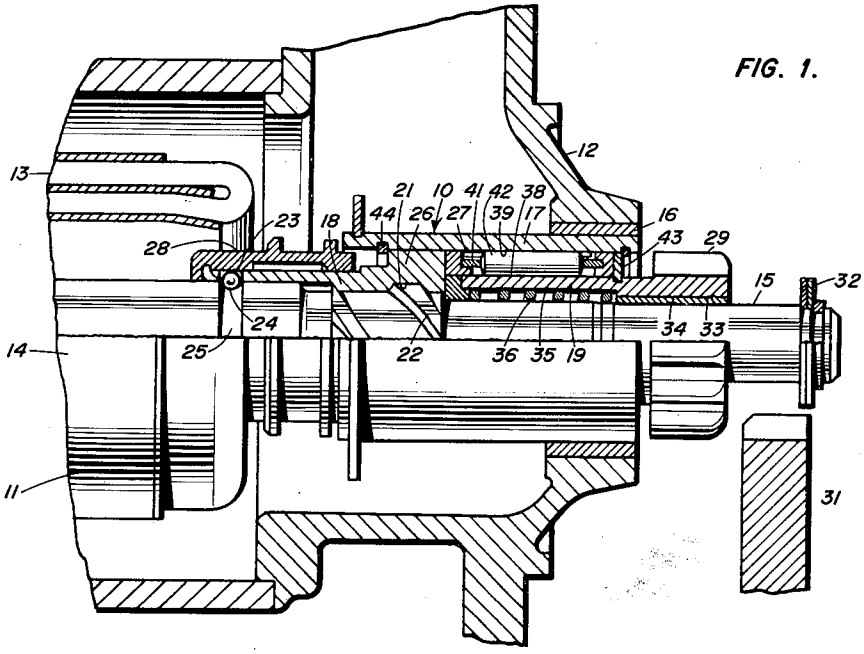
Oct. 9, 1962 W. HOVEN 3,057,212

STARTER CLUTCH

Filed July 11, 1960 3 Sheets-Sheet 1

FIG. 1.



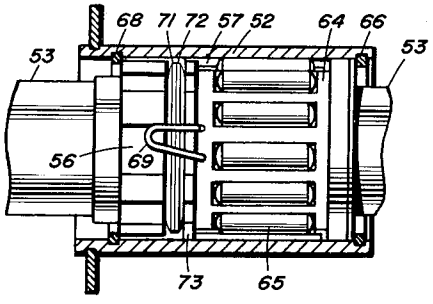


FIG. 4.

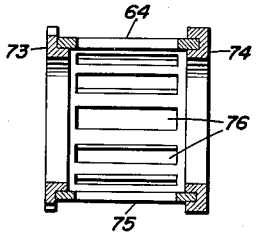


FIG. 5.

WILHELM HOVEN
INVENTOR

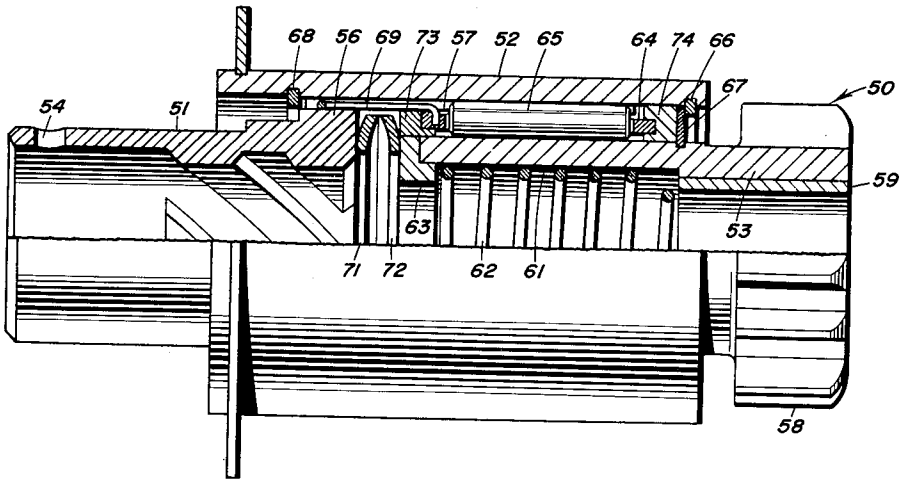
Norman L. Blodgett
ATTORNEY

Oct. 9, 1962 W. HOVEN 3,057,212

STARTER CLUTCH

Filed July 11, 1960 3 Sheets-Sheet 2

FIG. 2.



