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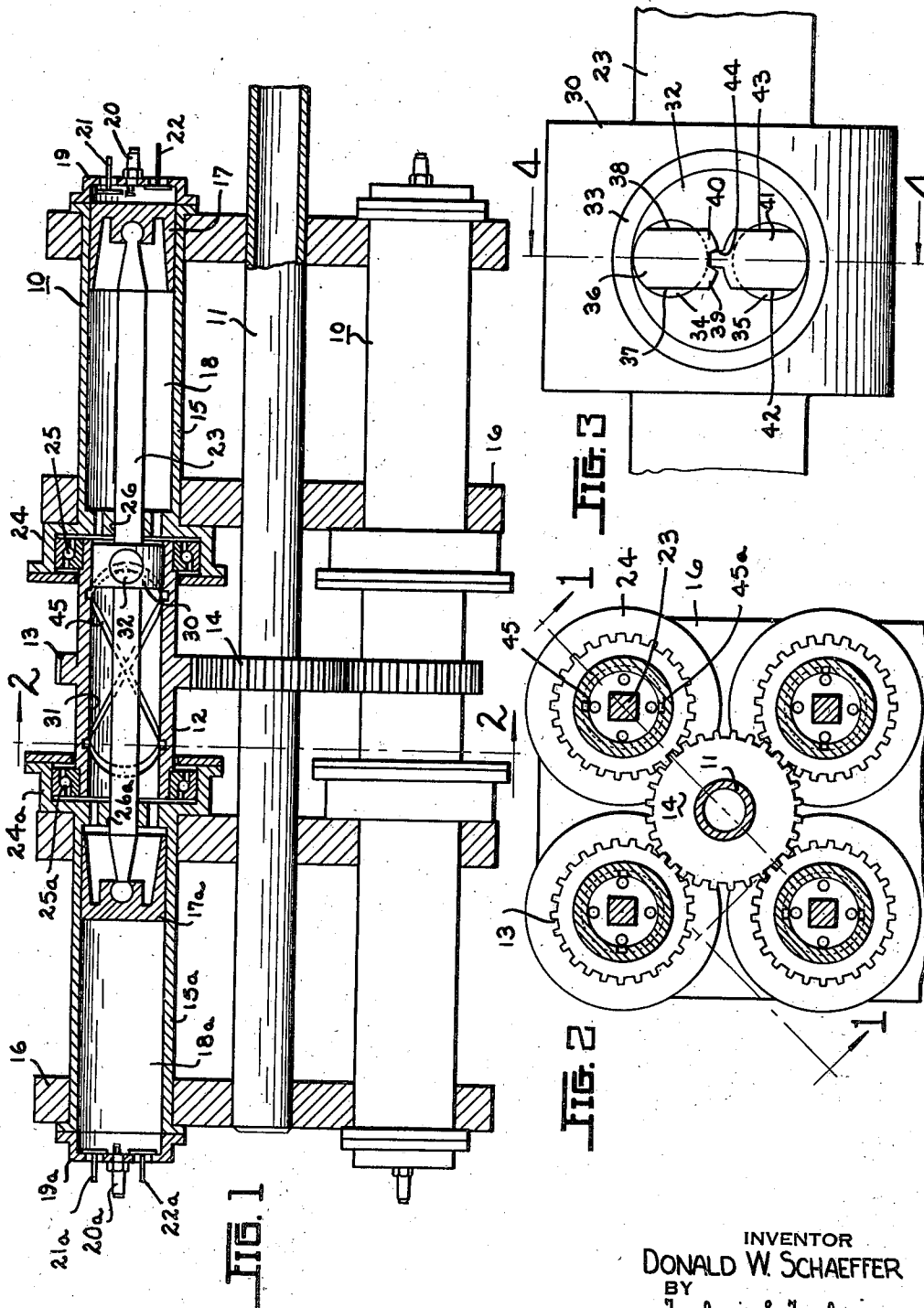
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INTERNAL-COMBUSTION ENGINE

