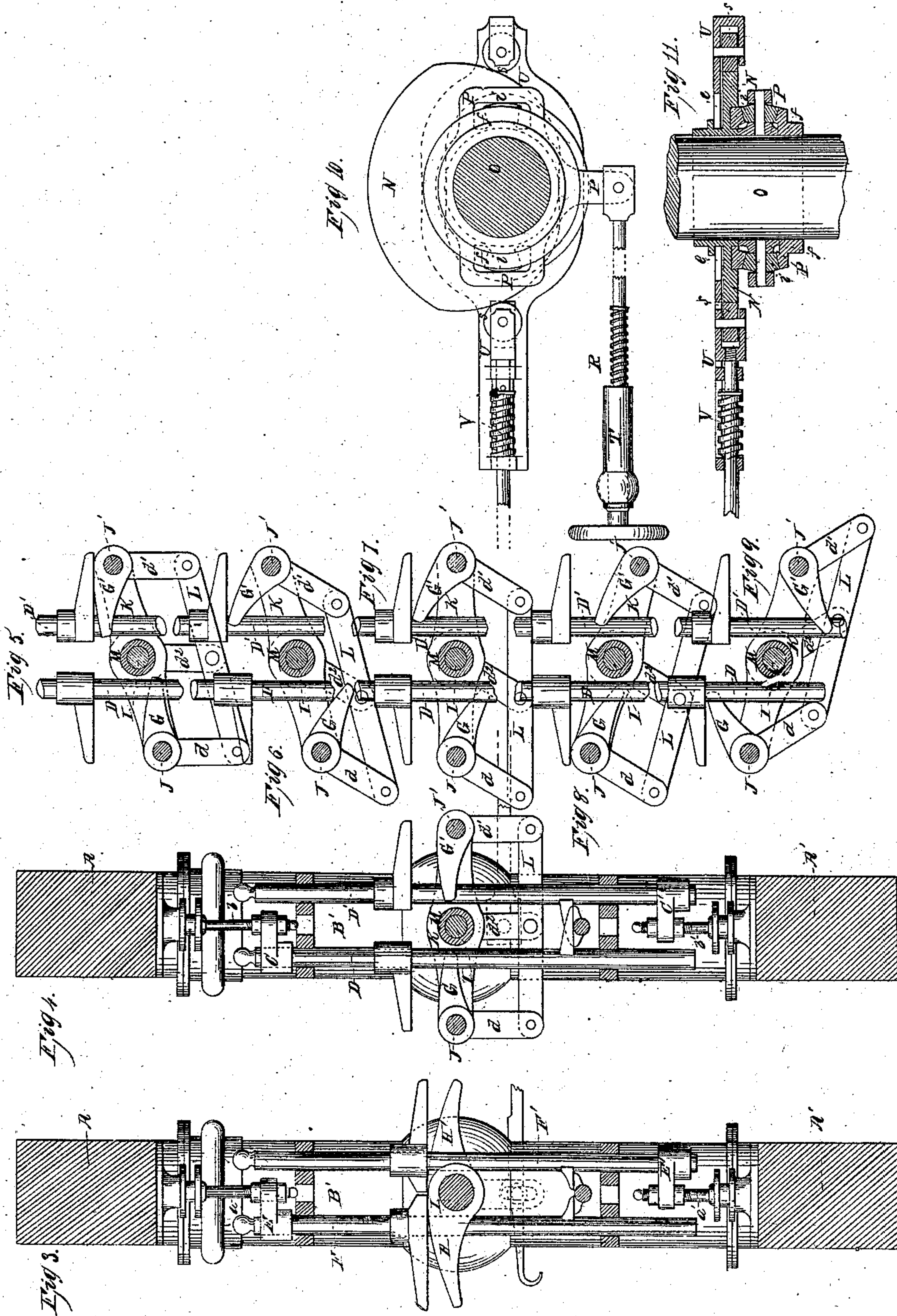


2 Sheets-Sheet 2.

E. S. Pennick,
Steam-Engine Valve-Gear.
No 15,576. Patented Aug. 19, 1856.



UNITED STATES PATENT OFFICE.

EDWARD S. RENWICK, OF NEW YORK, N. Y.

VALVE-MOTION FOR STEAM-ENGINES.

Specification of Letters Patent No. 15,576, dated August 19, 1856.

