

# United States Patent

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[54] **OSCILLATING INTERNAL COMBUSTION ENGINE**  
9 Claims, 16 Drawing Figs.

[52] U.S. Cl..... **123/18,**  
74/52, 91/339

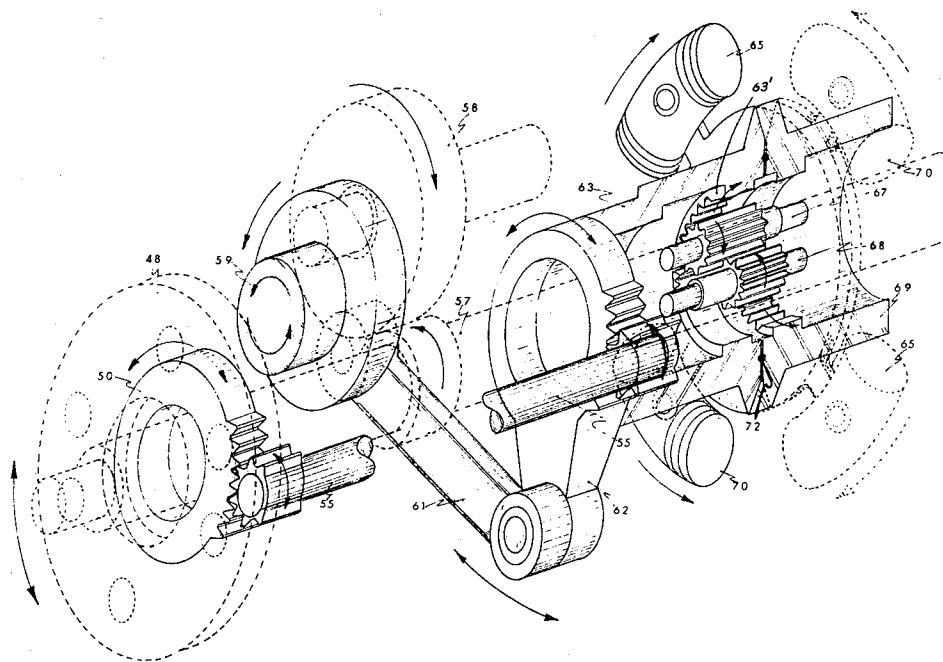
[51] Int. Cl..... **F02b 53/00**

[50] Field of Search..... 123/18, 18  
(A); 91/339; 92/67; 230/159; 74/52

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**ABSTRACT:** The invention hereinafter disclosed is a power unit which includes an internal or external combustion engine having an annular cylinder, arcuate pistons which oscillate in that cylinder and improved mechanism for translating the power developed in the engine to a shaft to be driven. The engine may be supplied with fuel either by injection or carburetion or by steam or fluid or gas under pressure and the arrangement is such that vibrations due to explosions of the fuel mixture or of power strokes are minimized and the output shaft is powerfully driven at uniform speed.



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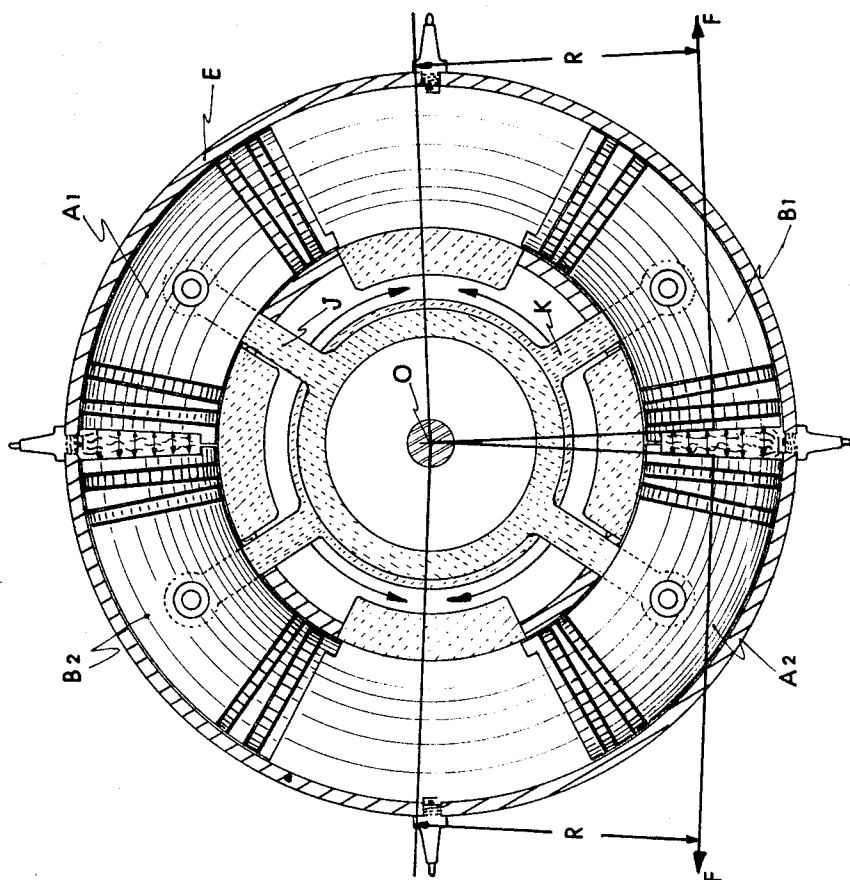