Filed Oct. 8, 1942

2 Sheets-Sheet 1



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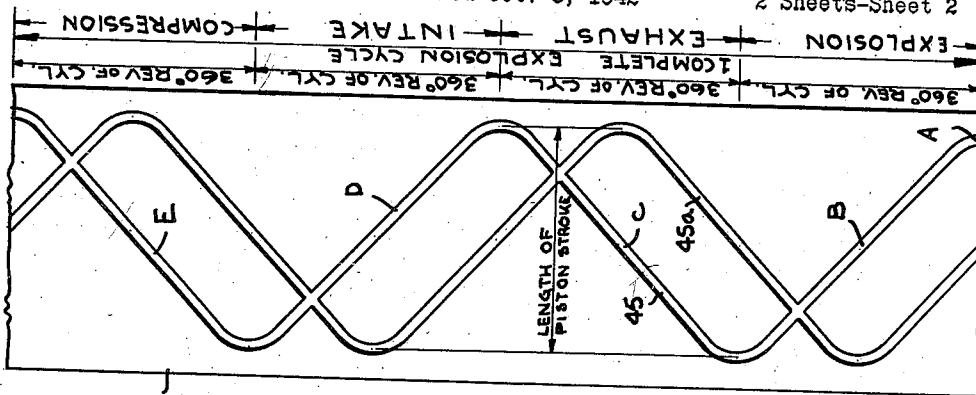
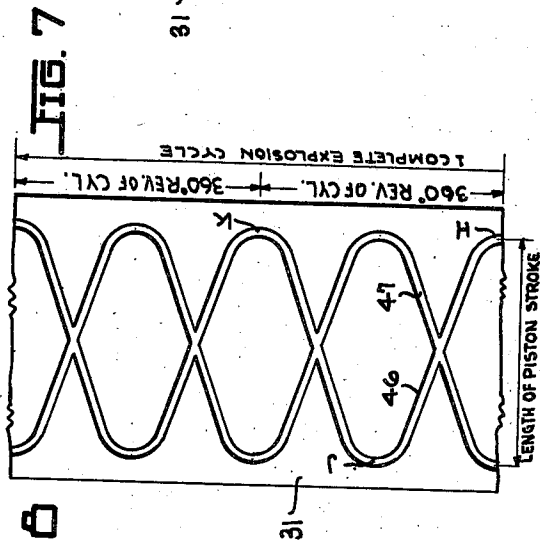
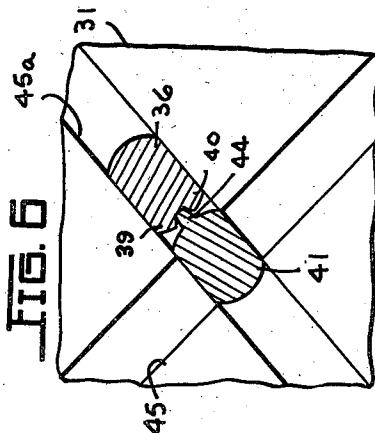
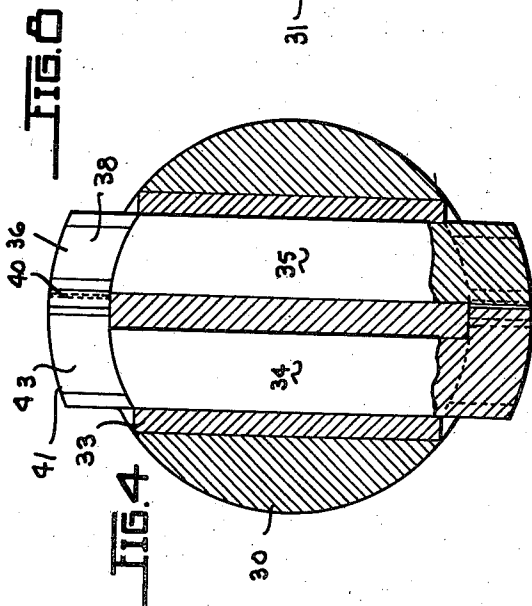
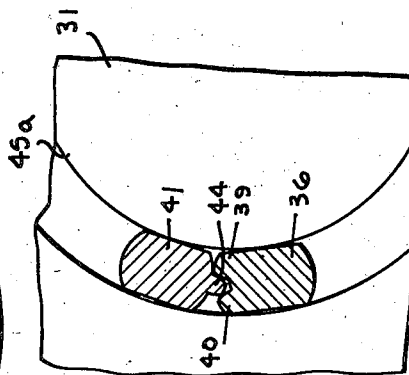
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2 Sheets-Sheet 2



