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REPLY TO
ATTN OF: GP

March 27, 1971

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned
U.S. Patents in STAR

In accordance with the procedures contained in the Code GP
to Code USI memorandum on this subject, dated June 8, 1970,
the attached NASA-owned U.S. patent is being forwarded for
abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,359,819

Corporate Source : Goddard Space Flight Center

Supplementary
Corporate Source :

NASA Patent Case No.: XGS-04227

Gayle Parker

Enclosure:
Copy of Patent

N71 21744

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FACILITY FORM 602

NASA-HQ

Dec. 26, 1967   L. J. VEILLETTE ET AL   3,359,819
BIDIRECTIONAL STEP TORQUE FILTER WITH ZERO
BACKLASH CHARACTERISTIC
Filed April 25, 1966
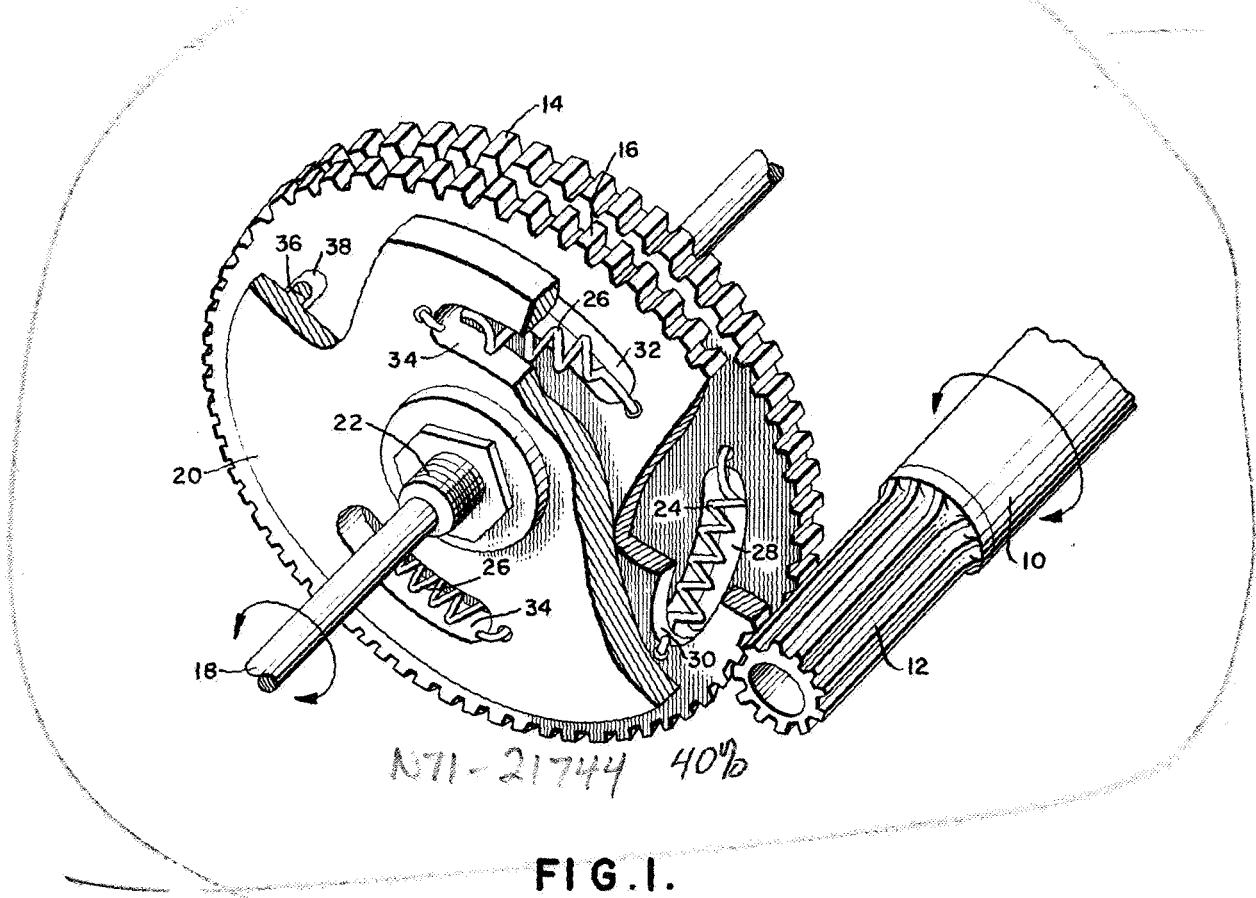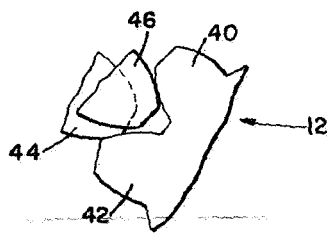

