R. K. MORCOM & A. JUDE.

TURBINE.

APPLICATION FILED JUNE 13, 1908.

909,103. Patented Jan. 5, 1909.

2 SHEETS—SHEET 1.

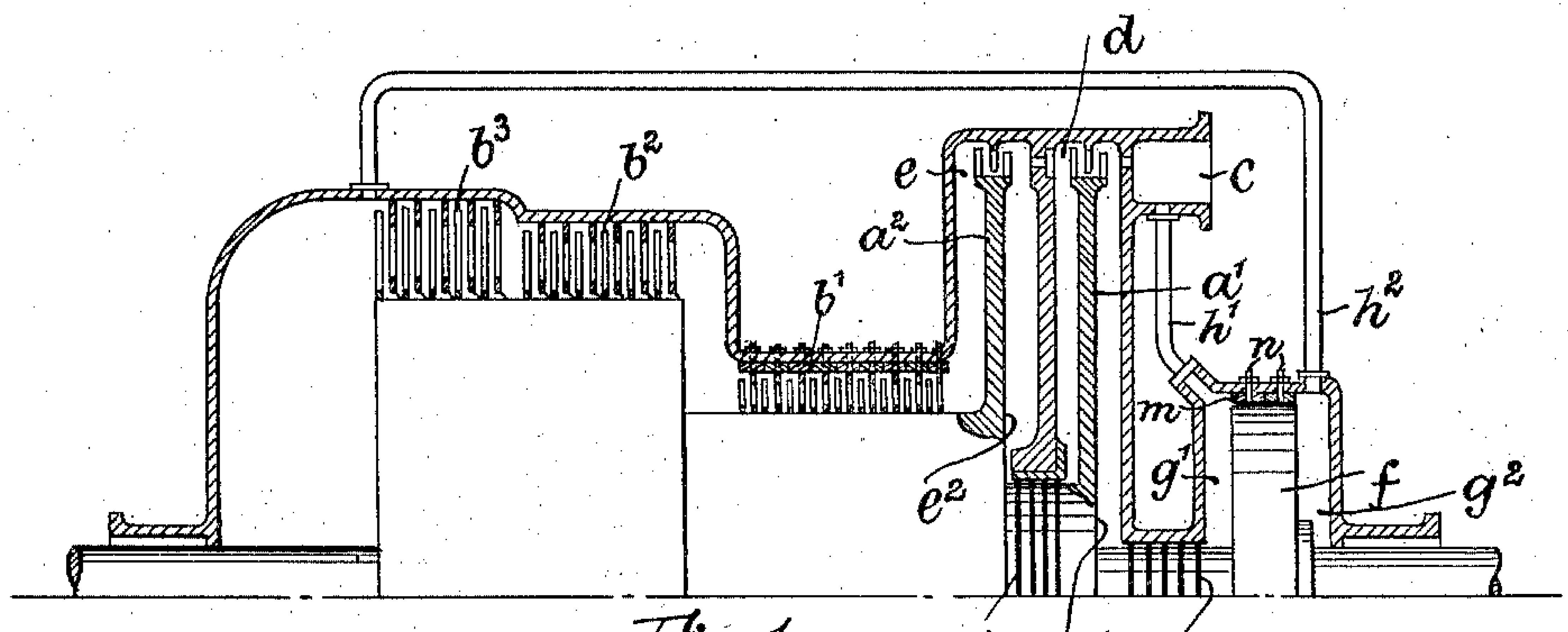

Fig.1.

