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[54] **SPEED CHANGING DEVICE**
5 Claims, 6 Drawing Figs.

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[50] Field of Search.....	74/801, 803, 705, 674

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ABSTRACT: A speed changing device comprising a stationary female ring gear, a rotating female ring gear having a different pitch diameter and in axial alignment with the stationary ring gear, and a drive gear system which rides about the stationary ring gear while simultaneously engaging and rotating the rotating ring gear. Speed reduction or amplification is accomplished by the difference in pitch diameters and resultant number of teeth of the ring gears and, in one embodiment, speed reduction is further accomplished by a planetary drive gear system.

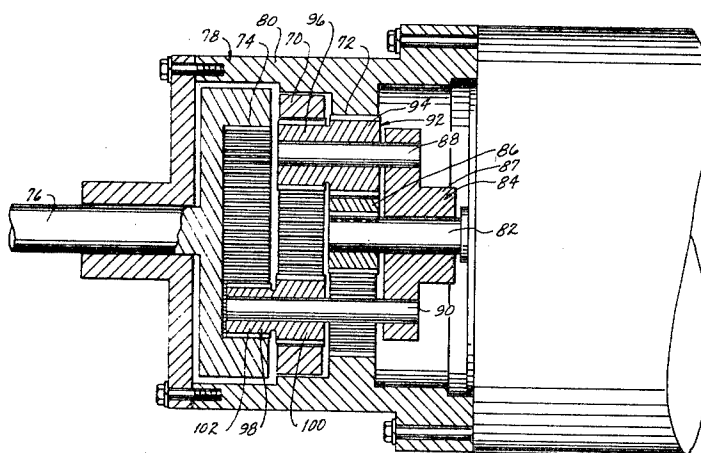


Fig. 1

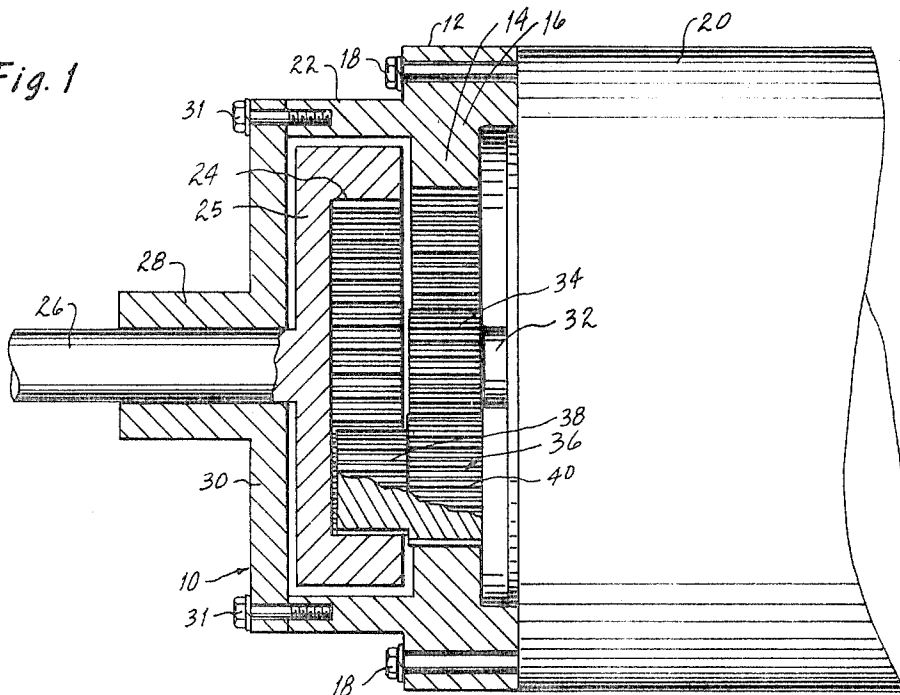
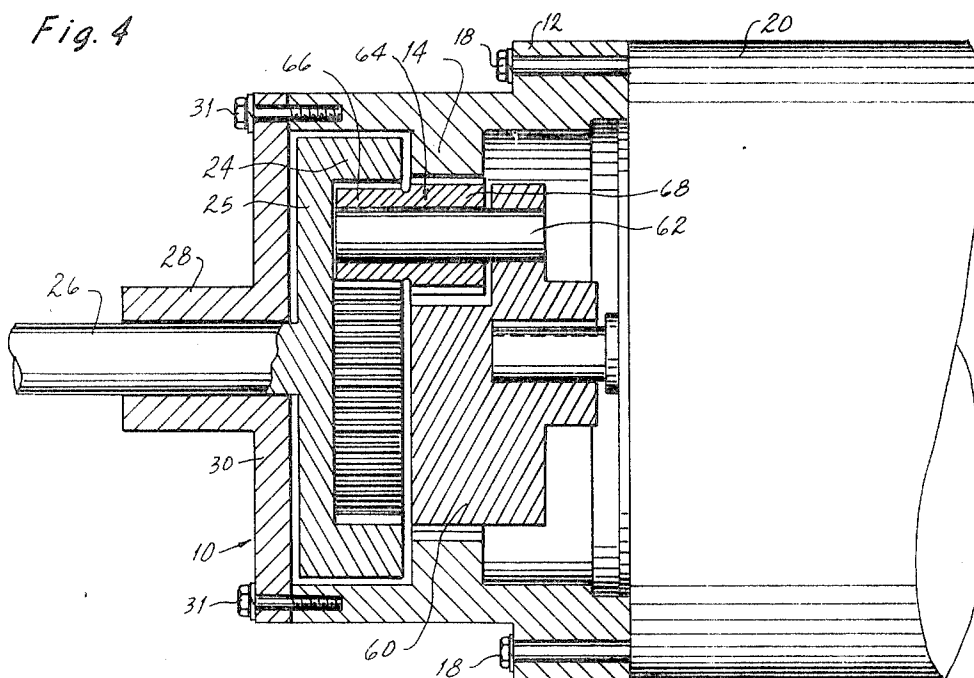