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INTERNAL-COMBUSTION ENGINE

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9 Claims. (Cl. 74-57)

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This invention relates to internal combustion engines.

An object of the invention is to provide an internal combustion engine wherein the power producing elements all move in a straight reciprocating motion and in substantial alignment with one another.

Another object of the invention is to produce an engine that avoids the use of eccentric rotating parts when changing reciprocating motion to rotary motion.

Another object of the invention is to provide an internal combustion engine that is constructed and arranged with opposed power producing elements.

It is a still further object of the invention to provide an internal combustion engine having opposed power producing elements that are constructed and arranged around a common drive shaft.

It is another object of the invention to provide an internal combustion engine that is constructed and arranged with the power producing elements disposed in opposed relationship and adapted for straight reciprocating motion for producing rotary motion by means of a concentrically rotating element that is rotated by a member that is moved through a reciprocating path coaxial with the path of reciprocation of the power producing elements.

Another object of the invention is to provide an internal combustion engine that may have any desired ratio between the piston stroke and the number of drive revolutions produced by the driven member.

Another object of the invention is to provide an internal combustion engine wherein the full expanding force of the expanded gas is utilized.

Further objects and advantages will become apparent from the drawings and the following description.

In the drawings:

Fig. 1 is a longitudinal cross-sectional view of an internal combustion engine embodying principles of this invention, and is taken along line 1-1 of Fig. 2.

Fig. 2 is a transverse cross-sectional view of the engine taken along line 2-2 of Fig. 1.

Fig. 3 is an elevational view of one of the drive members carried by the engine connecting rod.

Fig. 4 is a transverse cross-sectional view of the drive member shown in Fig. 3, and is taken along line 4-4 of Fig. 3.

Fig. 5 is a partial cross-sectional view of a portion of the drive track and the driving members

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to show their relationship when at one end of the drive track in the driven member of the engine.

Fig. 6 is a partial cross-sectional view of the drive track and drive members showing the manner in which the members pass over track crossings.

Fig. 7 is a development of the drive track of the engine shown in Fig. 1 wherein the driven member is imparted with four revolutions for each complete explosion cycle of the four-cycle engine.

Fig. 8 is a development of the cam track for the engine of this invention wherein the driven cylinder is imparted with two revolutions for each complete explosion cycle of the engine.

This invention relates to an internal combustion engine which may be either of the four-cycle or two-cycle type. The invention is also adaptable for application upon a gas engine or a Diesel engine. The principle of the invention therefore is not limited to a particular type of engine and the description hereinafter set forth is not to be construed in limiting the features of the invention to a particular engine when those features are described in co-operation with a particular form of engine.

In Figs. 1 and 2 there is disclosed a gasoline engine of the four-cycle type wherein a plurality of power units 10 are disposed radially about the center drive shaft 11. Each of the power units 10 is provided with a rotatable member 12 that has a gear 13 integral therewith. The gears 13 on the rotatable members 12 are in meshing relationship with a gear 14 secured to the drive shaft 11. Rotation of the members 12 thereby produces rotation of the drive shaft 11 for suitably driving any device.

