Nov. 5, 1940. M. S. ARIENS 2,220,197

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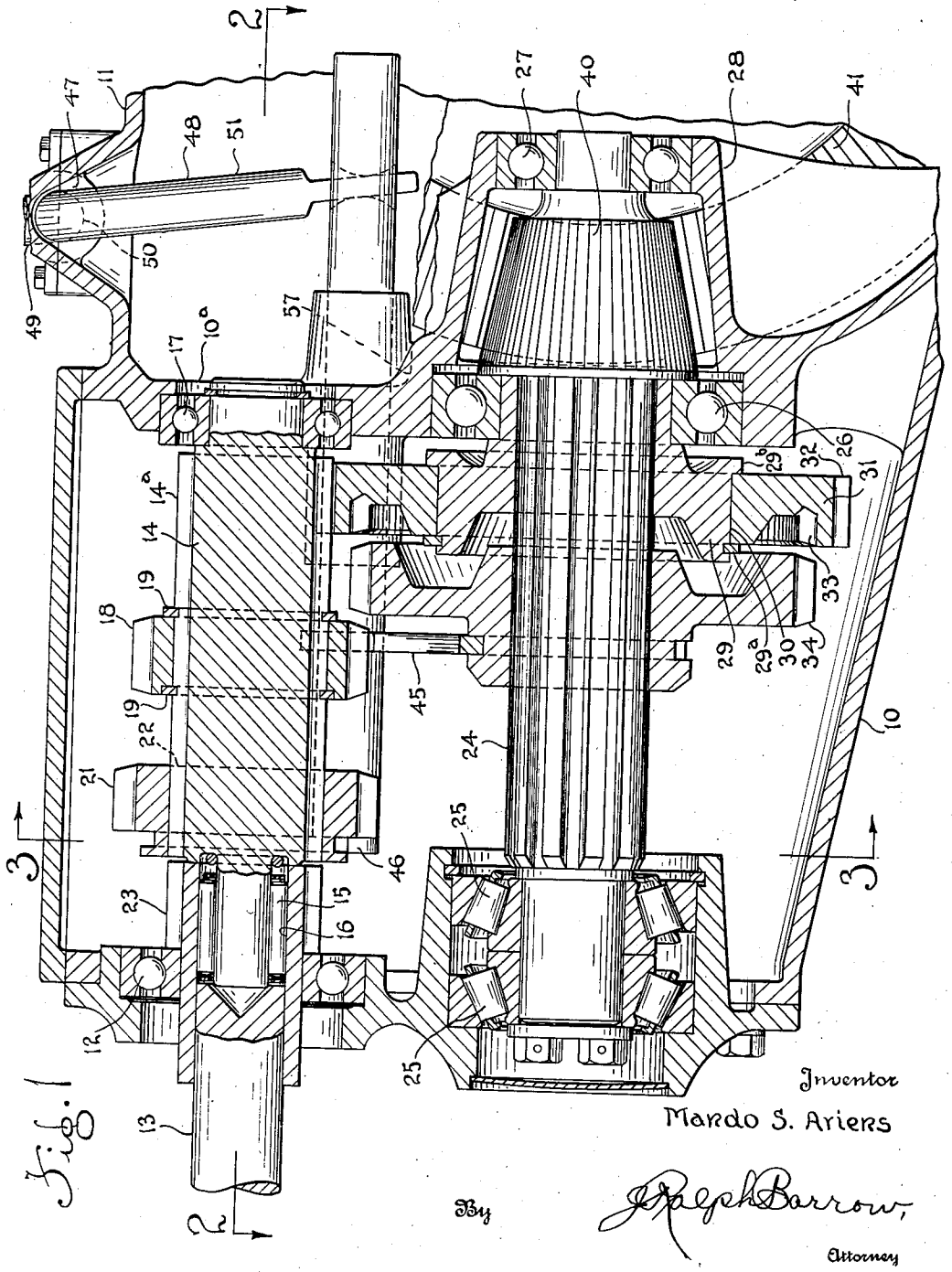


Fig. 1

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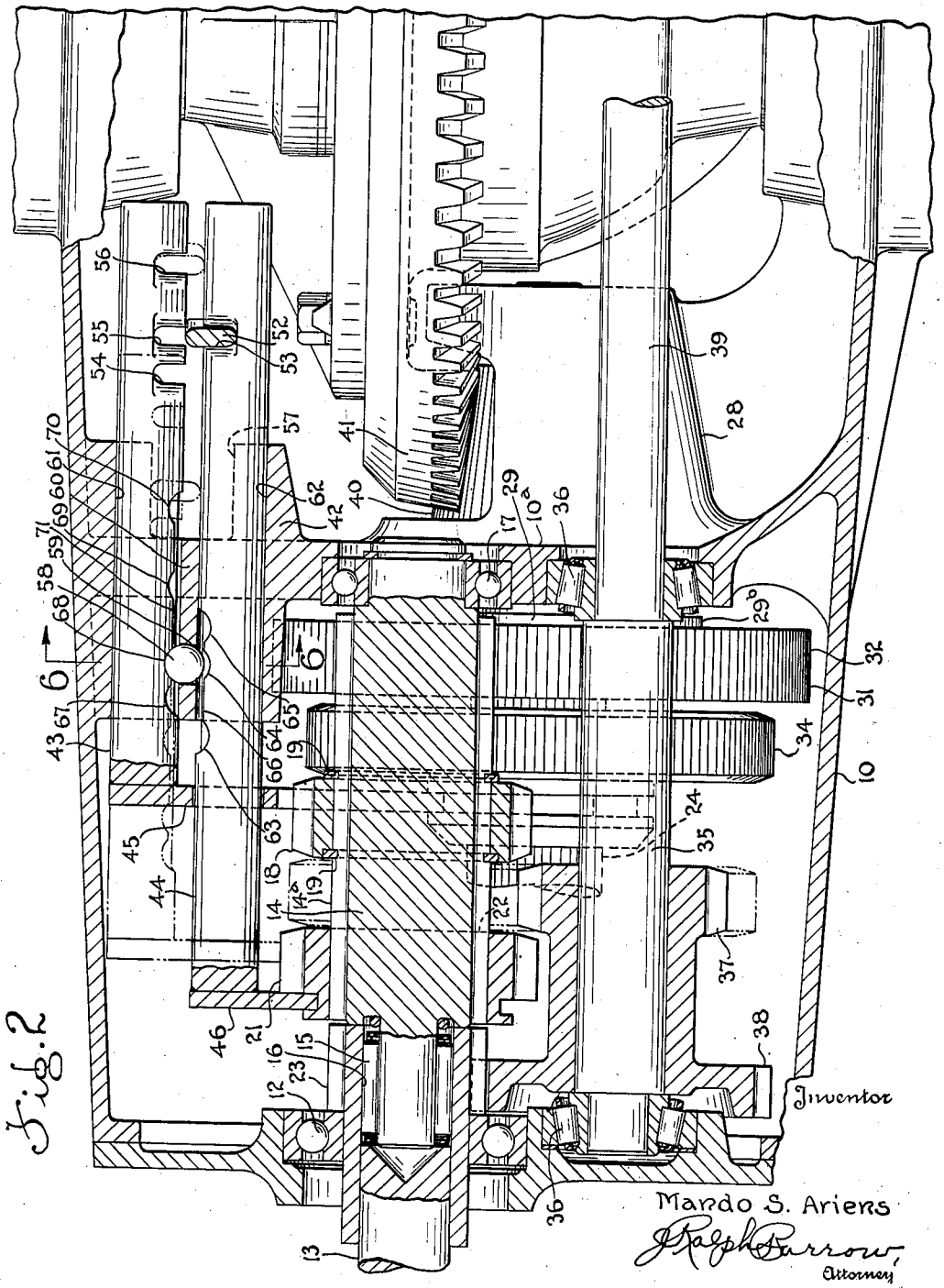


