W. A. CHRYST.

ENGINE STARTING SYSTEM.

APPLICATION FILED SEPT. 30, 1915.

1,369,220. **Patented Feb. 22, 1921.**

3 SHEETS—SHEET 1.

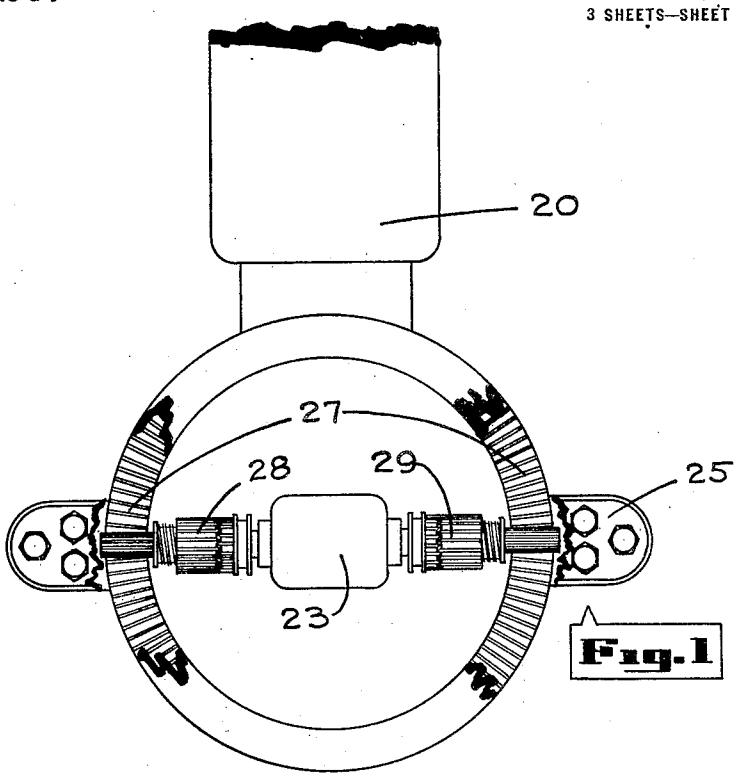

Fig. 1

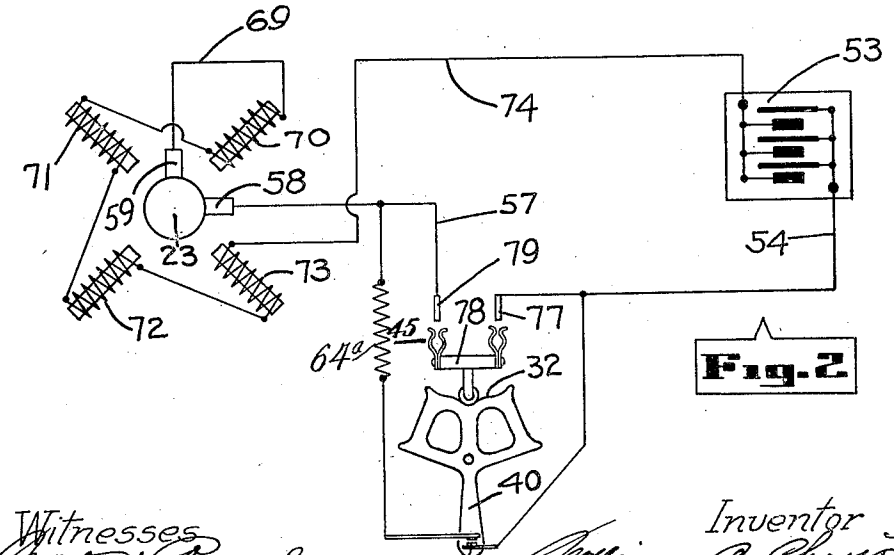

