May 29, 1934. H. P. CHANDLER ET AL 1,960,965

STARTING MECHANISM

Filed Sept. 25, 1931 2 Sheets-Sheet 1

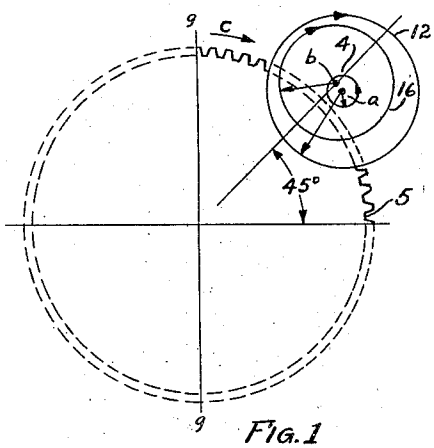


FIG. 1

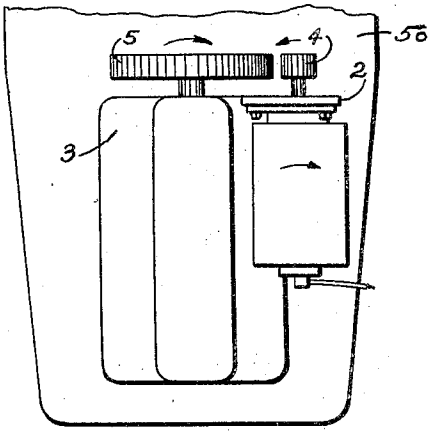


FIG. 4

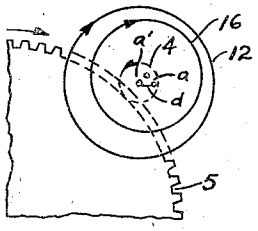


FIG. 2

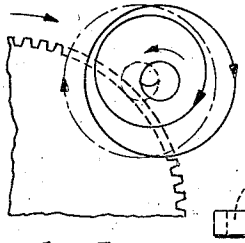


FIG. 3

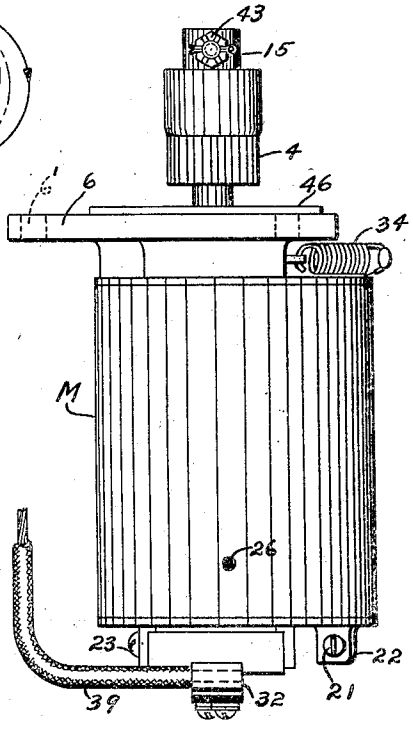


FIG. 5

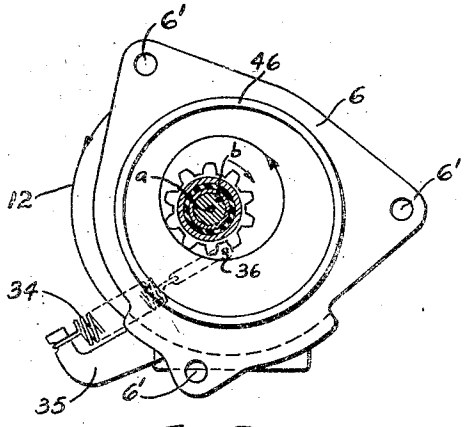


FIG. 7

Inventors
HOMER P. CHANDLER
SAMUEL S. MATTHES

By

Attorney

May 29, 1934. H. P. CHANDLER ET AL 1,960,965

STARTING MECHANISM

Filed Sept. 25, 1931 2 Sheets-Sheet 2

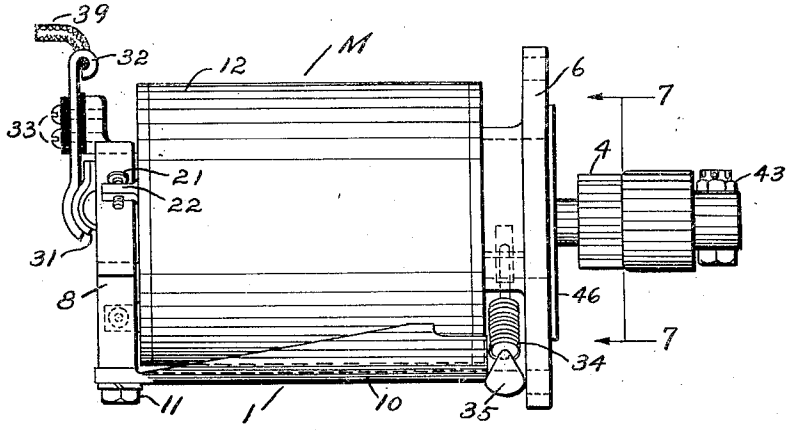


FIG. 6

