No. 659,930. Patented Oct. 16, 1900.

D. KEMBLE.

STEAM TURBINE.

(Application filed Nov. 17, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

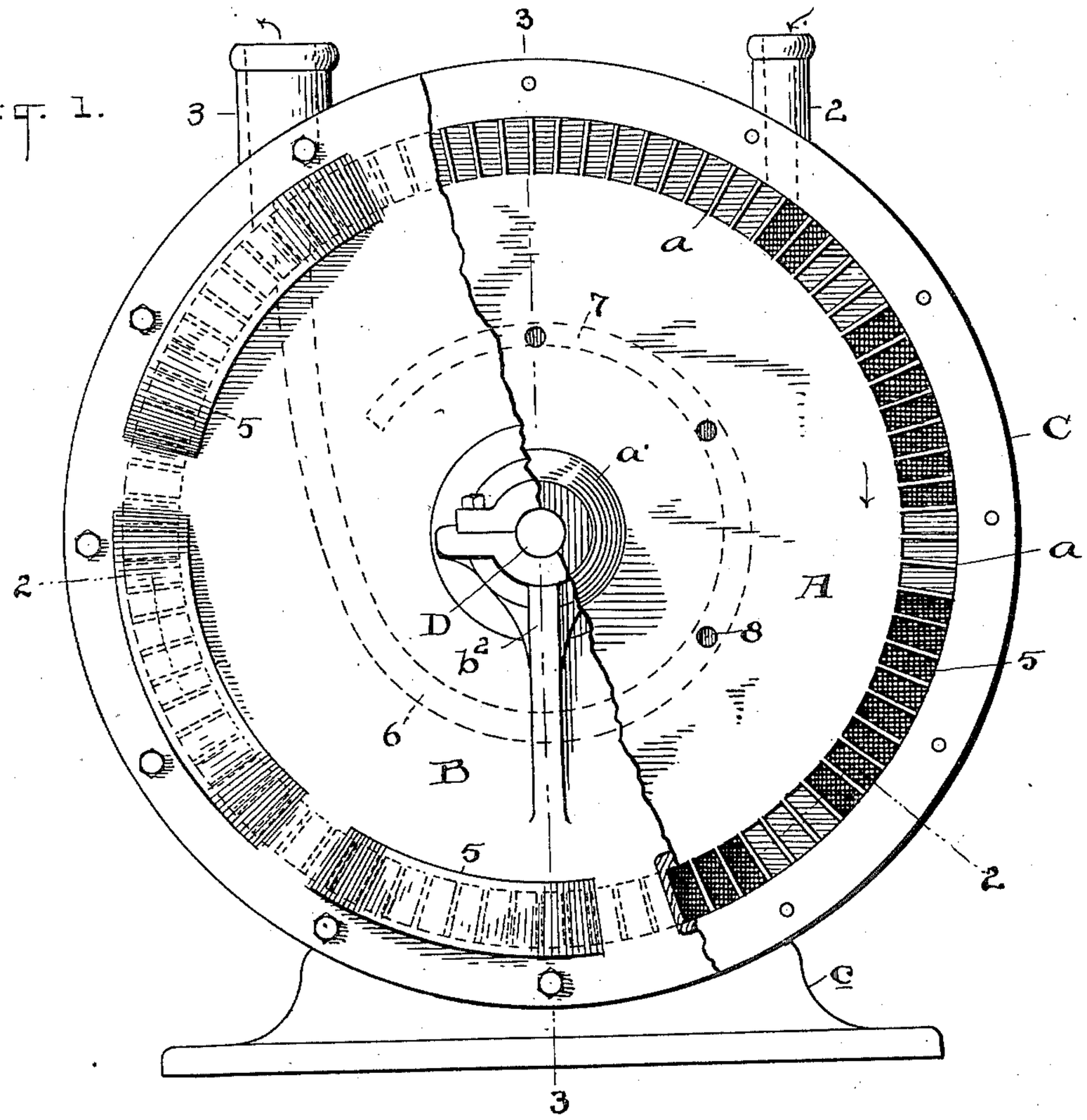
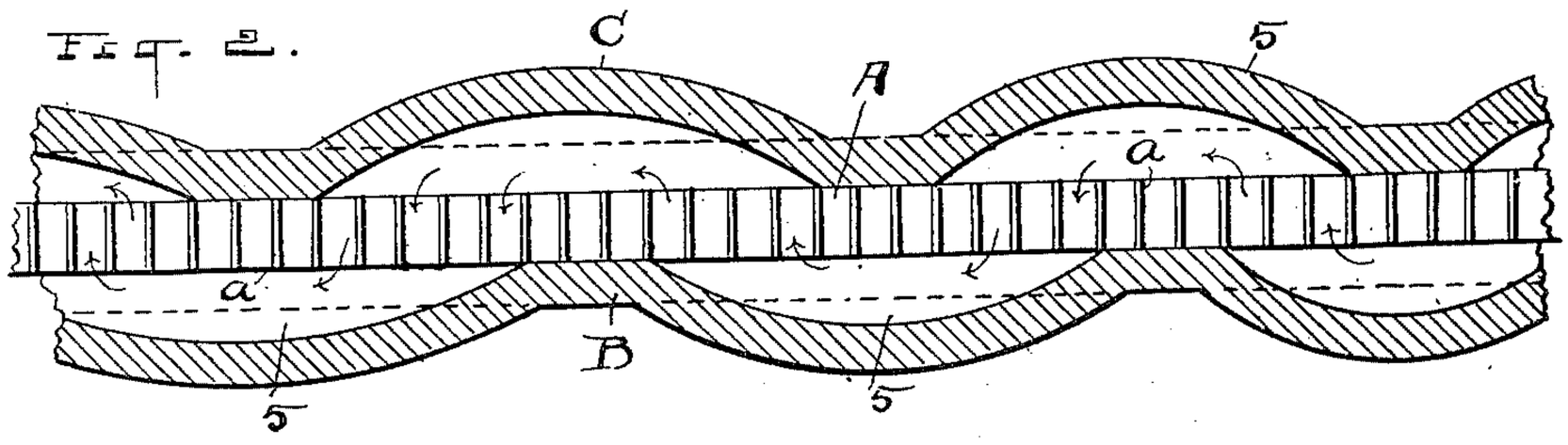


