Oct. 30, 1956 L. PETERLIK ET AL 2,769,099

STARTING ARRANGEMENT

Filed March 25, 1955 5 Sheets-Sheet 1

Fig. 1

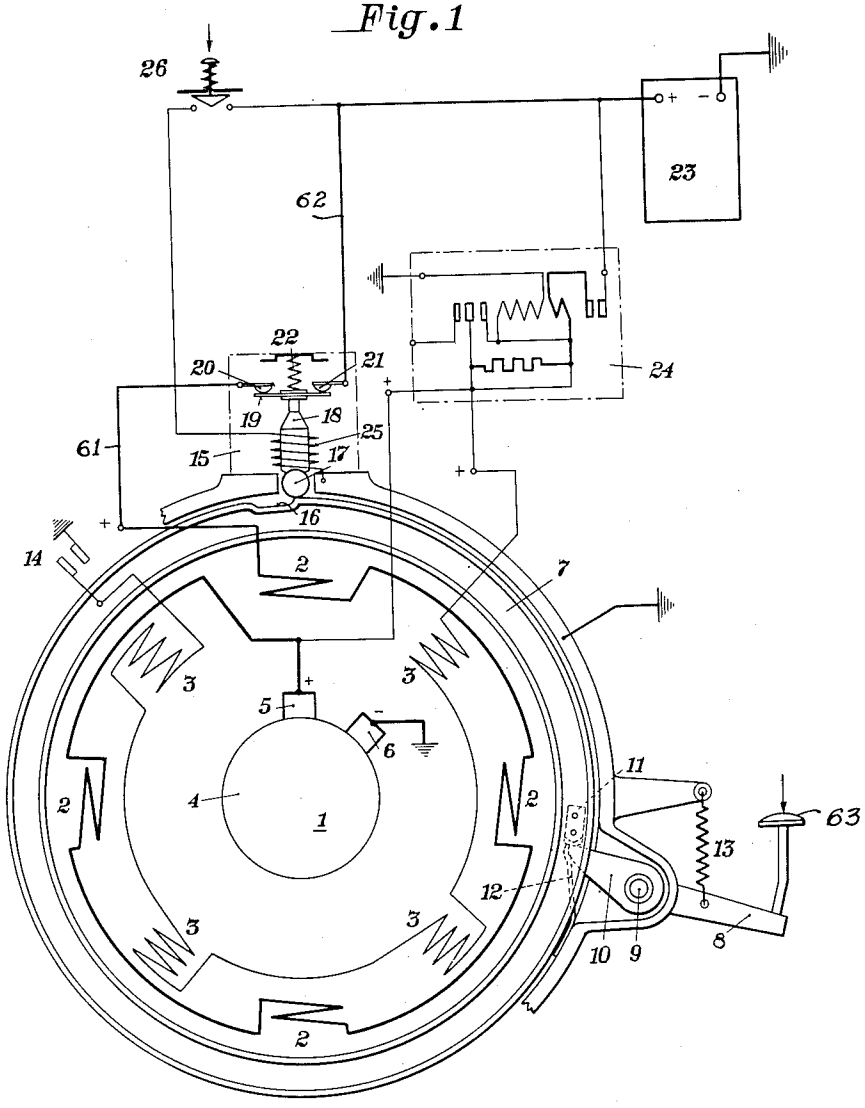
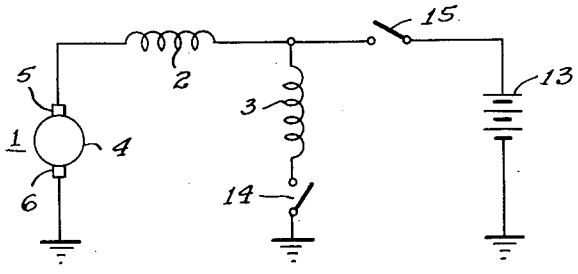


