

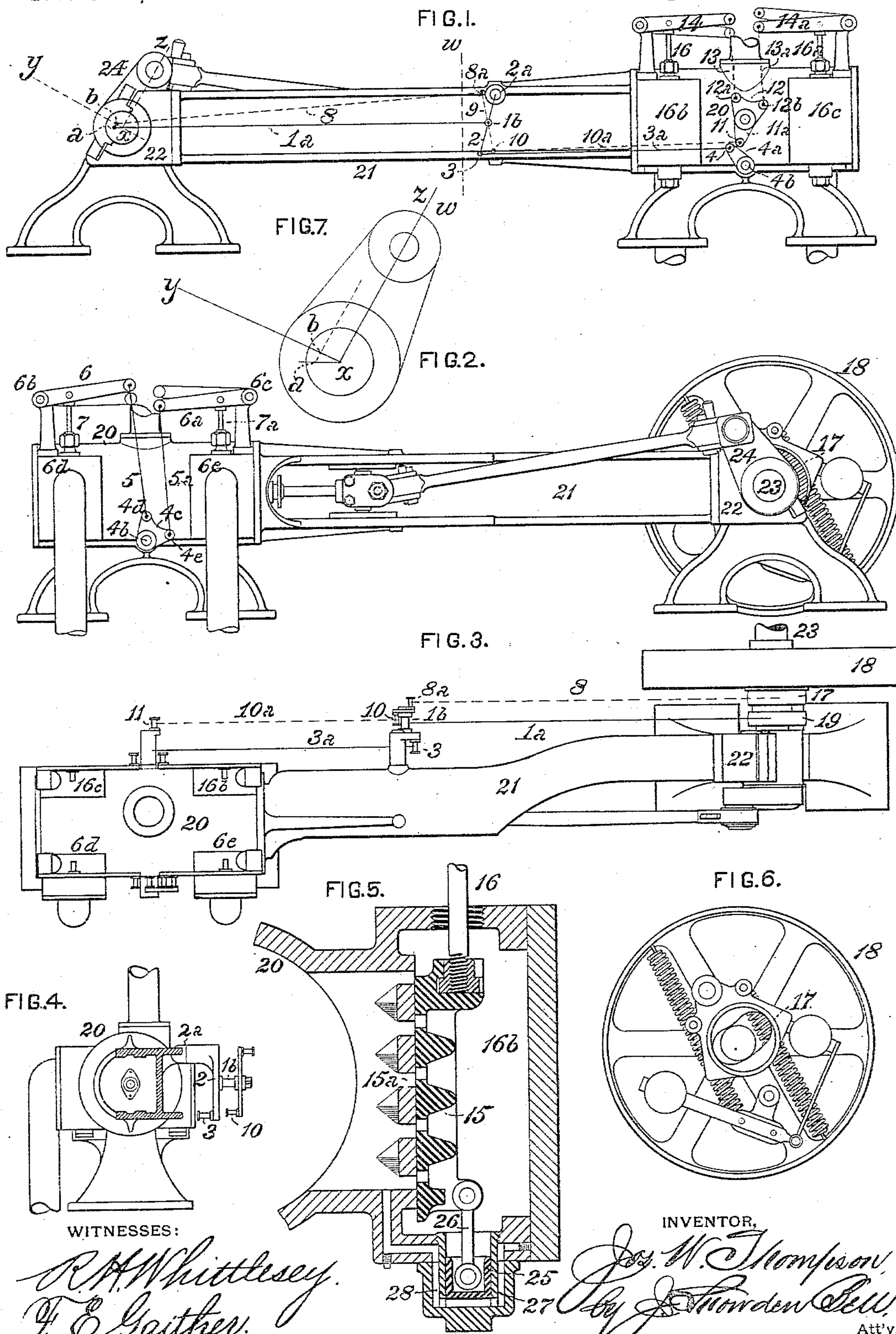
(No Model.)

J. W. THOMPSON.

VALVE GEAR.

No. 381,596.

Patented Apr. 24, 1888.



WITNESSES:

*R. A. Whittlesey.*  
*F. E. Gaither.*

INVENTOR,

*J. W. Thompson.*  
*By J. H. Gordon Bell.*  
Att'y.



