G. WESTINGHOUSE.

TURBINE BLADE.

APPLICATION FILED OCT. 8, 1908.

976,418.

Patented Nov. 22, 1910.

2 SHEETS—SHEET 1.

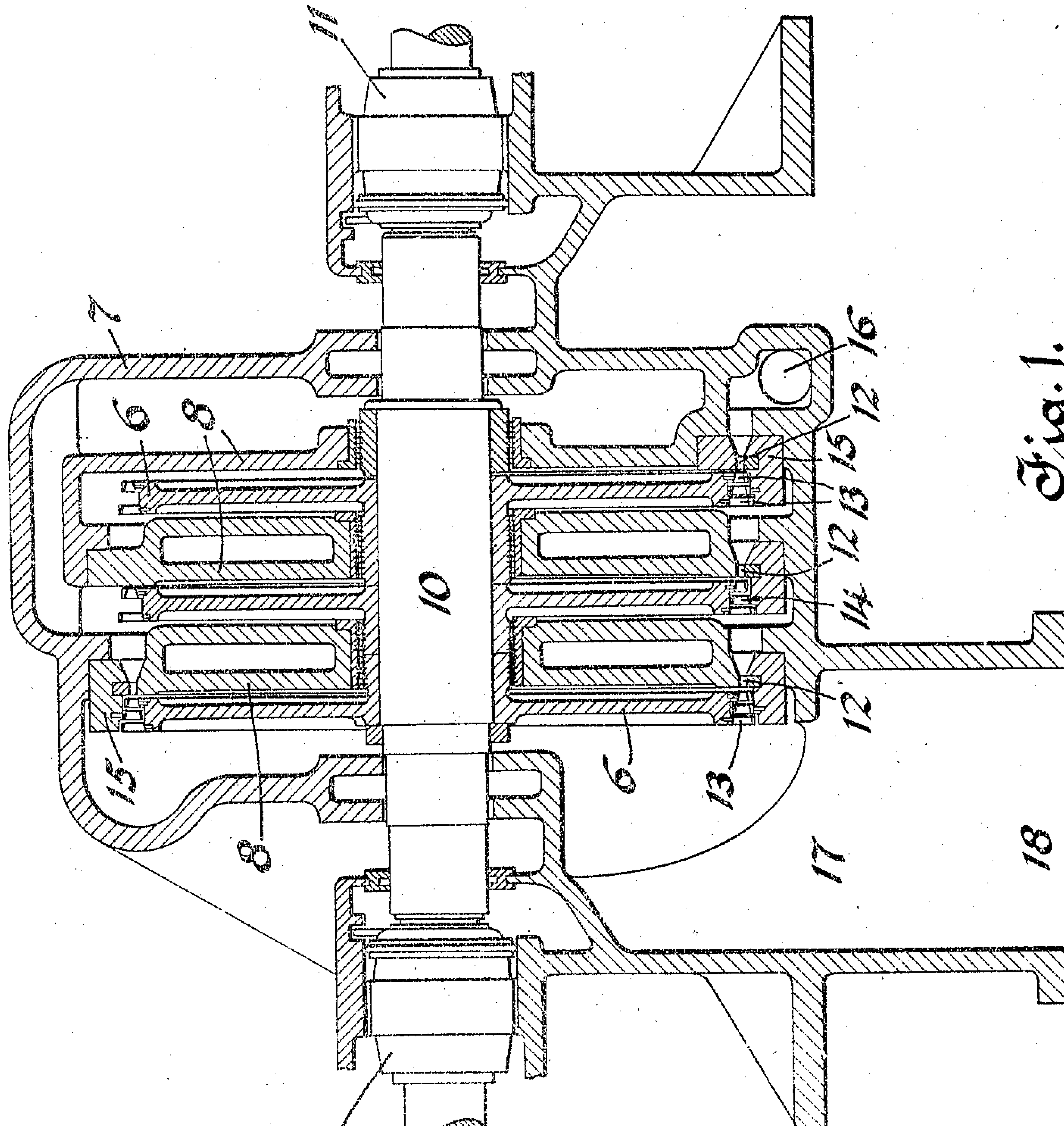

Fig. 1.