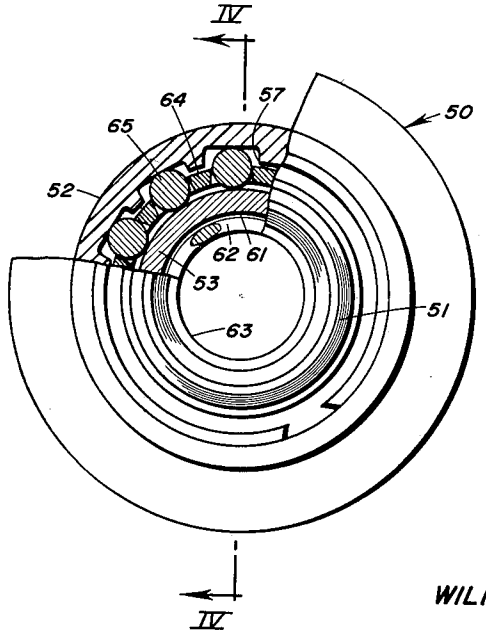


FIG. 3.

WILHELM HOVEN
INVENTOR

Norman S. Blodgett
ATTORNEY

Oct. 9, 1962 W. HOVEN 3,057,212

STARTER CLUTCH

Filed July 11, 1960 3 Sheets-Sheet 3

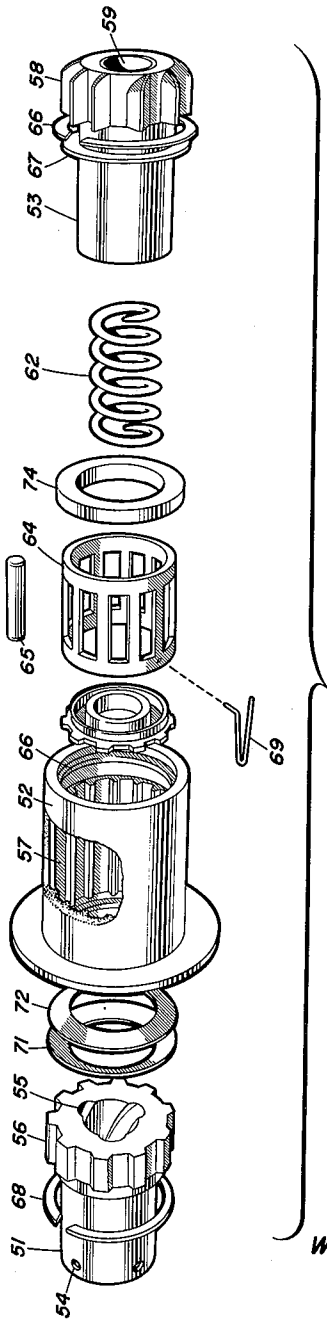


FIG. 6.

WILHELM HOVEN
INVENTOR

BY Norman S. Blodgett
ATTORNEY

United States Patent Office 3,057,212 Patented Oct. 9, 1962

3,057,212
STARTER CLUTCH

Wilhelm Hoven, Wurselen, Germany, assignor to Garbe, Lahmeyer & Co. Aktiengesellschaft, Aachen, Germany

Filed July 11, 1960, Ser. No. 42,129
Claims priority, application Germany July 13, 1959
5 Claims. (Cl. 74—7)

This invention relates to a starter clutch and more particularly to apparatus, commonly known as a Bendix clutch, arranged to connect and disconnect a starter motor to an internal combustion engine.

