No. 766,044. PATENTED JULY 26, 1904.

M. D. KALBACH.

STEAM TURBINE.

APPLICATION FILED OCT. 23, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

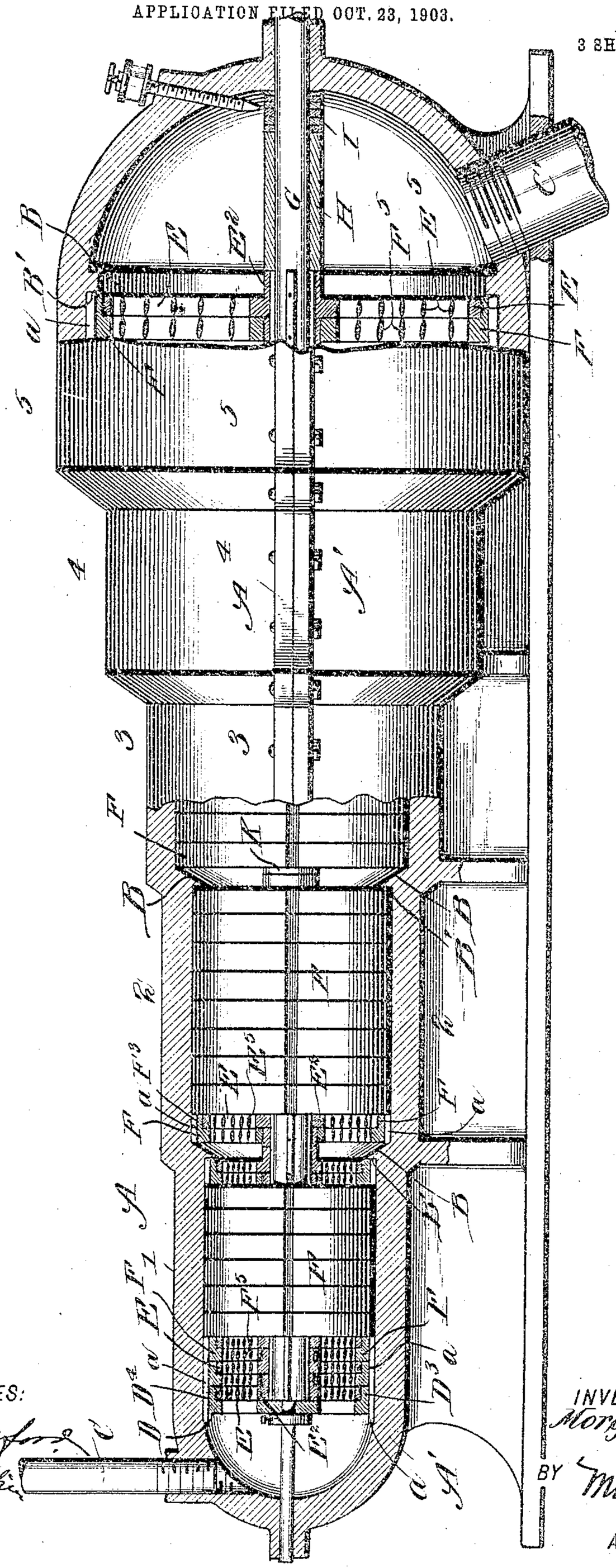

Fig. 1.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.

