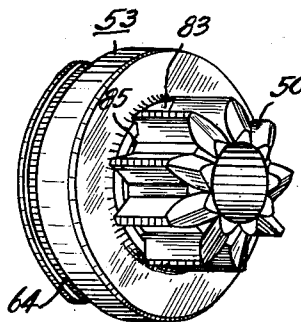
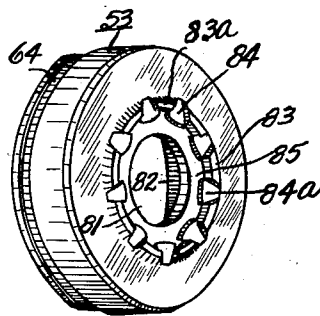
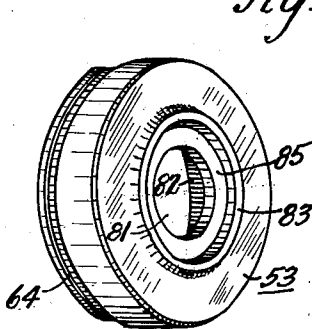
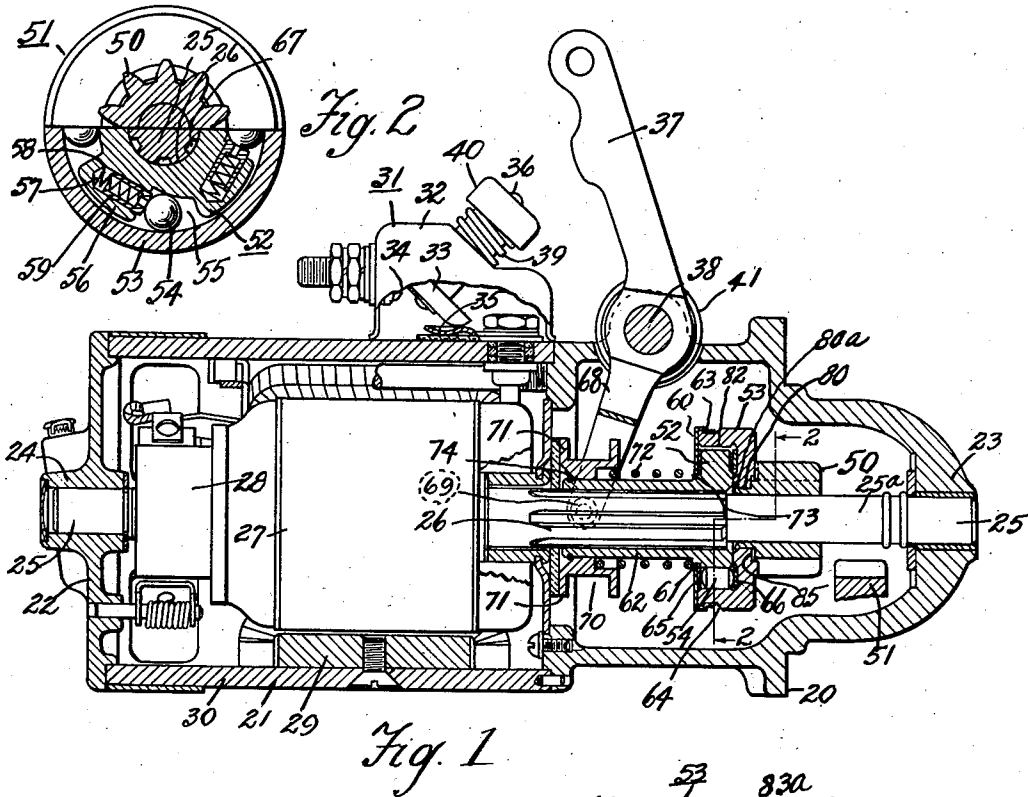


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METHOD OF MAKING A CLUTCH SHELL AND PINION
ASSEMBLY FOR ENGINE STARTER DRIVES
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METHOD OF MAKING A CLUTCH SHELL AND PINION ASSEMBLY FOR ENGINE-STARTER
DRIVES

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This invention relates to the manufacture of clutch shell and pinion assemblies for engine starting apparatus and particularly for the type of apparatus which comprises a motor, a pinion driven by the motor and movable axially into mesh with a gear of an engine to be started, and an overrunning clutch for drivingly connecting the motor with the pinion and for permitting the pinion to overrun the motor while the pinion remains in mesh with the engine gear after the engine becomes self operative.

