No. 683,688.

Patented Oct. 1, 1901.

L. HOLLINGSWORTH, Jr.

STEAM ENGINE.

(Application filed Aug. 10, 1894.)

(No Model.)

3 Sheets—Sheet 1.

Fig. 1.

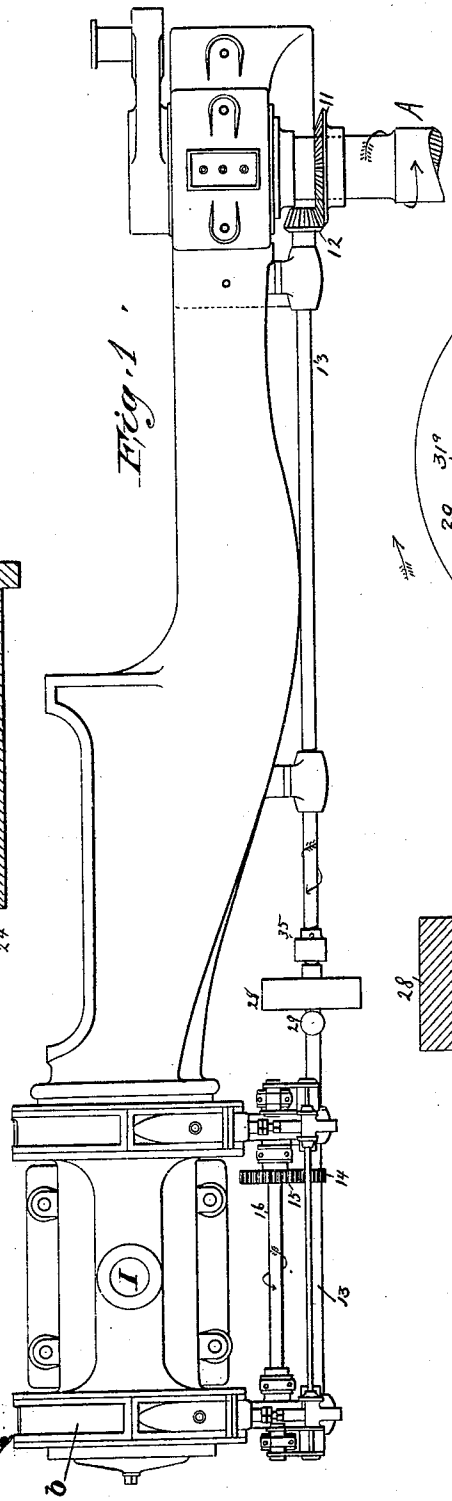


Fig. 5.

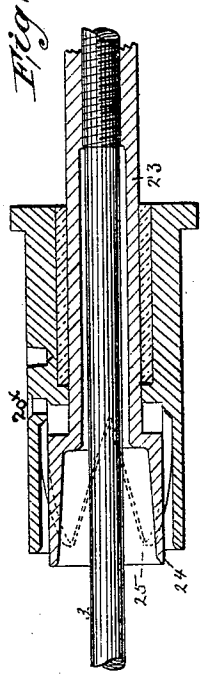


Fig. 6.

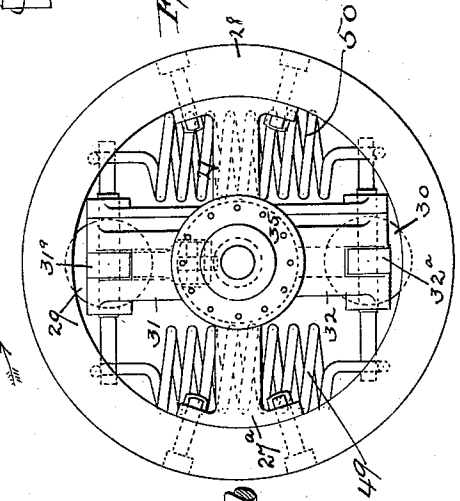
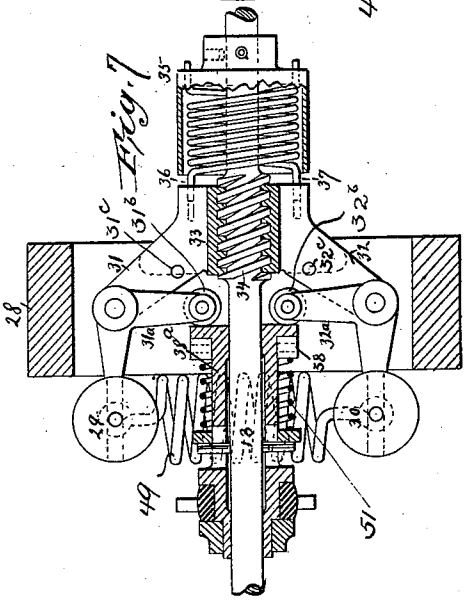