Fig. 2

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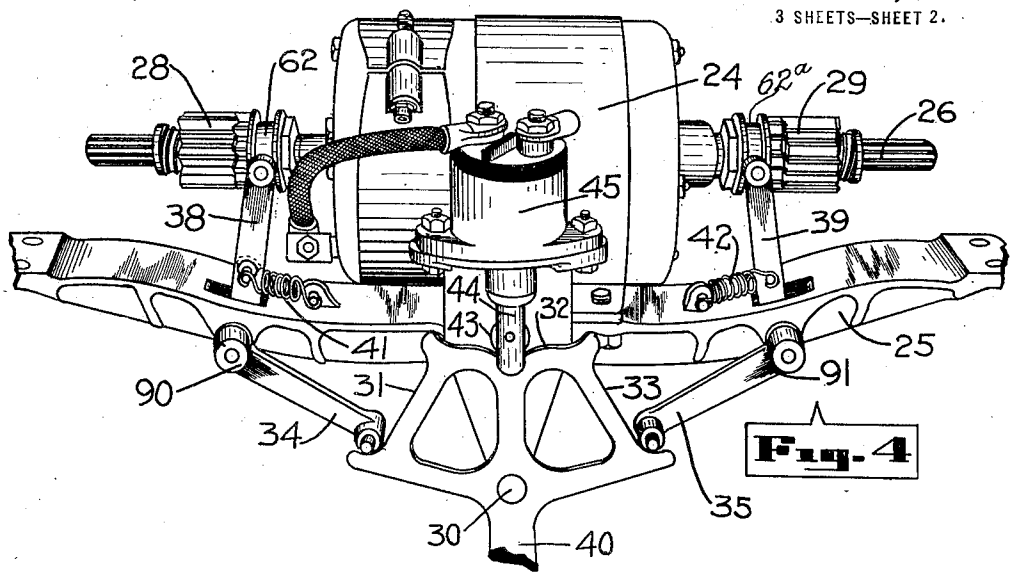

Fig. 4

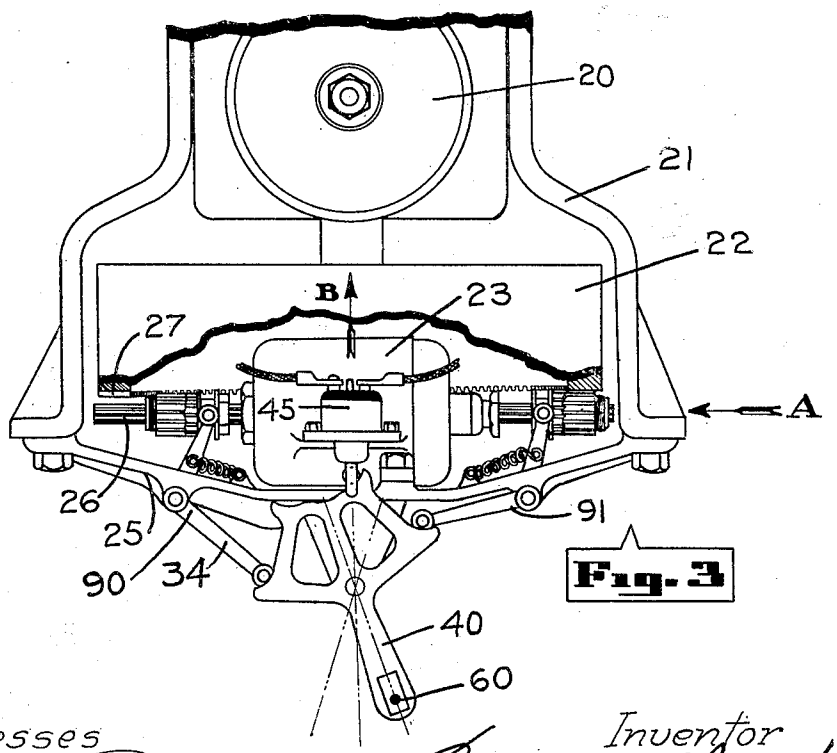

Fig. 3

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3 SHEETS—SHEET 3.