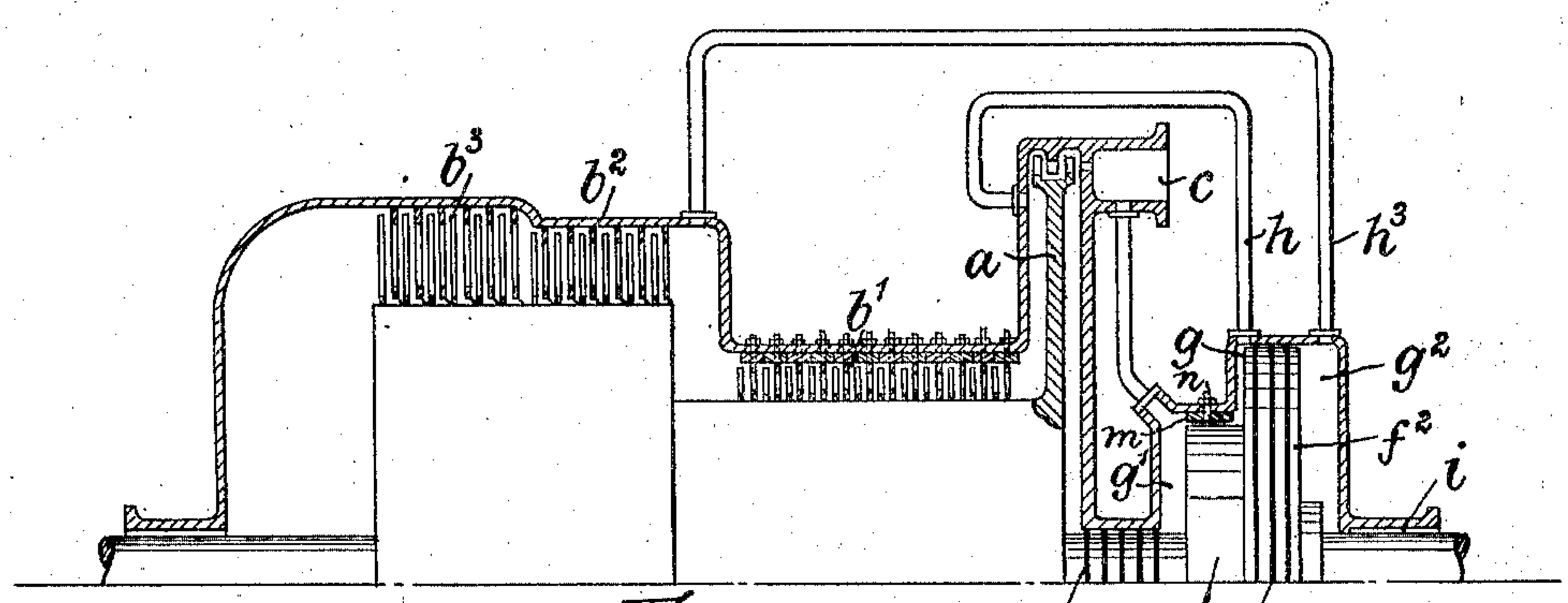

Fig.2.

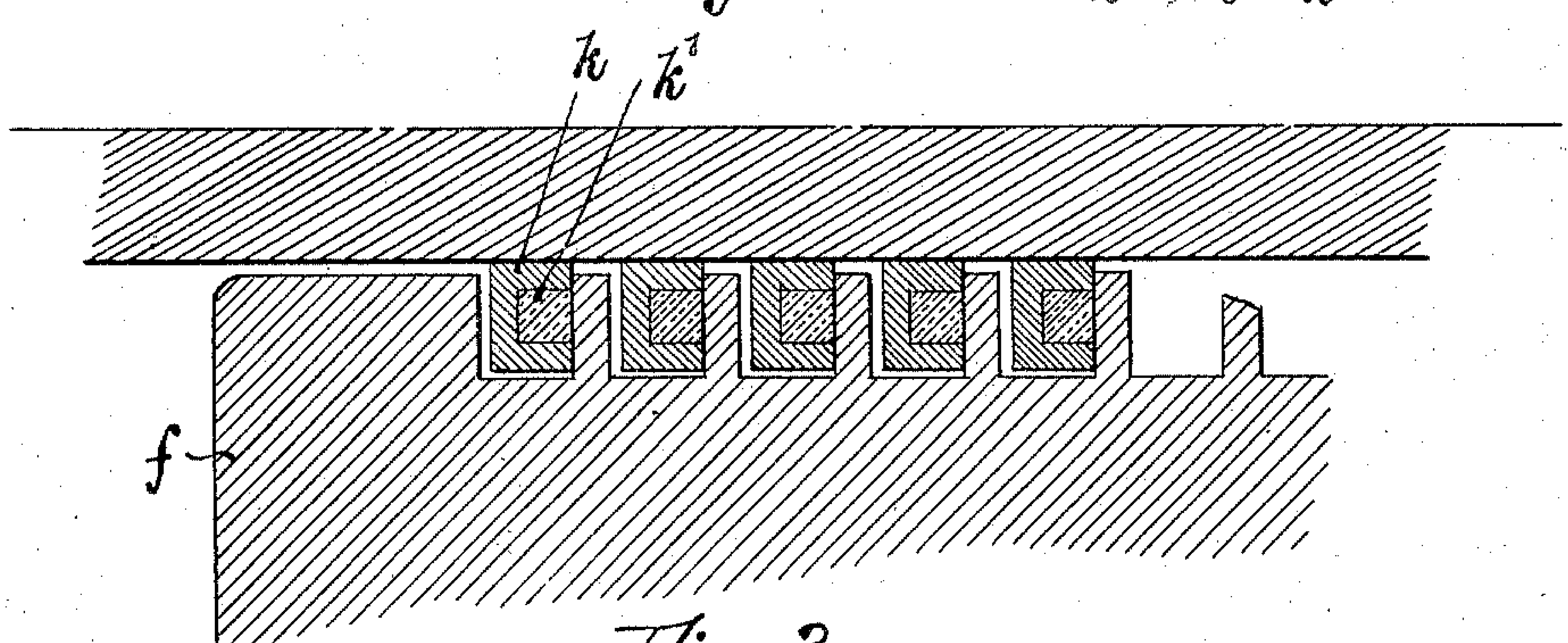

Fig.3.