Fig. 2.



Attest
P. B. Moser
H. E. Mudra

Inventor
Duston Kemble
By H. F. Fisher
Atty

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Fig. 3.

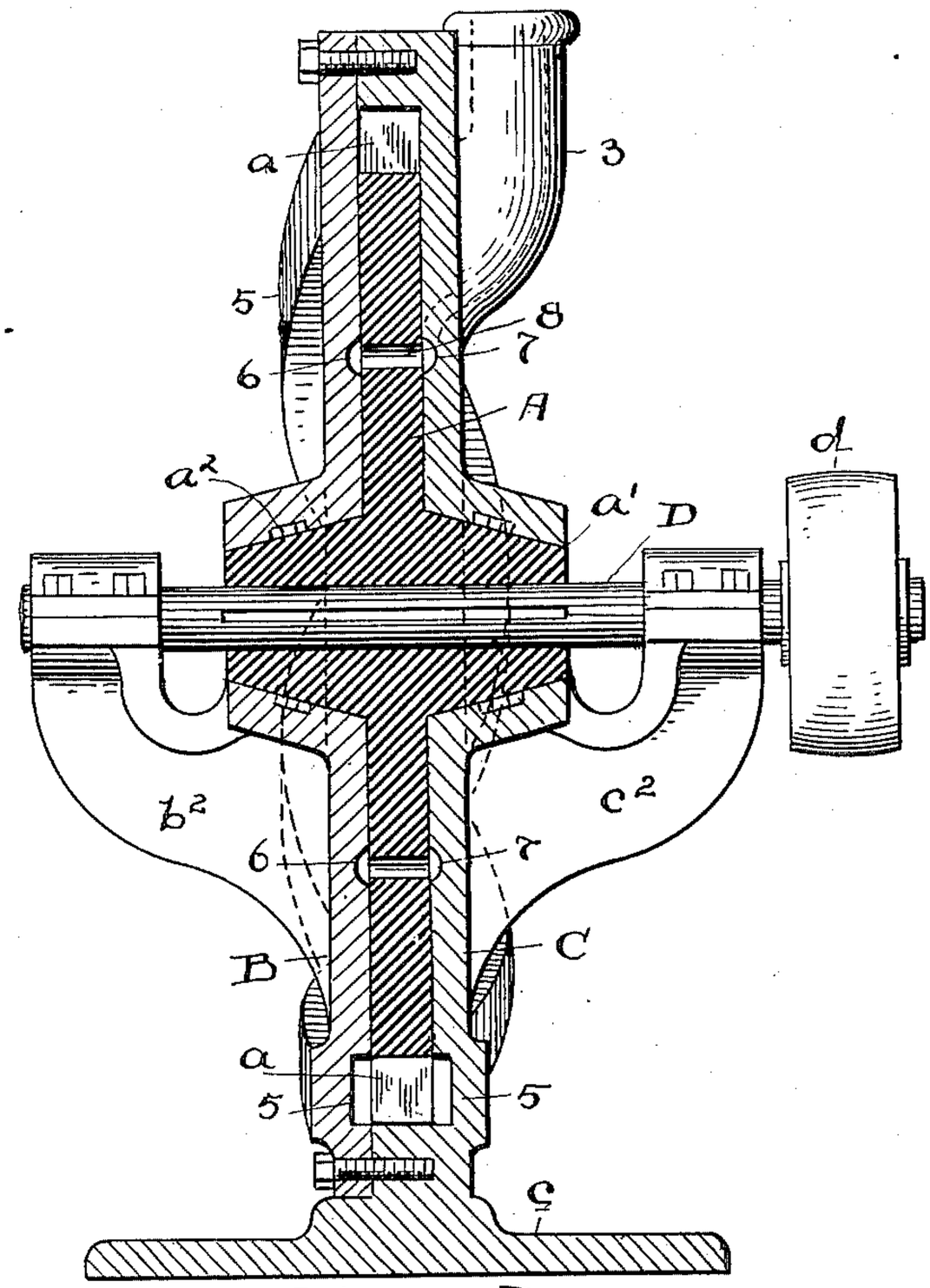
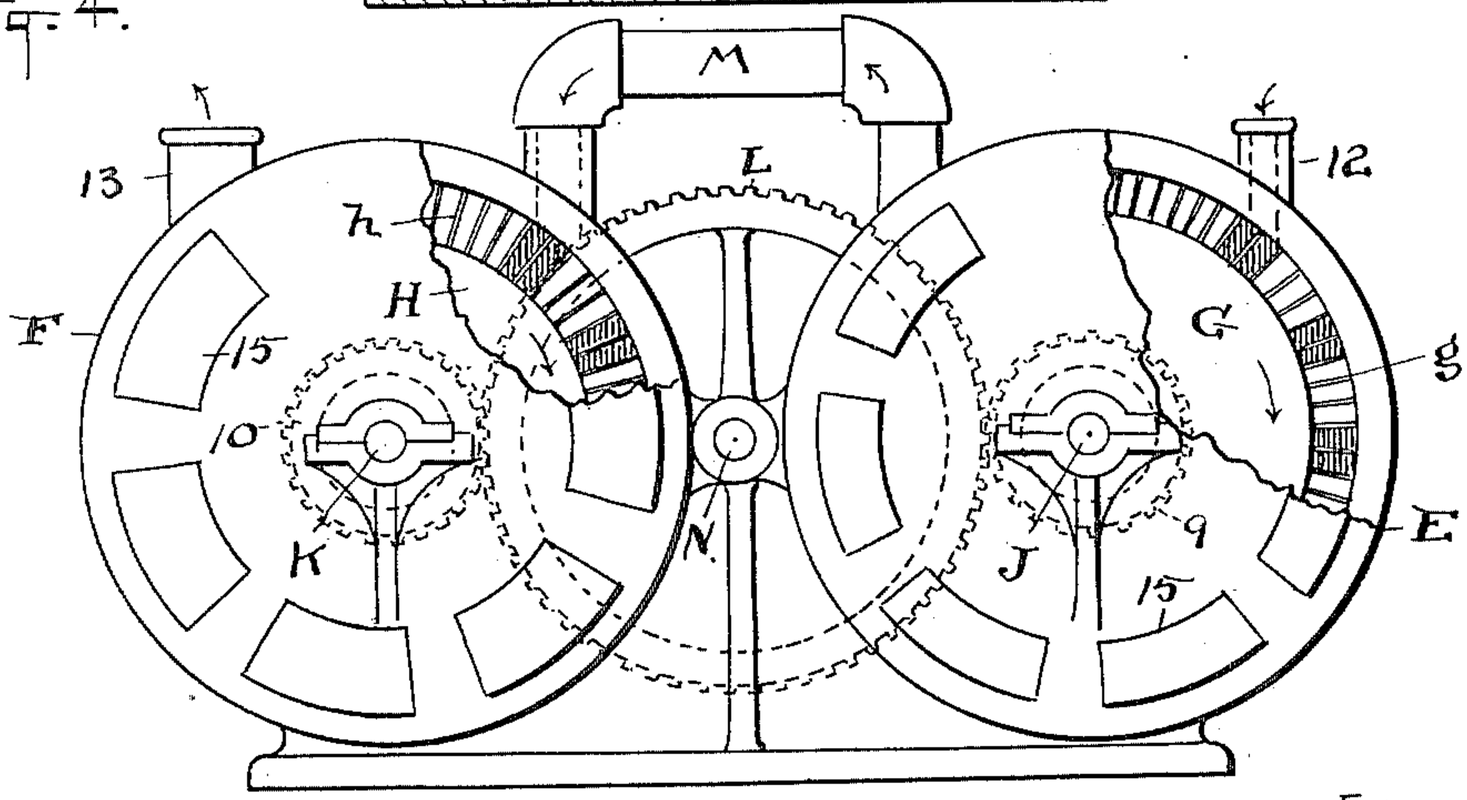