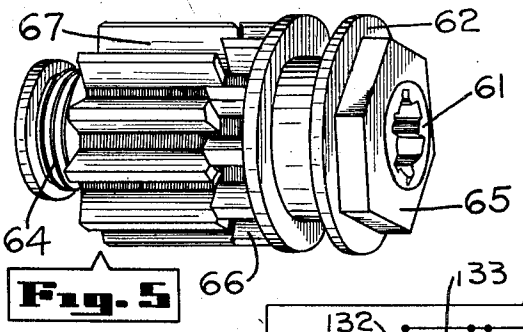

Fig. 5

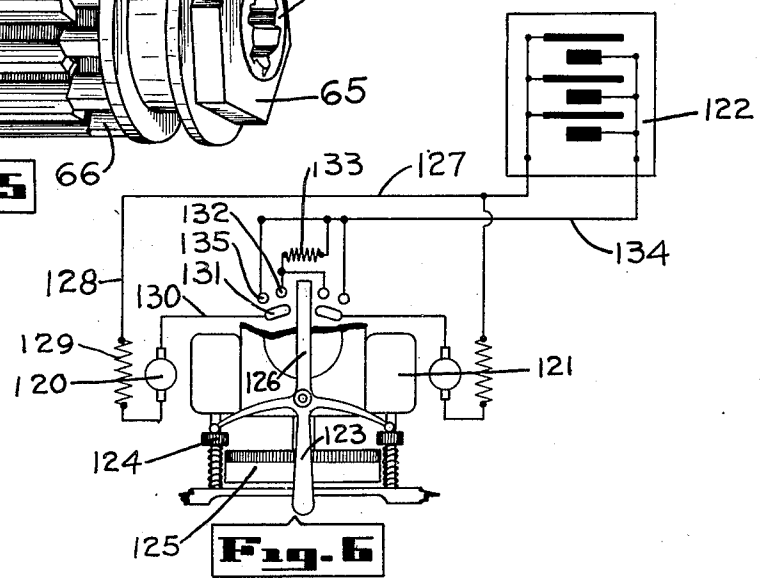

Fig. 6

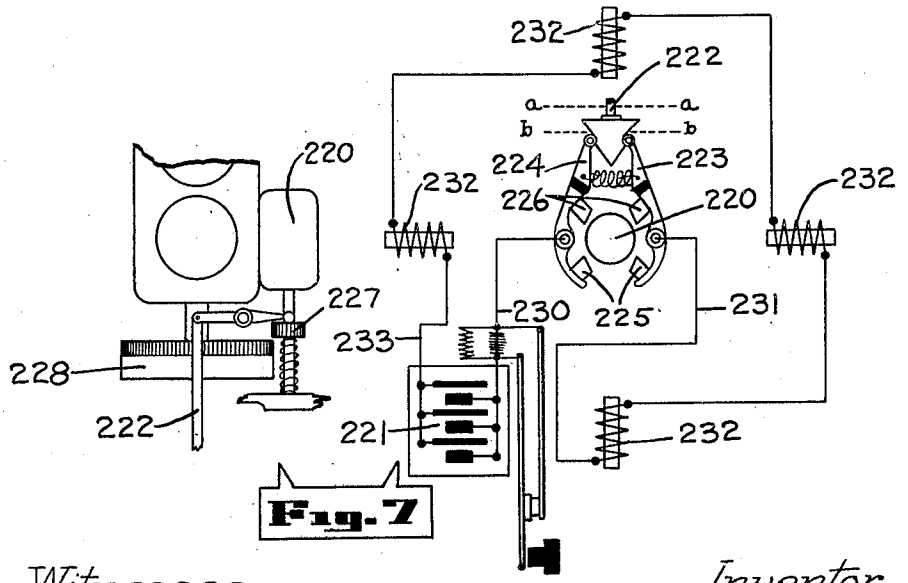

Fig. 7

Witnesses
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UNITED STATES PATENT OFFICE.

WILLIAM A. CHRYST, OF DAYTON, OHIO, ASSIGNOR TO THE DAYTON ENGINEERING LABORATORIES COMPANY, A CORPORATION OF OHIO.

ENGINE-STARTING SYSTEM.

1,369,220. Specification of Letters Patent. Patented Feb. 22, 1921.

Application filed September 30, 1915. Serial No. 53,264.

To all whom it may concern:

Be it known that I, WILLIAM A. CHRYST, a citizen of the United States of America, residing at Dayton, county of Montgomery, and States of Ohio, have invented certain new and useful Improvements in Engine-Starting Systems, of which the following is a full, clear, and exact description.

This invention relates to improvements in starting systems for internal combustion or explosion engines, and more particularly to that type of system which is adaptable for use with engines capable of operating either in a forward or reverse direction.

One of the objects of the present invention is to provide a starting system in combination with a reversible engine, which may be so coupled up to said engine as to crank the engine in either a forward or reverse direction, in accordance with the direction in which it is desired to have the engine run, after it has once been started.

One manner of attaining the above object may be by providing a single prime mover, capable of operation in one direction and having a plurality of connecting units or devices which may be actuated to couple up the prime mover and engine, so as to operate the engine in either a forward or reverse direction.

