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(21) International Application Number: PCT/US99/00448 (22) International Filing Date: 8 January 1999 (08.01.99) (71) Applicant: JOHNSON ELECTRIC AUTOMOTIVE, INC. [US/US]; 47660 Halyard Drive, Plymouth, MI 48170 (US). (72) Inventors: TUMBERLINSON, Robert, L.; 2727 Old Alice Road #156, Brownsville, TX 78521 (US). CLARKE, Mauricio; 4010 Houston Drive, Harlingen, TX 78550 (US). (74) Agent: MOLNAR, John, B.; MacMillan, Sobanski & Todd, LLC, One Maritime Plaza, Fourth Floor, 720 Water Street, Toledo, OH 43604 (US).		(81) Designated States: CN, JP, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>
(54) Title: TWO-PIECE PINION GEAR (57) Abstract <p>A two-piece pinion (30) gear includes a metal outer portion (44) and a plastic inner portion (46). The metal outer portion includes a plurality of gear teeth (36) that are adapted to be engaged by a driving member. The plastic inner portion preferably includes a spiraled groove (42) that is adapted to ride along a spiraled track (26) on a spline shaft (24) associated with an electric starting motor (20).</p> <div style="display: flex; justify-content: space-around; align-items: center;"> </div>		

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TWO-PIECE PINION GEAR

BACKGROUND OF THE INVENTION

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This invention generally relates to a pinion gear having a metal portion and a plastic portion that is useful for a starting system for small engines.

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Starting systems in small engines typically include an electric starting motor. An electric starting motor typically includes a plastic spline shaft that extends out of a motor housing. A plastic pinion gear is supported on the spline shaft and is engaged by a driving member or a ring gear. The pinion gear and the spline shaft driven by the starter motor rotate, causing the pinion gear to engage the drive member (ring gear), which starts the engine.

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Since plastic spline shafts are used, plastic pinion gears typically were required. Metal pinion gears could not be used because of the undesirable wear caused on the spline shaft during typical starting cycles. Plastic pinion gears are not as durable as desired because the engagement of the driving member on the plastic gear teeth causes wear.

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Therefore, there is a need for an improved pinion gear that will be more durable and still be accommodated on the plastic spline shafts typically associated with small engine starting systems.

SUMMARY OF THE INVENTION

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In general terms, this invention is a two-piece pinion gear that has a metal outer portion and a plastic inner portion. The metal outer portion includes a plurality of radially outwardly extending gear teeth that are adapted to be engaged

by a driving member to cause rotation of the pinion gear. The outer member includes a central opening through the center of the outer member. The central opening includes a plurality of first locking members equally spaced around the central opening. The plastic inner portion includes a plurality of second locking members along an outer edge of the inner portion. The first locking members and the second locking members engage to maintain the inner portion aligned with the outer portion. The inner portion includes a central bore that is adapted to be received upon the plastic spline shaft of a small engine starting system.

The various features and advantages of this invention will become apparent to those skilled in the art in the following detailed description of the presently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagrammatic illustration of a small engine starting system including a pinion gear designed according to this invention.

Figure 2A is an elevational view of a pinion gear designed according to this invention.

Figure 2B is a cross-sectional illustration taken along the lines B-B in Figure 2A.

Figure 3 is an elevational view of an outer pinion portion designed according to this invention.

Figure 4 is an elevational view of an inner pinion portion designed according to this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

5 Figure 1 illustrates a small engine starting system 20 that includes an electric motor within a housing 22. A plastic spline shaft 24 extends out of the housing 22. The plastic spline shaft 24 preferably includes a spiraled track 26 extending along at least a portion of the length of the spline shaft. A two-piece pinion 30 is supported on the shaft 24.

10 A driving member 32 includes gear teeth 34 (schematically illustrated) that engage a plurality of gear teeth 36 on the pinion 30. As the pinion 30 causes the driving ring gear to rotate, the engine starts as desired. As those skilled in the art will appreciate the pinion 30 moves axially along the spline 26 as the two are rotating.

15 Figures 2A and 2B illustrate the two-piece pinion 30 in more detail. A central bore 40 through the center of the pinion 30 includes a spiraled groove 42. The spiraled groove 42 rides along the spiraled track 26 on the shaft 24 so that rotation of the shaft 24 results in rotation of the pinion 30.

20 Importantly, the pinion 30 includes an outer portion 44 that is made from a metal material. The preferred embodiment includes either a molded powdered metal piece or a cut steel part. An inner portion 46 is made from a plastic material. Plastic is required for the inner portion so that the interaction between the pinion 30 and shaft 24 will not cause undesirable wear on the shaft. The outer

portion 44 is made from metal so that the engagement of the driving member 32 on the gear teeth 36 will not cause the undesirable wear that has been experienced with the prior art.