Fig. 9



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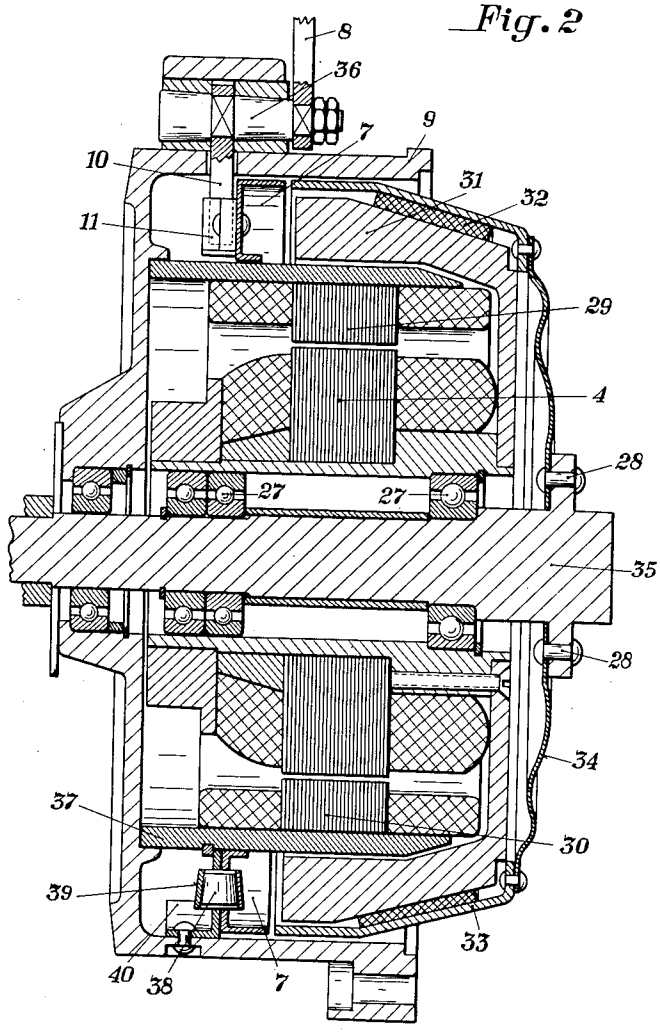
Oct. 30, 1956 L. PETERLIK ET AL 2,769,099

STARTING ARRANGEMENT

Filed March 25, 1955

5 Sheets-Sheet 2

Fig. 2



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Oct. 30, 1956 L. PETERLIK ET AL 2,769,099

STARTING ARRANGEMENT

Filed March 25, 1955

5 Sheets-Sheet 3

Fig. 3a

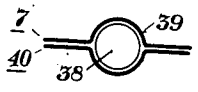


Fig. 3b

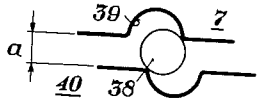


Fig. 4a

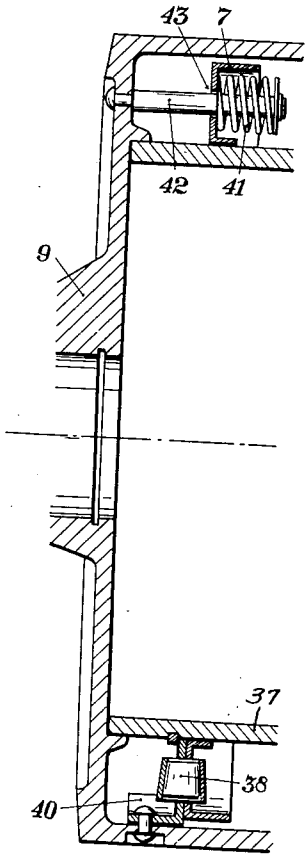
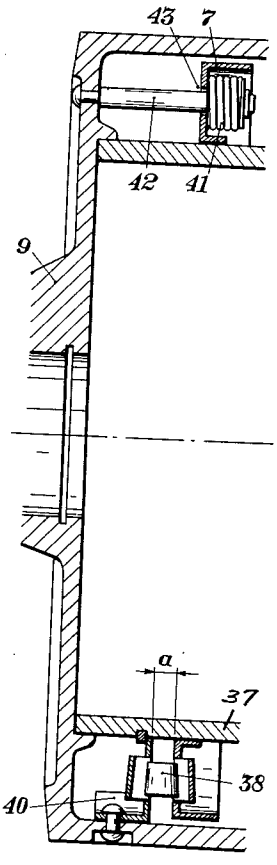