More particularly, this system may include an electric motor having an armature shaft which carries shiftable connecting devices on each end thereof, and then to combine said motor with the engine, in such a manner that when the operating members are actuated to shift one of said connecting devices into position to couple up the motor and the engine, the said motor will tend to crank the engine in one direction, while when the operating devices are moved to another position, the other connecting device will be shifted into coupled position and the engine will be cranked in an opposite direction.

Again, the above object may be attained by providing a plurality of prime movers, in combination with a common controlling element having a plurality of operative positions, so that when said controlling element is moved to one of its operative positions, one of said prime movers will be connected to the engine.

The functions of this controlling element, when moved to another of its operative positions, is substantially the same with respect to another prime mover. The result of the above arrangement and construction is that when one of the prime movers is brought into operation, the engine may be cranked in one direction, while when another of the prime movers is brought into operation, the engine will be cranked in an opposite direction.

Another manner whereby the above object may be readily attained is to provide the prime mover, which may comprise an electric motor, with a plurality of field and armature windings and then suitable mechanical connecting devices, in combination with a main operating member which will operate relative to certain parts of the electric motor and its connections, to cause the motor to rotate either in a forward or reverse direction, and concomitantly to operate the mechanical connecting devices to couple up the engine with the motor, whereby the engine may be cranked in either a forward or reverse direction, in accordance with the desire of the operator.

Another object of the present invention is to provide a starting system wherein the connecting units which are shiftable into and out of position to couple up the starting system with the engine, have an initial movement imparted thereto during the coupling up operation so as to facilitate and insure this operation.

A further object of the present invention is to provide a starting device for engines of the reversible type, which may be of simple and compact construction, and may be manufactured at small cost and still maintain a high efficiency in its operation.

Further objects and advantages of the present invention will appear from the following description, reference being had to the accompanying drawings, wherein preferred embodiments of the present invention are clearly set forth.

In the drawings:

Figure 1 is a view in end elevation of a combustion or explosion engine, showing one embodiment of the present invention combined therewith.

Fig. 2 is a diagrammatic view of one set

of electrical devices, circuits and connections forming a part of the system shown in Fig. 1.

Fig. 3 is a top plan view of the apparatus shown in Fig. 1, certain of the parts being broken away for the sake of clearness.

Fig. 4 is a detail perspective view of the prime mover and the controlling mechanism included in the present invention.

Fig. 5 is a detail view of one of the coupling devices removed from the shaft of the prime mover. This view also discloses a novel one-way clutch structure which forms a part of the present invention.

Fig. 6 is a top plan view of a modified form of the present invention, combined with a combustion or explosion engine.

Fig. 7 is a top plan view of another modified form of the present invention; this view also disclosing the electrical circuits and connections included in this modified form.

Referring to the drawings, the numeral 20 designates an engine of the internal combustion or explosion type, which is capable of operation either in a forward or reverse direction, to drive or propel any suitable associated mechanism, such as propellers, vehicle wheels, or other arrangements in either a forward or reverse direction.

With engines of the above mentioned type, it is desirable to provide certain devices whereby said engine may be automatically cranked and started in either a forward or reverse direction, so that the said engine may assume its operation in either direction in accordance with the wishes and desires of the operator.

This starting device includes a prime mover, such as an electric motor 23, which may be of any desired type, but which is preferably shown as being of the series wound type, due to the high torque characteristics of such a type of motor.

In Figs. 1 to 5 inclusive, it will be noted that the starting motor 23 is suitably mounted upon a bracket 25, which in turn is fastened to supporting members 21, forming a part of an engine frame or base. This bracket is so mounted on the supporting members 21, that the motor 23 will be held in a determined position relative to said flywheel, by means of a strap 24 which encircles the motor and is secured to the bracket 25 in any suitable manner. Certain parts of the controlling elements are supported by means of the bracket 25 (see particularly Figs. 3 and 4), as will be explained hereinafter.

The motor 23 is preferably mounted with its axis intersecting and normal to the axis of the flywheel (when the apparatus is in the position shown in Fig. 1); that is, the frame of the motor which carries the armature and its shaft 26, is positioned at substantially the center of the flywheel, so that the projecting ends of the shaft 26 will lie adjacent to the opposite sides of the toothed face of the flywheel (see Figs. 1 and 3).