Fig. 4



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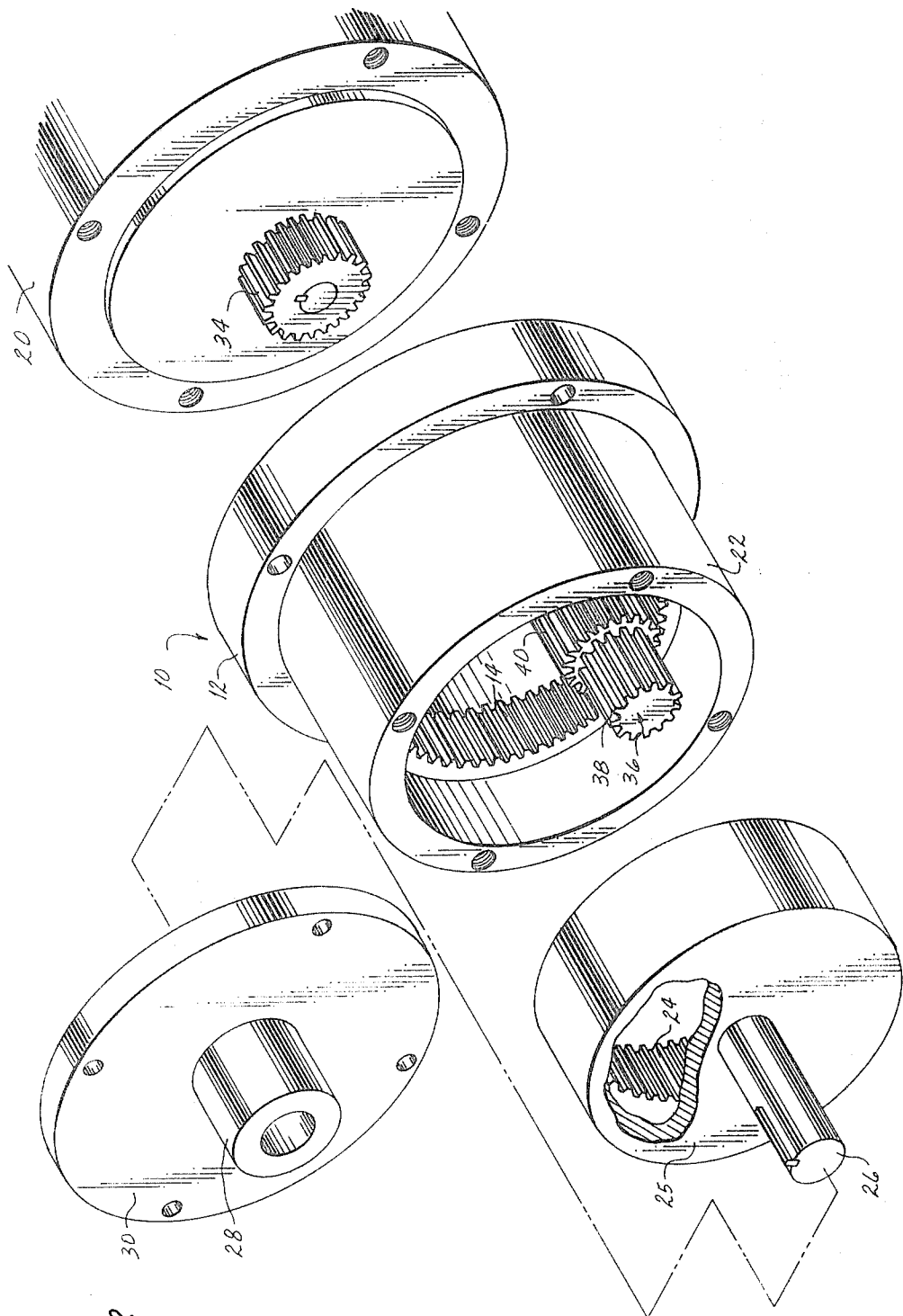


