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(54) A METHOD OF CHANGING THE NUMBER OF SPEED RATIOS WITHIN A TRANSMISSION

(71) We, MASSEY-FERGUSON SERVICES N.V. Abraham de Veerstraat 7A, Curacao, Netherlands Antilles, a company organised under the laws of Netherlands Antilles, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to transmissions for frameless tractors and like vehicles, and more particularly to a method of changing the number of speed ratios within a transmission housing after the initial build-up of such a vehicle.

It may be sometimes desirable to change the number of speed ratios within the driveline of a vehicle after the vehicle has been initially built. In some vehicles this is possible by simply adding a further transmission either before or after the initial transmission whereby the number of speed ratios can be increased. However, while this is possible in vehicles having a separate frame, this has not been possible in frameless tractors wherein the transmission housing along with the rear or centre housing and the engine block form the tractor frame.

It is an object of the present invention to provide a method of converting a transmission from a first number of speed ratios to another number of such ratios.

According to the present invention we provide a method of changing the number of speed ratios within a transmission capable of giving a number of ratios in both the forward and reverse directions of rotation, said method comprising the following steps; providing a transmission including a housing having an inwardly extending annular flange; a first change gear mechanism capable of giving a number of ratios in one direction of rotation only mounted within the housing to one side of the annular flange; an initial second change gear mechanism removably mounted on the inwardly extending annular flange and in series connection with the first change gear mechanism, the initial second change gear mechanism including a forward/reverse change gear mechanism; providing a further second change gear mechanism also including a forward/reverse change gear mechanism and capable of giving a number of speed ratios in one of the directions of rotation different to that given by the initial second change gear mechanism in the same direction of rotation; removing the initial second change gear mechanism from within the housing; and installing the further second change gear mechanism within the housing.

Using the above method it is possible, for example, for a tractor dealer or the manufacturer to relatively easily change the number of speed ratios of a tractor which has previously been fully assembled by the manufacturer to meet the requirements of a particular customer.

For example, the removal of the initial second change gear mechanism may simply comprise the removal of only a forward/reverse change gear mechanism and the installation of the further second change gear mechanism may comprise the installation of a forward/reverse change gear mechanism and a two-speed planetary gear set. Such a conversion would double the number of speed ratios which the transmission as a whole can provide.

When both the initial and further change gear mechanism include a shift rail and the transmission includes a shifting mechanism the method includes the additional steps of disconnecting the shift rail of the initial second change gear mechanism from the shifting mechanism and connecting the shift rail of the further second change gear mechanism to the shifting mechanism.

In a preferred arrangement the initial and further second change gear mechanisms are

supported in separate support structures adapted to be removably secured to the annular flange and the method includes the steps of detaching the support structure of the initial second change gear mechanism from the annular flange prior to removal from the housing and securing the support structure of the further second change gear mechanism to the annular flange after insertion of the further mechanism into the housing.

One embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a side view of a frameless tractor in which the principles of the present invention are incorporated;

Figure 2 is a sectional view of one transmission option;

Figure 3 is an enlarged view of a portion of the transmission shown in Figure 2;

Figure 4 is a section taken generally along the line 4-4 in Figure 3;

Figure 5 is a section taken generally along the line 5-5 in Figure 4, and

Figure 6 is a view similar to Figure 3 showing a second transmission option.

Referring first to Figure 1, a frameless tractor is illustrated, the tractor being indicated generally at 10 and including an engine 12, a transmission indicated generally at 14, the transmission including a housing 16, a rear or centre housing 18, and an axle housing 20. Front and rear wheels 22, 24 are mounted on the tractor in a conventional manner. As can be seen from Figure 1 the engine 12, transmission housing 16 and centre housing 18 form structural support members for the tractor and therefore this type of tractor is generally referred to as a frameless tractor.

In accordance with the principles of this invention first and second change gear mechanisms, indicated generally at 26 and 28, (Figure 2) are coupled to each other within the transmission housing. The first change gear mechanism as illustrated is of a type giving eight different speed ratios. The second change gear mechanism is of a type including a forward/reverse mechanism, and it may include additional speed ratios. Thus, in the embodiment illustrated in Figure 2 the second change gear mechanism includes a forward/reverse mechanism as well as mechanism for providing two additional speed ratios to the input of the first change gear mechanism 26, thereby providing a transmission having 16 speeds. Differing second change gear mechanisms may be employed and a second version is illustrated in Figure 6. In order to provide for the substitution of one change gear mechanism for another it has been necessary to design the first and second change gear mechanisms and the housing in a special manner.