Figure 3 illustrates the metal outer portion showing a central opening 50 through the metal portion 44. A plurality of locking members 52 preferably are equally spaced around the central opening 50. In the preferred embodiment the first locking members are axially extending grooves defined along the inner circumference of the outer portion 44. In the illustrated embodiment, each groove is radially aligned with a gear tooth 36.

Figure 4 illustrates the inner portion 46. A plurality of second locking members 54 are provided along the outer perimeter of the inner portion 46. The second locking members preferably are tabs that are correspondingly shaped to the shape of the first locking members 52. When the inner portion 46 is received within the central opening 50 of the outer portion 44 the first locking members 52 and the second locking members 54 engage to maintain an alignment between the two portions.

When the inner portion is made from a press fit plastic piece, an adhesive preferably is used to maintain the inner portion within the outer portion 44. The illustrations of Figures 2A and 2B show an embodiment of this invention where the inner portion 46 is injection molded. In that embodiment, no adhesive is needed between the inner portion 46 and the outer portion 44.

This invention provides the advantage of having a pinion gear that is suitable for use on a plastic spline shaft yet durable enough to be repeatedly engaged by a

metal driving member or ring gear. This represents an improvement over prior pinions, which typically last for approximately 3000 starting cycles when used with a small engine starting system. A pinion gear designed according this invention can last approximately ten times longer than the all-plastic pinions of the prior art.

5 The preceding description is exemplary rather than limiting in nature. Variations and modifications may become apparent to those skilled in the art that do not necessarily depart from the purview and spirit of this invention. The following claims must be studied to determine the legal scope of protection given to this invention.

CLAIMS

We claim:

1. A pinion, comprising:

5 a metal outer portion having a plurality of outwardly extending teeth and a central opening that includes a plurality of first locking members spaced about said central opening; and

a plastic inner portion having a plurality of second locking members spaced about an exterior surface on said inner portion, said second locking members engaging said first locking members to maintain said inner and outer portions in a
10 selected alignment, said inner portion including a central opening adapted to be received on a spline shaft.

2. The pinion of claim 1, wherein said first or second locking members comprise grooves and the other of said first or second locking members comprise
15 correspondingly shaped tabs formed on said inner portion.

3. The pinion of claim 1, wherein said first locking members comprise a plurality of radially and outwardly extending notches formed in said outer portion and said second locking members comprise a corresponding plurality of radially and
20 outwardly extending tabs formed on said inner portion.

4. The pinion of claim 3, wherein said tabs have a generally rounded cross-section and said notches are correspondingly shaped to nestingly receive said tabs.

5. The pinion of claim 1, wherein there are an equal number of said teeth, first locking members and second locking members, respectively, and wherein each said corresponding first locking member and second locking member are radially aligned with one of said teeth.

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6. The pinion of claim 5, wherein said teeth and said first locking members are equally circumferentially spaced about said outer portion and said second locking members are equally circumferentially spaced about said inner portion.

10 7. The pinion of claim 1, wherein said central opening through said inner portion includes a spiralled groove formed to ride along a corresponding spiralled track on said spline shaft and wherein said spline shaft is made from plastic.

15 8. The pinion of claim 1, wherein said inner portion comprises a press fit piece of plastic and wherein said pinion further comprises an adhesive between said inner and outer portion to maintain said portions in axial alignment.

9. The pinion of claim 1, wherein said inner portion comprises injection molded plastic.

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10. The pinion of claim 1, wherein said outer portion comprises cut steel.

11. The pinion of claim 1, wherein said outer portion comprises molded powdered metal.

12. A small engine starting device, comprising:

a starter motor housing;

a plastic spline shaft extending generally outwardly from said housing; and

a pinion supported on said spline shaft and having a plastic inner portion

5 having a central opening that is received upon said spline shaft and a plurality of
first locking members spaced about an exterior surface on said inner portion, and
including a metal outer portion having a plurality of radially outwardly extending
gear teeth adapted to engage a driving member and a central bore through said
outer portion including a plurality of second locking members spaced about said
10 central bore that engage said first locking members such that said inner and outer
portions rotate in unison.

13. The device of claim 12, wherein there are an equal number of said teeth,
first locking members and second locking members, respectively, and wherein each
15 said first locking member and corresponding second locking member are radially
aligned with one of said teeth.

14. The device of claim 12, wherein said spline shaft includes a spiralled track
extending along a portion of a length of said shaft and said inner portion central
20 opening includes a correspondingly shaped spiralled groove so that said spline is
rotated as said pinion is rotated and moved along said spiralled track as said teeth
are driven by the driving member.

15. The device of claim 12, wherein said inner portion comprises a press fit piece of plastic and wherein said pinion further comprises an adhesive between said inner and outer portion to maintain said portions in axial alignment.

5 16. The device of claim 12, wherein said inner portion comprises injection molded plastic.

17. The device of claim 12, wherein said outer portion comprises cut steel.

10 18. The device of claim 12, wherein said outer portion comprises molded powdered metal.