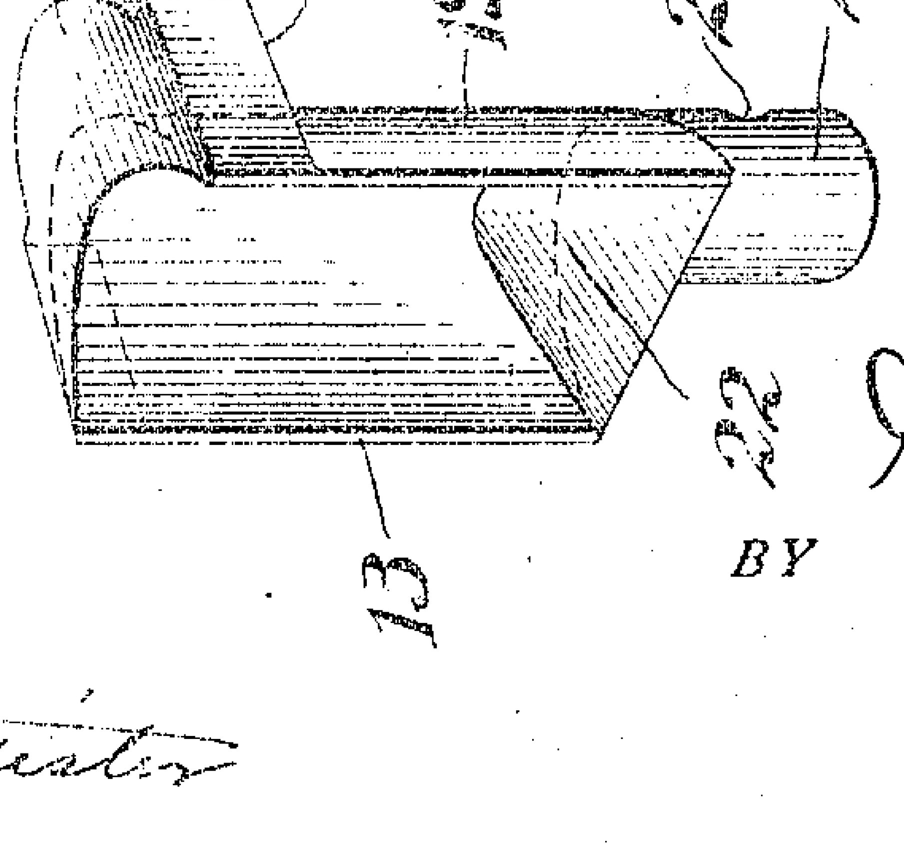

Fig. 5.

WITNESSES:

B. C. Dwis

E. W. McCallister

INVENTOR.

George Westinghouse

BY

Jno. S. Green

His ATTORNEY IN FACT.

G. WESTINGHOUSE.

TURBINE BLADE.

APPLICATION FILED OCT. 8, 1908.

976,418. Patented Nov. 22, 1910.

