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(54) Title:  DUAL PULLEY TRANSMISSION UNIT

(57) Abstract:  With reference to figure 1, the present invention provides a transmission unit comprising: an input pulley (108) mounted on an input shaft (49); an output pulley (100) mounted on an output shaft (4); an epicyclic arrangement gears (51, 58, 54); a brake assembly (60, 70, 71, 78) operable to brake a sun gear (51) of the epicyclic arrangement; and a one-way clutch (53) which acts between the input shaft (49) and the output shaft (4) to allow relative rotation therebetween in only one direction. The brake assembly (60, 70, 71, 78) comprises a plurality of flyweights (60) which when rotating apply a force acting to disengage the brake and a biasing spring (78) which applies a force acting to engage the brake. When torque is reacted by the sun gear (51) then the reacted torque results in an axial force which acts to engage the brake. For a first range of low rotational speeds of the input shaft the output shaft (4) rotates at a rotational speed greater than the input shaft (49); and for a second range of high rotational speeds the one-way clutch locks the output shaft (4) to the input shaft (49) to rotate therewith.

FIG. 1
The present invention relates to a dual pulley transmission unit suitable for use in driving ancillary devices of an internal combustion engine, such as an alternator, a supercharger, power steering pump, a water pump and an oil pump.

It is typical for internal combustion engines to be provided with a pulley mounted to the crankshaft which rotates at a crankshaft speed. This pulley is then connected by a belt or by belts to various devices driven by the internal combustion engine which are ancillary to the internal combustion engine itself (or, in certain applications, ancillary to the vehicle in which the internal combustion engine is provided). To date, the ratio of the speed of rotation of the crankshaft to the speed of rotation of the ancillary devices is typically fixed for all engine speeds. However, this is disadvantageous. For instance, it is advantageous for a supercharger at low engine speeds to run at a speed which is a first higher multiple of crankshaft speed whilst at higher engine speeds the supercharger runs at second lower multiple of crankshaft speed. Traditional drive arrangements for superchargers do not permit this. The same logic also applies to the operation of alternators, power-assisted steering pumps, air-conditioning pumps etc.

The present invention provides a transmission unit comprising:

an input pulley mounted on an input shaft for rotation therewith;
an output pulley mounted on an output shaft for rotation therewith;
an epicyclic arrangement of a helical sun gear, helical planet gears and a helical annulus gear, the helical planet gears being supported by a planet carrier;
a brake assembly operable to brake the sun gear; and
a one-way clutch which acts between the input shaft and the output shaft to allow relative rotation therebetween in only one direction; wherein:
the planet carrier is attached to the input shaft for rotation therewith;
the annulus gear is attached to the output shaft for rotation therewith;
the brake assembly comprises a plurality of flyweights driven to rotate by the input shaft which when rotating apply a force acting to disengage the brake and a biasing spring which applies a force acting to engage the brake;
the sun gear is mounted to slide axially within the epicyclic arrangement and is connected to the braking assembly in such a way that when torque is reacted by the sun gear then the reacted torque results in an axial force on the sun gear which is relayed to the braking assembly and acts to engage the brake and when the flyweights are driven to rotate then the force applied by the flyweights gives rise to an axial force on the sun gear opposed to the axial force resulting from the reacted torque;
in a first range of rotational speeds of the input shaft the spring force and the axial force resulting from the reacted torque together exceed the force applied by the flyweights and together engage the brake and thereby prevent the sun gear from rotating;
in a second range of rotational speeds of the input shaft, greater than the rotational speeds of the first range, the force applied by the flyweights exceeds the sum of the spring force and the axial force resulting from the reacted torque and disengages the brake and thereby allow the sun gear to rotate;

for the first range of rotational speeds rotation is relayed from the input shaft via the planet carrier and the planet gears carried thereby to the output shaft and the output shaft rotates at a rotational speed greater than the rotational speed of the input shaft; and

for the second range of rotational speeds the sun gear is free to rotate and the one-way clutch locks the output shaft to the input shaft to rotate therewith.

