M. L. HARRIS.

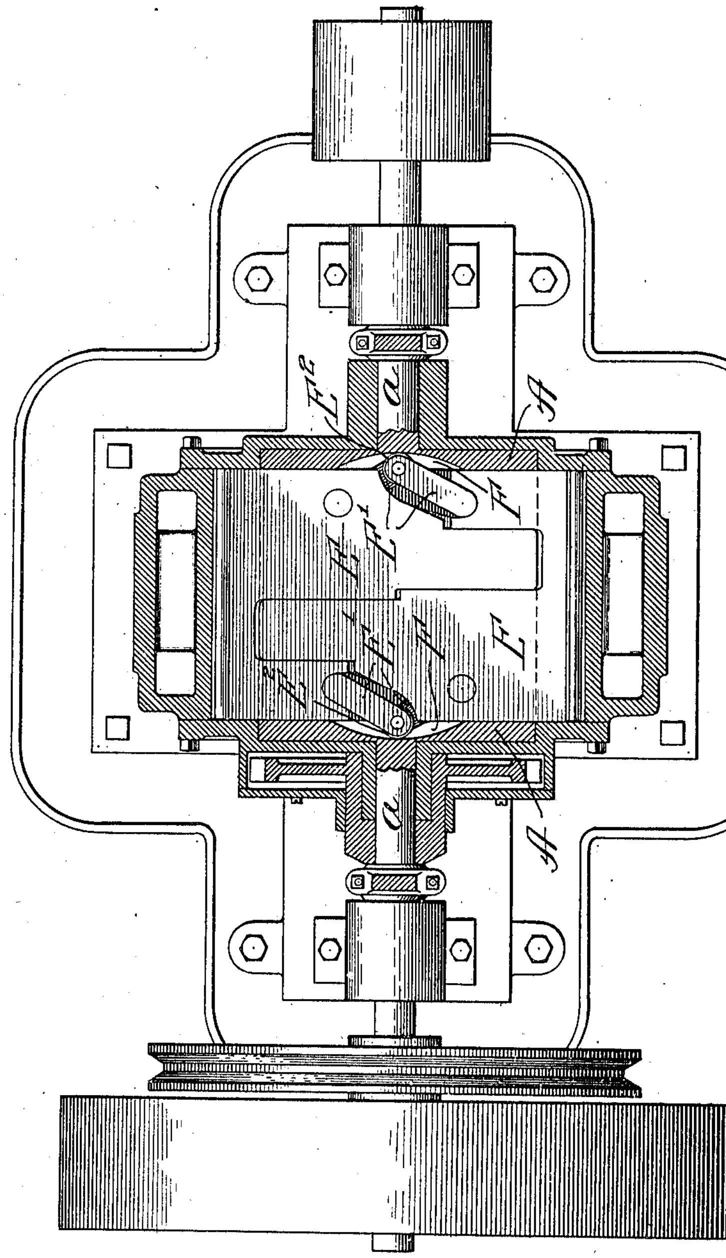
ROTARY ENGINE.

APPLICATION FILED AUG. 15, 1908.

974,485. Patented Nov. 1, 1910.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

John Enders

Chas. H. Bull

Inventor:

Malcolm L. Harris

By Dyrenforth, Lee, Chritton & Wiles

Attys.

