W. E. B. POWELL.

HYDROCARBON ENGINE.

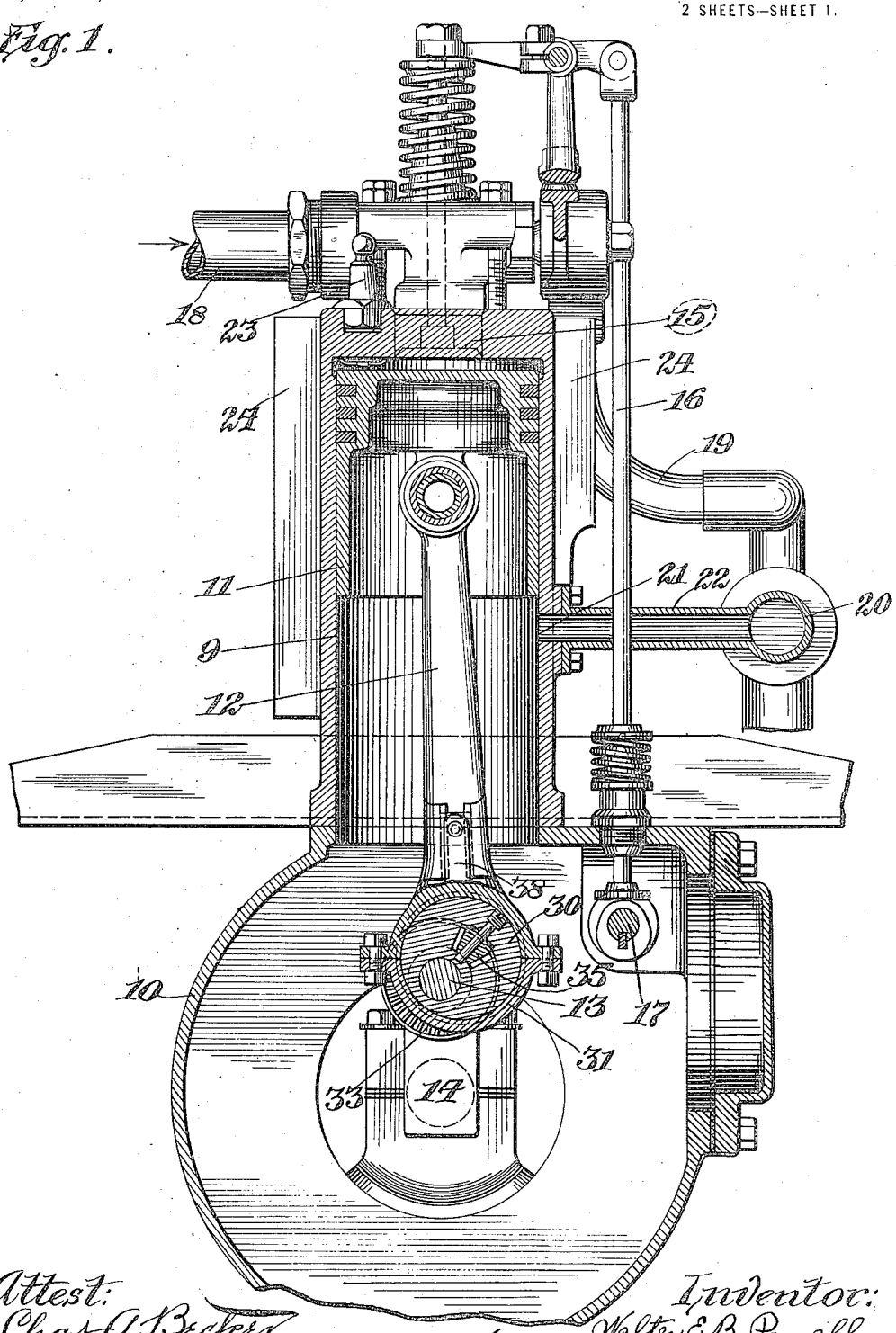
APPLICATION FILED MAY 19, 1911.

1,162,710.

Patented Nov. 30, 1915.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 2.