Preferred embodiment of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a cross-section through a first embodiment of two-speed transmission according to the present invention;

Figure 2 is a representation of a meshing sun gear and planet gear of the transmission unit of Figure 1;

Figure 3 is a schematic representation of the Figure 1 transmission unit operating with a first transmission ratio;

Figure 4 is a schematic representation of the Figure 1 transmission unit, operating with a second transmission ratio;

Figure 5 is a schematic drawing showing the front of an engine with the two-speed transmission unit of Figure 1 and also auxiliary devices driven by the transmission unit;
Figure 6 is a cross-section through a second embodiment of two-speed transmission according to the present invention; and

Figure 7 is a cross-section through a third embodiment of two-speed transmission according to the present invention.

In Figure 1 a two-speed transmission unit can be seen. It comprises an input pulley 108 which receives drive from an internal combustion engine via a belt, as will be described later. The input pulley 108 is mounted on an input shaft 49 for rotation therewith. The input shaft 49 is secured in a housing which comprises a central housing section 2, an end cover 80 and an end cover 95. The input shaft 49 is mounted for rotation in a bearing 90 and by needle bearings arranged in a cage, shown as 104, which act between the input shaft 49 and an output shaft 4. An output shaft 4 is coaxial with the input shaft 49 and is formed as a sleeve having a central aperture through which the input shaft 49 passes. The output shaft 4 is itself mounted in the housing 2, 80, 95 by a bearing 96 and by a bearing 7. An output pulley 100 is mounted on the output shaft 4 for rotation with the output shaft 4.

A one-way sprag clutch 53 acts between the input shaft 49 and the outer shaft 4, the one-way sprag clutch allowing the output shaft 4 to rotate quicker than the input shaft 49, but preventing the output shaft 4 from rotating slower than the input shaft 49 by locking them to rotate together (i.e. the one-way clutch permits relative rotation in only one sense).
Drive from the input pulley 108 is transmitted via the input shaft 49 and via a planet gear carrier 50 to planet gears such as 58. The planet gear 58 is rotatably mounted on the planet carrier 50 by a needle roller bearing 57 interposed between the planet gear 58 and a satellite axle 55. A steel washer 56 holds the planet gear 58 in place on the axle 55. A low friction plate 54 is provided to act between the washer 56 and a planet carrier cover 51.

The planet gear 58 meshes with a sun gear 64 which is mounted coaxially around the input shaft 49, separated from the input shaft 49 by a plane bearing 66. The planet gear 58 also meshes with an annulus gear 5 which is mounted on the output shaft 4 for rotation therewith. A snap ring 6 holds the annulus gear 5 in place on the output shaft 4.

The sun gear 64 is attached to a friction disk carrier 65 which rotates with the sun gear. The friction disk carrier 65 carries a plurality of friction disks 70 which are held in splined engagement with the carrier 65 by grooves on the exterior of the carrier 65. The splined engagement allows the friction disks 70 to move axially along the carrier 65, but prevents the friction disks 70 rotating relative to the carrier 65 and hence rotating relative to the sun gear 64.

A pusher plate 61 is provided to act between the planet carrier cover 51 and the friction disk carrier 65 (via a thrust washer 62 and an adjusting washer 72) and the operation of this will be described later.
A plurality of steel disks 69, 71 sandwich the friction disks 70. They are slidable in grooves provided on an internal surface of the housing 2 and are slidable axially along the housing while being constrained from rotation relative to the housing. The friction disks 80 and steel disks 69,71 are kept in place by a retaining ring 68.

The friction disks 70 and the steel disks 69, 71 act to provide a braking assembly which can either brake rotation of the sun gear 51 to hold the sun gear 51 stationary or, alternatively, allow the sun gear 51 to rotate freely. In operation of the transmission unit the sun gear 51 is allowed to rotate freely when the input shaft 49 is rotated in a high rotational speed range and the sun gear 64 is braked and held stationary while the input shaft 49 is rotated in a low rotational speed range. How this is achieved will be explained later.

