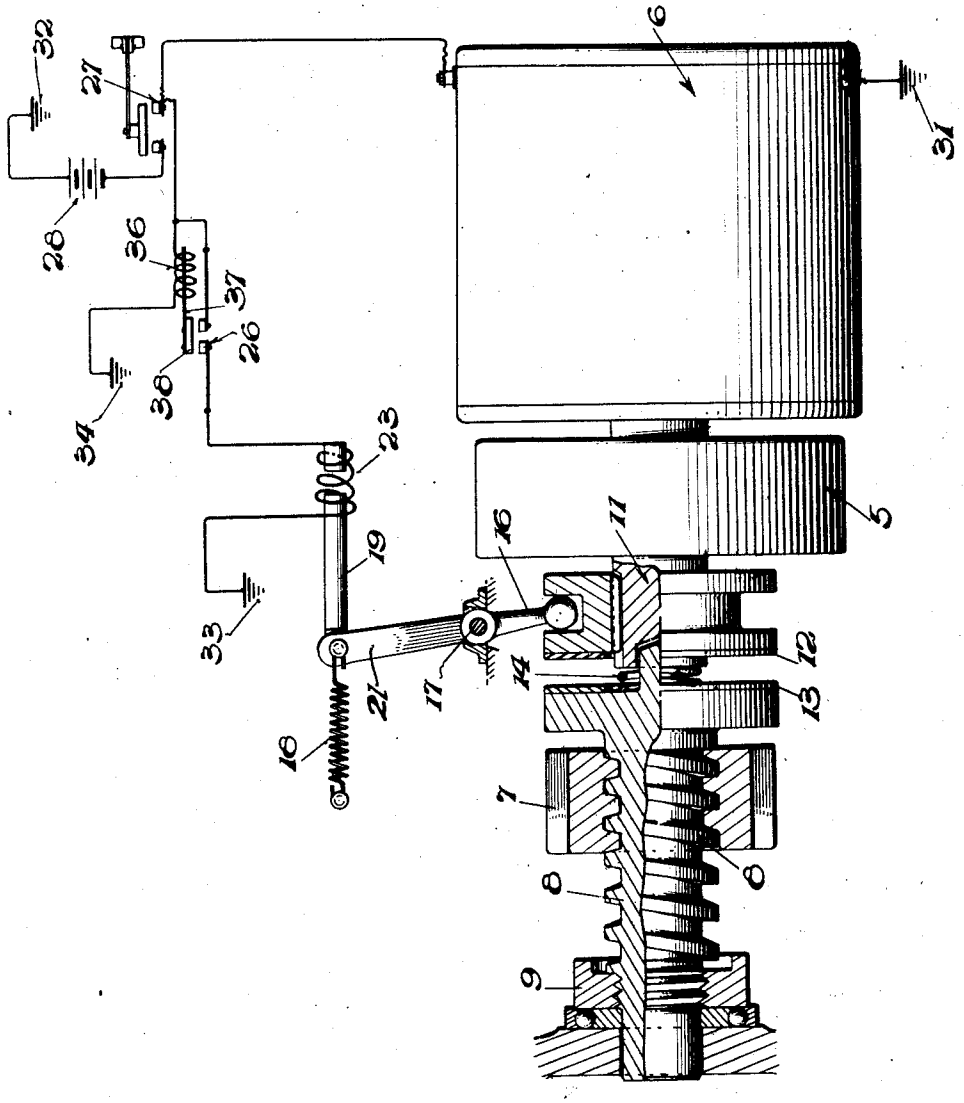
May 26, 1942. D. P. KEARNEY 2,284,431

ENGINE STARTING APPARATUS

Filed July 2, 1941



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UNITED STATES PATENT OFFICE

2,284,431

ENGINE STARTING APPARATUS

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Application July 2, 1941, Serial No. 400,845

6 Claims. (Cl. 290—38)

This invention relates to engine starting apparatus and more particularly to starters of the inertia type.

Such starters have commonly utilized a light inertia member, or flywheel, which is actuated by either manual or power means to a very high speed so as to store energy therein, the energy thus stored being then transmitted to a driven or engine-engaging member through a reduction gear train or other transmission.