Fig. 7.



Attest:
C. W. Benjamin
Chas. E. Emery

Inventor:
Loftus Hollingsworth Jr.
by Livingston Fenton
Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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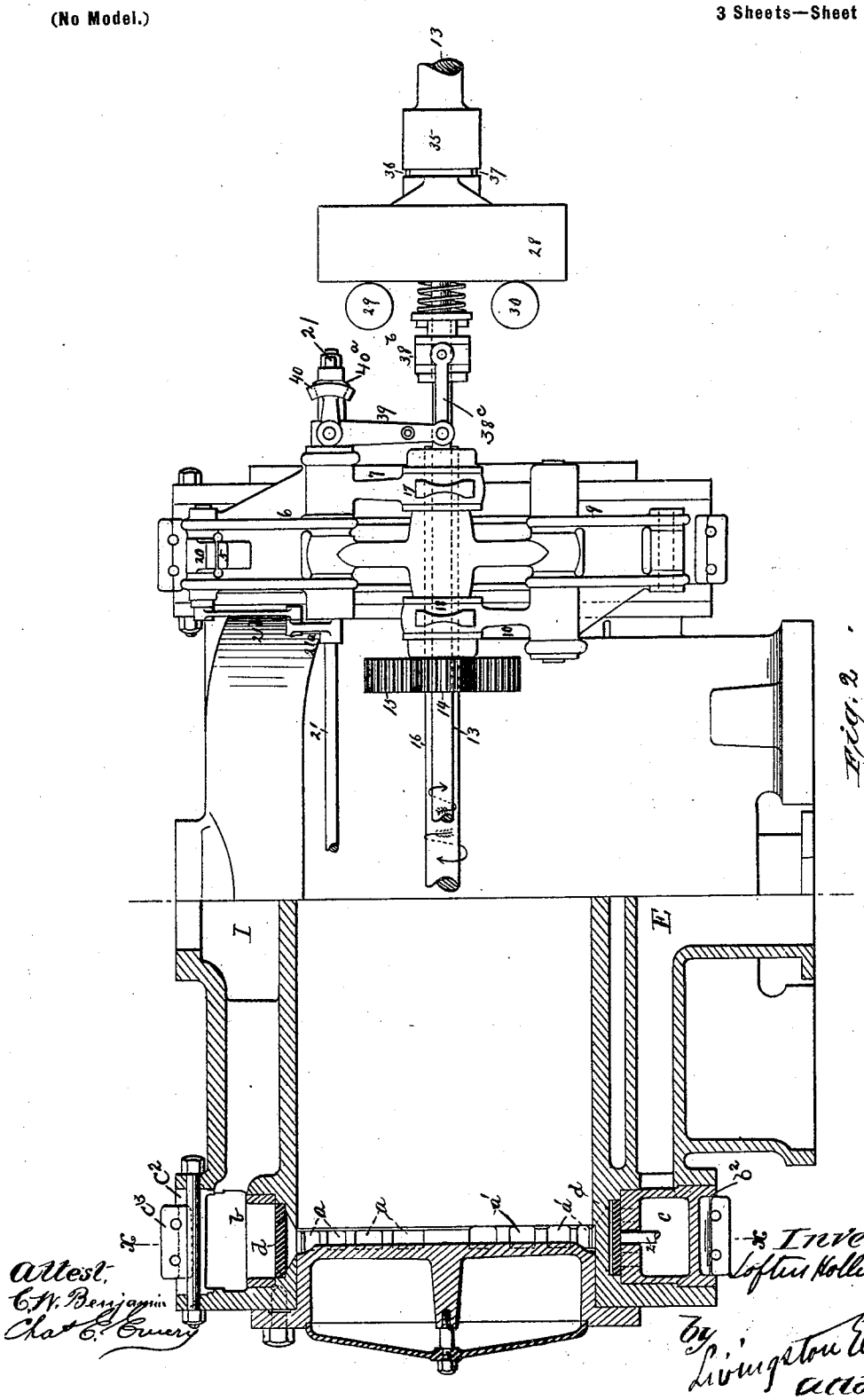