The components within the transmission unit are lubricated by action of components within the unit. A pump body 83 is illustrated alongside a pump rotor 84, a pump stator 82, and a pump cover 86 containing the previously-mentioned components. An O-ring seal 87 acts between the pump cover 86 and the surrounding housing cover 80. The pump rotor 84 rotates with rotation of the shaft 49, the pump rotor 84 being mounted on a pump sleeve 75 which in turn is mounted on the input shaft 49 for rotation with the input shaft. The pump rotor 84 acts with the pump stator 82 to pump lubricant around the transmission unit. Also in the unit there is an oil deflector ring 67 which rotates with the input shaft 49 and helps to circulate lubricant oil around the unit. A spacer washer 105 and an O-ring seal 106
placed around the ends of the shafts 49 and 4 keep lubricant oil within the unit. An inner ring seal 109 and a lip seal 102 are also provided for this purpose. A further lip seal 98 also prevents the escape of lubricant oil around the output pulley 100.

The operation of the previously described brake assembly is controlled by a spring washer 78 which acts between the casing cover 80 and a pressure plate 42. The friction disks 70 and the steel disks 71 are sandwiched between the pressure plate 42 and the retaining ring 68.

An assembly comprising the pressure plate 42, the washers 62, adjusting washer 72, the friction disk carrier 65 and the sun gear 51 is slidable axially along the input shaft 49.

As seen in Figure 2, the sun gear 64 is a helical gear, meshing with helical planet gears of the planet carrier, such as the planet 58. As torque is transmitted between the sun gear 64 and the planet gears (e.g. 58) then the sun gear 64 is slid to the right, as shown in the figures 3 and 4 where the arrows 300 show the action of the force, so that the bearing 61 is pushed up against the pusher plate 61, with the force then reacted by the planet carrier cover 51. The force acts in the same direction as the spring force, which is indicated by arrows 301. These forces, at low rotational speeds of the input shaft 49, acting via the pressure plate 42 together push the friction plates 70 into frictional engagement with the friction plates 69,71 and this brakes the sun gear 64 and holds the sun gear 64 stationary. The planet gears rotate around the stationary
sun gear 64 and transmit motion from the input shaft 49 to the output shaft 4 via the annulus gear 5. The output shaft 4 is thus in geared connection with the input shaft 49 and rotates at a higher rotational speed than the input shaft 49. This is permitted by the one-way clutch 53.

At higher speeds, free ends of flyweights such as 60 are forced radially outwardly by the rotation of the planet carrier 50. This causes the L-shaped flyweights such as 60 to rotate about their elbows. This in turn causes the flyweights 60 to apply pressure on the pusher plate 61 which then moves axially to the left (as shown in the figures) the assembly comprising the sun gear 64, the bearing 61, the spacer 72 and the pressure plate 42. In other words, the separation between the planet carrier cover 51 and the friction plate carrier 65 is increased. The assembly is moved against the biasing action of the spring 78 and the force applied by the flyweights indicated by arrows 302. This movement releases the brake and therefore allows the sun gear 64 to rotate freely. The one-way clutch 53 then locks the output shaft 4 to rotate with the input shaft 49. With the sun gear 64 rotating freely, no torque is reacted by the sun gear 64 and thus no axial loading on the sun gear 64 is occasioned by the interaction of the gears.

The balance of forces between, on the one hand, the forces applied by the flyweights such as 60, on the other hand, and the forces applied by the spring 78 and by the axial loading on the sun gear 64, sets the point at which the brake is engaged and disengaged. The operation of the brake enables the transmission unit to provide two different gear ratios and enables the unit to switch between these two
different gear ratios without the need for any external control and without the need for supply of hydraulic fluid or for electronics to control the switchover. The switchover happens purely mechanically. On a shift from braked to non-braked condition, the torque reacted by the sun gear 64 decreases as the braking force decreases and this speeds the transmission ratio change since the axial force on sun gear 64 decreases with decrease in reacted torque. On a shift from unbraked to braked condition, the braking of the sun gear increases the axial force on the sun gear 64 (indicated by arrows 300) which acts against the flyweight generated forces 302 in addition to spring force 301 to fully brake the sun gear 64 quickly. In both cases, the duration of frictional slipping of the plates is limited.