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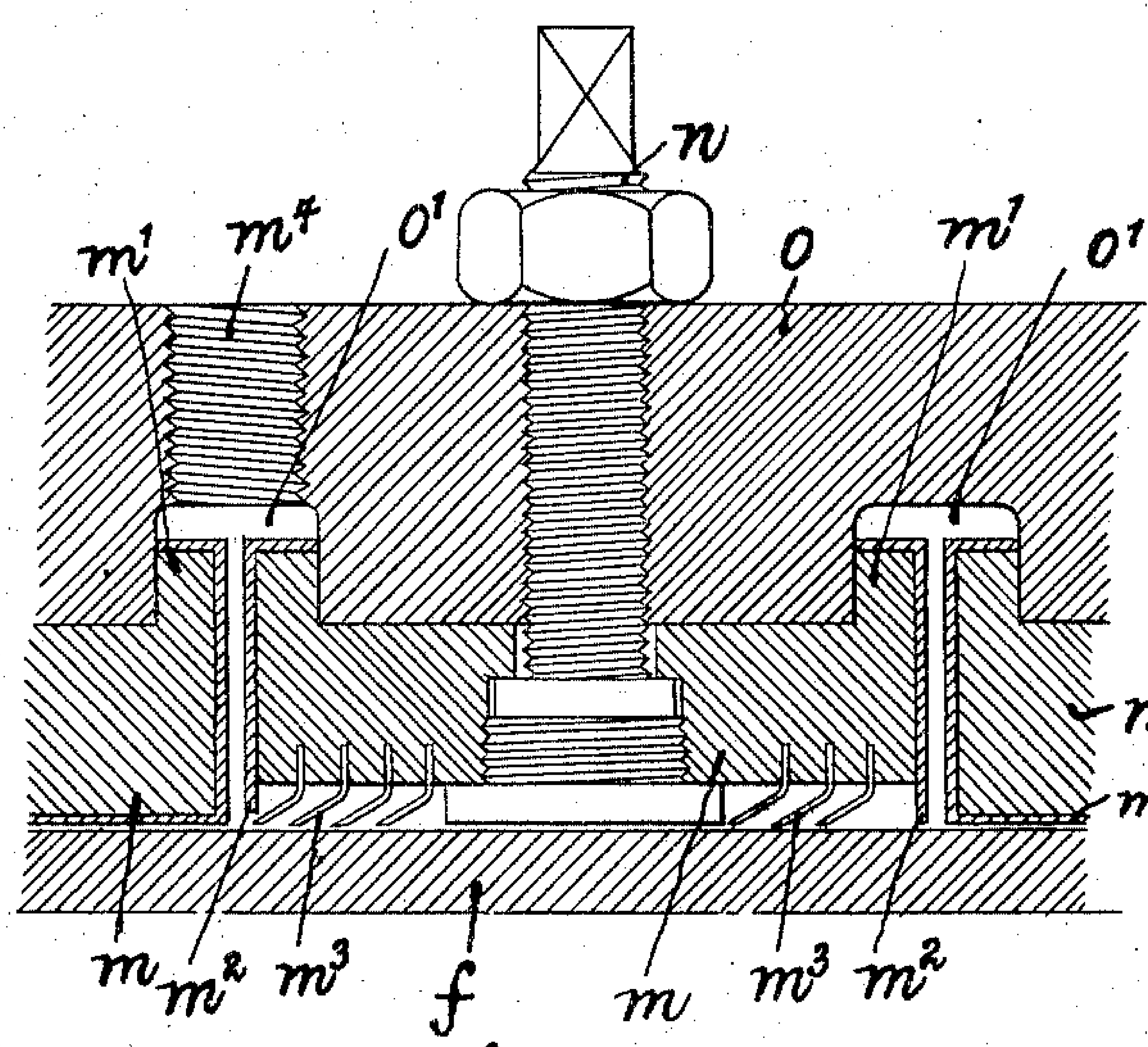

Fig. 4.