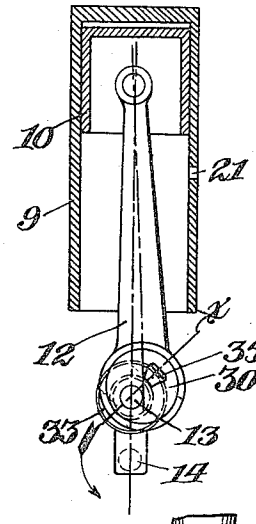


Fig. 3.

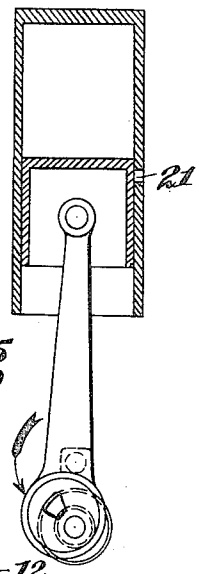


Fig. 4.

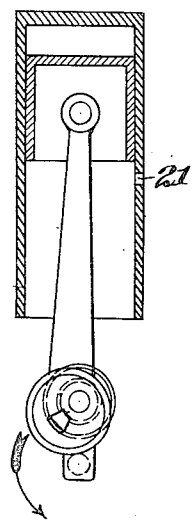


Fig. 5.

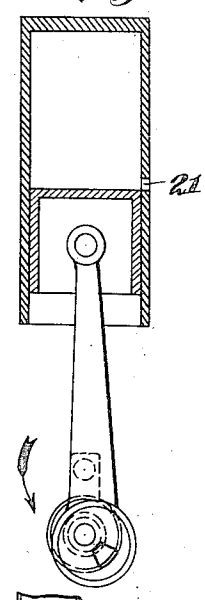


Fig. 6.

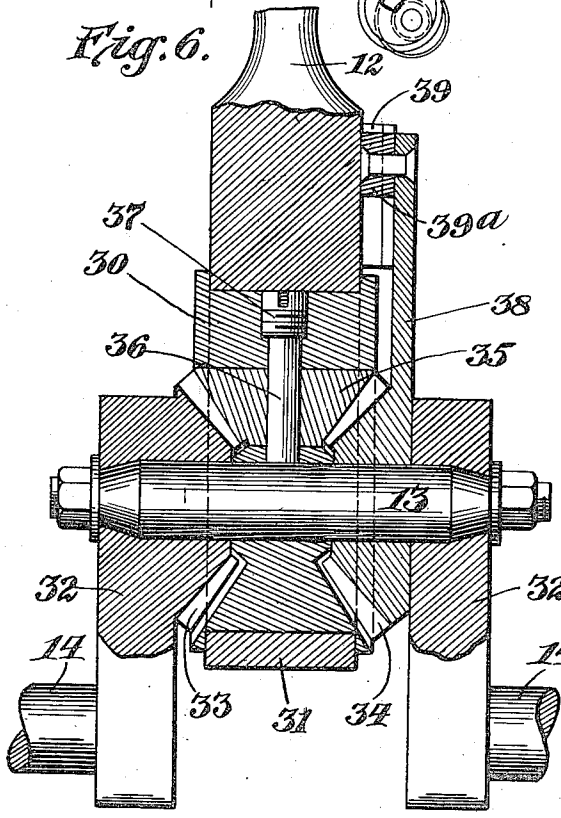


Fig. 8.

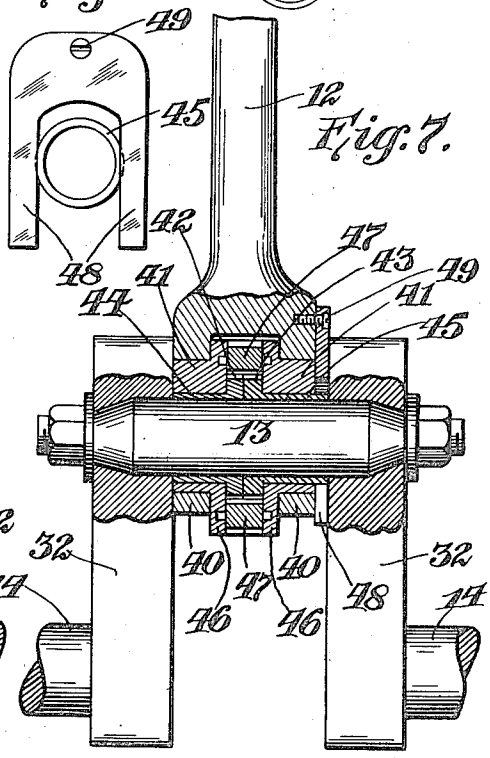


Fig. 7.

