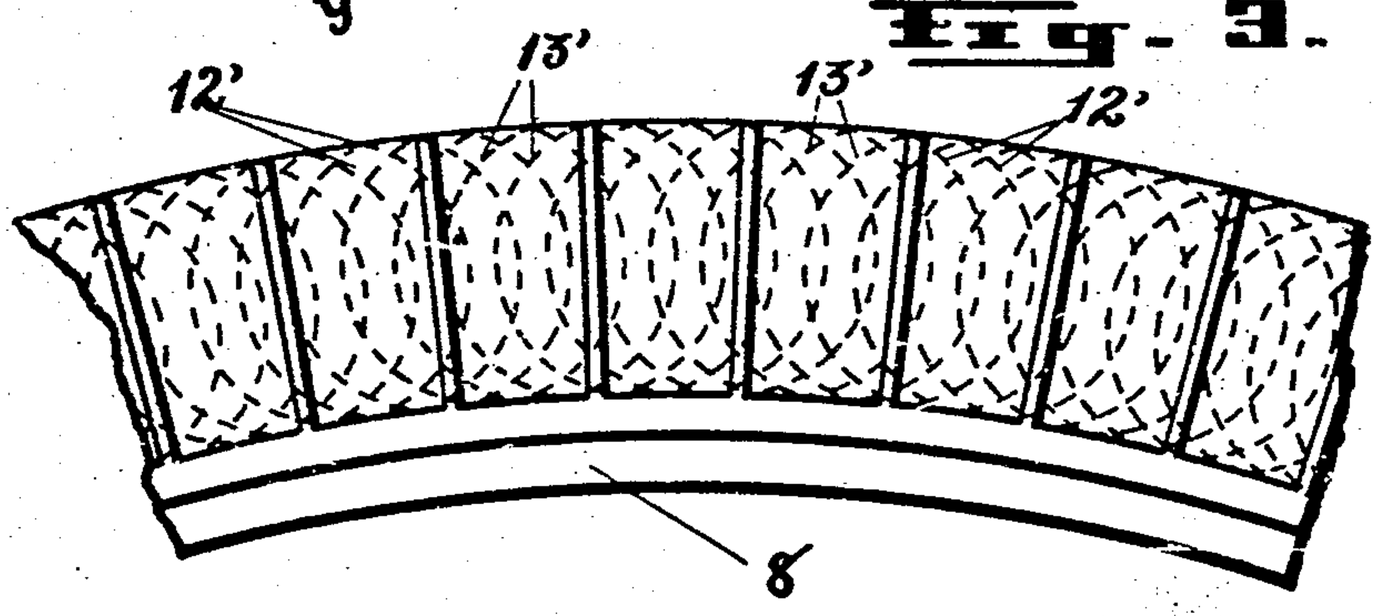
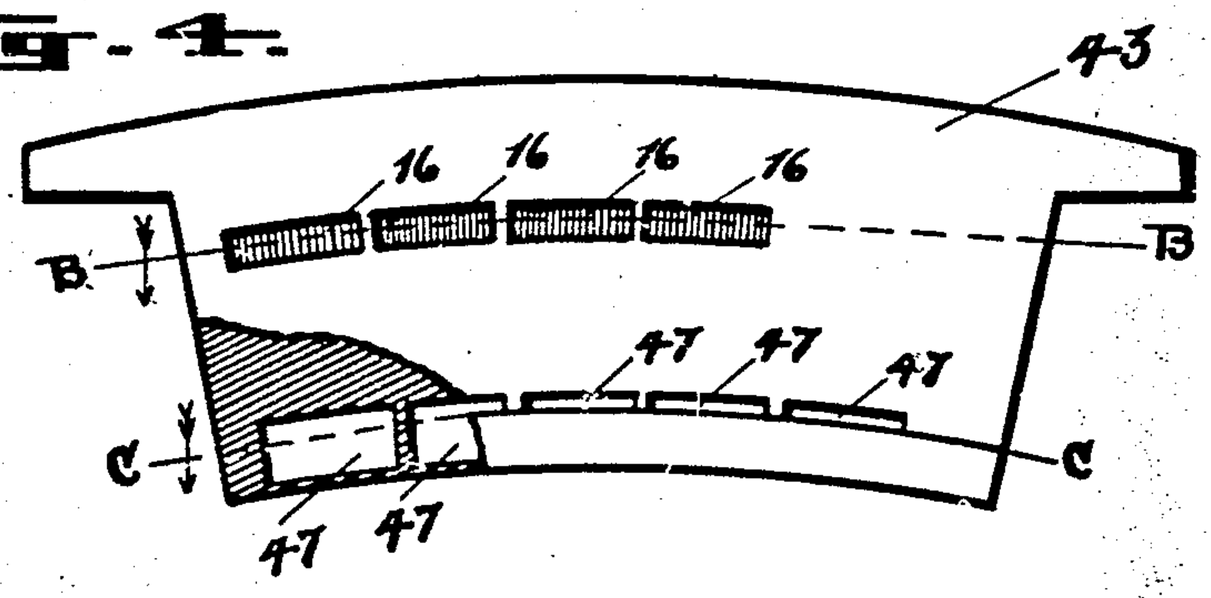