2 SHEETS—SHEET 2.

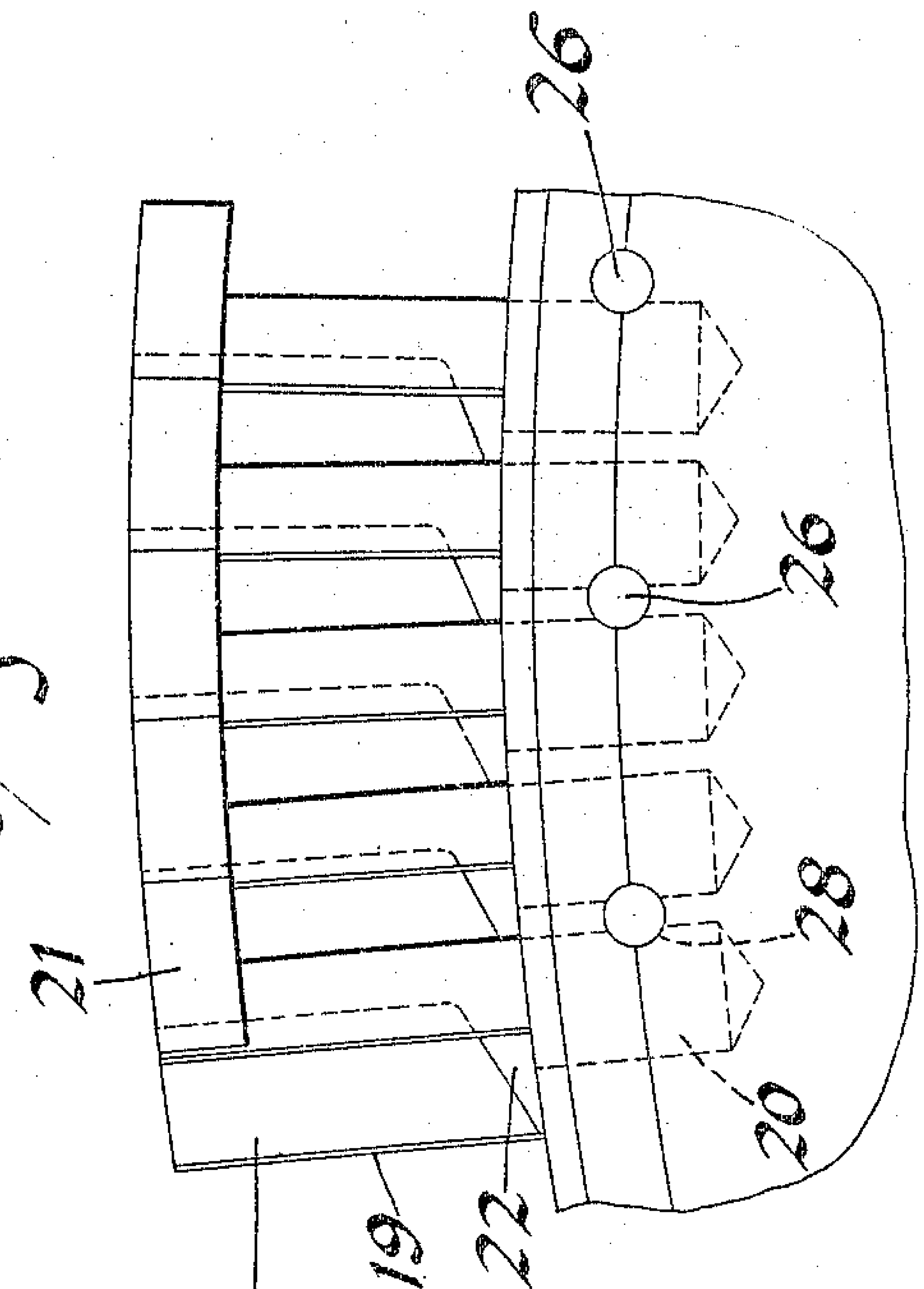

Fig. 3.