In certain engine starters which have been in use, the overrunning clutch comprises a clutch cam or driving member which rotates within a clutch shell or driven member and cooperates with balls or rollers, which, while the motor is driving the pinion, are wedged by the cam against the inner cylindrical surface of the clutch shell. The cam is preferably splined to the motor shaft and the shell drivingly connected with the pinion by making the shell integral with the pinion. Means are provided for preventing withdrawal of the cam axially from the shell so that when the clutch is moved axially in either direction, the pinion will move with it.

It has been stated that it has been the practice heretofore to make the clutch shell and pinion in one piece, but the present invention contemplates manufacturing the pinion and clutch shell assembly in two pieces, since it has been discovered that the manufacture of this part of the starting apparatus can be carried on more economically and, that a better and more uniform product is insured by first manufacturing the pinion and clutch shell separately.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a longitudinal sectional view of engine starting apparatus embodying the present invention.

Fig. 2 is a sectional view on line 2—2 of Fig. 1.

Figs. 3 and 4 are perspective views of the clutch shell in two stages of manufacture.

Fig. 5 is a perspective view of the clutch shell and pinion assembly.

Referring to Figs. 1 and 2, 20 designates a supporting frame and gear housing by which the apparatus is mounted upon the frame of the engine, which is not shown. The frame 20 supports the motor field frame 21 which in turn supports an end frame 22. The frames 20 and 22 provide bearings 23 and 24 for the motor armature shaft 25, which is provided with longitudinal splines 26. The armature shaft 25 supports an armature core 27 carrying windings connected with a commutator 28, and the core rotates between pole pieces 29 surrounded by field windings 30. The motor circuit is controlled by switch 31, housed by a case 32, mounted on the frame 21. The case 32 supports a movable switch contact 33 engageable with a stationary contact 34 carried by the case 32 and a stationary contact 35 insulatingly supported by the frame 21. The movable contact 33 is operated by a rod 36 located in the path of movement of a lever 37 pivoted upon a stub shaft 38 supported by the frame 20. The switch is normally maintained open by a spring 39 located between the case 32 and the cap 40 attached to the rod 36. The lever 37 is normally maintained in the position shown in Fig. 1 by a helical coil spring 41. The shaft 25 includes a smooth portion of reduced diameter 25^a along which a motor pinion 50 is slidable into mesh with an engine gear 51. The pinion 50 is connected with the motor shaft 25 by a one-way or overrunning clutch 49 which comprises a clutch cam or driving member 52, a clutch shell or driven member 53, and rollers 54, each located in a notch 55 provided by the cam 52. Each arm 56 of the cam 52 provides a recess 57 for receiving a spring 58 and a plunger 59 urged by the spring 58 against a roller 54. The clutch shell 53 and the clutch cam 52 are maintained in assembled relation by a circular plate 60, having a central opening 61 through which the hub 62 of the clutch cam 52 extends and having a flange 63 which is spun into a knurled groove 64 of the shell

53. 65 is a washer located between the ends of rollers 54 and plate 60, and 66 is a washer located between the ends of rollers 54 and the inside wall of the clutch shell 53. The hub 62 of the cam 52 is internally broached to provide internal splines 67 cooperating with the shaft splines 26. The lever 37 is provided with a bifurcated extension 68 carrying studs 69 received by groove 70 in a collar 71 which is slidable along the hub 62 of the cam 52. A compression spring 72 is located between the collar 71 and a shoulder 73, provided by the cam 52, and is normally maintained in a state of compression. Removal of the collar 71 from the hub 62 is prevented by a wire split ring 74 received by a suitable annular groove in the hub 62. By a method and construction to be described, the shell 63 is drivingly connected with the pinion 50.

The engine is started by moving the lever 37 counter-clockwise in order to move the pinion into mesh with the engine gear 51, and to close the motor switch 31. In case of gear tooth abutment prior to meshing the pinion with the engine gear the spring 72 will yield to permit closing the motor switch whereupon the motor shaft will rotate in order to turn the pinion 50 into meshing registration with the engine gear 51. When this occurs the pinion 50 will be moved quickly into mesh with the gear 51 due to the sudden release of the compressed spring 72.