Fig. 2.

Attest.
C. W. Benjamin
Chas. E. Emery

Inventor:
Lofton Hollingsworth Jr.
By Livingston Emery
Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 683,688. Patented Oct. 1, 1901.

L. HOLLINGSWORTH, Jr.

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(No Model.) 3 Sheets—Sheet 3.

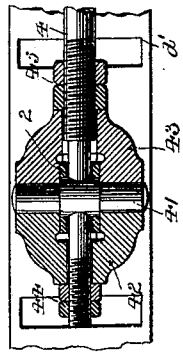


Fig. 4a.

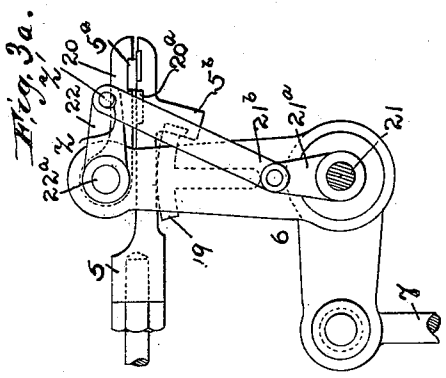


Fig. 3a.

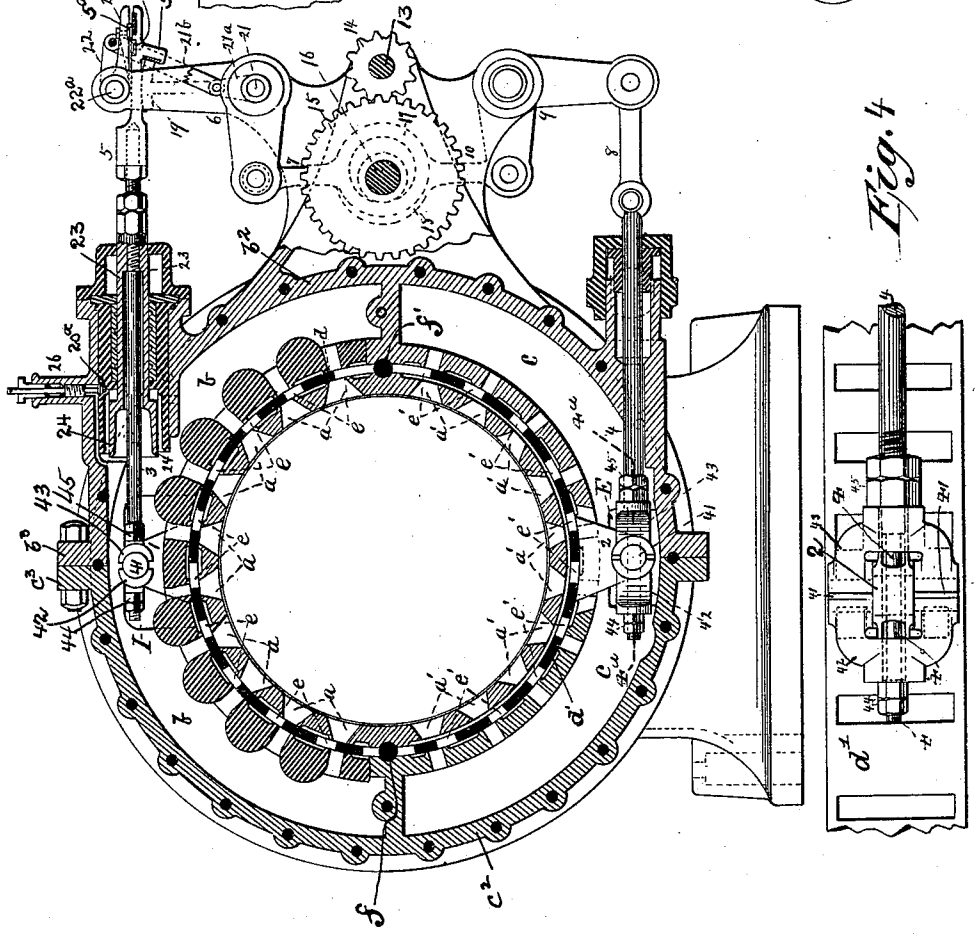


Fig. 3.

Fig. 4

Attest:
C. W. Benjamin
Chas. E. Emery.

Inventor:
Loftus Hollingsworth Jr.
By Livingston Lemmy
Atty

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

LOFTUS HOLLINGSWORTH, JR., OF SCOTCHPLAINS, NEW JERSEY.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 683,688, dated October 1, 1901.

Application filed August 10, 1894. Serial No. 519,915. (No model.)

To all whom it may concern:

Be it known that I, LOFTUS HOLLINGSWORTH, Jr., a citizen of the United States, residing at Scotchplains, county of Union, and State of New Jersey, have invented certain new and useful Improvements in Steam-Engines, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

In steam-engines, more particularly of the horizontal type, considerable difficulty has been experienced in adapting the usual releasing-valve-gear construction to any but a very moderate rotative speed from the fact that the valves are usually heavy, the travel or swing of the releasing-gear long, and consequently comparatively rapid, the connections to the dash-pot indirect, working with atmospheric pressure only, and hence the parts comparatively large, heavy, and slow-acting. For these reasons I have devised the valve-gear herein described, which is simple, compact, directly connected, short-travel, quick-acting, and controlling sufficient area for the free admission of steam. I have also devised various other novel features of construction which when taken together render the apparatus complete and perfect as to running.