Fig. 4.



WITNESSES:

Gertrude Tallman

A. F. Ostrom

INVENTOR.

Charles. W. Dake.

BY Russell & Earl

ATTORNEYS.

No. 869,773. PATENTED OCT. 29, 1907.

C. W. DAKE.

REVERSIBLE ELASTIC FLUID TURBINE.

APPLICATION FILED JAN. 10, 1907.

3 SHEETS—SHEET 3.

Fig. 5.

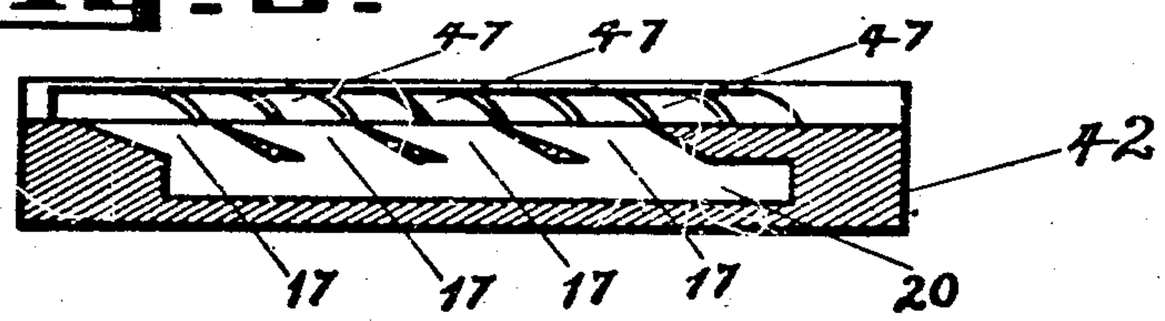


Fig. 6.

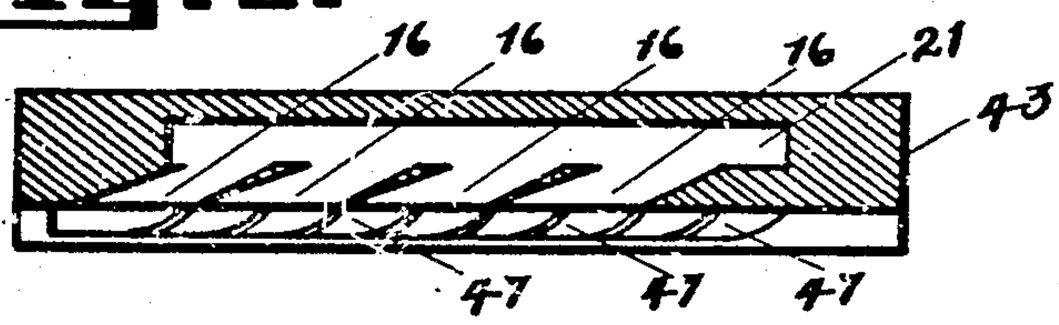


Fig. 7.

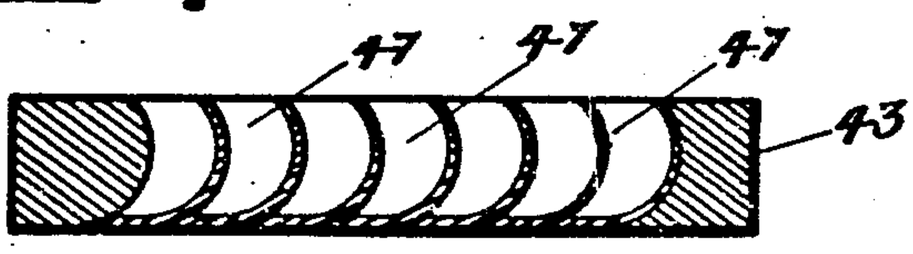


Fig. 8.