Sometimes when it is attempted to engage the rapidly rotating starter member with a rotatable member of a large engine to be started while the latter is at rest, only the ends of the teeth of the engaging member become meshed, and there not being sufficient metal to take up the load, distortion or breaking of the teeth occurs.

It is therefore one of the objects of the present invention to provide a novel engine starter of the inertia type in which the driving member may be fully engaged with the rotatable member of the engine to be started without transmitting any load therebetween, and the full load may subsequently be gradually applied, the full faces of the engaged teeth taking the stress without distortion or breaking.

Another object is to provide an engine starter which is rugged and strong enough, and of sufficient capacity, to start a reasonably high compression engine in a dependable and efficient manner without requiring a structure of excessive size, weight, or cost of manufacture.

Another object is to provide an engine starter of the inertia type embodying a high speed flywheel of considerable mass, and novel means for effecting movement of the engine-engaging or driven member to engine-engaging position during the first stage of the flywheel's acceleration.

A further object is to provide a novel engine starter wherein the driven member of the starter may be moved into cranking engagement with the engine to be started at a time when the former is subject to little or no driving torque, the driving connection between said member and its source of energy being adapted to yield after said movement has been completed, and to continue to yield while the driving energy is being cumulatively stored in the driving element of the starter, after which torque transmission begins automatically.

These and other objects will appear more fully from a consideration of the detailed description of the invention which follows. Although only one embodiment of the present invention is described and illustrated in the accompanying drawing, it is to be expressly understood that the drawing is for the purpose of illustration only, and is not be construed as a limitation of the scope of the invention, reference being had for this purpose to the appended claims.

In the drawing reference character 5 designates the inertia member, or flywheel, numeral 6 its driving motor, and numeral 7 the engine-engaging, driven element of the starting apparatus. As shown, the driven element 7 is a pinion of the screw-actuated "Bendix" type that moves axially of its supporting and driving shaft 8 in order to engage the engine member (not shown); the axial movement being finally arrested by engagement with adjustably positioned stop-nut 9.

The motor 6 has a projecting rotor shaft 11, to which is keyed the flywheel 5; and splined thereto is the driving half 12 of a normally disengaged clutch 12, 13; the driven half 13 being shown as integral with the screw-shaft 8. A compressible spring 14 is interposed between the end faces of the shafts 8 and 11, and a yoke 16 straddles the clutch half 12, as shown. This yoke 16 is shiftable about a pivot shaft 17 by means 18 and 19 disposed on opposite sides of the yoke extension 21.

Means 18 is shown as a spring which normally holds the yoke 16 (hence the clutch element 12) in the position shown in the drawing, and means 19 is the movable pole-piece, or plunger, of a solenoid 23 forming part of a circuit which also includes two serially connected switches 26 and 27. A source of current is shown at 28, and ground connections at 31, 32, 33, and 34; the last-named being the terminal of a coil 36 which surrounds a bi-metallic element 37 fixedly mounted at one end and carrying on its free end a contact 38 which is adapted to bridge the contacts of switch 26, when the element 37 becomes sufficiently heated.

In operation, closure of switch 27 energizes motor 6 and coil 36, the two units being in parallel circuits leading from the common source 28. As the motor shaft 11 begins to rotate, the frictional contact with spring 14 is sufficient to impart the necessary rotary movement to the driven shaft 8 to insure completion of the meshing action of the pinion 7, as previously described. In the event of end-to-end tooth contact, the spring friction is augmented by reason of the resulting axial deflection thereof, wherefore there is assured sufficient rotation for full meshing; but, if preferred, the same result may be

achieved by use of mesh-facilitating clutch elements on parts 11 and 8, respectively, which auxiliary clutch elements would be self-disengaging as soon as the end-to-end tooth contact ceased.