Each of the power units 10 consists of a pair of cylinders 15 and 15a that are disposed in axial alignment and are carried within a suitable frame structure 16. Each of the cylinders 15 receives a piston 17 respectively whereby the power chambers 18 and 18a are provided in the cylinders 15 and 15a. The cylinders 15 and 15a are provided with the usual heads 19 and 19a respectively for closing the end of the cylinder and for receiving the spark plugs 20 and 20a. The heads 19 and 19a are provided with inlet valves 21 and 21a and with outlet valves 22 and 22a respectively.

The pistons 17 and 17a are interconnected by means of a connecting rod 23 that rigidly connects the pistons in spaced relationship with respect to one another and causes them to reciprocate in unison.

The rotatable member 12 is disposed around the connecting rod 23 and positioned between the inner ends 24 and 24a of the cylinders 15 and 15a respectively. The member 12 is suitably bearing in the ends 24 and 24a by means of the ball bearing members 25 and 25a.

From Fig. 1 it may thus be seen that each of the power units 10, that comprise a part of the gasoline engine, consists of a pair of opposing cylinders that are in axial alignment so that the pistons in the cylinders can reciprocate in unison in a manner that one of the pistons will be at the bottom of its stroke when the opposite piston is at its top stroke. Therefore, the explosion in one cylinder produces motion of the piston in the opposite cylinder to carry it through its cycle of operation. The rotatable member 12 provides the flywheel necessary to carry the pistons over the portion of the cycle of operation that does not comprise the power stroke. By providing a power unit with opposed power producing members therein a more uniform balance of the engine can be obtained. Also, it is possible to avoid all eccentrically movable parts and thereby reduce unbalance of parts within the engine.

In order to change the reciprocating motion of the connecting rod 23 into rotary motion for driving the drive shaft 11, a piston 30 is slidably disposed within a cylinder bore 31 provided in the rotatable member 12. The piston 30 is suitably secured to the connecting rod 23 and is adapted to reciprocate axially within the cylinder bore 31. The piston 30, however, is prevented from rotation relative to the connecting rod 23, and the connecting rod 23 is prevented from rotation upon its axis because the rod 23 is preferably of a square shape adapted to slide in square-shaped bearings 26 and 26a provided in the end walls 24 and 24a of the cylinders 15 and 15a respectively.

The piston member 30 is shown in more detail in Figs. 3 and 4 and consists of a cylindrical member 32 that is positioned within a bearing shaft or sleeve 33 provided at a right angle to the axis of the piston 30. The cylindrical member 32 is adapted to rotate within the bearing sleeve 33 in a manner that will be hereinafter described. The cylindrical member 32 carries a pair of cylindrical members 34 and 35 that have their axes parallel to the axis of the member 32 and spaced therefrom as shown in Figs. 3 and 4. The members 34 and 35 are adapted to rotate within the member 32 for reasons which will become apparent in the subsequent description.

The cylindrical member 34 is provided with an extension 36 on both ends thereof that is provided with parallel side walls 37 and 38. The extension 36 is also provided with a gear segment consisting of the gear teeth 39 and 40. The cylindrical member 35 is also provided with extensions 41 provided on both ends thereof that has parallel side walls 42 that are in planar alignment with the parallel side walls 37 and 38 of the extensions 36 on the member 34. The extension 41 is also provided with a gear tooth 44 adapted to engage the gear segment on the extension 38 between the gear teeth 39 and 40 thereof. This arrangement permits a limited rotation of the members 34 and 35 relative to one another but retains the parallel side walls of the extension on these members in planar alignment in a manner that is hereinafter described.

As previously mentioned the piston 30 is adapted to reciprocate within the cylinder 31 provided in the member 12. The inner surface of

the cylinder 31 is provided with a continuous groove or track 45 that receives the extensions 36 and 41 of the piston member 30. As shown in Fig. 1 the track 45 has the configuration of a figure 8, one track 45 being provided for the extensions projecting from opposite ends of the members 34 and 35 in the piston 30. To more clearly define the contour of the track 45 we can assume that the track begins at one end of the member 12 at the bottom thereof. The track 45 then proceeds upwardly and forwardly in the cylinder surface 31 until the track has traveled halfway around the cylinder at which time it will be halfway forward of the full length of the track. The track then proceeds downwardly around the surface of the cylinder and forwardly until it again passes halfway around the cylinder, at which time the track will then be at the opposite end of the member 12 and will have made one complete revolution of the cylinder 31. The return path of the track 45 is made in a like manner so that the complete path of travel therefore forms a figure 8 that is an endless path from one end of the cylinder to the other, and in traveling the length of the cylinder 31 from one end to the opposite end and back again the path has made two revolutions of the cylinder.