Fig. 2

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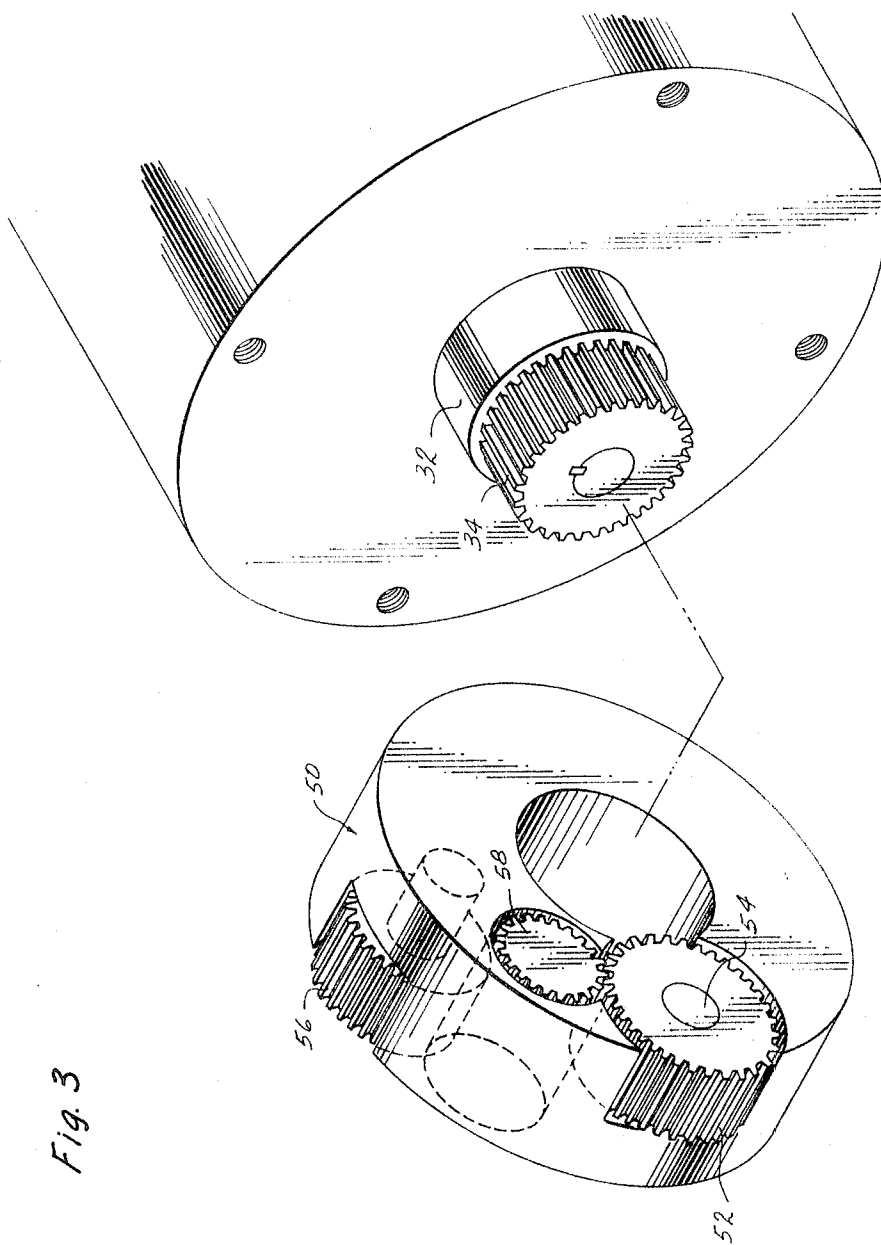
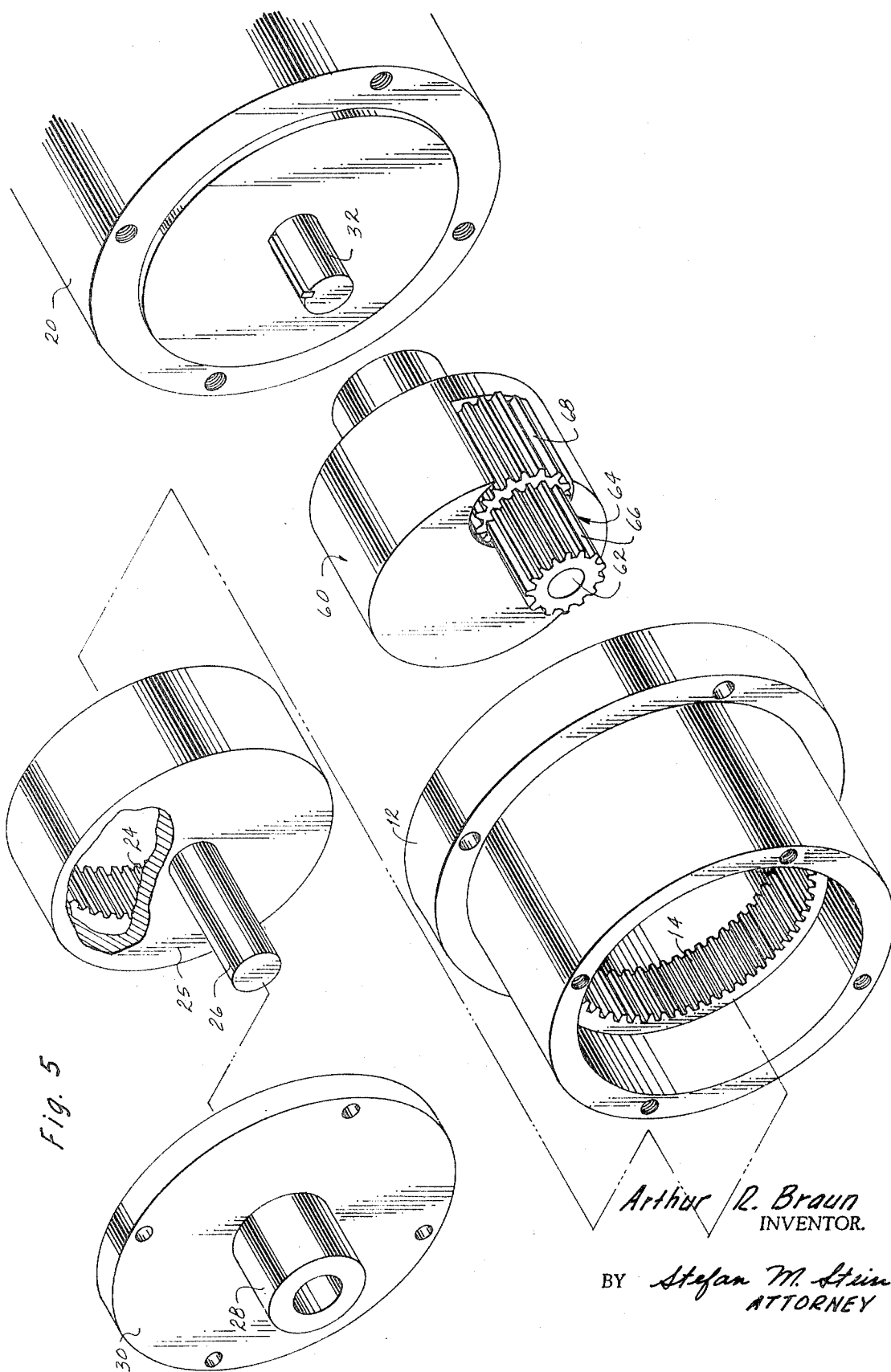