To this end the first change gear mechanism 26 is provided with a first hollow shaft 30 and a second two piece shaft 34, the rear end of the first shaft 30 being rotatably journaled in the rear end wall 32 of the housing 16, and the rear end of the second shaft assembly 34 being rotatably journaled in a bearing plate 35 which is in turn carried by the rear wall 32. A plurality of intermeshing gear sets 36 are carried by the first and second shafts 30, 34 and are selectively interconnectable to transmit power from one shaft to the other. One manner in which the gears 36 may be mounted on the shafts 30, 34 is illustrated in U.K. Patent 1 391 854. The second shaft assembly 34 is divided into forward and rear portions 38, 40, respectively, the forward end of the rear portion 40 being journaled by bearings 42 carried within a cylindrical recess on the rear end of the forward portion 38. The forward portion 38 may be referred to as a counter shaft, and the rear portion 40 as an output shaft. The output shaft 40 is coupled to a driven member (not shown). The forward end of the counter shaft 38 is carried by a bearing 44 which is in turn supported by a first flange 46 which extends inwardly from the generally cylindrical side walls 48 of the housing 16. An additional flange 50 is provided between the first flange 46 and the rear wall 32, the additional flange 50 carrying a further bearing 52 which rotatably supports a rear portion of the counter shaft 38.

In order to removably mount a second change gear mechanism within the housing, the housing 16 is provided with an inwardly extending annular flange 54. A support structure indicated generally at 56 is removably secured to the second flange 54. In the embodiment illustrated in Figures 2 and 3 the support structure 56 is formed of two parts which shall be referred to as the front cover 58 and the support frame 60. The front cover 58 is provided with a radially outwardly extending circular flange 62 which is secured to the annular flange 54 by bolts 64 or the like. The support frame 60 has a radius less than that of the annular support flange 54 and is secured to the front cover 58 by cap screws 66. The front cover and support frame 58, 60 co-operate with the rear wall 32 to form a fluid reservoir within the housing 16. In addition, the support frame 60, which is rigidly mounted within the housing, is utilized to support the forward end of the main shaft 30. To this end, a bearing support 68 which carries a bearing 70 is secured in place by bolts 72. The forward end of the first shaft 30 is journaled within the bearing 70.

The support frame 60 carries additional bearings 74 and 76 in which is journaled a

hollow third shaft 78. Rotatably mounted on the third shaft are spaced apart forward and reverse gears 80, 82. A shiftable coupler 84 is keyed to the shaft 78 and may be shifted axially of the shaft to drivingly interconnect either the forward gear 80 with the shaft 78 or the reverse gear 82 with the shaft 78. The coupler is caused to be shifted by a shift rail 83 and fork 85. The shift rail is carried by the support member 56 for axial sliding movement. The gear 80 is at all times in constant mesh with a gear 86 carried by the forward end of the counter shaft 38. The support structure 56 additionally carries a stub shaft 88 (Figures 4 and 5) upon which is mounted a reverse idler 90 having a first toothed portion 92 which is constantly in mesh with the teeth on gear 82, and a second toothed portion 94 which is constantly in mesh with the teeth on gear 86.

