2 Sheets—Sheet 1.

D. TURNER.

Steam-Engine.

No. 202,894. Patented April 23, 1878.

Fig. 1.

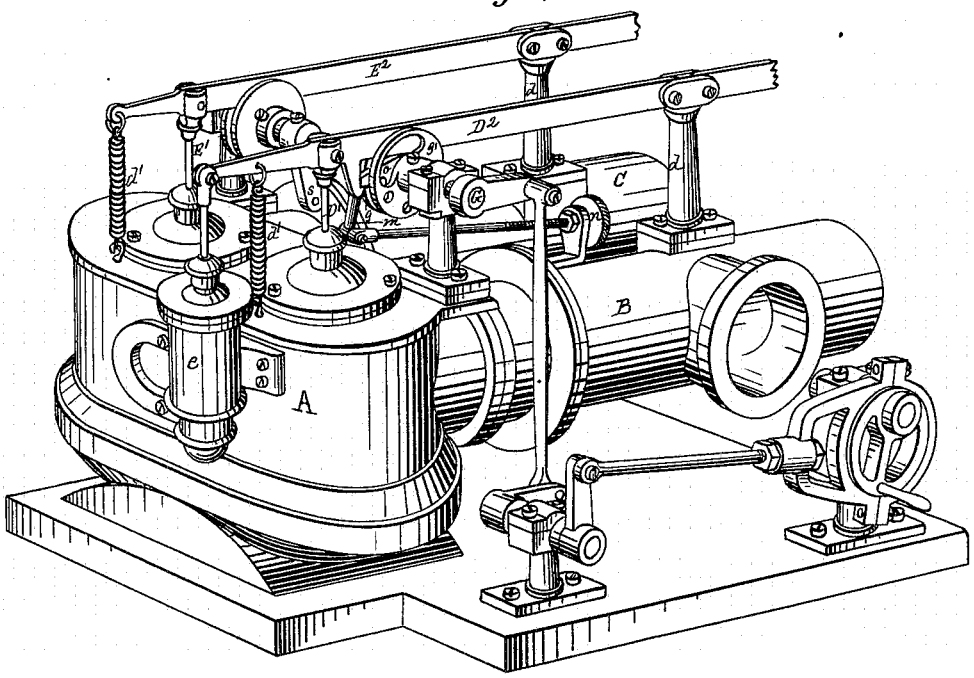

Fig. 2.

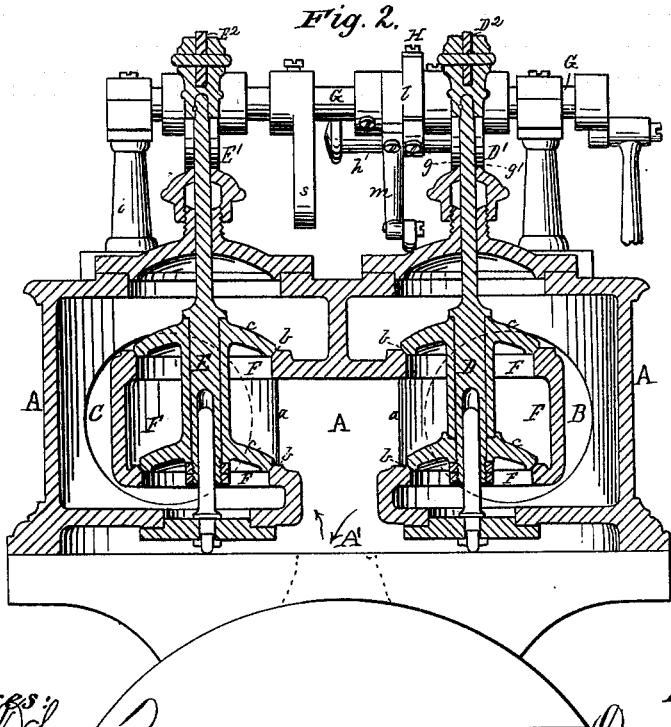

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Fig. 3.

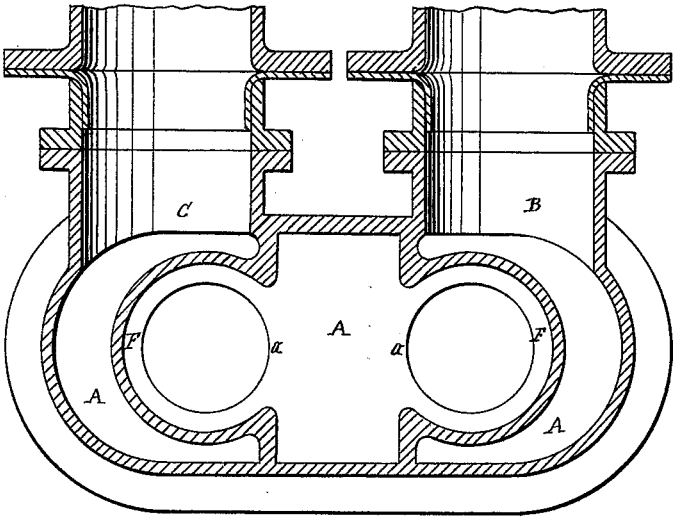


Fig. 4.