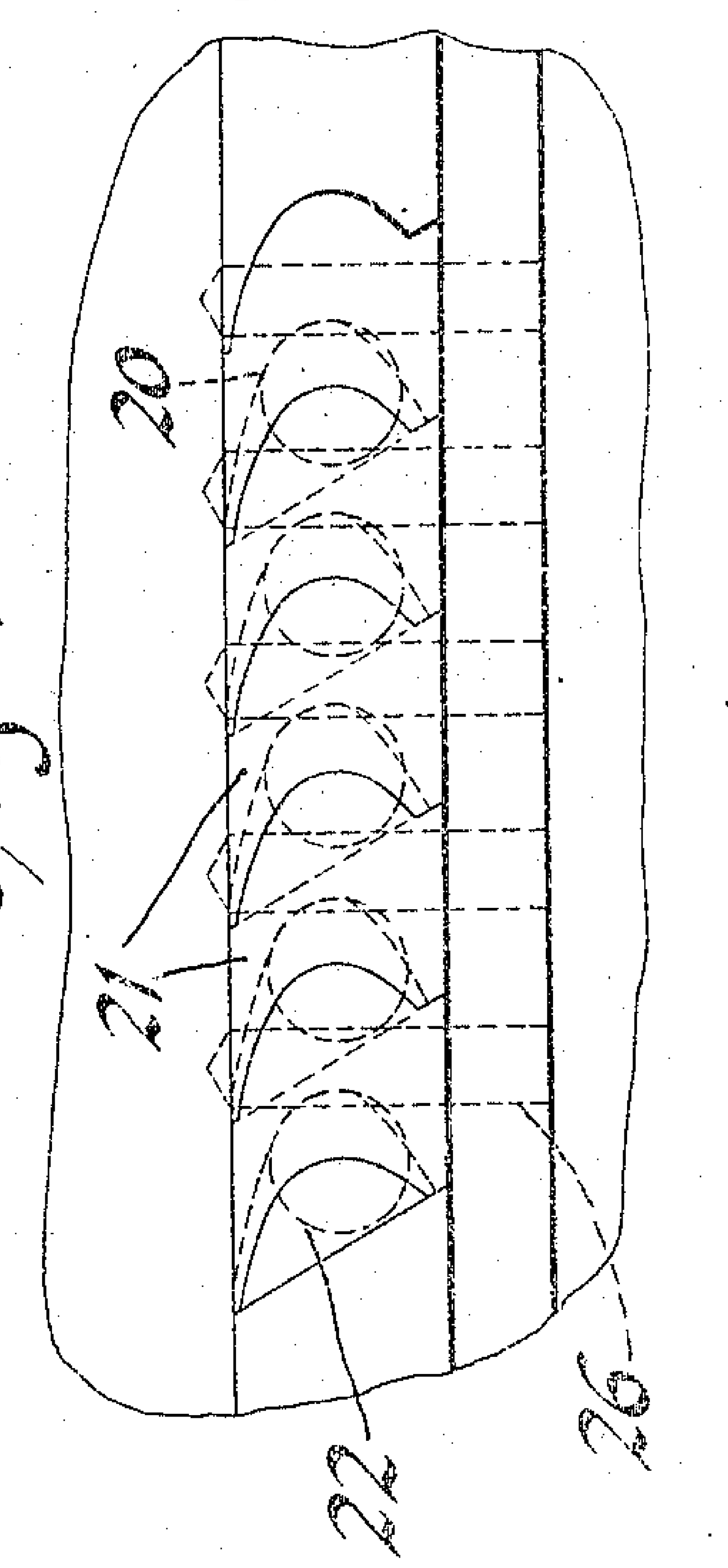

Fig. 4.