Fig. 3

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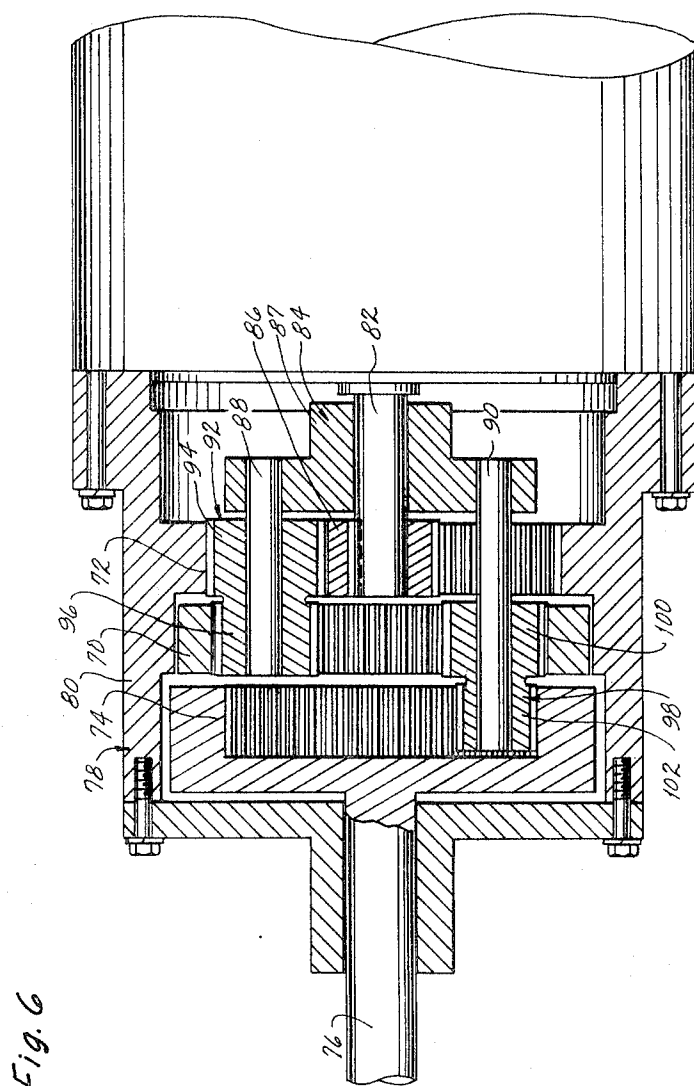


Fig. 6

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SPEED CHANGING DEVICE

This invention relates to a speed changing device; more particularly, to a speed changing device for changing the rotational velocity between two shafts in axial alignment.

Many types of speed changing devices are currently available on the market. However, there is still need for improvement in several areas. One of these areas is the ability to economically manufacture an effective speed changing device which will accomplish speed amplification or speed reduction with related torque advantages. Known speed changing devices ordinarily utilize either an unnecessary complicated gear train system or gears such as worm or bevel gears which are relatively difficult to machine. In addition, because of their complicity, known speed changing devices are usually difficult to assemble and their housings are unnecessarily intricate. All these factors add to the devices' manufacturing cost. Attempts have been made to design an economical speed changing device. However, in a competitive market, it is desirable, if not essential, that these designs be improved upon.

Another area where improvement is needed is the ability to manufacture a speed changing device which can be utilized to either effectively amplify or reduce the speed of an input drive shaft. Present devices are unsatisfactory in that they cannot be converted from a speed reducer to speed amplifier, or vice versa. Or if they can be converted, it is unduly time consuming and cumbersome, usually involving more than changing a few basic components.

Still another area where improvement is needed is the ability to manufacture an effective speed changing device in small sizes and with lightweight components for operating a clock or similar instrument where size and weight are critical. Most speed changing devices today are limited in the degree in which they can be reduced. Those that can be reduced do not effectively provide a sufficient reduction or amplification of an input spindle having a particular r.p.m. Moreover, since it is often desirable to make the components of these devices out of lightweight material such as plastic, known speed changing devices are objectionable in that they usually cannot easily be fabricated from this material.

Accordingly, it is an object of this invention to provide a speed changing device which will accomplish speed reduction with related torque advantages to an input spindle having a particular r.p.m.

Another object is to provide a speed changing device which can be operated to either amplify or reduce the speed of a given input shaft having a particular r.p.m.

Still another object is to provide a speed changing device which may easily be converted to either amplify or reduce the speed of a given input shaft having a particular r.p.m.

A further object is to provide a speed changing device which will accomplish great ratio reduction or amplification but yet have a simple housing configuration.

A still further object is to provide a speed changing device which may be fabricated in very small sizes.

Another object is to provide a speed changing device which has positive drive characteristics without excess wear or friction in the gear system.

Another object is to provide a speed changing device which can easily be manufactured of lightweight components such as plastic.

Another object is to provide a speed changing device which is practical and economically feasible to manufacture.