It will therefore become apparent that when the piston 30 is moved axially in a leftward direction in the member 12, as shown in Fig. 1, the extensions 36 and 41 provided on the cylindrical member 32 will traverse the track 45 and cause the member 12 to make one complete revolution when the piston 30 traverses the member 12 through one stroke of the piston 17 as produced by an explosion of gas within the cylinder 15. In making the power stroke just mentioned the piston 17a in the cylinder 15a will compress the gas within the cylinder 15a so that the subsequent explosion of the gas within the cylinder 15a will produce a power stroke of the piston 17a and return the piston 15 to its initial position as shown in Fig. 1, and thereby produce a second revolution of the rotatable member 12. Therefore the member 12 will make two revolutions for each complete stroke of the pistons 17 and 17a, the complete stroke including both upstroke and downstroke.

As heretofore mentioned the engine disclosed in Fig. 1 is a four-cycle engine and since the operation of such engines are well-known, it is not believed necessary to go into the detailed functions of the operation of such an engine. Each of the power units 10 consist of a pair of pistons 17 and 17a and are disposed around the drive shaft 11 so that the axes of the cylinders 15 and 15a are parallel with the drive shaft 11. By properly timing the explosion cycle in each of the power units 10 it will be readily apparent that the arrangement of the cylinders shown in Figs. 1 and 2 will produce a gasoline engine of an eight-cylinder type. It is not necessary however to have the drive shaft 11 parallel with the axes of the cylinders 15. This drive shaft may be disposed of any other suitable angle with respect to the power units 10 and be suitably geared to the gears 13 provided on the rotatable members 12.

As previously mentioned the member 32 is rotatable within the piston 30, and the reason for this now becomes apparent because the member 32 is required to rotate within the piston 30 to permit the extensions 36 and 41 to follow the contour of the track 45, the orbit of the member 32 being constantly changed during the travel of

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the piston 30 from one end to the other of the cylinder 31. Also, it now becomes apparent that the members 34 and 35 must rotate on their axes because of the contour of the track 45 at the ends of the cylinder 31, this contour being the rounded end of the figure 8. To permit the parallel side walls of the extensions 36 and 41 to follow and engage the side walls of the track when in the end sections thereof, the members 34 and 35 must rotate relative to one another. However, there is a danger of the members 34 and 35 having a tendency to separate and follow different tracks when they pass over a track crossing which is shown in Fig. 6. In this instance the tooth 44 retains its meshing relationship between the teeth 39 and 40 on the extension 36 so that when the members pass over the track crossing there will be no tendency for them to split the crossing and thereby result in damage to the apparatus.

In Fig. 7 there is shown a development of the track 45 wherein the complete length of the track is laid out in a plane and the relation of the track portions to a complete explosion cycle is set forth to indicate the revolutions of the member 12 with regard to the portions of the complete explosion cycle. Considering the piston 30 to be at one end of the member 12 the extensions 36 and 41 engage the track 45 at the section indicated with the letter A. One complete explosion cycle of a four-cycle engine, of course, includes two complete strokes of the piston for each of the cylinders. Therefore, the length of the graph shown in Fig. 7 represents one complete explosion cycle which includes explosion, exhaust, intake and compression. The explosion stroke of the complete cycle will drive the piston 30 to the opposite end of the member 12 as seen in Fig. 1 and thereby cause the member 12 to rotate one complete revolution. This path of travel is represented by the portion B of the track 45. The return stroke of the piston 17 during the exhaust stroke will produce a second revolution of the member 12 as represented by the section C of the track 45. The sections D and E merely repeat the revolutions of the member 12 during the remaining intake and compression strokes of the four-cycle operation. It may thus be seen in one complete explosion stroke of the engine disclosed in Fig. 1 the member 12 makes four complete revolutions so that there is a two to one ratio between the number of revolutions of the member 12 and the stroke of the pistons. The cam track 45a is like the track 45 but is displaced 180° on the cylinder from the track 45 to receive the extensions on the opposite end of the members 34 and 35.

