

July 14, 1931.

H. T. HERR

1,814,802

STARTING SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed July 19, 1929

2 Sheets-Sheet 1

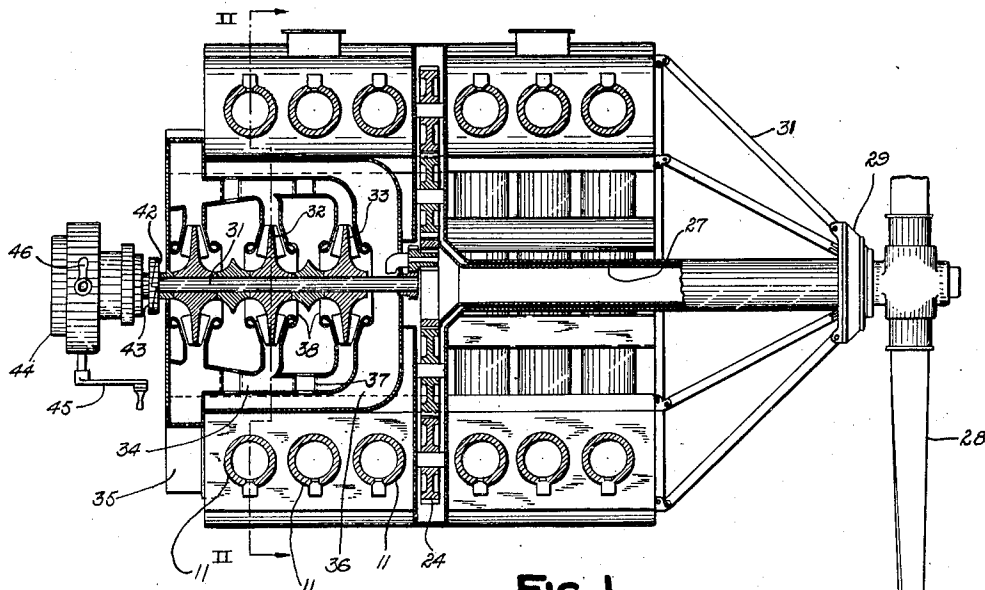


FIG. 1.

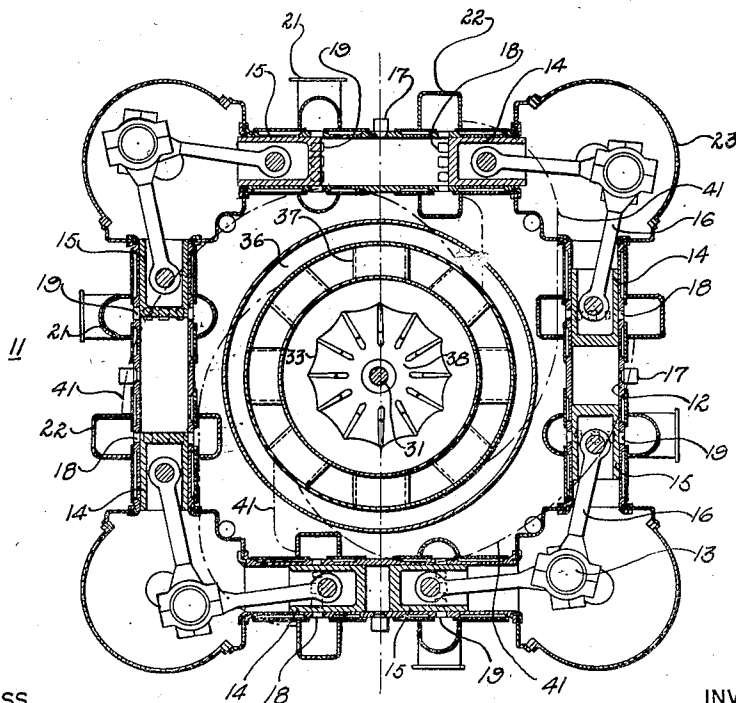


FIG. 2.

WITNESS
E. Lutz.

INVENTOR
H.T. HERR.
BY
A. B. Pearis
ATTORNEY

July 14, 1931.