Mounted forwardly of the forward/reverse gear mechanism is a 2-speed planetary gear set indicated generally at 96, which gear set along with the forward/reverse mechanism completes the second change gear mechanism 26. The planetary gear set includes a hollow input shaft 98 the forward end of which is coupled to a drive member such as a tractor clutch plate (not shown). The rear end of the input shaft 98 is supported by a bearing 100 disposed within an aperture of the clutch release bearing carrier 102 which is in turn secured to the front cover 58 by fastener 104. A ring gear 106 is secured to the input shaft 98 by bolts 108. A hydraulically operated clutch pack 110 may be utilized to couple the ring gear 106 to a planet carrier 112. Thus, when fluid is introduced into the chamber 114 behind the piston 116, the clutch pack 110 will be engaged thereby locking the planet carrier 112 to the ring gear 106. The planet carrier is provided with a plurality of axially extending stub shafts 118 on which are mounted planet gears 120. The teeth 112 on the ring gear 106 and the teeth 124 on a sun gear 126 are in constant mesh with the teeth on the planet gears 120. The planet carrier 112 is coupled directly to the third shaft 78 upon which the forward/reverse gear mechanism is mounted, and the sun gear 126 is journaled for rotation about the shaft 78. A clutch disc 128 is secured to the sun gear, which clutch disc may be utilized to hold the sun gear from rotation. To this end compression springs 130 are disposed in suitable recesses in the front cover 58, the springs 130 acting against a pressure plate 132 to normally bias the clutch disc 128 into engagement with a flat surface on the support frame 60. The clutch disc 128 may be disengaged by introducing fluid under pressure into chamber 134 to cause piston 136 to engage the pressure plate 132 and move the plate 132 away from the clutch disc 128 and flat surface. The fluid circuit for operating the planetary gear set 96 is illustrated somewhat schematically in Figure 2 and includes a pump 138, fluid reservoir 140, valve 142, and manual control lever 144. When the valve is in the position illustrated in Figure 2 fluid from the pump 138 will be returned directly to the reservoir through line 146. In this position the springs 130 will hold the clutch disc 128 against the flat surface of the housing 60. When the manual control lever 144 is shifted to its other position (not illustrated) fluid from the pump 138 will be introduced into line 148 and thence into chambers 114 and 134 to cause the piston 136 to disengage the pressure plate 132 and piston 116 to engage the hydraulically operated clutch pack 110. The preload of springs 130 is so designed that when fluid is introduced into the chambers 134 and 114 the hydraulically operated clutch pack 110 will be partially engaged prior to the full disengagement of the first clutch 128. In the event that the clutch 128 became disengaged before the clutch 110 became engaged it would be possible for power flow to be interrupted from the shaft 98 to the shaft 78. By employing springs 130 having a certain preload characteristic it is possible to insure continuous power flow as the planetary gear set is being shifted from its high speed ratio when clutch 128 is engaged to its low speed ratio when clutch pack 110 is engaged, and vice versa.

In the embodiment shown in Figures 2 to 5 the transmission 14 has 16-speed ratios. In the embodiment illustrated in Figure 6, which will now be described, the 2-speed planetary input portion of the second change gear mechanism is eliminated and therefore the transmission 14 is capable of only eight forward speeds. Before describing Figure 6 in detail it should be observed that some of the components of the second change gear mechanism illustrated in Figure 6 and indicated generally at 150 are identical to components illustrated in Figures 2 to 5, and these components will be indicated by the same reference numerals. In addition, while a first change gear mechanism is illustrated having 8-speeds, other first change gear mechanisms could be employed having a different number of speeds, such as 4, 6 etc.

The second change gear mechanism 150 of the type illustrated in Figure 6 includes a combined front cover and support frame 152 provided with an annular flange 154 which may be secured to the annular second flange 54 of the transmission housing 16 by bolts 64. A bearing 70 is carried by a rear portion of the support 152 and is secured in place by screws 156 and a bearing retainer 158. The forward end of the main shaft 30 is journaled within the bearing 70. An input shaft

160, whose forward end is coupled to a drive member such as a tractor clutch, has its rear end coupled directly to the third shaft 78. The forward end of the hollow third shaft 78 is supported by a spacer 162 which is in turn supported by a bearing 164 carried by the support frame 152. The rear end of the shaft 78 is also supported by a bearing 166 carried by the support frame 152. A forward/reverse mechanism including forward and reverse gears 80, 82 and coupler 84 are mounted about the shaft 78, the gear 80 being in constant mesh with gear 86 on the forward end of counter shaft 38 and the gear 82 being in constant mesh with a reverse idler 90. A fork 85 engages the coupler 84 and is shifted by a shift rail (not shown) which is carried by the support frame 152.

By designing the transmission in the manner indicated above it is possible to utilize the same basic or first change gear mechanism 26 with a variety of second change gear mechanisms which may provide, for example, only a forward/reverse gear mechanism of the type illustrated at 150 in Figure 6, a 2-speed forward/reverse mechanism of the type illustrated at 28 in Figures 2 to 5, or by other input mechanisms such as, for example, a 3-speed forward/reverse mechanism of the type illustrated in U.S. Patent 1 399 373. The manner of converting a tractor from the 16-speed transmission of the type illustrated in Figure 2 to the 8-speed transmission of the type illustrated in Figure 6 will now be described.