In the present disclosure the clutch 49 is constructed so that the pinion 50 will be rotated by the motor when the shaft 25 turns in a clockwise direction, as viewed in Fig. 2. When the engine becomes self-operative the pinion 60 will be driven in the same direction but at a speed greater than the speed of the shaft 25, hence the shell 53 will overrun the cam 52.

The clutch shell, cam and pinion members are constructed preferably of high grade nickel steel alloy manufactured in an electric furnace. The pinion 50 is manufactured separate from the shell and includes a tubular extension 80. Before the pinion is carbonized the surfaces of the extension 80 and a portion of the pinion teeth about $\frac{1}{8}$ of an inch from extension 80 are copper-plated to prevent the penetration of carbon into the steel material of the pinion. The pinions are packed with carbonizing material such as bone charcoal in a carbonizing box and are heated for four hours at from 1675° to 1725° F. The pinions are permitted to cool while remaining packed with the carbonizing material in the carbonizing boxes after the lids of the boxes have been removed.

The clutch shell 53 is provided with a central opening 81, concentric with its inner cylindrical surface 82, and with an annular boss 83, concentric with the opening 81. The shell 53 is placed between coining dies which de-

form portions of the boss 83 so as to provide interrupted boss portions 83^a separated by recesses or depressions 84. The depressions 84 are shaped and spaced so as to each receive an end portion of a tooth 50^a of the pinion 50, as shown particularly in Fig. 5. The shell 53 is provided with a counter-bored portion 85, which receives the material 84^a which has been deformed from the boss 83 to provide the gear-tooth receiving recess 84. After making the shell in the manner described, it is carburized for about 5½ hours at 1700° F., following the method used in carburizing the pinion. After the shell is cooled it is secured to the pinion by passing the pinion tubular extension 80 through the opening 81, fitting the ends of the pinion teeth into the recesses 84 and then riveting over the pinion extension as at 80^a against the inside wall of the shell 53. The next step is to heat treat the pinion and shell assembly in order to harden the wearing surfaces thereof. This is done preferably by immersing the pinion and shell assembly in a bath of molten potassium cyanide for 30 minutes, the bath being approximately at 1350 to 1375 degrees F. After heating the assembly it is quenched in oil, and the pinion is re-riveted to the shell to overcome any looseness between the tubular extension 80 and the shell which may have taken place by reason of heat treatment.

The heat treatment provides a clutch shell wearing surface 82 which is harder than the wearing surface of the pinion teeth 50^a, due to the fact that a greater amount of carbon has penetrated the clutch shell than the pinion teeth as a result of the greater carburizing time and temperature of the clutch shell. It is desirable that the clutch shell be harder than the pinion teeth, since this surface is subjected to the action of the hardened steel rollers 54, whereas the pinion cooperates with the relatively soft metal flywheel gear 51. On the other hand, the pinion teeth are heat treated so that they will be relatively strong and tough to withstand strains incident to driving the gear 51. The tubular extension 80, which functions as a rivet for attaching the pinion to the shell, remains soft during the heat treatment so that it may be easily swedged without breaking. Those portions of the pinion teeth which are received by the recesses 84 provided by the shell 53 also remain soft during the heat treatment and hence, provide relatively strong members for transmitting torque from the clutch shell to the portions of the pinion teeth which engage the flywheel gear.

From the foregoing description of the construction and method of assembling and heat treating the pinion and clutch shell assembly, it is apparent that certain advantages result from making the pinion and clutch shell separately, and afterwards joining them together. In the first place, there is a