In Fig. 8 there is shown a chart representing the development of the track in the rotatable member 12 when the member 12 is given one revolution for each complete stroke of the piston, that is two revolutions per complete explosion cycle. In this arrangement the track 46 for the rotatable member 12 is arranged so that the end portion H represents the beginning end of the stroke. To complete one revolution of the member 12 for a single complete stroke of the piston, the piston must make a complete down and up stroke so that the portion J of the track 46 represents the complete bottom of the stroke of the piston and is only displaced 180° from the starting point of the track. Therefore the complete track from the starting point H to the completion point K represents 360° or one revolution of the member 12 for a complete stroke of the piston.

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The track 47 is provided for receiving the opposite end of the drive member in the same manner as heretofore described but is displaced 180° from the track 46. It is thus apparent that by changing the pitch of the track that any number of revolutions of the member 12 can be produced for each complete stroke of the piston of the engine.

The term "sinusoidal" as used in this application, is not to be construed as limited strictly to a sine curve, but is intended to include all curves having the general shape and contour of a sine curve whether or not they conform strictly to the equation $y = \sin x$.

While the apparatus disclosed and described herein constitutes a preferred form yet it is to be understood that the apparatus is capable of substantial alteration without departing from the spirit of the invention, and that modifications that fall within the scope of the appended claims are intended to be included herein.

Having thus fully described my invention what I claim as new and desire to secure by Letters Patent is:

1. An internal combustion engine having a cylinder and a piston therein for reciprocation in said cylinder, said engine being characterized by a mechanism for transforming reciprocatory motion into rotary motion consisting of a rotatable cam cylinder, a piston cam follower reciprocable within said cam cylinder and driven by the piston of the motor, endless track means on said rotatable cam cylinder that spirals from one end to the other and returns to close upon itself, and drive means extending from said follower piston in said rotatable cam cylinder and engaging said track to produce rotation of said cam cylinder upon reciprocation of said follower piston therein, said drive means comprising a rotatable member carried by said follower piston, and interengaging relatively rotatable parts extending from said last mentioned rotatable member for engaging said track.

2. An internal combustion engine having a cylinder and a piston therein for reciprocation in said cylinder, said engine being characterized by a mechanism for transforming reciprocatory motion into rotary motion consisting of a rotatable cam cylinder, a piston cam follower reciprocable within said cam cylinder and driven by the piston of the motor, endless track means on said cam cylinder that spirals from one end to the other and returns to close upon itself, and drive means extending from said follower piston in said rotatable cam cylinder engaging said track to produce rotation of said cam cylinder upon reciprocation of said follower piston therein, said drive means comprising a rotatable member carried by said follower piston for following the angular changes of said track, and a pair of rotatable members disposed within said last mentioned rotatable member for engaging said track, said pair of rotatable members having means for limiting rotation of said pair of members and for retaining the same in a predetermined aligned relation.

3. A two-cycle internal combustion engine including at least a pair of cylinders arranged in axial alignment and having pistons reciprocable therein, connecting rod means interconnecting said pistons whereby they reciprocate in unison, a cam follower carried by said connecting rod means, driven rotatable cam means associated with said follower and having an endless track thereon that spirals from one end to the other of the cam means and returns to close upon itself,

and means extending from said follower into engagement with said track for rotating said cam means upon reciprocation of said follower, said means comprising a pair of cylindrical members having parallel axes and having their ends projecting from said follower to engage said track means, and connections constraining said members to equal and opposite rotations on their said axes whereby said cam means receives a substantially continuous power impulse from said cylinders.