# UNITED STATES PATENT OFFICE.

JOSEPH W. THOMPSON, OF SALEM, OHIO, ASSIGNOR TO THE BUCKEYE  
ENGINE COMPANY, OF SAME PLACE.

## VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 381,596, dated April 24, 1888.

Application filed November 23, 1887. Serial No. 256,310. (No model.)

*To all whom it may concern:*

Be it known that I, JOSEPH W. THOMPSON, of Salem, in the county of Columbiana and State of Ohio, have invented certain new and useful  
5 Improvements in Valve-Gears for Steam-Engines, of which improvements the following is a specification.

My invention relates, generally, to engines of the "automatic cut-off" class, and more  
10 particularly to those of the type in which the automatic adjustments of the point of cut-off are effected by means of variations in the travel of a valve-operating member without the employment of disengaging mechanism or releasing-gear.

The object of my invention is to provide a valve-gear having flat, simple, sliding, and wear-compensating independent induction and exhaust valves, the former being controlled by  
15 a centrifugal governor, and being so assisted in their movements as to be acted on by the governor without substantial or objectionable disturbance of its operation, such valve-gear being capable of high speed, and possessing,  
20 further, the capabilities of being placed under the complete control of the operator as to induction and exhaust, and worked by hand with facility under any pressure of steam for backing or other purposes, when desired, by the  
25 detachment of a single rod, and of admitting of the location of the valve-actuating rods at any desired distance from the center line of the engine, so as to be desirably applicable in tandem compound engines having either their  
30 large or their small cylinder nearest the bed.

To this end my invention, generally stated, consists in the combination of a fixed eccentric set in proper angular position, an exhaust  
35 valve or valves actuated by said fixed eccentric, an adjustable eccentric adapted to modify to a greater or less degree the movement derived from the fixed eccentric when the required point of cut-off is earlier than that due to the unmodified movement of said fixed eccentric, a centrifugal governor controlling the  
40 position of the adjustable eccentric, a compound rocker-shaft system coupled to the rods of the fixed and the adjustable eccentrics, and an induction valve or valves to which the  
45 compound rocker-shaft system imparts the un-

modified or only slightly-modified movement of the fixed eccentric for the latest point of cut-off and a more or less modified movement compounded from the movements of both eccentrics for earlier points of cut-off. 55

My invention further consists in the combination of an induction-valve and a piston coupled thereto, said piston being open on one side to the valve-chest and communicating on the other with the cylinder at the end to which  
60 the valve admits steam, so that the steam admitted by the induction-valve tends to open the same by its pressure on the piston.

The improvements claimed are hereinafter fully set forth. 65

In the accompanying drawings, Figure 1 is a side view, in elevation, of a steam-engine embodying my invention, with the governor and eccentrics removed and the connecting-rods of the valve-gear indicated by single lines, those  
70 of the fixed eccentric and exhaust-valves by full lines, and those of the adjustable eccentric and induction-valves by broken lines; Fig. 2, a similar view of the engine, taken from the opposite side and with the governor in place. 75  
Fig. 3, a plan or top view; Fig. 4, a vertical transverse section at the line *ww* of Fig. 1; Fig. 5, a vertical transverse section on an enlarged scale through one of the induction-valve chests; Fig. 6, a view in elevation of a  
80 governor desirably adapted for use in connection with my improvements; and Fig. 7, a diagram, on an enlarged scale, illustrating the positions of the eccentrics.

My invention is illustrated as applied in a  
85 horizontal engine having its cylinder 20 fixed to one end of a bed or frame, 21, to the opposite end of which are secured the bearings 22 of the main or crank shaft 23. Steam is admitted to the cylinder 20 by multiported or  
90 gridiron slide induction-valves 15, and exhausted therefrom by similar exhaust-valves, there being independently-operated valves for induction and exhaust, respectively, at each end of the cylinder. The induction-valves  
95 are actuated by an adjustable eccentric, 17, which is concentric, or nearly so, with the crank-shaft 23 at the adjustment which effects the latest point of cut-off, and which corresponds with the position of repose of the gov- 100



ernor at which the proper movements are imparted to the induction-valves by a fixed eccentric, 19, which operates the exhaust valves. To effect earlier cut-off, the adjustable eccentric 17 is moved by a suitable centrifugal governor, 18, along a line substantially at right angles to the mean direction of the rod of the adjustable eccentric when the crank 24 is on its center, such movement acting to shorten and advance the movement derived from the fixed eccentric without change of induction, or change other than may be desired.

