Feb. 23, 1926. 1,574,573

J. T. HALE

INTERNAL COMBUSTION ENGINE

Filed Oct. 19, 1923 2 Sheets-Sheet 1

Fig. 1.

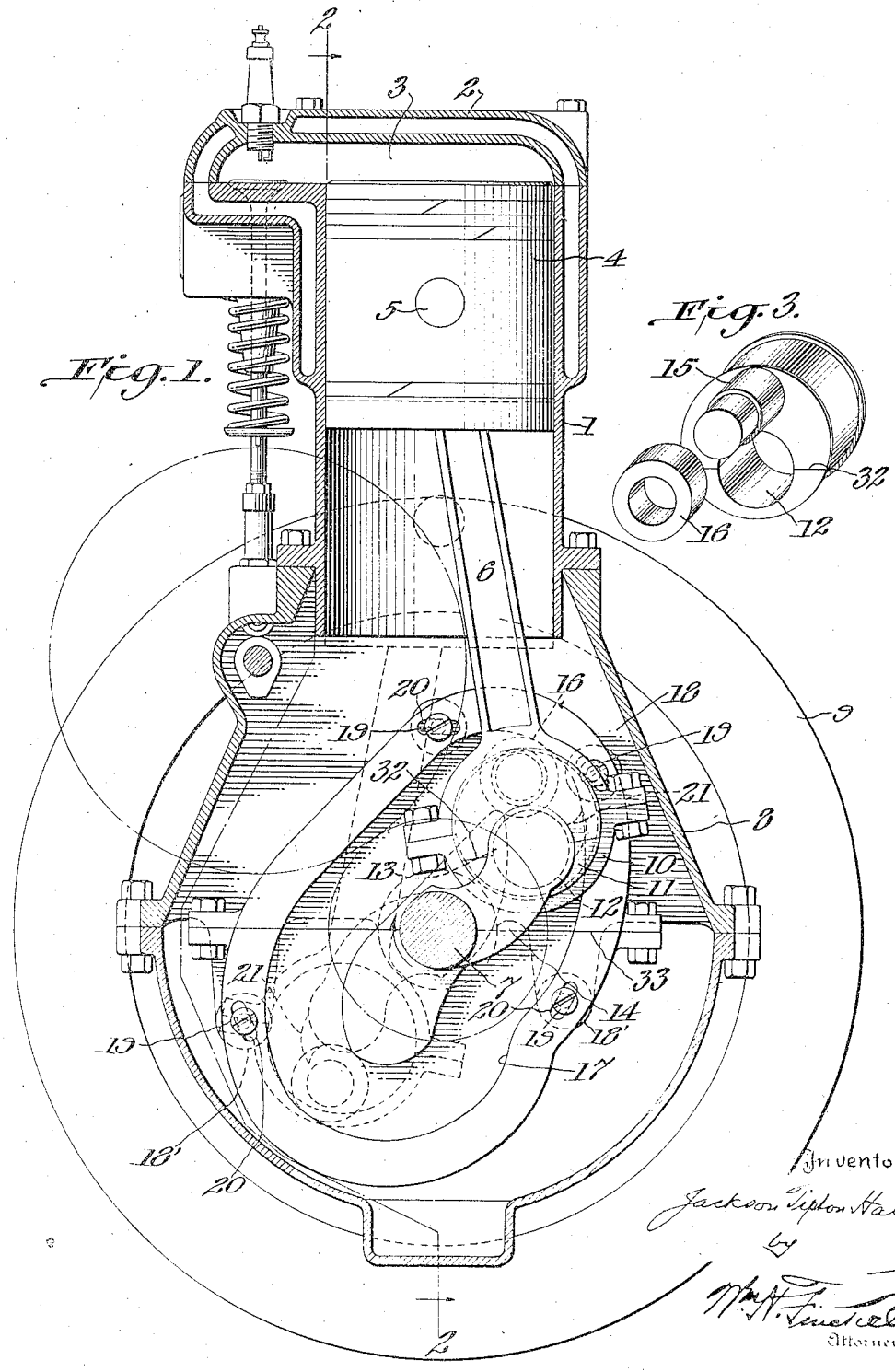


Fig. 3.