Fig. 4.



Attest
R. Bruce
H. E. Myers.

Inventor.
Duston Kemble
By H. F. Fisher
Atty

UNITED STATES PATENT OFFICE.

DUSTON KEMBLE, OF CLEVELAND, OHIO.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 659,930, dated October 16, 1900.

Application filed November 17, 1898. Serial No. 696,686. (No model.)

To all whom it may concern:

Be it known that I, DUSTON KEMBLE, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Steam-Turbines; and I do declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in steam-turbines, and the theory upon which the construction and operation proceed and are practically worked out by me may be stated as follows: First, any jet or current of steam when passing through a pipe or other channel from a boiler into the open air, or even into a condenser, if it encounters any obstacle, as a plug or even a thin vane of wood or metal, will press against that obstacle or vane with a force in proportion to the amount or angle of obstruction and the strength of resistance opposed by the obstructions to the passage of the steam. If the resistance of the obstacle is greater than the total pressure of the steam in the channel, the steam will be turned aside unless the channel is completely closed, when the steam will be wholly stopped from passing. If the channel is not closed so as to cut off completely any portion of the steam, the latter will continue on its course with some loss of pressure, caused by the detention in striking against the obstacle which remains in its way; but if the resistance of the obstacle or vane is only just sufficient to retain the original pressure of the steam while the vane itself is being pushed along with nearly the same rate of speed at which the steam is moving through the channel then nearly the whole pressure of the steam is utilized in thus driving the vane before it. Although this may be difficult to realize with a single vane, yet with a series of vanes, and still more if the fixed portion of the channel itself be so turned as to bring the same current of steam in successive impacts against the one continuous series of vanes, the resistance may be so adjusted to the pressure that the vanes will be driven along continuously with a force nearly equal to the steam-pressure which is thereby utilized in work. However, it may be that in practice only a part of the initial pressure of the steam will thus be utilized in work on account of back pressure in portions of the channel still to be considered. If now the next portion of the channel be enlarged as to its sectional area and the number or size of the vanes in this new part of the channel be enlarged to correspond with said change in the channel, then we shall have a wider or thicker current of steam at a lower unit of pressure acting upon a larger area of vane-surface by free expansion in the newly-acquired space of the wider channel the same as in the second or third cylinders of a compound piston-engine. Thus this process of repeated impact and repeated enlargements of the channel for steam and of the vane areas may go on until the full expansion force of the steam is utilized.

