

SPECIFICATION

Planetary gear mechanism

- 5 This invention relates to planetary gear mechanisms used, for example, as transmissions. When large torques are involved, brake packs are often provided for braking the ring gear or planet gear carrier of one or more planetary
- 10 gear assemblies of the mechanism.
- In many such mechanisms, particularly transmissions where plural brake packs are used, one for each planetary gear assembly, the stationary plates of each brake pack have
- 15 been secured between housing parts in any of a variety of ways and, in the usual case, dowels have been employed to locate the housing parts with respect to each other in order to achieve proper orientation of the
- 20 various components. Such dowels require precision machining in order to achieve precise alignment and, as a consequence, fabrication of such mechanisms is considerably more expensive than would be the case if precision
- 25 machining could be minimized or eliminated altogether.
- According to the present invention, in a planetary gear mechanism including input and output shafts; at least one planetary gear
- 30 assembly interconnecting the shafts and including a sun gear, at least one planet gear in mesh with the sun gear and mounted on a rotary carrier and a ring gear in mesh with the planet gear; at least two housing parts at least
- 35 partially enclosing the planetary gear assembly; a brake assembly including a piston, a first brake plate engageable by the piston and secured against rotation relative to the housing parts, a second brake plate aligned with
- 40 and engageable by the first brake plate upon operation of the piston and mounted on the ring gear or the carrier against relative rotation with respect thereto; a plurality of tie bolts assembling the housing parts and passing
- 45 through the first brake plate to provide the securement against rotation relative to the housing parts; and coil springs urging the first plate towards the piston and away from the second plate; there are a plurality of aligned
- 50 bores in the housing parts radially outwardly of the planetary gear assembly and a plurality of pins loosely received in corresponding ones of the bores and extending through the first
- 55 plate, the cross sections of the pins being less than those of the corresponding bores so that the pins are able to float transversely relatively to the bores, and the coil springs being disposed on corresponding ones of the pins in abutment with the first plate.
- 60 This construction eliminates the need for dowels and the costly precision machining of parts associated therewith.
- The first brake plate may comprise a generally circular, disc-like member having an open-
- 65 ing in its centre; a plurality of equally angu-

- larly spaced tangs extending radially outwardly from the periphery of the member; equally angularly spaced tie bolt receiving apertures one in each tang displaced from the
- 70 centre thereof in the circumferential direction; and, on each of at least three angularly spaced ones of the tangs and displaced from the centre thereof in the circumferential direction oppositely from the tie bolt receiving
- 75 aperture, a spring engaging formation including an opening for reception of the corresponding spring mounting pin.

- Such a brake plate, which is broadly claimed in our corresponding application of
- 80 even date, ref. GJE 5079/035, can be used as a non-rotatable plate in any position in a brake pack, whether in abutment with the piston or remote therefrom. Thus, by using any adjacent two identical non-rotatable plates
- 85 in a mutually reversed position, i.e. with the corresponding faces of the two plates facing one another, with their tie bolt receiving apertures in axial alignment, the spring engaging formation of one plate next to the piston will
- 90 be out of axial alignment with the tangs of the other plate. The coil springs and their rods can then pass the other plate and engage the spring engaging formations of the one plate.

- The brake plate may have n substantially
- 95 equally angularly spaced tangs extending radially outwardly from the periphery of the member, where " n " is an even integer; every X th tang having at least one dimension, which may be a circumferential or radial dimension,
- 100 greater than that of the remaining tangs, wherein " X " is an integer of 2 or more and wherein n/X is equal to an integer of 2 or more; a plurality of equally angularly radially spaced tie bolts receiving apertures, one in
- 105 each tang; and, on the part of each X th tang having the greater dimension, a spring engaging formation including an opening for reception of the corresponding spring mounting pin. In this case it will not be necessary to
- 110 reverse the two non-rotatable brake plates, but merely to use them with a relative angular orientation such that the tangs with the greater dimension of one plate are out of axial alignment with those of the other plate, to
- 115 achieve the same advantages.