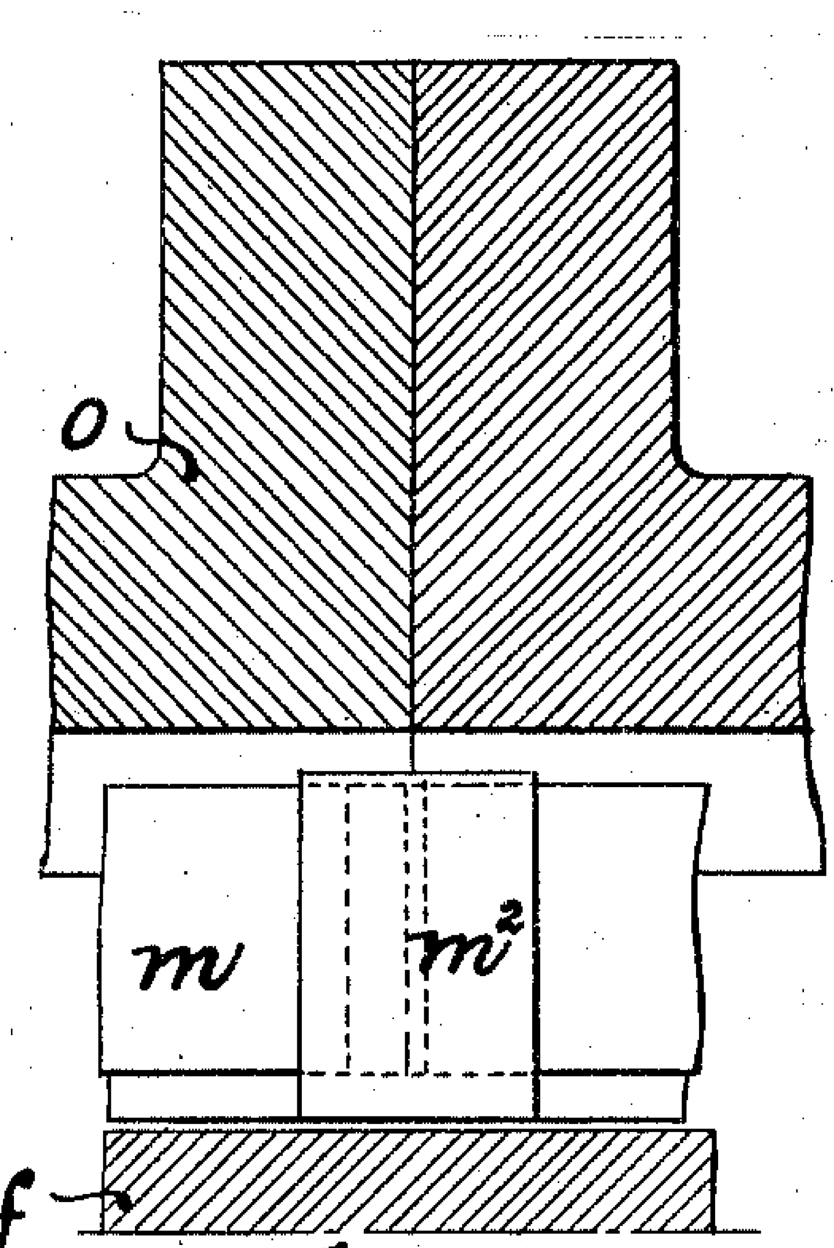

Fig. 5.

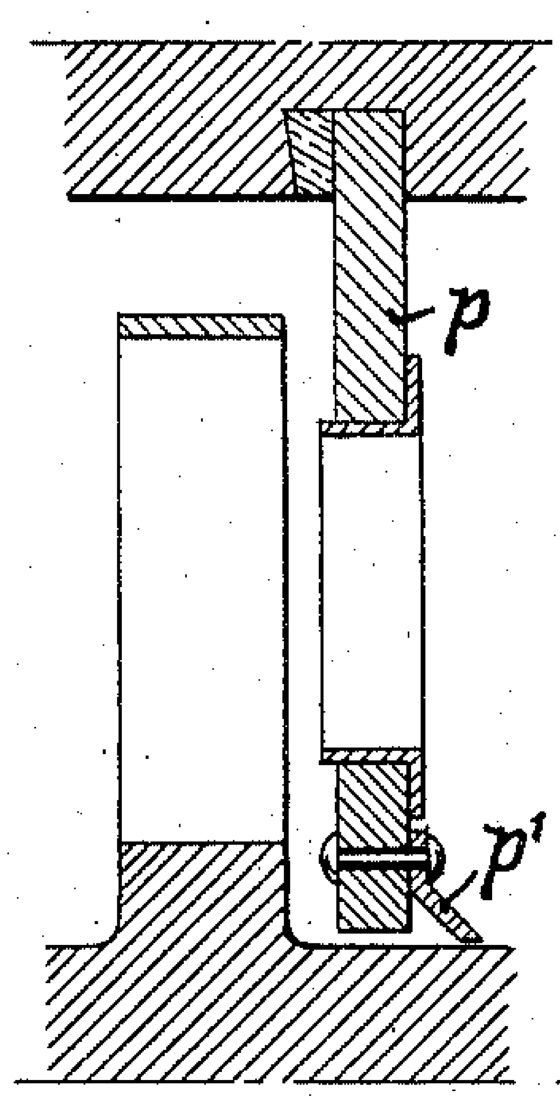

Fig. 6.