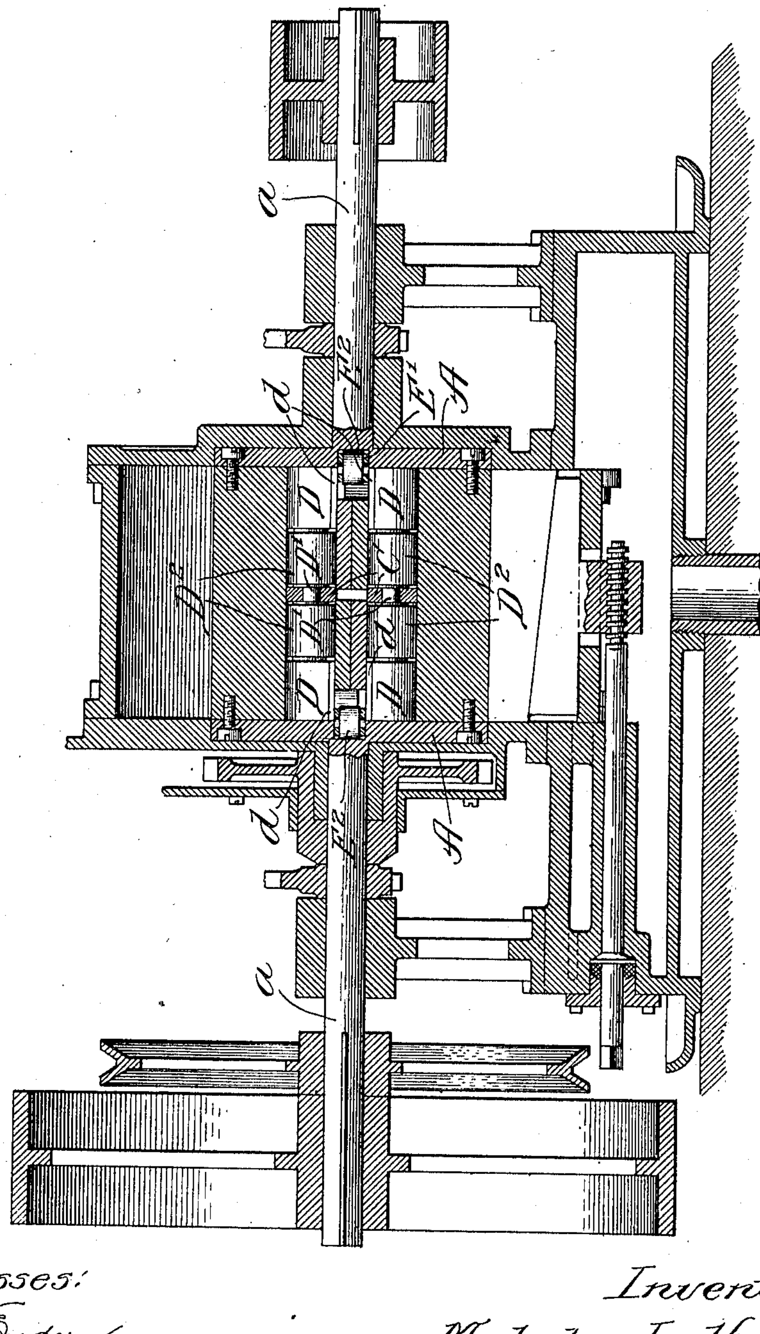
THE NORRIS PETERS CO., WASHINGTON, D. C.

M. L. HARRIS.
ROTARY ENGINE.
APPLICATION FILED AUG. 15, 1908.

974,485. Patented Nov. 1, 1910.

5 SHEETS—SHEET 2.

Fig. 2



Witnesses:
John Enders
Chas. H. Bull

Inventor:
Malcolm L. Harris.
By Dyrenforth, Lee, Chritton & Wiles
Attys.