Fig. 4b



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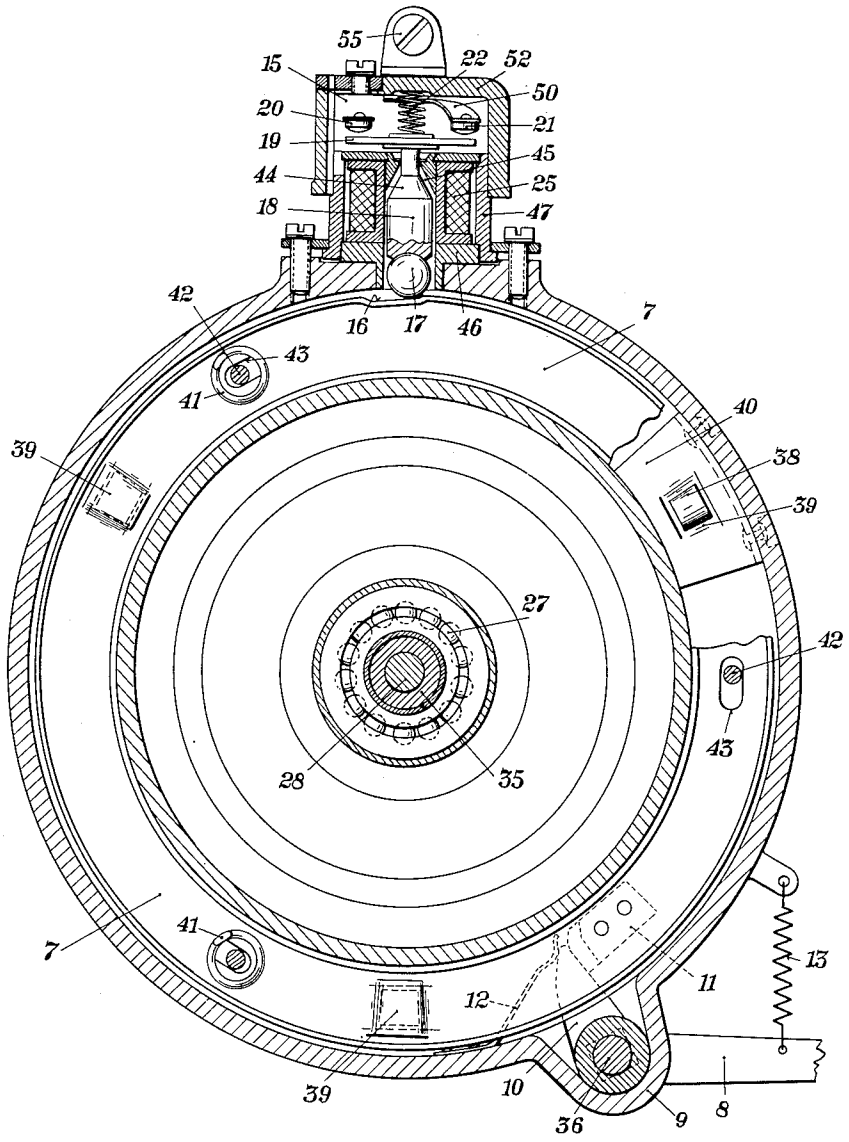
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STARTING ARRANGEMENT

Filed March 25, 1955 5 Sheets-Sheet 4

Fig. 5



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Oct. 30, 1956 L. PETERLIK ET AL 2,769,099

STARTING ARRANGEMENT

Filed March 25, 1955 5 Sheets-Sheet 5

Fig. 6

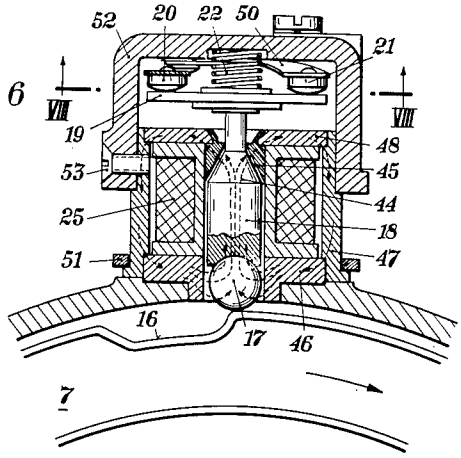


Fig. 7

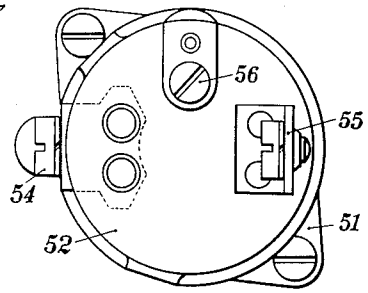
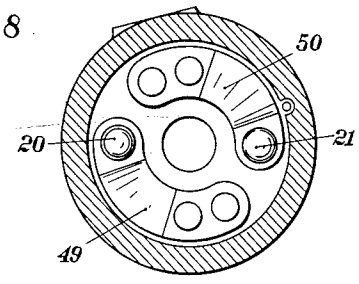


Fig. 8



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United States Patent Office 2,769,099 Patented Oct. 30, 1956

2,769,099

STARTING ARRANGEMENT

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Application March 25, 1955, Serial No. 496,764

Claims priority, application Austria March 31, 1954

5 Claims. (Cl. 290—31)

The present invention relates to a new and improved method and apparatus for starting engines. More particularly the present invention relates to a new and improved method and apparatus for starting internal combustion engines. This application is a continuation-in-part of U. S. patent application Serial #438,710, filed June 23, 1954.

There are flywheel starter arrangements for internal combustion engines wherein a flywheel is disconnected from the shaft of the engine and is rotated by a motor until a predetermined amount of kinetic energy is stored therein. The rotating flywheel is then connected to the shaft of the engine for starting the same. Simultaneously with the connection of the flywheel to the engine shaft, the driving motor is deenergized so that the kinetic energy stored in the flywheel is exclusively available for starting the internal combustion engine.

