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THIS NASA INVENTION APPEARS TO HAVE EXCELLENT COMMERCIAL POTENTIAL

NASA CASE NO. ARC-11,325-1

PRINT FIG. The Figure

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(NASA-Case-ARC-11325-1) CLUTCHLESS MULTIPLE DRIVE SOURCE FOR OUTPUT SHAFT Patent Application (NASA) 11 p HC A02/MF A01 CSCL 131

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SERIAL NO. 354,126
FILE DATE: 3/2/82

NASA CASE NO. ARC-11325-1

Clutchless
Multiple Drive Source for Output Shaft

Invention Abstract

The subject invention relates to a multiple drive source for an output shaft which may be driven either concurrently or exclusively by separate sources of rotational power, without requiring the use of a clutch and without using a planetary gear.

A multiple drive source (10) for output shaft (12) has a first shaft (14) connected to a first source (16) of rotational power. First shaft (14) has a first gear (28) fixedly mounted on the shaft. A second gear (32) is fixedly mounted on a gear shaft (30), which gear shaft (30) is parallel to first shaft (14). A third gear (34), also fixedly mounted on gear shaft (30), meshes with a fourth gear (36), which fourth gear (36) is fixedly mounted on the output shaft (12). First input shaft (14) and output shaft (12) are rotatably mounted through a housing (24), which housing (24) is itself rotatable with respect to base 20. First input shaft (14) and output shaft (12) are coaxial and in end-to-end relationship. A second input shaft (46) is connected to a second source (42) of rotational power. A fifth gear (48) is fixedly mounted on second input shaft (46) and meshes with a sixth gear (54), which is fixedly mounted on rotatable housing (24), and in coaxial relationship with first input shaft (14). In operation, first drive source (16) and gear train (56) provide rotational power in a first direction (60) to drive output shaft (12) in a given direction (62) of rotation. The second source (42) of rotational power may be operated either to decrease the rate of rotation imparted to output shaft (12) by first source (16) of rotational power, or increase that rate of rotation, depending on which direction the housing (24) is rotated by the second source (42) of rotational power.

Prior art multiple drive sources for an output shaft either require the use of clutches or utilize a planetary gear. This multiple drive source for an output shaft can provide a 1:1 gear ratio, since it does not utilize a planetary gear, and it is also capable of being implemented in a smaller, lower cost form than conventional multiple drive sources for output shafts.