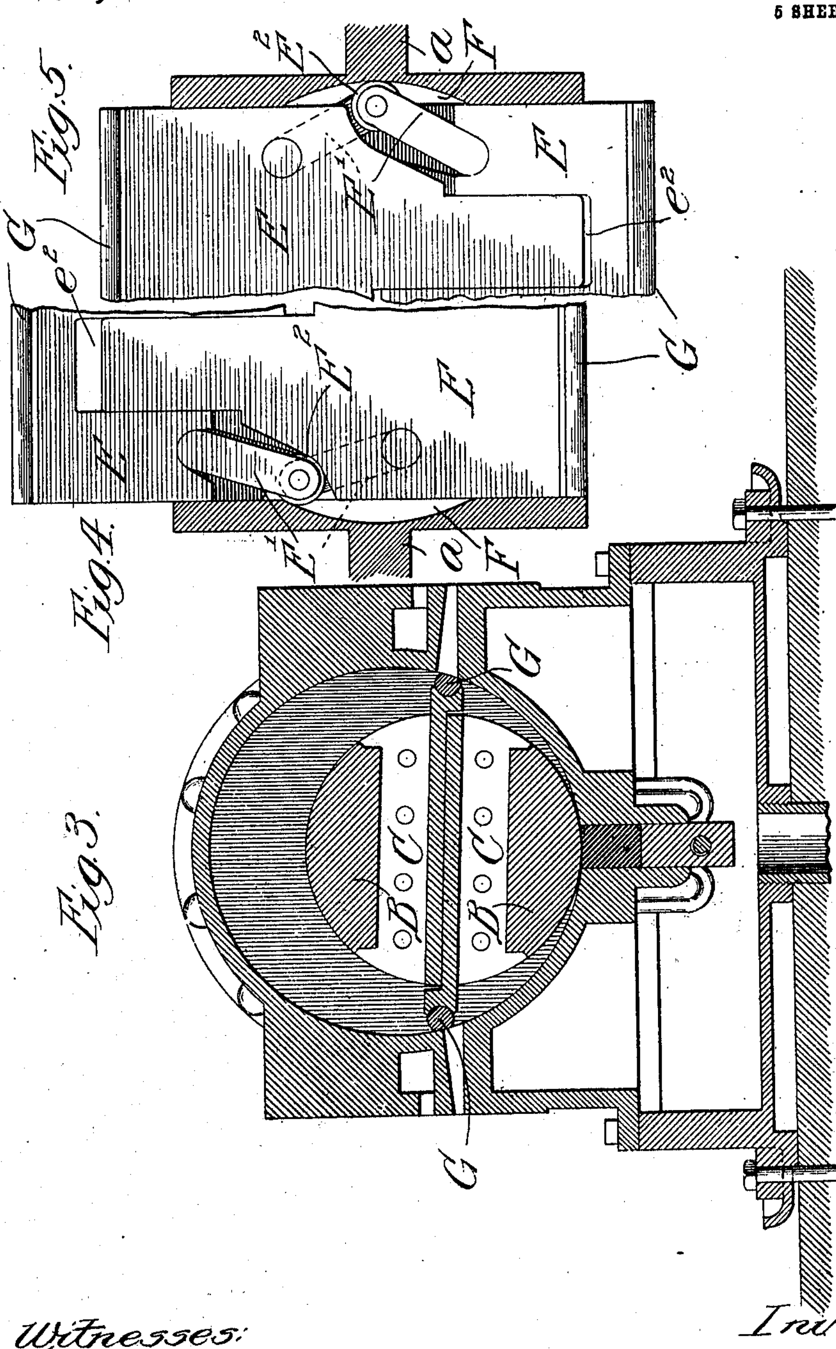
M. L. HARRIS.

ROTARY ENGINE.

APPLICATION FILED AUG. 15, 1908.

974,485. Patented Nov. 1, 1910.

5 SHEETS—SHEET 3.



Witnesses:

John Enders

Chas. H. Buell

Inventor

Malcolm L. Harris.

By Dyrenforth, Lee, Chritton & Wiles

Attys.

M. L. HARRIS.
ROTARY ENGINE.
APPLICATION FILED AUG. 15, 1908.

974,485.

Patented Nov. 1, 1910.
5 SHEETS—SHEET 4.

Fig. 6.