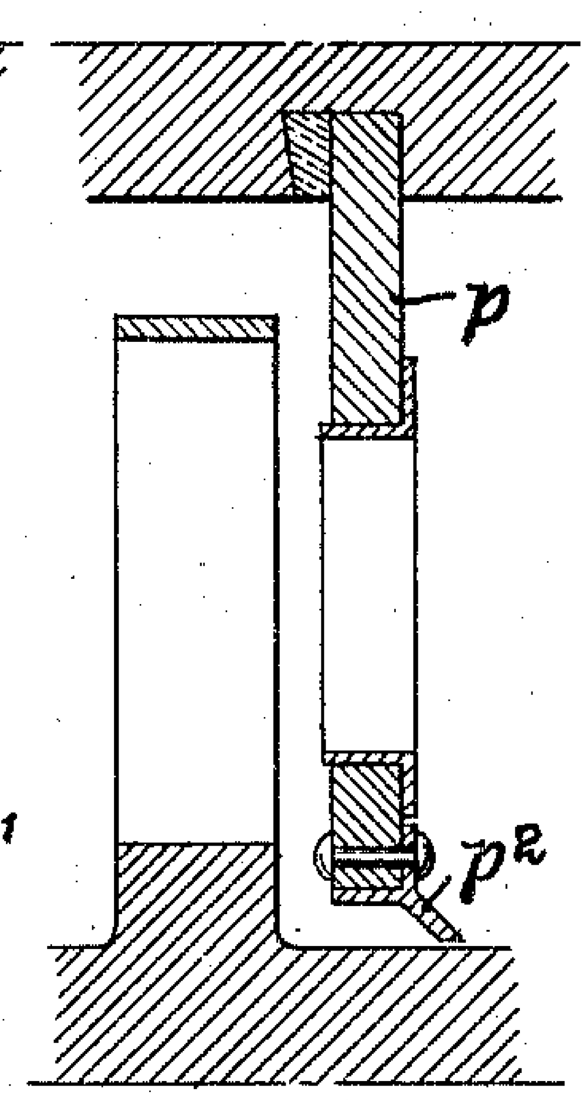

Fig. 7.