FIG. 2

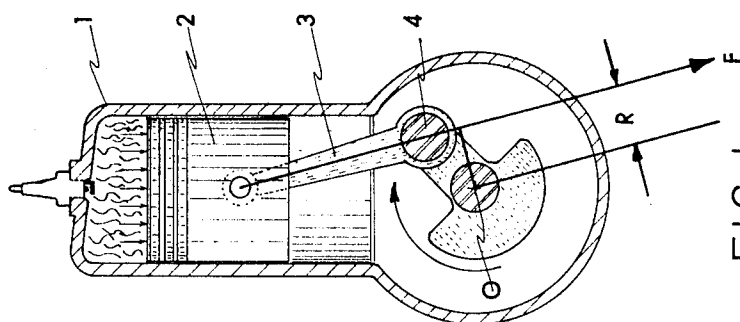


FIG. 1

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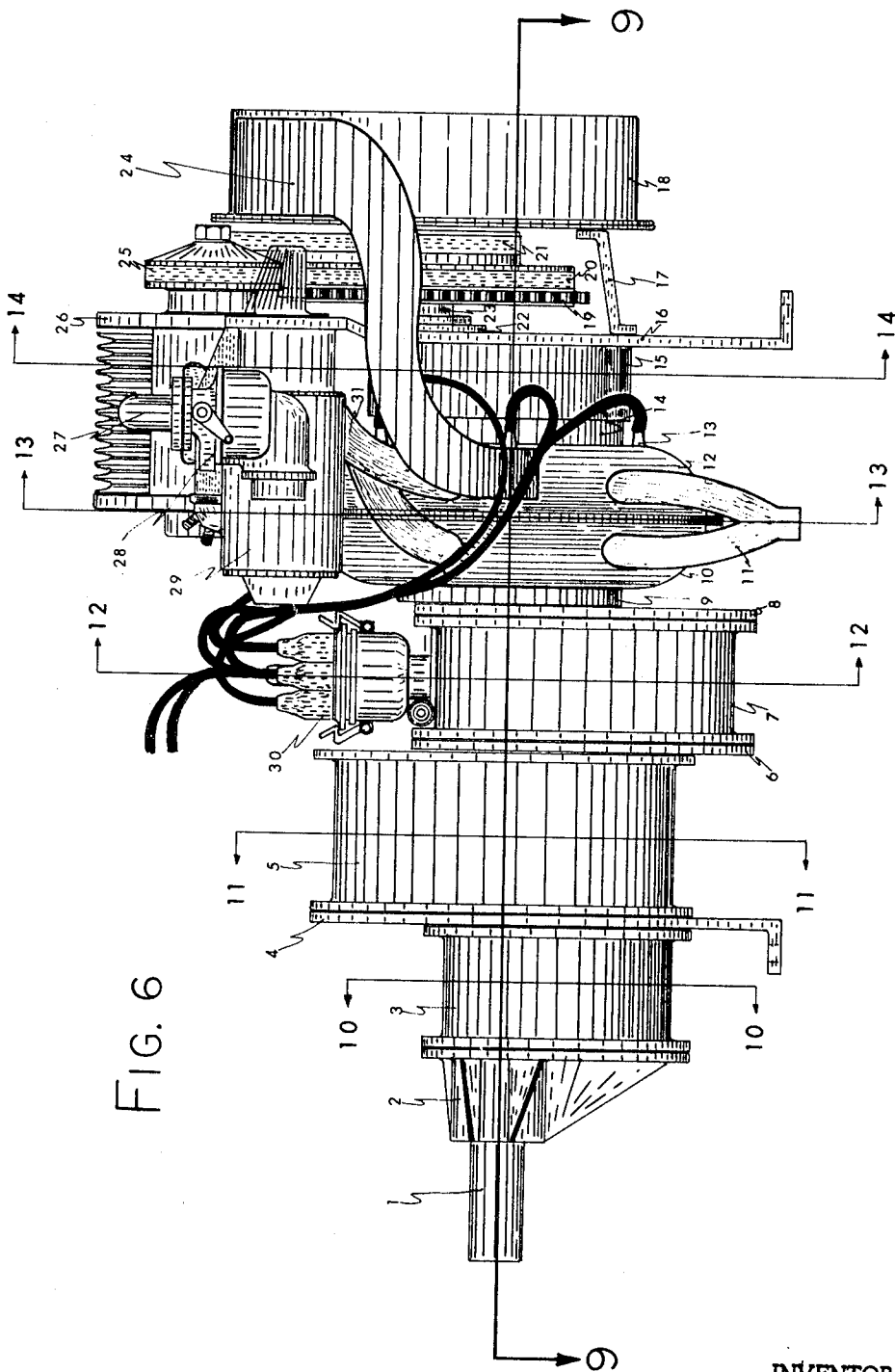
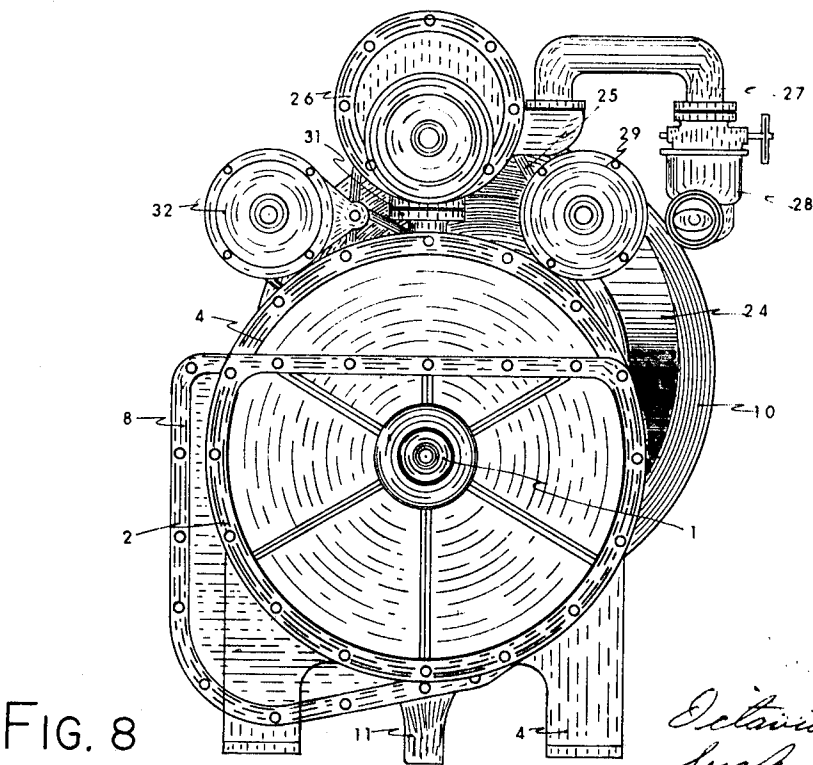
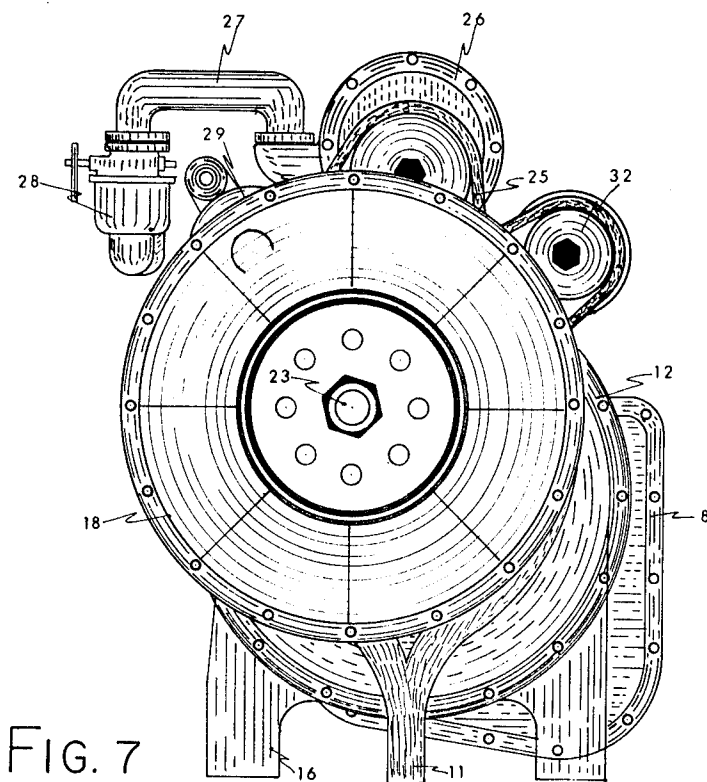