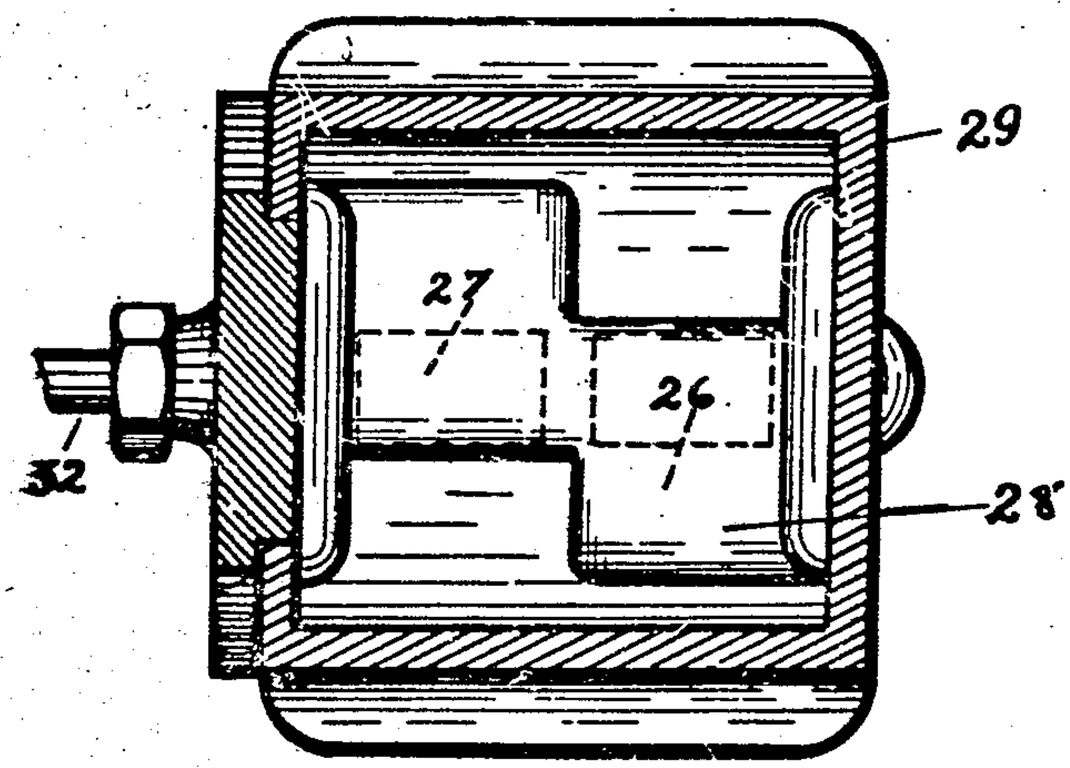
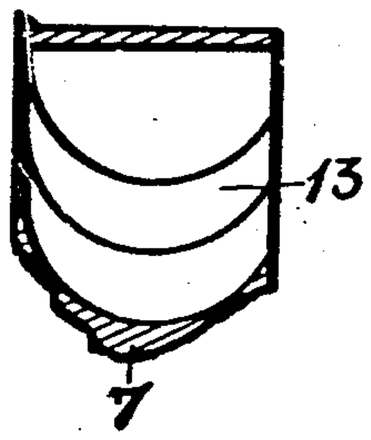


Fig. 9.



WITNESSES:

Gertrude Tallman

A. J. Thurston

INVENTOR.

Charles. W. Dake.

BY Chappell & Earl

ATTORNEYS.

UNITED STATES PATENT OFFICE.

CHARLES W. DAKE, OF GRAND RAPIDS, MICHIGAN.

REVERSIBLE ELASTIC-FLUID TURBINE.

No. 869,773. Specification of Letters Patent. Patented Oct. 29, 1907.

Application filed January 10, 1907. Serial No. 351,607.

To all whom it may concern:

Be it known that I, CHARLES W. DAKE, a citizen of the United States, residing at the city of Grand Rapids, county of Kent, State of Michigan, have invented certain new and useful Improvements in Reversible Elastic-Fluid Turbines, of which the following is a specification.

This invention relates to improvements in reversible elastic fluid turbines.