Fig. 2

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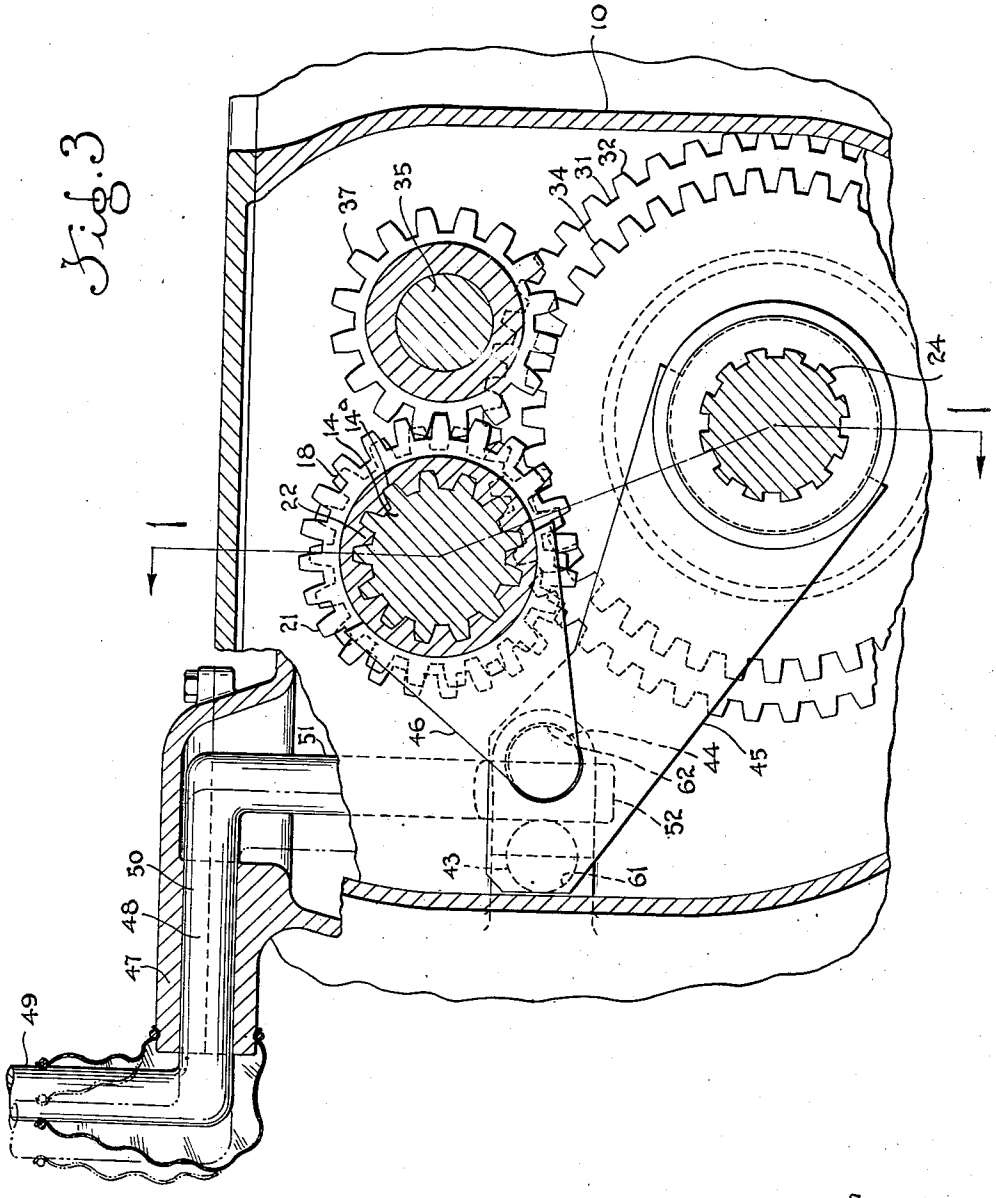
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TRANSMISSION

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Fig. 3



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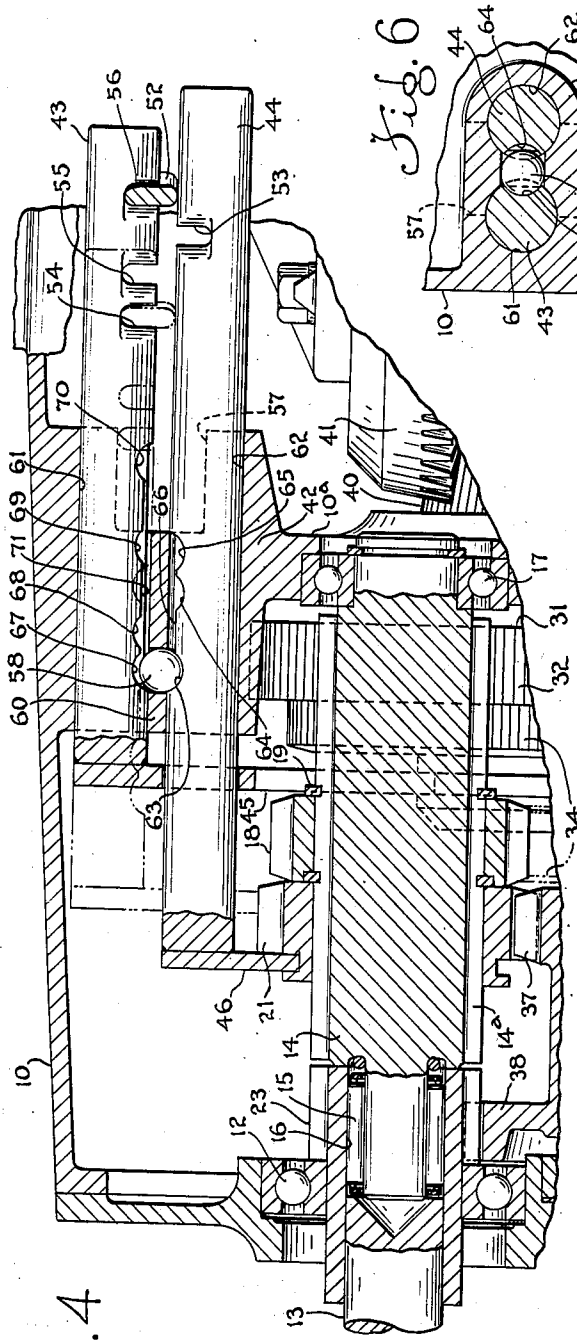