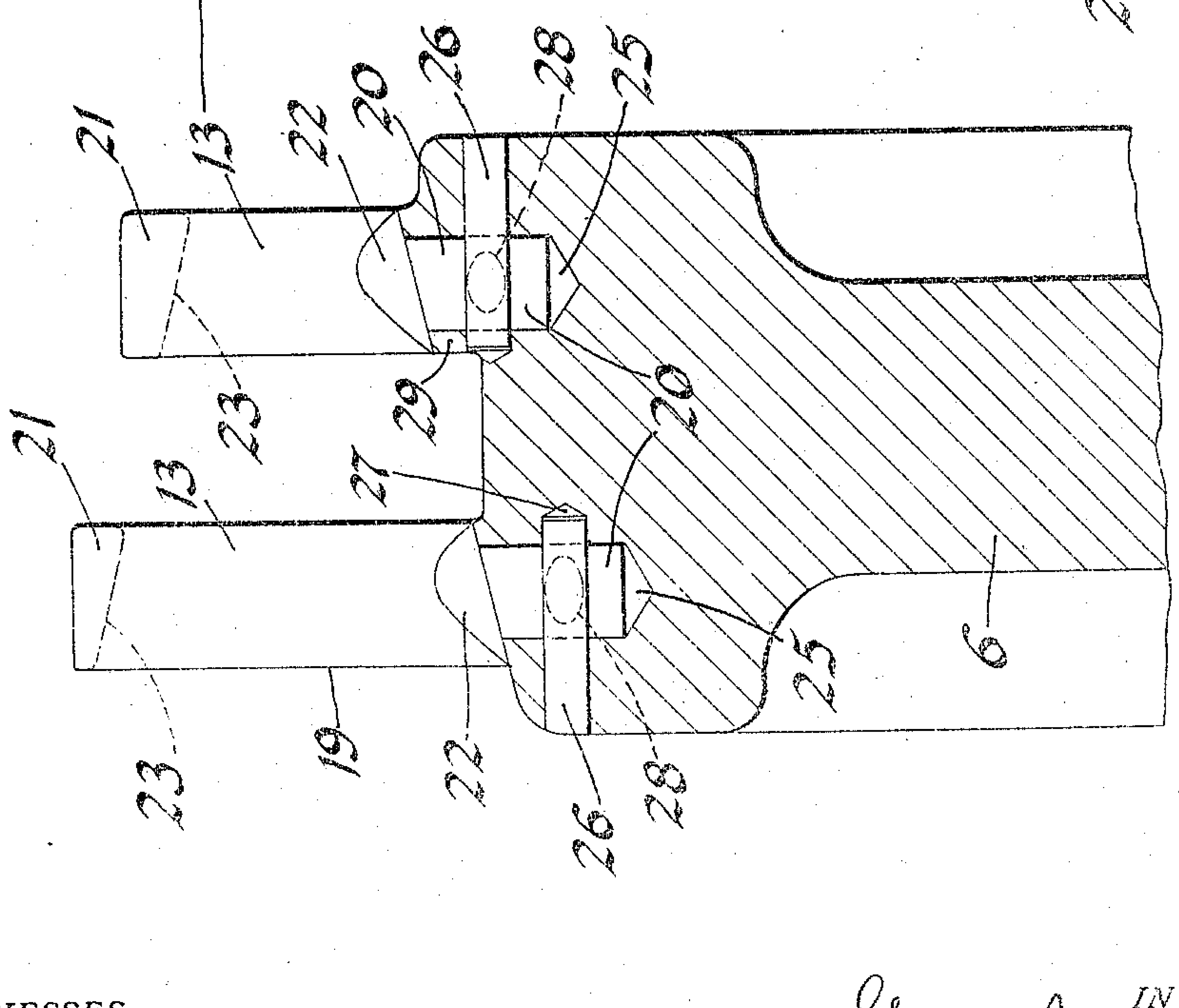

Fig. 2.

WITNESSES:

B. C. Fey

G. W. McCallister

INVENTOR.

George Westinghouse

BY Jno. S. Green

his ATTORNEY IN FACT.

UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, OF PITTSBURG, PENNSYLVANIA.

TURBINE-BLADE.

976,418. Specification of Letters Patent. Patented Nov. 22, 1910.

Application filed October 8, 1908. Serial No. 456,815.

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Means for Mounting Turbine-Blades, of which the following is a specification.

This invention relates to turbine blades and has for an object the production of new and improved means for mounting the blades to the blade-carrying elements of the turbine. This and other objects I attain in an apparatus embodying the features illustrated in the drawings accompanying this application and forming a part thereof.

Figure 1 is a longitudinal vertical section through the axis of a turbine embodying my invention; Fig. 2 is a partial transverse section of a rotor element carrying blades which embody my invention and which are mounted to the blade-carrying element in accordance with my invention; Fig. 3 is a fragmental view of a row of rotor blades embodying my invention; Fig. 4 is a plan view of the blades shown in Fig. 3; and Fig. 5 is a perspective view of one of the blades.