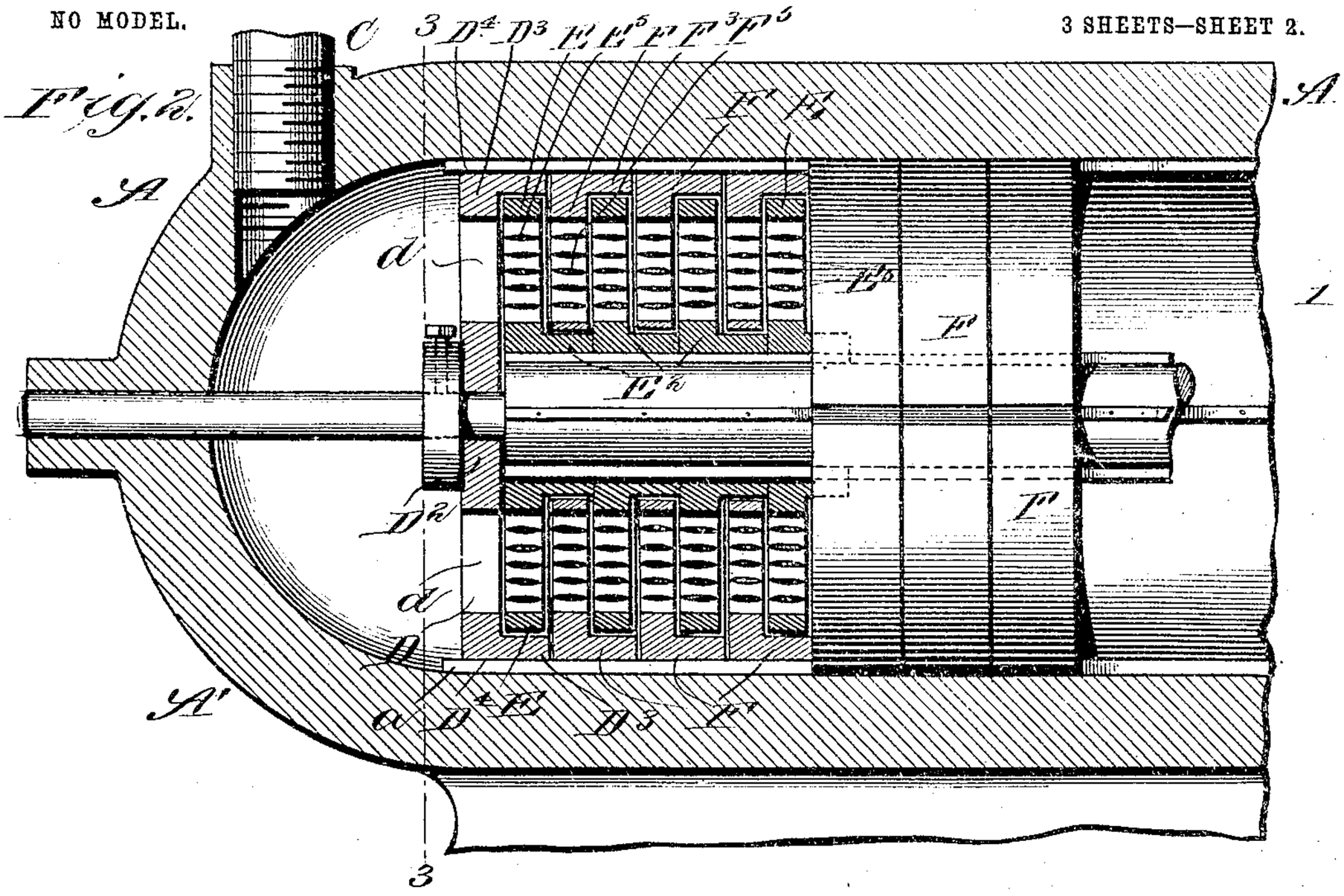

Fig 3

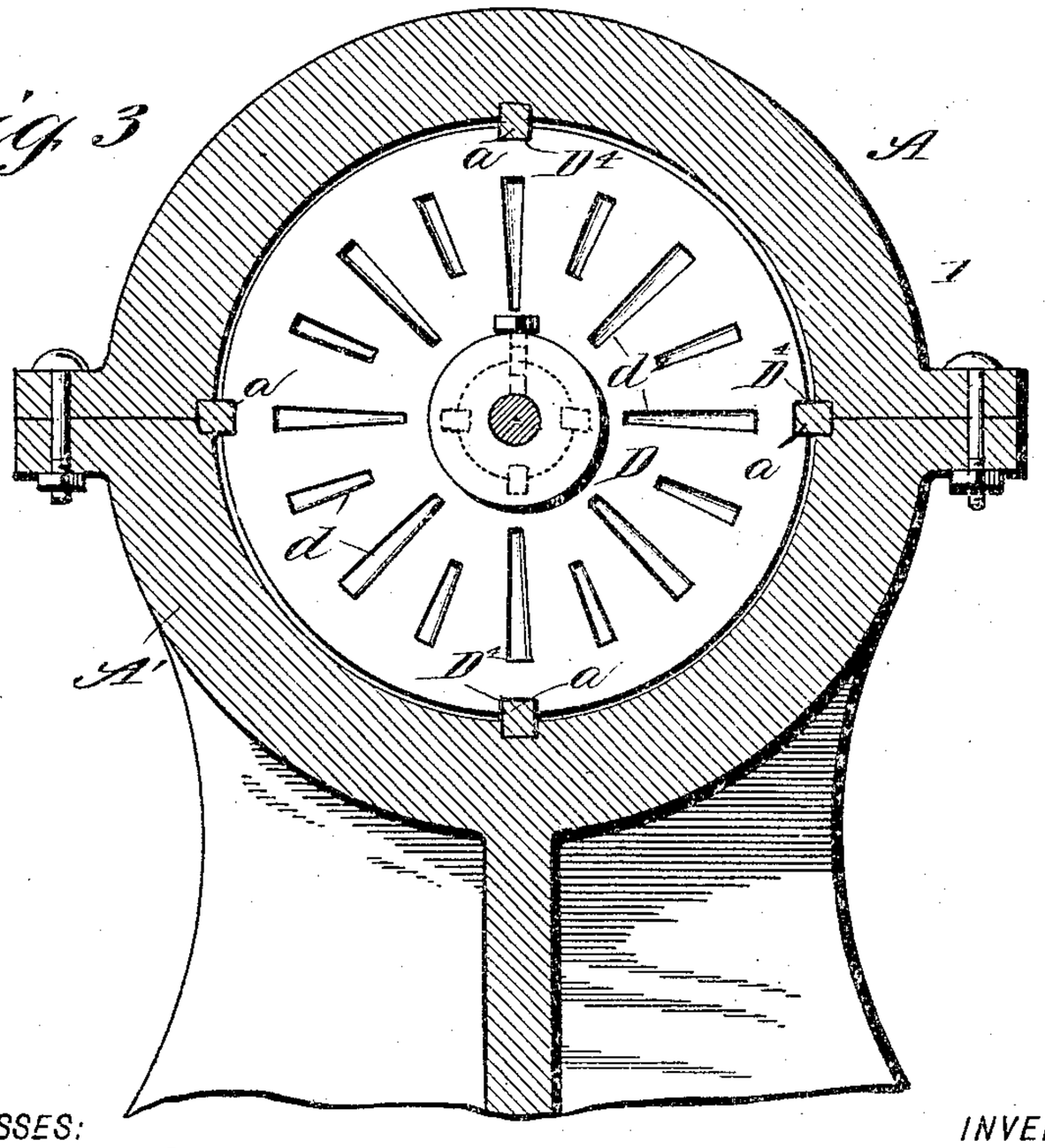