Fig. 4

Fig. 6

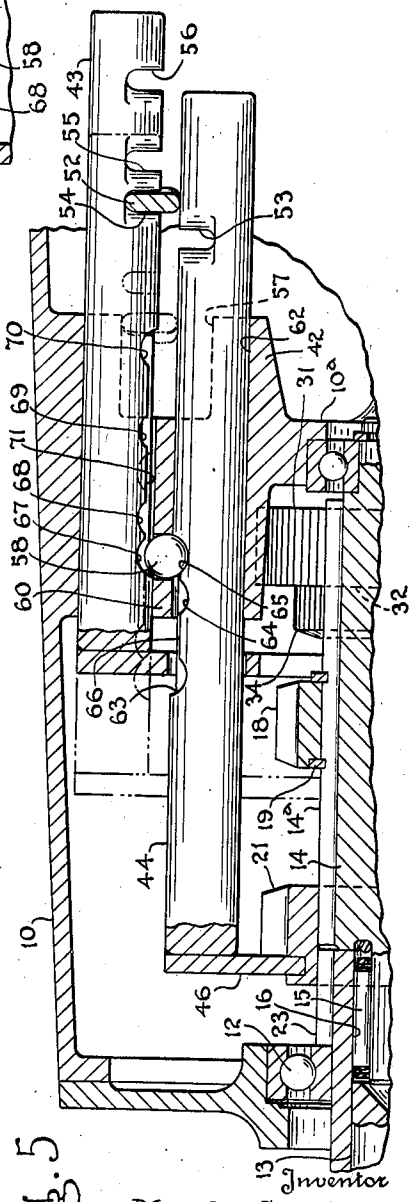


Fig. 5

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Fig. 8

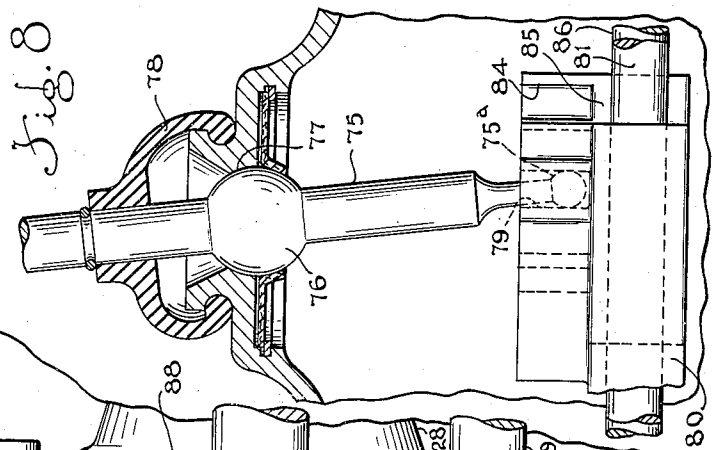
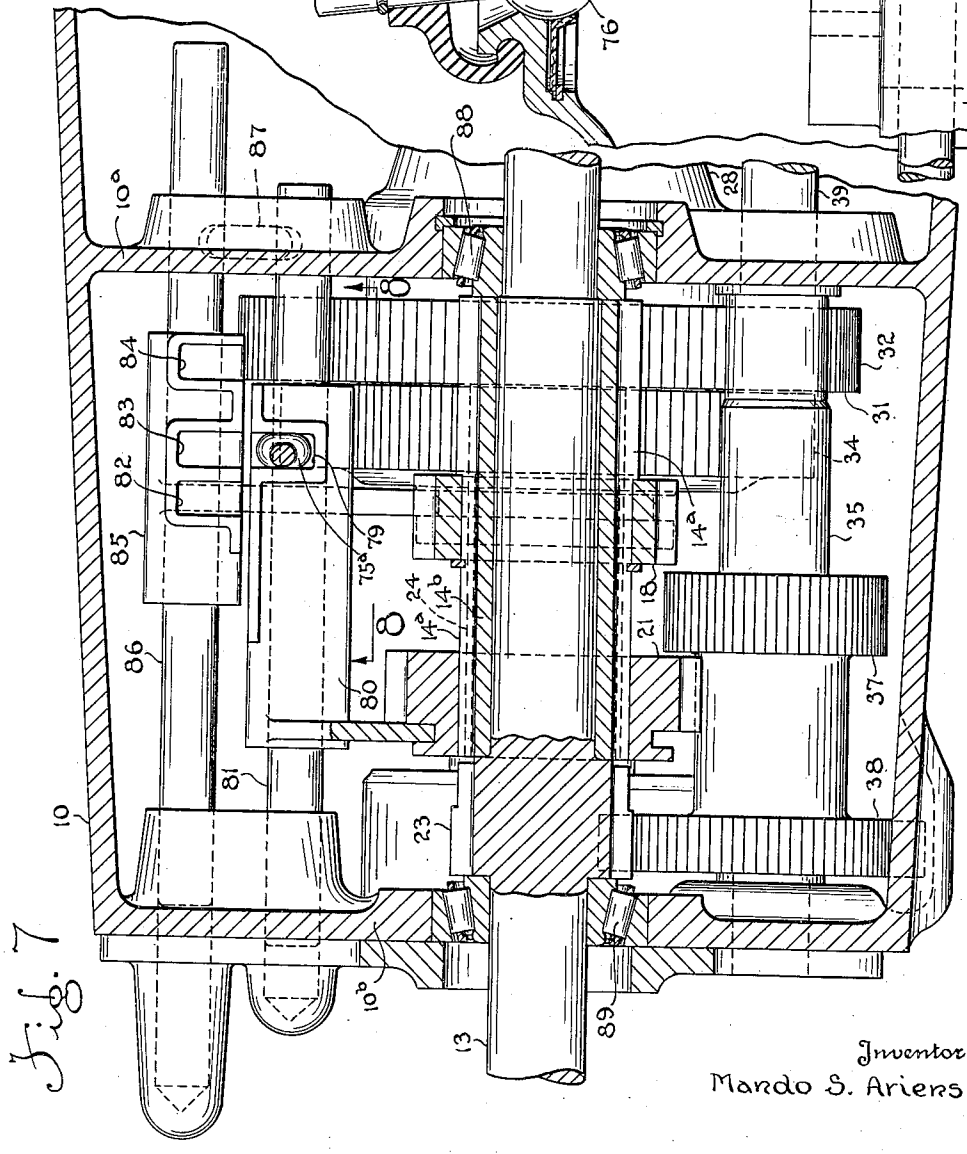


Fig. 7



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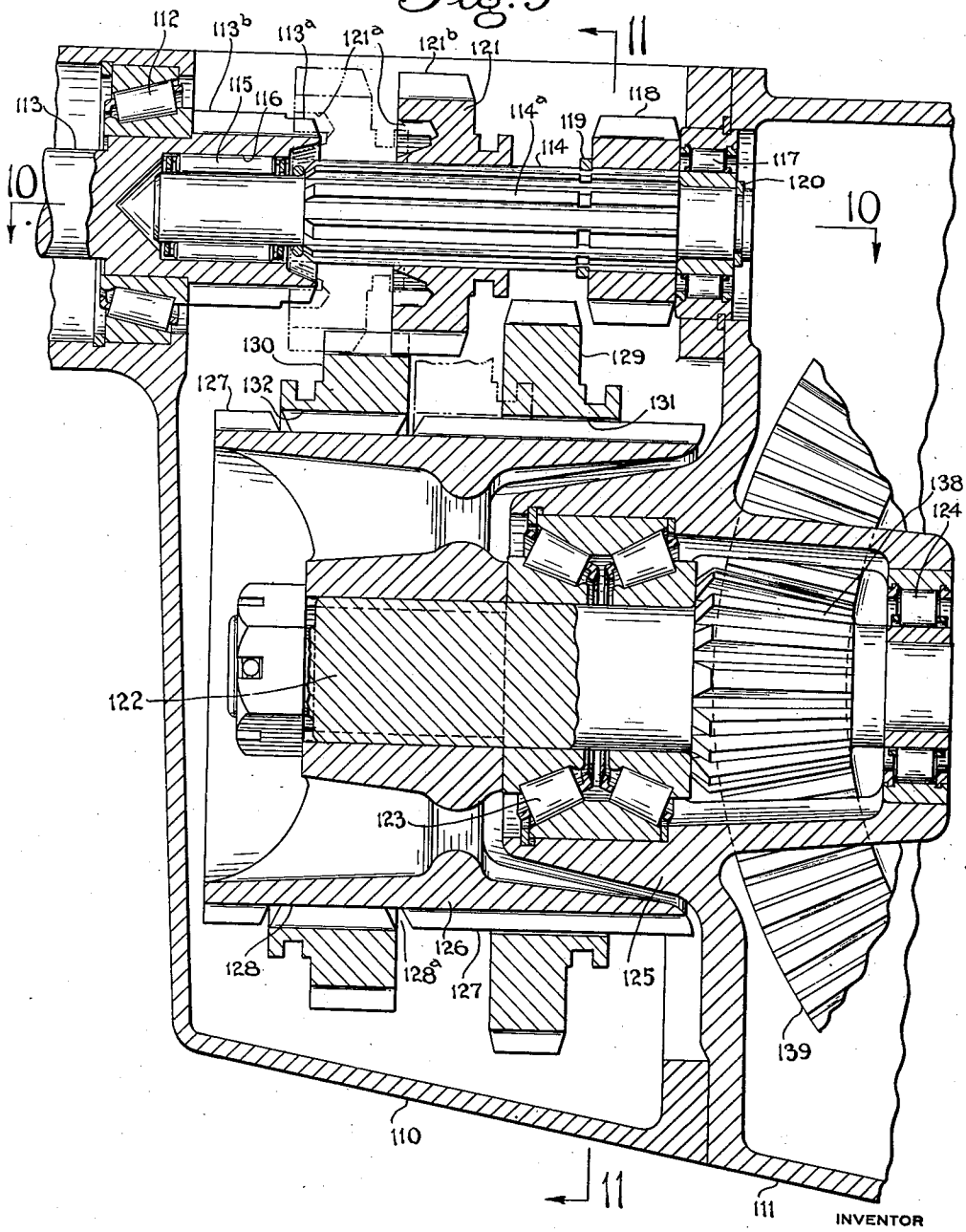
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Fig. 9