In accordance with these objects, the invention essentially comprises a stationary female ring gear, a rotatable female ring gear having a different pitch diameter and in axial alignment with the stationary ring gear, and a drive gear system which rides about the stationary ring gear while simultaneously engaging and rotating the rotating ring gear. Speed reduction or amplification between an input motor drive shaft and a driven shaft driven by the rotating ring gear is accomplished by the difference in pitch diameters and resultant number of teeth of the ring gears.

In a preferred embodiment, the drive gear system comprises an axially aligned motor shaft drive gear, and a planetary gear formed with two, coaxial, integral pitch diameters. The portion of the planetary gear having the larger pitch diameter planetates about the stationary ring gear while being driven by the drive gear. Simultaneously, the portion of the planetary gear having the smaller pitch diameter engages and rotates the rotatable ring gear. In this embodiment, the rotatable ring gear has a smaller pitch diameter and fewer gear teeth than the stationary ring gear. Speed reduction is accomplished by the planetary drive gear system in addition to the difference in pitch diameters and resultant number of teeth of the ring gears.

In a first modification, instead of the planetary gear being formed with two different coaxially aligned pitch diameters, a series of gears are contained in the retainer or housing. These latter gears perform the same function as the unitary gear described in the preferred embodiment, and the operation and speed reduction is essentially the same.

In a second modification, in lieu of the planetary gear, a drive gear is eccentrically mounted on the motor shaft and is formed with two coaxially, aligned integral pitch diameters. The larger pitch diameter engages the stationary ring gear while the smaller pitch diameter engages and rotates the female ring gear. In this modification, speed reduction or amplification is accomplished solely by the difference in pitch diameters of the ring gears.

In a third modification, a second rotating ring gear is installed. The second rotating ring gear is also in axial alignment and preferably has a smaller pitch diameter than the first rotating ring gear. This acts as a second stage and further reduces the speed of the drive shaft in accordance with the difference in pitch diameters and the number of teeth between the rotating ring gears and the stationary ring gear. Additional stages or rotating ring gears to further reduce the speed of the driven shaft may be easily provided.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a cross-sectional view of the invention with a planetary drive gear system.

FIG. 2 is an exploded perspective view of the embodiment shown in FIG. 1, showing the parts and their assembly.

FIG. 3 is an exploded perspective view of the invention with a planetary drive gear system mounted on a gear retainer.

FIG. 4 is a cross-sectional view of the invention with an eccentric drive gear system.

FIG. 5 is an exploded perspective view of the embodiment shown in FIG. 4 showing the parts and their assembly.

FIG. 6 is a cross-sectional view showing a modification of the invention with a second rotating ring gear or second stage.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings in detail, in particular FIGS. 1 and 2, the speed changing device is generally indicated as 10. The device comprises a frame 12 cast integrally with a stationary female ring gear 14 adjacent a flange 16 on one end of the frame. Flange 16 is bolted by a number of bolts 18 to a motor housing 20, only a portion of which is shown. At its other end, frame 12 is formed with a cylindrical wall 22 rotatably receiving a rotatable female ring gear 24. The rotatable ring gear lies rearwardly and in axial alignment with stationary ring gear 14. To provide a speed reduction, rotatable ring gear 24 has a smaller pitch diameter than stationary ring gear 14 and accordingly has one or more less teeth. It is cast with a disclike support plate 25 attached to a centrally located driven shaft 26. To journal driven shaft 26, a hub 28 is provided. Hub 28 has a hub flange 30 removably attached to frame 12 by bolts 31.

A motor (not shown) within motor housing 20 rotates a motor drive shaft 32. Splined to this drive shaft is a planetary gear 36 which planetates between drive gear 34 and stationary gear 14. Planetary gear 36 comprises two, integral, axially aligned pitch diameters 38 and 40; the smaller pitch diameter designated as 38, and the larger pitch diameter designated as 40. The larger pitch diameter engages drive gear 34 and planetates about stationary gear 14 while simultaneously the smaller diameter 38 engages and rotates female ring gear 24.

The operation of the device is as follows. Upon energizing the motor, motor drive shaft 32 rotates drive gear 34 which in turn planetates planetary gear 36. Gear 36, in planetating, rotates about its own axis and also about stationary female ring gear 14. Since the smaller portion 38 of the planetary gear engages rotatable ring gear 24, the rotatable gear is rotated by this planetary action. Driven shaft 26, being integral with rotating ring gear 24, also rotates. However, the rotation of driven shaft 26 is relatively slow in comparison to the rotational velocity of motor shaft 32. This is caused by the amount of difference between the diameters of the pitch circles or the difference in the number of teeth of the two female ring gears and also by virtue of the planetary gear effect.