H. T. HERR

1,814,802

STARTING SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed July 19, 1929

2 Sheets-Sheet 2

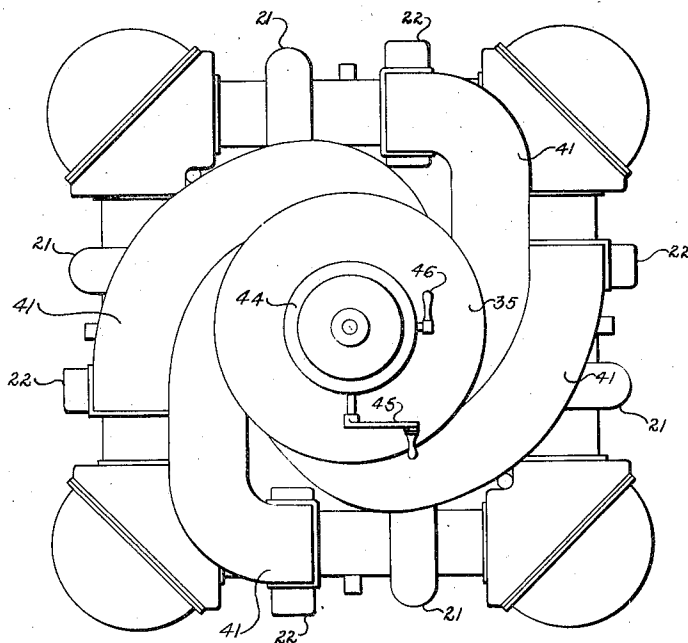


FIG. 3.

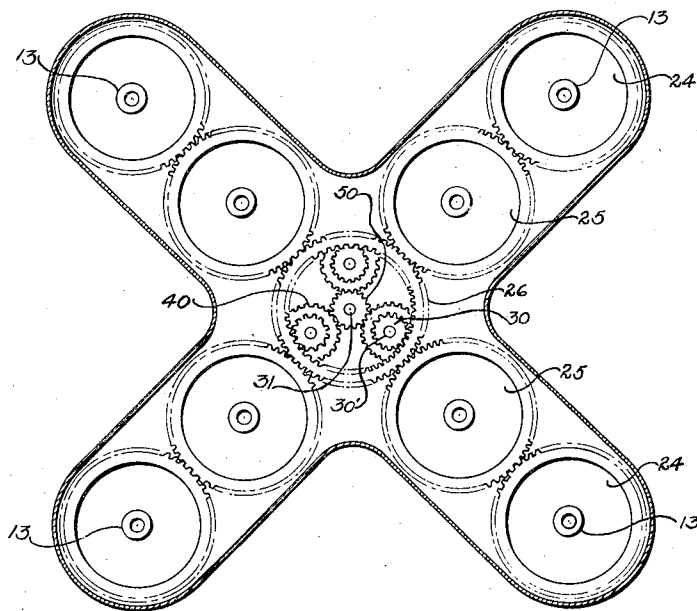


FIG. 4.

WITNESS

E. Lutz

INVENTOR

H. T. HERR

BY

a. b. Reavis
ATTORNEY

UNITED STATES PATENT OFFICE

HERBERT T. HERR, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

STARTING SYSTEM FOR INTERNAL COMBUSTION ENGINES

Application filed July 19, 1929. Serial No. 379,450.

My invention relates to internal combustion engines and particularly to starting systems therefor and it has for an object to provide apparatus of the character designated
5 which shall operate reliably and effectively and which shall be readily applicable to various types and forms of internal combustion engines.

It has for still another object to provide a
10 system of the character designated so arranged that there may be readily embodied therein various types of motor devices such as, for example, mechanical, electrical, hydraulic, etc., for initiating the starting move-
15 ment.

It has for still another object to provide a system of the character designated which shall be especially applicable to engines of the multi-cylinder type and which shall provide for applying the starting torque to an
20 intermediate or central portion of the crank shafts of engines of this character in order that the stresses set up in the engine crank shaft incident to starting may be lessened.

It has for still another object to provide a starting system which shall be especially applicable to engines embodying two or more crank shafts and more especially to engines of the square or polygon type, that is, engines composed of a plurality of polygonal
30 sets of cylinders disposed in side-by-side relation and defining a polyhedron, the crank shafts being located between adjacent cylinders and extending longitudinally of the polyhedron.

It has for still another object to provide a system of the character designated, which shall be especially applicable to engines provided with scavenging or supercharging
40 blower apparatus driven from the engine and at a greater speed than the engine in that I propose to utilize the drive mechanism between the blower and the engine to connect
45 the starter to the engine, thereby simplifying the construction of the starting system and lessening the weight thereof.

These and other objects are effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawings,
50

forming a part of this application, in which:

Fig. 1 is a longitudinal view, in section, of a polyhedral form of engine provided with one form of starting system arranged in accordance with my invention;

Fig. 2 is a transverse, sectional view, taken on the line II—II of Fig. 1;

Fig. 3 is an end view, in elevation, of the engine and starting system shown in Fig. 1; and,

Fig. 4 is a transverse view, in elevation, of the transmission mechanism embodied in the engine shown in Fig. 1.