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Fig. 4.

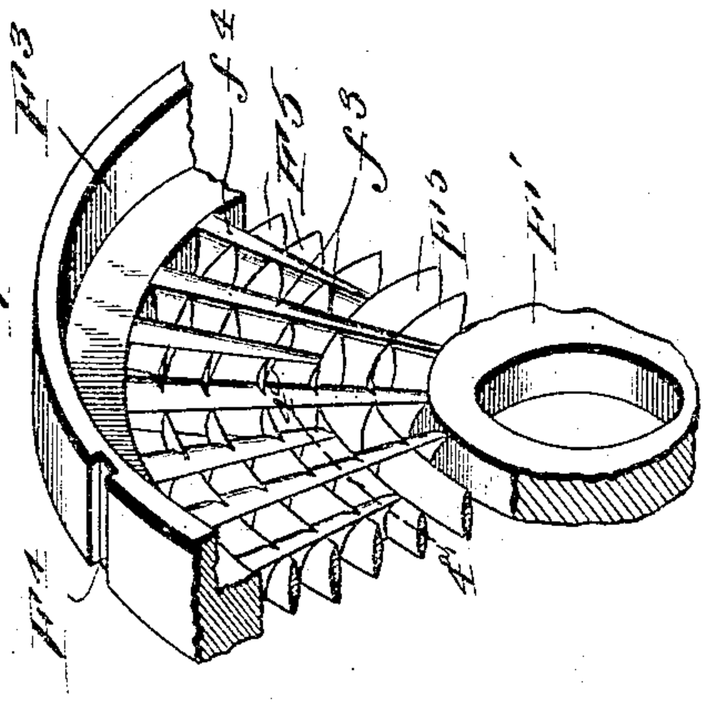


Fig. 4a.