It is first necessary to separate the transmission housing 16 from the engine 12 and to move these parts apart. To this end, it would be necessary to dis-connect all lines, controls, etc., which extend between the engine 12 and housing 16. After this has been done bolts 168 (Figure 1) which secure the housing 16 to the engine must be removed to permit the front and rear halves of the tractor to be moved apart. The power take-off shaft 170 which extends through the hollow shafts 98, 78 and 30 is then removed. (The front end of the PTO shaft is connected to the engine flywheel by a spline.) After this has been done it is necessary to remove various lubrication lines (not illustrated) and to then remove the clutch release bearing carrier 102, the saddle assembly 172, the clutch release lever 174, and the clutch cross shaft 176. As the shift rail 83 and fork 85 for the forward/reverse mechanism are carried by the structure 56 it is necessary that the shift cover 182 be removed from the right side of the transmission housing in order to disengage the reverse actuator 184 from the forward reverse saddle 186 carried at the rear end of the shift rail 83. While the mechanism for operating the reverse actuator 184 is not illustrated it should be observed that the reverse actuator 184 may be carried at one end of a rock arm, the other end of which is connected to a rock shaft which may be rotatably mounted in the shift cover 182. The shaft column and controls for the other shift rails 188, as well as the mechanism for operating the reverse actuator 184, are positioned to one side of the first change gear mechanism 26.

When the assembly 28 is being removed it is essential that it be pulled out axially approximately two inches to cause the front ends of shift rails 188 and the rear end of lubrication tube 190 to be disconnected from their associated recesses. The assembly is then rotated counterclockwise approximately 1/8 of a turn and is then pulled from the transmission housing 16. To install the assembly 150 in the housing 16 the procedure outlined above is followed in reverse order.

It will be appreciated from the above description that not only does the present invention provide a simple and efficient means of extending the ratio range of the first change gear mechanism and providing a forward/reverse facility but by removably supporting the second change gear mechanism as a whole within the housing removal of the second gear change mechanism is greatly facilitated making easy adjustments of the overall ratio range of the transmission possible by the use of different second change gear mechanisms. The constructional details of the transmission described above are the subject of our co-pending U.K. Patent Application Numbers 23948/78 and 23949/78. Serial Nos 1605067 and 1605068.

WHAT WE CLAIM IS:-

1. A method of changing the number of speed ratios within a transmission capable of giving a number of ratios in both the forward and reverse directions of rotation, said method comprising the following steps: providing a transmission including a housing having an inwardly extending annular flange; a first change gear mechanism capable of giving a number of ratios in one direction of rotation only mounted within the housing to one side of the annular flange; an initial second change gear mechanism removably mounted on the inwardly extending annular flange and in series connection with the first change gear mechanism, the initial second change gear mechanism including a forward/reverse change gear mechanism; providing a further second change gear mechanism also including a forward/reverse change gear mechanism and capable of giving a number of speed ratios in one of the directions of rotation different to that given by the initial second change gear mechanism in the same direction of rotation; removing the initial second

change gear mechanism from within the housing; and installing the further second change gear mechanism within the housing.

2. A method according to claim 1 in which the removal of the initial second change gear mechanism simply comprises the removal of only a forward/reverse change gear mechanism and the installation of the further second change gear mechanism comprises the installation of a forward/reverse change gear mechanism and a two-speed planetary gear set.

3. A method according to claim 1 or claim 2 applied to a transmission in which both the initial and further second change gear mechanisms include a shift rail and the transmission has a shifting mechanism, said method including the additional steps of disconnecting the shift rail of the initial second change gear mechanism from the shifting mechanism and connecting the shift rail of the further second change gear mechanism to the shifting mechanism.

4. A method according to any one of claims 1 to 3 applied to a transmission in which the initial and further second change gear mechanisms are supported in separate support structures adapted to be removably secured to the annular flange, said method including the steps of detaching the support structure of the initial second change gear mechanism from the annular flange prior to removal from the housing and securing the support structure of the further second change gear mechanism to the annular flange after insertion of the further mechanism into the housing.