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UNITED STATES PATENT OFFICE.

WALTER E. B. POWELL, OF ST. LOUIS, MISSOURI.

HYDROCARBON-ENGINE.

1,162,710. Specification of Letters Patent. Patented Nov. 30, 1915.

Application filed May 19, 1911. Serial No. 628,305.

To all whom it may concern:

Be it known that I, WALTER E. B. POWELL, a citizen of the United States, and residing at St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Hydrocarbon-Engines, of which the following is a specification.

This invention relates to hydrocarbon engines and to a variable crank motion which is especially adapted to be used in that class of machines.

In hydrocarbon engines of the four-cycle type, an auxiliary exhaust is often provided which is opened near the end of the working or explosion stroke, and means must be provided for keeping the auxiliary exhaust closed during the intake stroke.

One of the objects of this invention is to construct a hydrocarbon engine in which a valve member (preferably the piston) is provided to open the auxiliary exhaust during the exhaust stroke only, and to provide means for securing efficient scavenging of the exhaust gases by means of the piston.

Another object is to provide a variable crank motion in which the means for securing the variable motion is of simple construction and wholly carried by and movable with the crank, and so constructed as to have an indefinite or any suitable gear ratio.

Further objects will appear from the detail description taken in connection with the accompanying drawings in which:

Figure 1 is a vertical section through an engine embodying this invention, Figs. 2 to 5 inclusive are diagrammatic views showing a complete cycle of operation, Fig. 6 is a section taken at right angles to that shown in Fig. 1, the pinion 35 being in this case positioned in axial alinement with the connecting rod; Fig. 7 is a view similar to Fig. 6 showing another form of this invention, and Fig. 8 is a detail of Fig. 7.

The engine to which this invention is shown as applied is a well known type of air cooled automobile engine having the inlet and exhaust valves mounted in the head.

Referring to the accompanying drawings and more particularly to Figs. 1 to 6 inclusive, 9 designates the cylinder bolted to the crank case 10, the engine being of the multi-cylinder type in which a series of cylinders are bolted to a single crank case. A piston 11 works in the cylinder, and a connecting rod 12 connects this piston with the crank pin 13 on the crank shaft 14. Both inlet and exhaust valves are in this case mounted in the head, one of these valves being shown at 15 and operated through a suitable valve rod 16 from a cam on a valve shaft 17 which shaft is driven from the crank shaft by means of the usual two-to-one gearing. An intake pipe 18 connects with the inlet valve casing, and an exhaust pipe 19 leads from the main exhaust valve casing to the exhaust manifold 20. The cylinder is provided with an auxiliary exhaust port 21 connected by a pipe 2 with the exhaust manifold 20. Each cylinder is provided with a spark plug 23 and cooling ribs 24.

The variable crank motion is shown in detail in Fig. 6, this figure showing slightly different proportions than the view Fig. 1, in order to bring out a condensed construction. Referring to Fig. 6 and also to Fig. 1, 30 designates an eccentric mounted to rotate on the crank pin 13 and provided with side flanges to receive the eccentric strap 31. The crank pin 13 is secured to the arms 32 of the crank in any suitable manner. One of the arms has secured thereto or formed integral therewith a bevel gear 33, and another bevel gear 34 is loosely mounted on the crank pin and on the opposite side of the eccentric, the opposite faces of the eccentric being recessed to receive the gears in order to condense the structure as much as possible. A pinion 35 is mounted in the eccentric and is supported on a bearing pin 36 so as to mesh with the bevel gears 33 and 34. The pin 36 is secured in position by having a threaded head 37 engaging a tapped hole in the eccentric, and this head is provided with a slot for engagement of a screw driver so that the pin may be secured in position or removed for removal or replacement of the pinion. The gear 34 has secured thereto or formed integral therewith an arm 38 which is provided with a block 39ª sliding in a guideway 39 on the connecting rod.

