

C. F. CHRISTOPHER.  
STEAM ENGINE.

No. 498,895.

Patented June 6, 1893.

FIG. 3.

Witnesses

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By *his* Attorneys,

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(No Model.)

2 Sheets—Sheet 2.

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FIG. 2.

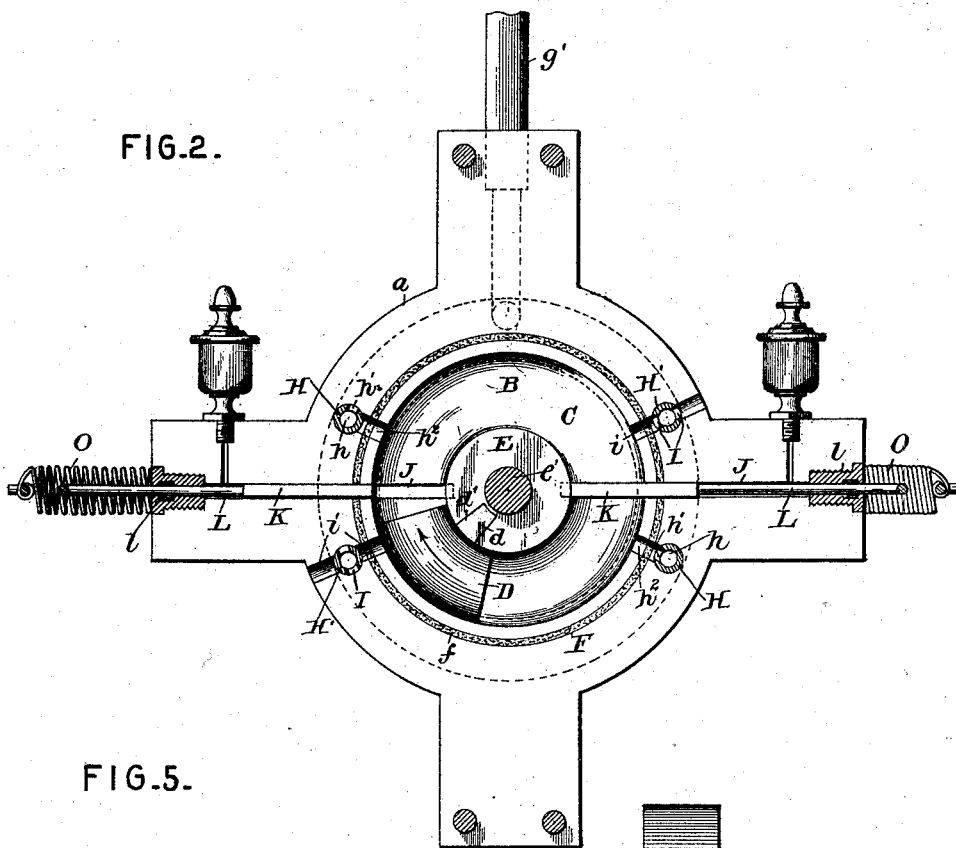
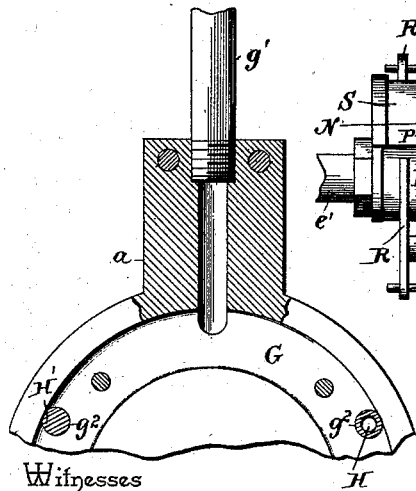


