

May 26, 1970

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3,513,724

SPEED REDUCTION MECHANISM

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2 Sheets-Sheet 1

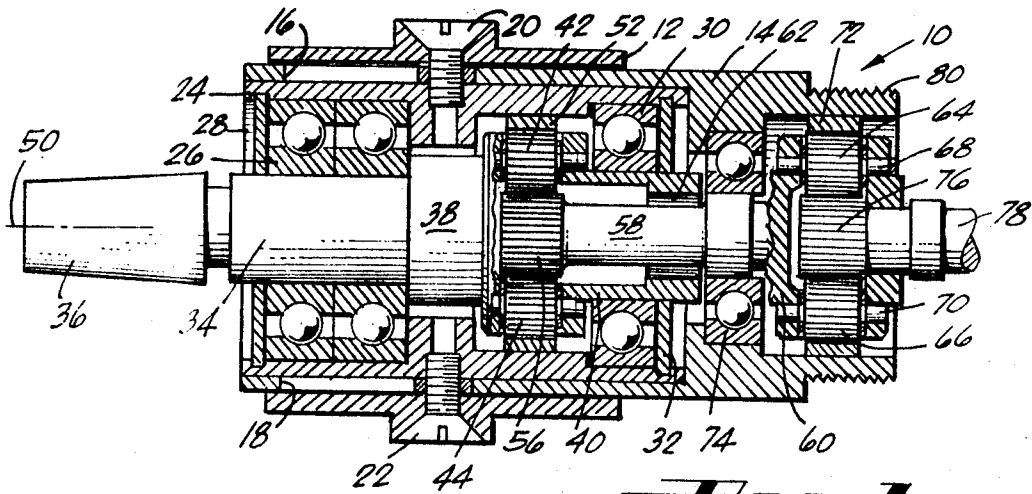


Fig. 1

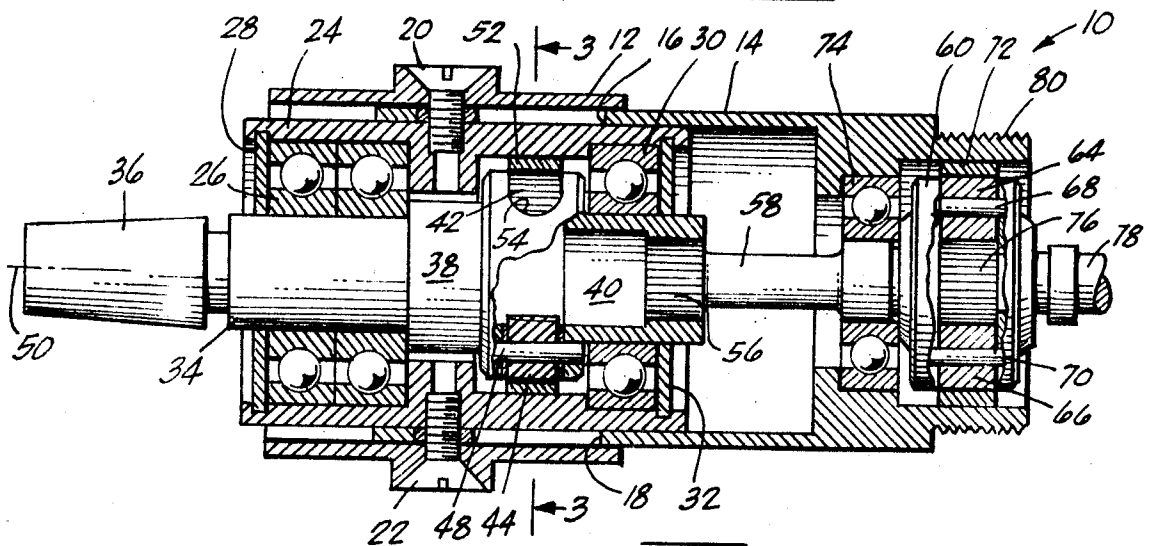