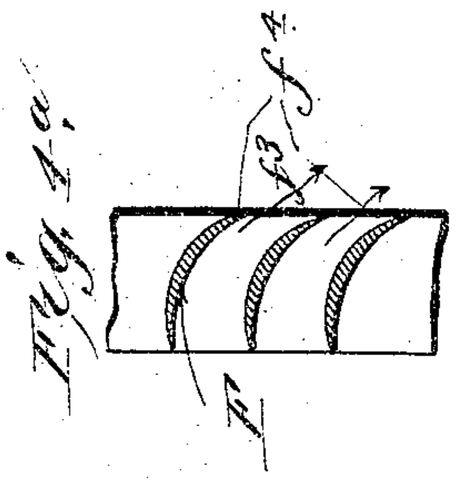


Fig. 5.

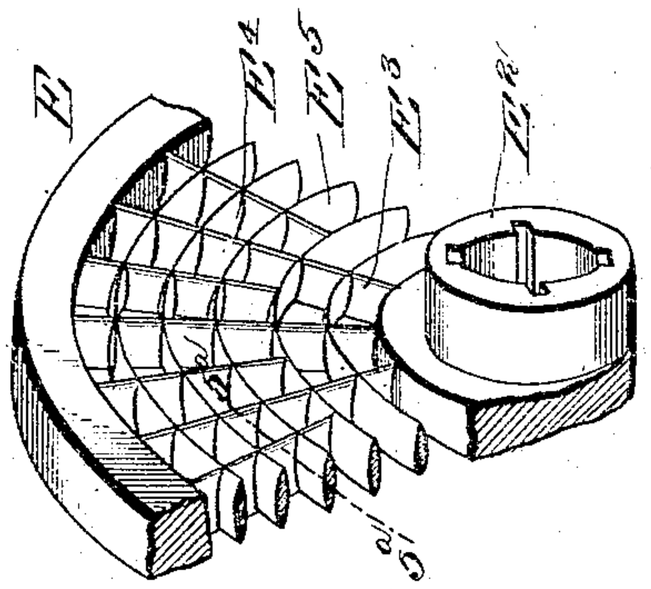


Fig. 5a.

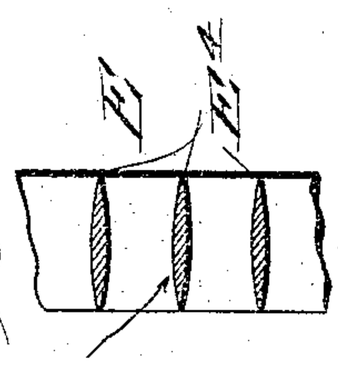


Fig. 6.

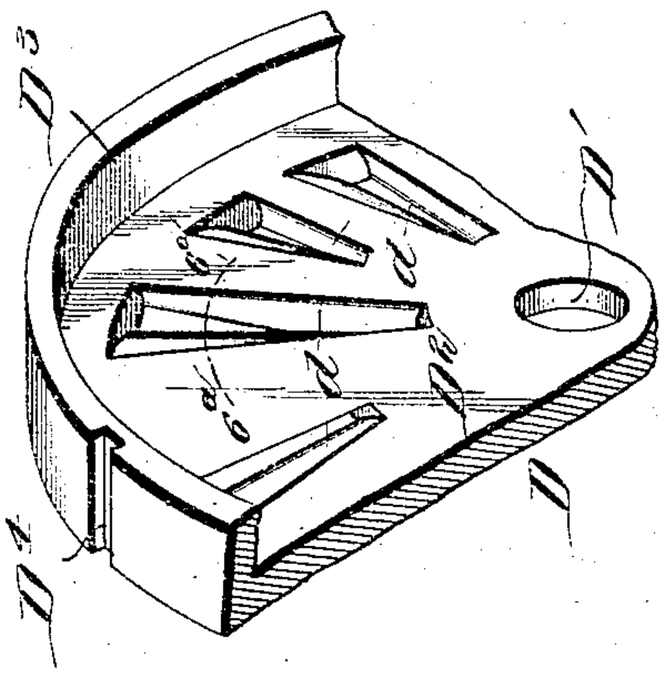


Fig. 6a.

