July 31, 1945. J. M. MURDOCK 2,380,778

INTERNAL-COMBUSTION ENGINE

Filed March 13, 1944. 2 Sheets-Sheet 1

Fig. 2.

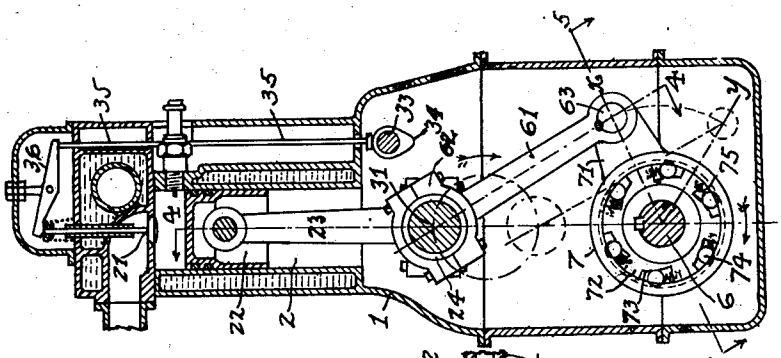
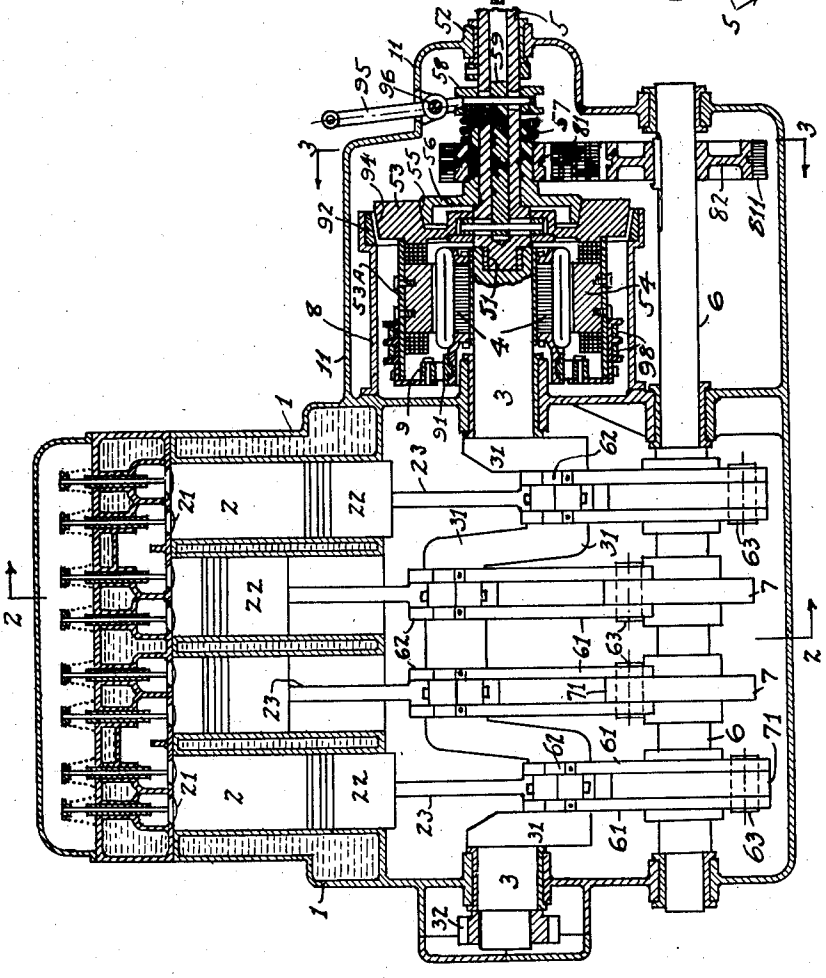


Fig. 1.



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Fig. 6.

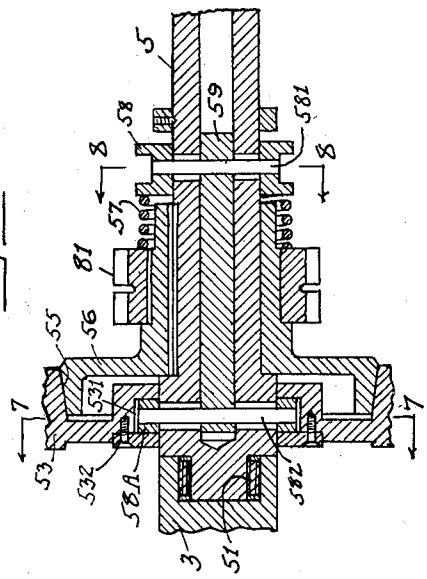


Fig. 8.