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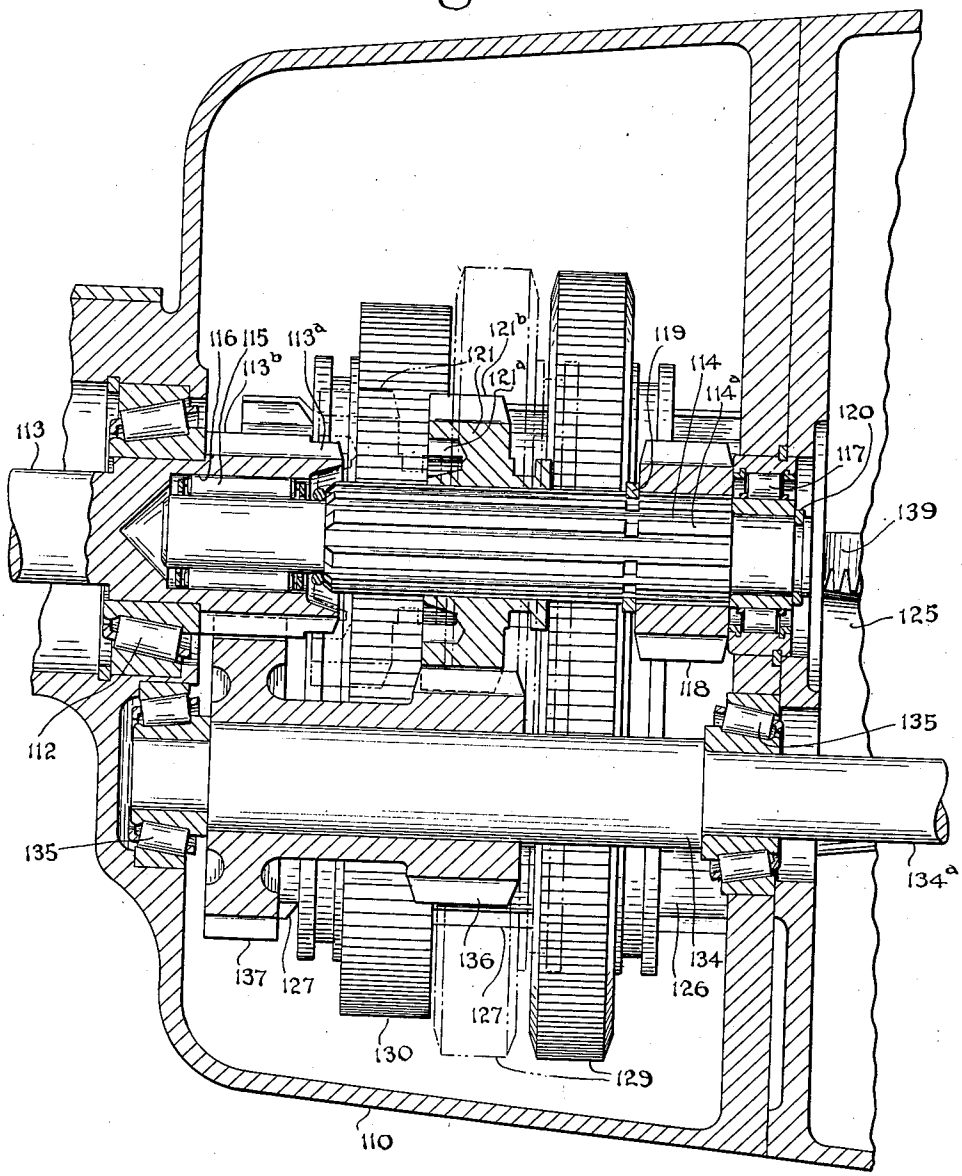
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Fig. 10



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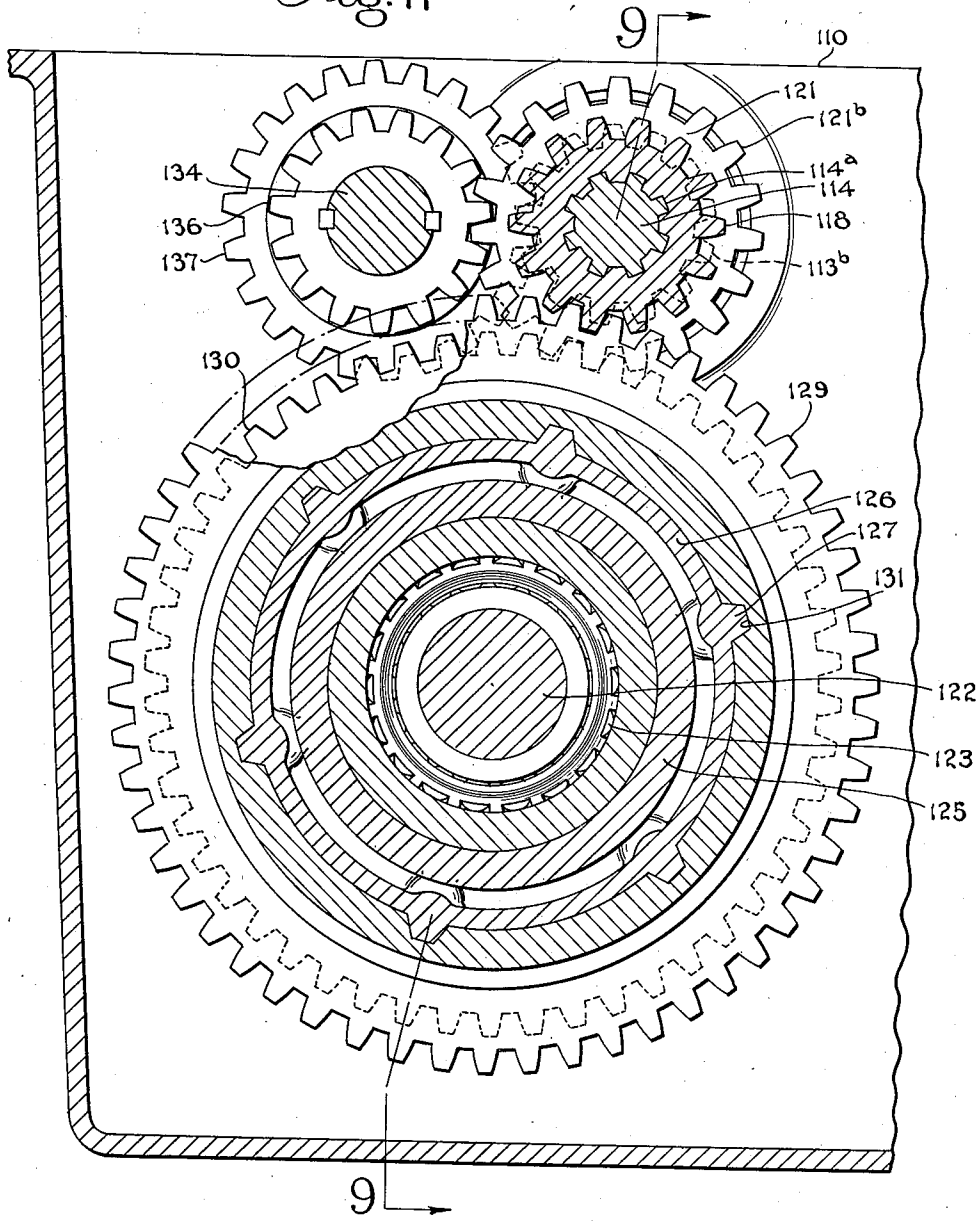
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TRANSMISSION