FIG. 6

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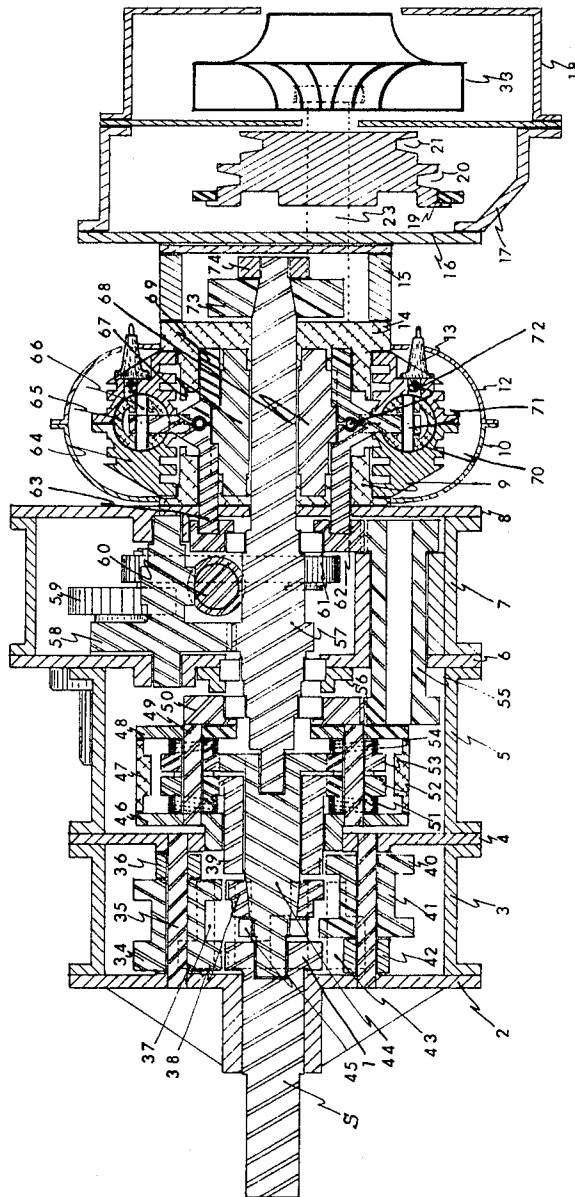


FIG. 9

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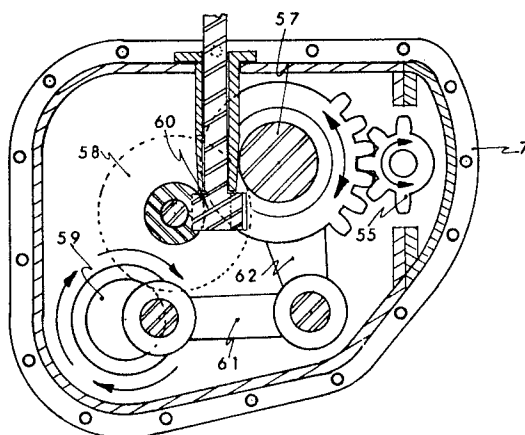


FIG. 12

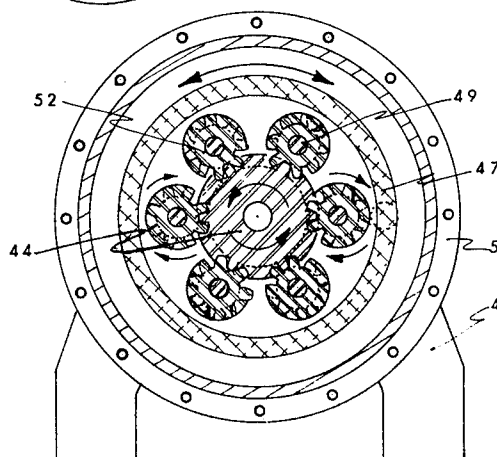


FIG. 11

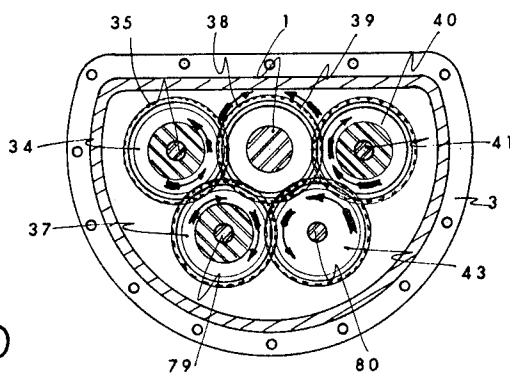


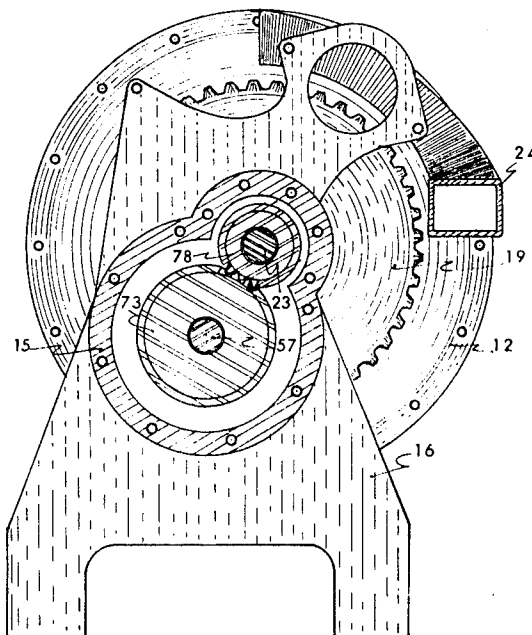
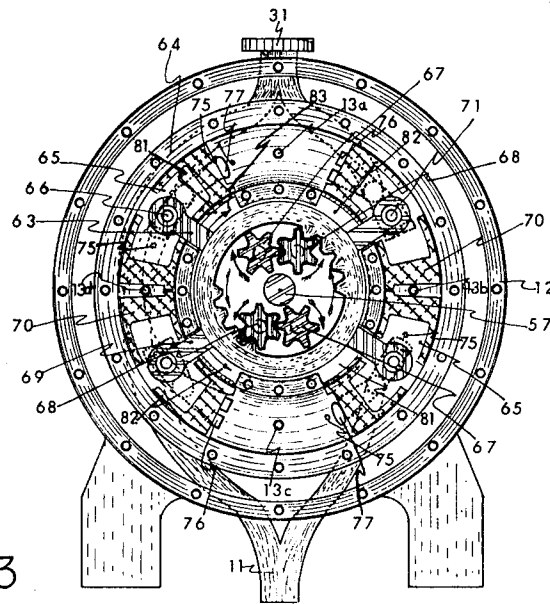
FIG. 10