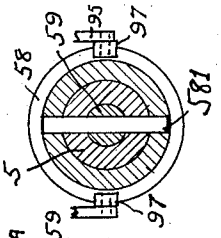


Fig. 7.

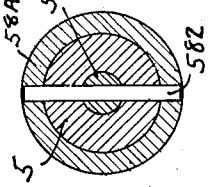


Fig. 5.

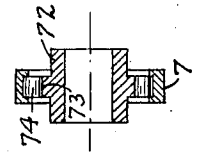


Fig. 4.

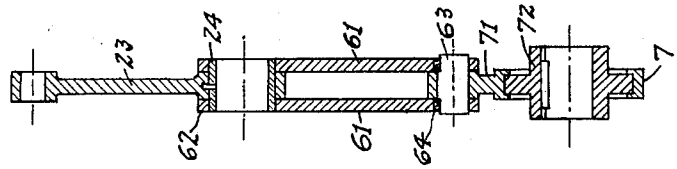
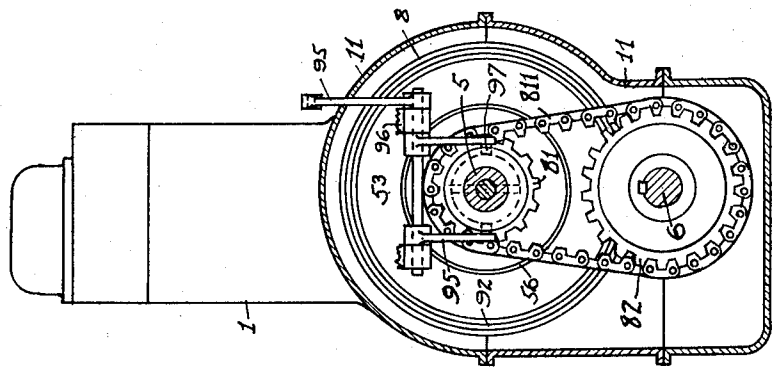


Fig. 3.



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Patented July 31, 1945 2,380,778

UNITED STATES PATENT OFFICE

2,380,778

INTERNAL-COMBUSTION ENGINE

Jesse M. Murdock, Detroit, Mich.

Application March 13, 1944, Serial No. 526,260

10 Claims. (Cl. 290—22)

My invention relates to internal combustion engines, and its principal object is to provide an engine of this character in which greater mechanical efficiency is obtainable than is the case with such engines as at present constructed.

In engines working on the four-stroke cycle as commonly used in motor-vehicle and airplane construction there is a considerable loss of power due to the poor tangential resultant obtainable from the thrust of the connecting rods when the cranks are in the vicinity of the dead centers. There is also a deficiency in the operating speed due to the fact that the crank shaft is rotated at constant velocity throughout the cycle, so that approximately seven-eighths of the total time per cycle is occupied in non-productive work such as the suction and exhaust strokes and the passing over of the dead centers.

According to the present invention the crankshaft is formed separately from the co-axial power-delivery shaft, being connected to the pistons by the usual connecting rods merely to insure the proper sequence of operations in the several cylinders, while the actual power strokes are transmitted intermittently by means of auxiliary connecting rods to an intermediate shaft which in turn drives the power shaft, through special clutch means, at a speed somewhat higher than the crankshaft speed, the arrangement being such that the crankshaft is rotated at a higher speed during the non-productive portions of the cycle than during the power strokes while the power shaft is kept at a nearly constant angular velocity by a flywheel mounted thereupon.

A further object is to provide an engine having electrical starting means and battery-charging means built directly therein and forming also part of the general operating system thereof.

In order that my invention may be readily understood, I will now describe a preferred embodiment of the same with reference to the accompanying drawings, in which—

Figure 1 is a vertical longitudinal section of a four-cylinder engine constructed according to my said invention.

Figure 2 is a vertical transverse section of the same taken approximately on line 2—2 of Figure 1, certain parts being shown in elevation.