An example of a planetary gear mechanism in the form of a transmission and constructed according to the invention is illustrated in the accompanying drawings, in which:—

- 120 *Figure 1* is a fragmentary, sectional view of the mechanism;

Figure 2 is a further fragmentary view of the mechanism;

- Figure 3* is a sectional view taken on the
- 125 line 3-3 in Fig. 2 illustrating a single brake plate; and,

Figure 4 is a sectional view taken on the line 4-4 in Fig. 2 illustrating a plurality of brake plates in alignment with each other.

- 130 The following description of the planetary

gear assemblies within the transmission will be described only broadly, the precise nature of the planetary gear assemblies in the transmission, the gear ratios and their interaction forming no part of the present invention.

With reference to Fig. 1, the transmission includes a rotatable input shaft 10 which may be driven by an engine via a torque converter or the like, neither one of which is shown.

The output of the transmission is taken from gear teeth 12 on a quillshaft 14 disposed in concentric relation to the input shaft 10.

Splined to the input shaft 10, is a sun gear 16 having two sets of gear teeth 18 and 20.

The teeth 18 are in mesh with a plurality of planet gears 22 (only one of which is shown) journaled on a rotatable carrier 24 which is journaled to a housing part 26 by bearings 28.

A ring gear 30 is in mesh with the planet gears 22 and is journaled for rotation within the assemblage by bearings 32 via a carrier 34 for planet gears 36 (only one of which is shown) meshed with the gear teeth 20. A ring gear 40 is meshed with the planet gears 36.

A third set of planet gears including plural planets 42 (only one of which is shown) includes a carrier 44 therefor which is connected to the carrier 34. The planet gears 42 are meshed with a sun gear 46 on the quillshaft 14 and a ring gear 48.

A carrier 50 for a fourth planetary gear assembly is connected to the ring gear 48 and mounts a plurality of planet gears 52 (only one of which is shown) which engage a sun gear 54 splined to the quill shaft 14 and a ring gear 56.

The ring gear 56 is selectively connectible to the quillshaft 14 via a rotating, piston operated, rotatable clutch assembly, generally designated 58, of conventional construction.

The housing part 26 includes an annular chamber receiving an annular piston which is operative to drive a stationary brake plate 62 in the axial direction to compress a brake pack including additional stationary plates 62 and interleaved rotatable plates 64 against a housing part 66. Housing part 66 is held against rotation by being sandwiched between the housing part 26, as best seen in the upper right-hand part of Fig. 1, and a housing part 68. The rotatable brake plates 64 are splined to the carrier 24, with the consequence that when the piston 60 is extended, the carrier 24 will be braked to halt the rotation thereof.

The housing part 68 includes an annular chamber receiving an annular piston 70 which is abutted by a stationary brake plate 72 identical to the brake plate 62 and which is operable to compress a brake pack including additional stationary brake plates 72 and interleaved rotatable brake plates 74. The pack is compressed against the housing part 66.

The rotatable brake plates 74 are splined to the ring gear 40 of the second planetary gear

assembly and when the piston 70 is extended, at some point in time, the ring gear 40 will be braked to a halt. As is well known, controls are provided so that the pistons 60 and 70 are never simultaneously pressurized.

The housing part 68 includes an additional annular chamber receiving an annular piston 80 which is abutted by a stationary brake plate 82 which is identical to the brake plates 62 and 72. The brake plate 82 can compress a further brake pack including additional stationary brake plates 82 and interleaved rotatable brake plates 84 against a housing part 86. The housing part 86 is held stationary by being sandwiched between the housing part 68 and a housing part 88, as best seen in the upper centre of Fig. 1. The rotatable brake plates 84 are splined to the carrier 50 of the third planetary gear assembly and thus, when compressed against the plates 82, will halt rotation of the same.

The housing part 88 includes an annular chamber receiving an annular piston 90 which abuts a stationary brake plate 92. The stationary brake plate 92 can compress a brake pack including an additional brake plate 92 and interleaved rotatable brake plates 94 against the housing part 86. The brake plates 92 are identical to the brake plates 62, 72 and 82.

When the piston 90 is extended to compress the pack, including the plates 92 and 94, the ring gear 56 for the fourth planetary gear assembly will be braked. Again, suitable controls are provided so as to prevent simultaneous pressurization of the pistons 80 and 90.

Those skilled in the art will readily appreciate that the input shaft and the output quillshaft 14 can be selectively coupled through the various planetary gear assemblies and/or the movable clutch 58 to provide a large variety of gear ratios.