In the operation of internal combustion engines, particularly those used in automobiles, it is common practice to provide a device to connect the starter motor to the engine in such a manner that the connection disengages when the engine starts up, despite the fact that the starter motor may still be revolving. This apparatus has consisted in the past of a sleeve which has an internal high-pitch thread engaging the starter motor drive shaft and which has an external pinion gear engaging an engine-driving ring gear. When the engine rotates faster than the motor, the sleeve is moved by the thread in such a way that the pinion is drawn out of engagement with the engine-driving gear. With such a starting motor arrangement, it has been found necessary to place the pinion on the motor shaft externally of the motor housing; this is done so that the adjacent bearing for the motor shaft is protected from dirt. One result of this arrangement is that the motor bearings are relatively close together, making it possible to construct the motor with a comparatively small air gap and with high efficiency. The main disadvantage of this well-known arrangement is that the cantilever position of the forces on the free end of the shaft brings about stresses in the bearing and early failure. Also, with the known construction the starter motor has been driven at engine speed for short periods of time, thus subjecting the bearings to excessive wear. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a starter clutch adapted to be located between the starter motor bearings instead of externally of them.

Another object of this invention is the provision of a starter having a clutch arrangement that is capable of a long life of service with a minimum of maintenance.

A further object of the present invention is the provision of a starter clutch, the major part of which is not exposed to foreign matter and may be properly lubricated.

It is another object of the invention to provide an engine starter arrangement in which the starter motor bearings are not subjected to stress in excess of that experienced at idle speed.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to certain of its structural forms, as illustrated by the accompanying drawings in which:

FIGURE 1 is a sectional view of a device embodying the principles of the present invention;

FIGURE 2 is a sectional view of another version of the invention;

FIGURE 3 is a partially-sectioned end view of the apparatus shown in FIGURE 2;

FIGURE 4 is a sectional view of the invention taken on the line IV—IV of FIGURE 3;

FIGURE 5 is a sectional view of a portion of the invention; and

FIGURE 6 is an exploded view of the invention.

In general, the invention consists of a starter motor arrangement in which the starter clutch slides along the motor shaft and has its outer surface mounted in a bearing in the motor housing. At the same time, the pinion is mounted on a sleeve that is carried in a needle-roller unidirectional clutch mounted inside the clutch. The invention contemplates that the outer sleeve of the starter clutch be considerably elongated to surround the threaded bushing; the outer sleeve of the clutch and the threaded bushing are connected by splines and the clutch unit is almost completely enclosed within the starter motor housing. In order to reduce the outside diameter of the clutch, the rollers of the needle clutch are contained in a common cage and are prestressed. Furthermore, a spring means is interposed between the pinion sleeve and the threaded bushing to absorb shock and vibration.

Referring first to FIGURE 1, wherein are best shown the general features of the invention, the starter clutch, indicated generally by the reference numeral **10**, is shown in use in a starter motor **11** having a housing **12**, a stator **13**, and a rotor **14** with a shaft **15**. Mounted in the housing **12** concentrically of the shaft **15** is a bearing **16**; the starter clutch **10** is rotatably and slidably mounted in this bearing. The starter clutch consists generally of an outer sleeve **17**, a threaded bushing **18**, and a pinion sleeve **19**. The inner bore of the threaded bushing **18** is formed with a worm groove **21** which engages a similar worm thread **22** of high pitch formed on the surface of the motor shaft **15**. An aperture **23** extends through the bushing and carries a detent ball **24** which engages a groove **25** formed in the surface of the motor shaft. The outer surface of the bushing is provided with spline ribs **26** which are slidably engaged with spline grooves **27** formed on the inner surface of the outer sleeve **17**. A suitable detent sleeve **28** surrounds the inner end of the threaded bushing **18** and contacts not only the surface of the motor shaft but also an outer cylindrical surface of the bushing. The pinion sleeve **19** extends from the motor housing **12**, as does the shaft **15**; the outer end of the sleeve is provided with a pinion **29** which is adapted to engage or disengage a driving ring gear **31** of an internal combustion engine, not shown. The outer end of the shaft is provided with a stop **32** to limit the axial travel of the pinion sleeve. The sleeve is formed at its outer end with a bore **33** in which is located a bushing **34** which is slidable along the motor shaft **15**. Entering the other end of the pinion sleeve is a counterbore **35** in which lies a coil spring **36**; the end of the counterbore is provided with a retaining ring **37** which holds the spring in place. It will be understood that the end of the spring closest to the bottom of the counterbore is suitably fastened to the shaft **15** and does not move with the pinion sleeve. The sleeve **19** is provided with a smooth cylindrical outer surface **38** and the outer sleeve **17** is provided with a smooth cylindrical inner surface **39**, the surfaces **38** and **39** being concentric with the axis of the shaft and being spaced to provide an annular space. In this last space is a cage **41** holding a series of long, thin rollers **42**, the cage and rollers constituting with the enclosing members a one-way clutch. The pinion sleeve **19** is fastened against axial movement outwardly of the outer sleeve **17** by a snap ring **43**, while the threaded bushing **18** is similarly fastened to the outer sleeve **17** by a snap ring **44** to limit outward movement.