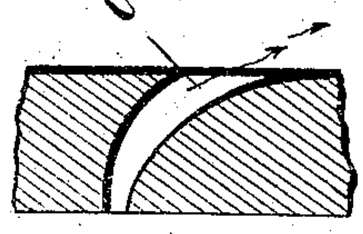
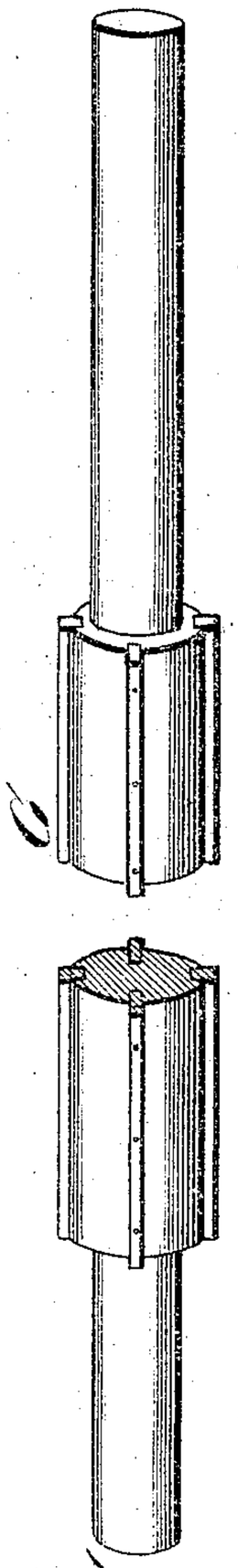


Fig. 1.



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No. 766,044. Patented July 26, 1904.

UNITED STATES PATENT OFFICE.

MORGAN D. KALBACH, OF LEBANON, PENNSYLVANIA.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 766,044, dated July 26, 1904.

Application filed October 23, 1903. Serial No. 178,222. (No model.)

To all whom it may concern:

Be it known that I, MORGAN D. KALBACH, a citizen of the United States, residing at Lebanon, in the county of Lebanon and State of Pennsylvania, have made certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

My invention is an improvement in steam-turbines, having for an object to provide a novel construction especially designed to secure the greatest expansion of the steam or other vapor and the utmost velocity possible in an apparatus of this class; and the invention consists in certain novel constructions and combinations of parts, as will be hereinafter described and claimed.

In the drawings, Figure 1 is a side elevation, partly in section, of an engine embodying my invention. Fig. 2 is a sectional elevation of the inlet portion of the engine. Fig. 3 is a cross-section on about line 3 3 of Fig. 2. Fig. 4 is a detail perspective view of a fragment of one of the intermediate partitions. Fig. 4ª is a detail section on about line 4ª 4ª of Fig. 4. Fig. 5 is a perspective view of a fragment of one of the revolving disks. Fig. 5ª is a detail section on about line 5ª 5ª of Fig. 5. Fig. 6 is a detail perspective view of a fragment of the initial or inlet partition. Fig. 6ª is a detail section on about line 6ª 6ª of Fig. 6; and Fig. 7 is a detail perspective view of the shafts, parts being broken away.

By my invention I aim to provide a novel construction whereby the steam may expand from time to time in its passage through the casing, thus securing a compound action resulting from the expansion of the steam in such manner as to secure the greatest power from a given amount of steam in the operation of the invention.

The casing is composed of an upper section A and a lower section A′, suitably united and formed to provide the series of cylinders 1, 2, 3, 4, and 5, gradually increasing in diameter, the cylinder 2 being slightly larger than the cylinder 1, the cylinder 3 larger than the cylinder 2, and so on, an inclined surface B being provided in the end of each of the cylinders and shoulders B′ being provided at the discharge end of each cylinder, the shoulder B′ forming an abutment for the last stationary disk of each series and the inclined surface affording a chamber between the last revolving disk of one series and the initial partition of the succeeding series, as best shown in Fig. 1 of the drawings. The casing has an inlet C at one end and a discharge C′ at the other end, the inlet being at the smaller and the outlet at the larger end of the casing, as shown in Fig. 1.

The inlet or initial partition D at the front or inlet end of the cylinder 1 will be understood from Figs. 6 and 6ª. This partition has a central opening D′ to fit over the shaft, a main web or plate D^2, and a rim D^3, the latter projecting from one face of the web D^2 a distance greater than the thickness of the succeeding revolving disk, forming a chamber in which the revolving disk E operates, as shown in Fig. 2. The outer edge of the partition D is grooved at D^4 to receive the keys *a* in the casing so the said partition D will be held from turning in the casing. The web D^2 of the partition D is provided with radially-extending ports *d*, which are elongated in a radial direction and which curve from the inlet or front face of the web D^2 to the opposite or discharge face of said partition and gradually widen toward the discharge end and are curved from their inlet to the discharge ends in the same direction and, as illustrated in Fig. 6ª, so the steam or other vapor will be given a direction, as indicated by the arrow in Fig. 6ª, so it will impinge the buckets of the revolving disk E and turn said disk and the shaft, as desired. As shown in Fig. 2, the initial partition D is succeeded by a revolving disk E, after which the disks E alternate with the intermediate partitions F. These latter, like the partition D, have each a rim F^3, grooved at F^4 to receive the keys *a* in the casing, and the rims D^3 and F^3 are made of such width as to incase the revolving disks loosely, so the latter may freely revolve between and will not bind against the partitions. The initial partitions of the sections 2 to 5 are as shown in Fig. 4.