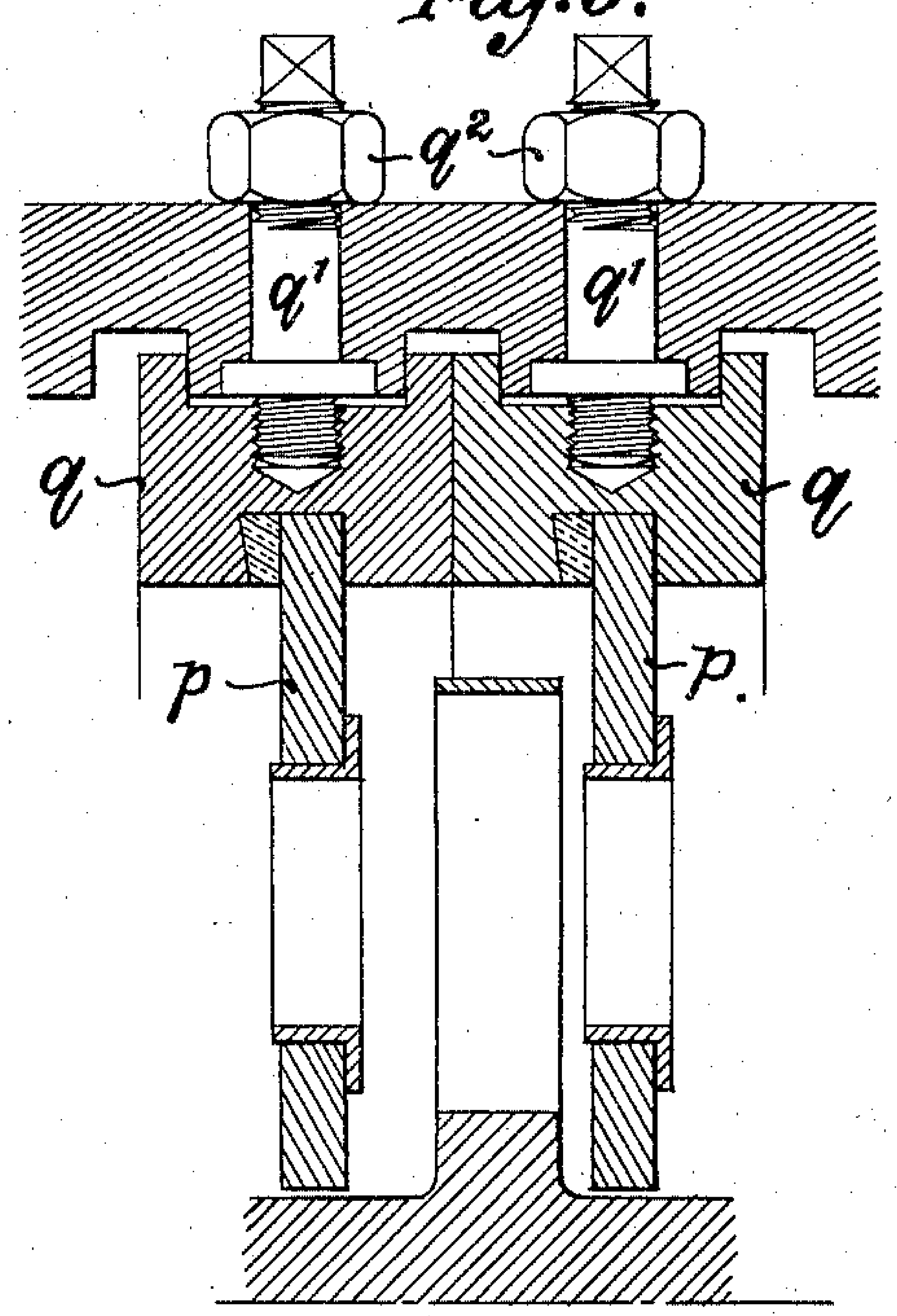

Fig. 8.

WITNESSES

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UNITED STATES PATENT OFFICE.

REGINALD KEBLE MORCOM AND ALEXANDER JUDE, OF BIRMINGHAM, ENGLAND, ASSIGNORS TO BELLISS & MORCOM LIMITED, OF BIRMINGHAM, ENGLAND.

TURBINE.

No. 909,103. Specification of Letters Patent. Patented Jan. 5, 1909.

Application filed June 13, 1908. Serial No. 438,431.

To all whom it may concern:

Be it known that we, REGINALD KEBLE MORCOM and ALEXANDER JUDE, subjects of the King of Great Britain, residing at Ledsam Street Works, Birmingham, in the county of Warwick, England, have invented new and useful Improvements in Turbines, of which the following is a specification.

This invention relates to an improved design of turbine to be operated by expansive fluid in which, by a new combination of known elements, the energy of high pressure steam can be rendered mechanically available in a more economical manner than hitherto and the invention comprises devices adapted to facilitate the adjustment of portions of the turbine subject to wear and tear so as to maintain, throughout the working life of the turbine, those pressure conditions on which efficient action depend.

The combination referred to is that of one or more vane-carrying wheels of relatively large diameter for the impulse action of the fluid in the initial or early stages of its expansion and a drum or drums for the later and terminal stages of the expansion for the further impulse action of the same fluid when, with the smaller pressure, the velocity of exit from the stator guide-blades is less and the volume is correspondingly greater.

Among other advantages, the impulse type of action has the merit that the static pressure of the fluid does not undergo any change during its passage between any one set of vanes so that the displacing effect on the rotor due to fluid-action on the vanes is derived only from the dynamic action by virtue of which the rotor is driven. On this account the axial displacing force on an impulse-driven rotor will be relatively small and permit of the employment of a comparatively small balancing-disk or dummy-piston.

A further advantage belonging to the impulse-type of action is, that leakage of fluid occurs only between the surface of the rotor and the inner edge of the diaphragm or partition of the stator which carries the guide-blades and not between the stator and the outer extremity of the vanes as in turbines of the pressure operating type. Accordingly, by the adoption of the impulse-action throughout the entire flow, the leakage areas will be minimized as well as the axial displacing force. But the adoption of the impulse-type involves a higher velocity of vane than would be requisite with an alternative type of action. This requirement is conveniently provided for by the well known use of wheels of large diameter for the initial and early stages of the expansion but, inasmuch as the employment of such wheels, in the later stages of the expansion when the volume of the fluid to be dealt with is so much greater, is cumbersome and costly and causes much loss by disk-friction, we have found that with a drum-built rotor with an increased number of expansion steps, to keep down the velocity of issue from any one set of guide-blades, a much more economical effect will be produced.

A drum-built rotor of impulse-type will, as compared with a wheel-rotor of the same type, have a larger circumference of leakage between the rotor and the inner edges of the partitions of the stator. Accordingly, to compensate for this inherent disadvantage we provide, as a portion of this invention, special clearance-adjusting devices at those portions of the turbine and as the purpose of the invention is to permanently maintain the necessary pressures at all parts of the turbine for economic and efficient working, leakage-adjusting devices will be required at all parts where leakage can occur as will presently be described. To balance the much mitigated pressure, which will be exerted on the rotor under the above circumstances, we adopt a revolving idle piston-disk but, in order that one of small area and diameter may suffice for the purpose, we subject it to a very considerable difference of pressure on its two faces.