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Fig. 11



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Fig. 12

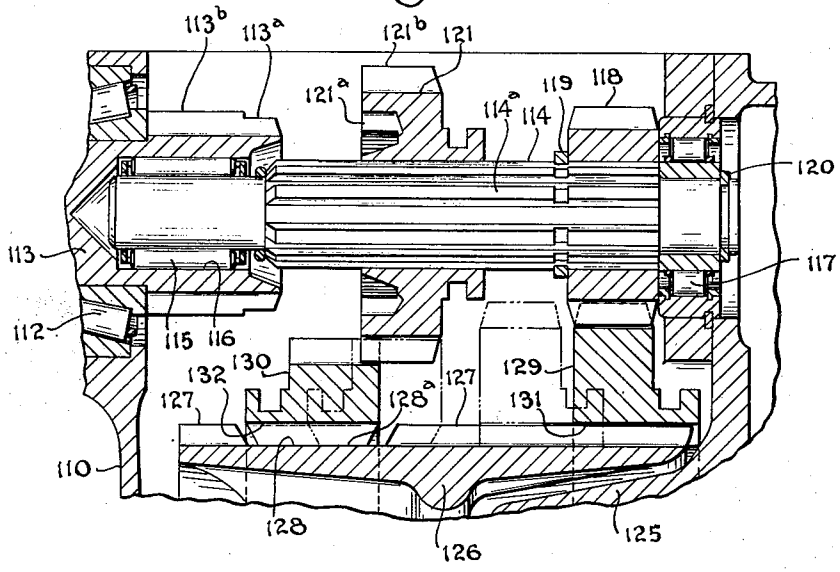
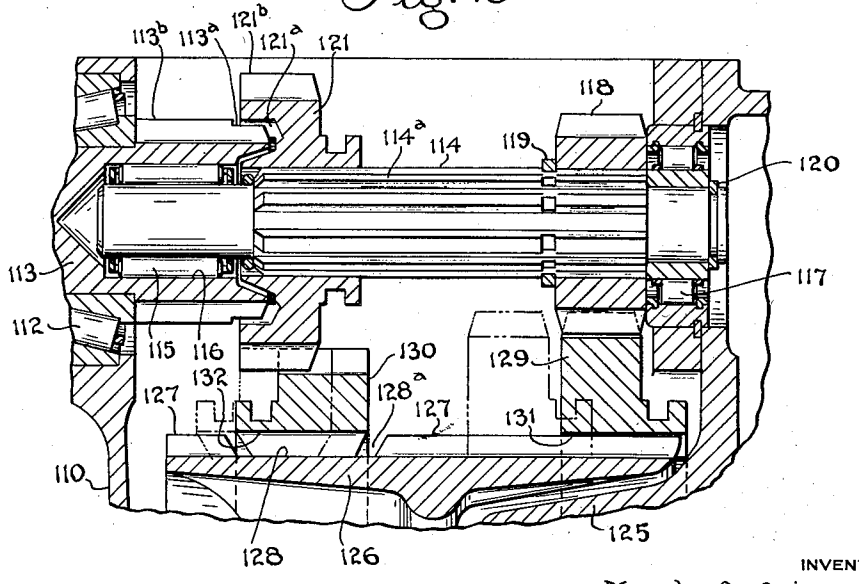


Fig. 13



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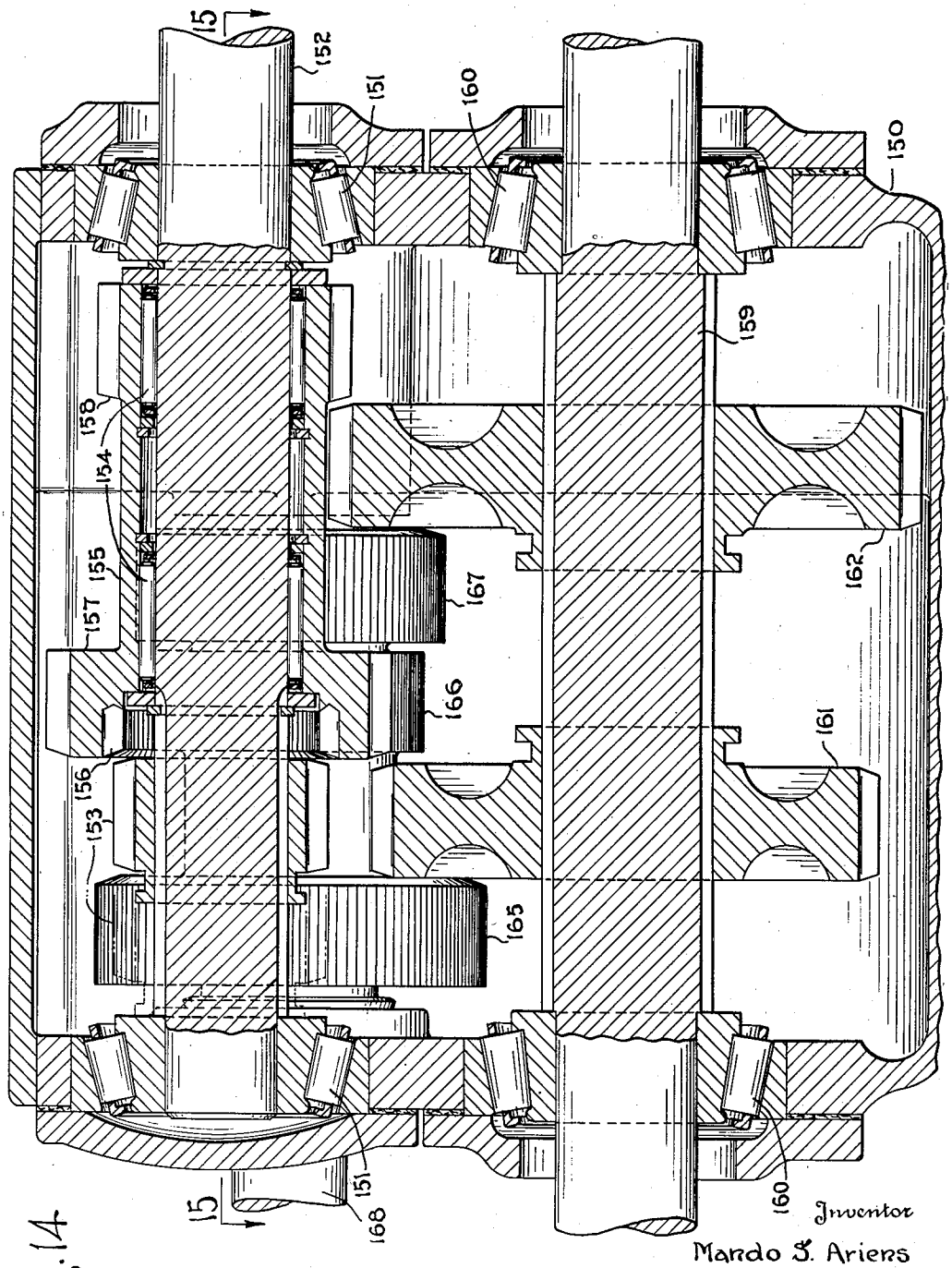