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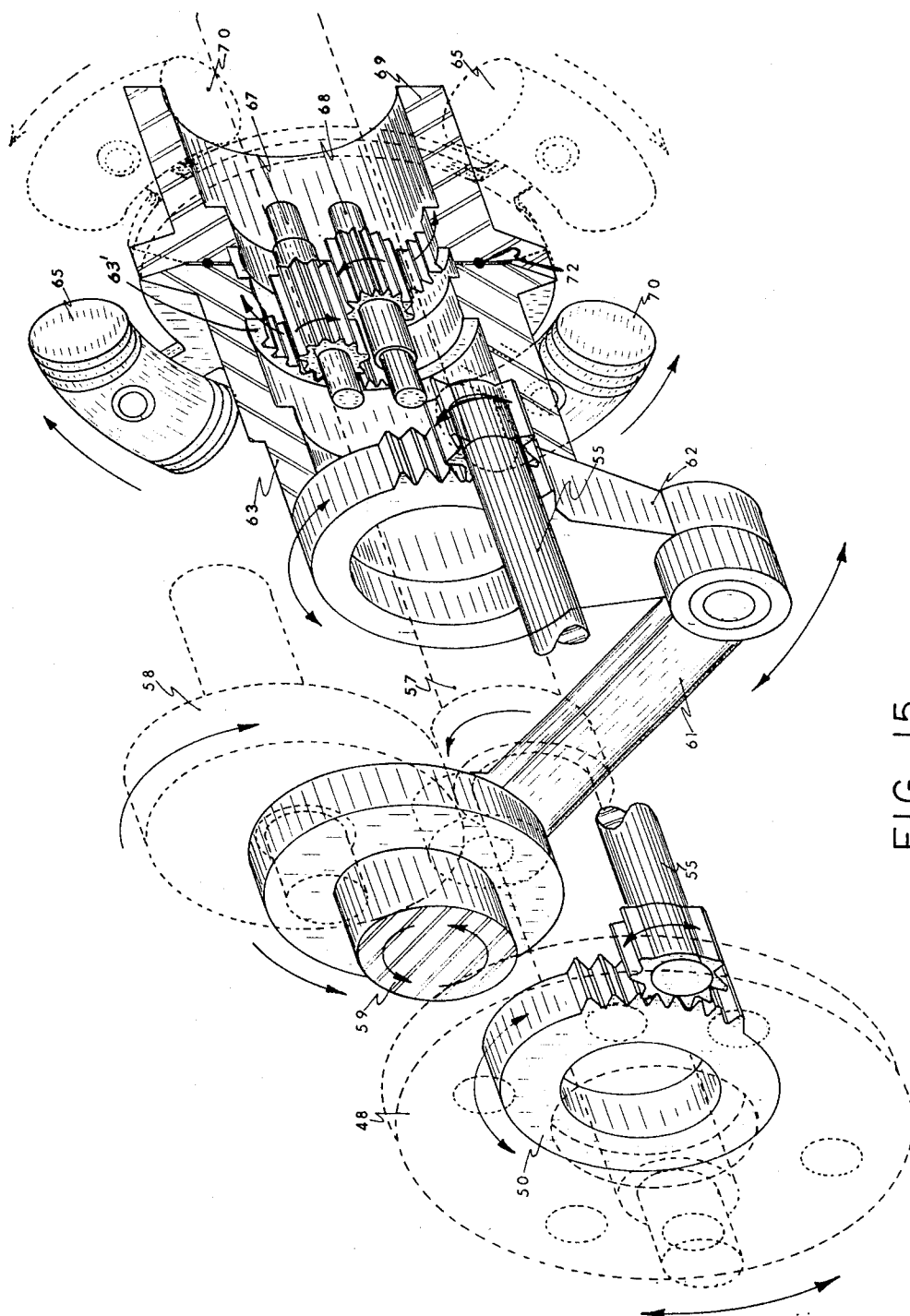


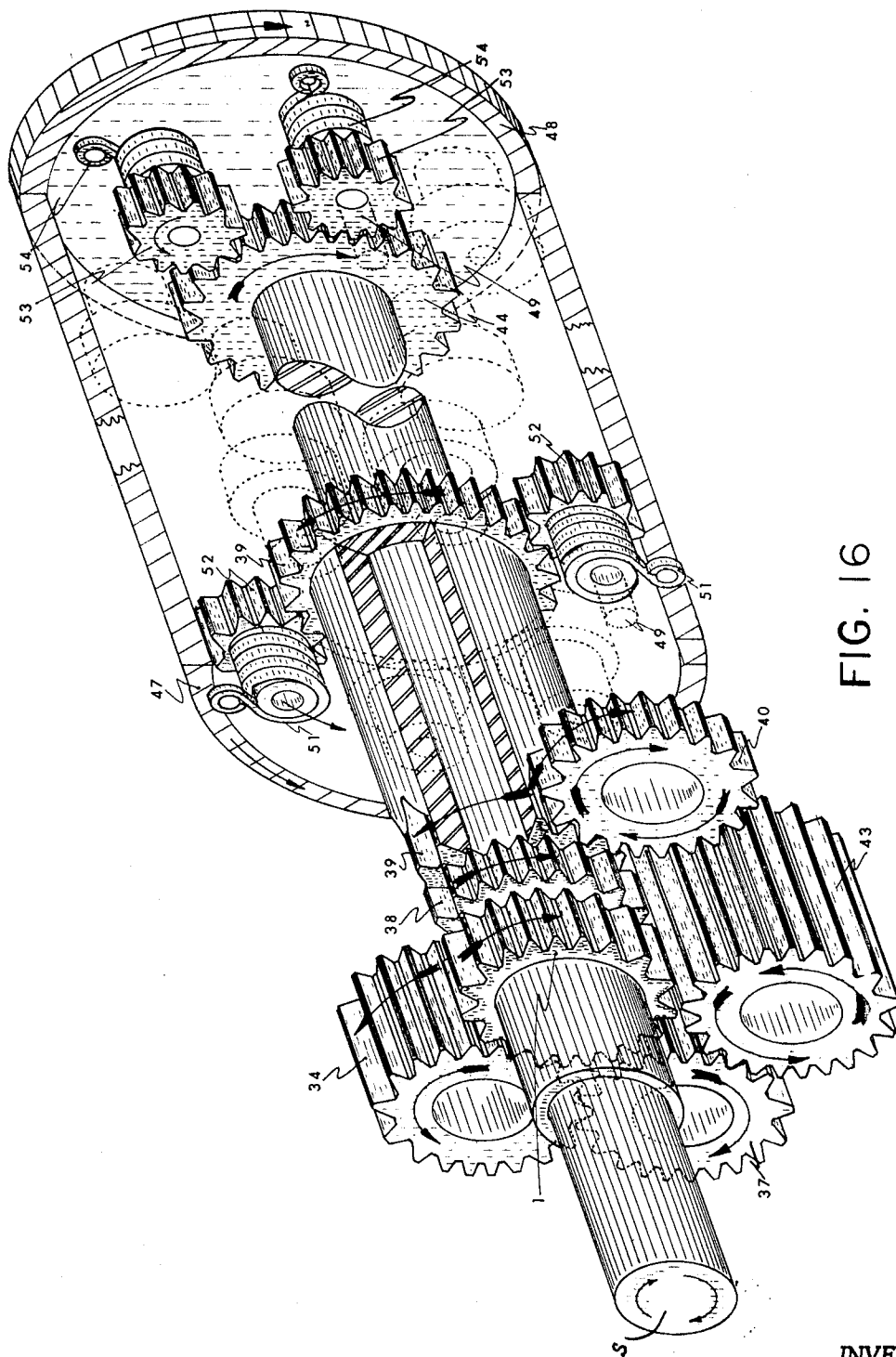
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## OSCILLATING INTERNAL COMBUSTION ENGINE

The object of this invention is to obtain high torque generation of power in an internal or external combustion engine, or air, gas or hydraulic motor and to transmit this power in a highly efficient manner to an output shaft.

It is also a purpose of this invention to accomplish the above objective by means of a machine which includes three basic mechanical systems, each one performing its own specific function, these mechanisms being interlinked to form a unit which performs in a superior manner.

The three aforementioned mechanical systems of this engine are:

- a. The improved and highly efficient power and torque generation system.
- b. The highly reliable and precise synchronizing mechanism.
- c. The highly efficient power- and torque-transmitting system.

