June 11, 1935. M. P. WHITNEY 2,004,643

STARTER DRIVE

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Fig. 1

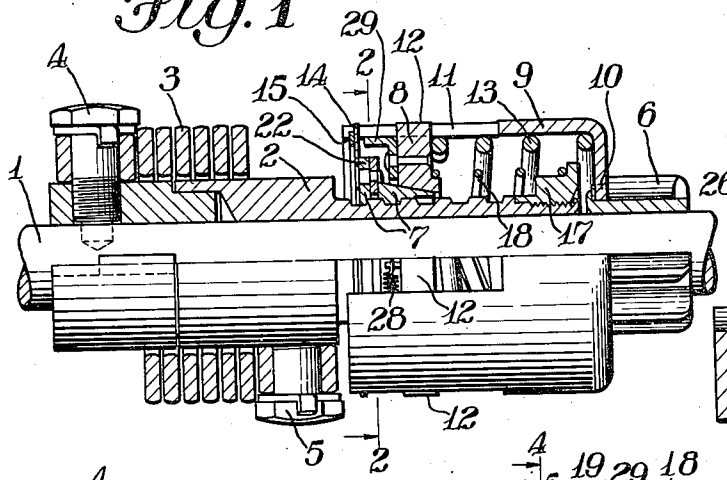
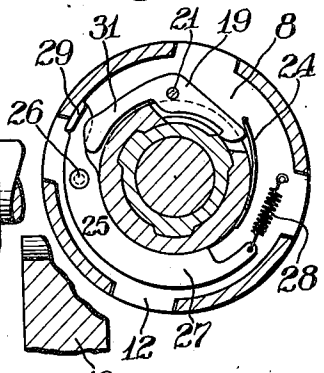