When the meshing action is completed, the inertia of the engine will resist further rotation of the entire transmission, including the pinion 7, and the flywheel 5 will accordingly proceed to run freely, and accelerate to high speed in response to the continued flow of current of the motor. When the parallel current flow through coil 36 has proceeded to the point where the heat generated is sufficient to move contact 38 on bimetallic element 37 into engagement with contacts 26, current will flow to solenoid 23, to move the yoke extension 21, adapted to be actuated by the said solenoid 23. This movement is communicated to the clutch member 12 to move the latter into engagement with clutch member 13, whereupon there is begun the transmission of driving torque from the now energized flywheel 5 to the now engaged pinion 7.

When the engine has been started by the torque thus transmitted to the engine member (not shown), the resulting acceleration of the pinion 7 to a speed beyond that of the starter driven shaft 8 causes the pinion to be reversely threaded back to the position indicated in Fig. 1. Meanwhile the release of the switch 27 permits the contact element 37 to cool off, whereupon switch 26 is unbridged, and spring 18 acts to return the clutch member 12 to the disengaged position (shown).

By the use of this novel clutch control, the driven member of the starter may be engaged with the engine member without any danger of injury to the teeth of the engaging jaws, and the energy stored in the flywheel may thereafter be transmitted to the driven member—that is, after the latter has become engaged with the engine member. However, under favorable conditions, as in summer weather, when starting may be accomplished with the exertion of comparatively little energy, it is possible to convert the unit into a direct-cranking starter by manually throwing arm 21 to apply full pressure to clutch 13, 12 at the out-set, rather than waiting for the flywheel 5 to be first accelerated. This possibility increases the usefulness of the invention.

It will be obvious that the invention is not limited to the form shown in the drawing, but is capable of a variety of mechanical embodiments. Various changes, which will now appear to those skilled in the art, may be made in the form, details of construction, and arrangement of the parts without departing from the spirit of the invention, and reference is therefore to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In combination with an engine starting inertia member rotatable to high speed to store energy, an engine-engaging member operable by said inertia member, means for rotating the inertia member, said means comprising a source of current, an electric motor, and a circuit from said source to said motor, means responsive to initial flow of current from said source, and the resulting initial rotation of said motor and inertia member, to move said engine-engaging member to engine-engaging position, and means responsive to continued flow of current to drivably connect said inertia member with said engine-engaging member, for transmission thereto of the energy stored in said inertia, member.

2. In combination with an engine starting inertia member rotatable to high speed to store energy, an engine-engaging member operable by said inertia member, means for rotating the inertia member, said means comprising a source of current, an electric motor, and a circuit from said source to said motor, means responsive to initial flow of current from said source, and the resulting initial rotation of said motor and inertia member, to move said engine-engaging member to engine-engaging position, and delayed action means for causing torque transmission to said engine-engaging member from said inertia member only after the latter has accelerated to a predetermined degree.

3. In combination with an engine starting inertia member rotatable to high speed to store energy, an engine-engaging member operable by said inertia member, means for rotating the inertia member, said means comprising a source of current, an electric motor, and a circuit from said source to said motor, means responsive to initial flow of current from said source, and the resulting initial rotation of said motor and inertia member, to move said engine-engaging member to engine-engaging position, and delayed action means for causing torque transmission to said engine-engaging member from said inertia member only after the engine-engaging member has moved into full engine-engaging position

4. In combination with an engine starting inertia member rotatable to high speed to store energy, an engine-engaging member operable by said inertia member, and heat responsive means for causing torque transmission to said engine-engaging member from said inertia member only after the latter has been energized for a period of time sufficient for said heat responsive means to become heated to a predetermined degree.

5. In combination with an engine starting inertia member rotatable to high speed to store energy, an engine-engaging member operable by said inertia member, means for moving said engine-engaging member to engine-engaging position, and heat responsive means for causing torque transmission to said engine-engaging member from said inertia member only after the latter has been energized for a period of time sufficient for said heat responsive means to become heated to an operative degree.

6. In combination with an engine starting inertia member rotatable to high speed to store energy, an engine-engaging member operable by said inertia member, means for moving said engine-engaging member to engine-engaging position, and heat responsive means for causing torque transmission to said engine-engaging member from said inertia member, only after the engine-engaging member has moved into full engine-engaging position.

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