In Fig. 1, I have shown somewhat diagrammatically a purely impulse type of turbine which consists of a rotor element provided with a number of blade-carrying wheels 6, a stationary casing 7 inclosing the rotor element, and stationary partitions 8 which are mounted on the casing and divide the working passages of the turbine into three separate stages.

The wheels 6 are mounted on a shaft 10 which is journaled in suitable bearings 11, supported by the casing 7 and located exterior to it.

Each stage includes one or more delivery nozzles 12, two annular rows of moving blades 13 mounted on the wheel 6 of the stage and a row of directing vanes 14 which are located between the blade rows and are disposed opposite to the stage supply nozzles.

The nozzles 12 are formed in segmental nozzle blocks 15 on which the stationary vanes 14 are mounted. The nozzles of the first stage communicate with and receive motive fluid from a passage 16 formed within the casing and communicating with a source of motive fluid supply. The nozzles of each of the other stages communicate with the adjacent preceding stage and receive the motive fluid discharged from the last row of blades of that stage. The number of nozzles is increased throughout the succeeding stage to accommodate the increased volume of the motive fluid due to the expansion. The motive fluid discharged from the last row of blades of the final stage is received by an exhaust passage 17, which is formed within the casing 7 and which communicates with the atmosphere or a condenser through an exhaust port 18.

The rotating blades 13 are adapted to be secured to the rotor wheels 6 and the peripheral face of each wheel is adapted to receive two rows of blades. The blades 13 and vanes 14 of each stage are so constructed and so arranged that the motive fluid delivered to them by the nozzles of the stage traverses, in passing through the stage, a passage which increases its radial dimension from the inlet to the exhaust side of the stage. The passage is inclosed between a shrouding, provided for the outer ends of the blades and vanes, and fluid directing lugs, formed integrally with each blade and vane and located adjacent to the base or mounting portion. The shrouding and the fluid directing lugs of one row of blades or vanes are so arranged that they respectively coöperate with the fluid directing lugs and the shrouding of the adjacent rows of blades or vanes in continuing the radially divergent fluid passage.

Each blade consists of a body portion 19, an integrally formed mounting portion 20, a shrouding flange 21 and a fluid directing lug 22. The body portion 19 is substantially crescent shaped in cross-section and is provided, at one end and on the convex side, with a shrouding flange 21 and at the other end with the cylindrical mounting portion 20, which extends longitudinally of the blade. The fluid directing lug 22 is formed integrally with the body portion 19 of the blade and is located on the concave side adjacent to the mounting portion of the blade. The shrouding flange 21 projects forwardly, relative to the direction of rotation of the blade. The inner face 23 of the flange 21 of each blade is inclined and coöperates with the fluid directing lug 22 of the next adjacent blade in forming a radially divergent fluid passage between the blades. The fluid directing face of the lug 22 is so inclined as to prevent eddy currents around the bases of the blades, and also to coöperate with the inclined face 23 of the shroud of the next row of blades or vanes in continuing the divergent fluid passage. The lugs also reinforce the bases of the blades and form a shoulder which contacts with the blade-mounting element and coöperates with the mounting portion 20 in securing the blades in place.

The peripheral face of each wheel 6 is provided with two rows of cylindrical holes 25, each of which is adapted to receive the mounting portion of one of the blades. The holes comprised in each row are so alined and spaced that the flanges 21 are so constructed that the outer or free end of the flange of each blade coöperates with, and fits snugly against, the concave face of the next adjacent blade when the blades are assembled in the blade-mounting holes and secured in place. This construction provides a shrouding for the outer or free ends of the blades which, besides being effective as a fluid directing agent, rigidly secures the outer ends of the blades in their proper relative positions.

The base portion 20 of each blade is positively locked into one of the holes 25 by means of a pin 26 which is located within a longitudinally extending hole 27 formed in the blade-carrying element and intersecting the blade mounting hole 25. The base portion of each blade is provided with a notch 28 which registers with the opening formed by the intersections of the holes 25 and 27 and which engages the pin 26 and thereby positively locks the blade to the blade-carrying element. By correctly locating the notches 28 on the base portions of the blades, the blades will be properly gaged when secured to the blade-carrying element. The holes 27 are preferably located between adjacent blade-mounting holes 25, so that one pin 26 is effective in positively locking two adjacent blades to the blade-carrying element.