Such a starting arrangement has inherent disadvantages since the only energy available for starting the internal combustion engine is the kinetic energy stored in the flywheel. It is clear that such kinetic energy is quickly used up. Accordingly, if the internal combustion engine has not started by the time the kinetic energy of the flywheel is used up, the engine will not start.

It is also apparent that the amount of torque necessary to start an internal combustion engine varies with temperature. It is clear at low temperatures the layers of oil in the bearings and cylinders of the engine will be quite thick and will not flow easily. Therefore at low temperatures a substantially high starting torque is necessary. If a large flywheel and a motor for rotating the flywheel are provided to attain sufficient kinetic energy for starting the engine at very low temperature it is apparent that this kinetic energy will be wasted when the engine is started at normal temperatures. On the other hand if only sufficient kinetic energy is available for starting the engine at normal temperature, it will not be possible to start the engine at low temperatures.

In accordance with the present invention a dynamoelectric machine is operated as a motor to rotate a flywheel disconnected from the shaft of the engine until a sufficient amount of kinetic energy is stored to start the engine at normal temperature. The rotating flywheel is then connected to the engine shaft and the electrical connections of the dynamoelectric machine are varied so that the flywheel and started engine drive the machine as a generator. However in the event of low temperatures when additional starting torque is required, means are provided for continuing to operate the machine as a motor to provide additional torque to be added to the rotating flywheel for the starting of the internal combustion engine. After the engine has started, the electrical connections of the dynamoelectric machine are rearranged so that it is driven as a generator.

Accordingly it is an object of the present invention to provide a new and improved method and apparatus for starting internal combustion engines.

Another object of the present invention is to provide a new and improved starting apparatus for internal combustion engines which normally provides sufficient starting torque to start the engine at normal starting temperatures.

A further object of the present invention is to provide a new and improved starting apparatus which includes additional starting torque that may be added to its normal starting torque whenever desired.

Still another object of the present invention is to provide a new and improved starting motor for internal combustion engines.

Another object of the present invention is to provide a new and improved switching mechanism for use with starting apparatus.

Still a further object of the present invention is to provide a new and improved clutch mechanism which may be used with starting motors for internal combustion engines.

With the above objects in view the present invention mainly consists in an apparatus for starting an internal combustion engine including a dynamoelectric machine having a rotatable armature, flywheel means fixedly connected to the rotatable armature and rotatable therewith, coupling means for connecting the armature and the flywheel to the shaft of a combustion engine and for decoupling them therefrom, whenever required, means for connecting and energizing the dynamoelectric machine as a motor to rotate the armature together with the flywheel whenever required, whereby for starting of the combustion engine the dynamoelectric machine is connected and energized as a motor to rotate the flywheel while it is decoupled from the shaft of the combustion engine until the flywheel attains a predetermined speed storing substantial kinetic energy, whereupon the armature and the flywheel are coupled to the shaft of the internal combustion engine for rotation of the shaft and starting of the combustion engine, and means for connecting the dynamoelectric machine as a generator simultaneously with the coupling of the flywheel to the engine shaft.

The present invention also includes a clutch mechanism for coupling to each other two members mounted coaxially and having a first coupling means on one of the members, second coupling means on the other of the members, one of the coupling means being movable in the direction of the common axis of the members between two positions in one of which it is in engagement and in the other of which it is out of engagement with the other of the coupling means, clutch operating means mounted turnably about the common axis of the members and movably in direction thereof, guiding means for guiding the clutch operating means during turning movement in one direction towards the one coupling means for moving the same from one of the positions thereof into the other and guiding the clutch operating means during turning movement in opposite direction away from the one coupling means permitting the same to move from the other position thereof back into the one position, and means for turning the clutch operating means about the common axis of the members.

The present invention is also embodied in a switching mechanism having a housing, a solenoid winding mounted within the housing, a magnetic core axially disposed within the solenoid winding for movement between a first and a second position, the core being composed of at least two parts, one part being substantially cylindrical in shape and the other part being substantially spherical, a first and a second contact electrically insulated from one another mounted in the housing, a contact plate mounted on one end of the core for electrically connecting the first and second contacts together when the core is in its second position, and means for urging the core into its first position where the contact plate is out of contact with the first and second contacts.