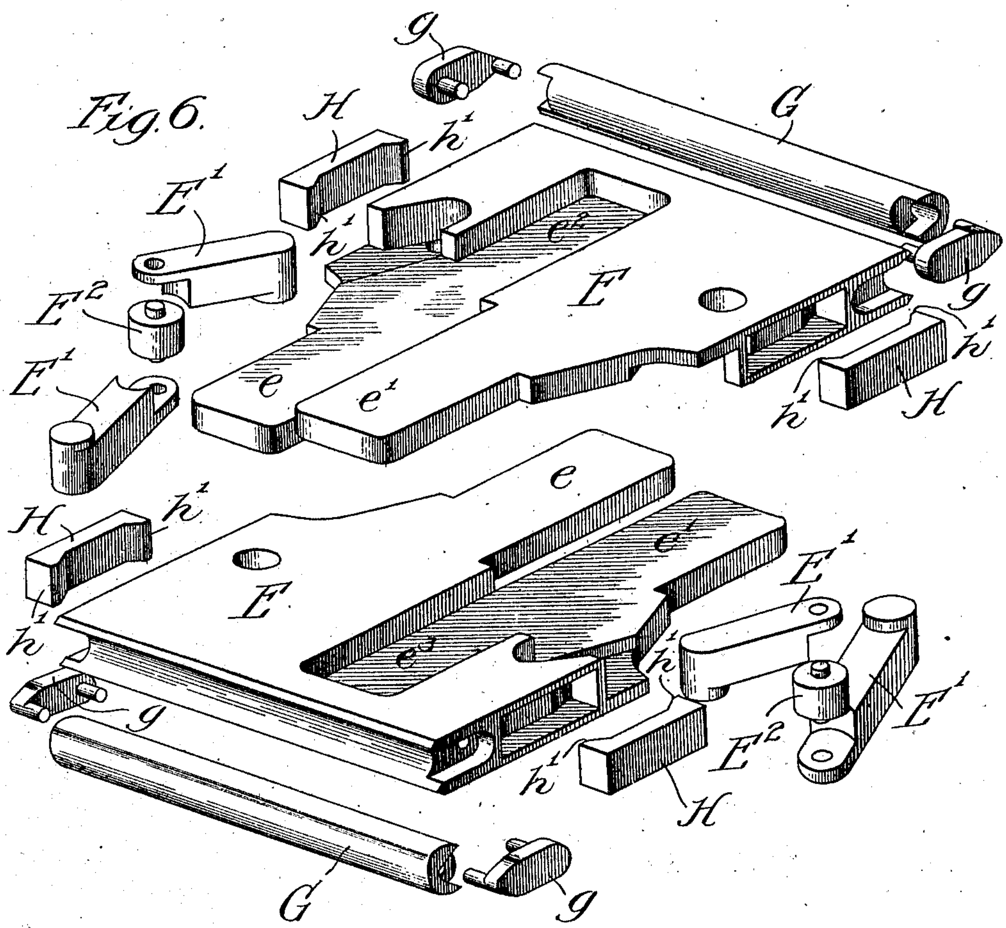
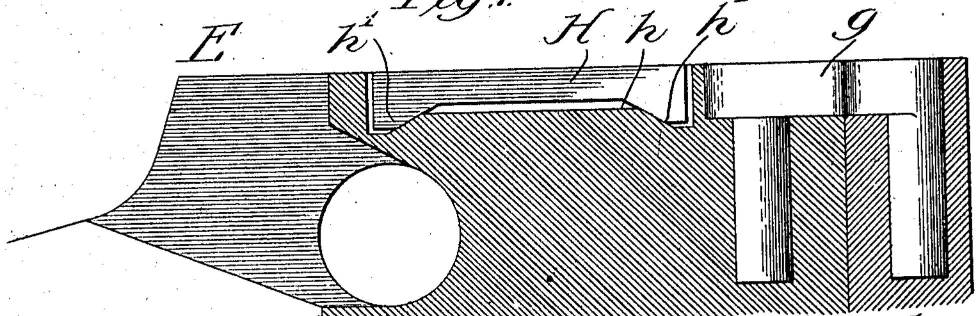


Fig. 7.



Witnesses:
John Enders
Chas. H. Buell

Inventor:
Malcolm L. Harris.
By Dyrenforth, Lee, Chritton & Wiles
Attys.

THE NORRIS PETERS CO., WASHINGTON, D. C.