Fig. 2



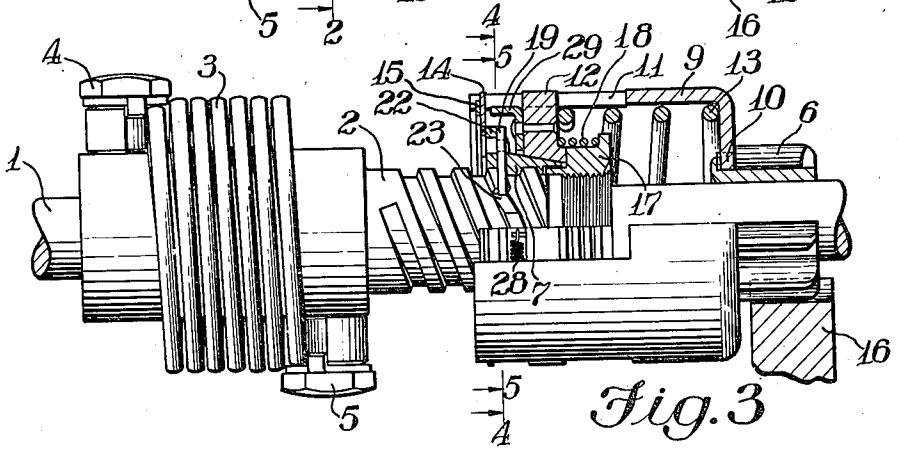


Fig. 3

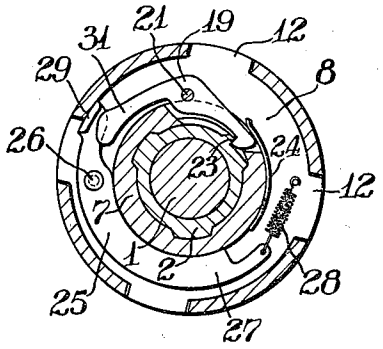


Fig. 4

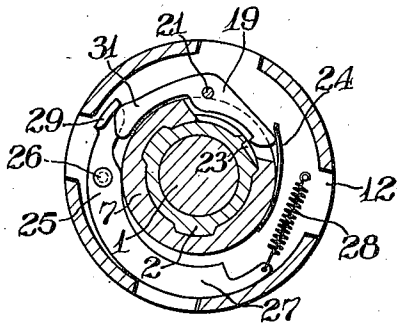


Fig. 5

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Fig. 6

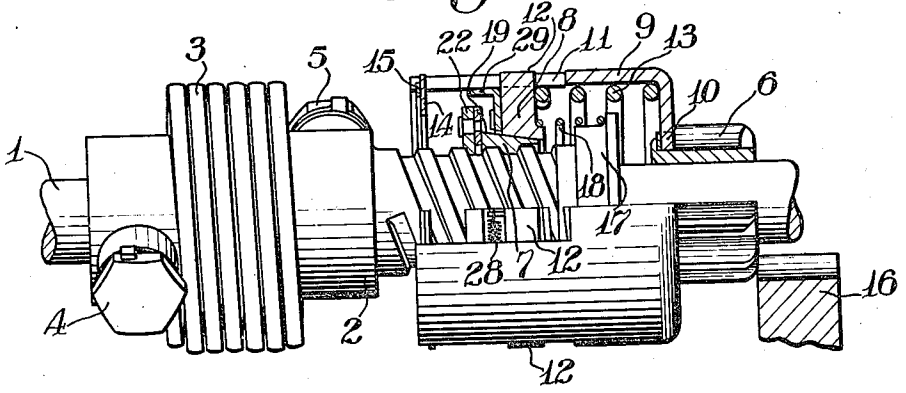


Fig. 9

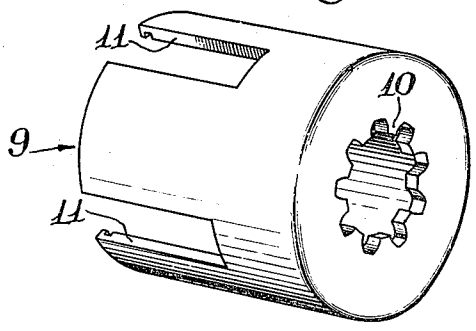


Fig. 7

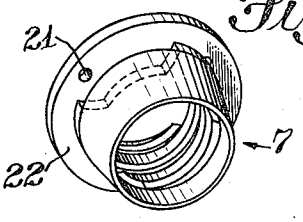
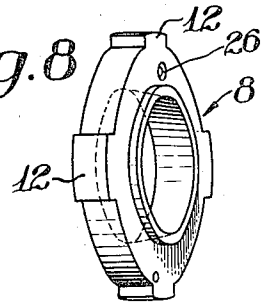


Fig. 8



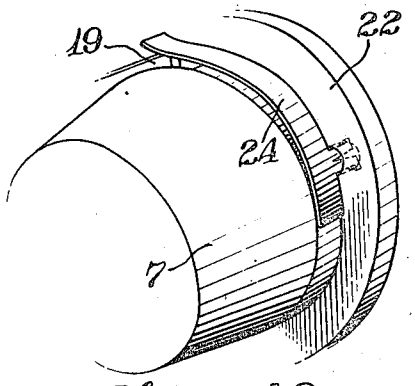


Fig. 10

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2,004,643

UNITED STATES PATENT OFFICE

2,004,643

STARTER DRIVE

Maurice P. Whitney, Elmira, N. Y., assignor to Eclipse Machine Company, Elmira Heights, N. Y., a corporation of New York

Application September 2, 1933, Serial No. 687,987

10 Claims. (Cl. 74—7)

This invention relates to starter drives for internal combustion engines of the type which automatically connects the starting motor to an engine to be driven, and disconnects the motor when the engine starts.

It is an object of the present invention to provide a novel starter drive which is efficient and reliable in operation and accurate and positive in its control of the starting connection.

Another object is to provide such a device which insures continuity of the cranking operation until the engine starts.

A further object is to provide such a device which permits the engine to overrun in case of a false start, but then immediately picks up the engine and continues the cranking operation until a true start is secured.

A further object is to provide such a device which prevents the engine from transmitting any appreciable driving effect to the starting motor in case of either a false or a true start.

Another object is to provide such a device in which the disconnection of the starter gearing is controlled by the speed of rotation of the engine flywheel irrespective of the speed of the armature shaft.