Also used in the present invention is a starting motor for internal combustion engines having a motor housing, a first and a second field winding mounted on the inner surface of the housing, a shaft rotatably mounted in the housing, an armature affixed to the shaft in operable association to the field windings, a flywheel fixedly mounted on the armature, an annular ring positioned adjacent the outer surface of the flywheel; resilient means for urging the annular ring against the flywheel, the resilient means being connected to both the annular ring and the shaft of the engine, an annular clutch plate movably mounted in the motor housing adjacent the annular ring, the clutch plate being movable in the axial direction of the shaft towards and away from the annular ring, and means for moving the clutch plate towards the annular ring into contact therewith for urging the annular ring away from the flywheel.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a starting apparatus constructed in accordance with the principles of the present invention;

Fig. 2 is a transverse sectional view of a starting motor capable of being used in the starting apparatus in accordance with the principles of the present invention;

Fig. 3*a* is a diagrammatic representation of a portion of the clutch mechanism used with the present invention when the clutch is in its normal position;

Fig. 3*b* is a diagrammatic representation of the same mechanism shown in Fig. 3*a* when the clutch is in its operated position;

Fig. 4*a* is a fragmentary view of Fig. 2 showing the relationship of various elements of the clutch mechanism in their normal position;

Fig. 4*b* shows the elements of Fig. 4*a* when the clutch is in its operated position;

Fig. 5 is a cross sectional view of starting apparatus capable of carrying out the principles of the present invention;

Fig. 6 is a transverse cross sectional view of a switch mechanism used in the starting apparatus;

Fig. 7 is a plan view of the switch mechanism shown in Fig. 6;

Fig. 8 is a cross sectional view taken on the line VIII—VIII of Fig. 6; and

Fig. 9 is a schematic diagram showing the electrical connections between several of the elements of the present invention.

Referring now to the drawings and more particularly to Figs. 1, 2 and 9 it can be seen that a dynamoelectric machine 1 has a rotatable armature 4, a series field winding 2 and a shunt field winding 3. Brushes 5 and 6 supply current to the dynamoelectric machine 1 or take current therefrom depending on whether the machine is operating as a motor or generator respectively. The brush 6 is connected to ground. The brush 5 is connected to one side of the series field winding 2 and is also connected to a conventional voltage regulator 24. The other side of the series field winding 2 is connected on conductor 61 to a contact 20 of a switch 15. Switch 15 has a second contact 21 which is connected on conductor 62 to the positive terminal of a storage battery 23. It is apparent that battery 23 may be the conventional storage battery used on automotive vehicles, for example.

The positive terminal of the storage battery 23 is also connected to one side of a normally open push button switch 26 the other side of which is connected to one end of a solenoid winding 25 of the switch 15. Axially disposed in the winding 25 is a substantially cylindrical magnetic core 18 which is connected to a contact plate 19. The core 18 is normally urged in a downward direction by the spring 22.

Beneath the core 18 is a magnetic ball 17 which makes contact with and rides on the outer surface of an annular clutch operating member 7. The clutch operating member 7 has a reentrant portion 16 in which the ball 17 normally is disposed. In Fig. 1 the member 7 is shown in its operated position after it has been rotated slightly in a counterclockwise direction.

The mechanism for operating the member 7 is mounted on the electrically grounded housing 9 of the machine 1, and includes a lever arm 10 pivotally mounted on the housing 9. The lever arm 10 is operated by a clutch lever 8 which for example may be connected to the foot pedal 63 of an automotive vehicle. The clutch lever 8 is normally urged upwardly by the spring 13.

The lever arm 10 cooperates with a bracket 11 fixedly mounted on the clutch operating member 7 and including a leaf spring 12 which is biased against the lever arm 10. It is clear that when the foot pedal 63 is depressed downwardly in the direction of the arrow the clutch lever 8 and lever arm 10 cooperate with the bracket 11 to rotate the annular clutch member 7 in a counterclockwise direction as shown.

In the position shown in Fig. 1 the unattached end of the leaf spring 12 abuts against the bracket 11 to relieve the downward pressure on the pedal 63. Accordingly, as can be seen in Fig. 5, when the pedal 63 is released, the spring 13 need only exert sufficient force to have the lever arm 10 push the spring 12 out of contact with the bracket 11. When this occurs the clutch operating member 7 is urged back toward its normal position by spring members 41 which will be described hereinafter. The clutch member 7 is also moved in an axial direction with respect to the machine 1 as will also be described.

In Fig. 1, a movable contact of a switch 14 is also connected to the clutch operating member 7 so that the switch 14 is opened when the clutch is operated and is closed when the member 7 is in its normal unrotated position. This movable contact of the switch 14 is connected to one end of the shunt field winding 13, the other end of which is connected to the brush 5.

From Fig. 9 it can be seen that when the switch 15 is closed and the switch 14 is opened the storage battery 23 energizes the dynamoelectric machine 1 which operates as a series motor. From Fig. 1 it is seen that the pressure of the foot pedal 63 rotates clutch operating member 7 in a counterclockwise direction to simultaneously open switch 14 and to urge the movable core of the switch 15 in an upward direction until contacts 20 and 21 of switch 15 are bridged by the contact plate 19 so that machine 1 operates as a series motor.