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1605069 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

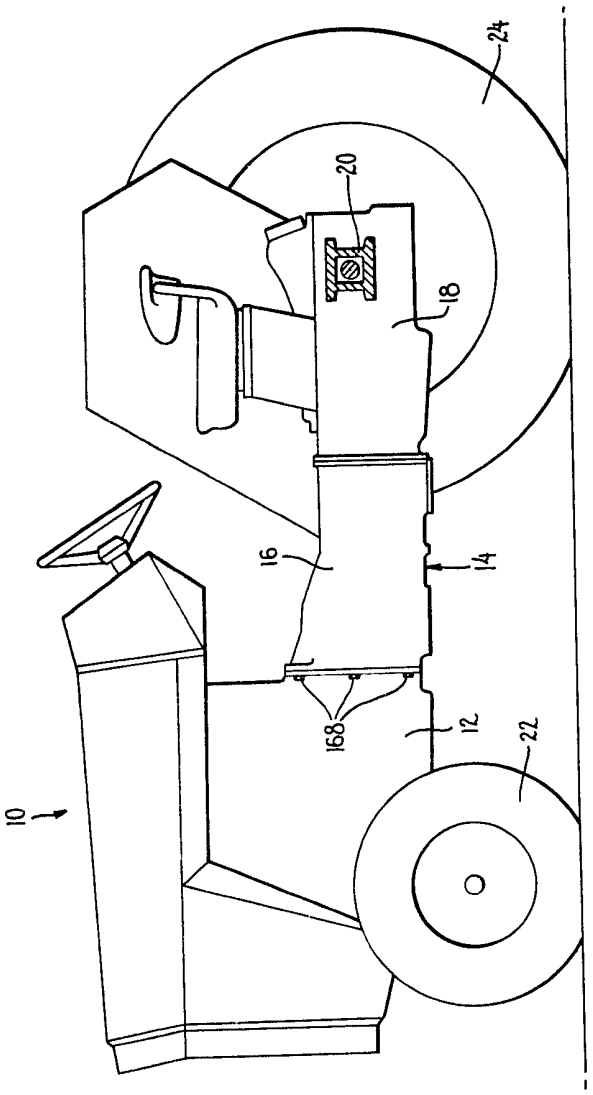
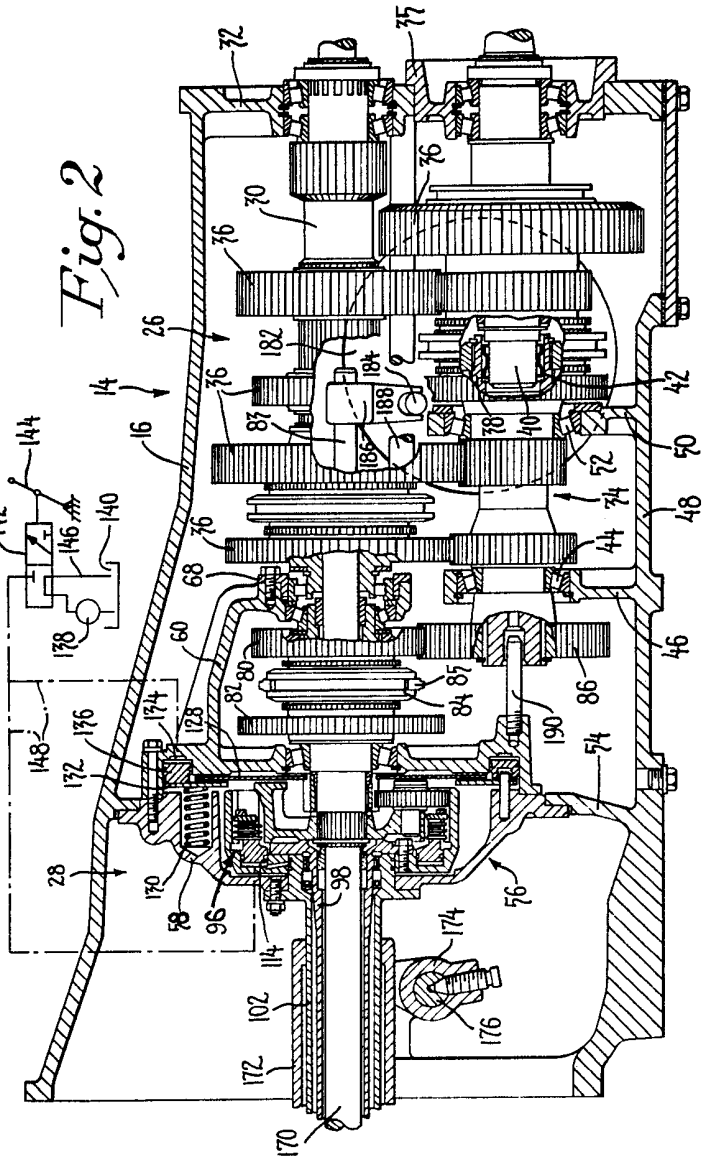