The two-speed transmission unit 1 is shown in use in Figure 5. Figure 5 shows an internal combustion engine 200 having a two-speed transmission unit 201 of the type described above. This has an input pulley 202 and an output pulley 203. The input pulley 202 is driven to rotate by a belt 204 which is driven by a pulley 205 mounted on and rotating with a crankshaft of the engine 200. The output pulley 203 drives a belt 206. The belt 206 in turn drives a pulley 207 which is connected to a supercharger which pressurises intake air of the engine 200. The belt 206 is also arranged to drive a pulley 208 which is connected to an alternator of the engine. At low engine speeds the transmission unit 201 operates (as described above) so that the output pulley 203 rotates at a rotational speed higher to the input pulley 202 and therefore the supercharger attached to pulley 207 and the alternator attached to pulley
208 are advantageously driven at rotational speeds in excess of crankshaft rotational speeds, with the ratio of rotational speed of pulley 207 to speed of rotation of pulley 205 having a first value and the ratio of the rotational speed of pulley 208 to the rotational speed of pulley 205 having a second value (which may be the same as the first value). Then at higher rotational speeds of the pulley 205 the transmission unit 201 changes the transmission ratio so that the output pulley 203 has the same rotational speed as the input pulley 202. Then the ratio of speed of rotation of pulley 207 to pulley 205 is a third ratio lower than the first ratio, e.g. the pulley 207 and the pulley 205 could be rotated with the same rotational speed. Also, the ratio of the rotational speed of pulley 208 to the rotational speed of pulley 205 is a fourth ratio different to the second ratio mentioned previously, e.g. the pulley 208 could rotate at the same rotational speed as the pulley 205. Operation of the ancillaries is thereby improved with the supercharger giving a greater boost at low engine speeds than it would otherwise and with the alternator generating more electrical power at lower engine speeds than it would otherwise. Smaller-sized alternators and superchargers can be used than in comparable engines with fixed transmission ratios.

Whilst above the input pulley 108 and output pulley 100 are both provided side-by-side on one side of the transmission unit, the input pulley could easily be relocated to the opposite side of the transmission unit, which may be of use in certain applications. In such a case the output shaft need not overlie the input shaft and the
two shafts could be arranged end-to-end with a one-way clutch arranged between facing ends of the shafts.

In Figure 6 a second embodiment of two-speed transmission unit 600 can be seen. It comprises an input pulley 608 which receives drive from an internal combustion engine via a belt, as described above in figure 5. The input pulley 608 is mounted on an input shaft 649 for rotation therewith. The input shaft 649 is secured in a housing which comprises a central cast aluminium housing section 602 and a cast aluminium end cover 680 (the figure 6 embodiment is simplified in comparison to the figure 1 embodiment by having only a single end cover, rather than two). The input shaft 649 is mounted for rotation in a bearing 690 and by needle bearings arranged in a cage, shown as 6104, which act between the input shaft 649 and an output shaft 604. The output shaft 604 is coaxial with the input shaft 649 and is formed as a sleeve having a central aperture through which the input shaft 649 passes. The output shaft 604 is mounted in the housing 602 by a bearing 696. The figure 6 embodiment is simplified in comparison to the figure 1 embodiment by using only one bearing to support the output shaft 604, made possible by reducing in length the output shaft 604 in comparison to the output shaft 4.

An output pulley 6100 is mounted on the output shaft 604 for rotation with the output shaft 604.

A one-way sprag clutch 653 acts between the input shaft 649 and the output shaft 604, the one-way sprag clutch 653 allowing the output shaft 604 to rotate quicker than the input shaft 649, but preventing the output shaft 604 from rotating slower than the input shaft 649 by locking them to
rotate together (i.e. the one-way clutch permits relative rotation in only one sense).

Drive from the input pulley 608 is transmitted via the input shaft 649 and via a planet gear carrier 650 to planet gears 658. Each planet gear 658 is rotatably mounted on the planet carrier 650 by a needle roller bearing 657 interposed between the planet gear 658 and a satellite axle 655. Steel washers 656 hold each planet gear 658 in place on a respective axle 655.

Each planet gear 658 meshes with a sun gear 664 which is mounted coaxially around the input shaft 649, the sun gear 664 being mounted for rotation relative to the shaft 649 rather than rotation with the shaft 649. Each planet gear 658 also meshes with an annulus gear 605 which is mounted on the output shaft 604 for rotation therewith.