The strap of the fixed eccentric 19, the center of which eccentric is shown at *a*, is coupled to the pin 1<sup>b</sup> of a rocker-arm, 2, by an eccentric-rod, 1<sup>a</sup>, which, in common with other rods of the valve-gear, is illustrated diagrammatically by a single line. The rocker 2 is pivoted upon a stud or bearing, 2<sup>a</sup>, fixed to the engine-frame, and carries upon its lower or free end a pin, 3, which is coupled by a rod, 3<sup>a</sup>, to a pin, 4, on an arm, 4<sup>a</sup>, secured to a transverse shaft, 4<sup>b</sup>, journaled in bearings below the cylinder 20, and carrying on the opposite side of the cylinder a wrist-plate, 4<sup>c</sup>, of similar form to those employed in the well-known Corliss valve-gear. Wrist-pins 4<sup>d</sup> and 4<sup>e</sup> on the wrist-plate 4<sup>c</sup> are coupled by rods or links 5 and 5<sup>a</sup> to levers 6 and 6<sup>a</sup>, pivoted on pins or in bearings 6<sup>b</sup> and 6<sup>c</sup> on the cylinder or on the exhaust-valve chests 6<sup>d</sup> and 6<sup>e</sup>, which are cast with or secured thereto, and the levers 6 and 6<sup>a</sup> are pivoted to the stems 7 and 7<sup>a</sup> of the exhaust-valves. The latter, which are not shown, are preferably gridiron or multiported slide-valves, similar to the induction-valve 15, (shown in Fig. 5,) and each controls a series of ports in a valve-face in one of the valve-chests 6<sup>d</sup> 6<sup>e</sup>, establishing communication between said chest and the cylinder.

The lever 6 is shown in the position which it occupies when the valve to which it is connected is in position to close the valve-chest ports, and the lever 6<sup>a</sup> in position in which its valve opens said ports. When either of the valves is closed, the wrist-pin 4<sup>d</sup> or 4<sup>e</sup>, by which it is actuated, is near and approaching its dead-center—that is to say, nearly in line with the centers of the wrist-pin shaft and of the pin in the valve-lever—so that the motion of the wrist-pin after closure is much reduced as it reaches and slightly passes the line of centers before beginning its return movement, as in the Corliss valve-gear. The movement of the exhaust-valve mechanism is derived wholly from the fixed eccentric and is in time and amount such as is proper to effect the exhaust opening and closure required.

The valves 15, which perform the functions of induction and cut-off, slide in induction-valve chests 16<sup>b</sup> 16<sup>c</sup>, one of which is located adjacent to each end of the cylinder 20, each valve governing a series of ports, 15<sup>a</sup>, in one of said chests and being actuated as now to be described. The adjustable eccentric 17 is coupled to the governor 18, and is adapted to be moved by said governor transversely to the

crank-shaft 23, and its strap is connected by an eccentric-rod (shown by the broken line 8) with a pin, 8<sup>a</sup>, on the upper arm of a double-armed rocker, 9, pivoted to work freely on a journal formed by an extension of the pin 1<sup>b</sup> of the exhaust-valve rocker 2, before described. A pin, 10, on the lower arm of the rocker 9 is connected by a rod, 10<sup>a</sup>, to a pin, 11, on an arm, 11<sup>a</sup>, which is fixed to a wrist-plate, 12, journaled on the side of the cylinder and similar in form and operation to the wrist-plate 4<sup>c</sup> of the exhaust-valve gear. The rocker 2, moving on the fixed pivot 2<sup>a</sup>, and the double-armed rocker 9, which has its pivot on the rocker 2, together constitute a compound-rocker system, which is similar in principle to that set forth in my Letters Patent No. 162,715, dated April 27, 1875, (reissued September 24, 1878, No. 85,8432,) and such construction is therefore not claimed, *per se*, as of my present invention. The wrist-plate 12 carries wrist-pins 12<sup>a</sup> and 12<sup>b</sup>, which are coupled by rods 13 13<sup>a</sup> to valve-levers 14 14<sup>a</sup>, journaled on the cylinder and pivoted to the stems 16 16<sup>a</sup> of the induction-valves 15. It will be seen that said valves are reciprocated by the wrist-plate 12 similarly to the exhaust-valves, before described.