Another purpose of this invention is to provide a mechanism which includes a cylinder, or several cylinders disposed in operative relationship about a common centrally located shaft, each cylinder being of circular shape, and of either circular, elliptical, rectangular or of other suitable cross section, the pistons being correspondingly shaped so as to fit closely within the cylinder or cylinders, the pistons being constrained to move in arcuate paths while the engine generates high torque.

It is also a purpose of this invention to provide a cylinder of such character that it can accomplish its objective without utilizing circumferential grooves and rings for sealing.

Another purpose of this invention is to provide a mechanism of the class described in which double-acting oscillating pistons are properly synchronized and their power duly integrated.

Another object is to provide means to secure pistons in groups in such manner that, while the pistons of one group have a fixed relationship with each other at all times, each group of pistons can move relatively to the other.

It is also a purpose of this invention to provide means to insure that the pistons of each set of pistons move, when activated, in opposite directions from a fixed point in the cylinder, at equal speeds and duly synchronized, each piston of each set always being displaced the same distance from that fixed point.

Because of the arrangement described in the preceding paragraphs, a practically vibration-free machine operation is realized.

Another purpose is to provide means for transmitting and for converting arcuate oscillatory motion of the pistons of the engine into unidirectional rotational motion of the output shaft, this output shaft being disposed axially of the circular cylinder or in any other convenient position relatively thereto.

Another purpose is to provide an auxiliary shaft located at that end of the machine which is remote from the end at which the output shaft is located. This auxiliary shaft, which is rotated by power taken from the synchronizing mechanism, can be used for driving all accessory equipment such as fan, water pump, oil pump, supercharger and any desired optional equipment.

Another purpose is to provide a machine that will render high output torque and power at reasonable speeds, with high power-to-weight ratio, and with high efficiency.

Additional objectives will become apparent as the invention is described in detail. In the description, reference will be made only to a machine working with one circular cylinder, four pistons (two per each set), circularly oscillating and reciprocating double acting pistons, spark-ignition, two stroke cycle arrangement, with scavenging pump scavenging only with air, direct fuel injection at low pressure into the working chambers. However, as previously mentioned, the machine may embody a number of circular cylinders with associated pistons connected, or adapted to be connected, in series relationship.

Machines embodying the novel features of this invention can be made to work in a number of different ways, for instance scavenging may be by combustible mixture, the ignition may be by spark-ignition or diesel four-stroke or two-stroke cycles, and steam, air or any fluid or gas under pressure, properly valved, may be employed.

In the accompanying drawings one embodiment of the invention is disclosed:

FIG. 1 is a schematic drawing showing the way in which the force generated by the pressure of combustion in the cylinder of an engine of conventional design generates torque.

FIG. 2 is a schematic drawing showing how torque is generated in an engine which embodies certain novel features of this invention.

FIGS. 3, 4 and 5 show schematically the sequence of events taking place in an engine embodying the novel features of this invention, working on two-stroke cycle, air-scavenged, with direct injection of fuel at low pressure, and with spark ignition.

FIG. 6 is a side view of a complete engine or power plant which includes the novel features of the invention.

FIG. 7 is a front view of the same engine.

FIG. 8 is a rear view of the engine.

FIG. 9 is a longitudinal sectional view taken on line 9-9, of FIG. 6.

FIG. 10 is a cross-sectional view taken on line 10-10, of FIG. 6.

FIG. 11 is a cross-sectional view taken on line 11-11, of FIG. 6.

FIG. 12 is a cross-sectional view taken on line 12-12, of FIG. 6.

FIG. 13 is a cross-sectional view taken on line 13-13, of FIG. 6.

FIG. 14 is a cross-sectional view taken on line 14-14, of FIG. 6.

FIG. 15 is a perspective view of the inner mechanical elements that appear in sections in FIGS. 12, 13 and 14.

FIG. 16 is a perspective view of the inner mechanical elements that appear in FIGS. 10 and 11.

FIGS. 1 and 2 are intended to illustrate in a general way how an engine constructed in accordance with the present invention is able to generate a higher torque than a conventional engine of similar basic dimensions.

In FIG. 1, a cylinder 1 is illustrated, within which cylinder a piston 2 moves down during a power stroke. This piston transmits the force, which is a component of the force generated by the gases of combustion, through connecting rod 3, to crankshaft 4. In a given position, such as the one shown, the torque generated is the equivalent of the product of the force component F along the connecting rod 3 by the radius R from the center of rotation 0.

Within circular cylinder E of FIG. 2 two sets of pistons oscillate circularly. The diametrically opposed pistons A1 and A2 are rigidly fastened to member J, and the other set of pistons B1 and B2 are rigidly secured to member K. It can be appreciated that in FIG. 2, the product of  $F \times R$  will be several times greater than in FIG. 1, since F can be assumed to be the same in both cases, but R is physically several times larger in FIG. 2 than in FIG. 1, even though the diameters of the pistons are the same. Thus it is clearly established that the higher capability of torque generation is obtained by the disposition of mechanical elements as illustrated in FIG. 2.

In the schematic drawings, FIGS. 3, 4 and 5, the manner in which an engine embodying the characteristics of this invention functions, when in use, is disclosed.

As shown in FIG. 3, circular tubular cylinder E is provided with intake ports D1, D2, D3 and D4; also exhaust ports C1, C2, C3 and C4. Fuel-injection nozzles are indicated at I-1, I-2, I-3 and I-4; and spark-plugs at G1, G2, G3 and G4; also slots H1, H2, H3 and H4. Inside the cylinder are two sets of pistons each set comprising two pistons. One set of pistons comprising pistons A1 and A2, rigidly connected to member J and the other set comprising pistons B1 and B2, rigidly connected to member K. The center of oscillation 0 is the center of cylinder E and members J and K oscillate about this center.

Referring to the position of these mechanical elements as shown schematically in FIG. 3: between pistons B2 and A1, and between pistons B1 and A2, chambers F1 and F3, respectively, are formed in each of which is a combustible mixture ready to be ignited by a spark plug such as indicated at G1 and G3. Between pistons A1 and B1, and A2 and B2 chambers F2 and F4 respectively are formed, in which scavenging by fresh air is taking place. This scavenging is accomplished by air under pressure, from a scavenging pump of satisfactory type, the air coming into the cylinder through intake ports D2 and D4, and coming out, pushing the remaining burnt gases, through exhaust ports C2 and C4. Assuming that at this moment spark plugs G1 and G3 ignite the compressed combustible mixture in chambers F1 and F3 then, due to the igniting of the mixtures as explained in the previous paragraph, expansion of gases starts to take place in these chambers F1 and F3.

Referring now to FIG. 4, the same basic mechanical elements are shown an instant after ignition took place in chambers F1 and F3. Due to the force generated by the gases expanding in chambers F1 and F3 the set of pistons B2 and B1 are propelled in a counterclockwise direction to a position as shown in FIG. 4. Meanwhile, simultaneously set of pistons A1 and A2 has been propelled by an equal force but in the opposite direction, at the same speed and distance but in clockwise direction to the position shown in FIG. 4.