The objects of this invention are, first, to provide an improved means of reversing the direction of the rotation of the turbine wheel. Second, to provide means of automatically reversing all of the stages of a multistage turbine when the principal or first stage wheel is reversed. Third, to simplify the construction of reversible elastic fluid turbines and to increase the efficiency of the same within given dimensions.

Objects pertaining to details of construction will definitely appear from the description and specification to follow.

I accomplish the objects of my invention by the devices and means described in the following specification. The invention is clearly defined and pointed out in the claims.

Portions of an elastic fluid turbine sufficient to illustrate my invention are clearly illustrated in the accompanying drawing, forming a part of this specification, in which,

Figure 1 is a detail axial section of my improved elastic fluid turbine, showing the several parts in their relative positions, the buckets and guide passages being shown diagrammatically and not at their corresponding angles. Only such parts of the casing valves, rotors or turbine wheels appear in this view as is necessary to fully understand the invention. Fig. 2 is a detail section, somewhat enlarged, taken on the irregular line X—X of Fig. 1, looking in the direction of the arrow at the end of the line. Only a broken section of the several parts is shown, and their relations are here shown diagrammatically. The position of the buckets indicates the direction of rotation, which is also shown by the arrows A and B. Fig. 3 is a detail side elevation view, somewhat enlarged, of the central bucket ring removed from the turbine wheel, the oppositely-facing U-shaped buckets being indicated by the dotted lines. Fig. 4 is a side elevation of one of the nozzle and guide passage blocks 43, removed from the turbine, a portion being sectioned, the nozzles 16 and the guide passages 47 appearing. Fig. 5 is a detail sectional view, somewhat enlarged, of the nozzle and guide passage blocks 42, taken on a line corresponding to line B—B of Fig. 4, and of the line B—B of Fig. 1, the buckets 42 and 43 being symmetrical but opposite, so that they act in opposite directions. Fig. 6 is a detail sectional view, slightly enlarged, of the nozzle and guide passage block 43, taken on a line B—B, looking in the direction of the little arrow and it will be seen that it is exactly symmetrical with the section of the block 42 illustrated in Fig. 5. Fig. 7 is a detail sectional view of the nozzle and guide passage block 43, taken on a line C—C of Figs. 1 and 4, which shows the guide passage 47 for conducting the fluid from one row of buckets to the rows of buckets on the opposite side of the guide block to secure the further reaction of the same. Fig. 8 is an enlarged detail sectional view of the reversing valve, taken on a line corresponding to line S—S of Fig. 1, and Fig. 9 is a detail sectional view on irregular line Y—Y of Fig. 2 and illustrates the U-shaped buckets as here used, the particular form being the subject of a pending application of mine.

In the drawing, similar numerals of reference refer to similar parts throughout the several views.

Referring to the numbered parts of the drawing, only such portions of an engine are illustrated as are necessary to an understanding of the different features.

The base and the bearings for the turbine wheels and other parts are not here illustrated at all, because my invention does not pertain to them. I show a portion of the front casing 1, in section, the ring casing 2 for the first stage, and the ring casing 3 for the secondary stage of the motor with the diaphragm 44 between the same. I also show a portion in section of the first stage turbine wheel 4 and also a similar portion of the secondary stage turbine wheel 5.

The bucket rings or segments 6 and 7 are substantially duplicates, except that they are symmetrical and point in opposite directions. The bucket ring 8 at the center has buckets formed on both sides thereof arranged to rotate the wheel in opposite directions, coacting with the buckets of the said rings 6 and 7, respectively, depending on which side of the wheel is in operation and in which direction it is rotating. Bucket rings or segments 9 and 10 of the second stage are exactly similar, except of a little larger size than the bucket rings 6 and 7 of the first stage turbine wheel, and the central bucket ring 11 is exactly similar to the central bucket ring 8 of the first stage turbine wheel, except that it is correspondingly larger.

U-shaped buckets 12 are formed in the bucket ring 6, and re-act with the U-shaped buckets 12′ on the corresponding side of the central ring 8, and on the opposite side of the wheel there are the buckets 13 in the rings 7 and 13′ in the corresponding side of the central bucket ring 8, which are exactly similar to the buckets 12 and 12′, except that they are arranged to re-act in the opposite direction and are symmetrical.