To all whom it may concern:

Be it known that I, EDWARD S. RENWICK, of the city, county, and State of New York, have invented certain new and useful Improvements in Valve-Motions for Engines Working Expansively; and I do hereby declare that the following is a full, clear, and exact description of my said invention, reference being had to the drawings, which are hereunto annexed and in which—

Figure 1 is a front elevation of the side pipes and valve chests of a steam engine with my improved valve motion applied thereto. Fig. 2 is a horizontal section of the same at the line $x x$ of Fig. 1. Fig. 3 is a vertical section of the same at the line $y y$ of Fig. 2; Fig. 4, a similar section at the line $z z$ of Fig. 2. Figs. 5, 6, 7, 8 and 9 are views of certain portions of the valve motion detached and in different positions. Fig. 10 is a side elevation of the spring cam box and accessories and Fig. 11 is a horizontal section of the same.

My invention has reference to those steam engines in which the supply of steam from the boiler is cut off after the piston has accomplished a certain portion of its stroke, so as to permit the steam acting upon the piston to exert upon the latter the power which the steam gives out in expanding during the remainder of the stroke. In order to enable such engines to work to the best advantage it has been customary for many years to arrange the valve motion, which actuates the valves and thus regulates the admission of steam, in such manner that the steam valve can be closed at different portions of the stroke of the piston so as to effect the cutting off of the supply of steam from the boiler sooner or later, as may be found best suited to work the steam to the best advantage. Many variable valve motions have been devised for this purpose, all of which are defective either from the complexity of their construction, or from the difficulty of effecting the necessary changes to produce variations in the period of cutting off the steam; or because they do not open and close the valves with sufficient speed, and thus cause what is technically termed the wire drawing of the steam.

The object of my invention is to effect the cutting off of the supply of steam from the boiler at any desired portion of the stroke by machinery, which is simple in its con-

struction and can be managed with ease, and which at the same time possesses the advantages of opening and closing the valves with as great speed as the proper working of the engine will admit.

The accompanying drawings represent a variable cut off valve motion in which my invention is embodied. In it, the steam valves are opened by the same mechanism which actuates the exhaust valves and coincident or thereabout therewith, and which when once adjusted is not altered while the engine is running. The closing of the steam valves, on the other hand, is effected by an independent mechanism, which controls that for opening the valves, and at the same time may be readily adjusted, while the engine is running, to vary the time at which this closing of the valve is accomplished.

The general arrangement of the valves in the valve motion represented is much the same as those now in use for ordinary lever-beam steam engines; the chests A, A', which contain the valves being connected by side pipes B, B', in the usual manner. The valves which are contained in the valve chests A, A', are supposed to be ordinary balanced puppet valves, and their valve stems a, a', b, b' , project toward each other through suitable stuffing boxes. The valve stems, b and b' , of the upper and lower steam valves are acted upon by lifters C C' which are secured to the lifting rods D D'; and the valve stems a, a' of the upper and lower exhaust valves, are also acted upon by lifters E E', which are secured to the lifting rods F, F'. The lifting rods, D, D', F, F', have feet secured to them which project over suitable toes G, G', H H', by means of which the feet, rods, and valves are lifted and lowered.

The exhaust toes H H' project in opposite directions from a rock shaft I, so that by rocking this shaft alternately in opposite directions the exhaust valves are alternately raised and lowered. Each steam toe is secured to an appropriate rock shaft and these two steam rock shafts J, J', are supported in bearings in the opposite ends of a pair of yokes K, K, which are secured to a cannon shaft M that rocks upon the exhaust rock shaft I. The cannon shaft is rocked to and fro by a cam or by an eccentric which moves it independently of the rock shaft I, its motion being sufficient to raise either

steam toe alternately, above a line passing through the center of the shaft and in a direction perpendicular to the motion of the valves, a distance equal to the required lift of the valves. The feet on the steam lifting rods are also set in such positions that when either steam toe is raised by the rocking of the cannon shaft, the toe that is lifted will barely touch its appropriate foot, so as to be just in the proper position to lift the lifting rod.