A structure is provided for causing the pistons 60, 70, 80 or 90 to retract when they are not subjected to fluid under pressure. In particular, at equally angularly spaced locations, in the preferred embodiment three such locations spaced at 120° are provided, the various housing parts are provided with bores which may be aligned. As seen in Fig. 1, the housing part 26 is provided with such a bore at 100, the housing part 66 at 102, the housing part 68 at 104, the housing part 86 at 106 and the housing part 88 at 108. The bores 102 and 106 are larger than the bores 100, 104 and 108 and, in the aligned ones of the bores 100-108, there is loosely received a floating, elongate pin 110. The pin 110 extends through holes, to be described, in each of the stationary clutch plates 62, 72, 82 and 92 in abutment with the corresponding pistons 60, 70, 80 and 90. The pin 110 does not, however, extend through the remaining stationary plates 62, 72, 82 and 92, as will be seen.

A compression coil spring 112 is disposed

well as to prevent the existence of cocking forces when might cause the plates to bind on the tie bolts 126. Of course, utilizing smaller tangs, such as is shown in Fig. 3 for the tangs 148, 152 and 156, minimizes material costs and therefore is preferable.

As a result of the foregoing construction, a universal brake plate is formed. Such a plate can be used in any one of the stationary brake plate positions illustrated and is not restricted to use as a brake plate abutting one of the pistons. Fig. 4 illustrates how such plates are oriented with respect to each other in the pack to achieve this function. The forwardmost brake plate illustrated in Fig. 4 is the brake plate 82 in abutment with the piston 80 and, it will be seen that even though the piston 80 acts oppositely of the piston 90, the forwardmost brake plate 82 is disposed identically to the brake plate 92 abutting the piston 90. The coil springs 114 are illustrated in dotted lines surrounding the pins 110 and, as will be appreciated from Fig. 1, are in abutment with the rear side of the forwardmost plate 82.

Also shown in Fig. 4 is a brake plate 82 not in direct abutment with the piston 80 and such a brake plate is given the designation 82R in Fig. 4. The plate 82R is identical to the plate 82 but has been rotated relatively thereto about a diameter through 180°, i.e., flipped. It is also rotated about its centre such that the apertures 134 in the plate 82 and the apertures 134 in the plate 82R are aligned to receive the tie bolts 126. This results in a pack configuration wherein the rear side of the larger tangs 150, 154 and 158 of the forwardmost plate 82 have parts directly facing a remote housing part, such as the housing part 86 (Fig. 2) so that the springs 114 may abut the same without interference or contact with any of the tangs on the rearwardmost plate 82R. When the brake plates also have the small tangs 148, 152 and 156, a similar result can be achieved merely by using the plates 82 and 82R with a mutual angular offset of 60°, rather than reversed, so that the large tangs of one plate are in axial alignment with the small tangs of the other plate.

It will accordingly be appreciated that a universal brake plate of this construction can be utilized at any position in a brake pack whereat a stationary brake plate is required. As result, the requirements for two, dissimilar, types of stationary plates and a single brake pack frequently required by the prior art is eliminated. Inventory expenses are thereby reduced as are manufacturing costs, since only one plate, as opposed to two, need to be manufactured and stocked. This feature can be employed in a variety of mechanisms, as mentioned previously, and is particularly useful in connection with the mechanism such as illustrated in Figs. 1 and 2 made wherein precision machining is eliminated.

CLAIMS

1. A planetary gear mechanism including input and output shafts; at least one planetary gear assembly interconnecting the shafts and including a sun gear, at least one planet gear in mesh with the sun gear and mounted on a rotary carrier and a ring gear in mesh with the planet gear; at least two housing parts at least partially enclosing the planetary gear assembly; a brake assembly including a piston, a first brake plate engageable by the piston and secured against rotation relative to the housing parts, a second brake plate aligned with and engageable by the first brake plate upon operation of the piston and mounted on the ring gear or the carrier against relative rotation with respect thereto; a plurality of tie bolts assembling the housing parts and passing through the first brake plate to provide the securement against rotation relative to the housing parts; and coil springs urging the first plate towards the piston and away from the second plate; wherein there are a plurality of aligned bores in the housing parts radially outwardly of the planetary gear assembly and a plurality of pins received in corresponding ones of the bores and extending through the first plate, the cross sections of the pins being less than those of the corresponding bores so that the pins are able to float transversely relatively to the bores, and the coil springs being disposed on corresponding ones of the pins in abutment with the first plate.