In FIG. 4, in chambers F1 and F3 expansion of gases is still taking place, since exhaust ports C1 and C3 have not yet been opened by pistons A1 and A2 respectively. Thus a power impulse is taking place by the effect of force generated by the pressure of the gases of combustion acting upon the working area of four pistons. The means by which the power of these two sets of pistons is combined or integrated will be hereinafter described in detail.

Still referring to FIG. 4, in chambers F2 and F4 compression of combustible mixture is occurring, since an instant after the two sets of pistons were projected in opposite directions when ignition took place as shown in FIG. 3, pistons B1 and B2 closed intake ports D2 and D4 respectively. An instant later pistons A1 and A2 closed exhaust ports C2 and C4 respectively, thus forming chambers F2 and F4, duly charged with fresh air from scavenging. Then an instant later, fuel-injection nozzles I-2 and I-4 delivered, at low pressure, properly measured amounts of fuel into said chambers F2 and F4, thus forming inside of each of said chambers a combustible mixture, which is being compressed by pistons A1 and B1, and pistons A2 and B2, as shown in FIG. 4.

FIG. 5 represents schematically the basic mechanical elements an instant later. Expansion of gases has ended in former chambers F1 and F3 since pistons A1 and A2 have uncovered exhaust ports C1 and C3 respectively, thus allowing burnt gases to start to escape.

It is of interest to note that an instant after exhaust ports C1 and C3 were uncovered, intake ports D1 and D3 were also uncovered by pistons B1 and B2 respectively, thus scavenging is taking place now in those sections which formerly when chambers F1 and F3. Also as shown in FIG. 5, the combustible mixture contained in chambers F2 and F4 as explained in connection with FIG. 4, has been already compressed to its highest degree, thus being ready to be ignited by spark plugs G2 and G4.

At this very moment, spark plugs G2 and G4 ignite compressed combustible mixture contained in chambers F2 and F4, causing the expansion of gases of combustion within said chambers. The expansion of said gases will cause a similar sequence of events in chambers F2 and F4 by set of pistons A1 and A2, and set of pistons B1 and B2 as that explained in describing the functioning of the engine with reference to FIG. 3, when the compressed combustible mixtures in chambers F1 and F3 were ignited, so that the two sets of pistons are projected in opposite directions as shown by the arrows in FIG. 5. In the same manner, in former chambers F1 and F3 will occur a sequence of events similar to that explained in reference to FIG. 3 for those sections which instants later formed chambers F2 and F4.

It can readily be understood from the above explanation that an uninterrupted sequence of events follow in the order recited so that a two-stroke, air-scavenged, direct fuel-injection at low pressure engine will be rapidly functioning. Because the moving parts are balanced, vibration of the engine is very largely eliminated. An air cooled engine of a two-stroke, air-scavenging, low pressure direct-fuel-injection type, may also be constructed and which embodies the same basic principle of operation.

It will be observed that in the drawings of this engine a carburetor has also been shown, this for the reason that this same design could function satisfactorily either by accomplishing the scavenging of the cylinders by introducing a mixture supplied by the carburetor and with the air of the scavenging pump, or by air from the scavenging pump and with direct fuel-injection. In the drawings the fuel-injection system has been omitted, since it is a standard accessory system which can easily be incorporated in the engine. Likewise any suitable ignition system may be employed.

It will now be explained how the engine can be started; then how it can be kept in operation; and finally how the power developed is transmitted to a member to be driven.

When the starting motor 29, (FIGS. 6 and 7) is activated it engages flywheel crown gear 19, (FIGS. 6, 9 and 14) turning it. The crown gear will in turn rotate its shaft 23 (FIGS. 6, 7, 9 and 14), which will rotate pulley 20, (FIGS. 6, 9), which through belt 25 (FIGS. 6, 7, 8), will power the scavenging pump 26 (FIGS. 6, 7, 8). As soon as the scavenging pump 26 is started, it supplies scavenging air under pressure which flows through intake manifold 31 (FIGS. 6, 8, 13) towards the cylinder chambers.

Also, shaft 23 rotates gear 78, (FIG. 14), which rotates gear 73 (FIGS. 9, 14), attached to shaft 57 (FIGS. 9, 12 and 15) which will rotate synchronizing crankshaft gear 59 (FIGS. 9, 12 and 15) thus rotating the synchronizing crankshaft 59 itself. Once the engine has started shaft 57 will be kept rotating, the engine providing the small amount of power needed. Rotation of shaft 57 will in turn rotate shaft 23 through gears 73 and 78 (FIG. 14). Shaft 23 will then drive all necessary accessory equipment, such as cooling fan, scavenging pump, generator, fuel-injection pump and so forth. Gear 58, through extended gear-teeth rotates distributor shaft gear 60 (FIGS. 12 and 13), thus actuating the distributor.

As synchronizing crankshaft 59 rotates, it imparts reciprocating motion to connecting rod 61 (FIGS. 9, 12 and 15), which in turn imparts circular oscillatory motion to arm 62, (FIGS. 12 and 15) which is rigidly attached to hollow cylindrical shaft 63, (FIGS. 9, 13 and 15) which is thus forced to oscillate circularly about a fixed axis.

This oscillating hollow shaft 63 through its extension arms shown in FIG. 9, 13 and 15 that enter the circular cylinder 64 through grooves 81 (FIG. 13), supports one set of pistons comprising two pistons 65, disposed 180° apart, as shown in FIGS. 9, 13 and 15. All pistons are of arcuate form and include at each end, in their section at the inner circumference, a small lip extension 83, (FIG. 13), for sealing overlap.

Hollow cylindrical shaft 63 has rigidly mounted thereon the member J (or extension arm, FIG. 15) to which pistons A' and A'' (or pistons 65, FIG. 15) are affixed and hollow shaft member 69 affixed thereto to member K or extension arm, FIG. 15 to which pistons B' and B'' (or pistons 70, FIG. 15) are secured, shafts 63 and 69 being supported for individual relative rotary movement about the axis of shaft 0 or 57. Shaft 63 has formed upon its inner surface two sets of gear teeth 63' (FIG. 15) diametrically opposed to each other as shown in FIG. 13, and hollow shaft 69 likewise is provided with two diametrically opposed sets of gear teeth, one of which is indicated at 69' (FIG. 15).

Two groups of gears are associated with these sets of gear teeth for the ultimate purpose of insuring that the relative movements of the two hollow shafts 63 and 69 and the pistons with which they are associated, move simultaneously, when the engine is in operation, through precisely predetermined

angles of rotation to insure that the pistons maintain at all times desired predetermined relationship to the inlet and exhaust ports and other elements of the engine. Each gear group includes two intermeshing gears 67 and 68 and these groups may be said to perform synchronizing functions. Gears 67 mesh with the teeth formed upon the inner face of hollow shaft 63, gears 68 mesh with the teeth formed upon the inner face of hollow shaft 69, and, as previously explained, the gears of each group are in constant mesh with each other.

It is thus clear that, for a given angular displacement of one set of pistons in one direction there occurs the same angular displacement, but in opposite direction, of the other set of pistons. The two sets of pistons will be kept in perfect synchronization, one with respect to the other, and both with respect to fixed points, which in this case can be fixed points located at the circular cylinder, such as: the spark plugs, intake and exhaust ports, and so forth. The stroke and the degree of approach between the two sets of pistons, which would determine the compression ratio, would depend upon the proportionality kept in a given design between the eccentricity of the synchronizing crankshaft, the length of the oscillatory arm and the gear ratio of the synchronizing gears.