The flywheel in the present instance is of the usual conical or cup-shaped construction, while the rim, formed by cutting out the interior of the flywheel, is provided with crown teeth 27 thus forming the toothed face referred to above.

The portions of the shaft 26, which extend beyond the motor frame, are suitably grooved or fluted to receive the shiftable connecting units 28 and 29. One of these units is shown in detail in Fig. 5 and comprises a sleeve 61, the interior of which is provided with ribs which have a sliding fit in the grooves formed on the armature shaft.

From the above description it will be readily understood that the connecting units are thereby free to slide on the armature shaft, but as a result of the above connection, must rotate therewith.

It is well understood by those skilled in the art, that it is of marked advantage to reduce the speed ratio of the motor when operating to crank the engine, so that while the motor may be operating at a relatively high speed, the engine will be cranked at a comparatively low speed. That is, in systems of the present type, the size of the motor is necessarily limited, and therefore a comparatively small motor is employed. A reduction gearing is preferably employed to transmit power from this small motor to the engine for starting purposes, inasmuch as by using reduction gearing the torque transmitted by the motor will be greatly increased, and will readily enable this small motor to crank the engine with sufficient speed to cause the engine to become self-actuating.

In the present instance the connecting devices and units mentioned heretofore, form a part of this reduction gearing. That is, these connecting units embody pinions of comparatively small diameter which are shiftable to engage with the flywheel of the engine, which of course is of relatively large diameter, whereby this reduction in the speed ratio between the motor and engine is secured.

However, it might sometimes happen that the operator will inadvertently maintain the connecting unit, which has previously been shifted into coupling position, in coupled position after the engine has become self-actuating, and it might therefore occur, if some device is not provided to prevent it, that the engine would drive the motor at excessively high speeds. This possibility in the present invention is substantially eliminated by constructing each of the connecting units of separate parts. That is, (describing only one of the units) the pinion 67 is mounted on the sleeve 61, free from the yoke

member 62, which is secured to the sleeve 61 in any suitable manner such as by the nut 65.

This yoke member also preferably carries a toothed member 66, the teeth of which operate normally to engage with the teeth of the pinion 67, which is normally held in this engaged position by means of a suitable spring 64. The locking faces of the teeth of the pinion 67 and the teeth of the member 66, are beveled, and the teeth of the pinion 67 project beyond the body of said pinion, so as to readily permit engagement between the teeth of the member 66 and the pinion, in the manner above described.

Now, if the operator maintains the connecting unit in engagement with the flywheel of the engine, after the engine has become self-actuating, there would be a tendency for the engine to drive the motor through the connecting unit.

However, due to the novel construction of these connecting units, that is, by constructing the pinion separate from the member 66, this pinion will tend to be driven by the engine, and due to the novel structure of the engaging parts of the pinion 67 and the member 66, the pinion 67 will tend to cam out of engagement with the member 66, whereby said pinion may be driven by the engine free from the member 66, and therefore free from the electric motor.

This disengaging movement of the pinion 67 from the member 66 will be resisted by the spring 64, and this spring will constantly tend to force the pinion 67 into normal driving engagement with the member 66.

Now, as the successive teeth of the pinion 67 pass over the teeth or pawls of the member 66, an audible clicking noise will be set up which will act as a signal to the operator and indicate that the operating member should be shifted so as to move the connecting units to their normal position.

The controlling mechanism of the present system, may of course be varied to meet conditions, but one preferred form is disclosed in Figs. 1, 2 and 3, which may be used to special advantage with the present system. This comprises a main operating member 40 pivotally mounted on the pin 30, which is carried by any suitable supporting member.

This controlling member 40 is provided with an operating head, provided with camming faces on the opposite sides thereof as at 31 and 33. These faces 31 and 33 normally engage with arms 34 and 35, which form a part of the bell-crank levers 90 and 91, suitably mounted on the bracket 25. These levers are connected to yoke members 62 and 62^a respectively, by means of the arms 38 and 39. Suitable springs 41 and 42 are mounted upon the bracket 25 and are connected to the arms 38 and 39 respectively, so as to hold the bell-crank levers and their associated parts in their normal position.

By referring to Fig. 3, the controlling member 40 is shown as being shifted to one of its operative positions, which will cause the unit 29 to be so shifted as to engage with the crown teeth of the flywheel 22.