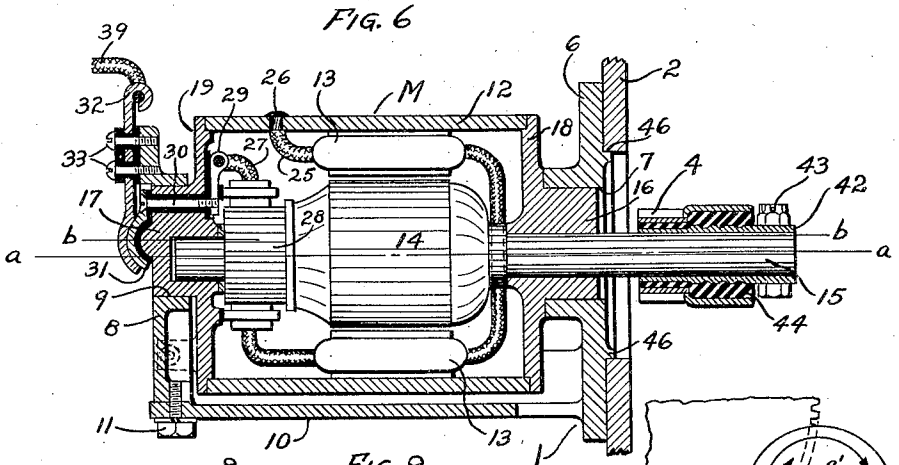


FIG. 9

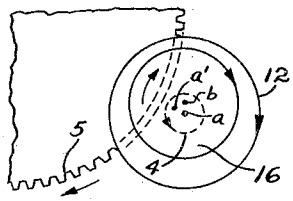


FIG. 10

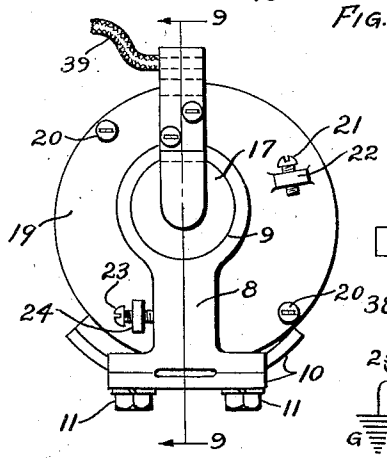


FIG. 8

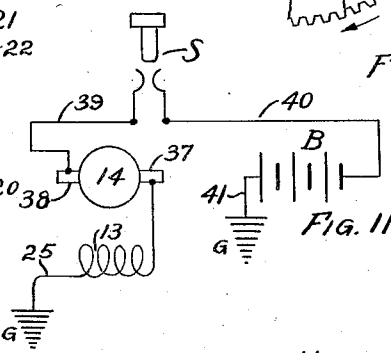


FIG. 11

Inventors

HOMER P. CHANDLER

SAMUEL S. MATTHES

By

Attorney

Patented May 29, 1934 1,960,965

UNITED STATES PATENT OFFICE

1,960,965

STARTING MECHANISM

Homer P. Chandler and Samuel S. Matthes,
Mansfield, Ohio

Application September 25, 1931, Serial No. 565,150

10 Claims. (Cl. 290—38)

Our invention relates to starting devices and particularly those devices adapted to starting engines of the explosive or internal combustion type.