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FIG.I.

FIG.2.

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The invention described herein was made by em-
ployees of the United States Government and may be
manufactured and used by or for the Government for
governmental purposes without the payment of any royal-
ties thereon or therefor.

The present invention relates generally to a gearing
system; and more particularly to a gearing system capable
of eliminating backlash and filtering input torque fluctua-
tions from a high inertia load.

In the application of a power source, such as a stepping
motor to drive a relatively large inertia load, it is de-
sirable to eliminate input torque fluctuations and com-
ponents of backlash within the gear train to obtain a
smoothed torque at the output of the system. In the space
sciences the elimination of such disturbances is important
in obtaining maximum efficiency from the performance
of the spacecraft. For example, solar panels and para-
bolic arrays adapted to collect the sun's energy and con-
vert it to electrical energy must be constantly aligned
with the sun to achieve maximum efficiency. The system
which provides this alignment must be free from un-
necessary angular fluctuations and overshoot and must
be effective in both directions of rotation.

It is therefore an object of this invention to provide a
gearing system capable of filtering torque fluctuations and
eliminating backlash in both directions of rotation of
the input.

Another object is to provide a gearing system capable
of filtering torque fluctuations and eliminating backlash
while at the same time functioning as a gear reduction
system over an appreciable range of gear ratios.

A further object of the invention is the provision of a
gearing system having torque filter and antibacklash char-
acteristics derived from single input and output means
without the necessity of intermediate idler means.

Still another object is to provide a device as above
described which is failsafe in the transmission of driving
torque.

Briefly stated, in accordance with one embodiment, the
invention comprises a gearing system including an input
shaft and an output shaft, driving means fixed to the
input shaft, and a pair of driven gears mounted freely for
rotation on the output shaft and interconnected through
elastomeric elements to a flange fixed on the output shaft
in such a manner that variations in input torque are
absorbed to provide a smoothed torque on the output
shaft.

The exact nature of this invention as well as other ob-
jects and advantages thereof will be readily apparent from
consideration of the following specification relating to the
annexed drawings in which:

FIGURE 1 shows an isometric view, partly in section,
of a preferred embodiment of the invention; and

FIGURE 2 is an enlarged view of the engagement of
the spur gears on the output shaft with the teeth of the
pinion gear on the input shaft.

Referring now to FIGURE 1, there is shown an input
shaft 10 which carries at one end the pinion or driving
gear 12 which is normally in mesh with two spur gears
14 and 16 both mounted to turn freely on the output shaft
18. Also mounted on the output shaft is the hub or flange

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20 which is fixed to the shaft as at 22. The hub and spur
gears 14 and 16 are interconnected through coil springs
24, and 26. Spring 24 connects gear 14 to gear 16 by con-
ventional means and is accommodated in slots 28 and 30
formed in the respective gears. Slots 32 and 34 formed
in the gear 16 and the hub 20 carry the second springs
26 which connect the hub to the latter gear. Note that
two complementary springs 26 are shown, and in the
illustrated embodiment a second spring 24 (not shown)
is similarly situated 180 degrees from the spring 24 seen
in FIGURE 1. This complementary placement aids in
reducing bearing friction but it is to be understood that
such spring pairs are not essential to an operable de-
vice, and that one spring for each connection would be
effective to accomplish the purposes of this sytsem.