By mechanical means which will be described hereinafter, machine 1 is connected to a flywheel. When the member 7 is rotated in a counterclockwise direction and moves axially with respect to the machine 1, the flywheel is disconnected from the shaft of the internal combustion engine to be started. The flywheel can then be rotated by the machine 1 operating as a series motor until the desired kinetic energy is obtained. The foot pedal 63 is then released and the clutch operating member 7 is returned to its normal position. This opens switch 15 when the ball 17 and the core 18 drop into the reentrant surface portion 16 of the member 7. At the same time the switch 14 is closed. As can be seen from Fig. 9 this disconnects the machine 1 from the storage battery 23 and permits the dynamoelectric machine to be operated as a generator.

It is clear that the voltage regulator 24 which was not shown in the schematic diagram of Fig. 9 for purposes of clarity conventionally connects and disconnects the generator to charge the storage battery 23 in a manner well known in the art.

Accordingly, with the above described arrangement

it is possible to disconnect the flywheel from the shaft of the internal combustion engine and to simultaneously connect the dynamoelectric machine and energize the same as a motor to rotate the flywheel. When the desired kinetic energy has been stored in the rotating flywheel it may be reconnected to the shaft of the internal combustion engine while the dynamoelectric machine is deenergized and simultaneously connected as a generator.

Therefore, with normal operating temperatures normal starting torque is provided by the rotating flywheel with a minimum current drain from the storage battery **23**. In the event of low temperatures however, when additional starting torque is needed, means are provided in accordance with the principles of the present invention to supply this additional starting torque.

These means include the switch **26** which may be depressed to energize the solenoid winding **25** by connecting it between the positive terminal of the storage battery **23** and ground. The core **18**, the ball **17** and the solenoid winding **25** are so arranged that a magnetic flux is provided by the winding **25** which is insufficient for the purposes of drawing the core **18** and the ball **17** up from their lowermost position against the pressure of the spring **22**. However, this magnetic flux is sufficient to keep the ball **17** and the core **18** in their upper position after they have been so moved by the counterclockwise rotation of the clutch member **7**.

Therefore, if the foot pedal **63** is depressed to rotate the clutch member **7** in a counterclockwise direction to connect the dynamoelectric machine **1** as a series motor to store kinetic energy in the rotated flywheel and the switch **26** is closed before the foot pedal **63** is released, the switch **15** will remain closed even after the clutch member **7** has returned to its normal position. With these connections the rotating flywheel will be connected to the shaft of the internal combustion engine and an additional starting torque will be provided as the dynamoelectric machine **1** continues to operate as a compound motor. After the engine has started, the switch **26** can be opened to release the core **18** and the ball **17** thereby opening switch **15** and contining to operate the dynamoelectric machine **1** as a generator.

Referring now to Fig. 2 the mechanical arrangement of the various members described with respect to Fig. 1 is shown. The rotatable armature **4** of the dynamoelectric machine **1** is rotatably mounted with respect to the rotatable shaft **35** of the internal combustion engine (not shown). The armature **4** is prevented from axial motion along the shaft **35** by the mounting bearings **27**. The poles **29** and **30** on which are mounted the series winding **2** and shunt winding **3** respectively are shown in operative relationship to the armature **4** and mounted within the housing **9**.

A flywheel **31** is fixedly mounted with respect to the armature **4** so as to be rotatable therewith. Mounted on the outer conical surface of the flywheel **31** is a clutch lining **32** that is shown cooperating with an annular coupling member **33** of the clutch mechanism. The couling member **33** is connected to the shaft **35** by means of the resilient diaphragm **34**. From this arrangement it is seen that the coupling member **33** is axially movable with respect to the shaft **35** but is arranged so as to always rotate with the shaft **35**.

Also mounted within the housing **9** are circumferentially spaced tapered bearing members **38** which are rotatably mounted within brackets **40** mounted on the housing **9**. The annular clutch operating member **7** is arranged about the inner part **37** of the starter housing **9**. Circumferentially spaced depressions **39** in the surface of the clutch operating member **7** mate with the bearings **38**. This is more clearly seen in Figs. 3*a*, 4*a* and 5. In Fig. 4*a* it can be seen that the clutch operating member **7** is normally urged into contact with the tapered bearings **38** and away from the annular coupling member **33** by springs **41**.

Each of the springs **41** are mounted on a stud **42** fixedly secured to the housing **9**. The stud **42** passes through a slot **43** in the clutch operating member **7**. This slot is arranged as shown in Fig. 5 so that the clutch operating member **7** may be partially rotated in a counterclockwise position from its normal position.