Fig. 1

Fig. 2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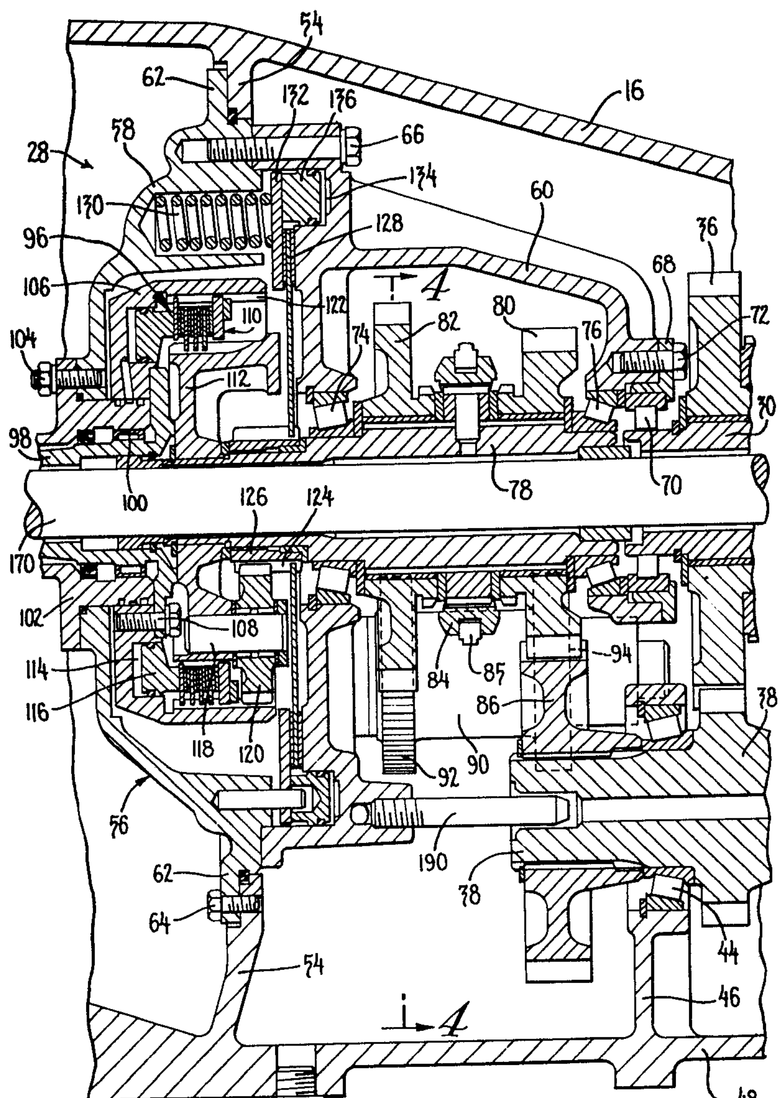
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Fig. 3