Now, having reference more particularly to the construction of the invention whereby the foregoing theory is rendered practical, reference may be had to the accompanying drawings, in which—

Figure 1 is a side elevation of my new and improved turbine, part of the casing at the front being broken away to disclose the internal construction. Fig. 2 is a cross-section on line 2 2, Fig. 1, looking down and disregarding the segmental character of the line on which the view is taken and giving it the appearance of a straight line, so as to clearly disclose the construction and arrangement of the parts. Fig. 3 is a vertical central sectional elevation of the turbine on line 3 3, Fig. 1. Fig. 4 is a side elevation of a modification of the invention, showing a compound turbine with gear and pipe connections between its members, as hereinafter fully described.

The construction shown in the foregoing views consists, primarily, of the central rotating or revolving disk A, which has about its periphery a series of radial vanes *a* of uniform size and spacing and extending across the edge of the disk from side to side thereof.

B and C represent the two sections of the casing for disk A, one of which preferably has the base *c* cast integral therewith, and the same section in this instance has a circular recess or cavity in its inner side of a depth to accommodate the disk A, and the other section B is placed on the opposite side of disk

A and is bolted to section C after the manner of a cylinder-head. If the base *c* were made an independent part and provided with a flange of the same thickness as the disk A and the sections B and C were bolted thereto, it would be an obvious equivalent of my present construction. In that case an inclosing ring could be interposed between sections B and C and bolted therewith to provide a working space for disk A. The disk or wheel A has a hub a' extending equally to both sides thereof and, if necessary, may be packed to prevent possible leakage—as shown, for example, at a^2, or at some other place, as may be found desirable. Each casing-section is shown here as constructed with an arm b^2 and c^2, respectively, in the upper portions of which are formed bearings for the shaft D. The said shaft is splined or otherwise secured in the hub of disk or wheel A, so as to turn therewith, and is provided with a pulley *d* or gear or other means for making power connections. One of the casing-sections, and in this instance the rear section C, which is formed with the base *c*, is provided with two elbows or short pipes 2 and 3 at its top and constituting the inlet and exhaust ports, respectively, for the steam. If desired, however, these ports might be on opposite sides and sections of the casing. Connected with each of said ports and extending entirely around within the casing from port to port is the sinuous or wavy channel for the steam (seen in cross-section in Fig. 2) formed in part by the reversely-curved so-called "ducts" 5 in the casing-sections B and C opposite the vanes *a*—that is, the ducts 5 and the space between the vanes *a* together constitute the entire channel or sinuous passage for the steam and in a sense also the duct for the steam; but for convenience and clearness of description the portions of the passage in the casing alone and outside of the vanes will be referred to as the "ducts" 5. These ducts are so constructed and arranged in respect to each other that each one except the first and last ones in the series overlaps the ends of the two opposite ones in the opposite section or plate of the casing or, to express it differently, so that two on one side terminate at a point near or directly opposite the middle of the opposite duct. These ducts are also made comparatively shallow and with gradually-decreasing depth from the center to each end and are curved in such a way as to make an angle with the vanes at both their ends. This produces such sinuosity in the channel that it traverses the vanes back and forth from side to side alternately in the direction of travel and utilizes both the direct and expansive force of the steam to the very best possible advantage for propelling the wheel.