The gears 33, 34 and 35 form together the elements of a planetary gearing. If the crank shaft is rotated, the eccentric will rotate on the crank pin at half speed and in the same direction. This is due to the fact that one gear 33 is secured to and moves with the crank, while the other gear 34 moves with the connecting rod so that the gears 33 and 34 will move relatively to each other at a speed equal to that of the crank shaft. For every revolution of the crank

shaft the eccentric will rotate a half revolution and in the same direction, and for every half revolution of the crank shaft the eccentric will move through 90°. If now the gears be so positioned that the axis of pinion 35 will be in alinement with the connecting rod, and the pinion and eccentric center located above the crank pin when the crank pin is in its highest position, then if the crank be rotated through a complete revolution, the eccentric will be rotated through a half revolution and the pinion and the eccentric center will be positioned below the crank pin. At the end of the next revolution the parts will be moved back to original position. This mechanism therefore furnishes means for varying the stroke of a member connected to it, a complete cycle extending through two revolutions. It will be seen however that if the axis of pinion 35 coincides with that of the connecting rod that only the upper limit of the stroke is varied while the lower limit will be the same for successive revolutions of the crank shaft. In order to vary both limits it is necessary to displace the axis of the pinion with respect to that of the connecting rod. This is shown in Figs. 1 to 5 inclusive. In this case this axis of the pinion which is indicated x is displaced backward an angle of 45° with respect to the connecting rod axis, (more correctly 45° from the vertical). In referring to Figs. 2 to 5 inclusive it will be seen that the pinion and the eccentric center will be displaced alternately above and below the crank for successive revolutions, and for the two successive strokes of the same revolution will be in the same position with respect to the crank. In this construction therefore both limits of the stroke are varied. This movement is especially advantageous and adaptable to hydrocarbon engines of the four-cycle type. In Fig. 2 the piston is at the upper limit of its exhaust stroke and ready to begin its intake stroke, the crank as well as the eccentric rotating in the direction of the arrow. At the end of the intake stroke and the beginning of the compression stroke (indicated in Fig. 3) the piston will not uncover exhaust port 21, since the eccentric center is still above the crank pin so that the stroke is shortened. During the compression stroke the piston will not move to the end of the cylinder but will leave the necessary compression space as indicated in Fig. 4, the piston being there shown at the upper limit of its compression stroke and ready to begin the working stroke. At this time the eccentric center will be below the crank pin. Near the end of the working stroke the piston will uncover the auxiliary exhaust port 21 as indicated in Fig. 5, which shows the position of the piston at the lower limit of the working stroke ready to begin the exhaust stroke. At this time the eccentric center is below the crank pin so that the piston will be in its lowest position. During the exhaust stroke the eccentric center will move from a position below to a position above the crank pin so that the piston will be moved nearly to the cylinder head so as to thoroughly exhaust the burnt gases. The final position of the piston at the end of its exhaust stroke is shown in Fig. 2.

Fig. 7 shows another form of this invention in which the planetary gearing is made up of spur instead of bevel gears. The eccentric strap is in this case bifurcated to form two spaced strap members 40 which embrace the eccentric which is composed of two members 41. The spur gears 42 and 43 are provided with sleeves 44 and 45 respectively, surrounding the crank pin and furnishing bearings for the eccentric members 41. These eccentric members are provided with flanges 46 having bearings for the pinions 47. These pinions (which may be any suitable number) are arranged to mesh with the gears 42 and 43 as is usual in planetary gear construction. The sleeve 44 is rigidly secured to the crank pin or to the crank arm 32 in any suitable manner so as to move therewith. The gear 43 and its sleeve 34 are however movably mounted upon the crank pin and connected to move with the connecting rod 12 as in the other constructions. For this purpose the end of the sleeve 45 is flattened as shown in Fig. 8 and engaged by a fork 48 pivoted to the connecting rod at 49. It will be understood that the eccentric strap is split as in the construction shown in Fig. 1 so that the parts may be assembled. The operation of this construction is similar to the one hereinbefore described, it being understood that as the crank rotates the eccentric will rotate on the crank pin at a different rate, in view of the fact that one gear 42 is fixed to and moves with the crank while the other moves with the connecting rod. This form furnishes however a very condensed construction having great strength compared to its size.