The sun gear 664 is attached to a friction disk carrier 665 which rotates with the sun gear 664. The friction disk carrier 665 carries a plurality of friction disks 670 which are held in splined engagement with the carrier 665 by grooves on the exterior of the carrier 665. The splined engagement allows the friction disks 670 to move axially along the carrier 665, but prevents the friction disks 670 rotating relative to the carrier 665 and hence rotating relative to the sun gear 664.

A pusher plate 661 is provided to act between the planet carrier 650 and the friction disk carrier 665. A plurality of steel disks 671 sandwich the friction disks 670. They are slidable in grooves provided on an internal
surface of the housing cover 680 and are slidable axially along the housing cover while being constrained from rotation relative to the housing. A spring washer 678 acts between the casing cover 680 and a pressure plate 642. The friction disks 670 and the steel disks 671 are sandwiched between the pressure plate 642 and an annular rim provided on the central casing section 602.

An assembly comprising the pressure plate 642, the friction disk carrier 665 and the sun gear 664 is slidable axially along the input shaft 649. The assembly can be slid in one direction to engage the friction plates 670 and steel plates 671 or slid in the opposite direction to disengage the friction plates and the steel plates 670. The friction disks 670 and the steel disks 671 act to provide a braking assembly which can either brake rotation of the sun gear 664 to hold the sun gear 664 stationary or, alternatively, allow the sun gear 664 to rotate freely. In operation of the transmission unit the sun gear 664 is allowed to rotate freely when the input shaft 649 is rotated in a high rotational speed range and the sun gear 664 is braked and held stationary while the input shaft 649 is rotated in a low rotational speed range. The brake is released by the use of a plurality of L-shaped flyweights e.g. 660 which pivot about their elbows as the speed of rotation of the planet carrier 650 increases and act to slide the assembly of sun gear 664, friction disk carrier 665 and pressure plate 642 to release the brake. How this is achieved has been explained above in relation to the embodiment of figure 1 - the operation of the figure 6 embodiment is identical.
In Figure 7 a third embodiment of two-speed transmission unit 700 can be seen. It comprises an input pulley 708 which receives drive from an internal combustion engine via a belt, as described above in figure 5. The input pulley 708 is mounted on an input shaft 749 for rotation therewith. The input shaft 749 is secured in a housing which comprises a central cast aluminium housing section 702 and a cast aluminium end cover 780 (the figure 7 embodiment is simplified in comparison to the figure 1 embodiment by having only a single end cover, rather than two). The input shaft 749 is mounted for rotation in a bearing 790 and by needle bearings arranged in a cage, shown as 7104, which act between the input shaft 749 and an output shaft 704. The output shaft 704 is coaxial with the input shaft 649; the input shaft 749 is formed as a sleeve having a central passage through which the output shaft 704 passes. The output shaft 704 is mounted in the housing 702 by a bearing 796. A first output pulley 7100 is mounted on one end of the output shaft 704 for rotation with the output shaft 704 and a second output pulley 7101 is mounted on the other end of the output shaft 704 for rotation with the output shaft 704 – the output shaft extends out of apertures provided in both ends of the casing 702,780. As shown the output pulleys 7100 abd 7101 are of different diameters, but they could be of the same diameter.

A one-way sprag clutch 753 acts between the input shaft 749 and the output shaft 704, the one-way sprag clutch 753 allowing the output shaft 704 to rotate quicker than the input shaft 749, but preventing the output shaft 704 from rotating slower than the input shaft 749 by locking them to
rotate together (i.e. the one-way clutch 753 permits relative rotation in only one sense).

Drive from the input pulley 708 is transmitted via the input shaft 749 and via a planet gear carrier 750 to planet gears 758. Each planet gear 758 is rotatably mounted on the planet carrier 750 by a needle roller bearing 757 interposed between the planet gear 758 and a satellite axle 755. Steel washers 756 hold each planet gear 758 in place on a respective axle 755.

Each planet gear 758 meshes with a sun gear 764 which is mounted coaxially around the input shaft 749, the sun gear 764 being mounted for rotation relative to the shaft 749 rather than rotation with the shaft 749. Each planet gear 758 also meshes with an annulus gear 705 which is mounted on the output shaft 704 for rotation therewith.