Another object is to provide such a device which is capable of accurate adjustment and in which the controlling parts are not subject to heavy strains or frictional effects.

Further objects and advantages will be apparent to those skilled in this art from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a side elevation partly in section of a preferred embodiment of the invention showing the parts in normal or idle position;

Fig. 2 is a section taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1 showing the parts in driving relation;

Fig. 4 is a section taken substantially on the line 4—4 of Fig. 3 showing the retaining latch in operative position;

Fig. 5 is a view similar to Fig. 4 showing the latch in tripped position;

Fig. 6 is a view similar to Fig. 1 showing the parts in the position assumed in case a tooth of the driving pinion abuts against a tooth of the engine gear during the meshing operation;

Fig. 7 is a detail in perspective of the driving clutch element;

Fig. 8 is a detail in perspective of the driven clutch element;

Fig. 9 is a detail in perspective of the barrel connecting the driven clutch element to the pinion; and

Fig. 10 is an enlarged detail in perspective of the driving clutch element showing details of the latching device.

Referring first to Fig. 1 of the drawings there is illustrated a power shaft 1, which may be the extended armature shaft of a starting motor, not shown. A hollow screw shaft 2 is slidably journalled on the power shaft and yieldably connected for rotation therewith by a suitable means such as a torsion spring 3 anchored at one end as at 4 to the power shaft and at the other end at 5 to the screw shaft. An engine driving member in the form of a pinion 6 is also slidably journalled on the power shaft 1 and has an overrunning driving connection therewith including a driving clutch element 7 threaded on the screw shaft, a driven clutch element 8 cooperating therewith, and a barrel 9 rigidly connected to the pinion as indicated at 10 and having a splined connection with the driven clutch element 8 as by means of slots 11 in the barrel and tongues 12 on the driven clutch element slidable therein.

Longitudinal movement of the driving clutch element 7 is yieldably transmitted to the pinion 6 through the driven clutch element 8 and a suitable yielding connection in the form of a spring 13. The clutch elements are retained in the barrel 9 by suitable means such as a toothed stop ring 14 in the end of the barrel arranged to engage the driving clutch element 7 and held in engagement with the slots 11 of the barrel as by means of a split locking ring 15. Longitudinal motion of the driving clutch element 7 is thus arranged to move the driving pinion 6 into and out of engagement with a member such as an engine gear 16 of the engine to be started.

Longitudinal motion of the driven clutch element 8 toward driving position is limited by a suitable stop on the screw shaft 2 in the form of a stop nut 17 fixed to the screw shaft in position to be engaged by the driven clutch element when the pinion 6 is in driving position. Since as clearly shown in Fig. 3 the longitudinal motion of the driving clutch element 7 is not so limited, it will be apparent that the clutch elements will be forced into driving relation and the clutch thus closed to form an operative connection from the screw shaft to the engine gear at this time. Means are provided for normally maintaining the driving parts in disengaged or idle position in the form of a light compression spring 18 arranged

between the stop nut 17 and the driven clutch element 8.

According to the present invention, means are provided for preventing the return movement of the clutch element 8 to idle position until a successful start of the engine has been secured as evidenced by the rapid rotation of the pinion 6 from the engine gear 16. As here shown this means is in the form of a latch 19 (Fig. 4) pivoted at 21 to a radial flange 22 of the driving clutch element 7, and adapted to engage a notch 23 on the screw shaft when in driving position, being urged into such engagement by suitable means such as a spring 24. Speed responsive means rotatable with the driven clutch element 8 and consequently with the pinion 6 for tripping said latch is provided in the form of an arcuate element 25 pivoted at 26 to the driven clutch element 8 having a long arm 27 arranged to be moved outwardly by centrifugal force against the action of spring 28 and an offset portion 29 adapted to engage an arm 31 of the latch 19 and trip the latch when the arm 27 has been thrown outwardly by centrifugal force.