Referring again to Fig. 2 it can be seen that the clutch lever **8** is mounted on a shaft **36** which is pivotally mounted on the housing **9** and carries the lever arm **10** which cooperates with the bracket **11** on the clutch operating member **7**.

Accordingly it can be seen that in the normal position, before the internal combustion engine is started the coupling member **33** connects the flywheel **31** and the rotatable armature **4** to the shaft **35** of the internal combustion engine. When the clutch lever **8** is depressed, the clutch operating member **7** is rotated in a counterclockwise direction. When this occurs the inner surfaces of the depressions **39** of the clutch operating member **7** ride up on the tapered bearings **38** to move the clutch operating member **7** in an axial direction towards the coupling member **33** to disengage the latter from the clutch lining **32**. This operated position of the clutch operating member **7** is shown in Figs. 3*b* and 4*b*.

From these last mentioned figures it can be seen that the clutch operating member **7** is moved in an axial direction for a distance equal to *a*. As previously described this counterclockwise and axial movement of the clutch operating member **7** also connects the dynamoelectric machine **1** to the storage battery **23** and energizes the same as a series motor. Accordingly the motor rotates the flywheel **31** which is now disconnected from the shaft **35**.

After the desired kinetic energy has been stored in the rotating flywheel **31** the clutch lever **8** is released to permit the springs **41** to return the clutch operating member **7** to its original position. This engages the coupling member **33** with the clutch lining mounted on the conical outer surface of the flywheel **31** and serves to transfer the stored kinetic energy from the flywheel to the shaft **35**.

Simultaneously with the return of the clutch operating member **7** to its original position, the dynamoelectric machine **1** is disconnected from the storage battery **23** and its field windings are arranged in such manner that the started internal combustion engine drives machine **1** as a generator.

Referring now to Fig. 6 the magnetic flux distribution within the switch **15** is shown. It is clear that in this figure the clutch operating member **17** has been rotated counterclockwise from its normal position. Accordingly the ball **17** has moved upwards along the side portions of the reentrant surface **16** to force the core **18** up against the spring **22**.

The core **18** has a conically constricted portion **44** which bears against a correspondingly shaped conical abutment **45**. In the particular configuration shown, the closed magnetic flux circuit includes the core **18**, the ball **17**, the base plate **46**, the casing **47** and the cover plate **48** which are all made of magnetic material. It can be seen that the lower portion of the core **18** has a convex shape to cooperate with the ball **17**. This permits a substantial portion of the magnetic flux to flow through the ball **17**.

The ball **17**, the core **18**, the conically constricted portion **44** and the abutment **45** are arranged and dimensioned so that an air gap exists between the conical constriction **44** and the abutment **45** when no current is flowing through the solenoid coil **25**. When the coil **25** is energized and the core **18** and the ball **17** are in their upper position, the core and ball are further raised by the magnetic forces set up within the solenoid coil. This closes the air gap previously existing between the constricted portion **44** and the abutment **45**.

As shown in Fig. 8 the contacts **20** and **21** are preferably made of resilient annular sectors **49** and **50** of elec-

trically conducting material. One material which can be used, for example, is spring bronze. The contact plate 19 shown in Fig. 6 which is mounted on the core 18 and closes the contacts 20 and 21 may be circular and made of electrically conductive material such as copper.

As shown in Fig. 7, the switch mechanism 15 is arranged in a casing 47 which is mounted on the housing of the dynamoelectric machine 1 by means of a flanged support 51. The contacts 20 and 21 of the switch 15 are mounted in an electrically insulated cap 52 which is secured on the casing 47 by screws 53. Externally, a cap 52 carries connections 54 and 55 of the contacts 20 and 21 respectively. Also mounted on the cap 52 is a terminal 56 which is connected to one end of the solenoid coil 25. As shown in Fig. 1 the outer end of the coil 25 is connected to the housing of the machine 1 which is grounded.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of starting apparatus differing from the types described above.

While the invention has been illustrated and described as embodied in a starting apparatus for internal combustion engines, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. Apparatus for starting an internal combustion engine comprising, in combination, a dynamoelectric machine having a rotatable armature; flywheel means fixedly connected to said rotatable armature and rotatable therewith; coupling means for connecting said armature and said flywheel to the shaft of a combustion engine and for decoupling them therefrom, whenever required; means for connecting and energizing said dynamoelectric machine as a motor to rotate said armature together with said flywheel whenever required, whereby for starting of the combustion engine said dynamoelectric machine is connected and energized as a motor to rotate said flywheel while it is decoupled from the shaft of said combustion engine until said flywheel attains a predetermined speed storing substantial kinetic energy, whereupon said armature and said flywheel are coupled to the shaft of said internal combustion engine for rotation of said shaft and starting of the combustion engine; and switch means operated by said coupling means for connecting said dynamoelectric machine as a generator simultaneously with the coupling of said flywheel to said engine shaft.