The position of the center of the adjustable eccentric 17 of the induction-valves, as indicated in Fig. 1, is at the point *b* on the line *x y*, and its position along said line between the point *x*, where it is concentric, or nearly so, with the crank-shaft and the point *b*, is varied and controlled by the centrifugal governor 18, with which it is connected in such relation that when the governor-weights are exerting no centrifugal action the eccentric 17 is concentric, or nearly so, with the shaft, and under and by the expansive or outward movement of the weights the eccentric is moved to a position of greater or less eccentricity along a straight or slightly-curved line.

During such periods as the adjustable eccentric 17 is concentric with the crank-shaft it will be inactive in imparting movement to its rod 8 and the pin 8<sup>a</sup>, to which it is attached, and said pin being then in line with the pivot 2<sup>a</sup> of the exhaust rocker-arm 2, or, what is substantially the same in effect, in such position upon a line between the pivot 2<sup>a</sup> and the center of the crank-shaft as may be necessary to equalize the extreme angles of the upper arm of the rocker 9 with the inclined rod 8, the entire compound-rocker system, composed of the exhaust and induction rockers 2 and 9, will move in unison as a single rocker-arm, and will impart to the exhaust and induction valves substantially coincident movements, so that the point of cut-off of the induction-valves will correspond with that which would be obtained from lap with a common slide-valve actuated by the fixed eccentric 19.

It will be seen that in order to work the engine by hand it is only necessary to unhook the rod of the fixed eccentric, when the valves, not being subject to movement or control by the adjustable eccentric, can be freely oper-



ated by the starting-bar throughout the entire range of the stroke of the piston, without having their movements interfered with or modified by those of the adjustable eccentric, as the latter is at the rate of speed at which such hand operation is effected brought by the governor to a position of adjustment in which it is concentric, or nearly so, with the shaft.

Inasmuch as the movement of the induction-valves is, by reason of the compound rocker-arm system through which it is transmitted, always that which would be derived from an eccentric of eccentricity equal to the distance between the centers of the two eccentrics and in angular position corresponding to the same acting through direct gear, the movement of the adjustable eccentric to a position of eccentricity, as at *b*, Fig. 1, will effect movement of the induction-valves similar to that which would be imparted to them through uncompounded gear by an eccentric of eccentricity equal to the distance *a b*, and in an angular position corresponding to the angle formed by a line joining the points *a* and *b* with the center line of the crank 24, allowance being made for the variation of the eccentric-rod 8 from parallelism with piston movement. Therefore when a line joining the centers of the eccentrics or the points *a* and *b* forms the same angle with the center line, *x z*, of the crank as is formed by the eccentric-rod 8 with the center line of the engine, and varies from parallelism in the same direction, the movement of the induction-valves will be coincident with that of the piston, and of an extent due to the distance *a b*, or similar to that produced by the Stevenson link-motion at mid-link position. Such position of the adjustable eccentric effects the earliest or zero cut-off.

In order to facilitate the operation of the governor and promote accurate regulation by relieving the governor as far as practicable from the duty of moving an unbalanced slide-valve, each of the induction-valves 15 is, as shown in Fig. 5, connected to and moves coincidentally with a piston, 25, one side of which is constantly subject to the pressure in the valve-chest and the other to the pressure in the cylinder at the end to which the valve admits steam. The piston 25, which is coupled by a link, 26, to the induction-valve 15, is fitted truly within a cylinder, 27, which is open at its top to the valve-chest 16<sup>b</sup> or 16<sup>x</sup>, so that the upper side of the piston shall be at all times subject to the pressure therein. A passage or channel, 28, which may be formed in the casting, as shown, or composed of a separate pipe or pipes, leads from the cylinder 27 on the under side of the piston 25 to the induction port of the cylinder 20, so as to maintain constant communication between the lower end of the cylinder 27 and the end of the cylinder 20, to which the induction-valve 15 admits steam. It will be seen that the effective pressure on the piston 25 and the valve 15 will always be the same, being the difference between the pressures in the chest 16<sup>b</sup> (or 16<sup>c</sup>)

and in the cylinder 20. The force exerted by the piston 25 being in the direction tending to open the valve 15, and the major portion of the movement of the valve when under pressure being in the direction of opening, the piston 25 may, by proper proportionment of area, be made to furnish sufficient force, or nearly so, to open the valve, thereby relieving the adjustable eccentric and governor of the duty due to the pressure on the valve.