Previous to this shifting of the unit 29, the switch 60, shown diagrammatically in Fig. 2, will be actuated so as to introduce the resistance element 60^a between the battery and motor whereby an initial low torque movement of the motor will be effected while the actuating unit 29 is being moved toward the gear teeth 27. As indicated in Fig. 3, this switch 60 may be located upon the handle of the controlling member 40 in any convenient manner. The closing of the switch 60 will establish a circuit from battery 53 through wire 54, switch 60, resistance 60^a, brushes 58, 59, wire 69, field windings 70, 71, 72, 73 and wire 74 which leads back to battery 53. This switch 60 would, of course, be closed prior to the movement of the unit 28 toward the gear teeth 27 for the same purpose as described hereinafter.

The reason for imparting an initial movement to this electric motor and the connecting units heretofore described, is to substantially eliminate the possibility of such conflict between the teeth of the pinions of the respective connecting units coming in conflict with the end faces of the teeth formed on the flywheel, in such a manner as to prevent their engagement.

By imparting an initial movement to the motor and therefore to the respective connecting units 28 and 29, it will be noted that regardless of which of these connecting units are to be thrown into engagement with the engine, they will be rotated at a slow speed during this enmeshing operation, inasmuch as it will be seen from the following description that the operation of the motor for starting purposes, is not effected until one of said connecting units is completely or in proper enmeshment with the flywheel.

While in certain of the figures the switch which controls the initial movement of the motor is shown as being operated independently of the operation of the main controlling member, it should be understood that this switch may be readily actuated by the initial operation of the main controlling member, as is shown in certain of the other figures of the drawing (see Fig. 6).

This initial movement will continue until the unit 29 has been brought into substantially fully meshed position, relative to the teeth of the flywheel, at which time the cam face 32, formed on the operating head of the controlling element 40, will be in such position as to actuate the switch plunger 44 through contact with the roller 43 (see Fig. 4).

The cam surface 32 is so proportioned

that the switch plunger 44 will not be moved sufficiently to effect a closing of the main circuits until the connecting unit 29 has been brought into the position mentioned above; that is, substantially fully enmeshed.

The detail construction of the switch 45 is not of importance in the present invention, inasmuch as any suitable switch may be employed.

With the parts in the position disclosed in Fig. 3, it will be readily understood that if the armature is rotating in a clockwise direction, when looking in the direction of the arrow "A" (see Fig. 3), the flywheel will be actuating in a clockwise direction, when looking in the direction of the arrow "B" (see Fig. 3). This will tend to crank the engine in either a forward or reverse direction, it depending entirely upon the connection of the engine with the mechanism with which it is associated, as to whether the direction of drive is forward or reverse.

The operation of the controlling element 40 into any of its several operative positions, will tend to close the following circuit: from the battery 53 through conductor 54, across contact plates 77, 78 and 79 of the switch 45, to lead 57 across the commutator brushes 58 and 59 of the motor, through lead wire 69, through the successive series field windings 70, 71, 72 and 73 respectively, back to the battery via conductor 74.

This closing of the motor circuit is effected by the operation of the lever 40 as stated above, but this closing of the switch 45 is not completed until the connecting unit which is to be thrown into engagement, has reached a determined degree of enmeshment, so as to substantially eliminate the objection of having the connecting units operate at a high rate of speed, when not in sufficient enmeshment with the teeth of the flywheel.

As soon as the engine has become self-actuating, due to the operation of the motor, the operator should release the controlling member 40, which will immediately assume its normal neutral position, due to the influence of the springs 41 and 42. This same effect of the springs will tend to move the connecting units 28 and 29 into their normal disengaged position.

Of course, as soon as the element 40 has returned to its normal position, the plunger 44 of the switch 45 will return to normal position and thereby break the motor circuit by separating the contacts 78 from the contacts 77 and 79 (see Fig. 2).

If it is desired to crank the engine in a direction opposite to that in which it is cranked by the above mentioned operation, it is only necessary that the controlling member 40 be moved into the extreme left-hand dotted line position shown in Fig. 3, so as to shift the connecting unit 28 into engagement with the flywheel of the engine.

The other operations of the system will be substantially the same as those described above, and the engine will be readily cranked in an opposite direction.