Referring to the drawings, Figure 1 represents a plan view of a horizontal engine embodying my invention and showing the operative mechanism. Fig. 2 is an enlarged side view, partly in section, of the cylinder and operative mechanism. Fig. 3 is a section on the lines $x\ x$ of Fig. 2, showing the valve connections and a more detailed view of the operative mechanism. Fig. 3^a is an enlarged view of the releasing-gear shown in Fig. 3. Fig. 4 is a plan view of a novel valve-rod connection that I have found very advantageous and efficacious. Fig. 4^a represents a section on line $4^a\ 4^a$ of Fig. 3 enlarged to the scale of Fig. 4. Fig. 5 is an enlarged sectional view of a novel construction of dash-pot, and Figs. 6 and 7 are views of an improved construction in governors.

Referring now to the drawings, we will first consider Figs. 1, 2, and 3. As the construction of the cylinder is novel, I have shown two sections thereof taken at different points, as Figs. 2 and 3. The cylinder is provided at or near each end with ports $a\ a'$. The inlet I and exhaust E are preferably cast integral with the cylinder proper. Steam-chests $b\ c$ are formed by semicircular casings $b^2\ c^2$, attached to the ends of the cylinder proper in any suitable manner and to each other by means of flanges $b^3\ c^3$. The part of the cylinder bearing the ports a constitutes a seat for a curved slide-valve d, having ports e corresponding to the ports a. The part of the cylinder bearing the ports a' is engaged by a curved slide-valve d', having ports e'. The valves $d\ d'$ are isolated from each other by the plugs $f\ f'$ or in other suitable manner. In the cylinder shown in the drawings the upper set of valves are for inlet of steam and the lower for exhaust. The valves at the other end of the cylinder are arranged in the same manner as shown in Figs. 2 and 3, but operate alternately through the intervention of suitable mechanism—*i. e.*, the inlet-valve operates with its diagonally opposite exhaust or the exhaust on the opposite end of the cylinder, and vice versa. Each inlet slide-valve is operated by means of an arm 1, attached to the valve and connected with a suitable link 3, which in turn is operated by a bell-crank 6, eccentric 17, and shaft 13, which is directly rotated by the main pulley-shaft A of the engine. Each exhaust slide-valve is operated in a similar manner by arm 2, link 4, bell-crank 9, eccentric 18, shaft 13, and main pulley-shaft A.