Referring to the drawings, I show in Fig. 1, an engine composed of a plurality of polygon aggregates 11 disposed in side-by-side relation and forming a polyhedron. As shown in Fig. 2, each of the polygon aggregates is composed of a plurality of cylinders 12 arranged so that their axes define a polygon, suitable crank shafts 13 being located at the corner regions of the polygon and extending longitudinally of the several assembled polygon aggregates. Provided in each cylinder 12 are opposed pistons 14 and 15 connected through suitable connecting rods 16 to adjacent crank shafts.

Although the engine shown in the drawings may be operated upon either the Diesel or the Otto cycle or upon the two-cycle or four-cycle principles, it is assumed in the present embodiment that the engine operates upon the two-cycle principle and upon the Diesel cycle. Hence, the fuel is injected into each cylinder through an admission port 17 located in a central portion thereof and between the opposed pistons. Located on opposite sides of the admission port 17, of each cylinder, are respective series of inlet and exhaust ports 18 and 19. The ports 18 and 19 are arranged to be covered and uncovered by the pistons associated therewith, and, preferably, the inlet ports 18 are located at alternate corner regions of the polygon while the exhaust ports are located at the remaining corner regions of the polygon. The pistons 15 controlling the exhaust ports may therefore be associated with alternate crank shafts and the pistons 14 controlling the admission ports associated with the re-

maintaining crank shafts. As disclosed and claimed in U. S. Patent No. 1,701,360 for internal combustion engine and assigned to the Westinghouse Electric and Manufacturing Company, the exhaust port controlling crank shafts preferably lead, angularly, the inlet port controlling crank shafts so that the exhaust ports of each cylinder are opened before the admission ports and closed before the latter. In this way, thorough scavenging and supercharging of each of the engine cylinders may be readily effected.

Associated with the exhaust ports in the respective cylinders are exhaust manifolds 21 and associated with the inlet ports 18 are admission manifolds 22. Each of the crank shafts 13 is provided with a suitable crank case 23; and, as shown in Fig. 1, located at an intermediate or central portion of each crank shaft 13, is a drive gear 24. Each of the drive gears 24 mesh, through suitable idler gears 25, with the external teeth of a master ring gear 26 located on the longitudinal axis of the polyhedron, all as particularly shown in Fig. 4. Secured to and rotatable with the master ring gear 26 is a drive shaft 27 which projects outwardly of the polyhedron and which is operatively connected to a driven element such as, for example, a propeller 28. Associated with the propeller 28 is a suitable thrust and steady bearing 29 supported from the engine structure by means of diagonally extending stay rods 31. For a more detailed description of the construction of the transmission mechanism for interconnecting the crank shafts and as well as for the structure supporting the propeller and connecting the same to the engine, reference may be had to my copending application, Serial No. 370,606, filed June 13, 1929, entitled Internal combustion engine, and assigned to the Westinghouse Electric and Manufacturing Company.

As shown particularly in Fig. 4, the internal teeth of the master ring gear 26 mesh with a plurality of circumferentially spaced pinions 30 located on fixed pinion shafts 31'. Each pinion 30 drives a gear 40, all of the gears 40 meshing with a common sun gear 50. The sun gear 50 is operatively connected to a shaft 31 of a blower 32, the gearing being so proportioned, as is apparent from the drawings, that the blower operates at a greater speed than the engine crank shafts.

The blower 32 is preferably disposed within the polyhedron defined by the engine cylinders in order that the entire engine structure may be made as compact as possible. While various types of blower apparatus may be employed, I have shown, by way of example, a blower having three runners 33, all driven from the common shaft 31 and operating in parallel to discharge fluid under pressure through an annular duct 34 to master

distributing manifold 35. Air is supplied to the blower 32 from an intake reservoir 36 having radially extending ducts 37 projecting through the discharge duct 34 and communicating with the eyes 38 of the respective runners. For a more detailed description of the construction and operation of my blower apparatus, reference may be had to my copending application, Serial No. 298,778, entitled Scavenging and supercharging system for internal combustion engines, and assigned to the Westinghouse Electric and Manufacturing Company. As shown particularly in Fig. 3, the master distributing manifold 35 is provided with a plurality of tangentially extending branch ducts 41 communicating, respectively, with the intake manifolds 22.

Preferably, the blower drive shaft 31 projects outwardly beyond the outer wall of the master distributing manifold 35 and is provided at its extremity with a jaw coupling 42 arranged to cooperate with a jaw coupling 43 of a starting motor 44. The starting motor 44 may be any conventional type; and, in the present embodiment, I have shown by way of example, a starting motor of the inertia type. As is well understood in the art, the inertia starter 44 is provided with a lever 45 for cranking the same and an operating rod 46 for engaging the starter jaw 43 with the jaw 42 of the blower shaft when the starter has been brought up to speed.