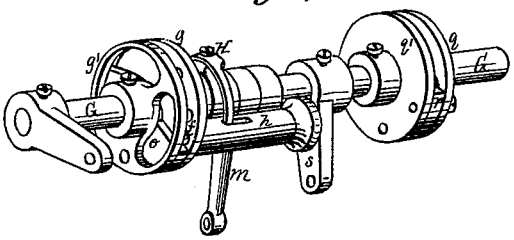


Fig. 5.

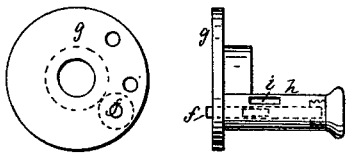


Fig. 6

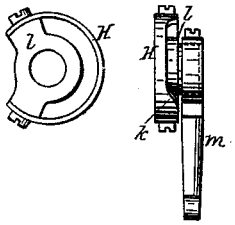


Fig. 7.

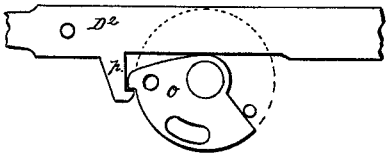
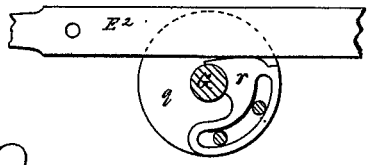


Fig. 8.

Fig. 9.



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UNITED STATES PATENT OFFICE.

DEMETRIUS TURNER, OF GRAND RAPIDS, MICHIGAN.

IMPROVEMENT IN STEAM-ENGINES.

Specification forming part of Letters Patent No. **202,894**, dated April 23, 1878; application filed December 8, 1877.

To all whom it may concern:

Be it known that I, DEMETRIUS TURNER, of Grand Rapids, in the county of Kent and State of Michigan, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare that the following specification, taken in connection with the drawings furnished, and forming a part thereof, is a clear, true, and complete description of my invention.

My said improvements relate to valve-gear, both for induction and exhaust.

One feature of my invention relates to gear for operating such induction-valves as are provided with closing springs, or, as in case of double poppet-valves, have the usual unbalanced steam-pressure in the closing direction, and which may be opened through the intermittent operation of a rock-shaft; and this portion of my invention consists in the combination, with an induction-valve, of a rock-shaft actuated from the crank-shaft, a spring-bolt mounted on the rock-shaft for enabling said shaft to open the valve, and a segmental cam which controls the bolt in permitting it to open the valve, and also in tripping it for allowing the valve to close. This combination affords a simple, effective, and durable "drop" for induction-valves. The cam is capable of adjustment, and it is also combined with a governor; and these features, in combination with the rock-shaft and spring-bolt, constitute portions of my invention.

For enabling the rock-shaft, through its spring-bolt, to communicate a slow initial opening movement to the valve, I employ an intermediate cam or toe between the spring-bolt and valve; and in this connection my invention further consists in the combination, with the rock-shaft, its spring-bolt, and segmental cam, of a toe axially mounted on the rock-shaft, which, when vibrated by the spring-bolt and rock-shaft, lifts the valve with a gradually-increasing speed, due to the outline of the cam-surface, which engages with the valve-rod or devices connected with and practically forming a part of said rod.

For preventing the operative end of the toe from dropping too far when released by the spring-bolt, I employ a stop-hook on the valve-rod connection, with which the toe engages; and such a hook, in combination with the toe spring-bolt, cam, and rock-shaft, constitutes another feature of my invention.

For operating the exhaust-valve by the rock-shaft, I employ, as another feature of my invention, a cam or toe, which is mounted between two flanges axially secured to the shaft, and which is adjustable on said flanges. This construction affords a simple, effective, and durable means for operating the exhaust-valves of an engine. The toe being easily detachable admits of its being gradually fitted during trial of the engine, and accurately adjusted after fitting, and it is attached to the rock-shaft with the expenditure of but little time and labor. Moreover, the toe, being of small size, can be made of cast-steel and readily hardened.