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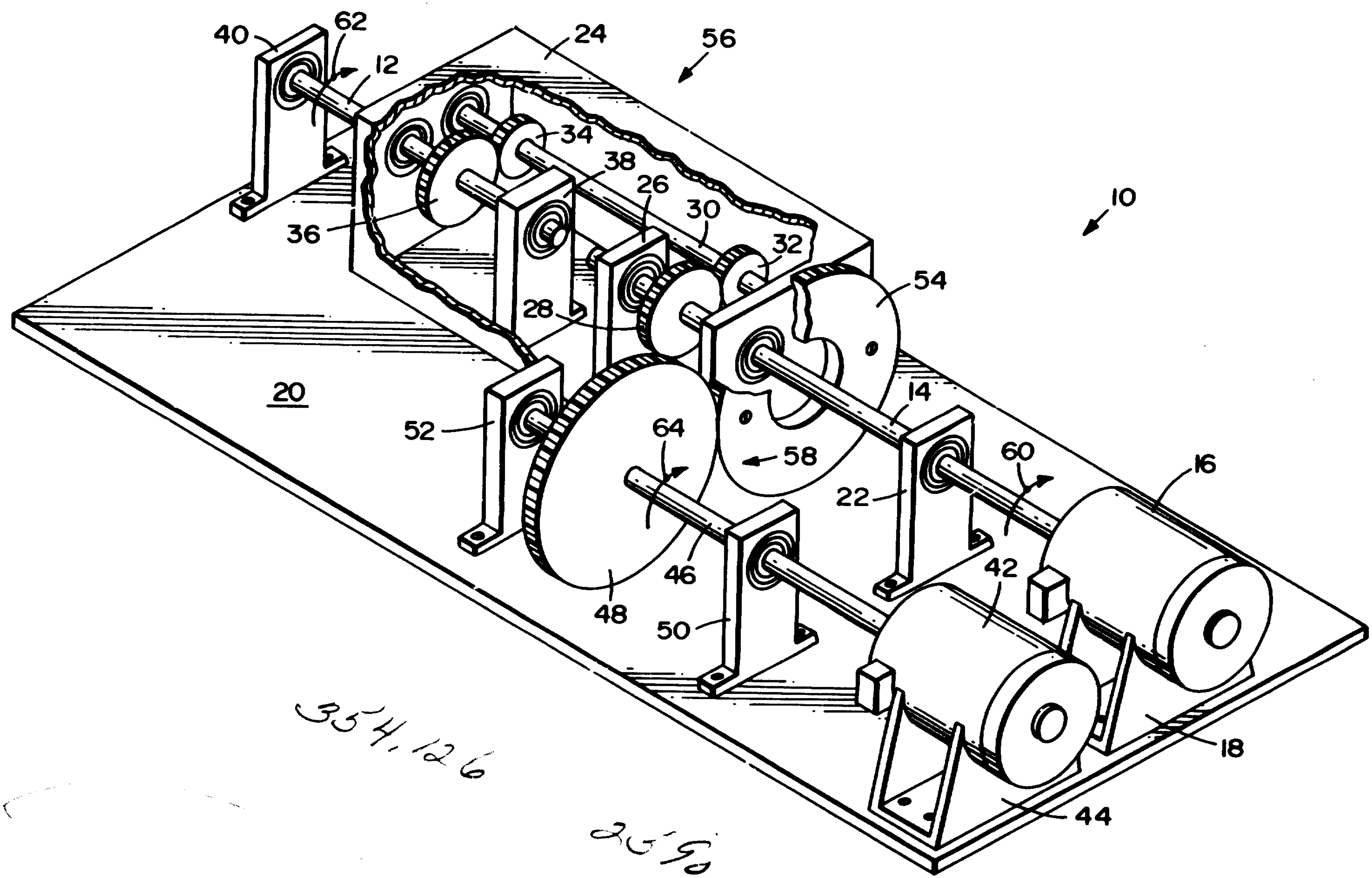
ARC-11,325-1



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CLUTCHLESS MULTIPLE DRIVE SOURCE FOR OUTPUT SHAFT

Origin of the Invention

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the government for governmental purposes without the payment of any royalties thereon or therefor.

Field of the Invention

This invention relates to an improved clutchless multiple drive source for an output shaft. More particularly, it relates to such a multiple drive source that is both low in cost and which may be embodied in physically small form. Most especially, it relates to such a multiple drive source which can be implemented with a 1:1 gear ratio and without any intervening clutch.

Description of the Prior Art

There is a wide variety of gear drives known in the art for connecting a source of rotational power, such as a gasoline engine or an electric motor, to an output shaft. Many of those gear drives are of the type for connecting a plurality of separate power sources to a common output shaft. Examples of such gear drives are described in U.S. Patents 2,180,599; 2,660,860; 2,971,402; 3,457,806; 3,507,173; and 3,748,927.

The multiple drive sources as disclosed in the above prior art either have clutches for disconnection of one of the power sources or incorporate planetary gears to allow the use of more than one power source simultaneously under different operating conditions. Such gear drives tend either to be complex or bulky in their construction, so that they have achieved acceptance primarily in relatively heavy duty situations, such as driving an aircraft propeller from more than one internal combustion engine. Planetary gear drives are employed where their physical bulk is not a problem and it is desired to avoid the use of a clutch mechanism in a multiple drive source. However, in addition to their bulk, another disadvantage of planetary gear drives is that a 1:1 gear ratio cannot be achieved with them.

Thus, despite the long history of multiple drive sources, a need still remains for further development of such drive sources to meet situations in which a clutchless drive which is physically small, low in cost and which can provide a 1:1 gear ratio is needed.

Summary of the Invention

Accordingly, it is an object of this invention to provide a clutchless, non-planetary gear multiple drive source for an output shaft.

It is another object of the invention to provide a clutchless, multiple drive source for an output shaft, which drive can provide a 1:1 gear ratio.

It is a further object of the invention to provide a clutchless, multiple drive source for an output shaft which can be implemented in a physically small, low cost configuration.

The attainment of these and related objects may be achieved through use of the novel multiple drive for an output shaft herein disclosed. This drive has a first shaft connected to a first source of rotational power. A gear train is mounted in a rotatably movable housing. The gear train operatively connects the first shaft and the output shaft. The first shaft and the output shaft are coaxial. A second shaft is connected to a second source of rotational power mounted so as to be stationary, other than with respect to the rotational power, with respect to the first source of rotational power. There is a means for coupling rotational motion from the second shaft to the rotatably movable housing.