One object of our invention is to provide a starter which is simple in construction and operation and which is efficient and reliable.

Another object of our invention is to provide a starter which will automatically throw into operative engagement with the device to be started and to automatically throw out of and free of engagement with such device instantly upon the device starting.

Another object of our invention is to provide a starter which may be engaged with the moving engine through accidental operation of the starter without injury to the parts thus engaged and which will be immediately thrown out of engagement and automatically rendered inoperative as a starter for the time being.

Another object of our invention is to cause engagement of the starter pinion with the engine gear through direct facial engagement of the teeth throughout their length as against the engagement taking place through longitudinal movement of the pinion relative to the gear as is the practice with many starters now on the market.

Still another object of our invention is to utilize the starting and running torque of the starter motor.

Our invention resides in the new and novel construction, combination and relation of the various parts herein described and shown in the drawings accompanying this specification.

In the drawings:—

Fig. 1 is a schematic view of the relation of the engine gear, motor frame, starter bearings and starter pinion when in the inoperative or "out" relation.

Fig. 2 is a schematic drawing showing the relation of the same parts as in Fig. 1 when the starter is in operative or "in" relation.

Fig. 3 is a schematic drawing showing the combination of Figs. 1 and 2.

Fig. 4 is a schematic drawing showing the top view of the relation of the starter to the engine as applied to an engine-driven car.

Fig. 5 is a top view of our engine starter.

Fig. 6 is a side view of our starter shown in Fig. 5.

Fig. 7 is an end view taken on the line 7—7 of Fig. 6.

Fig. 8 is a view of the left-hand end of Fig. 6.

Fig. 9 is a longitudinal sectional view taken on the line 9—9 of Fig. 8.

Fig. 10 is a modified schematic view of the relation of the parts shown in Fig. 1.

Fig. 11 is a schematic view showing the operating connections, switch and battery in combination with the starter.

Engine starters in the past have generally been of such construction as to involve a great many parts for throwing the starter into and out of engagement or mesh with the engine gear and the operation has been such as to produce considerable wear upon the parts when engaging and disengaging and especially is such wear very large if the starter should be thrown into operative relation with the engine while in motion and many times such operation results in breakage of starter parts.

In our invention the parts are reduced to a minimum and the motor can be thrown into and out of engagement with the engine with practically no wear upon the parts and may be thrown into engagement with the moving engine without any destructive or injurious effects and will be immediately and automatically thrown out of engagement with the engine under such conditions.

In our preferred embodiment of the invention we provide a starter frame or cradle 1 which may be mounted upon a bracket 2 secured to the engine frame 3 so that the pinion 4 on the starter will be permanently held in fixed operative relation with respect to the gear 5 on the engine.

We are describing the operation of the starter with respect to the engine when the starter is in the position shown in Figs. 1 and 4.

The starter frame is provided with a holding flange 6 which is provided with spaced openings 6' by means of which the starter may be secured to the bracket 2 through the medium of bolts, screws or other fastening devices.

The flange 6 acts as a bearing for one end of the starting motor and has a bore 7. The other end of the motor is supported by means of a separately formed bearing 8 having a bore 9 and secured to the lower part 10 of the frame 1 by means of the bolts 11.

We prefer to use an electric motor M as the power unit in our starter, comprising a field frame 12 and coils 13 and armature 14 mounted on the shaft 15 which in turn is mounted in the bearings 16 and 17 projecting from the end plates 18 and 19 respectively and fixedly secured to the field frame 12 by means of the countersunk screws 20.