In the operation of this device, and starting with the parts in the idle positions as illustrated in Fig. 1, energization of the starting motor causes rapid rotation of the power shaft 1 which is transmitted through the spring 3 to the screw shaft 2. The driving clutch element 7, by reason of its inertia and the inertia of the driven clutch element 8, barrel 9 and pinion 6 which are lightly clutched thereto by virtue of the spring 13, does not immediately take up the rotation of the screw shaft and accordingly is translated with said associated parts by virtue of its threaded engagement therewith into driving position as illustrated in Fig. 3. Such translatory motion is limited by the engagement of the driven clutch element 8 on the stop nut 17 whereby the clutch elements 7 and 8 are forced together and clamped to the screw shaft 2, thus forming a driving connection from the screw shaft to the pinion 6 whereby the pinion is rotated to crank the engine.

At this time the latch 19 engages in the notch 23 of the screw shaft 2 and positively prevents the backward motion of the driving clutch element 7. If the load on the starting motor is temporarily relieved as by the engine going over its compression points or by an initial weak explosion in an engine cylinder, the pinion 6 and driven clutch member 8 are accelerated and may attempt to overrun the screw shaft 2. In such case, the clutch elements 7, 8 back off from the stop nut 17 sufficiently to relieve the clutching engagement between said elements, sufficient play being allowed between the latch 19 and the notch 23 to permit such slight retrograde movement. Thereafter the driven clutch member 8 and its associated parts are permitted to overrun the driving clutch element 7 until the driving force of the engine gear is dissipated, whereupon the starting motor picks up the load and continues the cranking operation. When a successful start is secured, however, the pinion 6 is accelerated by the rotation of the engine gear sufficiently to cause the centrifugal tripping element 25 to move into operative position to engage the latch 19 as shown in Fig. 5 and trip the same whereupon the driving clutch element 7 is permitted to be carried with the driven clutch element 8 and the parts thus returned to their idle positions.

In case a tooth of the driving pinion engages a tooth of the engine gear during the meshing operation, as illustrated in Fig. 6, the splined connection 11, 12 between the driven clutch element 8 and the barrel 9 permits said clutch element to continue its longitudinal motion, compressing the spring 13 and thereby increasing the driving effect of the clutch elements. If this driving effect due to the pressure of the spring 13 is not sufficient to index the pinion into proper driving relation, the driven clutch element advances into engagement with the stop nut 17 whereupon the clutch elements are positively forced together, locking the pinion to the screw shaft to insure the indexing action. As soon as the pinion has been indexed, the spring 13 expands and snaps the pinion into meshing engagement with the engine gear.

It will be readily appreciated that the location of the latch 19 between the power shaft 1 and the overrunning connection 7, 8 prevents the transmission of driving stresses from the engine gear back through said latch when the engine starts, and permits the latch to function without undue friction. The arrangement of the centrifugal tripping element on the driven clutch element in position where, during its rotation, it will strike and trip the latch when moved into operative position by centrifugal force, is also conducive to a high degree of accuracy in regulating the releasing operation. It will be understood that the regulation of the speed at which tripping takes place may be accomplished by the use of a spring 28 of suitable tension. If an adjustment of such speed is desired while the drive is assembled, this may readily be secured in a suitable manner such as by selecting a spring 28 of sufficient stiffness to retain the centrifugal element 25 at higher than the desired speeds, and then stretching said spring by small amounts by inserting a tool such as a screw driver through the openings 12 in the barrel 9 between the convolutions of the spring and twisting the same to slightly space one or more of said convolutions.

What is claimed is:

1. In an engine starter drive, a power shaft, an engine driving member mounted for movement with respect thereto into and out of engagement with a member of the engine to be started, means for rotating the driving member from the power shaft including a connection which permits the engine driving member to freely overrun the power shaft, means located between the shaft and the overrunning connection for preventing disengaging movement of the driving member, and means responsive to a predetermined rotational speed of the engine driving member for rendering said preventing means inoperative.

2. In an engine starter drive, a power shaft, an engine driving member mounted for movement with respect thereto into and out of engagement with a member of the engine to be started, means including a latch adapted to be locked on said shaft for preventing disengaging movement of the driving member, means for rotating the driving member from the power shaft including a connection which permits the engine driving member to freely overrun the power shaft while locked thereon against disengaging movement, and means responsive to a predetermined rotational speed of the engine driving member for tripping said latch.