The sun gear 764 is attached to a friction disk carrier 765 which rotates with the sun gear 764. The friction disk carrier 765 carries a plurality of friction disks 770 which are held in splined engagement with the carrier 765 by grooves on the exterior of the carrier 765. The splined engagement allows the friction disks 770 to move axially along the carrier 765, but prevents the friction disks 770 rotating relative to the carrier 765 and hence rotating relative to the sun gear 764.

A pusher plate 761 is provided to act between the planet carrier 750 and the friction disk carrier 765. A plurality of steel disks 771 sandwich the friction disks 770. They are slidable in grooves provided on an internal
surface of the housing 702 and are slidable axially along the housing 702 while being constrained from rotation relative to the housing 702. A spring washer 778 acts between the casing 708 and a pressure plate 742. The friction disks 770 and the steel disks 771 are sandwiched between the pressure plate 742 and an snap ring 799 provided on the casing 702.

An assembly comprising the pressure plate 742, the friction disk carrier 765 and the sun gear 764 is slidable axially along the input shaft 749. The assembly can be slid in one direction to engage the friction plates 770 and steel plates 771 or slid in the opposite direction to disengage the friction plates and the steel plates 770. The friction disks 770 and the steel disks 771 act to provide a braking assembly which can either brake rotation of the sun gear 764 to hold the sun gear 764 stationary or, alternatively, allow the sun gear 764 to rotate freely. In operation of the transmission unit the sun gear 764 is allowed to rotate freely when the input shaft 749 is rotated in a high rotational speed range and the sun gear 764 is braked and held stationary while the input shaft 749 is rotated in a low rotational speed range. The brake is released by the use of a plurality of L-shaped flyweights e.g. 760 which pivot about their elbows as the speed of rotation of the planet carrier 750 increases and act to slide the assembly of sun gear 764, friction disk carrier 765 and pressure plate 742 to release the brake. How this is achieved has been explained above in relation to the embodiment of figure 1 - the operation of the figure 7 embodiment is identical.
Although the two-speed transmission units have been described above in their use in connection with an internal combustion engine and in use driving engine ancillaries, they are not limited to such use and could be used in any application where a two-speed drive is needed with the speed change occurring mechanically without the need for supply of hydraulic pressure to the transmission unit or electrical/electronic control. Nevertheless, the units are of particular advantage in their use with an internal combustion engine since a plurality of different ancillaries of the engine can be driven from a single transmission unit which requires no connection to the hydraulic circuits of the engine, nor any electronic or electrical control by the engine management system. The transmission units can easily be fitted with existing engine designs without requiring substantial modifications of the existing engine designs.
CLAIMS

1. A transmission unit comprising:

   an input pulley mounted on an input shaft for rotation therewith;

   an output pulley mounted on an output shaft for rotation therewith;

   an epicyclic arrangement of a helical sun gear, helical planet gears and a helical annulus gear, the helical planet gears being supported by a planet carrier;

   a brake assembly operable to brake the sun gear; and

   a one-way clutch which acts between the input shaft and the output shaft to allow relative rotation therebetween in only one direction; wherein:

   the planet carrier is attached to the input shaft for rotation therewith;

   the annulus gear is attached to the output shaft for rotation therewith;

   the brake assembly comprises a plurality of flyweights driven to rotate by the input shaft which when rotating apply a force acting to disengage the brake and a biasing spring which applies a force acting to engage the brake;

   the sun gear is mounted to slide axially within the epicyclic arrangement and is connected to the braking assembly in such a way that when torque is reacted by the sun gear then the reacted torque results in an axial force on the sun gear which is relayed to the braking assembly and acts to engage the brake and when the flyweights are driven to rotate then the force applied by the flyweights gives rise to an axial force on the sun gear opposed to the axial force resulting from the reacted torque;

   in a first range of rotational speeds of the input shaft the spring force and the axial force resulting from...
the reacted torque together exceed the force applied by the flyweights and together engage the brake and thereby prevent the sun gear from rotating;

in a second range of rotational speeds of the input shaft, greater than the rotational speeds of the first range, the force applied by the flyweights exceeds the sum of the spring force and the axial force resulting from the reacted torque and disengages the brake and thereby allow the sun gear to rotate;

for the first range of rotational speeds rotation is relayed from the input shaft via the planet carrier and the planet gears carried thereby to the output shaft and the output shaft rotates at a rotational speed greater than the rotational speed of the input shaft; and

for the second range of rotational speeds the sun gear is free to rotate and the one-way clutch locks the output shaft to the input shaft to rotate therewith.