The axis *a*—*a* upon which the armature rotates coincides with the longitudinal axis of the field frame 12, in other words, the field frame 12 and the armature 14 have a common axis *a*—*a* but the axis *a*—*a* is not the axis upon which the frame pivots.

The axis of the field bearings 16 and 17 upon which the field frame 12 rotates is represented by the line *b*—*b*. It will be noted that the axes *a*—*a* and *b*—*b* do not coincide, in other words, the axis of the armature is eccentric with respect to the axis upon which the field frame rotates such that if the field frame 12 and ends 18 and 19 rotate

about the axis *b*—*b* then the axis *a*—*a* will form a path of revolution about the axis *b*—*b*.

In Fig. 1 is represented schematically the relation of the field frame 12, the field frame bearing 16, the armature pinion 4 and engine gear 5. The axes of the starter are represented as positioned on a radial line approximately 45° with the horizontal, although this particular relation is not necessary.

It is well known that the armature and the field of an electric motor produce a torque, that is, a force which produces or tends to produce relative rotation or torsion. In the field of the motor is held stationary, the torque produces a rotation of the armature only, but should the armature be fixed so that it cannot rotate, then the field would rotate about the armature. We have found that if the field frame and the armature should be mounted so that both are free to rotate, relative rotation of the field and armature will take place about their common axis upon energization of the field and armature, and we have further found that the field frame will rotate relative to the armature and to its supports, also the armature will rotate relative to the field and relative to the supports.

We have also found that if the field frame is mounted to rotate upon eccentrically disposed bearings having the axis of rotation *b*—*b*, that the armature will rotate relative to the frame 12 but opposite thereto upon the axis *a*—*a* and the field frame 12 and armature will rotate as a unit simultaneously upon the axis *b*—*b*.

We make use of these findings as a means of moving the armature pinion into and out of engagement with the engine gear in order to rotate the engine gear and to disengage the starter pinion from the gear instantly and automatically upon the engine starting under its own power.

Referring to Fig. 1 the direction of desired rotation of the engine gear is indicated by the arrow *c* and the center of rotation of the field frame and armature as a unit and relative to the engine gear is about the axis *b* and rotation of the armature relative to the field frame 12 and the gear 5 is upon the axis *a*. The relative directions of rotation of the parts 4, 12 and 16 with respect to each other and the gear 5 are indicated by the arrows. The axis *a* revolves about the axis *b*.

We find that the instant the motor field and armature are energized, the torque between these parts in order to overcome their inertia will cause the motor field 12 to rotate upon the axis *b* as indicated and the armature 14 will rotate about its axis *a* in the direction indicated and simultaneously with the rotation of the field 12 and its bearing 16 about the axis *b* the axis *a* will revolve clockwise about the axis *b* bringing the armature pinion 4 into mesh with the engine gear 5 as shown in Fig. 2, the axis of the armature having moved through the path *d* from the position *a* to the position *a'*.

The armature 14 will continue to rotate upon its axis *a*—*a* and will rotate the engine gear 5 but the motor frame 12 will be prevented from rotating beyond its cooperative position with the engine gear through the engagement of the adjusting screw 21 positioned in the lug 22 (see Fig. 8) with the bearing 8. The adjusting screw 23 mounted in the lug 24 will engage the bearing 8 when the starter is inoperative.

Fig. 3 is a combination of the schematic arrangements shown in Figs. 1 and 2, the starter parts in their "out" positions being shown by solid lines and in their "in" positions by dotted lines.

The motor M may be of the usual standard type used in engine starters modified and mounted in a support so that the field frame may rotate relative to the armature and to the support 1.

It is usual to ground one side of the motor circuit and this we have indicated as the lead 25 secured to the frame 12 at 26 and the lead 27 from the armature 28 is connected to a terminal 29 insulated from the frame and which is held in position by means of the insulated screw 30 which also holds in position a spherically shaped terminal 31 which rotates with the field frame 12 about the axis *b*—*b*. It will be appreciated that the terminal 31 is therefore connected to the armature lead 27 in insulated relation to the frame. Mounted upon the bearing 8, and in insulated relation thereto, is a terminal 32 secured by the screws 33 and contacting with the terminal 31. The cupped surfaces give greater area of contact.