Each steam rock shaft is fitted with an arm d , d' ; the exhaust rock shaft is also fitted with an arm d^2 , and these three arms are connected by a link, L , which is pivoted to all three arms and is in this instance just as long between the centers of the pins as the distances between the centers of the three shafts J , I , J' . By this link and the arms the rock shaft J J' are caused to rock, simultaneously with the rock shaft I ; and this simultaneous movement will take place no matter in what position the shafts J J' are placed by the movement of the cannon shaft. If an exhaust valve toe H is rocked upward to raise the exhaust valve lifting rod, the steam toes will be correspondingly rocked; and if this rocking takes place after the shaft J' has been raised by the rocking of the cannon shaft M , the corresponding steam lifting rod D' will be raised. The admission of steam to one end of the cylinder will then be coincident with the exhaust of steam from the opposite end thereof, and the several parts of the mechanism will be in the positions in which they are shown in Fig. 6. If then the cannon shaft be rocked to lower the shaft J' , the steam toe G' , although still pointing upward, will be lowered bodily to the position in which it is shown in Fig. 7, and this downward movement will permit the lifting rod D' to descend, and lower and close the steam valve, thus cutting off the flow of steam from the boiler. By continuing the rocking of the cannon shaft M the opposite steam rock shaft J will be raised until its toe is just in the right position to act upon the foot of its appropriate lifting rod as shown in Fig. 8. Hence the rocking of the exhaust rock shaft I , to close the one exhaust valve and open the other, will cause the lifting of the correspondingly opposite steam lifting rod D as shown at Fig. 9.

The exhaust rock shaft I and the cannon shaft M may be rocked in any known manner which will effect the desired result; but I prefer to rock each one by a cam working in a spring cam box, such as is shown at V , Figs. 10 and 11, in which the wipers or friction wheels s s are constantly held in contact with the rim of the cam N by the action of a spring V . The exhaust cam should be secured to the main crank shaft of the engine or to some other shaft revolv-

ing simultaneously therewith, so as to maintain the same angular position with respect to the crank when the crank shaft is revolving in the same direction. The steam cam should be affixed to its shaft in such manner that its angular position with respect to the crank can be changed to alter the periods of rocking the cannon shaft, so as to lower the steam toes at variable periods of the stroke of the piston and thus cut off the steam at different parts of the stroke. I prefer to effect this angular change of the cam by the device I have shown in Figs. 10 and 11, in which N is the cam loose upon the crank-shaft O , and having a beveled wheel e secured to it. P is a frame through which the shaft revolves, but which can be rocked to and fro and held in any desired position by a screw R or other means. This frame supports the axles of two beveled pinions i , i , which gear into the beveled wheel e , and also into a beveled wheel f , that is fast to the shaft O . The nature of this arrangement is such that when the shaft revolves in one direction the cam will revolve equally and simultaneously in the opposite direction, and if the frame P be turned upon the shaft slightly in either direction, the cam N will have its angular position with respect to the shaft altered, and this alteration will produce a corresponding alteration in the time at which the acting surface of the cam operates upon the friction wheels s s and rocks the cannon shaft M thus effecting the cut off at a different part of the stroke of the piston.

The movement of the pinion frame P , to vary the cut off, may be effected in various ways. In the valve motion thus described it is effected by a screw R' working in a swivel nut T which can be turned by the engineer. It may also be effected by means of a governor operated by the engine itself, and this governor may be made to effect the change either by a variation in the power required from the engine, or from a variation in the speed of the crank shaft. The governor which I should prefer to use for this purpose is a piston working in a cylinder which is supplied with a stream of water whose volume varies with the speed of the engine, and which is permitted to escape from the cylinder through a hole of constant size; hence an increase or diminution in the volume of the supply will be followed by a corresponding change in the position of the piston which is supported by the water beneath it; and the piston in moving will change the position of the pinion frame with which it is connected and thus vary the cut-off.

From the foregoing description it is clear that the variations in the period of lowering the steam valves is effected, without adjusting any other parts of the valve motion, by

changing the angular position of the cam with respect to the crank of the engine, so that the relation between the movement of the rock shaft that effects the cutoff and the movement of the crank is varied to vary the cut off. This feature of my apparatus is common to some valve motions which have long since become public property; it distinguishes the class of valve motions to which my invention belongs from that class in which the relation between the movement of the rock shaft, or other mechanism for operating the apparatus that effects the cut off, and the movement of the crank is not varied but always remains the same, and in which the variations in the period of lowering the steam-valves is effected by adjusting the steam toes or other parts of the valve motion so as to vary the manner in which they communicate movement to the lifting rods.