Referring now to Fig. 1, I will describe the operative mechanism of the engine. The main pulley-shaft A has attached at a suitable point a bevel-gear 11, which meshes with a gear 12 and operates shaft 13. The relation of the gears is preferably about three to one. Shaft 13 runs the entire length of the engine and operates the valves thereof by the intervention of suitable mechanism, which I will now describe. At a suitable point on the shaft 13 is attached a spur-gear 14, that meshes with a gear 15, located on an independent shaft 16. The relation of these gears 14 and 15 is preferably about one to three, but must be the same as the relation of gears 11 and 12. The idea of gearing up the shaft 13 and then gearing the shaft 16 down to the speed of the main pulley-shaft is that a smaller shaft can be employed to transmit the

necessary power to operate the valves and also to drive the governor at a high speed to render it more effective and sensitive. Suitably secured to the shaft 16 are eccentrics 17, one for each inlet-valve, and each provided with an eccentric-strap suitably attached to rod 7, which is pivoted to and operates bell-crank 6, which in turn operates valve-socket 5 through clutch 20, eccentrics 18, one for each exhaust-valve and each provided with an eccentric-strap suitably attached to eccentric-rod 10, which is pivoted to and operates bell-crank 9, which in turn operates valve-stem 4 through link 8. The socket 5 and link 8 operate the upper and lower sets of valves. As the steam enters the upper set of valves it is necessary that the lower set be closed, as they connect with the exhaust. This is accomplished by adjusting the eccentrics 17 and 18. It is also necessary that the upper set or admission-valves have some releasing mechanism controlled by the governor, whereby when the proper amount of steam has been admitted to complete the stroke of the piston the valves will be released and quickly closed by the dash-pots, which will be described hereinafter. This is accomplished by a releasing-gear constructed and operated as follows: On the valve-stem 3 is rigidly secured a socket 5, which is prolonged and is provided with a hardened block 5^a and a leather-faced tongue 5^b projecting from the under side of the socket 5. The bell-crank 6 vibrates on a hollow shaft through which the shaft 21, which is operated by the governor, penetrates, thus providing a long bearing. On the shaft 21 is a crank 21^a, connecting with a link 21^b, slotted longitudinally, as shown at z, to receive a pin or stud z' on a crank 22, which is rigidly attached to a pivot 22^a, that penetrates the bell-crank arm and is rigidly attached to the latch 20. The said latch is provided with a hardened block 20^a, which is adapted to abut against the hardened block 5^a and operate the valve-stem. An oscillating or vibratory motion is transmitted to the bell-crank 6 by the eccentric 17 through the eccentric-rod 7, the bell-crank to the latch 20, and in turn to the valve. It is evident that the bell-crank arm and the link 21^b move through different arcs and that when these arcs intersect the latch 20 and block 20^a will be raised from contact with the socket 5 and block 5^a and the valve be released from its driving mechanism and closed by the dash-pot. This will also occur whenever the motion of the governor-shaft is affected by a change of load on the main pulley-shaft and is a safeguard against the running away of the engine. The segment 19, striking the leather-faced tongue 5^b, will on the return of the bell-crank arm in case the dash-pot refuses to work return the valve to its first position. This recovery would naturally be very racking to the valve mechanism of the admission-valves unless some means for cushioning its recovery be provided. For this purpose I have devised an improved dash-pot, (shown in Fig. 3 and enlarged in Fig. 5,) which is as follows: The connecting-link or valve-stem 3 has secured thereto a hollow plunger of preferably two diameters, 23, slightly larger than the stem and, 24, considerably larger. The larger, 24, slides in a pot and is centered by a serrated bearing-surface 25. (Shown more particularly in Fig. 5.) The object of the serrations is the gradual closing off of the free circulation of the steam and gradually increasing the pressure behind the plunger and partially absorbing the momentum of the plunger until the face of the plunger reaches the point where no more steam can escape except by pass-port 20^x, which is controlled and adjusted by the screw 26, as in the usual vacuum dash-pot construction. The portion 23 of the plunger is made somewhat larger than the stem to allow for any slight springing of the stem in oscillating the valves.