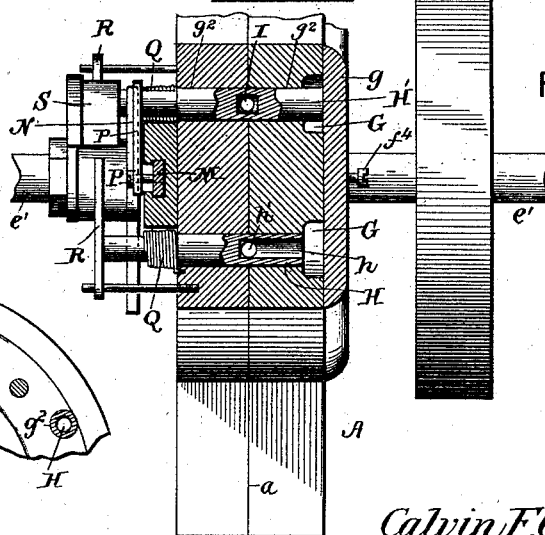
FIG. 5.



Witnesses

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FIG. 4.



By his Attorneys,

Inventor  
Calvin F. Christopher

C. F. Christopher

# UNITED STATES PATENT OFFICE.

CALVIN F. CHRISTOPHER, OF SPARTANBURG, SOUTH CAROLINA, ASSIGNOR,  
BY DIRECT AND MESNE ASSIGNMENTS, TO THE CHRISTOPHER ROTARY  
CIRCULAR STEAM CYLINDER COMPANY.

## STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 498,895, dated June 6, 1893.

Application filed September 28, 1892. Serial No. 447,094. (No model.)

*To all whom it may concern:*

Be it known that I, CALVIN F. CHRISTOPHER, a citizen of the United States, residing at Spartanburg, in the county of Spartanburg and State of South Carolina, have invented a new and useful Steam-Engine, of which the following is a specification.

This invention relates to steam engines; and it has for its object to provide an improvement in engines of that type known as rotary engines, wherein the piston travels in a circle around the shaft to which the same is directly secured.

To this end the invention primarily contemplates certain improvements in machines of this character whereby the power of the steam is utilized to its fullest extent, and to provide new and efficient means for actuating the valves and the cylinder heads or gates, to secure the proper feed of the steam to and from the cylinder.

With these and other objects in view which fairly fall within the scope of this invention, the same consists in the novel construction, combination and arrangement of parts hereinafter more fully described, illustrated, and claimed.

In the accompanying drawings:—Figure 1 is a front elevation of an engine constructed in accordance with this invention. Fig. 2 is a vertical longitudinal sectional view thereof. Fig. 3 is a horizontal transverse sectional view. Fig. 4 is a detail sectional view on the line 4—4 of Fig. 1. Fig. 5 is a detail rear elevation partly in section of the rear end of the casing, the steam chest cap-plate being removed.

Referring to the accompanying drawings, A represents a sectional casing comprising the opposite halves or sections *a*, which are suitably bolted together to form the complete casing or cylinder of the engine, and each of the sections is provided upon its inner face with the circular groove B, which when aligned with the opposing groove of the other section completes an inclosed steam cylinder or channel C, truly circular in cross section and perimeter, and accommodating the rounded or circular piston plug D, snugly registering with said channel or circular cylinder and

provided with a flat integral extended arm *d*, seated in a registering notch *d'*, formed in the shaft disk E, thus providing a rigid though removable connection of the piston plug to the shaft disk, which disk works between the inner flat faces of the core portions *e*, formed by the channeling out of the circular steam groove or channel. The shaft disk E, is either integrally or fixedly mounted on the drive shaft *e'*, extending transversely through bearing perforations in the casing and having secured to one or both ends thereof, cranks, band wheels, &c, to communicate motion directly to any machinery desired, without the employment of intermediate gearing.

In order to provide for a perfectly tight steam joint between the meeting faces of the opposite sections *a*, I form in such faces the packing grooves F, which receive suitable packing *f*, and to provide suitable packing on the opposite wear faces of the central shaft disk E, the inner flat faces of the core portions *e*, are provided with the packing grooves *f'*, which grooves receive in the bottom thereof movable adjusting rings *f*<sup>2</sup>, and suitable packing *f*<sup>3</sup>, placed in the grooves upon said rings, and adapted to be adjusted as tightly as desired, or as may be necessary, against the opposite faces of said central disk, by means of the adjusting screws *f*<sup>4</sup>, working through opposite sides of the casing and having their inner ends bearing against the movable packing adjustable rings before referred to. This latter arrangement for adjusting the packing may be duplicated for the packing just described between the meeting faces of the casing sections.