Figure 3 is a vertical transverse section taken approximately on line 3—3 of Figure 1, showing one method of driving the power shaft from the intermediate shaft.

Figure 4 is a fragmentary section taken on line 4—4 of Figure 2, illustrating the assembly of the main and auxiliary connecting rods.

Figure 5 is a fragmentary section taken on line 5—5 of Figure 2 showing one form of clutch for driving the intermediate shaft.

Figure 6 is a fragmentary longitudinal section, drawn to an enlarged scale, showing the clutch operating mechanism upon the power shaft.

Figure 7 is a transverse section taken on line 7—7 of Figure 6, and Figure 8 is a similar section taken on line 8—8, showing certain details to be hereinafter described.

Like characters designate corresponding parts throughout the several views.

In the drawings, 1 is the motor casing having the integrally cast cylinders 2 fitted with overhead valves 21 and with pistons 22, all of conventional construction. A crank shaft 3 having two pairs of opposed cranks 31, all disposed in the same plane, is coupled to the pistons by connecting rods 23 and one end of this shaft carries a pinion 32, connected by gearing, not shown, with the cam shaft 33 which has cams 34 for operating the valves through push rods 35 and rocker arms 36 in the usual manner. The other end of the crank shaft projects through the casing sufficiently to receive an armature 4 which is secured to it, and co-axially therewith is the power shaft 5, supported at one end by a pilot bearing 51 within the end of the crankshaft and at the other end in a bearing 52 in the gear casing 11. Upon the power shaft 5 is loosely mounted a flywheel 53, which carries within a cylinder 53A, a series of field magnets 54 surrounding the armature 4 and arranged in co-operative relation therewith, while the flywheel itself is provided with clutch means, to be described hereinafter, adapted to connect it in driving relation with the shaft 5 and alternatively to connect it to the fixed casing 8 which surrounds it.

Below the crank shaft 3, and parallel thereto, is an intermediate shaft 6, upon which are mounted a series of four one-way clutches 7, of the well-known cam-and-roller type, each of which has a lever arm 71 coupled to the corresponding crank pin by a pair of auxiliary connecting rods 61. One method of assembling the various rods upon the crank pin is shown in Figure 4, in which the main rod 23 is relatively narrow, but has a bushing 24 extending the full width of the crank pin, and upon the projecting ends of this bushing are hinged the big ends 62 of the auxiliary rods. The small ends of these rods carry pins 63, the ends of which are secured in position as by screws 64, while the center of each pin engages one of the lever arms 71 of the clutch member 7. The clutch cams 72, keyed upon the shaft 6, have in-

clined portions 73 so arranged that the rollers 74 engage the member 7 during the downward strokes of the connecting rods and slip freely thereupon during the upward strokes. The rollers, as shown in Figure 2 of the drawings, are held yieldingly in position by springs 75 so as to avoid any back-lash or lost motion, and in some cases I may interpose guide blocks between the springs and the rollers in the manner well known in the art.

As shown in the enlarged views, Figures 6, 7 and 8, the flywheel 53 has an internal inclined bore 55 adapted to fit upon the conical clutch member 56 keyed to the power shaft 5, and is normally kept in engagement therewith by a compression spring 57, the free end of which presses upon the collar 58, said collar being connected by a transverse pin 581, passing through slots in the shaft as shown, to a rod 59, which rod slides longitudinally in a central bore of the shaft. The rod 59 carries at its inner end a pin 582 passing through slots in the shaft and into a collar 58A, this latter collar fitting rotatably within the cavity 531 in the flywheel and being held longitudinally therein as by the flange 532. In this manner the pressure of the spring 57 is caused to maintain the flywheel in engagement with the clutch member 56.

Keyed upon the boss of the member 56 is a sprocket 81, which is coupled by a silent chain 811 to a larger sprocket 82 so that the power shaft 5 rotates at a higher speed than the intermediate shaft 6. Thus the intermediate shaft, to which the force of the explosions is transmitted from the pistons directly through the rods 23 and 61 instead of through the cranks 31, receives approximately the total power generated, and further, due to the relatively increased leverage upon the member 71, and to the fact that the intermediate shaft is free from the crankshaft, a greatly augmented force is imparted at this time to the intermediate shaft and from it to the power shaft, to be partly stored in the flywheel upon the latter. It will be observed, moreover, that owing to the obliquity of the rods 61 in relation to the vertical center line of the engine, the working strokes of the members 71 coincide approximately with the actual power strokes of the pistons, that is to say, the upper limits of their movement, at x in Figure 2, occur very near to the ignition point, while the lower limits, at y, occur at about the usual point of exhaust valve opening, so that practically no lost motion is permitted during the power strokes.