Fig. 2

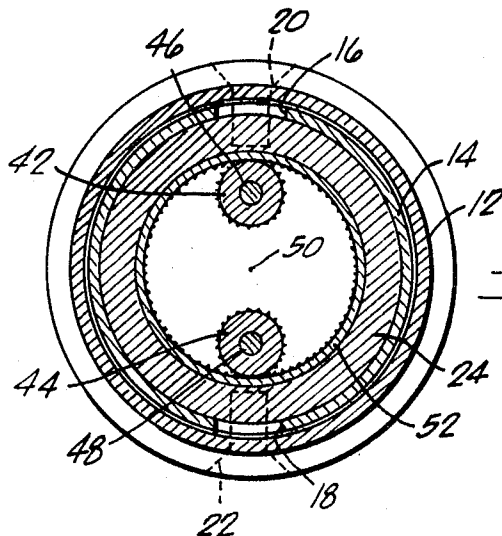


Fig. 3

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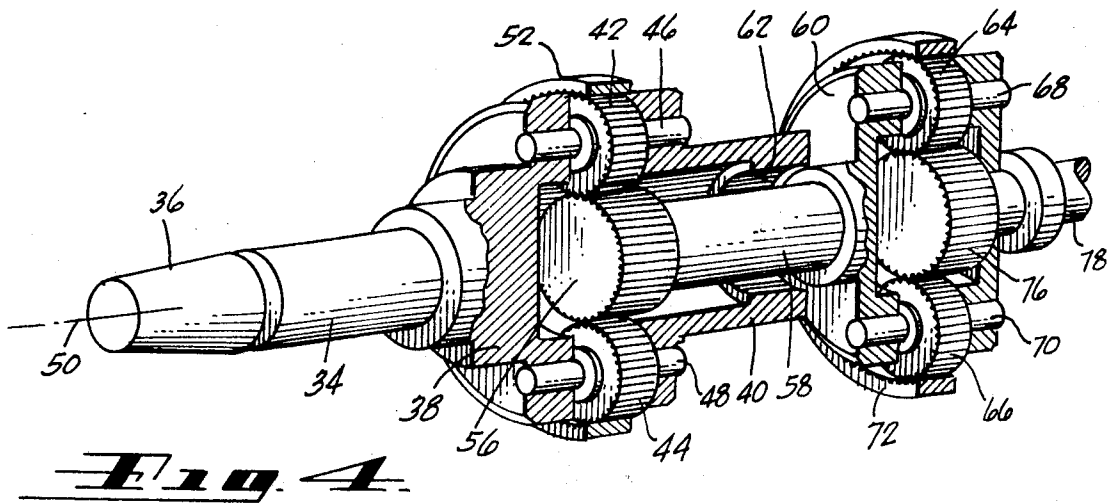
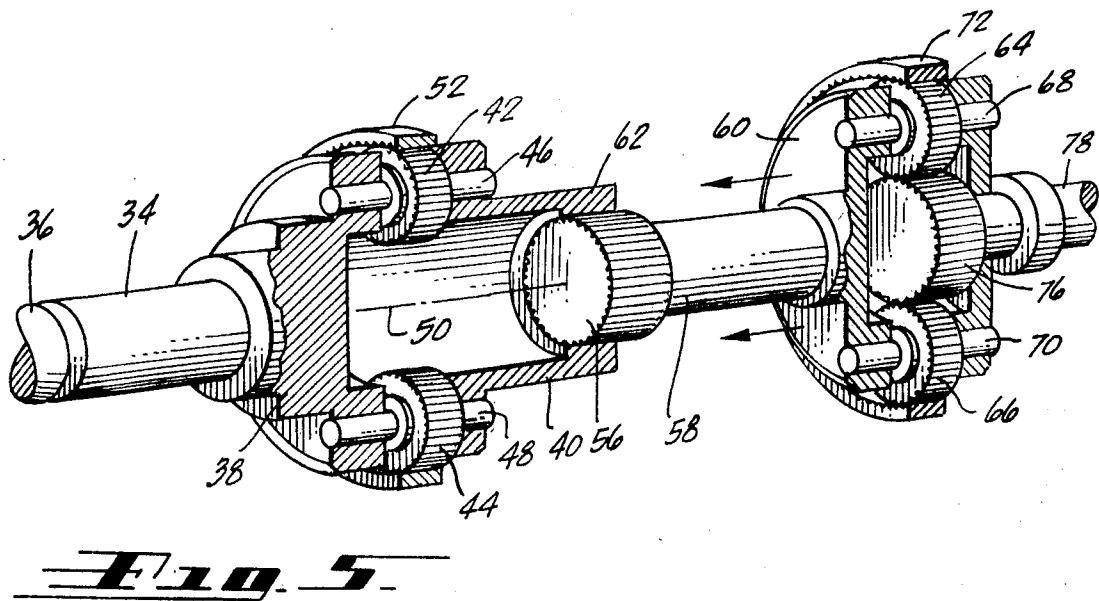
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SPEED REDUCTION MECHANISM