It will therefore be seen that this invention accomplishes the objects aimed at. The means for turning the eccentric are wholly carried by and movable with the crank and occupy a comparatively small space. It is therefore not necessary to connect parts of the mechanism on the crank with gears and the like on the crank case or on the engine frame as in prior constructions. In prior constructions it was necessary that the gears have a certain fixed ratio, for instance, a two-to-one ratio. This is however not necessary in this case. Here the gears need not have any definite or fixed ratio. The pinion 35 can have any ratio compared with the gears 33 and 34, since there will always be

the same speed relation whatever be the size of the gears. The same is true of the construction shown in Fig. 7.

The mechanism is so constructed that the position of the eccentric center above and below the crank pin can be adjusted as desired. Thus the axis x can be adjusted to any desirable angle with respect to the connecting rod by placing the crank in the position shown in Figs. 2 and 6, then moving the gear 34 out of mesh with the pinion 35, then rotating the eccentric to the desired angle, and then throwing the gears in mesh again. The parts can thus be adjusted between any desired limits. Thus if the line x be positioned in alinement with the connecting rod, with the eccentric center above the crank pin, the difference between the upper limits of the piston for alternate revolutions will be a maximum while the piston will move to the same lower limit. If the eccentric be positioned so that the line x is at right angles to the connecting rod or horizontal, then the piston will move to the same upper limit while the lower limit will have a maximum variance. Between these two extremes the adjustment can be made as desired, thus for a 45° position of x the variance will be about equal for both end positions of the piston.

It will be noted that during the period that the greatest stress is applied to the piston, *i. e.*, during the working stroke (Figs. 4 to Fig. 5) the eccentric center is below the crank pin and moves through a relatively small angle on each side of the lower dead center of the eccentric. The lever arm will therefore be very small at this time (practically zero for most of the time) and therefore the strain on the gears will be very small. It will also be noted that the eccentric center moves downwardly during the compression stroke (Figs. 3 to 4) so that the gears will not have to rotate the eccentric against the back pressure of the compressed gears. The lever arms are a maximum during the exhaust and intake strokes when the stress on the gears will be slight. The piston in this case acts as a valve member to control the auxiliary exhaust port, and the crank motion performs a function of a valve operating means. The crank motion may however be used for operation of other types of valves and for other purposes which it is not necessary to describe.

It is obvious that various changes may be made in the details of constructions without departing from this invention, and it is therefore to be understood that this invention is not to be limited to the specific construction shown and described.

Having thus described the invention what is claimed is:

1. In a hydrocarbon engine, the combination of a cylinder, a piston therein, a crank shaft connected to said piston, and mechanism having the elements thereof in continuous engagement and wholly carried by and movable with said crank shaft for causing said piston to perform a variable stroke.

2. In a hydrocarbon engine, the combination of a cylinder having a port, a valve member controlling said port, a shaft connected to said valve member, and mechanism having the elements thereof in continuous engagement and wholly carried by and movable with said shaft for giving said valve member a variable movement during different revolutions of said shaft.

3. In a hydrocarbon engine, the combination of a cylinder having a port, a valve member controlling said port, a shaft connected to said valve member, and means for causing said valve member to have a variable movement during different revolutions of said shaft, including a set of meshing gears wholly carried by and movable with said shaft.

4. The combination with a crank shaft and a connecting rod, of an adjustable member connecting said crank shaft and said connecting rod, and driving means connecting said adjustable member with said crank shaft and with said connecting rod and in continuous engagement therewith constructed and arranged to automatically adjust said adjustable member to automatically vary the effective length of said connecting rod.

5. The combination with a crank, of an eccentric thereon forming a crank pin bearing, and gearing wholly carried by and movable with said crank for rotating said eccentric on said crank at a different rate than the crank.

6. The combination with a crank shaft having a crank pin, of an eccentric movable on said crank pin, a pair of gears one rigidly connected with said crank pin and the other movable thereon adapted to turn said eccentric on said crank pin, and means connecting said gears.