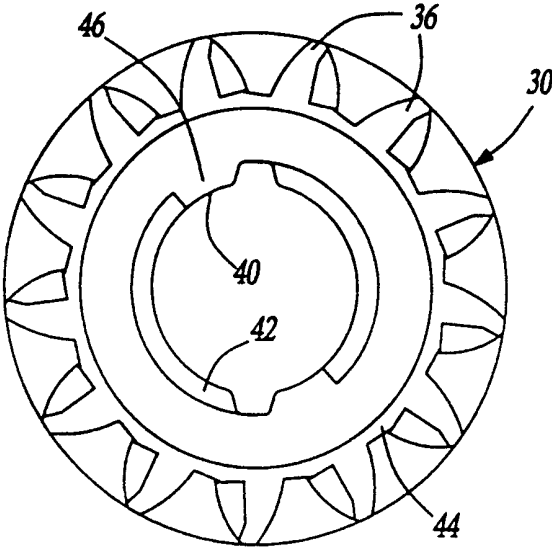
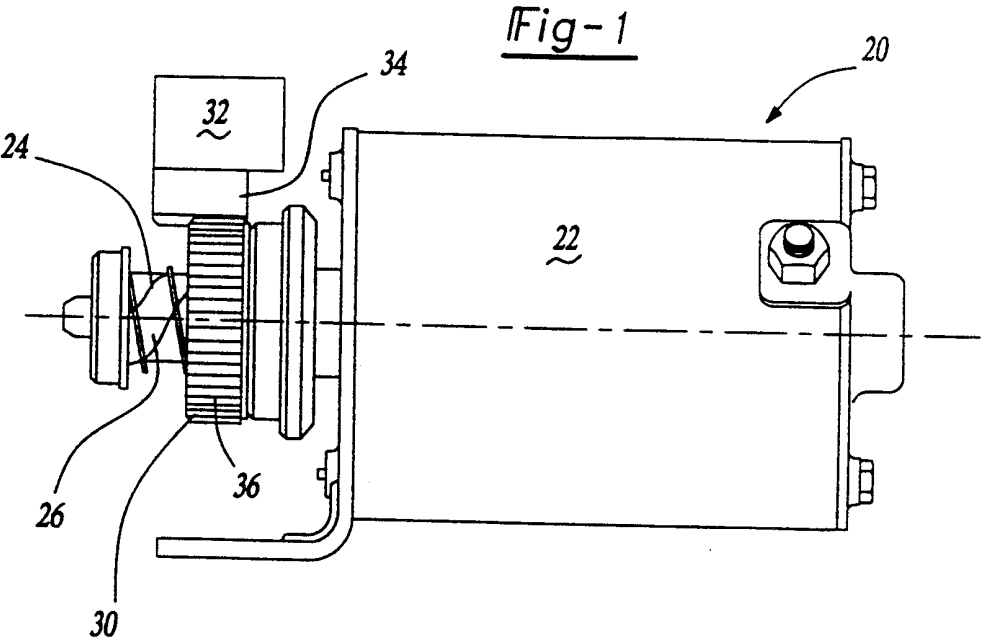


Fig-2A

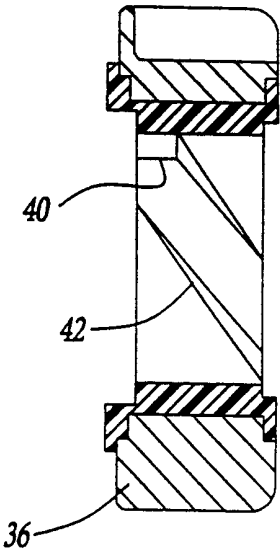


Fig-2B

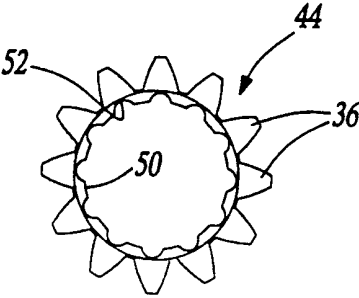


Fig-3

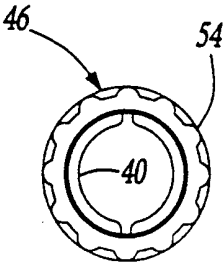


Fig-4

INTERNATIONAL SEARCH REPORT

International Classification No

PCT/US 99/00448

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16H55/06 F02N15/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16H F02N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 929 028 A (KIRKEGAARD JOHN KIRK) 30 December 1975 (1975-12-30)	1,9,10, 12,14, 16,17
A	column 1, line 3 - line 66; figures ---	2-8,11, 13,15,18
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	abstract; figures 1,2 ---	
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A	US 3 200 665 A (WELLS MARTIN) 17 August 1965 (1965-08-17) the whole document -----	1,12

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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