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5 Claims

ABSTRACT OF THE DISCLOSURE

A speed reduction mechanism wherein a first planetary gear assembly and a second planetary gear assembly are employed in a single unit, the mechanism being adjustable to operate either the first gear assembly or the first and second gear assemblies thereby effecting two separate reduced speed settings.

BACKGROUND OF THE INVENTION

In the performing of some operations on metal, cement or other hard surfaces, constant speed tools, which are either electrically or pneumatically operated, are frequently employed. A constant speed tool is one that operates at a single velocity setting (revolutions per minute). The power input to the tool causes operation of the tool at a predetermined velocity. For example, a particular type of drilling tool is operated pneumatically and is specifically designed to rotate at a constant speed. The speed setting of the drill is determined by the pressure and volume of the fluid supply and the physical size and type of the drill motor assembly. Using these factors, the drill is caused to operate at a velocity which gives the greatest efficiency.

When performing some operations, such as drilling, the maximum speed of the motor is the most desirable speed to be employed. However, operations such as reaming, tapping and champhering usually require a much lower speed than drilling if the operation is to be done properly. In the prior art an effort has been made to reduce drill speed to perform these other operations. One way in which this is accomplished is to regulate the volume of the pressurized fluid supply to the pneumatic motor thereby varying the speed of the motor. However, this lowering of the input causes the efficiency of the entire motor to also be lowered. Therefore, the maximum efficiency of the motor at which it has been originally designed to operate is not maintained. It would be more desirable to vary the output speed through a separate mechanism thereby maintaining motor efficiency at a maximum.

Heretofore, there have been a few attempts to design a speed reduction mechanism to vary the output of a motor. However, such mechanisms may only be used with relatively low r.p.m. motors (under 1,000 r.p.m.). Such speed reducers usually employ a single gear system which gives a single reduction. Almost always it is required that a plurality of reduced speeds are necessary. Therefore, several separate units need to be employed giving different reductions. It would be desirable to design a speed reduction mechanism which would be adjustable to different settings yet small in size and light in weight and operable at a relatively high tool output efficiency.

SUMMARY OF THE INVENTION

The apparatus of this invention relates to a speed reduction mechanism wherein it is easily adjustable between a high and low speed position. Basically, the mechanism

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of this invention embodies spaced, in-line planetary gear systems with the option of transmitting power either through only one planetary gear system or through both planetary gear systems. The combination of structure to construct the reduction mechanism of this invention includes an outer housing within which is telescopically mounted an inner housing. Each of the housings include a planetary gear system with the power being transmitted from one system to the other system through a drive gear assembly. The entire mechanism can be adjusted so that the drive gear assembly either operates the second planetary gear system or bypasses such.

An object of the apparatus of this invention is to employ a speed reduction mechanism which is adjustable between two speed settings.

A further object of the invention is to provide a speed reduction mechanism which is easily adjustable between the first and second speed reduction settings.

A further object of the apparatus of this invention is to employ planetary gear systems to effect the speed reduction, the combination of such systems with the associated structure being held to a minimum.

A further object of this invention is to construct a speed reduction mechanism which is operable at relatively high speeds.

A further object of the apparatus of this invention is to provide a speed reduction mechanism which is light in weight and relatively small in size.