Since it has been shown that two sets of pistons moving within a circular cylinder can reciprocate circularly following a perfectly predetermined and synchronized sequence, it is clear that such an engine will start as soon as the ignition system is activated, since it is following rigidly and forcibly a sequence of events such as explained when reference was being made to FIGS. 3, 4 and 5 during the description of the basic principle.

An engine thus in operation would be generating power at very high torque on a circularly oscillating shaft, this power being transmitted to the output shaft through a motion rectifier mechanism that will render rotary motion at a high degree of efficiency.

The manner in which power is conducted to a shaft to be driven and the specific mechanism employed will be described. As previously explained, when expansion of gases starts in any two opposite chambers formed inside the circular cylinder and between the two sets of pistons a power stroke begins by reason of the motion imparted to the two sets of pistons by the pressure of the gases. When an expansion is taking place (always in two opposite chambers) pistons 65 (FIG. 15), transmit power in the clockwise direction, while set of pistons 70 (FIG. 15), transmit power in the counterclockwise direction. This power of the two sets of pistons is integrated by means of gears 67 and 68 (FIGS. 15 and 13), and is transmitted still in circularly oscillatory motion to hollow shaft 63 (FIG. 15), as explained previously. Shaft 63 (FIG. 15), carries rigidly attached arm 62 (FIG. 15), which then oscillates circularly also. Oscillatory arm 62 (FIG. 15), has a gear sector, which meshes with one end of shaft 55 (FIGS. 9, 12 and 15), which then oscillates.

On the other end of shaft 55 is a gear which meshes with gear sector 50 forcing it to also oscillate circularly (FIGS. 9 and 15). This circularly oscillating gear sector 50 is rigidly attached to end plate 48 (FIGS. 9 and 15), which is part of the rectifier clutch housing.

This rectifier clutch housing includes end plate 48, cylindrical cover plate 47 (FIGS. 9, 11, 16), and by the other end plate 46 (FIG. 9) (in FIG. 16 it has been omitted for the sake of clarity). Since housing end plate 48 (FIGS. 9, 16), is being forced to oscillate circularly by gear sector 50 (FIGS. 9, 16), the whole housing also oscillates circularly.

To and between end plates 46 and 48 are rigidly fixed 6 small shafts 49 (FIGS. 9, 11, 16) equidistantly angularly spaced-apart around a common axis. These six shafts 49 serve to rotatably support sets of clutch gears 52 and 53, each set comprising six gears, (FIGS. 9, 11, 16). Each clutch gear is rotatable in one direction only by means of an attached spring clutch member 51, gears 52 being held against rotation when housing constituted by end plates 46 and 48, and cover 47 (FIGS. 9, 11, 16) moves in a counterclockwise direction, and

being released for rotation when the housing rotates in the opposite direction, while gears 53 operate in the reverse manner by reason of the reverse action of the clutches connected thereto. Each gear has as an extension an integral sleeve the surface of which is lightly engaged by the circular elements of a spiral spring of rectangular cross section. One end of each spring is fixed by suitable fastening means to its adjacent end plate.

A brief explanation of how these one-way clutches operate follows. Referring to FIG. 16, gears 53 are rotatably mounted on fixed shafts 49, which are attached to end plate 48. Sleeve-like axial extensions of gears 53 are encircled by closely fitting springs 54 which are helical in form. One end of each spring is attached to the adjacent end plate 48. When the housing, and by the same token end plate 48, oscillates in the direction shown by arrow on end plate 48, the springs 54 tighten on the sleeves of the gears 53, thus preventing these gears from rotating. In so doing, the stationary nonrotating gears then move gear 44 in the same direction as that in which end plate 48 is moving until movement in that direction ceases.

When the rotary movement of end plate 48 is reversed, the springs 54 loosen, thus liberating the sleeves of gears 53, allowing them to rotate about the axes of shafts 49. Thus gear 44 always has unidirectional rotational motion.

As end plate 48 moves on its return stroke, gears 53 will ride idly on gear 44, being duly meshed, since they freely rotate on shafts 49 because the clutch springs 54 have released them. This happens while the end plate 48 is oscillating in the direction opposite to that shown by the arrow on said end plate. Thus, the one-way motion effect is accomplished. In lieu of the spiral spring clutch illustrated other types of suitable one-way clutches may be employed. A second series of gears, each indicated by the reference numeral 52, mesh with gear 39, the sleeve-like extension of each such gear being rotatably mounted upon a short supporting shaft 49 affixed to the end plate 46. Clutch members 51, attached to end plate 46 encircle these sleeve-like extensions of gears 52, the clutches being so disposed, however, that they function in gripping and releasing the gear extensions about which they are disposed, reversely to the manner in which clutches 54 function i.e. they grip and hold gears 52 against rotation when the housing 47 rotates in a direction which is the reverse of the direction indicated by the arrow on end plate 48.

It is believed that the manner in which power is transferred to the driven shaft will be understood from the preceding description but this operation will be summarized.

If it be assumed that at a given stage the housing is moving in the direction shown by the arrow on end plate 48 (FIG. 16), the gears 52 rotate freely while in mesh with gear 39. Gears 53 will not rotate, being prevented from rotating by clutch members 54, and will thus cause, during such power impulse, gear 44 to rotate in the direction of the arrow shown. Gear 44 will transmit said motion and power through its shaft extension to gear 38 (FIGS. 9, 10, 16), to which it is rigidly attached. Gear 38 drives double gear 34 (FIGS. 9, 10, 16), in the direction shown by the arrows in FIG. 16. Gear 34 drives output shaft through gear 1 of said output shaft in the direction shown by the arrow on gear 1, thus transmitting fully to the output shaft the power coming from the two sets of pistons through the oscillating arm 62, during such power impulse. (FIG. 16). But gear 34 also drives gear 37, (FIGS. 9 (dotted), 10, 16) in the direction shown in FIG. 16. Gear 37 drives double gear 43 (FIGS. 9 (dotted), 10, 16) in the direction indicated by the arrow, in FIG. 16.

A. Gear 43 will then rotate gear 40 in the direction indicated by the arrow in FIG. 16, which will then turn gear 39, in the direction indicated by the arrow in FIG. 16, which, through its extension, will turn gears 52 which are free to rotate about shafts 49 in the direction in which gear 39 drives them. Gears 52 are dragged along, even while meshing with gear 39, in the direction shown by the arrow at end plate 48, since shafts 49 are rigidly attached to said end plate 48, since

shafts 49 are rigidly attached to said end plate. Thus, a power impulse is being delivered to the output shaft, when the housing is moving in the direction indicated by the arrow placed on end plate 48. This power impulse is being transmitted through gears 53, 44, 38, 34 and 1, while simultaneously constantly meshing gears 37, 43, 40, 39 and 52 become idlers due to the fact that gears 52 are at this stage free rotate about shafts 49.

When the housing rotates in the direction shown by the arrow on end plate 48 the output shaft 1 receives a power impulse causing it to rotate in the direction shown by the arrow on output shaft 1 in FIG. 16. When the housing has ended its oscillation, and thus a power impulse, in the direction indicated by the arrow on the end plate 48 (FIG. 16), it will begin to move in the opposite direction. Under these circumstances, gears 53 ride freely on gear 44, as explained previously.