Fig. 14

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TRANSMISSION

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Fig. 16

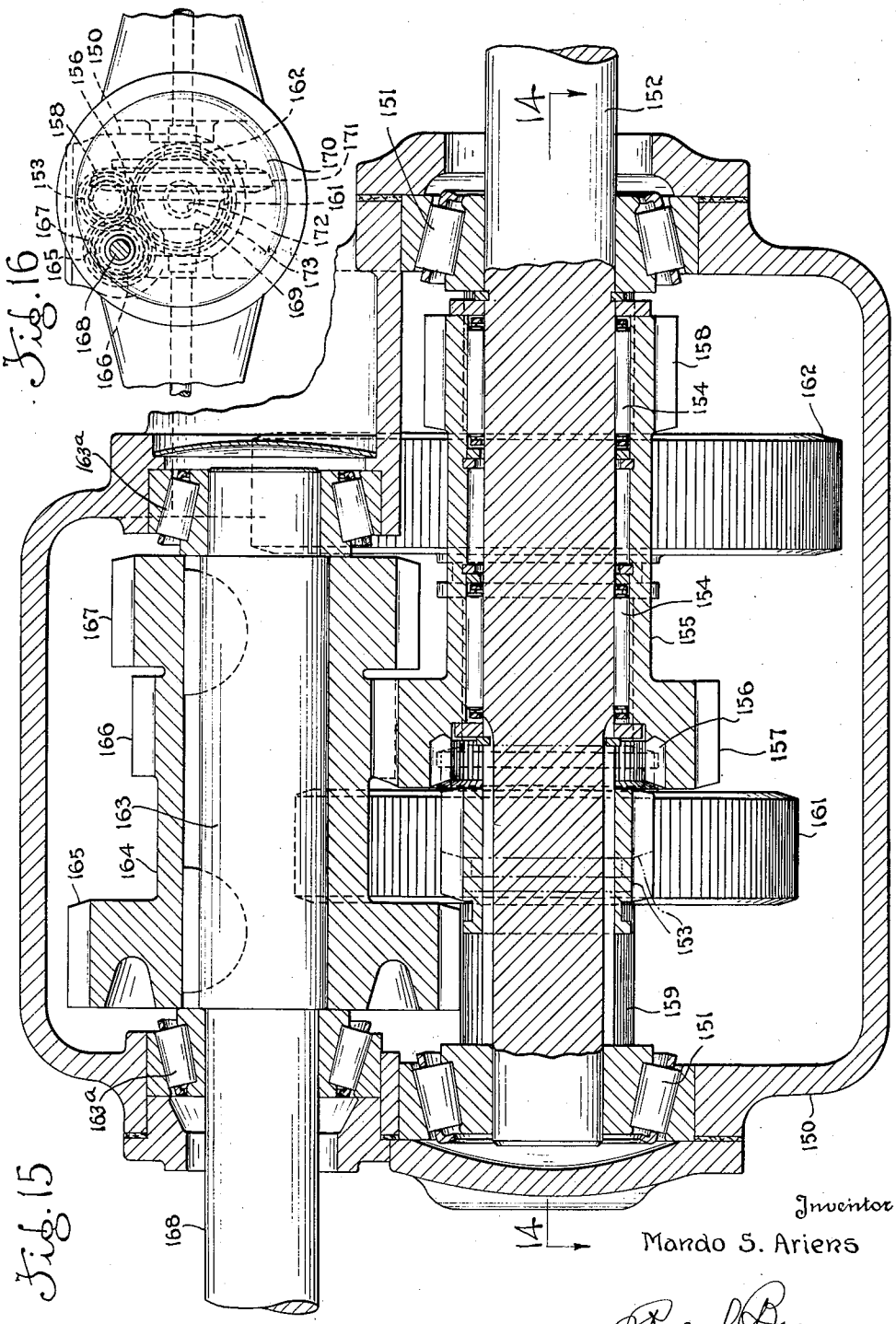


Fig. 15

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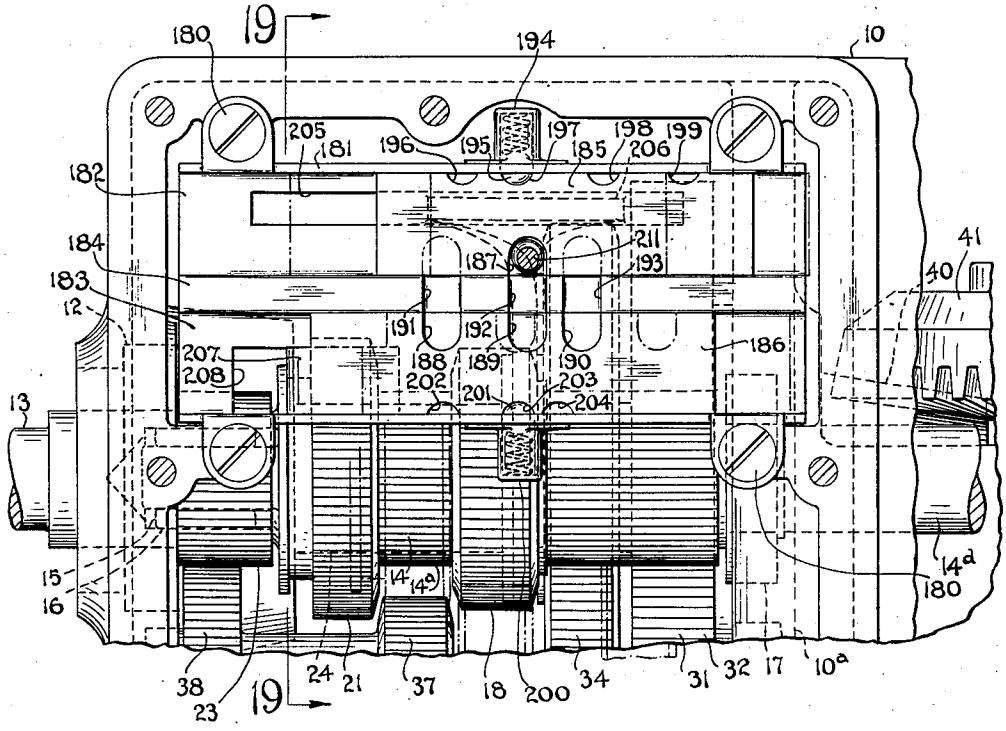
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Fig. 17