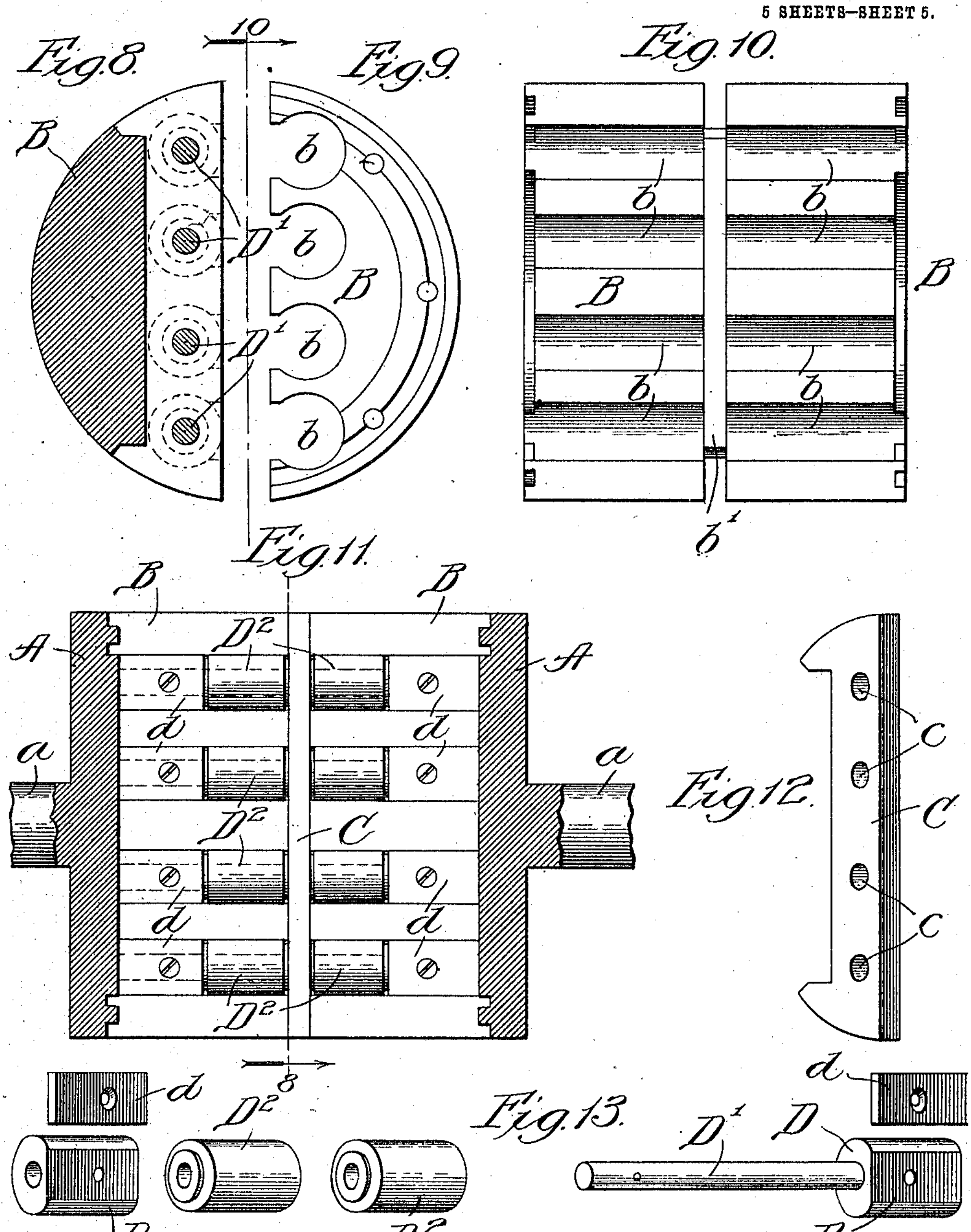
M. L. HARRIS.

ROTARY ENGINE.

APPLICATION FILED AUG. 15, 1908.

974,485. Patented Nov. 1, 1910.

5 SHEETS—SHEET 5.



Witnesses:

John Enders

Chas. H. Bull.

Inventor:

Malcolm L. Harris.

By Dyrenforth, Lee, Chritton & Wiles

Attys.

THE NORRIS PETERS CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

MALCOLM L. HARRIS, OF CHICAGO, ILLINOIS.

ROTARY ENGINE.

974,485. Specification of Letters Patent. Patented Nov. 1, 1910.

Application filed August 15, 1908. Serial No. 448,690.

To all whom it may concern:

Be it known that I, MALCOLM L. HARRIS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Rotary Engines, of which the following is a specification.

My invention relates to improvements in rotary engines and particularly in certain of the details of construction thereof which will hereinafter appear.

The improvements can be used on rotary engines of many types but were primarily designed for use in connection with an engine of the general form and construction shown in my Patent No. 889,460 granted June 2nd, 1908, and they are illustrated herein in connection with an engine of that type. The improvements are designed to produce a better and more efficient operation of the engine than is practicable with the form shown in said patent and as will be evident from the description hereinafter given they can, if desired, be applied to other types of engines with corresponding results.