In Fig. 6 a modified form of the present invention is clearly shown. This form includes separate electric motors designated by numerals 120 and 121, one of which is mounted on each side of the engine. These motors are each normally disconnected from the engine and each may be connected with the engine by gearing controlled by a common controlling member which also controls electric circuits so arranged that one of these motors will crank the engine in one direction when that motor is connected to the engine, or if the controlling member be shifted to another position, the other motor will be connected with the engine and will crank the engine in the opposite direction.

In the present modified form, a single source of current is employed as at 122, and has suitable circuit connections with the respective motors, as will be described hereinafter.

The main operating or controlling member 123 is suitably mounted in such a manner that it may be moved to a plurality of operative positions, in any one of which positions the circuit connections between the source 122 and one of the motors will be closed concomitantly with the completion of the shifting of one of the connecting units.

By referring to Fig. 6, the operation of the system will be described when the same is brought into operation by the shifting of the controlling member 123 into the extreme right-hand position.

Upon the initial movement of this controlling member, the connecting unit 124 will be moved toward the flywheel 125, and concomitantly an initial movement will be imparted to the motor 120 by the closing of the following circuit, through the effect of a bridging element 126, carried by the controlling member 123: from the battery 122, conductors 127 and 128, through the series field winding 129, across the brushes of the motor 120, through conductor 130 to the common terminal 131, across the bridging element 126 to the terminal 132, through resistance unit 133, and back to the opposite side of the battery via conductor 134.

The object of imparting an initial movement to the motor, is simply to facilitate in the connecting up of the pinion of the connecting unit with the flywheel gearing.

Now, as soon as the pinion 124 has been brought into enmeshment with the flywheel gearing a determined degree, the controlling member 123 will be moved into position to close the following circuit, which may be designated the main cranking motor circuit: from the battery 122, conductors 127 and 128, through series field winding 129, across

the brushes of the motor 120 to lead wire 130, common terminal 131, through the bridging element 126 to the terminal 135 and thence back to the battery via conductor 134.

If it is desired to crank the engine in a direction opposite to that resulting from connecting the motor 120 therewith, the main controlling lever 123 should be shifted to its extreme left-hand operative position, in which case the motor 121 will be connected up to the flywheel gearing and a substantially duplicate set of circuit connections will be so effected as to give the required operations to the motor.

In Fig. 7 a still further modified form of the present invention is disclosed, wherein the starting device includes a single prime mover or motor with a single controlling element, adapted to be shifted into position to couple up the engine and starting device for starting purposes, and having sets of electrical circuits and connections under control of the common operating element, which may be shifted into several operative positions to cause the prime mover or electric motor to rotate in either a forward or reverse direction, and to thereby crank the engine in either a forward or reverse direction, in accordance with the direction in which it is desired to have the engine operate.

This electric motor is adapted to be coupled up to the engine by a single connecting unit, which is operated by a main controlling element which, however, when in its neutral position maintains this connecting unit in disengaged position relative to the motor and engine.

In order to start the engine in either a forward or reverse direction in this modified form of the present invention, the electrical circuits, connections and devices are so arranged that under the control of the main operating member, they may be so actuated as to effect the operation of the motor in either one of the two directions, whereby the engine may be cranked in either a forward or reverse direction.

The above described arrangement will be described more specifically hereinafter.

Referring to the diagrammatic portion of Fig. 7, the electric motor is designated by the numeral 220, and is adapted to have circuit connections with the battery or source 221.

The main controlling element 222 controls the brush rigging, which comprises the arms 223 and 224 respectively, which carry the respective sets of brushes 225 and 226.

Now, by referring to the structural portion of Fig. 7, it will be seen that the main operating member 222 is so connected with the pinion 227, that when said lever is actuated this pinion will be thrown into engagement with the flywheel 228.

The operation of the element 222 to the position denoted by dotted lines "*a*—*a*," will cause the arms 223 and 224 of the brush rigging to operate so that the brushes 226 will come in contact with the armature of the motor.

In this position current will flow from the battery through the lead wire 230, across the armature via brushes 226, through the lead wire 231, thence through the series field windings 232 back to the battery via wire 233.

This will cause the motor to operate in one direction and will therefore crank the engine in one direction through its mechanical connections therewith.

Now, if the operator throws the controlling element 222 to the position denoted by the letters "*b*—*b*," the arms 223 and 224 of the brush rigging will be so actuated as to bring the brushes 225 into contact with the armature, and thereby close the following circuit: from the battery 221 through the lead wire 230, across the armature via brushes 225, thence through the conductor 231, series field windings 232 back to the battery via the wire 233.