To more particularly describe my invention, I will refer to the accompanying drawings, in which—

Figure 1 represents, in perspective, a steam-chest containing one induction and one exhaust valve with their valve-gear, the whole being adapted for connection with one end of a steam-engine cylinder, it being understood that a duplicate thereof is required for connection with the opposite end of the cylinder. Fig. 2 represents the steam-chest and both valves in vertical central section. Fig. 3 represents the same in horizontal central section. Fig. 4 represents, in perspective, the rock-shaft detached. Fig. 5 represents, in end and side view, the spring-bolt, segmental cam, and flange detached from the rock-shaft. Fig. 6 represents, in end and in side view, the segmental cam detached from the spring-bolt and rock-shaft. Fig. 7 represents the toe detached from the rock-shaft, with a portion of the valve-bar resting thereon, and provided with a stop-hook. Fig. 8 represents the spring-bolt detached. Fig. 9 represents a portion of the exhaust-valve bar, the toe which operates the exhaust-valve, and one of the flanges to which the toe is attached.

The steam-chest A is one of two which are mounted on and attached, respectively, to opposite ends of a steam-engine cylinder, (not shown,) and it communicates with said cylinder through port A′, both for the induction of steam from steam-pipe B, and for exhaust by

way of pipe C. The induction-valve D and exhaust-valve E are double or balanced poppet-valves, provided with valve-rods D^1 and E^1, respectively.

The cylindrical shell F within the steam-chest is, as heretofore, isolated or detached therefrom, except at one side, in which there is a port, *a*, connecting the interior of the shell with the central portion of the steam-chest, and communicating thence via port A′ with the engine-cylinder, as clearly illustrated in Figs. 2 and 3. The upper and lower ends of this shell are open, and provided with valve-seats *b* for the two plates *c* of the poppet-valve. One of these cylindrical shells is shown with the induction and one with the exhaust valve. Both shells are free to expand or contract, neither being in any manner obstructed in that respect, except at the portions connecting with the steam-chest and surrounding the ports *a*; but these connecting portions constitute so small a proportion of the bulk of the shells as to not materially affect their uniform expansion and contraction.

In the drawings, the valve-rods D^1 and E^1 are shown to be provided with bars D^2 and E^2, respectively; but these bars are well-known appendages to valve-rods, and constitute no portion of my invention. Each bar is pivoted to its standard *d*, and may be provided with a retractile spring, *d′*, for accelerating the closing of the valve, which would, however, take place without the spring if the upper valve *c* be larger than the lower.

While the poppet-valve is preferred by me, other forms of valve may be used in connection with the novel valve-gear hereinafter described, provided the valve used has a closing spring and a lever, with which the valve-opening devices may engage.

The induction-valve D is provided with a dash-pot, *e*, or its equivalent, the plunger of which is attached to the outer end of valve-bar D^2.

As the valve-bars are merely means of connection between the valve-rods and the mechanism by which the valves are lifted, I propose to employ at times other forms of connection equally well known—as for instance, a yoke on the valve-rod, within which the lifting mechanism is located, in which case a spring encircling the rod might be employed, and the dash-pot be located above the yoke, all in a manner well known, and not in any way affecting the operation of the parts or the value of my improvements.

The valves are operated by the rock-shaft G, which derives its motion through suitable connections with the crank-shaft, as by an eccentric, as shown in the drawings, but which is not in the position which it would occupy on an engine.

The rock-shaft is provided with two pairs of flanges secured thereto, with space between their inner faces sufficient to receive a valve-bar.

The induction-valve is lifted by a spring-bolt, *f*, which is housed in a sleeve, *h*, projecting laterally from flange *g*, and parallel with the rock-shaft, the outer end of the bolt projecting through said flange into the space between flanges *g* and *g′*. The spring-bolt *f* within the sleeve is longitudinally slotted, as shown in Fig. 8, and the sleeve is provided with a coincident but longer slot, *i*.

H denotes a segmental cam (shown in Fig. 6) provided with an inclined surface at one edge, as at *k*. This cam is the segment of a circle of which the axis of the crank-shaft is the center, and it occupies the slots in the spring-bolt *f* and sleeve *h*.

The inclined cam-surface at *k*, by contact with the end of the slot in the spring-bolt, causes the latter to move longitudinally and withdraw its head from the face of flange *g*, and on the reverse movement of the rock-shaft the bolt is free to return to its protruded position as soon as it passes the inclined surface.

It is obvious that the inclined surface at *k* can be so far advanced by the movement of the segmental cam that the spring-bolt will in no manner be effected by it, and it is equally obvious that the cam may be moved in the opposite direction so far as to retain the bolt wholly within the sleeve, and so prevent the valve from being opened.

The segmental cam is secured at each end to a hub, *l*, loosely mounted on the rock-shaft.