In order to assure the return of the field frame to its normal or "out" position when the starter is inoperative, a spring 34 is secured to a projecting lug 35 from the starter frame and connected to the motor frame by means of the pin 36. This brings the stop screw 23 into contact with the bearing 8. If desired the lead 27 may be brought out through an opening in the field frame 12 or the end plate 29, thus avoiding the use of the special connection comprising the parts 29 to 33 inclusive.

In Fig. 11 is shown a schematic hook-up comprising the field 13 having one end connected to ground G and the other end connected to the armature brush 37, and the other armature brush 38 connected to a switch S by means of the conductor 39. The switch S is also connected to one side of the battery B by means of the conductor 40, the other side of the battery is connected to ground through the conductor 41. The motor, it will be recognized, may be of 2 or 4 pole type, or more if desired, but we have shown a 2-pole motor for simplicity.

When the switch S is closed as by means of the foot of an operator, the field and armature will be energized and the starting torque will instantly throw the pinion 4 into engagement with the gear 5. The armature will rotate in cooperative relation with the gear and rotate the same but the instant the engine starts to rotate under its own power and drives the armature of the starter, the torque between the motor field and armature will not be sufficient to maintain the field frame in its "in" position and the armature pinion in cooperative relation with the engine gear and the motor field will then rotate back to its normal or "out" position and with it the armature and be held in that position by the spring 34. We find that this "out" position of the starter will be maintained even though the switch S remains closed and the armature 14 rotates since the torque between the field and armature is very small while the armature is rotating with practically no load.

We also find that if the engine is running and the switch S is closed, the starter will throw into operative relation with the engine gear due to the initial starting torque of the motor but the instant engagement takes place and the engine drives the motor pinion, the starter will drop out of engagement with the engine gear and return to its normal or "out" position even though the switch S may still be closed due to

the torque not being sufficient to maintain the field frame in its "in" position.

We find that the engagement of the motor pinion with the engine gear takes place with practically no noise or wear upon the teeth and other parts of the apparatus and any engagement of gearing while the engine is operating takes place without clashing. The teeth of the pinion or gear may be so shaped as to assist in the said engagement.

In order to reduce the shock upon the various parts at the time of engagement of the pinion with the gear and cause as silent operation as possible, we mount the pinion 4 upon a sleeve 42 which is secured to the shaft 15 by means of bolt 43 with an interposed mass of resilient vulcanized rubber 44. The pinion 4, sleeve 42 and rubber insert 44 may be secured together by vulcanizing the rubber to the other parts thus forming what may be termed a surface union of the rubber to the metal parts, or it may be secured by means of suitable cement or held by mechanical means such as clamping.

The arrangement of the starter parts with respect to each other and to the engine gear may be considerably varied and the starter may be positioned at various points about the circumference of the engine gear but if placed on the opposite side of the vertical center line *g—g* of the engine gear 5 from that shown in Fig. 1, the axis *a* would then be positioned above the axis *b* so that the rotation of the starter upon its axis *b* would throw the pinion 4 into engagement with the engine gear 5.

In Fig. 7 one is looking at the end of the motor oppositely from that in Figs. 1, 2 and 3 and, therefore, the axis *a* is oppositely disposed to the axis *b* from that shown in Figs. 1, 2 and 3.

In Fig. 10 the axis *b* is shown in direct vertical alignment with the axis *a*, with the center of gravity of the motor below the axis *b*, and substantially in alignment with the axes *a* and *b*, thus the starter will return to its normal position by gravity. We use the spring 34 to make the return of the starter to its "out" position more positive and to maintain it in the "out" position against side throw of the car as the starter field and armature may be said to approximate a pendulum hung in its eccentric bearings 16 and 17 and swinging about the axis *b*.