Buckets 14 in the bucket rings 10 and 14′ in the side of the central bucket ring 11 of the secondary stage turbine wheel correspond to the buckets 13 and 13′ of the first stage turbine wheel, and the buckets 15 of the bucket rings 9 and 15′ in the central bucket ring 11 correspond exactly to the buckets 12 and 12′ in the

first stage turbine wheel. The buckets 15 and 15′ face in the opposite direction from the buckets 14 and 14′ and these have the same relation to each other that the buckets 12 and 12′ have to the buckets 13 and 13′.

High pressure nozzles 16 and 17 are in the nozzle and guide blocks 42 and 42′, respectively, being exactly similar except symmetrical for delivering fluid to the buckets of the two sides of the prime or first stage of the turbine. Nozzles 18 and 19 of the second stage correspond to the nozzles 16 and 17 of the first stage rotor, being located respectively in corresponding guide passage blocks, the blocks being numbered 40 and 41, respectively. Guide passages 47 are through the nozzle and guide passage blocks 42, 43 and 40 and 41, being exactly opposite and symmetrical in each of the said pairs of blocks, the details of such guide passages clearly appearing in Figs. 4 and 7, and their relative position also being indicted in Fig. 1. There is a row of nozzles and of guide passages in each block. An elastic fluid passage 20 delivers to the nozzles 17 and a similar passage 21 delivers to the nozzle 16. A similar passage 22 delivers to the nozzle 18 and a similar passage 23 delivers to the nozzle 19 of the second stage.

An annular elastic fluid chamber 24 delivers fluid to the several direct acting nozzle blocks, and an annular fluid chamber 24 delivers fluid to the several reverse nozzle-blocks, these annular chambers being indicated in the cross-section appearing in Fig. 1. Passages 26 and 27 lead from the valve chamber 29 to these annular chambers 25 and 24, respectively. A valve 28 is provided for admitting fluid to either of the passages 26 and 27, or for closing the same as may be required to operate the turbine in either direction, or to stop it, the ports in the valve being arranged in relation to each other, so that, when one is opened, the other is closed, and so that both may be closed. The ports are so arranged that only one can be opened at a time. The valve casing 29 is provided with a flange 30 to which a fluid supply pipe 31 is connected. The valve 28 is provided with a stem 32, which is under control of the hand lever 33, by means of which the valve, and consequently the engine, is controlled.

A small port leads from the annular chamber 24 to actuate a valve which controls the admission of the elastic fluid to the secondary stage turbine, and a similar port 34′ leads from the annular chamber 25 to act upon the same valve when steam is admitted to this part of the engine to automatically control the flow of steam to the secondary stage rotor. These ports lead to a valve chamber 36, within which is located a piston valve 35, which has an annular port at its center and connects the conducting passage 38 to the passage 38′ when the valve is in the upper position, as indicated in Fig. 1, or to the port or passage 39, when the valve is moved downward by the pressure of the steam delivered through the port 34. The port 38′ leads from the valve chamber 36 to the passage 22, already herein referred to and described, into the nozzle and guide passage block 40 and the port 39, shown by dotted lines, leads from the valve chamber 36 to the passage 23′ and thence to the passage 23 into the nozzle and guide passage block 41 already heretofore described.

It will be observed that the various segments and rings are secured to the disks or wheels 4 and 5 by bolts 45, therethrough, the peripheries of the wheels being dove-tailed and the central rings 8 and 11 being oppositely dove-tailed. The oppositely-facing rings 6 and 7, and 9 and 10, are conformed to these dove-tails, so that, when the bolts are tightened, all of the parts are positively located and locked together in their correct relation.

I desire to remark that many of the details of this structure can be varied without departing from the broad features of my invention. I believe, however, that I have shown details of the construction that possess merits in themselves, and I desire to claim the same specifically as well as the broad feature of the invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a reversible elastic fluid turbine, the combination of a suitable casing divided by a diaphragm; a primary and a secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, consisting of a central ring with U-shaped buckets facing in opposite directions on the opposite sides thereof, and segments or rings corresponding thereto and opposite the same; nozzle and guide blocks in pairs, one block at least for each set of buckets facing in opposite directions; annular passages connected to each series of guide blocks in pairs; a valve arranged to control the admission of the fluid to either of said passages separately, or to shut off the said fluid entirely; an automatic valve between the two parts of the engine, the same being a piston valve operated by the elastic fluid; passages leading from the annular chambers of each side of the primary turbine to opposite ends of the valve chamber of the piston valve for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled by the said automatic piston valve for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