To regulate and to maintain a nearly constant speed of the engine against any variation of load and steam-pressure and to preclude all possibility of a runaway, I have devised a governor of improved construction. (Illustrated in Figs. 6 and 7.) Rigidly secured to the shaft 13 is a screw-thread of coarse pitch 34, on which and capable of rotation is the internally-threaded hub 33. Projecting from said hub are arms 27, 27^a, 31, and 32. At the extremities of these arms 31 32 are pivotally attached the bell-cranks 31^a and 32^a, which carry on each of their horizontal arms the governor-balls 29 30 and on each of their vertical arms the friction-rollers 31^b 32^b. The other two arms 27 and 27^a are rigidly attached to the inertia-weight 28. Mounted on shaft 13 and capable of a sliding motion parallel to the axis of said shaft is a spring-pressed sleeve 38^a, said sleeve being in contact with and receiving motion from the friction-rollers 31^b 32^b, the contact between said rollers and said sleeve being maintained by the spring 51, the compression of said spring being adjusted by the nut 38. It will be noticed that the governor is not rigidly attached to the shaft 13, but is loosely mounted on the thread 34 and is driven by the springs 36 37, which have one end rigidly secured to the hub 33 and the other in a case 35, which is rigidly secured to the shaft 13. Thus the governor is driven by the shaft 13 through the intervention of the springs 36 37. The operation of the said springs will be described in connection with the operation of the governor, which is as follows: When the engine is starting, the governor-balls 29 30 are at their inmost position and the bell-crank arms 31^a 32^a are against the pins 31^c 32^c. The parts remain in this position until within perhaps two or three revolutions of the running speed of the engine. Then the governor-balls 29 30 begin to move and assume their running position when the engine reaches its normal or running speed. In case of a change from the normal speed of the engine—say

too fast—the shaft 13 will be accelerated; but as the speed of the governor cannot instantly be changed on account of the heavy rim 28, which is driven by the springs 36 37, the entire governor will be advanced along the shaft 13 on the screw-thread 34 in a direction to produce an earlier cut-off of steam to the cylinder through the operation of the following-described connections between the sleeve 38[a] and the shaft 21: A collar 38[b] loosely embraces the said sleeve and a link 38[c] connects said collar with one arm of a bell-crank lever 39, the other arm of which carries a toothed segment 40, in mesh with a bevel-gear 40[a] on the shaft 21. Almost instantly the governor-balls will assume a new position, due to the greater centrifugal force arising from the acceleration of the shaft 13, and maintain the early cut-off of steam-supply. In event of the engine running below its normal speed the action just described will be reversed. The effect of centrifugal force upon the governor-balls is counterbalanced by the action of the springs 49 50.

In case of accident, should springs 49 and 50 break, the governor-balls would fly outward to their extreme position and produce an early cut-off of steam or cut off the steam entirely, thus stopping the engine. Should springs 36 and 37 break, the governor would stop, but shaft 13 would continue to revolve and screw 34 to advance the entire governor along said shaft and cut off the steam entirely. Should shaft 13 or gears 11 or 12 break, the engine would immediately stop, as the source of motion to the shaft 13 and to the governor and valves would be removed. Hence the engine would stop. Thus it is almost impossible that a runaway occur and there is no necessity for the safety devices now in use.