The operation of the invention will now be readily understood in view of the above description. When the starter button (on an automobile) is pressed, the detent sleeve **28** is moved in a conventional manner and the detent ball **24** moves through the aperture **23** and out of the groove **25**. The starter motor **11** is energized and the rotor **14** rotates relative to the stator **13**. The rotation of the stator and the shaft **15** acts through the worm

thread 22 and the worm groove 21 to move the threaded bushing 18 axially along the shaft; relatively little rotation of the bushing takes place because of the generous lead of the thread. As the bushing moves along the shaft, it carries with it the outer sleeve 17 and the pinion sleeve 19 because of their interconnection. Eventually, the outer end of the pinion sleeve and the pinion 29 strike the stop 32; after that the rotation of the shaft is transmitted directly to the pinion which, in turn, engages and rotates the ring gear 31 so that the internal combustion engine is turned over. When the engine starts and speeds up, it drives back through the driving gear 31 which then drives the pinion 29 instead of the reverse action as was previously true. The high-speed rotation of the pinion is transmitted to the pinion sleeve, the outer sleeve, and the threaded bushing; the rotation of the bushing at a rate faster than the shaft causes the bushing to move axially back to its original position and, because of its interengagement with the worm groove 21 and the worm thread 22, these other elements move with it. The coil spring 36 had previously resisted the movement of the pinion sleeve toward engagement with the stop 32, but now assists the movement in the other direction. Because of the interposition between the pinion sleeve 19 and the outer sleeve 17 of the one-way clutch formed by the cage 41 and the rollers 42, the fact that the pinion sleeve may be rotated very rapidly by the engine does not bring about a similar rapid rotation of the outer sleeve 17 after the initial return phase. As a matter of fact, the sleeve continues to rotate only at the speed of the normal idling speed of the starter motor, so that the bearing 16 is not subjected to excessive wear.

Referring now to FIGURE 2, wherein is shown another embodiment of the invention, the starter clutch, indicated generally by the reference numeral 50, is shown as consisting of a threaded bushing 51, an outer sleeve 52, and a pinion sleeve 53. The threaded bushing is provided with a detent aperture 54 and an internal worm groove 55; external splines 56 engage similar axial grooves 57 formed on the inner surface of the outer sleeve 52. The pinion sleeve 53 has an external pinion 58 and an internal supporting bushing 59; it is also formed with a counterbore 61 in which is located a coil spring 62 whose right-hand end is adapted to be fastened to the motor shaft. A locking ring 63 is located in the inner end of the counterbore and holds the coil spring in place. Between the pinion sleeve and the outer sleeve is a one-way clutch made up of a cage 64 and rollers 65. Snap rings 66, 67, and 68 serve to lock the pinion sleeve, outer sleeve, and the threaded bushing together. A series of V-shaped wire springs 69 are connected at one end to the cage 64 and lie within the grooves 57 in the outer sleeve. A pair of Belleville springs 71 and 72 are interposed between the threaded bushing and the pinion sleeve.