Upon the cylinder 53A, which supports the field magnets 54, are carried brushes 9, held in contact with a commutator 91 upon the armature 4, so that when the power shaft 5, and with it the magnets, is rotated, a turning effort is transmitted to the armature and to the crankshaft 3, causing the latter to move the pistons through the complete cycle of their operation, but owing to the elastic nature of the transmission thus effected, the crankshaft may travel at various angular velocities during the different portions of the cycle. Thus during the suction and exhaust strokes, and when the cranks are passing over the dead centers, the crankshaft speed may approximate that of the power shaft, which, as previously stated, is positively driven at a higher speed than the intermediate shaft. Conversely, the intermediate shaft, not being compelled to conform to the crankshaft speed, may rotate somewhat slower under the power impulses, as determined by the balancing influence of the flywheel.

The combination of armature and field magnets above described may be employed for starting the engine, for which purpose the flywheel is held stationary in the following manner. Upon the casing 8 is an internal cone clutch member 92 adapted to frictionally engage a conical surface 94 upon the periphery of the flywheel 53. The latter surface is brought into contact by pressure upon a lever 95, pivoted at 96 to the casing 11, having rollers 97 engaging a groove in the collar 58, as shown in Figures 1, 6 and 8. By this means the collar 58A, with the flywheel, is forced by the rod 59 so as to disengage the wheel from the clutch member 56 and cause it to engage the fixed surface 92. Current from a storage battery or other source being then introduced through the insulated slip rings 98 upon the cylinder 53A, the device operates as a starting motor.

Similarly, the combination may be employed as a generator for charging a battery or other purpose while the engine is running, the field magnets being held stationary in the manner just described.

The methods of making the various electrical connections for the starting operation and for the generation of current are so well known in the art that no further explanations are deemed necessary.

It will be observed from the foregoing description and by reference to the drawings that I have provided an engine which is capable of performing with much greater efficiency than is possible with engines of ordinary construction, and while I have herein shown and described a preferred embodiment of my said invention, it will be readily understood by those skilled in the art to which the same pertains that various changes and modifications may be made to suit any particular or peculiar requirement without departing from the scope of the appended claims. For example, while I have herein shown my improvements as applied to a four cylinder engine, they may be applied with equal advantage to an eight cylinder engine, more particularly when all of the cranks lie in a common plane. Further, instead of the roller type clutches for transmitting power from the auxiliary connecting rods to the intermediate shaft, I may adopt one-way clutch means of other types such as those operated by hydraulic means. Similarly, in place of the electrically operated driving clutch between the power shaft and the crankshaft, I may employ any other of the well known forms of elastic clutch, such as those operated by compressed air.

Having thus described my said invention, what I claim and desire to secure by Letters Patent of the United States is:

1. In an internal combustion engine, the combination, with a series of power cylinders having therein pistons and having valves and valve-operating mechanism; of a crankshaft having cranks coupled to said pistons by main connecting rods; a power shaft in co-axial alignment therewith and having a flywheel thereupon; an intermediate shaft spaced from said crankshaft and parallel thereto; a series of one-way clutches upon said intermediate shaft connected by auxiliary connecting rods to said crankshaft to receive power impulses therefrom in spaced succession, successive power impulses spaced apart in the cycle by an interval of a length not less than the power impulse and during which in-

terval power is not transmitted from the crankshaft to the intermediate shaft, positive gear means connecting said intermediate shaft and said power shaft; and elastic clutch means connecting said crankshaft and said power shaft in driving relation whereby said crankshaft may be driven by said power shaft at speeds varying inversely as the torque resistance.