4. In an engine, a cylinder, a piston reciprocable in said cylinder, a piston rod attached to said piston at one end and having its other end extending exteriorly of said cylinder, a cam member rotatable on an axis coincident with the axis of said rod and having an endless sinusoidal guide means coaxial with said axis, a cam follower carried by said rod and slidably engaging said cam member, said follower comprising a pair of cylindrical members rotatable in said rod on spaced parallel axes normal to said rod, each cylindrical member having an end formed to slidably engage said guide means, means connecting said cylindrical members for equal and opposite oscillation relatively to said rod, and means limiting said rod to reciprocation only.

5. In an engine comprising a power cylinder, a piston reciprocable in said cylinder and a rod attached at one end to said piston with its other end extending exteriorly of said cylinder, a flywheel member mounted for rotation on an axis coincident with the axis of said rod, said member having an interior endless sinusoidal guide channel co-axial with said axis, a first cylindrical member carried by said rod for rotation on a second axis normal to said rod and having spaced bores parallel to said second axis, drive members rotatably mounted in said bores, respectively, and having their ends slidably engaging said channel, means connecting said members for equal and opposite oscillation, and means limiting said rod to reciprocation only.

6. In an engine, a power cylinder, a piston reciprocably fitting said cylinder, a piston rod attached at one end to said piston and having its other end extending from said cylinder, a flywheel member mounted for rotation upon a first axis coincident with the axis of said rod, said member being formed to have an interior, sinusoidal endless track extending co-axially with said axis, a cylindrical member carried by said rod for rotation on a second axis normal to said first axis, there being spaced bores in said cylindrical member parallel to said second axis, drive members rotatably fitting said bores, each member having an end slidably engaging said track, means connecting said members for opposite oscillation in said bores, and means preventing rotation of said piston rod.

7. In an engine having a power cylinder, a piston reciprocably fitting said cylinder, a piston rod connected to said piston and having one end

projecting from said cylinder, means limiting said rod to reciprocation only, a flywheel member rotatable on a first axis coincident with the axis of said rod, said flywheel being formed with an interior, endless, sinusoidal guide channel co-axial of said first axis, drive members carried by said rod for oscillation on spaced parallel second and third axes normal to said first axis, said drive members having flattened end portions slidably fitting said channel, and means connecting said members for simultaneous oscillation in opposite directions of rotation.

8. In an engine having a power cylinder, a piston reciprocably fitting said cylinder, a piston rod connected to said piston, means limiting said rod to reciprocation only with respect to said cylinder, a flywheel member journaled upon a first axis coincident with the axis of said rod, there being an endless sinusoidal guide channel in said member extending co-axially about said first axis, a cylindrical member carried by said rod for rotation upon a second axis normal to said first axis, there being spaced bores in said cylindrical member offset from and parallel to said second axis, drive members, each journaled in a respective bore, each member having at least one end flattened to slidably fit said channel, said drive members being interconnected for equal and opposite oscillation within their respective bores.

9. In an engine, a power cylinder, a piston reciprocably mounted within said cylinder, a piston rod having a first axis and connected to said piston, a member having an interior endless cam channel of generally sinusoidal form and extending co-axially about the axis of said rod, means mounting said cylinder and member for relative rotation about said axis, a cylindrical member carried by said rod for rotation about a second axis normal to said first axis, a pair of drive members journaled in said cylindrical member on parallel axes spaced from said second axes, said drive members having flattened portions slidably fitting said cam channel, and means connecting said drive members for equal and opposite oscillation with respect to said shaft.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
773,021	Lewis	Oct. 25, 1904
1,076,807	Anderson	Oct. 28, 1913
1,813,259	Schick	July 7, 1931
1,814,333	Parker	July 14, 1931
2,041,319	Blamgren	May 19, 1936

FOREIGN PATENTS

Number	Country	Date
316,923	Germany	1919