From the above description it will be noted that when the current passes through the brushes 225, and thus through the armature, the direction in which the current passes through the armature will be exactly opposite in direction in which the current passed through the armature, when the brushes 226 were in operative contact to said armature. This will of course cause a reversal in direction of rotation of the armature and thereby cause a reversal in direction in rotation of the engine, whereby said engine would be started in a reverse direction.

In this modified form of the present invention, an initial movement may be imparted to the pinion 227, in substantially the same manner as in the U. S. patent of Charles F. Kettering, dated August 17, 1915, and the co-pending applications of Charles F. Kettering and William A. Chryst Serial No. 778,934, filed July 14, 1913, and Serial No. 846,911, filed June 24, 1914, and it is therefore deemed unnecessary to illustrate and describe means for accomplishing this result.

While the forms of mechanisms herein shown and described, constitute preferred forms of embodiments of the invention, it is to be understood that other forms might be adopted all coming within the scope of the claims which follow.

What I claim is as follows:

1. In a starting system, the combination with a reversible engine; of a starting device therefor, including an electric motor having an armature and its shaft; mechanical connecting devices carried on each end

of said armature shaft, said devices being normally disconnected from the engine; of an electrical source having circuit connections with said motor; and means for shifting either of said connecting devices to couple up the engine and the electric motor, and to concomitantly close said circuit, whereby said motor will crank said engine, either in a forward or reverse direction, for starting purposes.

2. In a starting system, the combination with a reversible engine, having a flywheel; of a starting device for said engine, including an electric motor; means for mounting said starting motor adjacent to said flywheel and in the same plane as that of the axis of the flywheel; said motor comprising an armature and its shaft; said shaft having its opposite ends adapted to lie adjacent to the periphery of said flywheel; shiftable connecting units mounted upon each end of said armature shaft, and adapted to rotate therewith, but capable of relative longitudinal movement thereto; a current source having circuit connections with said motor; and a controlling member operable to one position to shift one of said connecting units into engagement with one side of said flywheel, and to concomitantly close said circuit connections, whereby said motor will crank the engine in one direction, said controlling element being operable to another position to shift the other connecting unit into engagement with the opposite side of said flywheel, and to concomitantly close the circuit connections, whereby the engine will be cranked in an opposite direction.

3. In a starting system, the combination with a reversible engine; of a starting device therefor, including an electric motor; a source of current having circuit connections with said motor; a plurality of shiftable means for mechanically connecting the starting motor to the engine, whereby to crank said engine in either a forward or reverse direction; and a controlling member having provisions for controlling a circuit connection for imparting an initial movement to said motor, while said controlling member may be moved to concomitantly actuate either of said shiftable means to facilitate the engagement of said means with the engine, and to subsequently close the circuit connections between the current source and said motor for starting purposes.

4. In a starting system, the combinatiton with a reversible engine; of a starting device therefor, including an electric motor; a shiftable connecting device mounted on each end of said motor and movable to connect the motor with the engine for starting purposes; a source of current, having a plurality of circuit connections with said motor; and a main controlling member operable to shift either one of said connecting devices into position to couple up the engine and starting device, said member having provisions for controlling a circuit whereby to concomitantly close one of said circuit connections between the current source and the motor, to impart an initial movement to said motor, and upon a completion of the shifting of the connecting device to close another circuit connection between the source of current and the motor, for actual starting purposes.

5. In a starting system, the combination with a reversible engine; of a starting device therefor normally disconnected from the engine; a plurality of independent connecting devices for connecting the engine and starting device; a manually operable controller for actuating either of said connecting devices and to effect the operation of the starting device to start the engine in either direction; said connecting devices including provisions for preventing the engine driving the starting device when said engine becomes self-operative.

6. In a starting system, the combination with a reversible engine; of a starting device therefor normally disconnected from the engine; a plurality of independent connecting devices for connecting the engine and starting device; a manually operable controller for actuating either of said connecting devices and to effect the operation of the starting device to start the engine in either direction; said connecting devices including provisions for preventing the engine driving the starting device when said engine becomes self-operative, and for indicating to the operator that the controller should be restored to position whereby the operation of the starting device may be discontinued.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

WILLIAM A. CHRYST.

Witnesses:
J. W. McDONALD,
O. D. MOWRY.