An improved construction of valve-rod connection whereby I may remove either inlet or exhaust valves for repair or examination without disturbing the adjustment of the valve-gear is shown in Fig. 3, and enlarged in Figs. 4 and 4[a]. The slide-valves *d d'* have projecting arms 1 and 2, which have rigidly attached thereto pins 41, the said pins and arms being perforated or slotted to receive the valve-stems 3 and 4, as clearly shown in Fig. 4[a]. Mounted on the valve-stems 3 and 4 are the bearing boxes or brasses 42 and 43, which have their bearing on the pins 41 and are adjusted and held in place by the nuts 44 and 45. Thus if we wish to remove either the upper or lower valve it is only necessary to remove one-half the steam-chest cover, take off the nuts 44, and slide the valve around in the direction of its seat until it is free to remove.

Having described the mechanical features of my invention, I will now describe its operation. Steam at nearly boiler-pressure is maintained in the chamber *b* and in a similar chamber on the other end of the cylinder when the engine is running, passes through the ports *e* of the valve *d*, and enters the cylinder through the cylinder-ports *a*, causing the piston to make one stroke. As the inlet for steam in the present instance takes place in the upper set of valves and the exhaust in the lower, it is obvious that the ports, similar in construction to the ports *a' e'* in the other head of the cylinder, are open to allow the exhaust of steam in front of the piston when the steam enters the ports *a e*. Thus we see that one set of inlet and one set of exhaust valves act simultaneously. This is accomplished by adjusting the eccentrics which are operated by the shaft 16, and which operate the valves in both ends of the cylinder. The other working parts of the engine have been described herein, but, briefly, the piston and connecting-rod set the main pulley-shaft A in rotation and the main pulley-shaft in turn operates the valves through the gears 11 and 12, shaft 13, gears 14 15, eccentrics 17 18 for the set of valves in one end of the cylinder and similar eccentrics for the set in the other end of the cylinder, and suitably-connected bell-cranks and links complete the operative mechanism. The speed is regulated and controlled by a governor located at a convenient point on the shaft 13.

Having now described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a steam-engine, the combination of a cylinder having circumferential curved inlet and exhaust valve seats, independent curved-inlet and exhaust valves engaging said seats, and operative means for oscillating said valves independently of each other.

2. In a steam-engine, the combination of a cylinder having circumferential curved valve-seats, curved valves engaging said seats, means for operating the valves, and steam-chests secured to the cylinder over the valve-seats.

3. In a steam-engine, the combination of a cylinder having circumferential curved valve-seats, semicircular steam-chests clamped to the cylinder and to each other over said valve-seats, curved valves engaging the said seats, and means for operating the valves.

4. In a steam-engine, a cylinder having at its ends supply and exhaust steam chests of semicircular form and circular valve-seats, pins or plugs inserted between the chests to separate them from each other, provision being thus made for machining the valve-seats round and round, curved valves fitting the seats, and valve-actuating mechanism.

5. In a steam-engine, a valve-rod connection comprising a projection or arm on the valve carrying a perforated cross-pin, a valve-rod extending through the said pin, bearing-boxes on said rod on opposite sides of the pin and arranged to clamp the same between them, and means for adjusting and holding said boxes in place.

6. In a steam-engine, a valve-rod connection comprising a projection on the valve car-

rying a cross-pin, the said pin and arm being bored through to receive the valve-rod, bearing-boxes on the valve-rod on opposite sides of the arm and constructed and arranged to engage the same and its pin, and means for adjusting and holding said boxes.

7. In a steam-engine, a valve-rod connection that consists of the combination of an arm attached to the valve, a pin or pins attached to said arm and perforated or slotted to receive the valve-stem, brasses or bearing-boxes abutting against said pins and holding the arm itself in position, substantially as set forth.

LOFTUS HOLLINGSWORTH, JR.

Witnesses:

LOUISA M. HOLLINGSWORTH,

LOFTUS F. HOLLINGSWORTH.