In operation, the first drive and the gear train may provide rotational power in a first direction to drive the output shaft in a given direction of rotation. The second source of rotational power may be operated either to decrease the rate of rotation imparted to the output shaft by the first source of rotational power, or increase that rate of rotation, depending on which direction the housing is rotated by the second source of rotational power.

The attainment of the foregoing and related objects, advantages and features of the invention should be more readily apparent to those skilled in the art after review of the following more detailed description of the invention taken together with the drawing, in which:

Brief Description of the Drawing

The sole figure of drawing is a perspective view of a multiple drive for an output shaft in accordance with the invention.

Detailed Description of the Invention

Turning now to the drawing, the multiple drive 10 for output shaft 12 has a first shaft 14 connected to a first source 16 of rotational power, such as an electric motor. Support 18 is bolted or otherwise fixedly mounted to base 20. First shaft 14 is rotatably mounted in support 22, also fixedly mounted to base 20. The first shaft 14 is also rotatably mounted in housing 24, and support 26 is fixedly mounted to housing 24. Housing 24 is itself free to rotate. A first gear 28 is fixedly mounted on first shaft 14. A gear shaft 30 has a second gear 32 fixedly mounted on it, with the second gear 32 in meshing relationship with first gear 28. Gear shaft 30 is rotatably mounted in housing 24. The gear shaft 32 has a third gear 34, also fixedly mounted to the shaft 30. Third gear 34 meshes with a fourth gear 36, which is fixedly mounted on the output shaft 12. The output shaft 12 is rotatably mounted in housing 24, in support 38 fixedly mounted within the housing 24, and to support 40, which is fixedly mounted to the base 20.

A second source 42 of rotational power, such as an electric motor, is also fixedly connected by a support 44 to base 20. The second source of power 42 is operatively connected to a second shaft 46. The second shaft 46 is parallel to the first shaft 14, the output shaft 12, and the gear shaft 30. A fifth gear 48 is fixedly mounted on the second shaft 46. The second shaft 46 is rotatably supported by supports 50 and 52, which supports are fixedly mounted to base 20. Fifth gear 48 is in meshing engagement with sixth gear 54, which is fixedly mounted to the rotatable housing 24. Sixth gear 54 is concentrically disposed relative to the first shaft 14, which is free to rotate with respect to the sixth gear 54. Since the output shaft 12 is axially disposed in end-to-end relationship with the first shaft 14, the sixth gear 54 is also concentrically disposed relative to the axis of shaft 12. In a preferred embodiment, the fifth and sixth gears 48 and 54 have a 1:1 gear ratio, though any gear ratio is possible. The first through fourth gears 28, 32, 34 and 36 provide a 500:1 gear ratio in the depicted embodiment, although the gear sizes actually shown in the drawing are much closer in size than necessary to provide that ratio, for simplicity in the drawing. It should be recognized that a gear train of parallel shaft gears of any desired ratio could be used for gears 28, 32, 34 and 36 comprising gear train 56.

There are certain relationships which are useful for an understanding of the operation of multiple source drive 10. First shaft 14 provides rotational power to the output shaft 12 through the gear train 56 contained within rotatable housing 24. Rotations of the first shaft 14, referenced to housing 24 of gear train 56, are capable of rotating the output shaft as a function of the gear ratio of the gear ratio of the gear train 56, R_{GT56} where:

(1) $$R_{GT56} = \frac{1}{T_{S1}}$$

wherein T_{S1} equals the number of turns first shaft 14 must make, relative to housing 24 of gear train 56, to cause output shaft 12 to turn one complete revolution, also referenced to housing 24 of gear train 56. First shaft 14 and the output shaft 12 are not physically connected. Torque, and therefore movement, is transferred from first shaft 14 to output shaft 12 through gears 32 and 34, whose center of rotation is not coaxial with respect to first shaft 14. R_{GT56} may take on any physically attainable value and gear train 56 may then act as either a coaxial speed reducer or a coaxial speed increaser.