A pin 36 projects axially from the hub 20 and rides in
the circumferential slot 38 in the gear 16. When the teeth
of spur gears 14 and 16 are meshed with the teeth of
pinion gear 12 spring 24 is in tension and acts to bias
the spur gears in opposite directions of rotation. The
second coil spring 26 is also placed in tension and assum-
ing no load at the output shaft the axial pin 36 will nor-
mally engage one end of the slot 38 as shown.

FIGURE 2 shows on an enlarged scale the mesh of
gears 14 and 16 with the pinion gear 12 carried by the
input shaft 10. Spring 24 which is pretensioned before
the gears are meshed forces the engaging tooth 46 of gear
16 against the top tooth 40 of the pinion. At the same
time the engaging tooth 44 of spur gear 14 is forced
against the bottom tooth 42 of the pinion. The driven
gears are thus effectively biased in opposite directions
about the output shaft 18, giving the device an antiback-
lash characteristic.

In operation when the input shaft 10 is rotated in a
clockwise direction torque is transferred directly to gear
14 which then drives gear 16 through spring elements 24.
Any torque pulsations are filtered by the springs 24 since
the pinion does not directly drive gear 16 in this direction
of rotation; and gear 16 is free to rotate slightly with re-
spect to the pinion. The hub 20 and output shaft 18 are
then driven counterclockwise with a smoothed torque
by the engagement of pin 36 in the end of slot 38. When
the input shaft is rotated counterclockwise it drives gear
16 directly. Gear 16 then drives the hub through springs
26 which filter out pulsations in the input torque. Note
that in this direction of rotation the pin 36 is free to move
a limited distance in the circumferental slot 38 and there-
fore gear 16 when driven clockwise will not drive the
flange 20 directly but only through springs 26.

The device thus comprises a bidirectional step torque
filter and anti-backlash driving system capable of filter-
ing small angular displacements, less than one arc-minute
(theoretically zero). In this application the elastic ele-
ments serve as enrgy storage devices. This permits con-
servation of power in step motor assemblies which drive
high inertia loads. Additionally, the system can provide
gear reduction for any reasonable gear ratio, simply by
selection of the desired size pinion and spur gears. No
intermediate idler elements are necessary. Further, the
pin and slot connection between the gear 16 and hub 20
makes the system failsafe with respect to the elastic ele-
ments for should either or both of the elastic elements
fail gear 16 would still drive the hub through pin 36.

The system is also adjustable in that by rotating the
gear 14 with respect to gear 16 before placing both gears
in mesh with the driving pinion the biasing tension of
springs 24 may be preselected according to the angular
displacement of the two gears. Of course, the number
and size of the springs used will depend upon the magni-
tude of the anticipated torque fluctuations. Also, elements
other than coil springs could be employed as long as the
necessary elastomeric qualities are present.

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It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alternations may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A gearing system for providing a smooth torque on an output shaft in response to a variable torque on an input shaft comprising:
a driving gear,
an output shaft,
first and second driven gears meshed with said driving gear and mounted for free rotation on said output shaft,
means for biasing said first and second driven gears in opposite directions of rotation on said output shaft,
and means for rotating said output shaft in response to rotation of one of said driven gears.

2. A gearing system as set forth in claim 1 wherein the means for biasing said first and second driven gears comprises elesatic means having one end conected to said first driven gear and the other end connected to said second driven gear such that said elastic means is placed in tension when the driven gears are in mesh with said driving gear.

3. A gearing system as defined in claim 2 wherein said means for rotating said output shaft includes a flange

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fixedly mounted on said output shaft, and a second elastic means having one end connected to said second driven gear and the other end connected to said flange.

4. A gearing system as defined in claim 3 wherein said flange carries an axially extending pin, and said second driven gear has formed therein a circumferential slot to accept said pin.

5. A gearing system as defined in claim 4 wherein said pin normally contacts one end of said slot and is free for limited movement within said slot in one direction of rotation of said driven gears.

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