The revolving disks E are alike, except as to size, and are of the special construction shown in Fig. 5. Each disk E has a central

portion E′, provided with a projecting hub E^2, which is keyed upon the shaft G to turn therewith and turns within the central portion or ring F′ of the adjacent intermediate partition F, as will be understood from Figs. 1 and 2. The disk E is also provided with the series of radial blades E^3 and E^4 and with the circular blades E^5, which, with the radial blades, form the buckets in which operate the steam or other vapor used in driving the engine. It will be noticed that the radial and circular blades of the disk E are straight or in planes parallel with the axis of the disk, as will be understood from Fig. 5^a. A special advantage results from constructing the revolving disk, as well as the intermediate partitions, from plates or disks, in that the radial partitions may be duplicated or increased, as shown at E^4, toward the outer rim of the blade, so that the buckets may be preserved throughout of substantially the same size and of the desired size to secure the best operation of the steam or driving vapor therein. In this connection it will be noticed the short radial blades E^4 do not extend to the center of the disk, but terminate at points somewhat remote therefrom. I thus provide the disk with radial blades extending from the center to the outer edge of the series of buckets and subblades which only extend from the outer edge of the buckets toward the center and terminate short of the latter.

The important advantage secured by constructing each revolving disk and also stationary disk or partition in one piece is that thereby they can be made very light, much more so than in constructions where separate vanes are employed, and this without reducing the strength required. Furthermore, by the construction of the disks so shown and described they may be easily and quickly placed in position in the process of construction or in erecting the engine, and by subdividing the disks as the diameter increases I am able to increase the surface subject to the impinging flow of the fluid employed in driving the engine. It will also be understood that the rims on the outer ends of the radial blades or walls of the revolving disks will have a tendency to keep the motion steady or uniform, operating in this respect by their weight somewhat in the nature of a fly-wheel and rendering the movement of the engine smooth and steady under variable loads.

The initial and intermediate partitions F have the central or bearing portions F′, turning on the hubs E^2 of the adjacent revolving disks, and these partitions F are provided with the radial blades f^3 and f^4, corresponding to the blades E^3 and E^4 of the disk E and with the circular blades F^5, corresponding to the blades E^5 of the revolving disk E. In this construction it will be noticed I also employ radial blades of different lengths, the longer blades f^3 extending from the central portion of the partition to the outer edge of the series of ports therein, while the shorter partitions only extend from the outer edge of the series of buckets toward the center of the partitions, but terminate at a point somewhat distant therefrom, as best shown in Fig. 4. These radial blades are curved, as shown in Fig. 4, so that the steam or other vapor passing therethrough will be given the direction indicated by the arrow in Fig. 4^a and will impinge the buckets of the revolving disks in such manner as to cause such disks to turn, and thereby turn the shaft as desired in the operation of the engine.

From the foregoing description it will be understood that the steam in operation passes first through the initial or inlet partition D, operates upon the first revolving disk, passes thence through the first intermediate partition, thence to the next revolving disk, and so on through the series of devices in the section 1 of the casing and is delivered at the end of said section to the expanding-chamber at the juncture of such section with the section 2, and so on through the several sections of the casing. It will be noticed from Fig. 2 that the hub extension E^2 of each revolving disk extends toward the discharge end of the casing and abuts the next succeeding revolving disk, so that the strain exerted upon the said disks in the direction of length of the shaft is transmitted toward the discharge end of the shaft and is exerted at such end against a sleeve H, which extends toward the end of the casing and bears against one of the series of rings I, which may be lubricated from a cup J, thus relieving the shaft of the end thrust of the revolving disk. Where necessary, collars or rings, as shown at K in Fig. 1, may be interposed between the hub of the last revolving disk of one series and the first revolving disk of the succeeding series.