At one side of the casing and formed in the outer face of one of the sections thereof, is a circular groove steam chest G, which is inclosed by the side cap or plate *g*, and which receives live steam from the boiler through the steam inlet *g'*, entering the top of one of said casing sections and opening into the top of the circular steam chest. By constructing the steam chest in the manner just described, the steam fills a circular space, which allows for the introduction of the same at the proper moment into the cylinder or channel C, so that the impact of the same may be re-

ceived by the piston plug traveling within said cylinder or channel.

The circular steam chest G, is pierced at opposite sides thereof with the opposite holes or bearing openings  $g^2$ , which openings are aligned with corresponding openings or continuations thereof, in the opposite casing section, and said bearing openings, which thus extend transversely through opposite halves of the casing, receive the oscillating live steam and exhaust cut-off plugs H and H', respectively. The live steam cut-off plugs, H, are arranged alternately with respect to each other, so that each opposite pair, or more properly, each upper and lower pair of plugs above and below the division abutments of the cylinder to be described, comprise a live steam and an exhaust plug. The live steam plugs H, are provided with longitudinal steam passages  $h$ , which open at one end into the circular steam chest G, from which said plugs receive their steam, and the other ends of said longitudinal steam passages communicate with the central steam openings  $h'$ , which are adapted to be thrown in and out of alignment with the inlet ports  $h^2$ , opening into the circular steam cylinder or channel. The exhaust cut-off plugs H', do not open into the circular steam chest G, but are provided with the central transverse exhaust openings I, which are adapted to be thrown in and out of alignment, as the plug oscillates, with the exhaust ports  $i$ , leading from the steam cylinder or channel outside of the casing. The valves herein described are adapted to be alternately controlled at the proper time so that the piston plug D, receives a fresh impact of steam at every half revolution thereof, or at the moment said plug passes each inlet port of the cylinder, while the spent steam, after every half revolution, is exhausted through the farthest exhaust port and plug.

The casing A, is provided in opposite ends thereof with the opposite guide grooves J, which extend from a point near the extreme opposite ends, into the central core portions  $e$ , and are adapted to receive the sliding gates or heads K. The said gates or heads K, are adapted to separate the steam cylinder or channel into two horizontal halves, in each of which the piston plug receives a fresh impact of steam, while the sliding gate or head nearest the open inlet port, forms the abutment or head for the cylinder or channel, and is therefore closed across the cylinder or channel, while the other sliding gate or head is at the same time moving out of the cylinder or channel, to allow the steam in front of the piston plug to escape through the exhaust valve or plug in the other portion of the channel, and also receding to allow the piston plug to pass by the same when it reaches that point. The sliding gates or heads K, are provided at their inner ends with the notches  $k$ , adapted when the same are closed to take over the edge of the central shaft disk E, so as to form a perfectly tight joint which pre-