Further objects and advantages of this invention will be readily appreciated and more clearly understood by reference to the following description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional view along the longitudinal axis of the apparatus of this invention showing the mechanism in a first position;

FIG. 2 is a view similar to FIG. 1 but showing the mechanism of this invention in a second position;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a partial cut-away, perspective view of the planetary gear train of this invention in the position shown in FIG. 1; and

FIG. 5 is a view similar to FIG. 4 showing the mechanism in the position depicted in FIG. 2.

DETAILED DESCRIPTION OF THE SHOWN EMBODIMENT

Referring particularly to the drawing, there is shown a speed reduction mechanism 10 of applicant's invention. Mechanism 10 includes a first housing 12 and a second housing 14, second housing 14 being telescopically movable within first housing 12. Second housing 14 includes a pair of diametrically opposed slots 16 and 18 which are to confine the movement of bolts 20 and 22, respectively. Bolts 20 and 22 are fixed to first housing 12 and permit movement of second housing 14 with respect to first housing 12. Bolts 20 and 22 are also secured to a sleeve 24 which is located interiorly of first housing 12 with a portion of second housing 14 being movable therebetween.

Sleeve 24 includes at one of its ends a double bearing assembly 26 which is retained therein by a bearing plate 28. Adjacent the other end of the sleeve 24 is a single bearing assembly 30 being confined therein by a bearing plate 32. The double bearing assembly 26 rotatably supports an output shaft 34 which is capable of transmitting power through a fitting 36 to a load (not shown). The other end of output shaft 34 is securely fixed to a

first gear housing 38, which terminates in a connection element 40. Element 40 is rotatably supported with respect to sleeve 24 by means of a single bearing assembly 30.

Within the first gear housing 38 are rotatably mounted and diametrically opposite each other two planet gears 42 and 44. Each of the planet gears 42 and 44 have an axis of rotation determined by pins 46 and 48 respectively. Pins 46 and 48 are not only in diametrical alignment but also equally spaced from the axis of rotation 50 of output shaft 34. Each of the planet gears 42 and 44 are to contact a ring gear 52 which is fixedly secured to sleeve 24. Openings 54 are provided within the first gear housing 38 to permit the contactual relationship between planet gears 42 and 44 and the ring gear 52.

A sun gear 56 is capable of being located in contactual relationship with both planet gears 42 and 44 with its rotational axis coinciding with axis 50. Sun gear 56 is connected to a shaft 58 which is fixedly secured to second gear housing 60. Sun gear 56 is capable of being removed from cooperation with the planet gears 42 and 44 to enter into a cooperative relationship with gear 62 which is a portion of element 40.

Second gear housing 60 is similar to first gear housing 38 in that it also contains planet gears 64 and 66 which are rotatably mounted through pins 68 and 70, respectively, planet gears 64 and 66 being in constant contact with a ring gear 72 which is fixedly secured to second housing 14. Also, second gear housing 60 contains openings therein (not shown) permitting access of the planet gears 64 and 66 to contact ring gear 72. Second gear housing 60 is rotatably supported with respect to second housing 14 through a bearing assembly 74. More than likely bearing assembly 74 will be composed of two single bearing units, only one being shown. A sun gear 76 is fixedly attached to input shaft 78 to be in contactual relationship with planet gears 64 and 66. It is to be noted that the axis of rotation of sun gear 76 coincides with axis 50.

Input shaft 78 is to include a fitting (not shown) on its outer extremity to permit connection to a driving motor (not shown). It is for this purpose that the screw threads 80 are provided on second housing 14 to facilitate attachment to the driving motor.