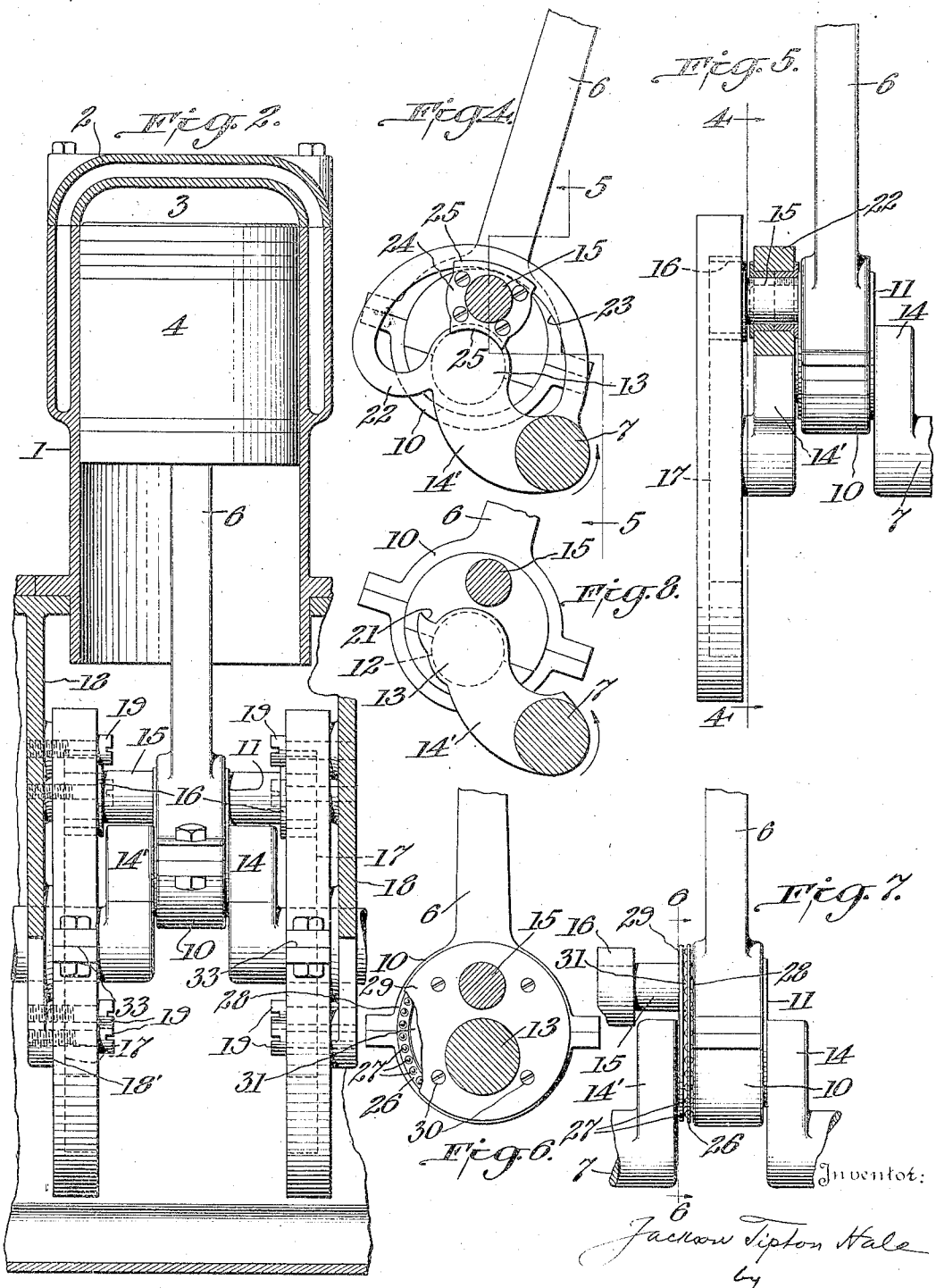
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INTERNAL COMBUSTION ENGINE

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UNITED STATES PATENT OFFICE.

JACKSON TIPTON HALE, OF FULTON COUNTY, GEORGIA, ASSIGNOR OF ONE-THIRD TO CHRISTOPHER LA FAYETTE HARDWICK, OF CLEVELAND, TENNESSEE.

INTERNAL-COMBUSTION ENGINE.

Application filed October 19, 1923. Serial No. 669,521.