vents the steam from forcing its way below or above such abutment, as the case may be, and each of said gates or heads K, is connected by a swiveled connection  $k'$ , with the stems or rods L, working through the end stuffing boxes  $l$ , arranged at opposite ends of the cylinder casing. The said rods or stems L, are provided at the outer ends with the right angularly disposed portions  $l'$ , which are loosely connected to the sliding operating bars M. The said sliding operating bars M, reciprocate within the grooved guide blocks  $m$ , secured to the front of the cylinder casing, and are provided at their inner ends adjacent to the driveshaft of the engine with the contact rollers  $m'$ , which are adapted to be engaged at every revolution of the shaft  $e'$ , by the cam plate N, fixedly secured to said shaft. The said cam plate N, is so constructed that as the shaft revolves under the leverage of the piston plug through one half of the steam cylinder or channel, the same is in contact with the contact roller at the inner end of the operating bar, controlling the sliding gate or head toward which the piston plug is traveling and is therefore opening such gate or head, as already referred to. At the moment the cam plate leaves the contact roller just noted, the gate or head by which the same is controlled is instantly withdrawn to its closed position to intersect the steam cylinder or channel by means of the retractile spring O. The springs O are suitably connected at one end to the steam chest side of the casing, and at the other ends to the extended arms  $o$ , which are connected to the outer ends of the sliding operating bars controlled by the cam just described. The sliding or reciprocating operating bars M, are further provided at a point adjacent to the inner contact rollers thereof with the projecting screws or pins P, which receive the slotted ends of the valve or plug arm  $p$ , the other ends of which are fixedly secured to the outer projecting ends of the opposite alternate exhaust plugs or valves H'. As the operating bars M, are slid out by the cam plate N, the same carry the swinging ends of the valve or plug arms  $p$ , and thereby cause the exhaust plugs or valves to be turned one quarter of a revolution, so as to close the exhaust port adjacent to the opening gate or head, as will be readily understood. At the moment the springs O, have closed either one of the gates or heads behind the piston plug which has just passed the same, it is necessary to provide means for instantly opening the live steam plug or valve adjacent to the gate or head just closed, and in order to provide for this, I extend the outer ends of the live steam plugs or valves similar to the outer extensions of the exhaust plugs or valves and place on such extended ends the opening springs Q, which normally hold the said live steam plugs or valves in such position as to provide a direct communication from the steam chest to the cylinder or channel. Fixedly secured to the extreme outer end of the

said live steam plugs or valves are the closing arms or cranks R, which have one end thereof lie in the path of the flanged cam plate S. The said flanged cam plate S, is fixedly secured to the shaft  $e'$ , alongside of the cam plate N, and is constructed on less than a half circle, so as to close and open the steam valves at the proper moment. As the shaft  $e'$ , revolves, the flanged cam S, raises or lowers the arms R, according to the position thereof, and in either event as the cam plate N, begins to open one of the gates or heads, at that moment the flanged cam closes the adjacent live steam plug or valve, while the opposite alternate live steam plug or valve is open and admitting steam. After the piston plug has passed the open gate or head, just as the spring closes the open gate or head, the cam has left the arm of the open live steam valve and therefore allows the spring of this valve to open the same to direct the steam against the piston plug which at that moment is abreast of the valve.

From the foregoing description, it is thought that the construction, operation and many advantages of the herein described steam engine will be apparent to those skilled in the art, but a short outline of the operation may be here added. The springs O, normally keep the gates or heads closed. As the drive shaft revolves under the impact of steam admitted through the live steam plug or valve which is open, the cams on the shaft are opening the gate or head toward which the piston is traveling, and close the live steam plug or valve nearest such gate or head, while at the same time closing the adjacent exhaust. The moment the piston plug has passed the open gate or head, the same closes to form a new abutment for the steam and therefore opens the adjacent exhaust, while the adjacent live steam plug or valve is left free to open and directs a fresh impact of steam against the piston plug. The position of the two cams is now changing, and therefore causes the opposite gate or head to commence to open, the adjacent exhaust to close and also the adjacent live steam plug or valve. This operation continues successively through each half revolution of the piston, so that during one complete revolution thereof, the same has received two impacts of steam, thereby causing the steam to be fully utilized, to maintain a continued even leverage on the drive shaft to revolve the same. At this point it may be further observed that at each end of the sectional casing are arranged adjustable flexible buffers or cushions, T, which are arranged in the path of the outer angle ends of the gate stems or rods, in order to receive the inward blow thereof and prevent the rattling and wear of the parts, and it may also be observed, that the retractile springs O, are connected at one end to adjusting screws U, which provide means for regulating the tension thereof to provide for the rapid closing of the gates or heads.

Having thus described the invention, what I desire to secure by Letters Patent is—

1. In a steam engine, the casing having an inclosed circular steam cylinder or channel, live steam and exhaust ports, and a circular steam chest at one side thereof, the drive shaft, a piston connected directly to said shaft and traveling in the cylinder or channel, and the live steam and exhaust plugs or valves, working in the casing, said live steam plugs or valves communicating directly with the side steam chest and the cylinder or channel, substantially as set forth.