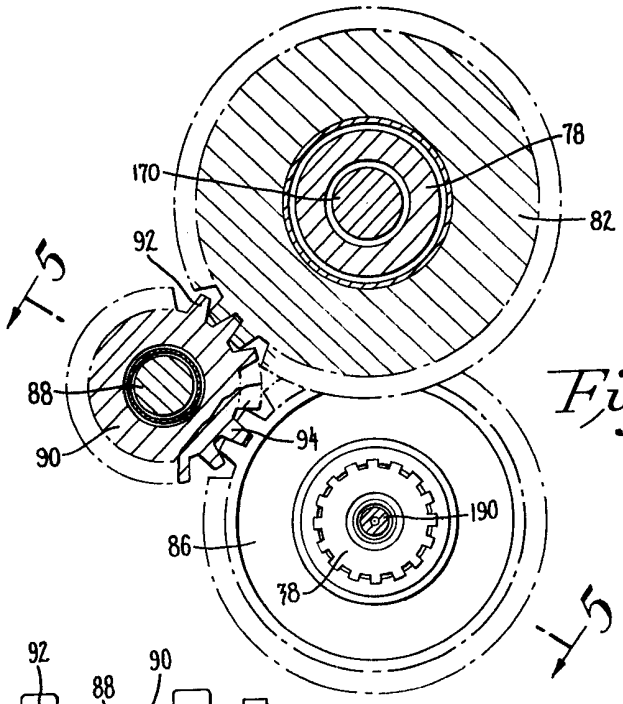

Fig.4

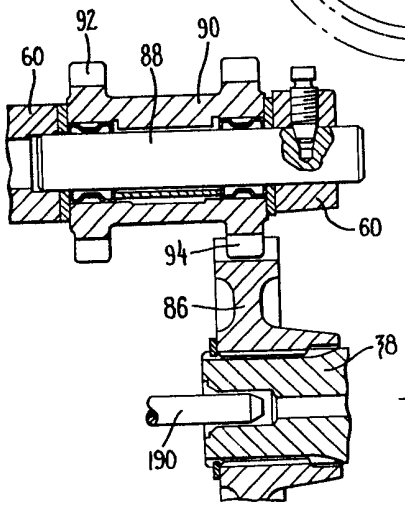

Fig.5

1605069 COMPLETE SPECIFICATION
5 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 5

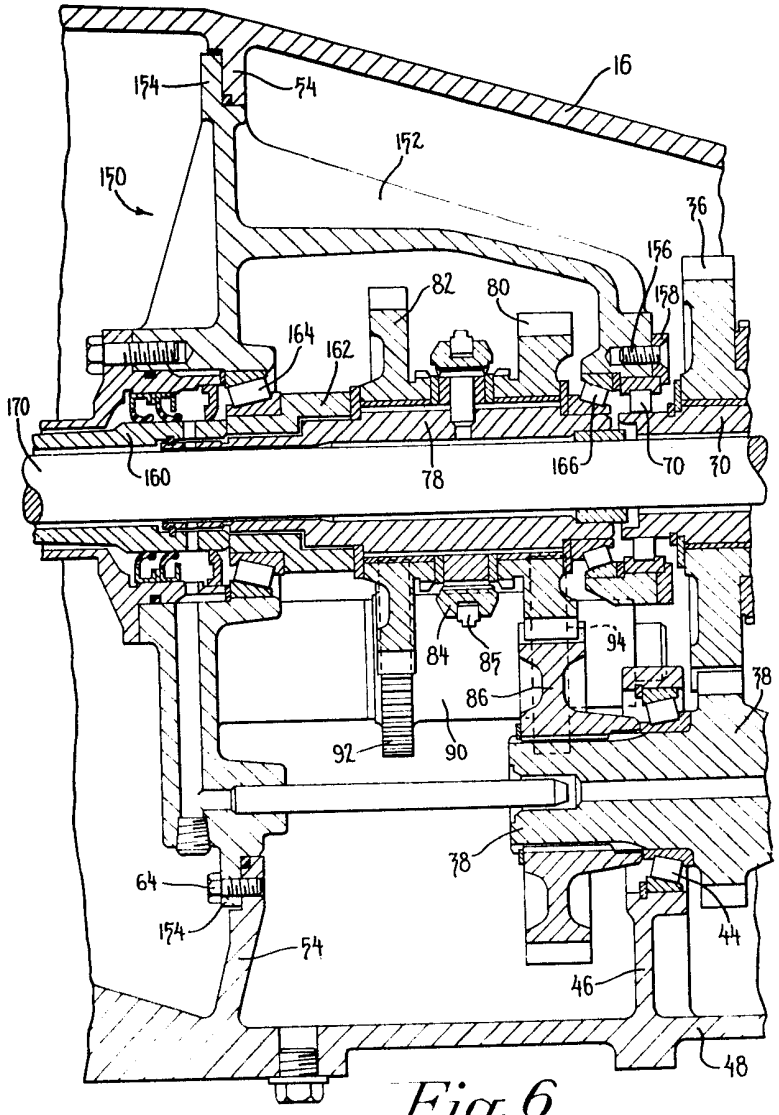

Fig. 6