FIGURE 3 shows particularly well the manner in which the cage 64 and the rollers 65 cooperate with the grooves 57 in the outer sleeve 52 to form a one-way clutch. The bottom surfaces of the grooves are inclined slightly, so that when the sleeve 52 rotates ahead of the sleeve 53, the rollers are jammed between the bottom surfaces of the grooves and the outer surface of the sleeve 53 and a driving connection is made; when the sleeve 53 rotates ahead of the sleeve 52 (as when the internal combustion engine starts and picks up speed), the rollers are loosely held and do not provide a driving connection. This disengagement is not completed, however, until the engine has caused the return movement of the clutch to its original position.

FIGURE 4 shows the manner in which the wire spring 69 is used to prestress the one-way clutch. FIGURE 5 is a sectional view through the cage 64; as indicated, it is provided with annular rims 73 and 74 between which extends a tubular member 75 which is provided with generally rectangular apertures 76, which (as is evident in FIGURE 3) have inclined edges.

FIGURE 6 is an exploded view of the embodiment of the invention shown in FIGURE 2. This view shows particularly well the manner in which the rim 73 of the cage 64 is notched to fit the splines 57 on the inside of the outer sleeve 52; such notches are not necessary on the rim 74, since it resides in a portion of the sleeve beyond the splines.

The operation of this embodiment of the invention is substantially the same as in the version described in connection with FIGURE 1 and the advantages are similar. For instance, the wear on the bearing in the motor housing is reduced. Also, the starting motor itself is spared considerable wear by the use of the present invention; while in the prior art devices the motor shaft was supported in a bushing connected with the pinion, the support is now provided by the outer sleeve 52 of the starter clutch. In the previously-known constructions, the pinion, when driven at high speed by the engine, speeded up the motor rotor far beyond its usual speed through friction of the overdrive; the motor housing bearing was thus under the strain provided by the full speed operation of the pinion. According to the present invention, however, the rotor is not forced to a speed of rotation beyond its idling speed, due to the reduced friction in the overdrive arrangement. The bearing in the motor housing is subjected only to the stress encountered at the idling speed of the motor and its friction serves to prevent speed-up of the rotor. The wire spring 19 maintains a peripheral preloading of the over-running one-way clutch and maintains the rollers 65 in the narrow portions of the grooves 57, so that the driving action is instantaneous. The Belleville springs 71 and 72 absorbs the shock of the pinion sleeve 19 striking the stop 32; this has the effect of reducing noise and vibration during the operation of the device.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A clutch for a starter motor, comprising
   (*a*) a housing in which the motor is mounted,
   (*b*) a motor shaft extending from the motor and having a free end,
   (*c*) a bearing mounted in the housing and extending around the shaft adjacent the said free end thereof,
   (*d*) a threaded bushing mounted on the shaft and having threaded engagement therewith,
   (*e*) a pinion sleeve also mounted on the shaft for free-sliding movement thereon,
   (*f*) an outer sleeve extending around substantial portions of the threaded bushing and the pinion sleeve in sliding driving relationship with the threaded bushing, the outer sleeve having a smooth cylindrical outer surface which is rotatably and slidably carried within the said bearing, and
   (*g*) a one-way roller-type clutch extending radially between the pinion sleeve and the outer sleeve and connecting the two sleeves in operative driving relation in one direction only of relative rotation.

2. A clutch as recited in claim 1, wherein the outer sleeve is connected by axial splines to the threaded bushing.

3. A clutch as recited in claim 2, wherein the one-way clutch includes a cage, elongated rollers in the cage, and cam-shaped grooves formed in the outer sleeve in which grooves the rollers reside.

4. A clutch as set forth in claim 3, wherein means is provided to pre-stress the cage and rollers so that the rollers normally bring about immediate power transfer between the outer sleeve and the pinion sleeve.

5. A clutch as set forth in claim 4, wherein spring means is interposed between the threaded bushing and the pinion sleeve.

References Cited in the file of this patent

UNITED STATES PATENTS

2,013,645 Carle ---------- Sept. 10, 1935
2,142,942 Janes ---------- Jan. 3, 1939
2,811,044 Sabatini ---------- Oct. 29, 1957
2,818,735 Sabatini ---------- Jan. 7, 1958
2,862,391 Schneider et al. ---------- Dec. 2, 1958