To all whom it may concern:

Be it known that I, JACKSON TIPTON HALE, a citizen of the United States, residing in the county of Fulton and State of Georgia, have invented a certain new and useful Improvement in Internal-Combustion Engines, of which the following is a full, clear, and exact description.

As is well known, in operating internal combustion engines, it is essential, in order to derive the maximum of power and efficiency from the explosive charges introduced into the combustion chambers of the cylinders of such engines, to cause ignition of such charges at the moment of highest compression, that is, when the piston is at the limit of its upward movement in the cylinder, and, consequently, in the common type of engine, when the crank shaft is at dead center. Timing of the spark so that the explosion occurs at approximately this particular moment is common practice, and operation of engines upon this principle is satisfactory where the engines are of the high speed type, for the reason that the momentum of the crank shaft and the usual fly wheel will carry the crank shaft around and prevent the motor from stopping on dead center or from kicking back at the moment the explosion takes place.

However, even where the method above described works out satisfactorily, as pointed out, a large proportion of the power developed by the explosion is expended in a direct line upon the crank shaft when it is at dead center, and the power so expended is lost. This loss of power occurs also when the crank shaft is only a few degrees past dead center at the time of firing, and it is therefore desirable to have the explosion occur when the crank is well past dead center, so that the entire force of the explosion may be utilized in the application of a turning force upon the crank shaft. In the ordinary type of engine, if explosion is so timed as to occur when the crank is past dead center, then such explosion occurs at a time when the combustible charge is not at its greatest compression and hence not capable of developing its greatest energy.

Moreover, when internal combustion engines are provided with starters, particularly electric starters of the type commonly in use in connection with the engines of motor vehicles, if a back kick should occur through preignition of the charge while starting, the starter motor or its clutch connection with the engine would in all probability be wrecked.

Furthermore, in slow speed engines where the momentum of the crank shaft and fly wheel is not so effective as in high speed engines, back kick is more apt to occur where the explosion is timed to take place at approximately dead center of the crank shaft than it is in high speed motors.

The main object of my invention is to provide an engine of such construction as to afford a maximum of power from the fuel used, and hence a minimum fuel consumption, and this is accomplished by so constructing the engine that, although the explosive charge is ignited at approximately the moment of highest compression, the crank shaft will, at the time of firing, be well past dead center.

Another object is to provide an internal combustion engine in which, although the explosions in the cylinders thereof are timed so as to take effect at the moment of maximum compression of the explosive charge, the connection between the piston and the crank shaft is such that back kick, or reverse rotation of the crank shaft, is rendered impossible.

The invention consists, broadly, in an internal combustion engine having the usual cylinder, piston, crank shaft and connecting rod, and means interposed in the connection between the connecting rod and crank shaft whereby when the piston is at the limit of its upward stroke in the cylinder, the crank shaft will be well past dead center, as I will proceed now to explain and finally claim.

In the accompanying drawings illustrating the invention, in the several figures of which like parts are similarly designated, Figure 1 is a central transverse vertical section through one cylinder of an engine embodying my invention. Fig. 2 is a section taken on the line 2—2 of Fig. 1 and looking in the direction of the arrows. Fig. 3 is a perspective view of the eccentric and roller carried by the connecting rod. Fig. 4 is a section of a crank shaft and connecting rod taken on the line 4—4 of Fig. 5 and illustrating a modification whereby binding between the eccentric and connecting rod is prevented. Fig. 5 is a section taken on the

line 5—5 of Fig. 4. Fig. 6 illustrates a modification of the means for preventing binding between the eccentric and connecting rod, a part of same being broken away to show the ball bearings and their cage. Fig. 7 is a side view of the parts shown in Fig. 6. Fig. 8 is a detail view of one crank arm showing the stop for the stud of the eccentric.

The engine herein shown has a cylinder 1, of any approved form and a cylinder head 2 applied thereto and providing a combustion space 3. Operating in the usual manner within the cylinder 1 is a piston 4 connected by a wrist pin 5, through a connecting rod 6 with the crank shaft 7 which latter is arranged in bearings in the crank case 8 in any approved manner and which carries the usual fly wheel 9.