2. In an internal combustion engine, the combination, with a series of power cylinders having therein pistons and having valves and valve-operating mechanism; of a crankshaft having cranks coupled to said pistons by main connecting rods; a power shaft in co-axial alignment therewith and having a flywheel thereupon; an intermediate shaft spaced from said crankshaft and parallel thereto; a series of one-way clutches upon said intermediate shaft connected by auxiliary connecting rods to said crankshaft to receive power impulses therefrom in spaced succession, successive power impulses spaced apart in the cycle by an interval of a length not less than the power impulse and during which interval power is not transmitted from the crankshaft to the intermediate shaft, positive gear means connecting said intermediate shaft and said power shaft to drive the power shaft at a higher R. P. M. than the intermediate shaft; and elastic clutch means connecting said crankshaft and said power shaft in driving relation whereby said crankshaft may be driven by said power shaft at speeds varying inversely as the torque resistance, said elastic clutch means comprising an armature secured to said crankshaft and a series of field magnets upon said power shaft arranged in electrical driving arrangement therewith.

3. In an internal combustion engine, the combination, with a series of power cylinders having therein pistons and having valves and valve-operating mechanism; of a crankshaft having cranks coupled to said pistons by main connecting rods; a power shaft in co-axial alignment therewith and having a flywheel thereupon; an intermediate shaft spaced from said crankshaft and parallel thereto; a series of one-way clutches upon said intermediate shaft connected by auxiliary connecting rods to said crankshaft to receive power impulses therefrom in spaced succession, successive power impulses spaced apart in the cycle by an interval of a length not less than the power impulse and during which interval power is not transmitted from the crankshaft to the intermediate shaft, positive gear means connecting said intermediate shaft and said power shaft to drive the power shaft from the intermediate shaft and at a higher R. P. M. than the intermediate shaft; and elastic clutch means connecting said crankshaft and said power shaft in driving relation whereby said crankshaft may be driven by said power shaft during said intervals, said elastic clutch means comprising an armature secured to said crankshaft and a series of field magnets upon said flywheel arranged in electrical driving arrangement therewith.

4. In an internal combustion engine, the combination, with a series of power cylinders having therein pistons and having valves and valve-operating mechanism; of a crankshaft having cranks coupled to said pistons by main connecting rods; a power shaft in co-axial alignment therewith and having a flywheel thereupon; an intermediate shaft spaced from said crankshaft and parallel thereto; a series of one-way clutches upon said intermediate shaft connected by auxiliary connecting rods to said cranks; positive gear means connecting said intermediate shaft and said power shaft; and elastic clutch means connecting said crankshaft and said power shaft in driving relation whereby said crankshaft may be driven by said power shaft at speeds varying inversely as the torque resistance, said elastic clutch means comprising an armature secured to said crankshaft and a series of field magnets upon said flywheel arranged normally in electrical driving relation therewith, a fixed casing surrounding said flywheel and said magnets, and auxiliary clutch means by which said magnets may be held stationary in said casing and employed to drive said armature from an external source of current for starting said engine.

5. In an internal combustion engine, the combination, with a series of power cylinders having therein pistons and having valves and valve-operating mechanism; of a crankshaft having cranks coupled to said pistons by main connecting rods; a power shaft in co-axial alignment therewith and having a flywheel thereupon; an intermediate shaft spaced from said crankshaft and parallel thereto; a series of one-way clutches upon said intermediate shaft connected by auxiliary connecting rods to said cranks; positive gear means connecting said intermediate shaft and said power shaft; and elastic clutch means connecting said crankshaft and said power shaft in driving relation whereby said crankshaft may be driven by said power shaft at speeds varying inversely as the torque resistance, said elastic clutch means comprising an armature secured to said crankshaft and a series of field magnets upon said flywheel arranged normally in electrical driving relation therewith, a fixed casing surrounding said flywheel and said magnets, and auxiliary clutch means by which said magnets may be held stationary in said casing and employed in conjunction with said armature for generating electrical current when the engine is running under its own power.

6. In an internal combustion engine, in combination, a series of power cylinders having pistons therein and having valves and valve operating mechanism, a crankshaft coupled by connecting rods with the pistons to receive power impulses therefrom, a power shaft in co-axial alignment with the crankshaft and having a flywheel thereon, an intermediate shaft spaced from and parallel to the crankshaft, driving mechanism coupling the intermediate shaft with the crankshaft to receive successive torque impulses therefrom, the successive torque impulses being spaced apart by an interval in the cycle of a length not less than the length of the torque impulse and during which interval torque is not transmitted from the crankshaft to the intermediate shaft, driving mechanism coupling the intermediate shaft with the power shaft to drive the power shaft and to maintain a predetermined speed ratio between said shafts, and elastic clutch mechanism operable to couple the crankshaft with the power shaft to be driven thereby during said intervals when the crankshaft is not delivering power to the intermediate shaft.