However, gears 52, (FIGS. 9, 16) are nonrotatably bound to their shafts 49 (FIGS. 9, 16) by the action of clutch springs 51 (FIGS. 9, 16) thus positively rotating gear 39, (FIGS. 9, 10, 16) in the direction of arrow at section 47 of the housing cover. An arrow also shows the direction at which gear 39, FIG. 16, is being driven by the set of gear clutches 52, FIG. 16. Double gear extension 39 drives gear 40 in the direction indicated by the arrow in FIG. 16, which drives double gear 43 in the direction indicated by the arrow in FIG. 16, which in turn drives gear 37 in the direction shown by the arrow in FIG. 16.

Gear 37 will drive gear 34 in the direction shown by the arrow in FIG. 16, and gear 34 will finally drive gear 1 of the output shaft in the same direction as this output shaft was forced to rotate by the previous power impulse of the housing, even though this previous power impulse of the housing cam from an opposite direction of oscillation of said housing. B. It is relevant to note that while gears 37, 43, 40, 39 and 52 were idlers during the previous power impulse, they become power-transmitting gears as can be seen from the explanation in the previous paragraph.

However, while this power impulse is taking place, constantly meshing gears 38, 44 and 53 become the idlers, due to the fact that during this stage gears 53 are free to rotate about their shafts 49, even though they are in constant engagement with gear 44, and are being carried by shafts 49 in the direction indicated by the arrow which may be seen on the end 47 of housing, and thus not interfering with the transmission of power through gears 52, 39, 40, 43, 37 and 34 to the output shaft gear 1.

In the light of all the previous explanations, it is now clear that although the power and high torque generated by this engine are delivered initially to a shaft which oscillates circularly, this motion is transformed into unidirectional rotary motion with a high degree of efficiency, thus providing the rotating output shaft with high power at high torque.

It will be observed that the motion-rectifier-and-power-transmitting mechanism lends itself for an easy way to reverse the direction of rotation of the output shaft. In fact, referring to FIG. 16, if gear 40 is moved to mesh with gear 38 instead of gear 39, but still meshing with gear 43, and at the same time gear 34 is moved to mesh with gear 39 instead of meshing with gear 38, but still meshes with gears 1 and 37, the reversal of rotation of the output shaft is accomplished. For this, gear 34 would have a groove at the center and of such width and depth so as to not interfere with gear 38 when it is moved to mesh with gear 39.

We claim:

1. An oscillating piston engine comprising a cylinder, pistons in said cylinder movable toward and away from each other under the influence of explosive charges, or of gas or fluid pressure, a work shaft to be driven, and means operatively connecting the pistons and said shaft, said means including mechanism for insuring unvarying travel at a predetermined sequence of said pistons in their movements under the influence of exploding fuel charges said mechanism including two hollow cylindrical members, mounted for oscillatory

movements about a common axis and each having an arcuate series of gear engaging teeth affixed to its inner surface, and gearing engaging said arcuate series of teeth and insuring that said shaft members oscillate through equal angles of travel in opposite directions when the pistons are actuated by explosive charges, or pressure in general.

2. The combination set forth in claim 1 in which means is interposed between the engine and shaft to be driven, whereby oscillatory movement of the pistons effects continuous unidirectional movement of the work shaft, said means including two members mounted for oscillation about a common axis and spaced-apart axially on said axis, one such member being operatively connected to the pistons of the engine and the other through a housing, to the shaft to be driven, and means for operatively connecting said members whereby the oscillatory movement of one is communicated to the other, said means including a cylindrical gear secured to each oscillatory member and two intermeshing gears operatively connecting said cylindrical gears, whereby said oscillatory members are constrained to move angularly through identical angles of travel.

3. The combination set forth in claim 1 in which said pistons are operatively connected to two output shafts by means which maintains them in synchronism at all times.

4. The combination set forth in claim 1 in which said mechanism includes a housing and concentric shafts the housing being connected to the pistons of the engine for oscillatory movement, and means interposed between said housing and shafts for converting the oscillatory movement of the housing into unidirectional rotary motion of the shafts.

5. In an oscillating piston engine, in combination, an engine cylinder of circular type (64), a power output shaft (S), opposed pistons in said cylinder arranged to be propelled in opposite directions by exploding charges (65, 70) and mechanism connecting each such piston to said power output shaft for rotating said shaft in one direction of rotation, said mechanism including a housing (47) and concentric shafts (44 and 39), the housing (47) being connected to the pistons (65 and 70) for oscillatory movement (50, 55, 63), and means interposed between said housing and said shafts (52, 39, 53, 44) for converting the oscillatory movement of the housing into unidirectional rotary motion of the inner shafts.

6. In an oscillating piston engine, in combination, an engine cylinder of circular type (64), a power output shaft (S), opposed pistons in said cylinder arranged to be propelled in opposite directions by exploding charges (65, 70) and mechanism connecting each such piston to said power output shaft for rotating said shaft in one direction of rotation, said mechanism including an oscillating housing (47) operatively connected to the oscillating pistons (65 and 70), said housing sets of gears (52 and 53) against rotation in one direction while permitting free rotation in the opposite direction, one set of gears being free to rotate in one direction during oscillation of the housing in one direction, the other set being free to rotate about their axes when the housing oscillates in the opposite direction, and two concentric shafts (44 and 3a) each set of gears being operatively connected to one of the two concentric shafts within the housing to effect the rotation thereof, whereby said shafts are driven in opposite directions about their common axis.

7. In an oscillating piston engine, in combination, an engine cylinder of circular type (64), a power output shaft (S), opposed pistons in said cylinder arranged to be propelled in opposite directions by exploding charges (65, 70) and mechanism connecting each such piston to said power output shaft for rotating said shaft in one direction of rotation, said mechanism including coaxial shafts, means for driving said shafts, in opposite directions, and gearing (38, 39, 40, 43, 37, 34) connecting said shafts to the output shaft whereby the output shaft is driven in one direction of rotation by power derived from the engine.

8. In an oscillating piston engine in combination, an engine cylinder of circular type, opposed pistons in said cylinder ar-

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ranged to be driven in opposite directions by exploding charges (65, 70), a shaft to be driven (59), two members mounted for oscillation about a fixed axis (63, 69) each such member being rigidly connected to a piston, means operatively connecting said members for integrating the power delivered by said pistons and insuring that the angular travel thereof, on their working strokes is invariable (67, 68), and means operatively and permanently connecting one of said oscillating members to the shaft to be driven whereby the oscillatory motion of said member effects rotation of said shaft

in one direction (61, 62).

9. The combination set forth in claim 8 in which said last-mentioned means comprises a link (61) connecting one of said oscillating members to the driven shaft, one end of the link being pivotally connected to the oscillating member at a point remote from the axis of oscillation and the other end pivotally connected to the shaft at a point offset from the axis of rotation of said shaft.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,580,228 Dated May 25, 1971

Inventor(s) OCTAVIO ROCHA and SERAFIN CANO

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The address of one of the joint inventors, Octavio Rocha, as set forth in the heading of the patent, should be:

AVE. TECNOLOGICO SUR No. 600  
MONTERREY, N. L., MEXICO

Signed and sealed this 16th day of November 1971.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

ROBERT GOTTSCHALK  
Acting Commissioner of Patents