The connecting rod used in carrying out my invention is a departure from the common practice in that it is formed at its lower end to provide a strap 10 for an eccentric 11, this eccentric being provided with a bore 12 to receive the crank pin 13 of a crank 14 and carrying upon a stud 15 a roller or cam follower 16 adapted to travel in a cam-way or track 17 of such predetermined conformation that during the down stroke of the crank shaft, the roller 16 is maintained in a direct axial line running from the wrist pin to the crank pin and is thus protected from the force of the explosion in the cylinder. This cam-way is supported within the crank case 8 in any suitable manner as by a septum or wall 18 provided with depending lugs 18', the cam-way being secured thereto by means of screws 19 or other suitable fastening means passing through slots 20 in its rim, whereby a limited angular adjustment of the cam-way, about the crank shaft as a center, may be obtained.

I have found that the best results, in the operation of my device, are obtained by using two sets of cam-ways and associated cooperating parts as shown in Fig. 2. I thereby obtain a better balance of the mechanism used and prevent binding of the various parts; and, inasmuch as the cam-way and its associated parts are the same on one side of the crank as on the other, I have hereinabove described only one set.

As shown in the drawing the piston 4 is at the top of its stroke, and, supposing that the stroke thereby completed is the compression stroke of the engine, the combustible charge contained in the chamber 3 is at the limit of its compression and consequently in that state best suited to produce its maximum power when ignited.

In the type of engines provided with the customary arrangement of crank shaft and connections between same and the piston, the crank of the crank shaft corresponding to the cylinder under compression would at this time be at dead center, as hereinabove pointed out, but it will be seen that by my arrangement, the crank is at this time well past dead center, and in fact so far past dead center that when the explosion of the charge occurs the maximum of its explosive force will be exerted to produce approximately the maximum of turning force upon the crank shaft. This result is obtained by means of the connection between the crank shaft and piston including the cam track 17, roller 16 and eccentric 11 through the connecting rod 6.

In the ordinary type of engine, the piston is only momentarily at the limit of its upward movement or compression stroke, and hence the maximum compression of the charge is only momentary, but with my arrangement of cam-way and eccentric I am able to produce a partial dwell at this point of highest compression. This is accomplished by so forming the upper portion of the cam-way that as the crank approaches, reaches and passes dead center, the roller 16 will rock around the cam track over its highest point, and, during this rocking movement of the roller, the piston, through its eccentric connection, will be maintained at the limit of its upward stroke.

It will be noted that as the crank shaft turns, the roller 16 will follow the cam track 17 in such a manner that it is sometimes above the crank pin 12 and at other times below this crank pin, (see the dotted line position, Fig. 1, in which the piston is at approximately the limit of its downward movement) and although the operation of the piston in the cylinder is substantially identical with the operation of pistons having the ordinary crank shaft connections, the point of connection of the piston with the crank shaft is always following behind the crank pin and consequently the crank pin is always relatively in advance of the piston and the possibility of back kick eliminated.

I have found in practice that when the crank pin has passed bottom center, and has started on its upward stroke, the momentum attained is such as to influence the roller 16 to cause the eccentric to rotate within its strap as the roller follows the cam-way so as to throw the roller too far around the cam-way. This is undesirable, and to prevent its occurrence, I provide the crank 14' with a stop 21 (see Fig. 8) against which the stud 15 will abut if the eccentric rotates as stated.

As above stated, I have found that the best results in the operation of my device are obtained by using two sets of cam-ways and associated parts, but it is conceivable that only one may be used, and, as is obvious, in view of the necessity for providing space for the rotation of the crank arm

14', it is necessary to make the stud 15 rather long, so that there is a tendency to produce a leverage between the roller 16 and the eccentric 11, and as such a leverage would be apt to cause binding of the eccentric in its strap, I have devised means which may be employed for preventing this binding, if desired.

One of such means is shown in Figs. 4 and 5 and comprises a guide 22 forming a part of the crank 14' and providing a guideway 23 formed between the guide 22 and the crank pin 13. The stud 15 extends through this guideway and is provided with a split bushing 24 flanged at 25 to embrace the guide 22 and the upper edge of the crank 14'. By this arrangement it will be seen that a continuous bearing is formed for the stud 15 between the eccentric 11 and the roller 16 and any tendency to create a leverage between these parts is eliminated.