2. Apparatus for starting an internal combustion engine comprising, in combination, a dynamoelectric machine having a rotatable armature; flywheel means fixedly connected to said rotatable armature and rotatable therewith; coupling means for connecting said armature and said flywheel to the shaft of a combustion engine and for decoupling them therefrom, whenever required; a first field winding arranged in series with said armature; first actuating means for energizing said first field winding, whenever required; a second field winding arranged in parallel with said armature, whereby for starting of the combustion engine said first field winding is energized by said first actuating means to operate said dynamoelectric machine as a series motor to rotate said flywheel while it is decoupled from the shaft of said combustion engine until said flywheel attains a predetermined speed storing substantial kinetic energy, whereupon said armature and said flywheel are coupled to the shaft of said internal combustion engine for rotation of said shaft and starting of the engine; and switch means operated by said coupling means for simultaneously deactuating said first actuating means and connecting said dynamoelectric machine as a generator when said flywheel is coupled to said engine shaft.

3. Apparatus for starting an internal combustion engine comprising, in combination, a dynamoelectric machine having a rotatable armature; flywheel means fixedly connected to said rotatable armature and rotatable therewith; coupling means for connecting said armature and said flywheel to the shaft of a combustion engine and for decoupling them therefrom, whenever required; a first field winding arranged in series with said armature; first actuating means for energizing said first field winding, whenever required; a second field winding arranged in parallel with said armature, whereby for starting of the combustion engine said first field winding is energized by said first actuating means to operate said dynamoelectric machine as a series motor to rotate said flywheel while it is decoupled from the shaft of said combustion engine until said flywheel attains a predetermined speed storing substantial kinetic energy, whereupon said armature and said flywheel are coupled to the shaft of said internal combustion engine for rotation of said shaft and starting of the engine; and means for energizing said first and second field windings to operate said dynamoelectric machine as a compound motor after said flywheel is coupled to said engine shaft.

4. Apparatus for starting an internal combustion engine comprising, in combination, a dynamoelectric machine having a rotatable armature; flywheel means fixedly connected to said rotatable armature and rotatable therewith; coupling means for connecting said armature and said flywheel to the shaft of a combustion engine and for decoupling them therefrom whenever required; a first field winding arranged in series with said armature; a second field winding arranged in parallel with said armature; a storage battery connected in circuit with said first and second field windings for energizing said dynamoelectric machine as a motor whenever desired; first switch means connected in circuit between said storage battery and said first field winding, said switch being operable between a closed and an open position; a second switch means connected in circuit between said storage battery and said second field winding and being operable between a closed and an open position, whereby for starting of the combustion engine said first switch means is closed and said second switch means is simultaneously opened to energize said dynamoelectric machine as a series motor and rotate the flywheel while it is decoupled from the shaft of said internal combustion engine until said flywheel acquires a substantial kinetic energy whereupon said armature and said flywheel are coupled to the shaft of said internal combustion engine for rotation of said shaft and starting of the combustion engine; and means for simultaneously opening said first switch means and closing said second switch means to connect said dynamoelectric machine as a generator when said flywheel is coupled to said engine shaft.

5. Apparatus for starting an internal combustion engine comprising, in combination, a dynamoelectric machine having a rotatable armature; flywheel means fixedly connected to said rotatable armature and rotatable therewith; coupling means for connecting said armature and said flywheel to the shaft of a combustion engine and for decoupling them therefrom, whenever required; a storage battery for energizing said dynamoelectric machine when desired; a switch housing mounted on said dynamoelectric machine; a solenoid winding mounted within said housing; a magnetic core axially disposed within said solenoid winding for movement between a first and a second position, said core being composed of at least two parts, one

part being substantially cylindrical in shape and the other part being substantially spherical, said spherical part of said core being in contact with said coupling means, a first and a second contact electrically insulated from one another mounted in said switch housing; a contact plate mounted on one end of said core for electrically connecting said first and said second contacts together when said core is in its second position; means for urging said core into its first position against said coupling means where said first and second contacts are disconnected; means for actuating said coupling means whereby for starting of the combustion engine said coupling means are actuated to decouple said flywheel from the shaft of said internal combustion engine, said coupling means simultaneously operating said core of said switch into its second position to close said first and second contacts to energize said dynamoelectric machine as a motor and rotate said flywheel until it acquires substantial kinetic energy whereupon said armature and said flywheel are coupled to the shaft of said internal combustion engine

for rotation of said shaft and starting of the combustion engine; and means for connecting said dynamoelectric machine as a generator simultaneously with the coupling of said flywheel to said engine shaft.

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