The starting torque which rotates the field frame upon its eccentrically disposed bearings and throws the pinion into mesh with the engine gear is of very short duration and the pinion is held in mesh with the engine gear only so long as the motor is exerting torque upon the engine gear.

The relation of the parts are such that the armature and motor field are each free to rotate simultaneously and relative to each other in opposite directions upon the axis *a—a* and the field rotates upon eccentrically disposed bearings having the axis *b—b* such that when the starting torque is exerted in the motor, the field will rotate upon its eccentric bearing and move the armature pinion which is mounted to revolve about the axis *b—b* of rotation of the field into engagement with the engine gear while the armature is rotating upon its own axis *a—a* and the pinion will remain in mesh with the engine gear as long as the starter is driving the engine but the pinion will drop out of engagement with the gear instantly upon the engine driving the pinion and the starter will automatically return to its normal or "out" position.

The amount of angular movement of the axis *a* to engage the pinion with the gear may be varied by varying the distance between axes *a* and *b*.

The circular flange 46 will assist in centering and holding the starter in fixed position on the bracket 2. We have referred to the "rotation" of the field frame 12 but it may be said that the "rotation" is more nearly that of a back and forth "oscillation" as the field moves between the stops 21 and 23.

Our invention is adapted to the starting of other devices than gasoline engines and the motor may be any translating device comprising two relatively rotating parts.

In Fig. 4 the auto frame or body is represented at 50. The outer end of the teeth on the pinion 4 may be rounded if desired thus meshing more easily with the gear teeth.

Modifications will suggest themselves to those skilled in the art and, therefore, we wish to be limited only by our claims.

We claim:—

1. The combination with an engine operable by its own power and having a starting gear, of a starter motor having a support with an opening therethrough and mounted on the engine frame in fixed relation to the engine and gear, the motor field mounted on the support to pivot upon its axis relative to the gear, an armature mounted on the motor field to rotate upon its own axis and pivot with the field upon the field axis, a starter pinion secured to the armature and rotatable therewith and projecting through the opening and movable into and out of operative engagement with the engine gear as the field pivots upon its axis, the pinion being normally out of engagement with the gear, means to energize the field and armature at will of an operator, the said energization of the starter creating a torque between the field and armature to rotate the armature and pinion upon the armature axis, the initial torque operating to rotate the field upon its axis to bring the pinion into operative engagement with the gear and rotate the same.

2. The combination with an engine operable by its own power and having a starting gear, of a starter motor having a support with an opening therethrough and mounted on the engine frame in fixed relation to the engine and gear, the motor field mounted on the support to pivot upon its own axis relative to the gear, an armature mounted on the motor field to rotate upon its own axis and pivot with the field upon the field axis, a starter pinion secured to the armature and rotatable therewith and projecting through the opening and movable into and out of operative engagement with the engine gear as the field pivots upon its axis, the pinion being normally out of engagement with the gear, means to yieldingly maintain the pinion normally out of engagement with the gear, means to energize the field and armature at will of an operator, the said energization of the starter creating a torque between the field and armature to rotate the armature and pinion upon the armature axis and move the pinion into operative engagement with the gear and rotate the same and which engagement is maintained until the engine starts and the pinion is rotated by the gear at which time the torque will be reduced and the pinion automatically returned to its normal "out" position and remain in the "out" position until the energization ceases and the armature ceases to rotate and re-energization takes place.

3. A starting device comprising a support having axially aligned spaced bearings, means to secure the support to a holding device, an electric motor having a field and an armature and shaft and axially aligned trunnions on the ends of the field each having an external and an internal bearing surface eccentrically disposed and the trunnions cooperating with the support bearings to mount the motor to pivot relative to the support, to either of two positions, means to limit the pivotal movement of the field in either position, a spring biased to rotate the field to and yieldingly maintain the field in one position, the armature shaft mounted within the said trunnions at the ends of the field, the axis of the armature being parallel to the axis of the field, means mounted on the armature shaft to rotate therewith and accessible for engagement with corresponding means on an engine to rotate the engine and means for electrically connecting the field and armature to a source of energy.