Another arrangement whereby binding may be obviated is shown in Figs. 6 and 7. This arrangement comprises a thrust bearing member including a cage 26 carrying a plurality of balls or other antifriction devices 27, and these balls bear against the face 28 of the strap 10 and upon a plate 29 rigidly secured by screws 30 to an extension 31 of the face of the eccentric 11. The balls and their cage are held in proper relation to the other parts by cooperation of the extension 31 with the inner circumference of the cage 26. It will thus be seen that any leverage action of the roller and stud upon the eccentric will be taken up by the ball bearing, and binding of the eccentric in its strap prevented.

The eccentric 11 is formed in two parts as indicated at 32 so that it may be assembled upon the crank pin 13. The cam-way 17 also is made in two parts as indicated at 33 so that it may be assembled around the crank shaft 7.

It will be apparent, therefore, that I provide a simple and effective means for enhancing the efficiency of the operation of internal combustion engines and for preventing back kick, for it is obvious that with the crank past dead center at the moment of firing, the force of the explosion will not be directed upon the crank shaft in a straight line downward, but will be directed as a turning force to one side of it, and if the crank is always past dead center at the moment of firing, back kick cannot occur.

I have herein referred to the upward and downward strokes of the piston, but it is to be understood that these terms are not intended to limit the invention to a vertical engine, as it is equally well adapted to a horizontal, or V-type, or other engine, and whether of the single-cylinder or multi-cylinder type.

Various changes in the mechanism embodying the invention, and in the construction and arrangement of its parts, are contemplated as within the spirit of the invention and the scope of the following claims.

What I claim is:—

1. In combination, a cylinder, a piston, a crank shaft, a connecting rod affording a connection between said piston and crank shaft, a cam track mounted in predetermined relation to said crank shaft, means whereby said cam track may be angularly adjusted with respect to said crank shaft, and a cam follower carried by said connecting rod and affording a connection between said cam track and connecting rod whereby when said piston is at the limit of its upward stroke said crank shaft will have passed dead center.

2. In an internal combustion engine, a cylinder, a piston, a crank shaft, a connecting rod, a cam track, means affording a connection between said piston, crank shaft and cam track, including an eccentric carried by said connecting rod and provided with a stud standing off therefrom and carrying a roller cooperating with said cam track, and means for preventing binding between said eccentric and connecting rod interposed between said roller and eccentric.

3. In an internal combustion engine, a cylinder, a piston, a crank shaft, a connecting rod, a cam track, means affording a connection between said piston, crank shaft and cam track, including an eccentric carried by said connecting rod and provided with a stud standing off therefrom and carrying a roller cooperating with said cam track, and means for preventing binding between said eccentric and connecting rod and including a thrust bearing interposed between said eccentric and said connecting rod.

4. In an internal combustion engine, a cylinder, a piston, a crank shaft, a connecting rod, a cam track, means affording a connection between said piston, crank shaft and cam track, including an eccentric carried by said connecting rod and provided with a stud standing off therefrom and carrying a roller cooperating with said cam track, and means for preventing binding between said eccentric and connecting rod and including a plate carried by said eccentric and a thrust bearing interposed between said plate and said connecting rod.

5. In an internal combustion engine, a cylinder, a piston, a crank shaft, a connecting rod, a cam track, means affording a connection between said piston, crank shaft and cam track, including an eccentric carried by a strap formed on said connecting rod and provided with a stud standing off therefrom and carrying a roller cooperating with said cam track, and means for preventing binding between said eccentric and connecting rod and including a plate carried by said ec-

centric and a thrust bearing interposed between said plate and the strap of said connecting rod.

6. In an internal combustion engine, a cylinder, a piston, a crank shaft, a connecting rod affording a connection between said piston and crank shaft and carrying an eccentric, a stud on said eccentric and means for preventing undue rotation of said eccentric comprising a stop on said crank shaft for cooperation with said stud.

7. In combination, a cylinder, a piston, a crank shaft, a cam-way, a connecting rod affording a connection between said piston and crank shaft, an eccentric carried by said connecting rod and provided with a stud carrying a cam follower travelling in said cam-way, and means for preventing undue rotation of said eccentric as said follower travels in said cam-way including a stop on said crank shaft for cooperation with said stud.

In testimony whereof I have hereunto set my hand this 17th day of October A. D. 1923.

JACKSON TIPTON HALE.