The periphery of the cam I have shown in the drawings for operating the cutoff is at certain parts concentric with the shaft to which it is attached; while these concentric portions are acting upon the friction wheels the yokes will not be moved, and if the exhaust rock shaft be operated by a cam of similar form the valves will be opened rapidly, will be held open the time required, and will be closed rapidly, and the rapidity with which they are opened and closed may be regulated in each engine as may be best suited to its work by giving the proper form to the periphery of the cam in the manner well known to engineers.

The spring cam box I have described possesses the great advantage of accommodating itself to the irregularities in the periphery of the cam resulting either from a defective construction or from wear; in this cam box the friction wheels or wiper are always kept in contact with the periphery of the cam, and hence all jar is avoided, and the apparatus may be made to work as noiselessly and as smoothly as an eccentric of the best construction. Care must be taken in constructing the cam box to use a spring strong enough to open the valves, otherwise the turning of the cam would compress the spring as far as the construction of the cam box would permit before imparting any movement to the valve motion. It is evident that much less power would be required to operate the valve motion if the weights of the lifting rods, lifters, and valves were counterbalanced, and I propose to counterbalance the weights of these parts by counterbalance weights acting through levers so as to diminish the strain upon the rock shaft and toes. If it be deemed expedient to give any lead to the exhaust valves, it may be obtained in the usual manner by setting the exhaust eccen-

tric or cam in a suitable position with respect to the crank. And if it be deemed expedient to give any lead to the steam valves, such lead may be obtained by adjusting the relative positions of the steam and exhaust toes upon their shafts, so that the valve of whichever side of the piston it is desired to lead fastest upon may be first lifted by the action of its appropriate toe upon its appropriate lifting rod.

The improvement I have described is not limited to valves opening and closing vertically, but may be applied to valves opening and closing at any inclination or even in horizontal directions; in the latter case, and in all others where the valves will not close by their own gravity, springs or weights should be employed to insure the closing of the valves. The improvement is not limited to balanced puppet valves alone, but may be applied to slide valves or turning valves; as however the description I have given clearly sets forth my invention I leave it to skilful engineers to apply it as they may deem best in practice.

It is clear that if the cam which operates the rock shaft M be made fast to the crank shaft, the cut off valve motion will become a fixed instead of a variable cut off motion; such an arrangement of my apparatus will be useful in many cases when the work to be performed by the engine is constant, or where it is not deemed expedient to use the steam to the best advantage.

Having thus described my improvement I wish it to be understood that I do not limit myself to the precise mechanical arrangement and construction of the various parts of the apparatus which I have described but propose to vary the same and to use the mechanical equivalents of various parts of the mechanism as circumstances may render expedient, and to meet the views of different constructors of steam engines. Neither do I claim any separate parts of the apparatus thus described which have been in common use prior to the date of my invention, as for example valves, valve-rods, toes, lifting rods, cams, &c. But

What I claim as my invention and desire to secure by Letters Patent is—

1. The combination of the parts of a valve motion substantially in the manner herein described, so that the steam valves shall be opened by mechanism at intervals coincident or thereabouts with the opening of the exhaust valves, and that the steam valves shall be closed by mechanism that is independent of the exhaust valves but which governs and controls the toes by which the steam valves are opened, in such manner that the closing of the steam valves does not change the angular position in which these toes have been placed to open the valves.

2. I also claim the cam and spring cam box in combination with the rock shaft, toes, feet, lifting rods, and lifters or other equivalents by means of which the valves of the engine are opened and closed.

3. I claim the combination of the steam toes G G¹, rock shafts J J¹, arms D D¹ D², and link L, with the exhaust rock shaft I for opening the steam valves.

10 4. I claim the combination of the yokes K K and shaft M with appropriate operating mechanism depending upon the movements of the crank shaft of the engine for holding the steam toes in the proper posi-

tion to open the valves and for lowering the same bodily to close the steam valves. 15

5. I claim closing steam valves that have been opened by moving the steam toes or their equivalents bodily, without changing their angular position, the distance required to shut the valves. 20

In testimony whereof I have hereunto subscribed my name.

EDWARD S. RENNICK.

Witnesses:

H. WIGHTMAN,
HENRY C. MOORE.