In the accompanying drawings:—Figure 1 is a half longitudinal section of a turbine showing a double-wheel and drum combination of rotor and a single balancing piston. Fig. 2 is a half longitudinal section of a modification in which a single wheel is combined with the drum and a differential balancing piston is employed. Fig. 3 is a longitudinal section of a portion of the stator and a portion of a balancing piston or of the rotor shaft. Fig. 4 is a longitudinal section of a portion of the stator and a portion of a balancing piston. Fig. 5 is a transverse section corresponding to Fig. 4. Fig. 6 is a longitudinal section through a portion of the stator and of the rotor drum showing a guide-blade carrying partition in cross-section. Fig. 7 is a view similar to Fig. 6 but showing a modification. Fig. 8 is a longitudinal section of a portion of the stator and of another portion of the rotor drum, the guide-blade carrying partitions being likewise shown in cross-section.

Referring to Fig. 1, which is to be regarded as a representative example, a^1 and a^2 are wheel-portions of the rotor by means of which the steam undergoes two stages of expansion, these being followed by a series of expansions carried out in the drum-portions b^1 b^2 b^3 of the rotor.

By adopting such conditions that the fluid, in flowing from the supply passage c to the compartment d, undergoes a fall of pressure and corresponding acquirement of velocity-energy which is utilized in passing the double series of vanes of the wheel a^1 without further alteration of static pressure in its progress past the vanes thereof, there will be the same fluid-pressure on both sides of the wheel a^1. If corresponding conditions occur in respect to the flow from the compartment d to the compartment e and passage through the double series of vanes of the wheel a^2, the pressures will be alike also on both sides of the wheel a^2. Thus by the two-fold expansion the pressure will be very considerably reduced without incurring much thrust on the rotor in an axial direction, such thrust as occurs being due to the fluid-pressures on the annular areas e^1 and e^2 of the bosses of the wheels a^1 and a^2. Additional axial thrust from right to left will be due to the fluid pressure on the drum portions of the rotor, but by the combination of wheel and drum with impulse action on both as above described, the one-way axial-force on the rotor can be kept relatively small. To balance this force by a piston f of the least diameter, we subject one side thereof namely g^1 to the initial pressure of the steam by the pipe connection h^1 and the opposite side g^2 to the terminal pressure of the steam by the pipe h^2 which, when a condenser is used, will be less than the atmospheric pressure.

Fig. 2 shows a modified example in which there is only one wheel a but in which there is a differential balancing piston, having two diameters f^1 and f^2, the side g^1 of which is subjected to the initial fluid-pressure conducted through the pipe h^1 as before, the space g which intervenes between g^1 and g^2 being, by the pipe h, subjected to an intermediate pressure which results from the expansion of the fluid from the supply passage c to the wheel a and the space g^2 on the further side of the larger portion of the balancing piston being subjected to a still lower pressure which may be the terminal pressure of the steam. In Fig. 2 the space g^2 is shown connected by a pipe h^3 to a space in the stator between the portions b^1 and b^2 of the rotor where the pressure is slightly greater than that of the atmosphere. This will entail a somewhat larger balancing piston than would be required if the space g^2 were in connection with a space in which the terminal pressure exists as in Fig. 1, but the modified arrangement has the advantage that, if leakage occurs past the stuffing box i, it will be of steam outwards in relatively small quantity, instead of air inwards which, by reason of a considerable difference of pressure, may be sufficient to appreciably impair the vacuum. With this arrangement also any steam which leaks past the balancing piston will be conducted by the pipe h^3 to traverse the portions b^2 and b^3 of the rotor and do work.

Fig. 3 shows the method of minimizing the leakage of steam past a balancing piston f or a portion of the rotor shaft neither of which are exposed to extreme differences of pressure, consisting of a series of Ramsbottom spring-rings k each of which, on the operating side thereof, carries an anti-friction non-seizing substance k^1, such as carbon, occupying a groove formed in the side of the ring.

Figs. 4 and 5 are two views of a contrivance for minimizing the leakage past a balancing-piston or portion of the rotor shaft exposed to greater differences of pressure, Fig. 4 being a part-longitudinal section and Fig. 5 a part-transverse section. In these figures, there are, interposed between the piston-portion f of the rotor and the surrounding portion o of the stator, a plurality of rings, each composed of a plurality of segments m. Each segment is supported by one or more stud-bolts n, which is adapted from the outside, even when the turbine is running, to either advance the segment towards the rotor or withdraw it. The steam-joint between the stator and the back of the segments m is effected by flanges m^1 which fit into internal grooves o^1 formed in the interior surface of the stator o. The joint between the adjacent segments of each ring is effected by means of an overlapping strip m^2 which, before assembly, is secured to the end of one segment, the end of the adjacent segment being beveled, as indicated in dotted lines in Fig. 5, to facilitate insertion. The segments may have a plain surface as represented by the outside rings in Fig. 4 or, as shown by the middle ring in that figure, they may be provided with deformable segmental packing strips m^3 which are adapted to yield to a radial force and which also, by the enlargements which occur between successive rings of strips offer a maximum obstruction to the leakage of steam. Between the rings of segments m any steam which may leak can be tapped off, as indicated at m^4 of Fig. 4, and returned through a pipe to a suitable portion of the stator to be utilized in the succeeding stages of the turbine action.