3. In an engine starter drive, a power shaft, an engine driving member mounted for movement with respect thereto into and out of engagement with a member of the engine to be

started, means for rotating the driving member from the power shaft including an overrunning connection comprising a driving element connected for rotation with the power shaft and a driven element connected for rotation with the engine driving member, means rotatable with the driving element for securing the same to the shaft, and speed responsive means rotatable with the driven element for tripping said securing means.

4. In an engine starter drive, a power shaft, an engine driving member mounted for longitudinal movement with respect thereto into and out of engagement with a member of the engine to be started, means for rotating and moving the driving member longitudinally from the power shaft including driving and driven clutch elements, means rotatable with the driving clutch element for preventing longitudinal movement thereof, and speed responsive means rotatable with the engine driving member for rendering said preventing means inoperative.

5. In an engine starter drive, a power shaft, an engine driving member mounted for longitudinal movement with respect thereto into and out of engagement with a member of the engine to be started, means for rotating and moving the driving member longitudinally from the power shaft including driving and driven clutch elements, a latch on the driving clutch element for preventing longitudinal movement thereof away from driving position and speed responsive means on the driven clutch element for tripping said latch.

6. In an engine starter drive, a power shaft, an engine driving member mounted for longitudinal movement with respect thereto into and out of engagement with a member of the engine to be started, means for rotating and moving the driving member longitudinally from the power shaft including driving and driven clutch elements, means for closing said clutch at the limit of the longitudinal engaging movement thereof, means for locking the driving clutch element in driving position while permitting sufficient backward movement thereof to release the clutch, and speed responsive means rotatable with the driven clutch element for releasing said locking means.

7. In an engine starter drive, a power shaft, a driving clutch element mounted thereon for longitudinal and rotary movement thereof and therewith, a driven clutch element arranged to be moved longitudinally by the driving clutch element, an engine driving member connected for rotation by said driven clutch element and arranged to be moved thereby into and out of engagement with a member of an engine to be started, means on the driving clutch element cooperating with the shaft to prevent movement of said clutch elements back to idle position, and speed controlled means mounted to rotate with said driven clutch element for rendering said preventing means inoperative.

8. In an engine starter drive, a power shaft, a driving clutch element in the form of a nut having a threaded connection therewith, a driven clutch element arranged to be moved longitudinally by the driving clutch element, an engine driving member connected for rotation by said driven clutch element and arranged to be moved thereby into and out of engagement with a member of an engine to be started, means on said shaft for limiting the engaging movement of the driven clutch element to thereby cause closure of the clutch, means on the driving clutch element cooperating with the shaft to prevent movement of said clutch elements back to idle position and speed controlled means mounted to rotate with said driven clutch element for rendering said preventing means inoperative.

9. In an engine starter drive, a power shaft, a driving clutch element mounted thereon for longitudinal and rotary movement thereof and therewith, a driven clutch element arranged to be moved longitudinally by the driving clutch element, an engine driving member connected for rotation by said driven clutch element and arranged to be moved thereby into and out of engagement with a member of an engine to be started, a latch on the driving clutch element for preventing rotation thereof on the shaft away from driving position, and a speed controlled trip for said latch mounted to rotate with the driven clutch element.

10. In an engine starter drive, a power shaft, a driving clutch element in the form of a nut having a threaded connection therewith, a driven clutch element arranged to be moved longitudinally by the driving clutch element, an engine driving member connected for rotation by said driven clutch element and arranged to be moved thereby into and out of engagement with a member of an engine to be started, means on said shaft for limiting the engaging movement of the driven clutch element to thereby cause closure of the clutch, a latch on the driving clutch element for preventing rotation thereof on the shaft away from driving position, said latch being arranged to allow the clutch elements to release and permit the driven clutch element to overrun, and a speed controlled trip for said latch mounted to rotate with the driven clutch element.

MAURICE P. WHITNEY.