It will be noticed from Fig. 2 that the space within the fixed partitions provided by the projecting flange or rim portions thereof is sufficient to permit the free turning of the revolving disks in the operation of the engine. It will also be noticed that the inclined construction at B, as shown in Fig. 1, affords an expansion-chamber at the inlet end of each section of the casing after the first, so that the steam discharged from one section may be expanded in advance of its operation upon the revolving disks of the succeeding section, as before described.

By the described construction I am able to secure the greatest expansion of the steam and to attain a high degree of velocity in the operation of the engine. It will also be understood that the several parts are so constructed that they may be readily replaced when worn or otherwise rendered unfit for use.

Having thus described my invention, what

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

1. The combination substantially as herein described, of the casing, having the series of succeeding cylinders, of increasing size, and having the inclined surfaces B and the stop-shoulders B′ at the juncture of said cylinders, the shaft, the initial or inlet disk keyed to the casing, and provided with radial elongated slots for the passage of the steam, such slots being curved to give a proper direction to the steam, the revolving disks, having central portions provided with tubular hub-extensions, and keyed on the shaft, said disks being provided with a series of radial and circular blades forming buckets, the radial blades being arranged in a plurality of series, one series extending from the inner to the outer edge of the buckets, and the other series lying between those of the first series and terminating at their inner ends at a point short of the inner edge of the buckets, and the intermediate partitions keyed to the casing, having central portions journaled on the hub-extensions of the adjacent revolving disks, and having radial and circular blades forming ports for the passage of the steam to the succeeding revolving disks, the radial blades being curved to give direction to the steam, and being arranged in series, those of one series being made shorter than and lying between the outer portions of those of the other series, said inlet and intermediate partitions being provided with projecting rim portions and inclosing the revolving disks, said revolving disks having the hub portion of one disk extending to and bearing against the succeeding disk, and the tube and rings between the last revolving disk and the casing, substantially as set forth.

2. In a turbine substantially as described, a disk having radial and circular blades and having the radial blades arranged in a plurality of series, those of one series being shorter than and lying between the outer portions of the alternating radial blades of the other series, substantially as set forth.

3. The combination in a turbine with the casing, the shaft, and a disk fixed to the casing, and having passages for the steam or the like to the revolving disk, of a revolving disk keyed on the shaft, and having circular and radial blades forming buckets for the steam, the radial blades being provided in a plurality of series, those of one series being made shorter than those of the other, and lying between the outer ends of the blades of such other series, substantially as set forth.

4. In a turbine, the combination with the casing and the shaft, of the revolving disk fixed on the shaft and having buckets, and the partition-disk fixed to the casing and having radial and circular blades forming passages for the steam or the like, the radial blades being curved in cross-section to give direction to the steam, and being arranged in a plurality of series, those of one series lying between the outer portions of the blades of the other series, substantially as set forth.

5. The combination with the shaft, and the casing, of the series of revolving disks keyed on the shaft and having extension-hubs operating each against the succeeding revolving disk, a series of thrust-receiving rings between the final revolving disk and the casing and the intermediate partitions fitting on said hub extensions and keyed at their outer edges to the casing, substantially as set forth.

6. The combination in a turbine, with the casing and the shaft, of the partitions having passages for the steam, the revolving disks keyed on the shaft and having hub portions abutting the succeeding disks whereby the end thrust of one revolving disk is transmitted to the next, and thrust-receiving devices between the final revolving disk and the casing, substantially as set forth.

7. The combination in a turbine, of the casing, the shaft, a partition-disk keyed to the casing, and having radial and circular blades forming ports or passages for the steam, the radial blades being arranged in a plurality of series, those of one series being shorter than those of the other and lying between the outer portions of the blades of such other series, such disk having a projecting rim portion, and a revolving disk having a central portion keyed on the shaft and provided with an extension-hub, and provided with radial and circular blades forming buckets, the radial blades being arranged in a plurality of series, those of one series being shorter than those of the other, and lying between the outer portions of the radial blades of such other series, substantially as set forth.

8. The combination in a turbine, of the casing, composed of a number of sections of increasing size, and provided in said sections with longitudinal keys, the shaft, partitions provided in their outer edges with grooves receiving the keys of the casing, and the revolving disks having buckets for the steam, keyed on the shaft, and alternating with the partitions which are keyed to the casing, substantially as an for the purposes set forth.

MORGAN D. KALBACH.

Witnesses:
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EPHRAIM LIGHT BOESHORE.