2. A gear mechanism according to claim 1, wherein there are a plurality of the planetary gear assemblies and the number of the housing parts exceeds the number of the planetary gear assemblies, and each of the pins links several of the housing parts and mounts a plurality of the coil springs.

3. A planetary gear mechanism according to claim 1, wherein there are a plurality of the planetary gear assemblies and each of the pins is common to at least some of the planetary assemblies and mounts the coil springs for the planetary gear assemblies to which it is common.

4. A planetary gear mechanism according to any one of the preceding claims, wherein the first brake plate comprises a generally circular, disc-like member having an opening in its centre; a plurality of equally angularly spaced tangs extending radially outwardly from the periphery of the member; equally angularly spaced tie bolt receiving apertures one in each tang displaced from the centre thereof in the circumferential direction; and, on each of at least three angularly spaced ones of the tangs and displaced from the centre thereof in the circumferential direction oppositely from the tie bolts receiving aperture, a spring engaging formation including an opening for reception of the corresponding spring mounting pin.

about the pin 110 so as to extend through the bore 102 and abut the stationary plates 62 and 72 in abutment with the pistons 60 and 70. A similar compression coil spring 114 extends through the bore 106 to abut the stationary clutch plates 82 and 92 in abutment with the pistons 80 and 90. As a consequence of this construction, those stationary plates 62, 72, 82 and 92 in direct abutment with the pistons 60, 70, 80 and 90 are spring biased by the associated spring 112 or 114 in such a way as to cause the associated piston to be moved to its retracted position. Thus, when pressurized fluid is not applied against one of the pistons, it will be moved to a retracted position to release compression on the associated brake pack. This construction assures proper retraction of the pistons and the release of compression in all brake packs when desired and because the bores are of greater diameter than the pin 110, allowing the latter to float, large tolerances may be employed eliminating the need for precision machined bores and their associated dowels.

Circumferentially spaced from the bores 100-108 and at equally angularly spaced locations about the centre line of the shaft 10, are a plurality of additional bores, in the exemplary embodiment, six in number. The housing part 26 includes a such a bore at 116, the housing part 66, a bore 118, the housing part 68, a bore 120, the housing part 86, a bore 122, and the housing part 88, a bore 124. Corresponding ones of the bores 116-124 are aligned for receipt of a corresponding number of tie bolts 126.

As best seen in Fig. 2, the tie bolts 126 have hex heads 128 at one end and a threaded end 130 oppositely thereof threadably received in a threaded part 132 of the bore 116 in the housing part 26. The tie bolts act to hold the components in assembled relation, as is well known.

In addition, the tie bolts 126 serve as reaction members for all of the stationary brake plates 62, 72, 82 and 92, including the plates 62, 72, 82, 92 in direct abutment with the pistons 60, 70, 80 and 90, to prevent rotation of the plates.

In particular, each of the plates 62, 72, 82 and 92 is provided with a plurality of apertures 134 through which corresponding ones of the tie bolts 126 extend.

In a highly preferred embodiment, the tie bolts 126 at least a surface hardened to a greater hardness than that of the clutch plates 62, 72, 82 and 92 in the vicinity of the apertures 134. This assures that wear due to torque reaction upon engagement of the various brake packs is confined to the brake plate and will not occur in the surface of the tie bolts 126 abutted by the brake plates.

Fig. 3 illustrates a single brake plate which may be used as any one of the brake plates

62, 72, 82, 92. While the illustration of Fig. 3 is specifically concerned with the plate 92 in abutment with the piston 90, for reasons that follow, it will be appreciated that its construction is typical.

The brake plate 92 in Fig. 3 is formed of a generally circular disc-like member 140 having opposed friction surfaces 142 and 144 (Fig. 2) which are parallel to each other. The member 140 includes a central, circular opening 146 as well as a plurality of substantially equally angularly spaced tangs 148, 150, 152, 154, 156 and 158 extending radially outwardly from the periphery of the member 140. The number of the tangs 148-158 will be equal to n and, preferably, but not always, n is an even integer, i.e., 2, 4, 6, 8, etc.