4. A starter motor comprising a field frame having projecting bearings at opposite ends axially aligned upon which the frame pivots and field coils within the frame, an armature positioned within the frame and having its shaft mounted in the said bearings in the ends of the frame and surrounded by the said external bearing surfaces, the axis of the field frame bearings and the axis of the armature bearings being parallel and spaced from each other and means for connecting the field coils and armature to a source of power to energize the field and armature to set up a torque between the two to rotate the armature and field frame relative to each other.

5. A motor comprising an armature and a field frame, the frame comprising a drum-shaped member of iron having enclosing end members, field cores projecting from the inner face of the drum and an energizing coil on each core, each end member provided with a bearing upon which to mount the frame in rotative relation to a support, the bearings on the frame being axially aligned and spaced longitudinally and each end member of the frame being provided with a second bearing to receive the armature shaft, the second bearing at each end being encircled by the bearing surface of the first bearing at that end and the axis of the bearings upon which the frame rotates being spaced from the axis of the bearings in which armature rotates.

6. A starting device comprising, in combination, an electric motor having a field and an armature and shaft mounted to rotate upon separate axes, the field to rotate upon its axis and the armature and shaft to rotate upon their common axis and revolve about the field axis when the field revolves and when the motor is energized and driving means on the armature shaft exterior of the field to transmit motion to a power translating device, a support mounted on the translating device, an opening through the support, the field mounted on one side of the support with the driving means on the other side and the shaft extending through the opening and the field rotatable on its axis relative to the support and the driving means movable transversely to the longitudinal axis of the opening.

7. Apparatus of the character described comprising, in combination, an engine, an upright support mounted on the engine and having an opening therethrough and a starting device, the starting device comprising a support, an electric motor having a field rotatably mounted on one side of the support and an armature provided with a shaft projecting through the opening and revolvable on an axis spaced from that of the field, means on the end of the armature shaft to engage with cooperating means on a power translating device positioned on the opposite side of the support from that of the motor field, the field having two positions, an "in" position in which the means on the armature and the cooperating means therewith engage and an "out" position in which the said means are out of engagement and means for moving the field to its "in" position by the reaction between the field and armature when the motor is energized, said field being returned to its "out" position automatically by the starting of the engine.

8. In apparatus of the class described comprising in combination, an engine, a vertically disposed support on the engine and having an opening therethrough, a motor having a field and an armature with a shaft secured to the support, the axes of rotation of the motor and armature passing through the said passage, bearings for the motor and armature upon which they rotate relative to each other and to the support, the bearing surface of the bearings upon which the motor rotates encircling the axes of rotation of the motor and armature, a starting member for the engine and a starter member for the motor and mounted on the armature shaft and movable into engagement with the starting member to rotate the engine when the motor rotates due to energization of the field and armature.

9. In apparatus of the class described comprising in combination, an engine, a support mounted on the engine, an opening through the support, a motor adapted to start the engine, a bearing at each end of the motor having an external bearing surface and upon which the motor rotates, a starting member for the engine and a starter member on the motor armature to be moved into engagement with the starting member when the motor rotates, means cooperating with said bearings to secure the motor to the said support in rotative relation thereto and in alignment with said opening through which the armature shaft projects with the starter member thereon, the said armature shaft being mounted in the said bearings eccentrically of the said bearing surfaces and means to energize the motor to rotate the motor in its bearing and to move the starter member into engagement with the starting member and to rotate the starter member upon its axis and independent of the motor rotation.

10. The combination with an engine, of a starter for said engine, said starter comprising an electric motor having a relatively rotatable field and armature, a pivotal mounting for said motor comprising a bearing trunnion for said motor field, the axis of said armature being located within the periphery of said trunnion but eccentric thereto so that the reactive torque on said field, when said armature is driven against a load, tends to rotate said motor on its pivotal mounting and shift the axis of said armature to bring said armature into driving connection with said engine.

HOMER P. CHANDLER.
SAMUEL S. MATTHES.