2. A transmission unit as claimed in claim 1, wherein:

the output shaft and the input shaft are co-axial and the output shaft is a sleeve and the input shaft extends through the output shaft;

the sun gear is co-axial with the input shaft and is mounted external to the input shaft for free rotation relative to the input shaft and for axial movement along the input shaft;

the sun gear is attached to a friction disk carrier which has a grooved portion on which are mounted one or more sun gear friction disk(s) which can slide along the grooved portion whilst being prevented from rotating relative to the friction disk carrier, the friction disk carrier sliding axially with and rotating with the sun gear;
one or more non-rotating friction disk(s) are mounted on a grooved static support and can slide along the grooved static support whilst being prevented from rotation; and the sun gear friction disk(s) and the non-rotating friction disk(s) are forced into frictional engagement with each other by the force applied by the biasing spring and the force resulting from the reacted torque.

3. A transmission unit as claimed in claim 2 wherein the input pulley and the output pulley are located side-by-side on one side of the transmission unit, the input pulley having a first radius and the output pulley having a second larger radius.

4. A transmission unit as claimed in claim 1, wherein:
   the output shaft and the input shaft are co-axial and the input shaft is a sleeve and the output shaft extends through the input shaft;
   the sun gear is co-axial with the input shaft and is mounted external to the input shaft for free rotation relative to the input shaft and for axial movement along the input shaft;
   the sun gear is attached to a friction disk carrier which has a grooved portion on which are mounted one or more sun gear friction disk(s) which can slide along the grooved portion whilst being prevented from rotating relative to the friction disk carrier, the friction disk carrier sliding axially with and rotating with the sun gear;
   one or more non-rotating friction disk(s) are mounted on a grooved static support and can slide along the grooved static support whilst being prevented from rotation; and
the sun gear friction disk(s) and the non-rotating friction disk(s) are forced into frictional engagement with each other by the force applied by the biasing spring and the force resulting from the reacted torque.

5. A transmission unit as claimed in claim 4 comprising first and second output pulleys, both mounted on the output shaft for rotation therewith, the input pulley and the first output pulley being located side-by-side on one side of the transmission unit and the second output pulley is located on the other side of the transmission unit.

6. A transmission unit as claimed in any one of claims 2 to 5 wherein:

the flyweights are each L-shaped and pivot about their elbows; and

the flyweights are located between the planet carrier and a push plate via which the flyweights apply force on the friction disk carrier, the flyweights acting to increase separation between the planet carrier and the friction disk carrier as their rotational speed increases.

7. A transmission unit as claimed in claim 6 wherein:

the biasing spring acts on a pressure plate via which the spring applies pressure to the sun gear friction disk(s) and the non-rotating friction disk(s) to force them together; and

the pressure plate, the friction disk carrier and the sun gear together form an assembly which slides axially under the action of the forces applied thereto, namely the spring force, the axial force resulting from reacted torque and the force applied by the rotating flyweights.
8. An internal combustion engine having a crankshaft; a crankshaft pulley mounted on the crankshaft for rotation therewith; a transmission unit as claimed in any one of the preceding claims; an input belt connecting the crankshaft pulley to the input pulley of the transmission unit; an engine-driven ancillary having an ancillary pulley via which drive is relayed to the ancillary; and an output belt connecting the output pulley of the transmission unit to the ancillary pulley.

9. An internal combustion engine as claimed in claim 8 which comprises a plurality of engine-driven ancillaries, each of which has an ancillary pulley and wherein the output belt connects the output pulley of the transmission unit to all of the ancillary pulleys of the engine-driven ancillaries.

10. An internal combustion engine as claimed in claim 8 or claim 9 wherein the engine-driven ancillaries comprise one or more of: a supercharger; an alternator; an oil pump; a water pump; power-assisted steering pump and/or an air conditioning pump.