In Figs. 6–8 are shown the detail of the blading at the drum-portions b^1 b^2 b^3 comprising devices for adjusting the width of the clearance-space between the rotor and the inner edges of the partition plates of the stator which carry the guide-blades. In Fig. 6, to the inner periphery of the stator plates p of the low-pressure portions b^2 b^3 of the rotor drum, a ring composed of segments p^1 of obtuse angle section is secured by rivets, the unsecured flange portion of the section being dish shaped and thereby adapted to be forced into closer proximity to the rotor by a deforming pressure which makes the angle still more obtuse. In Fig. 7 the segments p^2 are of Y section one flange of which is adapted to be deformed towards the surface of the rotor. In these the principle of the adjustment resides in the capability of flattening a dished surface to a greater or less degree. Fig. 8 shows an adjustable mounting of the plates p of the high pressure portion b^1 of the rotor drum where it is desirable that a more exact adjustment and one also capable of being effected from the exterior while the turbine is in operation, be employed. In this construction the adjustment of the periphery of the plates p towards or from the rotor is effected in a manner similar to that adopted in Figs. 4 and 5. In this figure, q q are segmental blocks by which the plates p are secured, the blocks being carried on the ends of the stud bolts q^1 q^1 provided with locking nuts q^2 q^2.

We claim:

1. A turbine for expansible fluids comprising a wheel, vanes carried thereon, a stator, a partition wall in said stator extending inwards to a portion of the rotor of small diameter, means for minimizing leakage between the edge of the partition and the rotor, guide-blades fitted in an aperture in said partition arranged to direct the fluid on to the wheel-vanes and effect an impulse-action thereon without change of pressure while passing between the vanes, a drum, vanes carried by the drum, a partition wall in stator extending inwards towards the drum surface, means for minimizing the leakage between the edge of the partition wall and the drum surface and guide-blades fitted in an aperture in said partition arranged to direct the fluid on to the drum-vanes and effect an impulse-action thereon without change of pressure while passing between the vanes.

2. In a turbine, means for adjusting the clearance spaces between the stator and the periphery of a balance-piston, comprising segmental blocks in said clearance spaces and adjusting bolts on which said blocks are mounted.

3. In a turbine, means for adjusting the clearance spaces between the stator and the periphery of a balance-piston, comprising segmental blocks in said clearance spaces, flanges on said blocks fitted in grooves formed in the stator and adjusting bolts on which said blocks are mounted.

4. In a turbine, means for adjusting the clearance spaces between the stator and the periphery of a balance-piston, comprising segmental blocks in said clearance spaces, flanges on said blocks fitted in grooves formed in the stator, strips overlapping the butting ends of adjacent blocks and adjusting bolts on which said blocks are mounted.

5. In a turbine, means for adjusting the clearance spaces between the stator and the periphery of a balance-piston, comprising segmental blocks in said clearance spaces, flanges on said blocks fitted in grooves formed in the stator, strips overlapping the butting ends of adjacent blocks, adjusting bolts on which said blocks are mounted and deformable strips secured to said blocks on the surface presented towards the balance-piston.

6. In a turbine of the impulse type, means for adjusting the clearance spaces between the stator plates and the low-pressure portions of the rotor drum, comprising deformable segments secured to the inner borders of the stator plates.

7. In a turbine of the impulse type, means for adjusting the clearance spaces between the stator plates and the low-pressure portions of the rotor drum, comprising deformable segments formed with an overhanging dished flange secured to the inner borders of the stator plates.

8. In a turbine of the impulse type, means for adjusting the clearance spaces between the stator plates and the high-pressure portions of the rotor-drum, comprising segmental blocks in which said plates are carried and adjusting bolts on which said blocks are mounted.

9. In a turbine of the impulse type, means for adjusting the clearance spaces between the stator plates and the high-pressure portions of the rotor-drum, comprising segmental blocks on which said plates are carried, flanges on said blocks fitted in grooves formed in the stator and adjusting bolts on which said blocks are mounted.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

REGINALD KEBLE MORCOM.
ALEXANDER JUDE.

Witnesses:
ERNEST HARKER,
ALBERT HALSTEAD.