7. The combination with a crank, of an eccentric movable thereon, a gear fixed to said crank, a gear movable on said crank, and a gear carried by said eccentric and meshing with said gears.

8. The combination with a crank and a connecting rod, of an eccentric movable on said crank and forming a bearing for said connecting rod, and mechanism comprising elements in continuous engagement carried by said crank and movable as a whole therewith for turning said eccentric on said crank.

9. The combination with a crank and a connecting rod, of an eccentric movable on said crank and forming a bearing for said connecting rod, and means for turning said eccentric on said crank including an element

fixed to said crank and an element movable on said crank and with said connecting rod, said elements being in continuous engagement.

10. The combination with a crank and a connecting rod, of an eccentric movable on said crank and forming a bearing for said connecting rod, and means for turning said eccentric on said crank including an element connected to and movable with said crank, an element movable on and relative to said crank and guided on said connecting rod to move therewith, and an element connected to and movable with said eccentric.

11. The combination with a crank and a connecting rod, of an eccentric movable on said crank, and a plurality of meshing gears comprising a gear connected to and movable with said crank, a gear connected to and movable with said connecting rod, and a gear connected to and movable with said eccentric.

12. The combination with a crank, of an eccentric movable thereon, a pair of gears mounted on said crank on opposite sides of said eccentric, and a gear mounted in said eccentric and meshing with said gears.

13. The combination with a crank and a connecting rod, of an eccentric movable on said crank, a pair of gears on said crank on opposite sides of said eccentric, one being fixed to the crank the other movable with the connecting rod and on said crank, and a gear in said eccentric meshing with said gears.

14. The combination with a crank, of an eccentric movable on said crank, and planetary gearing one element of said gearing being fixed to said crank, one element being movable on said crank, and another element being connected to said eccentric.

15. The combination with a crank and a connecting rod, of an eccentric movable on said crank and forming a bearing for said rod, and planetary gearing having one element connected to said crank, one element connected to said rod, and one element connected to said eccentric.

16. In an engine, the combination of a cylinder, a piston therein, a crank shaft connected to said piston, and means for causing said piston to perform a variable stroke, comprising a set of three gears meshing in series, two of said gears having a relative movement, and an automatically adjustable member connected to the third gear.

17. In an engine, the combination of a cylinder, a piston therein, a crank shaft connected to said piston, a shiftable element connected to said piston, and means for positively shifting said element to a plurality of positions for causing said piston to automatically perform a variable stroke, said element and said means being wholly mounted on and movable with said shaft.

18. In an engine, the combination of a cylinder, a valve member operating therein, and means for causing said member to perform a variable movement comprising, two elements having a relative movement, and an element engaging each of said two elements and operated thereby.

19. In an engine, the combination of a cylinder, a valve member operating therein, and means for causing said member to perform a variable movement comprising, two elements having a relative movement, and an element connecting and driven by said two elements and having a movement which bears a predetermined ratio to the relative movement of said two elements.

20. In an engine, the combination of a cylinder, a valve member operating therein, and means for causing said member to perform a variable movement comprising, two elements having a relative movement, and an actuated element having a rolling engagement with each of said two elements.

21. In an engine, the combination of a cylinder, a valve member operating therein, and means for causing said member to perform a variable movement comprising, two elements having a relative movement, and an intermediate element driven by said two elements and movable with one of said elements.

22. In an engine, the combination of a cylinder, a valve member operating therein, and means for causing said member to perform a variable movement comprising, two elements having a relative movement, and an element intermediate and driven by said two elements and having a movement relative to both said two elements.

23. In an engine, the combination of a cylinder, a member operating therein, and means for causing said member to perform a variable movement comprising, two gears, and an actuated member having a gear meshing with each of said two gears.

24. In an engine, the combination of a cylinder, a member operating therein, and means for causing said member to perform a variable movement comprising, two gears having the same diameter, and an actuated member having a gear meshing with each of and actuated by said two gears.

In testimony whereof I affix my signature in presence of two witnesses.

WALTER E. B. POWELL.

Witnesses:
MARIE E. PAUCH,
J. H. BRUNINGA.