From the foregoing description, the method of operating my improved starting system will be apparent. Assuming that the engine is idle and that it is desired to start the same, the inertia starter 44 is first of all actuated by the crank handle 45 until such time as the required amount of inertia has been developed, whereupon the operating rod 46 is moved and the jaw 43 thrown into engagement with the jaw 42 of the blower shaft. Movement of the blower shaft results in moving all of the crank shafts of the engine, the arrangement of the gearing being such that the crank shafts move at a relatively slower speed than the blower shaft. Adequate movement of the crank shafts is effective to cause ignition of the fuel in the engine cylinders and operation of the engine ensues.

Operation of the engine causes the blower shaft 31 to be driven at a speed greater than the engine crank shafts and the jaw 43 of the inertia starter is "kicked out" and the starter disconnected from the engine. During the operation of the engine, the blower 32 distributes air under pressure to the distributing manifold 35 and thence to the respective cylinder manifolds 22.

In the operation of the engine, the pistons of the respective cylinders move outwardly upon their working strokes in predetermined timed sequence; and, upon the exhaust ports 19 of each cylinder being uncovered by their

associated piston 15, the burnt gases are liberated to the exhaust manifold 21. After opening of the exhaust ports 19, the admission ports 18 are opened and the air under pressure supplied by the blower 32 sweeps the burnt gases remaining in the cylinder outwardly through the exhaust ports 19. This scavenging process continues until the exhaust piston 15 closes the exhaust ports 19 during its return stroke but, the admission ports 18 being still open, the air supplied by the blower 32 continues to enter the cylinder and serves to supercharge the same. The supercharging process continues until such time as the admission ports 18 are closed by their associated piston 14 whereupon the pistons 14 and 15 move toward each other upon their compression stroke. At a suitable point in the compression stroke, the fuel is injected into the compressed air obtaining in the cylinder and ignition again takes place in accordance with the well known principles of the Diesel cycle.

From the foregoing, it will be apparent that I have provided a starting system which is especially applicable to engines equipped with blowers or superchargers in that the transmission mechanism utilized for driving the blower or supercharger at a speed greater than the engine is utilized during times of starting to drive the engine at a speed less than that of the starting motor. In this way, only one transmission mechanism is required for both the blower drive and the starting system and hence the weight and the space occupied by the starting system is materially reduced, a feature that is especially desirable with engines employed in the propulsion of aircraft.

It will be further apparent that I have provided a starting system which is especially applicable to engines wherein a plurality of aligned cylinders are associated with a common crank shaft in that the starting torque is provided at a central or intermediate portion of the crank shaft, rather than at an end portion, and hence the stresses set up in the crank shaft incident to starting are lessened.

It will be still further apparent that I have provided a starting system which is especially adapted for use with engines of the multi-crank shaft type in that the starting torque is simultaneously applied to several crank shafts and hence the forces imposed upon any one crank shaft are lessened.

It will also be apparent that I have devised a starting system which is especially applicable to engines of the square or polygon type in that the transmission mechanism for interconnecting the crank shafts for operation in unison is utilized as a part of the starting system.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is

susceptible of various changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The combination with an internal combustion engine embodying a plurality of polygonal sets of cylinders disposed in side-by-side relation and defining a polyhedron, crank shafts interposed between adjacent cylinders and extending longitudinally of the polyhedron and transmission means extending transversely of the polyhedron and located centrally of the ends thereof for interconnecting the crank shafts for operation in unison, of a blower disposed within the polyhedron, a starting mechanism located exteriorly of the polyhedron, and means, including speed transformation means, for connecting both the blower and the starter to the engine crank shafts, said connecting means embodying at least a portion of said transmission means.

2. The combination with an internal combustion engine embodying a plurality of polygonal sets of cylinders disposed in side-by-side relation and defining a polyhedron, crank shafts interposed between adjacent cylinders and extending longitudinally of the polyhedron and transmission means extending transversely of the polyhedron and located centrally of the ends thereof for interconnecting the crank shafts for operation in unison, of a blower including a blower shaft disposed within the polyhedron, a starter disposed coaxial with the blower and operatively connected to the blower shaft, and means, including speed transformation means, for operatively connecting the blower shaft to the engine crank shafts.

3. The combination with an internal combustion engine embodying a plurality of polygonal sets of cylinders disposed in side-by-side relation and defining a polyhedron, crank shafts interposed between adjacent cylinders and extending longitudinally of the polyhedron and transmission means extending transversely of the polyhedron and located centrally of the ends thereof for interconnecting the crank shafts for operation in unison, of a blower located within the polyhedron and having a blower shaft disposed coaxial with the polyhedron, a starter disposed exteriorly of the polyhedron and connected to the blower shaft, and means including speed transformation means for operatively connecting the blower shaft to the engine crank shafts.

In testimony whereof, I have hereunto subscribed my name this 5th day of July, 1929.

HERBERT T. HERR.