As illustrated in Fig. 3, every second tang has at least one dimension greater than that of the remaining tangs. As seen in Fig. 3, the tangs 150, 154 and 158 have a greater width than the tangs 148, 152 and 156, that is, in the illustrated case, the greater dimension extends circumferentially of the disc 140. Every X th tang has such a greater dimension.

Preferably, but not always, X will be an integer of 2 or more. When X is an integer of 2 or more, the quantity n/X is equal to an integer of 2 or more.

Each of the tangs 148-158 includes a tie bolt receiving aperture 134 and it will be observed from Fig. 3 that the apertures 134 are equally angularly spaced. Moreover, they are equally radially spaced from the centre of the disc 140 and preferably are radially elongate as, for example, by being formed as two intersecting, nonconcentric bores 160 and 162. Because of the radial elongation of the apertures 134, they may shift somewhat to self-align the centre of rotation of their associated brake pack, again, eliminating the need for precision machining.

It will also be observed that the apertures 134 in the tangs 150, 154 and 158 are displaced to one side of the centre of such tangs.

Displaced to the side of the centre of the larger tangs 150, 154 and 158, oppositely from the apertures 134, are openings, in the illustrated case holes 164. The holes 164, when used, receive the pins 110 and the immediately surrounding area of each tang 150, 154 and 158, when the holes 164 receive the pins 110, will be abutted by one of the springs 112 or 114.

In a highly preferred embodiment, there will be at least three of the larger tangs provided. Where the larger tangs have their large dimension extending in the circumferential direction, the smaller tangs 148, 152 and 156 may be dispensed with in favour of the large tangs entirely. Generally, however, there will be at least three of the large tangs and at least three of the small tangs to ensure adequate guidance for the stationary plates as



well as to prevent the existence of cocking forces when might cause the plates to bind on the tie bolts 126. Of course, utilizing smaller tangs, such as is shown in Fig. 3 for the tangs 148, 152 and 156, minimizes material costs and therefore is preferable.

As a result of the foregoing construction, a universal brake plate is formed. Such a plate can be used in any one of the stationary brake plate positions illustrated and is not restricted to use as a brake plate abutting one of the pistons. Fig. 4 illustrates how such plates are oriented with respect to each other in the pack to achieve this function. The forwardmost brake plate illustrated in Fig. 4 is the brake plate 82 in abutment with the piston 80 and, it will be seen that even though the piston 80 acts oppositely of the piston 90, the forwardmost brake plate 82 is disposed identically to the brake plate 92 abutting the piston 90. The coil springs 114 are illustrated in dotted lines surrounding the pins 110 and, as will be appreciated from Fig. 1, are in abutment with the rear side of the forwardmost plate 82.

Also shown in Fig. 4 is a brake plate 82 not in direct abutment with the piston 80 and such a brake plate is given the designation 82R in Fig. 4. The plate 82R is identical to the plate 82 but has been rotated relatively thereto about a diameter through 180° , i.e., flipped. It is also rotated about its centre such that the apertures 134 in the plate 82 and the apertures 134 in the plate 82R are aligned to receive the tie bolts 126. This results in a pack configuration wherein the rear side of the larger tangs 150, 154 and 158 of the forwardmost plate 82 have parts directly facing a remote housing part, such as the housing part 86 (Fig. 2) so that the springs 114 may abut the same without interference or contact with any of the tangs on the rearwardmost plate 82R. When the brake plates also have the small tangs 148, 152 and 156, a similar result can be achieved merely by using the plates 82 and 82R with a mutual angular offset of 60° rather than reversed, so that the large tangs of one plate are in axial alignment with the small tangs of the other plate.

It will accordingly be appreciated that a universal brake plate of this construction can be utilized at any position in a brake pack whereat a stationary brake plate is required. As result, the requirements for two, dissimilar, types of stationary plates and a single brake pack frequently required by the prior art is eliminated. Inventory expenses are thereby reduced as are manufacturing costs, since only one plate, as opposed to two, need to be manufactured and stocked. This feature can be employed in a variety of mechanisms, as mentioned previously, and is particularly useful in connection with the mechanism such as illustrated in Figs. 1 and 2 made wherein precision machining is eliminated.