The invention is fully illustrated in the accompanying drawings in which:

Figure 1 is a horizontal section through the engine on the plane of the shaft thereof; Fig. 2 is a vertical section on the plane of the shaft, the piston blades being shown in a horizontal position and the valve gear being omitted for the sake of simplicity; Fig. 3 is a transverse vertical section; Fig. 4 is a fragmental longitudinal section through the drum showing the vanes and operating device therefor in one position; Fig. 5 is a corresponding view showing the vanes in another position; Fig. 6 is a perspective view showing the manner of assembling the vanes and their details of construction; Fig. 7 is a central section through one of the vanes in a plane parallel to the faces thereof; Fig. 8 is a transverse section through one-half of the drum in the line 8 of Fig. 11; Fig. 9 is an elevation of one end of one-half of the drum with the end-plates removed; Fig. 10 is an elevation of one-half of the drum looking from the inside, that is in the direction of the arrow 10 in Fig. 9; Fig. 11 is a similar elevation showing all the parts of the drum assembled with the heads in section; Fig. 12 is a perspective view of the bridge which is inserted in the drum; and Fig. 13 is a perspective view showing the manner of assembling the rollers and shafting therefor.

The engine of this application is identical in construction and operation with that of my prior patent referred to excepting for the improvements herein shown which relate exclusively to the construction of the drum and blades. The engine itself is fully described in detail in said patent and such description will not be here repeated.

Referring to the drawings, A, A are the drum-heads, upon which are mounted the shaft-sections *a*, *a* all as set forth in the patent aforesaid. Between the drum-heads are supported two generally semi-cylindrical drum-frames B, similar each to each. These drum-frames are of such dimensions as to leave between them when bolted in place between the heads, a space sufficient to receive the blades of the engine, which will be hereinafter described in detail, and their curved faces conform to the curvature of the drum-heads as illustrated. Each drum-frame has extending longitudinally through it a plurality of cylindrical channels or ways *b* (Fig. 9), each of such size and so positioned that the curve of its wall if prolonged would cut the front or flat face of the drum-frame. Each cylindrical channel or way *b* is cut away in its forward portion, so that each channel or way forms a considerable gap in the flat face of the corresponding drum-frame. This construction and arrangement is fully illustrated in Figs. 9 and 10.

In addition to the longitudinally extending cylindrical channels or ways *b*, each drum-frame is provided with a transverse parallel walled channel b^1 medially disposed between the ends of the frame, the said channel b^1 being adapted to receive and be completely filled by a bridge C (Figs. 8 and 12) provided with a plurality of transversely extending perforations *c* adapted to serve as medial bearings for the roller shafts presently to be described. Each drum-frame has inserted in the ends of the channels or ways *b* two segmental blocks D one at each end, which blocks support between them a shaft D^1, one for each of the cylindrical channels *b*. The shafts D^1 pass through the perforations *c* in the bridge C so as to receive therefrom a medial bearing, and the blocks D and shafts D^1 are prevented from rotating by means of cleats *d* screwed to the flat faces of the blocks D after they are positioned.

Between each block D and the bridge C and journaled upon the shaft D^1 is a roller D^2 having reduced projecting ends bearing respectively against the blocks and bridge, the peripheries of the rollers projecting to or beyond the normal plane of the forward face of the drum-frame.

After the parts are assembled in each drum-frame to the positions set forth above and fully illustrated in Fig. 11, the two drum-frames with the parts carried thereby are secured in place between the drum-heads so that the resulting drum in general resembles that described in my patent but is provided on the two sides of the slot therethrough with rollers which will form anti-friction bearings for the blades.

Referring to Fig. 6 the construction of the blades will be set forth. The blades are similar each to each and symmetrical with respect to each other so that they can be assembled from similar parts on their reversing end to end as will be set forth. Each blade is of substantially the same width as the space between the drum-heads and is of the thickness of the space between the rollers carried by the drum-frame. The length of each blade is such that when its outer end is in contact with the cylinder wall at that point where the relative extension of the blade is least, *i. e.*, when the blades are horizontal in the construction shown, the opposite end of the blade will lie at substantially the opposite periphery of the drum. The blades are indicated generally in the drawings by the reference letter E and it will be seen that each is made of flat metal of the proper thickness, the outer ends of the blades being substantially the width of the longitudinal dimensions of the cylinder and the inner ends being cut away. The narrowed inner ends of the blades are separated into two parallel faced furcations e, e^1 similar each to each and symmetrically arranged. The two furcations e, e^1 are planed off on their faces so that each is substantially half the thickness of the blade of which it forms a part, the planing for the two furcations taking place on opposite sides of the blade so that one furcation is on one face of the blade and the other furcation is on the opposite face. The thinning of the material of the blades is carried toward the outer ends thereof in the form of channels or depressions e^2, e^3, each of such size as to receive the corresponding furcation on another similar blade. Each channel or depression is, however, made slightly longer than the corresponding furcation for a purpose which will presently appear.