The ducts 5 on both sides of the casing may be made of uniform size and shape throughout the entire circuit of the steam-channel, so as simply to sustain the force of the steam by repeated impact upon the vanes and without provision for expansion; but preferably and as shown in Fig. 2 the ducts may be varied in length successively, making the first ones to cover a certain number of vanes and the succeeding ones more and more at intervals toward the exhaust. Practically this works out as seen in Fig. 2, wherein the steam-channel is gradually enlarged as it crosses the vanes and covers an increasing number of vanes progressively. Thus at the extreme right there are three vanes open at both sides in the steam-channel, while at the next two crossings there are four in each, and in the fourth crossing there are five. This or any other preferred ratio of increase may be adopted to give the desired room for the steam to work also by expansion; but, if preferred, the same exposure may be maintained at all the crossings, as already described. It will of course be understood that the ducts 5 correspond in width to the depth of the vanes *a* and may be rounded or angular in cross-section. In the present structure they are angular, as seen in Fig. 3, and this is the better form.

The disk or wheel A may, if found necessary or desirable, be furnished with a tire for strengthening the vanes and protecting them from injury. It may also have any suitably-shaped hub and any arrangement of packing or provision for preventing leakage of steam toward the shaft. An example of construction for this purpose is seen in Figs. 1 and 3, wherein are shown small circular ducts 6 and 7 in both sections of the casing and having an outlet to the exhaust. A few transverse holes 8 are formed in the disk A opposite these ducts and serve as open passages from one to the other, and thus the steam which may work back to this point is trapped and carried off.

In Fig. 4 I show a compound or double-chambered turbine comprising two separate casings E and F and two separate and different disks or wheels G and H within. On the shafts J and K of these wheels are pinions 9 and 10, which are operatively connected by a large gear-wheel L on the power-shaft N. The main steam-inlet 12 is on casing G and the main exhaust 13 on casing F, and a pipe M serves to convey the steam from one casing or section of the machine to the other. Both casings have ducts 15 opposite the vanes *g* and *h* of the respective wheels corresponding to the ducts 5 in the other views; but the vanes *g* and *h* differ in size or surface area relatively about as shown, so that while the steam is supposed to operate in the first instance chiefly by direct impact upon the vanes *g* it operates both directly and by expansion upon vanes *h*, since these vanes are materially deeper than vanes *g*, and there is room for expansive action as well by saving the steam to play upon large surface area at lower pressure. I might of course provide for gradual expansion in each chamber by progressively enlarging the ducts 15 in each casing

somewhat after the manner in Fig. 2; but in the example of turbine here shown and described I have compounded the structure on purpose to get the expansive effect of the steam in the second chamber. The two sections of this turbine might be set side by side on the same shaft, if preferred, and their operative connections be materially varied without departing from the spirit of the invention.

What I claim is—

1. A steam-turbine casing consisting of two side sections provided each with a series of opposite curved depressions having smooth surfaces and arranged in respect to each other to form a sinuous circular channel for the steam, in combination with a single wheel having on its periphery a series of radial vanes extending into said channel, the curved depressions constituting the channel being of such length as to each cover a series of said vanes, substantially as described.

2. The turbine-casing having a sinuous circular channel for the steam formed by a series of complementary ducts in both sides of the casing, said ducts curved lengthwise and each overlapping the ends of two opposite ducts, so as to carry the steam around in a circle, and a wheel in the casing having vanes running in said channel, said ducts having such length as to overlap a series of the said vanes both at their entrance to the duct and at their exit therefrom, substantially as described.

3. A steam-turbine casing having two sides and a series of ducts successively in each side curved in the direction of their length and arranged successively to form a sinuous circular channel, in combination with a single disk-shaped wheel having a series of radially-disposed vanes on its periphery the full width of the wheel and the full depth of the said channel, the length of curvature of the said ducts constituting the steam-channel being such that at each point where the steam traverses the periphery of the wheel it will strike a series of the vanes, substantially as described.

Witness my hand to the foregoing specification this 10th day of November, 1898.

DUSTON KEMBLE.

Witnesses:
H. T. FISHER,
R. B. MOSER.