2. In a reversible elastic fluid turbine, the combination of a suitable casing divided by a diaphragm; a primary and a secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, consisting of a central ring with U-shaped buckets facing in opposite directions on the opposite sides thereof, and segments or rings corresponding thereto and opposite the same; nozzle and guide blocks in pairs, one block at least for each set of buckets facing in opposite directions; annular passages connected to each series of guide blocks in pairs; a valve arranged to control the admission of the fluid to either of said passages separately, or to shut off the said fluid entirely; an automatic valve between the two parts of the engine; passages leading from the annular chambers of each side of the primary turbine for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled by the said automatic valve for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

3. In a reversible elastic fluid turbine, the combination of a suitable casing, divided by a diaphragm; a primary and secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, arranged to be acted upon to rotate the wheel in opposite directions; nozzle and guide blocks in pairs, one block at least for each set of buckets, facing in opposite directions from each other, arranged to co-act with the corresponding rows of buckets; passages connected to each series of guide blocks; a valve arranged to control the admission of fluid through said passages separately or to shut off the fluid entirely; an automatic valve between the two parts of the engine, the same being a piston valve operated by the elastic fluid; passages leading from the annular chambers in each side of the primary turbine, to

opposite ends of the valve chamber of the piston valve, for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled from the said automatic piston valve, for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

4. In a reversible elastic fluid turbine, the combination of a suitable casing, divided by a diaphragm; a primary and secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, arranged to be acted upon to rotate the wheel in opposite directions; nozzle and guide blocks in pairs, one block at least for each set of buckets, facing in opposite directions from each other, arranged to co-act with the corresponding rows of buckets; passages connected to each series of guide blocks; a valve arranged to control the admission of fluid through said passages separately or to shut off the fluid entirely; an automatic valve between the two parts of the engine; passages leading from the annular chambers in each side of the primary turbine for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled from the said automatic valve, for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

5. In a reversible elastic fluid turbine, the combination of a suitable casing divided by a diaphragm; a primary and a secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, consisting of a central ring with U-shaped buckets facing in opposite directions on the opposite sides thereof, and segments or rings corresponding thereto and opposite the same; nozzle and guide blocks in pairs, one block at least for each set of buckets facing in opposite directions; annular passages connected to each series of guide blocks in pairs; means arranged to control the admission of the fluid to either of said passages separately or to shut off the said fluid entirely; an automatic valve between the two parts of the engine, the same being a piston valve operated by the elastic fluid; passages leading from the annular chambers of each side of the primary turbine to opposite ends of the valve chamber of the piston valve for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled by the said automatic piston valve for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

6. In a reversible elastic fluid turbine, the combination of a suitable casing divided by a diaphragm; a primary and a secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, consisting of a central ring with U-shaped buckets facing in opposite directions on the opposite sides thereof, and segments or rings corresponding thereto and opposite the same; nozzle and guide blocks in pairs, one block at least for each set of buckets facing in opposite directions; annular passages connected to each series of guide blocks in pairs; means to control the admission of the fluid to either of said passages separately or to shut off the said fluid entirely; an automatic valve between the two parts of the engine; passages leading from the annular chambers of each side of the primary turbine for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled by the said automatic valve for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

7. In a reversible elastic fluid turbine, the combination of a suitable casing, divided by a diaphragm; a primary and secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, arranged to be acted upon to rotate the wheel in opposite directions; nozzle and guide blocks in pairs, one block at least for each set of buckets, facing in opposite directions from each other, arranged to co-act with the corresponding rows of buckets; passages connected to each series of guide blocks; means to control the admission of fluid through said passages separately or to shut off the fluid entirely; an automatic valve between the two parts of the engine, the same being a piston valve operated by the elastic fluid; passages leading from the annular chambers in each side of the primary turbine to opposite ends of the valve chamber of the piston valve, for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled from the said automatic piston valve, for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

8. In a reversible elastic fluid turbine, the combination of a suitable casing, divided by a diaphragm; a primary and secondary turbine wheel, each of which is provided with a double set of buckets at its periphery, arranged to be acted upon to rotate the wheel in opposite directions; nozzle and guide blocks in pairs, one block at least for each set of buckets, facing in opposite directions from each other, arranged to co-act with the corresponding rows of buckets; passages connected to each series of guide blocks; means to control the admission of fluid through said passages separately or to shut off the fluid entirely; an automatic valve between the two parts of the engine; passages leading from the annular chambers in each side of the primary turbine to opposite ends of the valve chamber of the piston valve, for throwing the automatic valve to pass the elastic fluid from the primary to the secondary turbine; a secondary turbine with passages controlled from the said automatic piston valve, for receiving the fluid that is delivered from the said primary turbine, all co-acting substantially as described and for the purpose specified.