It is obvious that two blades of the type described can be assembled into a composite whole by merely turning one blade end for end with respect to the other, two such blades being shown in Fig. 6. When two such blades are taken the furcations e on one will enter the depression e^2 on the other and the furcation e^1 will enter the depression e^3 on the other, and when the blades are pushed together to their fullest extent and placed in the drum they will just span the cylinder of the engine when in a horizontal position and when in such position the ends of the depressions e^2, e^3 will lie just beyond the periphery of the drum while the ends of the furcations on the blades will lie at or just within the periphery of the drum.

Each blade when assembled has pivoted to it at the side links E^1 which are mutually pivoted together by roller pivots E^2 which, when the blades are drawn apart lie just beyond the lateral edges of the blades, and which when the blades are pushed together extend considerably beyond the sides thereof. It will be observed from the drawings that the toggle-links thus formed lie in channels to receive them in the blades and that when the two blades are assembled they form practically a rectangular unit capable of longitudinal expansion and contraction and having merely the centrally projecting toggles provided with rollers.

The drum-heads are provided with curved cam-tracks F cut into the adjacent faces thereof in line with the slot between the drum-frames, which cam-tracks are adapted to receive and coöperate with the roller-pivots E^2 of the links described. The result of this construction is that when either blade is forced in, as one blade is constantly being forced in the rotation of the drum, it will cause such action of the toggle-pivots along the cam-track provided to receive it as will move the opposite blade to a predetermined position. The curve of the cam-track is so arranged that the blades will make their proper movement regularly and without either undue space between their ends and the cylinder wall, through which leakage of steam might take place, or on the other hand without undue friction which might tend to decrease the efficiency of the engine.

In Figs. 4 and 5 the manner of operation is illustrated, Fig. 5 showing the blades contracted as much as possible and Fig. 4 showing them at their maximum extension. Starting with the parts in the position shown in Fig. 5 it may be assumed, for instance, that the blade toward the lower portion of the sheet is being forced inward by contact with the face of the cylinder. This operation will obviously move the pivot of the toggle upward as shown in the drawing with the result that the pivot will be forced in and the opposite blade will be extended to a greater distance than the lower blade is moved in, so that the two blades vary their total lengths thereby producing a continuously proper fit. When the blade has been pushed in as far as possible, the parts will occupy the position shown in Fig. 4, where the maximum extension prevails, thereupon the upper blade will begin to be pushed in by contact with the wall of the cylinder thereby forcing downward the toggle-pivot, but on this occasion the toggle-pivot has an opportunity to move outward sidewise into the space afforded by the cam-track, and consequently the lower blade although it moves downward moves less rapidly than the upper blade. In this way the blades constantly occupy positions such that their total length is exactly right to produce successful operation.

It will be observed from Figs. 3 and 1 that there is a gap between the end of each furcation and the depression which receives it on the corresponding blade. This gap extends beyond the periphery of the drum just at the moment when the blades are contracted to their greatest extent, which is at the time the blades are horizontal and are passing the ports of the engine. As a result live steam will enter the gap at one end of the blade while there will be practically no pressure in the gap at the other end and this unbalanced pressure will tend to separate the blades, holding them in a properly distended condition and minimizing the friction on the walls of the cylinder.

It is to be observed that the blades are provided at their ends with the packing-cylinders G held in place by links g, all as set forth in my patent referred to and for the same purpose. In addition to this packing provided at the ends, I provide on the sides of the blades packing-members H let into depressions or channels provided for the purpose in the edges of the blades toward their outer ends. The depressions in the blades are provided with projections h along their bottoms, which projections are beveled at the ends as illustrated. The packing-blocks H have correspondingly beveled lugs h^1 and the packing-members are in practice made of material having a higher co-efficient of expansion under heat than has the material of the blades. In practice the packing-blocks are made of phosphor bronze while the blades are made of steel but any other suitable combination of materials could be used if desired. The result of this construction is that as the blades expand under heat and would normally tend to crowd the packing-blocks against the sides of the cylinder, the said blocks themselves extend longitudinally more rapidly than the blades expand, thereby separating the beveled lugs h^1 and causing the packing-blocks to recede into the depressions in the blades. It is obvious that composite construction can have its properties varied by varying the angle of the bevels referred to, the steeper the bevel the greater the amount the blocks recede into the material of the blades and the bevel will obviously be arranged in such manner as to keep the outer faces of the packing-blocks in a constant plane. The angle of the bevel will of course have to be varied with differing materials but it can readily be determined by experiment with any given combination, the combination which I have happened to use requiring a bevel of about thirty degrees (30°).