In FIG. 3, a modified form of the invention is illustrated. In lieu of planetary gear 36 with its two coaxial pitch diameters as seen in FIGS. 1 and 2, a gear retainer or gear housing 50 is provided. The gear retainer is disclike with a central opening to receive the drive gear 34. On one face, the disc has a recess and a bore to respectively receive a first driven gear 52 and its axle 54. The axle is rotatably retained within the bore by conventional means. Driven gear 52 meshes with drive gear 34 and stationary gear 14. On the opposite face of the disc, a second driven gear 56 is similarly positioned and retained on gear retainer 50. This gear is positioned such that when driven gear 52 engages stationary gear 14 and drive gear 34, the second driven gear 56 meshes with rotatable gear 24. An idler gear 58 extends through gear retainer 50 and meshes gears 52 and 54, whereby gear 56 is rotated by gear 52. Idler gear 58 is also rotatably retained within retainer 50 in a customary manner.

In operation, the gear system within gear retainer 50 performs in substantially the same way as planetary gear 36 previously discussed. Gear 52 is rotated by drive gear 34 and planetates about stationary ring gear 14. This movement is transferred to second driven gear 56 by idler gear 58. Being meshed with driven gear 56, rotatable gear 24 is rotated accordingly. As should be evident, driven shaft 26 is rotated with the same rotational velocity whether planetary gear 36 or the gear system within retainer 50 utilized, providing the pitch diameter ratio between stationary gear 14 and rotatable gear 24 remains the same.

A second modification is shown in FIGS. 4 and 5. In this modification, the speed reduction due to planetary gearing is eliminated; except for what is described hereinafter, all the other elements of the embodiment described for FIGS. 1, 2 and 3 remain the same. Drive shaft 32 has keyed on its outward end a disclike member 60. Attached to the outer face of disc 60, parallel to the longitudinal axis of the motor shaft, is a journal shaft 62 for rotatably receiving an eccentric drive gear 64. Eccentric drive gear 64, similar to planetary gear 36 seen in FIGS. 1 and 2, is formed with two integral, axially aligned pitch diameters 66 and 68; the smaller pitch diameter designated 66 and the larger diameter designated 68. The portion of gear 64 having the large pitch diameter 68 engages and rides about stationary gear 14 while rotating on its own axis. Simultaneously, the smaller pitch diameter portion 66 engages and rotates rotatable ring gear 24.

Speed reduction in this instance, since there is not a planetary gear effect as in FIGS. 1 and 2, is effectuated solely by the difference in pitch diameters and resultant number of teeth of the stationary and female ring gears.

In FIG. 6 a third modification of the invention is shown. This modification shows an additional rotatable female ring gear 70 providing a second stage reduction. In this modification, the second female rotating ring gear 70 is axially aligned

with a stationary ring gear 72. Rotatable ring gear 70 has a smaller pitch diameter than stationary ring gear 72. A first female rotating ring gear 74 has a smaller pitch diameter than rotating ring gear 70 and is also axially aligned with stationary ring gear 72. First female rotating ring gear 74 is integral with a driven shaft 76. The housing frame 78 is essentially the same as that described for the embodiment and modifications shown in the previous figures with the exception that the frame's cylindrical wall 80 is elongated to accommodate the additional rotatable ring gear. Freely rotatable on a motor shaft 82 is a spider 84 and splined to shaft 82 is a drive gear 86. The spider includes a hub 87 with two U-shaped extending journal arms 88 and 90. A planetary gear 92 is rotatably received on arm 88. Planetary gear 92 is formed with a large pitch diameter 94 which meshes with drive gear 86 and stationary gear 72 and is also formed with a smaller pitch diameter 96 which simultaneously engages second rotatable ring gear 70. The second journal arm 90 of spider 84 engages a similar planetary gear 98 whose large pitch diameter 100 meshes with second rotatable ring gear 70 and whose smaller pitch diameter 102 meshes with first rotatable ring gear 74.

In operation, upon motor shaft 82 being rotated by a motor (not shown), drive gear 86 rotates which in turn planetates planetary gear 92 about stationary ring gear 70 causing spider 84 to rotate about its axis. As planetary gear 92 planetates, its smaller pitch diameter portion 96 rotates second rotatable ring gear 70. Also, since spider 84 carries planetary gear 98 and since the larger pitch diameter portion 100 of this gear engages second rotatable ring gear 70, first rotatable ring gear 74 is also rotated by its engagement with the smaller pitch diameter 102 of planetary gear 98. Axiomatically, rotation of first ring gear 74 rotates drive shaft 76.