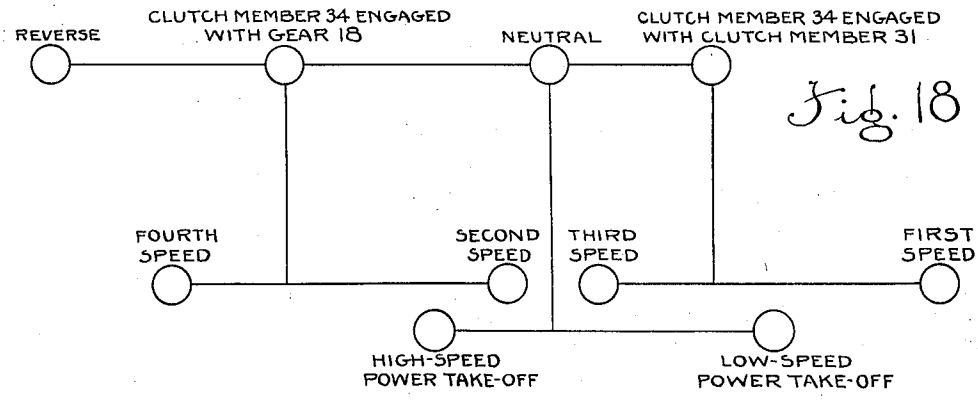


Fig. 18

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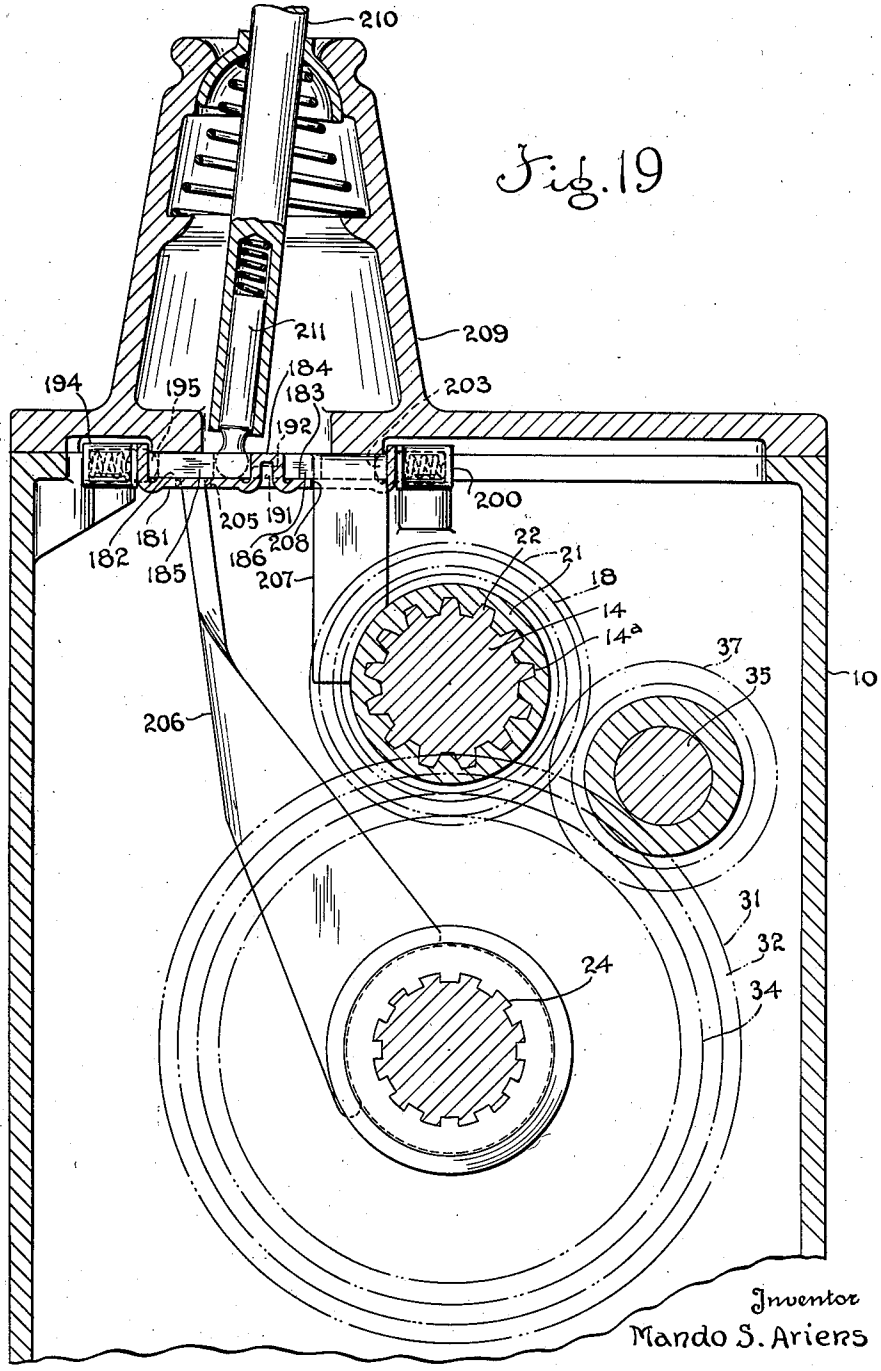
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TRANSMISSION

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Fig. 19



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Patented Nov. 5, 1940

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UNITED STATES PATENT OFFICE

2,220,197

TRANSMISSION

Mando S. Ariens, Brillion, Wis.

Application September 30, 1936, Serial No. 103,342

7 Claims. (Cl. 74—326)

This invention relates to transmissions and has particular relation to transmissions of the multi-speed or change-speed gear type, by which power is transmitted by means of gear-trains from a power source to the output side at different speeds as selected by an operator.

One object of the present invention is to provide in a transmission an intermediate shaft between the power input and power output shafts and means, such a back gear shaft adapted to be so used in association with the power-input and intermediate shafts, as to drive the intermediate shaft at will at more than one speed with change speed gear mechanism between the intermediate and output shafts to provide a set of speed changes for the output shaft for each speed of the intermediate shaft.

Another object of the invention is to provide a transmission through which may be obtained a number of different speeds in one direction and one or more speeds in reverse direction, but to obtain this result with fewer gears than has been heretofore required.

Another object is to provide a power transmission of small dimensions through which may be obtained extremely large speed reductions.

Another object is to eliminate the necessity for a double reduction between the transmission and the driving axle of automotive and tractor construction.

Still another object is to provide a transmission in which one or more gears may be utilized for several purposes, as for example, to obtain a direct drive, an indirect drive, or reverse, according to the requirements of the operator.

A still further object is to obtain auxiliary power take-offs, at either high or low speeds or both, from the transmission itself without adding extra gears, shafts or bearings.

Yet another object is to provide a transmission in which one or more of the gears may be used to perform the function of an oil-thrower whenever the power-input shaft is in operation in neutral or in gear.

Another object is to provide a transmission in which the power-input shaft is well above the center of the rear axle, which makes possible a greater clearance between the bottom of the engine and the ground, and permits the propeller shaft to be located well below the center line of the engine, thereby eliminating the necessity of having either a high floor line or a raised casing above the floor line of automotive vehicles or the like.

Another object is to provide a simple gear shifting mechanism which will operate easily and effectively in connection with a gear transmission having a large number of speed changes.

Other objects will be readily seen from the following brief description of the mechanism in connection with the accompanying drawings thereof.

Of the accompanying drawings:

Figure 1 is a vertical cross-section through a form of the mechanism embodying the invention, taken substantially on the line 1—1 of Figure 3.

Figure 2 is a horizontal cross-section taken on the line 2—2 of Figure 1.

Figure 3 is a vertical cross-section taken on the line 3—3 of Figure 1.

Figures 4 and 5 are fragmentary cross-sectional views of a portion of the mechanism shown in Figure 2, illustrating various steps in the operation thereof.

Figure 6 is a cross-section taken on the line 6—6 of Figure 2.

Figure 7 is a horizontal cross-section of the transmission shown in Figures 1 to 6 with a few changes in the construction thereof.

Figure 8 is a cross-section taken substantially on the line 8—8 of Figure 7.

Figure 9 is a vertical cross-section similar to Figure 1, illustrating another embodiment of the invention, and taken substantially on the line 9—9 of Figure 11.

Figure 10 is a horizontal cross-section taken on the line 10—10 of Figure 9.

Figure 11 is a vertical cross-section taken on the line 11—11 of Figure 9.

Figures 12 and 13 are fragmentary cross-sectional views of a portion of the mechanism shown in Figure 9, illustrating various steps in the operation thereof.

Figure 14 is a vertical cross-section similar to Figure 1, illustrating still another embodiment of the invention, taken substantially on the line 14—14 of Figure 15.

Figure 15 is a horizontal cross-section taken on the line 15—15 of Figure 14.

Figure 16 is a fragmentary rear view, on a reduced scale, of a differential housing of a vehicle, illustrating the use of an auxiliary power take-off in connection with Figures 14 and 15.

Figure 17 is a fragmentary top view of a preferred form of gear-shift mechanism illustrated in connection with a form of transmission substantially the same as that shown in Figures 1, 2 and 3.

Figure 18 is a diagrammatic view of the various shifts obtainable with the mechanism shown in Figure 17.

Figure 19 is a vertical cross-section taken on the line 19—19 of Figure 17.

Referring to Figures 1 to 7 inclusively, of the drawings, 10 is a transmission housing which may be integral with a differential housing 11 of any automotive vehicle or tractor, or it may be secured in any suitable manner to power means where speed changes are desired. Rotatably journaled in a suitable bearing 12, at the top of the housing 10 is a power-input shaft 13 which may be coupled or clutched to a power source or engine (not shown).

An intermediate shaft 14, on the same axis with the power-input shaft 13, is journaled at one end in a suitable bearing 15 within a counterbore 16 in the end of the input shaft 13, and is journaled at its other end in a bearing 17 mounted in the casing 10. Secured to the shaft 14 intermediate the ends thereof is a gear 18, said gear being prevented from lateral movement by means of circular keys 19, 19 and from relative rotation by teeth 14a on said shaft serving as splines. Slidably but non-rotatably mounted on the intermediate shaft 14 is a combined gear and clutch member 21, said member being provided with internal clutch teeth 22 engaged with the teeth or splines 14a on the intermediate shaft and selectively engageable with external teeth on a gear member 23 which latter is fixed on the end of the input shaft whereby gear and clutch member 21 may function as a clutch connecting the input shaft 13 with the intermediate shaft 14.