5 saving of material since the pinion may be
made of a round bar of stock considerably
less in diameter than a round bar required
for making the clutch shell. Since it is de-
sirable to have the clutch shell provided with
a harder wearing surface than the pinion,
the heat treatment can be readily carried out
by carburizing the clutch shell separate from
the carburizing of the pinion. If these mem-
bers were integral, it would be difficult to
carburize the wearing surfaces of the clutch
shell to a greater degree than the wearing
surfaces of the pinion, but by making the
shell and pinion in separate pieces, these
pieces may be carburized separately, one to
a greater extent than the other. As explained
before, the heat treatment of the assembly
produces greater hardness of the shell than
of the pinion. Where the pinion and shell
have been first made integral, it has been the
practice to harden all portions of the piece
to the same degree, therefore, the pinion
teeth would be rendered more hard than
necessary for durability and would at the
same time be rendered more brittle, and
hence, more apt to break. To overcome this
it was necessary to add more material to the
pinion in order to obtain the required
strength. Since the manufacture of the pin-
ion separate from the shell permits giving
the pinion a heat treatment differing from
the heat treatment of the shell, it is possible
to give the pinion the proper heat treatment
required for hardness and strength, hence it
is possible to make the pinion of the mini-
mum amount of material. The reduction in
the amount of material is not only desirable,
but also the reduction in the weight of the
pinion so as to reduce the amount of mass to
be moved by the spring 72 when "jumping"
the pinion into mesh with the engine gear
after the switch 32 has been closed. It is
obvious that the less mass the spring 72 has
to move, the more rapid will be its action in
moving the pinion into mesh with the engine
gear after the motor starts, hence the less
damage to the entering portions of the pin-
ion and gear teeth when this occurs. Since
each part of the pinion and clutch shell as-
sembly may receive its own individual car-
burizing treatment, it is possible to manufac-
ture the clutch shell also with the minimum
amount of material, resulting in reduction
in cost and the amount of mass to be moved
by the spring 72.

While the form of embodiment of the pres-
ent invention as herein disclosed, constitutes
a preferred form, it is to be understood that
other forms might be adopted, all coming
within the scope of the claims which follow.

What is claimed is as follows:

1. The method of making a clutch shell and
pinion assembly for an engine starter drive
which comprises forming the shell and pin-
ion of alloy steel of substantially the same

composition, carbonizing the shell for a
longer time than the pinion, assembling
these parts together, and in heat-treating the
assembly to produce surface hardness, where-
by the surface of the shell will be harder than
the surface of the pinion.

2. The method of making a clutch-shell
and pinion assembly for an engine starter
drive which consists in making a clutch shell
with an annular row of depressions each for
receiving a portion of a pinion tooth, in mak-
ing a pinion with a tubular extension con-
centric with its bore and adapted to fit into
a hole in the shell concentric with the an-
nular row of depression therein, in carboniz-
ing the shell and pinion, in fastening the
shell and pinion together by entering the
pinion teeth into the shell depressions and
the pinion extension into the hole in the shell
and by riveting the pinion extension against
the inner wall of the shell, in heat-treating
the assembly to produce hardness and in ri-
veting the pinion extension.

3. The method of making a clutch-shell
and pinion assembly for an engine starter
drive which includes making a clutch-shell
of relatively soft metal having an annular
boss concentric with a central bore therein,
coining depressions in the annular boss to
provide recesses each for receiving a portion
of a pinion tooth, and securing the pinion to
the shell.

4. The method of making a clutch-shell
and pinion assembly for an engine starter
drive which includes making a clutch-shell
of relatively soft metal having an annular
boss concentric with a central bore therein,
making a counter-bore adjacent the central
bore and within the boss, forcing portions of
the boss into the recess provided by the coun-
ter-bore in order to provide recesses each
for receiving a portion of a pinion tooth, and
securing the pinion to the shell.

5. The method of making a clutch-shell
and pinion assembly for an engine starter
drive which includes making a clutch-shell of
relatively soft metal, coining an annular row
of depressions in the shell to provide rec-
esses each for receiving a portion of a pin-
ion tooth, and in securing the pinion to the
shell.

6. The method of making a clutch-shell
and pinion assembly for an engine starter
drive which includes making a clutch-shell
of relatively soft metal having an annular
boss concentric with a central bore therein,
coining depressions in the annular boss to
provide recesses each for receiving a portion
of a pinion tooth, making a pinion with a
tubular extension adapted to pass through
the bore in the shell, fitting the pinion and
shell together, and riveting the pinion exten-
sion against the inner wall of the shell.

7. The method of making a clutch-shell
and pinion assembly for an engine starter

drive which includes making a clutch-shell
of relatively soft steel having an annular
boss concentric with a central bore therein,
coining depressions in the annular boss to
provide recesses each for receiving a portion
5 of a pinion tooth, making a pinion with a tu-
bular extension adapted to pass through the
bore in the shell, carbonizing the shell and
pinion, fitting the pinion and shell together,
riveting the pinion extensions against the in-
10 ner wall of the shell, and in hardening the
assembly by heat treatment.

In testimony whereof I hereto affix my sig-
nature.

WILLIAM A. CHRYST.

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