This modification provides greater speed reduction considering the difference in pitch diameters or number of teeth between the second rotatable ring gear 74 and stationary gear 72.

Although the speed changing devices shown by the figures have their gears sized to act as speed reducers, it should easily be understood that the devices may easily be converted to speed amplifiers. This is accomplished merely by reversing the device. That is, rotate the drive shaft on the rotatable ring gear with the motor and substitute and drive a driven shaft where the motor shaft is presently keyed to the device.

It should now be evident from the above description that a novel speed changing device has been provided which will accomplish speed amplification or speed reduction with related torque advantages to an input drive shaft having a particular r.p.m. The speed changing device has a number of features which make it economical to manufacture. The device uses spur-type gears throughout which enables the gears to be easily machined or cast or extruded of plastic material. The housing is simple and the method of assembling the gear trains in the housing is easy and uncomplicated, making it easy to fabricate and increasing the speed of assembly. The speed changing device may be easily converted from a speed reducer to a speed amplifier by interchanging a few basic components. The particular mode of assembly and construction of the gear train further enables the device to be manufactured in very small sizes, and of lightweight components such as plastic or the like. It is readily adaptable to be modified with the provision of additional stages or rotating ring gears to provide even greater reduction of speed between the driven shaft and an input spindle if this is to desired.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of

the invention which, as a matter of language, might be said to fall therebetween.

Now that the invention has been described:

What is claimed is:

1. A speed changing device comprising, a frame, a stationary female ring gear attached to said frame, a first rotatable female ring gear having a different pitch diameter than said stationary ring gear and rotatably received within said frame in axial alignment with said stationary ring gear, a driven shaft rotated by said first rotatable ring gear, a drive shaft, and gear means comprising a gear housing including a central aperture arranged to receive said drive shaft, a first gear mounted on one face of said housing and meshing with said stationary ring gear and said drive shaft, a second gear freely rotatably mounted on an opposite face of said housing, said second gear meshing with said first rotatable female ring gear and an idler gear engaging said first and second gears; said gear means rotated by said drive shaft and riding about said stationary ring gear while simultaneously engaging and rotating said first rotatable ring gear, whereby a speed change is effectuated at least in part between the drive shaft and driven shaft by the difference in pitch diameters of said ring gears.

2. The speed changing device of claim 1 wherein said first rotatable ring gear has a smaller pitch diameter than said stationary ring gear whereby speed reduction is effectuated between the drive shaft and driven shaft by the difference in pitch diameters of said ring gears.

3. The speed changing device of claim 1 further including said frame being cylindrical and having two ends, a flange formed on a first end of said frame for attachment in axial alignment to a motor housing, said stationary ring gear formed integrally with said frame and in axial alignment with said drive shaft, a sleeve comprising a second end of said frame,

said rotatable ring gear rotatably received within said sleeve, and said driven shaft formed integrally with said first rotatable ring gear, and a hub closing the second open end of said frame and journaling said driven shaft.

4. A speed changing device comprising a frame, at least first and second rotatable female ring gears rotatably positioned within said frame, a drive shaft, a driven shaft rotated by at least one of said first and second rotatable ring gears, said second rotatable ring gear having a greater pitch diameter than said first rotatable ring gear but smaller pitch diameter than said stationary ring gear, gear means attached to said drive shaft and including a first and second planetary gear both of which comprise a large pitch diameter and a small pitch diameter, said large pitch diameter of said second planetary gear engaging said second rotatable ring gear while simultaneously said small pitch diameter engages said first rotatable ring gear, said large pitch diameter of said first planetary gear engaging said stationary ring gear while simultaneously said small pitch diameter engages said second rotatable ring gear, and a spider for rotatably carrying said planetary gears, whereby a speed change is effectuated at least in part between said drive shaft and said driven shaft by the difference in pitch diameters of said ring gears.

5. A speed changing device as in claim 4 wherein said first rotatable ring gear is attached to said driven shaft, said second rotatable ring gear arranged in axial alignment with said stationary ring gear and said first rotatable ring gear and positioned between and rotatably arranged relative to both said first rotatable ring gear and said stationary ring gear; whereby said first and second rotatable ring gears simultaneously rotate at different speeds relative to said stationary ring gear.

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