The governor shown in Fig. 6 is illustrated merely as an example of a form which is desirably applicable for use in connection with the valve-gear hereinbefore described, but is not claimed as of my present invention, not being an essential thereof, and being a construction which forms the subject-matter of a separate application by me, filed November 28, 1887, Serial No. 256, 311. Any other form of governor having the capacity of moving an eccentric in a straight path or a curved path which is not of extremely short radius may, moreover, be employed in substitution of that shown.

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

1. The combination of a cylinder, a piston adapted to reciprocate therein, independent valves for performing the functions of admission and cut-off and of exhaust, respectively, a wrist-plate connected to the exhaust-valves and coupled to an eccentric having a fixed range of movement, and a wrist-plate connected to the induction-valves and coupled to an eccentric which is adjustable between a position of substantial concentricity and one corresponding with the maximum range of motion of the induction-valves, substantially as set forth.

2. The combination of a cylinder, a piston adapted to reciprocate therein, independent valves for performing the functions of admission and cut-off and of exhaust, respectively, a fixed eccentric, an adjustable eccentric which is variable between a position of substantial concentricity and one giving maximum traverse, a centrifugal governor coupled to the adjustable eccentric, and a compound-rocker system connected to both of said eccentrics and to the valves, these members being combined for joint operation to impart to the valve or valves performing the functions of admission and cut-off the movements of substantially the fixed eccentric only for the latest point of cut-off, and movements compounded of those of both eccentrics for earlier points of cut-off, substantially as set forth.

3. The combination of a cylinder, a piston adapted to reciprocate therein, an exhaust valve or valves, a main rocker working upon a fixed bearing, an eccentric fixed upon a shaft rotated by the piston and coupled directly to said rocker, intermediate connections coupling the exhaust valve or valves with said rocker, an induction valve or valves controlling admission and cut-off, a supplemental



rocker working upon a bearing on the main rocker and coupled to the induction valve or valves, a centrifugal governor, and an adjustable eccentric coupled to the governor and  
5 connected to a pin on the supplemental rocker, substantially as set forth.

4. The combination of a main or working cylinder, an induction-valve controlling admission thereto, a pressure cylinder communicating at one end with the chest of the induction-valve and at the other with the main cylinder at the end thereof supplied by said valve, and a piston fitting the pressure cylinder and coupled to the induction-valve, substantially as set forth.  
15

5. The combination of a main or working

cylinder, an induction-valve controlling admission thereto, a wrist-plate connected with an eccentric and coupled to a lever which operates the induction-valve in such relation 20 that the major portion of the traverse of the valve when under pressure is in the direction of opening, and a piston coupled to the induction-valve and working in a cylinder which communicates at one end with the chest of 25 the induction-valve and at the other with the main cylinder at the end thereof supplied by said valve, substantially as set forth.

JOSEPH W. THOMPSON.

Witnesses:

JOHN E. ROGERS,  
L. C. HOLE.

Correction in Letters Patent No. 381,596.

It is hereby certified that Letters Patent No. 381,596, granted April 24, 1888, upon the application of Joseph W. Thompson, of Salem, Ohio, for an improvement in "Valve-Gear," was erroneously issued to the "Buckeye Engine Company," as assignee of the entire interest; that said Letters Patent should have been issued to said *Joseph W. Thompson and the Buckeye Engine Company jointly*, said Buckeye Engine Company being assignee of one-half interest only in said invention as shown by the assignments recorded in this Office; and that said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 1st day of May, A. D. 1888.

[SEAL.]

D. L. HAWKINS,  
*Assistant Secretary of the Interior.*

Countersigned:

BENTON J. HALL,  
*Commissioner of Patents.*