When arranged for a permanent or fixed cut-off, the cam is made stationary by means of a standard bolted to the top of the steam-chest, and it may be accurately adapted to cut off at a certain point in the stroke, or it may be made adjustable by means of elongated bolt-holes, so that it may be advanced or withdrawn, when the engine is at rest, by loosening the bolts.

The segmental cam is provided with the pendent arm *m*, which is loosely fitted to the hub *l* of the segmental cam, and is adjustable thereon by means of a set-screw.

A governor may be attached to the arm *m* in a manner well known, for effecting an automatic variable cut-off. In the drawing it is shown to be provided with a hand-governor, *n*, which consists of a hand-wheel axially tapped, and a screw-rod which connects with the pendent arm *m*, so that the segmental cam may be readily adjusted while the engine is in motion, to cut off at various points in the stroke of the piston, or so set that steam will be admitted to the cylinder to the fullest possible extent.

It will be seen that the spring-bolt may be arranged to engage directly with the valve-bar in operating as a valve-opening device, and that the segmental cam will cause the bolt to be tripped at any predetermined point, and allow the valve to close, and the combination of these parts, which admit of such an arrange ment, constitutes one portion of my invention. It is, however, important that the initial opening movement of the valve should be slower than the movement of the rock-shaft and bolt,

and I therefore modify the action of the rock-shaft by introducing between the bolt and the valve a cam or toe, *o*, Fig. 7, which is axially but loosely mounted on the rock-shaft between the flanges *g g'*. The cam-surface of this cam, which engages with the lower edge of the valve-bar, may be shaped so as to vary to any desired extent the speed of the lift of the valve; but I prefer that it be opened with a gradually-increased speed until tripped, or until fully opened.

When released by the tripping of the spring-bolt the working end of the cam is liable to be so far depressed as to throw its opposite end above the bolt, and in order to limit its free movement I provide a stop-hook, *p*, with which the toe engages after being released. This stop-hook, in this instance, is formed on the valve-bar; but it is immaterial whether it be a moving device or a stationary one, provided that it affords a surface on which the cam may strike after being released, and provided it be so located as to secure the proper limitation of movement.

It will be seen that the segmental cam, spring-bolt, and rock-shaft control the movements of the valve with reference to time, and that the cam permits, by the peculiar shape of its working-surface, an extensive variation of the character or quality of the valve movement.

The operation of the exhaust-valve is as heretofore, and my improvements in that connection do not relate to any novel mode of operation, but to the peculiar combination, with a rock-shaft and flanges, of a cam attached thereto and adjustable thereon. The flanges are shown at *q q'*, secured by set-screws to the rock-shaft, with space between their coincident faces sufficient to receive the valve-bar. The cam *r* has a curved slot for the passage of bolts from one flange through to the other, and this admits of its ready adjustment, with relation to the valve-bar, for determining the time at which the valve shall be opened and closed. The shape of the cam is more or less modified in fitting during the trial of each engine, and this cam, being readily applied and detached, can be fitted with but little trouble and expense, and, being of small bulk, it can be made of cast-steel and readily hardened; and the same is true of the cam-lever employed with the induction-valve. So far as my knowledge extends, this cam may be correctly placed with relation to the flanges, rock-shaft, and valve with less expense and labor than can such devices as have heretofore been employed in a similar connection.

The induction and exhaust valves at the opposite end of the engine-cylinder are provided with a duplicate rock-shaft and appendages, which are connected with the one shown by means of a rod and the pendent arm *s* on the rock-shaft.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination, with an induction-valve, of a rock-shaft actuated from the crank-shaft, a spring-bolt mounted on said shaft for opening the valve, and a segmental cam which controls said bolt in permitting it to open the valve, and also in tripping the bolt for allowing the valve to close, substantially as described.

2. The combination, with an induction-valve, of a rock-shaft, a spring-bolt mounted thereon, and an adjustable segmental cam, substantially as described.

3. The combination, with an induction-valve, of a rock-shaft, a spring-bolt mounted thereon, and a segmental cam which controls the spring-bolt, and is itself controlled by a governor, substantially as described.

4. The combination, with an induction-valve, of a rock-shaft, a spring-bolt mounted thereon, a segmental cam for controlling the bolt, and a cam-lever which at one end lifts the valve on being depressed at the opposite end by the spring-bolt and rock-shaft, substantially as described.

5. The combination, with an induction-valve, of a rock-shaft, a spring-bolt mounted thereon, a cam for controlling the bolt, a cam or toe axially mounted on the rock-shaft, and a stop for limiting the free movement of the toe when released by the bolt, substantially as described.

6. The combination, with an exhaust-valve, of a rock-shaft, provided with flanges and a toe for opening and closing the valve, which is adjustably mounted between the flanges, substantially as described.

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