9. In a reversible elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the casing, provided with a double set of buckets at its periphery, consisting of a central ring with U-shaped buckets facing in opposite directions on the opposite sides thereof, and segments or rings corresponding thereto and opposite the same; nozzle and guide blocks, in pairs, one at least for each set of buckets facing in opposite directions; passages connected to each of said pair of guide blocks, and a valve arranged to control the admission of fluid to either of said passages, separately or to shut the same off entirely, co-acting for the purpose specified.

10. In a reversible elastic fluid turbine, the combination of a suitable casing; a turbine wheel within the casing, provided with a double set of buckets at its periphery, consisting of a central ring with U-shaped buckets facing in opposite directions on the opposite sides thereof, and segments or rings corresponding thereto and opposite the same; nozzle and guide blocks, in pairs, one at least for each set of buckets facing in opposite directions; passages connected to each of said pair of guide blocks, and means to control the admission of fluid to either of said passages, separately or to shut the same off entirely, co-acting for the purpose specified.

11. In a reversible elastic fluid turbine, the combination of a suitable casing; a pair of fluid passages, one for the direct action and the other for the reverse; a turbine wheel with double sets of buckets facing to act in opposite directions, consisting of the web 4, dovetailed at its periphery, a ring 8, provided with oppositely-facing U-shaped buckets on its opposite sides, fitted to one periphery of the web 4, and having a dovetail at its inner part, the broad portion of which abuts against the broad portion of the dovetail of the web, both of said dovetails being provided with shoulders, bucket segments 6 and 7, on opposite sides of the said web, corresponding to the buckets on the corresponding sides of said ring 8, having shanks corresponding to the said dovetailed portions, and a transverse bolt through the shanks and the web near its periphery, for clamping the parts together and locking them in correct relation to each other, all co-acting substantially as described and for the purpose specified.

12. In a reversible elastic fluid turbine, the combination of a suitable casing; a pair of fluid passages, one for the direct action and the other for the reverse; a turbine wheel with double sets of buckets facing to act in opposite directions, consisting of the web 4, dovetailed at its periphery, a ring 8, provided with oppositely-facing

U-shaped buckets on its opposite sides, fitted to the periphery of the web 4 and having a dovetail at its inner part, the broad portion of which abuts against the broad portion of the dovetail of the web, both of said dovetails being provided with shoulders, bucket segments 6 and 7, on opposite sides of the said web, corresponding to the buckets on the corresponding sides of said ring 8, having shanks corresponding to the said dovetailed portions, means for clamping the parts together and locking them in correct relation to each other, all co-acting substantially as described and for the purpose specified.

13. In a reversible elastic fluid turbine, the combination of a suitable casing, containing a series of chambers; a turbine in each chamber, with a double series of U-shaped buckets arranged to react in opposite directions; independent guide passages and nozzles corresponding to said double series of buckets; a valve means arranged to control said fluid passages; and an automatic valve between the first chamber and the second chamber controlled by the direct fluid pressure, for directing the flow of fluid into the second chamber from the first chamber, co-acting for the purpose specified.

14. In a reversible elastic fluid turbine, the combination of a suitable casing containing a series of chambers; a turbine in each chamber, with a double series of buckets arranged to react in opposite directions; independent guide passages and nozzles corresponding to said double series of buckets; a valve means arranged to control said guide passages; a passage between the first and second chambers; a piston valve to control said passage; and a steam passage leading from each of the guide passages of the said first turbine to opposite ends of said piston valve for reversing the throw of the piston valve automatically by the reverse of the main valve, co-acting for the purpose specified.

15. In a reversible elastic fluid turbine, the combination of the casing; a reversible turbine with oppositely faced U-shaped buckets; nozzle blocks arranged between the said buckets, having a series of delivery nozzles; a corresponding series of guide passages; and means to deliver to one or the other of said nozzle blocks, co-acting as specified.

In witnesse whereof, I have hereunto set my hand and seal in the presence of two witnesses.

CHARLES W. DAKE. [L. S.]

Witnesses:

CHARLES A. MERRELL,

FRED L. CHAPPELL.