2. In a steam engine, the gate-divided cylinder having an integral steam chest at one side, the piston moving in the cylinder, the hollow live steam plugs or valves opening at one end into the side steam chest and the interior of the cylinder, and the exhaust plugs or valves, substantially as set forth.

3. In a steam engine, the casing having an inclosed circular steam cylinder or channel, live steam and exhaust ports opening into the channel, and an integral circular steam chest groove at one side, hollow live steam plugs or valves communicating with the side steam chest and the live steam ports of the cylinder, alternately arranged exhaust plugs or valves communicating with the exhaust ports, sliding gates or heads intersecting the steam cylinder or channel between the opposite pairs of valves, the shaft, the piston moving in the cylinder or channel, and means for simultaneously controlling each gate or head and the valves adjacent thereto, substantially as set forth.

4. In a steam engine, the combination of the casing having a circular steam cylinder or channel, and opposite guide grooves leading from the opposite ends of the casing and intersecting the steam cylinder or channel, the drive shaft having a central disk, the piston plug connected to said disk, the sliding gates or heads moving in said opposite grooves and having end notches taking over the edge of the shaft disk, operating rods or stems swiveled at their inner ends at  $k'$  to said gates or heads, live steam and exhaust valves arranged adjacent to each gate or head, connecting devices between the outer ends of said rods or stems and the exhaust valves, and means for simultaneously controlling each live steam valve with the exhaust valve nearest the same, substantially as set forth.

5. In a steam engine, the cylinder casing, the drive shaft, the piston moving in the casing and connected to said shaft, the opposite sliding gates or heads having stems or rods working through opposite ends of the casing, sliding operating bars moving upon one side of the casing and connected at their outer ends to said rods or stems, retractile springs normally closing the gates or heads and connecting said bars, the oscillating exhaust plugs or valves arranged adjacent to each gate or head and connected with the sliding bars, the cam plate mounted on the drive shaft and

alternately extending each bar, and working the exhaust valve therewith, live steam valves arranged in a line with exhausts, and the means for controlling the four valves, substantially as set forth.

5 6. In a steam engine, the cylinder casing, the drive shaft, the piston moving in the casing and connected to said shaft, the opposite cylinder-intersecting sliding gates or heads  
10 having cushioned stems or rods working through opposite ends of the casing, grooved guide blocks secured to one side of the casing, sliding bars moving in said blocks and connected at their outer ends to said rods or  
15 stems and provided at their inner ends with contact rollers and adjacent projecting pins, retractile springs connected to the outer end of said bars, the oscillating exhaust plugs arranged adjacent to each gate or head and having  
20 at their outer ends slotted arms taking over said projecting pins, live steam valves arranged in a line with the exhaust valve near each gate and having at their outer ends operating arms, springs mounted on the extended  
25 ends of the live steam valves and normally opening the same, and adjacent cams mounted fixedly on the drive shaft and adapted to alternately engage said contact rollers and the live steam valve arms respectively, substantially  
30 as set forth.

7. In a steam engine, the combination with the cylinder casing, the drive shaft, and the piston moving therein, of the opposite spring closed sliding gates or heads intersecting the cylinder, opposite pairs of live steam and exhaust valves arranged adjacent to each gate or head, and having outer extended ends, sliding operating bars moving outside the casing and connected at their outer ends to the sliding gates or heads and provided at their inner  
35 ends with contact rollers and adjacent pins, slotted operating arms connected to the opposite alternate exhaust valves and engaging said pins, springs arranged on the extended ends of the live steam valves to normally open  
40 the same, closing arms secured to the extended ends of the live steam valve, a cam plate mounted on said shaft and engaging the contact rollers of said sliding bars, and an adjacent flanged cam plate secured to the shaft  
45 and adapted to have the flange thereof engage the closing arms of the live steam valves, substantially as set forth.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in  
50 the presence of two witnesses.

C. F. CHRISTOPHER.

Witnesses:

JOHN H. SIGGERS,  
E. G. SIGGERS.