The stationary vanes 14 are substantially similar to the blades and are secured to their blade-mounting elements in substantially the same manner as the blades are secured to the wheels 6. The vane mounting elements 15 are each provided with blade mounting holes 25 in which the bases of the vanes 14 are secured by means of pins 26. Although it is not essential to provide the high pressure stages of the turbine with a complete annular row of directing vanes, the outer ends of the vanes are nevertheless provided with the shrouding flanges 21 and the base portion of each blade is provided with a fluid directing lug 22. The flanges 21 coöperate to form a shroud for the vanes comprised in a row and this shroud and the fluid directing lugs 22, of the row of vanes, respectively coöperate with the fluid directing lugs and the shroud of the adjacent rows of blades in forming the radially divergent fluid passage through which the motive fluid passes.

The blades and vanes of each succeeding row, in each stage, increase in length to accomplish the formation of the radially divergent passage, and consequently each wheel 6 is adapted to carry two rows of blades of different lengths. The peripheral face of each wheel is provided with a flange 29 which projects laterally and in which the blade mounting holes 25 of the shorter row of blades carried by the wheel are drilled. The peripheral face of this flange and also the peripheral face of the wheel proper adjacent to the blade mounting holes of the larger blades, are inclined to coöperate with the fluid directing flanges 22 in forming the radially divergent passage.

In accordance with the provisions of the patent statutes, I have disclosed my invention together with the apparatus which I now consider to represent the best embodiment of it, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim is:

1. In combination with a turbine blade-carrying element provided with a plurality of blade-mounting apertures, blades provided with base portions adapted to fit said apertures and pins, each pin engaging recesses in the base portions of two adjacent blades, for securing said blades to said element.

2. In combination with a turbine blade-carrying element provided with a plurality of blade-mounting holes, blades provided with notched mounting portions adapted to be secured into said holes, the notches of two adjacent blades facing each other, pins each engaging two adjacent notches provided in the mounting portions of adjacent blades and adapted to secure said blades to said element.

3. In combination with a turbine blade-carrying element provided with a plurality of cylindrical blade-mounting apertures, blades provided with cylindrical mounting portions adapted to be secured into said apertures, separate pins engaging recesses provided in the mounting portions of the blades and adapted to secure said blades to said element and a shrouding flange formed integrally with each blade.

4. In combination with a turbine blade-carrying element provided with a plurality of blade-mounting apertures arranged in a row, and a pin-receiving aperture located between and intersecting each pair of adjacent blade-mounting apertures, blades provided with mounting portions adapted to be

located in said blade-mounting apertures, and a pin located in each pin-receiving aperture and engaging the base portions of adjacent blades to secure them to said element.

5. In combination with a turbine blade-carrying element provided with a plurality of alined blade-mounting apertures, blades provided with base portions adapted to be located in said apertures, a single means for positively locking two adjacent blades in place and a flange provided on the outer or free end of each blade and adapted to engage with the next adjacent blade to form a shroud for the blades.

6. In combination with a turbine blade-carrying element provided with a plurality of cylindrical blade-mounting apertures, blades provided with cylindrical base portions adapted to be located in said apertures, and means carried by said element for positively locking said blades in place within said apertures.

7. In combination with a turbine blade-carrying element provided with a plurality of alined blade-mounting apertures, concavo-convex blades provided with base portions adapted to fit said apertures; one blade having a notch on its convex side and the other blade having a notch on its concave side, and means carried by said element for positively engaging the respective notches to lock the base portion of each blade into an aperture.

In testimony whereof, I have hereunto subscribed my name this 2nd day of October, 1908.

GEO. WESTINGHOUSE.

Witnesses:
H. C. Tener,
Wm. H. Capel.