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

1. The combination with a cylinder and a rotatable drum eccentrically mounted therein, of a pair of blades passed diametrically through the drum and arranged to contact with the wall of the cylinder, a pair of links, one connected to each blade and mutually pivoted together to form a toggle and a cam mounted upon the drum and engaging the joint of the toggle, the curvature of the cam being such that when either blade is in any given position, the toggle will be extended by coöperation with the cam to such an extent as to bring the other blade into a position where the combined lengths of the blades will equal the length of the chord of the cylinder determined by the position of the first blade.

2. The combination with a cylinder and a rotatable drum eccentrically mounted therein, of two blades extending diametrically from the drum and adapted to contact with the cylinder wall, cams at the ends of the drums adjacent to the blades and two pairs of toggle-links at opposite ends of the blades, one link of each pair engaging each blade and the joint of the pairs engaging the corresponding cams, the curvature of the cams being such that when either blade takes a given position, the toggle will be extended to such a degree that the other blade will be forced by the action of the toggle-links to a position where the combined effective length of the blades will equal the length of the chord of the cylinder determined by the position of the first blade.

3. The combination with a cylinder and a rotatable eccentric drum, of two overlapping blades, each having depressions to receive portions upon the other blade, the depressions being such and so arranged with respect to the drum that one always projects outside the drum so that the live steam in the working chamber of the engine will enter the depression to force the blades in opposite directions.

4. The combination with a cylinder and a rotatable drum eccentrically journaled therein, of a pair of similar blades extending diametrically through the drum, each blade having on each face a tongue and a depression side by side, each depression being opposite to the tongue on the opposite face and of such size as to receive a tongue within it, whereby when the similar blades

are reversed relatively the tongues on each will fit the depressions on the other, each blade thus engaging both sides of the other.

5. The combination with a cylinder and a rotatable drum eccentrically journaled therein, of a pair of similar blades extending diametrically through the drum, each blade having on each face a tongue and a depression side by side, each depression being opposite the tongue on the opposite face and of such size as to receive a tongue within it, whereby when the similar blades are reversed relatively the tongues on each will fit the depressions on the other, and the depressions being longer than necessary to receive the tongues and being arranged so that one set of depressions projects at all times from the drum to receive live steam from the working chamber of the engine to force the blades apart.

6. In an engine exposed to the action of heat and subject to expansion, a non-expanding member comprising portions having different coefficients of expansion, meeting in beveled surfaces, constructed to permit the elements to approach each other under expansion as each expands.

7. In an engine exposed to the action of heat, a non-expanding member consisting of two portions of different coefficients of expansion, meeting on planes at angles to their lengths, the planes being so disposed that as both materials expand, one member will approach the other to counteract the expansion and when both materials contract, the members will be wedged apart to offset contraction.

8. In an engine exposed to the action of heat, a non-expanding member comprising a main portion of a material of low coefficient of expansion and a packing-member having a higher coefficient of expansion, meeting on correspondingly beveled planes, the planes of bevel on the material of lower coefficient of expansion being convex and that on the material of higher coefficient of expansion being concave, whereby as the materials are heated, the material of higher coefficient of expansion will move down the beveled planes of the other member to offset the expansion thereof.

9. In a rotary engine, a blade and a packing-member therefor formed of metals of different coefficients of expansion, the blade and packing-members meeting on beveled planes constructed and arranged to cause the parts to approach each other by the action of heat to offset expansion.

10. In a rotary engine, a blade and a packing-member therefor of higher coefficient of expansion than the blade, the blade and packing-member meeting on different planes, convex on the blade and concave on the packing-member, whereby as the materials expand under the heat, the packing-member will elongate more rapidly than the blade and thereby approach the same by movement upon the beveled plane to offset expansion.

MALCOLM L. HARRIS.

In presence of—
R. A. Raymond,
L. Heislar.