CLAIMS

1. A planetary gear mechanism including input and output shafts; at least one planetary gear assembly interconnecting the shafts and including a sun gear; at least one planet gear in mesh with the sun gear and mounted on a rotary carrier and a ring gear in mesh with the planet gear; at least two housing parts at least partially enclosing the planetary gear assembly; a brake assembly including a piston, a first brake plate engageable by the piston and secured against rotation relative to the housing parts, a second brake plate aligned with and engageable by the first brake plate upon operation of the piston and mounted on the ring gear or the carrier against relative rotation with respect thereto; a plurality of tie bolts assembling the housing parts and passing through the first brake plate to provide the securement against rotation relative to the housing parts; and coil springs urging the first plate towards the piston and away from the second plate; wherein there are a plurality of aligned bores in the housing parts radially outwardly of the planetary gear assembly and a plurality of pins received in corresponding ones of the bores and extending through the first plate, the cross sections of the pins being less than those of the corresponding bores so that the pins are able to float transversely relatively to the bores, and the coil springs being disposed on corresponding ones of the pins in abutment with the first plate.

2. A gear mechanism according to claim 1, wherein there are a plurality of the planetary gear assemblies and the number of the housing parts exceeds the number of the planetary gear assemblies, and each of the pins links several of the housing parts and mounts a plurality of the coil springs.

3. A planetary gear mechanism according to claim 1, wherein there are a plurality of the planetary gear assemblies and each of the pins is common to at least some of the planetary assemblies and mounts the coil springs for the planetary gear assemblies to which it is common.

4. A planetary gear mechanism according to any one of the preceding claims, wherein the first brake plate comprises a generally circular, disc-like member having an opening in its centre; a plurality of equally angularly spaced tangs extending radially outwardly from the periphery of the member; equally angularly spaced tie bolt receiving apertures one in each tang displaced from the centre thereof in the circumferential direction; and, on each of at least three angularly spaced ones of the tangs and displaced from the centre thereof in the circumferential direction oppositely from the tie bolts receiving aperture, a spring engaging formation including an opening for reception of the corresponding spring mounting pin.



5. A planetary gear mechanism according to any one of claims 1 to 3, wherein the first brake plate comprises a generally circular, disc-like member having an opening in its centre; n substantially equally angularly spaced tangs extending radially outwardly from the periphery of the member, where " n " is an even integer; every X th tang having at least one dimension greater than that of the remaining tangs, wherein " X " is an integer of 2 or more and wherein n/X is equal to an integer of 2 or more; a plurality of equally angularly and radially spaced tie bolts receiving apertures, one in each tang; and, on the part of each X th tang having the greater dimension, a spring engaging formation including an opening for reception of the corresponding spring mounting pin.
6. A planetary gear mechanism according to claim 5, wherein n is equal to at least 6, and n/X is equal to at least 3.
7. A planetary gear mechanism according to claim 5 or 6, wherein the greater dimension extends in the circumferential direction.
8. A planetary gear mechanism according to claim 4, wherein the second brake plate is interposed between the first brake plate and a third brake plate which is constructed identically to the first brake plate and is also secured against rotation relative to the housing parts, one of the first and third brake plates being reversed with respect to the other such that the tie bolt receiving apertures in these plates are axially aligned with one another while the spring engaging formations on one of these plates are out of axial alignment with the tangs on the other of these plates.
9. A planetary gear mechanism according to any one of claims 5 to 7, wherein the second brake plate is interposed between the first brake plate and a third brake plate which is constructed identically to the first brake plate and is also secured against rotation relative to the housing parts, the first and third plates being so relatively angularly oriented that the tie bolts receiving apertures in these plates are axially aligned with one another while the spring engaging formation on one of these plates are out of axial alignment with the tangs on the other of these plates.
10. A planetary gear mechanism according to any one of claims 4 to 9, wherein the tie bolts have a greater surface hardness than the tangs whereby wear due to torque reaction will occur in the tangs rather than in the tie bolts.
11. A planetary gear assembly according to any one of claims 4 to 10, wherein the tie bolt receiving apertures are radially elongate.
12. A planetary gear assembly according to claim 1, substantially as described with reference to the accompanying drawings.

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