Gear 48 and gear 54 comprise a second gear train 58 in its simplest form. Gear 48 is physically attached to second shaft 46 and rotates directly with it. Gear 54 is physically connected to housing 24 of gear train 56 and has an axis of rotation that is coincident with the axis of rotation of output shaft 12. Gear 48 drives gear 54. Rotations of second shaft 46 are capable of rotating housing 24 as a function of the gear ratio R_{GT58}, where:

(2) $$R_{GT58} = \frac{1}{T_{S2}}$$

wherein T_{S2} equals the number of turns second shaft 46 must make, referenced to base 20, to cause the gear train 56 housing 24 to rotate one complete revolution, also with respect to base 20. Unlike the gear ratio in a planetary gear train, gear ratio R_{GT58} may take on any physically attainable value, including 1:1.

The angular velocity of output shaft 12, $\dot{\theta}_{out}$, referenced to base 20, in response to the input angular velocities of the first and second shafts 14 and 46, may be expressed:

(3) $$\dot{\theta}_{out} = R_{GT56}\dot{\theta}_1 - R_{GT58}\dot{\theta}_2\,(1-R_{GT56})$$

where $\dot{\theta}_1$ and $\dot{\theta}_2$ are the angular velocities, referenced to base 20 of first shaft 14 and second shaft 46, respectively. The positive sense for each shaft 14, 12 and 46 is shown in the drawing by arrows 60, 62 and 64, respectively. Relationship (3) shows that both input shafts 14 and 46 may rotate output shaft 12 with respect to base 20 concurrently, or exclusively, and with no intervening clutch. The exact relationship of input shaft 14 and/or 46 to output shaft 12 velocity is directly a function of the two gear ratios R_{GT56} and R_{GT58}.

Similarly the change in angular position of output shaft 12, $\Delta\theta_{out}$, with respect to support 20, in response to changes in angular positions of the input shafts 14 and 46, $\Delta\theta_1$ and $\Delta\theta_2$ respectively, may be expressed:

$$(4) \qquad \Delta\theta_{out} = R_{GT56}\Delta\theta_1 - R_{GT58}\Delta\theta_2\,(1-R_{GT56})$$

Relationship (4) shows that both input shafts 14 and 46 may alter the angular position of output shaft 12 concurrently or exclusively, and without the use of an intervening clutch.

In an alternative form of the invention, the functions of input shaft 46 and output shaft 12 could be exchanged. A second source of rotational power connected to shaft 12 would then drive shaft 46 through gear train 58. Shaft 12 in this embodiment then becomes a part of gear train 56 housing 24. For this embodiment, relationships (3) and (4) above would be slightly modified.

It should now be apparent to those skilled in the art that a novel multiple drive source output capable of achieving the stated objects of the invention has been provided. A multiple drive source for an output shaft that is clutchless and which does not utilize a planetary gear is provided, so that a 1:1 gear ratio is attainable. Further, because a planetary gear is not employed, this multiple drive source for an output shaft can be implemented in a physically small, low cost configuration.

It should further be apparent to those skilled in the art that various changes in form and details of the invention as shown and described may be made. It is intended that such changes be included within the spirit and scope of the claims appended hereto.

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NASA Case No. ARC-11325

ABSTRACT OF THE DISCLOSURE

A multiple drive source (10) for output shaft (12) has a first shaft (14) connected to a first source (16) of rotational power. First shaft (14) has a first gear (28) fixedly mounted on the shaft. A second gear (32) is fixedly mounted on a gear shaft (30), which gear shaft (30) is parallel to first shaft (14). A third gear (34), also fixedly mounted on gear shaft (30), meshes with a fourth gear (36), which fourth gear (36) is fixedly mounted on the output shaft (12). First input shaft (14) and output shaft (12) are rotatably mounted through a housing (24), which housing (24) is itself rotatable with respect to support 20. First input shaft (14) and output shaft (12) are coaxial and in end-to-end relationship. A second input shaft (46) is connected to a second source (42) of rotational power. A fifth gear (48) is fixedly mounted on second input shaft (46) and meshes with a sixth gear (54), which is fixedly mounted on rotatable housing 24, and in coaxial relationship with first input shaft (14). In operation, first drive source (16) and gear train (56) provide rotational power in a first direction (60) to drive output shaft (12) in a given direction (62) of rotation. The second source (42) of rotational power may be operated either to decrease the rate of rotation imparted to output shaft (12) by first source (16) of rotational power, or increase that rate of rotation, depending on which direction the housing (24) is rotated by the second source (42) of rotational power.