The operation of the apparatus of this invention is as follows: With the mechanism in the position shown in FIGS. 1 and 4, power is being transmitted through input shaft 78 which causes rotation of sun gear 76. Planet gears 64 and 66 are likewise rotated, which operate upon ring gear 72. As ring gear 72 is fixed and does not move, the second gear housing 60 rotates. This rotational movement is transmitted through shaft 58 to sun gear 56 and in a similar manner through planet gears 42 and 44. As planet gears 42 and 44 operate upon fixed ring gear 52, first gear housing 38 is rotated, which results in the rotation of output shaft 34. What actually has occurred is that the speed of the shaft rotation 78 has been substantially reduced by being transmitted through the planetary gear assemblies and then to output shaft 34. In actual practice it has been found that an input shaft velocity of 18,000 revolutions per minute can be reduced to 450 revolutions per minute at output shaft 34. Although the reduction in shaft velocity is substantial, there is no loss in power through the unit except for the small amount lost in the mechanical movements of the mechanism.

It may be desirable that 450 r.p.m. is too great a reduction and that a higher r.p.m. is needed. For this purpose second housing 14 may be longitudinally moved with respect to fixed housing 12, so that sun gear 56 is moved out of driving relationship with the planet gears 42 and 44 and into driving relationship with gear 62. This position is shown in FIGS. 2 and 4 of the drawings. What has occurred is that, although the input power is still being transmitted through sun gear 76 and planet gears 64

and 66 through housing 62 to shaft 56, power is no longer being transmitted through gears 42 and 44. The power is now being applied directly to output shaft 34 through connection element 40 which is a portion of first gear housing 38. Planet gears 42 and 44 function as mere idler wheels with respect to ring gear 52 and upon rotation of shaft 34. In this position the input velocity of shaft 78 is only being reduced by means of planet gears 64 and 66 and ring gear 72. In actual practice it has been found that a reduction from 18,000 r.p.m. to 2,000 r.p.m. is quite easily accomplished.

It is to be understood to be within the scope of this invention that any ratio of the gear teeth between the sun gear and the respective planetary gears and the ring gear may be made. Accordingly, the ratio of the number of teeth between the gears determines the reduction in rotational velocity. Therefore, it may be desired to establish a ratio with each of the gear systems which could substantially alter the reduced speed outputs which have been found to be satisfactory to this inventor. Also, any type of a gear may be employed, such as helical, spur or herringbone gears.

It is believed that the inventive concepts of this invention have been adequately described in the foregoing. Although the speed reduction mechanism of this invention has been designed to perform most advantageously with a pneumatically driven motor, it is to be considered within the scope of this invention that applicant's structure could be readily employed in combination with other motors such as electric motors or combustion engines. Further, as the apparatus of this invention has been specifically designed to cooperate with a single speed motor, it is to be considered within the scope of this invention to also employ it in combination with variable speed motors. Further, it is to be considered evident that considerable modifications and elaborations of the subject invention can be carried out with respect to the various features of the invention, without departing from the scope and spirit thereof.

What is claimed is:

1. A speed reduction mechanism comprising:

a) an input shaft, said input shaft having one terminal connected to a first sun gear, said first sun gear being capable of effecting rotation of a plurality of first planet gears, said first planet gears being rotatably mounted to a first housing, said housing being directly connected to a drive gear, said first planet gears being connected to rotatively move relative to a first ring gear; and

b) a second housing directly connected and intermediate an output shaft and a connection element, said connection element including an internal gear, said second housing having a plurality of second planet gears rotatably attached thereto, said second planet gears being connected to rotatively move relative to a second ring gear, said drive gear being capable of effecting rotation of said second planet gears, said drive gear being movable axially relative to said connection element.

2. An apparatus as defined in claim 1 wherein:

a) said drive gear is movable between a first and second position, said first position being when said drive gear is capable of effecting rotation of said second planet gears, said second position being when said drive gear is capable of effecting rotation of said internal gear.

3. An apparatus as defined in claim 2 wherein:

a) a locking means is fixed with respect to said second housing, said first housing being movable with respect to said second housing to effect movement of said drive gear between said first and said second positions, said locking means being capable of retaining said first housing in a fixed relationship with respect to said second housing when said drive gear is positioned in either said first or second position.

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4. An apparatus as defined in claim 3 wherein:
said first and second ring gears are fixed relative to
their environment, said first and second housings
being rotatable to effect rotation of said output shaft.
5. An apparatus as defined in claim 4 wherein:
the rotational speed of said output shaft is at least
nine times less than the rotational speed of said input
shaft.

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