7. In an internal combustion engine, in combination, a series of power cylinders having pistons therein and having valves and valve operating mechanism, a crankshaft coupled by connecting rods with the pistons to receive power impulses therefrom, a power shaft in co-axial alignment with the crankshaft and having a flywheel thereon, an intermediate shaft spaced from

and parallel to the crankshaft, driving mechanism coupling the intermediate shaft with the crankshaft to receive successive torque impulses therefrom, spaced apart by an interval in the cycle during which driving torque is not being transmitted from the crankshaft to the intermediate shaft, driving mechanism coupling the intermediate shaft with the power shaft to drive the power shaft and to maintain a predetermined speed ratio between said shafts, and elastic clutch mechanism operable to transmit driving torque from the power shaft to the crankshaft effective to drive the crankshaft only during said intervals when the crankshaft is not transmitting driving torque to the intermediate shaft.

8. In an internal combustion engine, in combination, a series of power cylinders having pistons therein and having valves and valve operating mechanism, a crankshaft coupled by connecting rods with the pistons to receive power impulses therefrom, a power shaft in co-axial alignment with the crankshaft and having a fly-wheel thereon, an intermediate shaft spaced from and parallel to the crankshaft, driving mechanism coupling the intermediate shaft with the crankshaft to receive successive torque impulses therefrom, spaced apart by an interval in the cycle during which driving torque is not being transmitted from the crankshaft to the intermediate shaft, driving mechanism coupling the intermediate shaft with the power shaft to drive the power shaft and to maintain a predetermined speed ratio between said shafts, and elastic clutch mechanism operable to transmit driving torque from the power shaft to the crankshaft effective to drive the crankshaft only during said intervals when the crankshaft is not transmitting driving torque to the intermediate shaft, said elastic clutch mechanism comprising an armature coupled with the crankshaft and a series of field magnets coupled with the power shaft and arranged in electrical driving arrangement with the armature.

9. In an internal combustion engine, in combination, a series of power cylinders having pistons therein and having valves and valve operating mechanism, a crankshaft coupled by connecting rods with the pistons to receive power impulses therefrom, a power shaft in co-axial alignment with the crankshaft and having a fly-wheel thereon, an intermediate shaft spaced from and parallel to the crankshaft, driving mechanism coupling the intermediate shaft with the crankshaft to receive successive torque impulses therefrom, spaced apart by an interval in the cycle during which driving torque is not being transmitted from the crankshaft to the intermediate shaft, driving mechanism coupling the intermediate shaft with the power shaft to drive the power shaft and to maintain a predetermined speed ratio between said shafts, elastic clutch mechanism operable to transmit driving torque from the power shaft to the crankshaft effective to drive the crankshaft only during said intervals when the crankshaft is not transmitting driving torque to the intermediate shaft, said elastic clutch mechanism comprising an armature coupled with the crankshaft and a series of field magnets coupled with the power shaft and arranged in electrical driving arrangement with the armature, and clutch means operable to couple the field magnets with the power shaft or to disconnect the same therefrom.

10. In an internal combustion engine, in combination, a series of power cylinders having pistons therein and having valves and valve operating mechanism, a crankshaft coupled by connecting rods with the pistons to receive power impulses therefrom, a power shaft in co-axial alignment with the crankshaft and having a fly-wheel thereon, an intermediate shaft spaced from and parallel to the crankshaft, driving mechanism coupling the intermediate shaft with the crankshaft to receive successive torque impulses therefrom, spaced apart by an interval in the cycle during which driving torque is not being transmitted from the crankshaft to the intermediate shaft, driving mechanism coupling the intermediate shaft with the power shaft to drive the power shaft and to maintain a predetermined speed ratio between said shafts, elastic clutch mechanism operable to transmit driving torque from the power shaft to the crankshaft effective to drive the crankshaft only during said intervals when the crankshaft is not transmitting driving torque to the intermediate shaft, said elastic clutch mechanism comprising an armature coupled with the crankshaft and a series of field magnets coupled with the power shaft and arranged in electrical driving arrangement with the armature, and auxiliary clutch means operable to hold said field magnets stationary to drive said armature from an external source of current.

JESSE M. MURDOCK.