Located at a suitable distance below the intermediate shaft 14 is a power-output shaft 24, journaled in bearings 25 and 26 in the housing 10 and a bearing 27 in a bevel-pinion housing 28, which latter may be integral with the housing 10. Secured to the shaft 24 at the end adjacent the bevel-pinion housing 28 is a supporting spider 29, having an annular bearing surface 30 about which a combined gear and clutch member 31 may be freely rotatable. The gear and clutch member 31 may be provided with external teeth 32 engageable with the teeth 14a on the shaft 14, which may provide a suitable gear on said shaft, and may also be provided with internal teeth 33 with which a gear or clutch member 34, shiftably but non-rotatably mounted on the shaft 24, may be engageable to provide a clutch. Lateral displacement of the gear and clutch member 31 may be prevented by means of an annular key 29a and an annular flange 29b on the supporting spider 29. The gear and clutch member 31 may be utilized as an oil-thrower at all times when the intermediate shaft is driven.

Referring to Figures 2 and 3, adjacent the intermediate shaft 14, is a back-gear shaft 35, suitably journaled in bearings 36, 36 in transmission housing 10. Gears 37 and 38, which may be integral with each other, are keyed to the shaft 35 in such a manner that said gear 38 may be in constant mesh with the gear 23 on the power-input shaft 13. The back-gear shaft 35 may be extended at 39 to provide a constant source of power take-off for any desired purpose, as for example for rear-end coupling drives to other machinery such as binders or similar units.

The transmission may be connected to a conventional form of differential by securing on shaft 24 a bevel pinion 40 which may mesh with a bevel gear such as 41 attached to the differential.

Any suitable gear-shifting means may be used, but Figures 1 to 6, inclusively, illustrate one type of mechanism which may be adapted for use with a transmission of this type. A pair of shifter rails 43 and 44 are shown slidably mounted in a shifter-rail support 42 integral with the transmission housing 10. The shifter rail 43 may be provided, at the end within the transmission housing, with a shifter fork or yoke 45, adapted to engage the gear or clutch member 34 as will be understood to shift the latter on the power-output shaft 24. The shifter rail 44 is similarly provided with a shifter fork or yoke 46 adapted to engage the gear member 21 to shift the latter on the intermediate shaft 14 or to shift it into clutching engagement with the gear 23.

Slidably journaled in a support 47 at the top of the differential housing is a shifter crank 48, comprising a handle 49 extending upwardly, a horizontal portion 50, and a downwardly extending crank arm 51. The crank arm 51 is provided at its lower end with suitably shaped extension 52 adapted to be shiftably engaged with a slot 53 in the shifter rail 44 in the neutral position shown in Figures 1 and 2, and with slot 53 on shifter rail 44 and also slots 54, 55, and 56 on the shifter rail 43 for the various shifts as desired by the operator, which will subsequently be described. The shifter rail support 42 may be provided with wall 10a adjacent the differential housing 11, to permit the crank arm 51 to swing freely.

A suitable interlock is provided to eliminate the possibility of both shifter rails being shifted at the same time. This interlock comprises a conventional ball 58 imprisoned in an opening 59 in the wall 60 between bores 61 and 62 in which the shifter rails are slidable. Notches 63, 64 and 65 in a recess 66 in the shifter rail 44, and 67, 68, 69 and 70 in a recess 71 in the shifter rail 43, may be provided as is best shown in Figures 2, 4, 5 and 6. These notches are so spaced that when one or other of the shifter rails is moved to any one of the predetermined positions to obtain a desired speed, the ball 58 slips into a notch in the opposite shifter rail as said ball is forced over by contact with the surface of the recess of the rail then being shifted. The ball thus forced into a notch holds one shifter rail in a fixed position while the other shifter rail is being moved.

In the description of a complete cycle of operation it will be assumed that the input shaft 13, and the back-gear shaft 35 through gears 23 and 38, are being constantly driven. The gear 37, being integral with the gear 38, will then also be constantly driven.

Figure 1, 2, and 3, in their full line positions, show the transmission in neutral. In this condition none of the gears are in driving connection to the power-output shaft and consequently no power is transmitted thereto. There is, however, a driving connection to the back-gear shaft 35.

The arrangement of the various gears for reverse shift is best shown in chain-dotted lines in Figures 2 and 3. Starting with all the gears otherwise arranged as for neutral, the shifter crank 48 is moved from the full line position to the chain-dotted position, as shown in Figure 3, so that the extension 52 of the crank arm 51 slides out of engagement with the slot 53 on the shifter rail 44, into engagement with the slot 55 in the shifter rail 43 (see Figure 2). With the extension 52 thus engaged the crank arm 51 may be swung to the left, as viewed in Figures 1 and 2, until the gear 34, through the shifter fork 45, is moved into engagement with the gear 37 to drive the power-output shaft 24 in reverse direction. After this operation has been accomplished the shifter rail 43 may be brought back to the full

line position shown in Figure 2, with the slot 55 opposite the slot 53, and the extension 52 again engaged with the slot 53.

First, or low speed, is obtained by engaging extension 52 with the slot 53 at the neutral position of both shifter rails and sliding the shifter rail 44 to the right until the slot 53 is opposite the slot 56. This brings the gear and clutch member 21 into engagement with the gear 37, through the shifter fork 46. Now, by sliding the extension 52 into the slot 56, the shifter rail 43 may be moved to the right to bring the clutch member 34 into clutching engagement with the gear and clutch member 31, as is best shown in Figure 4. This arrangement gives a driving connection between the intermediate shaft 14 and the power-output shaft 24 for the slowest speed of the intermediate shaft.

Second speed is obtained by moving the shifter rail 43 from the full line position to the chain-dotted position shown in Figure 4, the ball 58 remaining in locking engagement with the shifter rail 44, until the gear 34 engages with the gear 18 on intermediate shaft 14 to drive the power output shaft at another speed for the slowest speed of the intermediate shaft.

When third speed is required the driving connection between the power-input shaft 13 and the intermediate shaft 14 must first be changed from indirect to direct. This is accomplished by shifting the shifter rail 43 from its position shown in full lines in Figure 4 to its neutral position which will bring the slot 56 on rail 43 to a point opposite the slot 53 on rail 44, and sliding the extension 52 into the slot 53. This step will disengage the clutch member 34 from the gear and clutch member 31. With the extension 52 thus engaged the shifter rail 44 may be moved to the left, disengaging the clutch member 21 from the gear 37 and clutchingly engaging it with the gear 23 on the power-input shaft, thereby driving the intermediate shaft 14 at the same speed as the power-input shaft. This last step will bring the slot 53 in rail 44 opposite the slot 54 on the shifter rail 43. Sliding the extension 52 into the slot 54, the shifter rail 43 may now be moved to the right to engage the clutch member 34 with the gear and clutch member 31, thereby obtaining third speed. The final arrangement of the parts for third speed is best shown in the full line position of Figure 5.

Fourth speed may be obtained with the same direct connection between the power-input shaft 13 and the intermediate shaft 14. With the extension 52 still engaged with the slot 54, the shifter rail 43 may be moved to the left, disengaging the clutch member 34 from the gear and clutch member 31 and engaging it with the fixed gear 18 on the intermediate shaft 14, as indicated by the chain-dotted position of the shifter rail 43 in Figure 5.

The neutral position of the gears may again be obtained by moving the shifter rail 43 to the right until the slot 54 is opposite the slot 53, sliding the extension 52 into slot 53, and moving the shifter rail 44 to the right until the extension is opposite the slot 55, thereby bringing all the parts back to the positions shown in full lines in Figure 2.

Figures 7 and 8 illustrate the use of a conventional ball and socket type of gear-shift lever with the same general arrangement of gears as is shown in Figures 1 to 6. The gear-shift lever 75, which may have a spherical portion 76 integral therewith, is swivelly mounted in a socket member 77 at the top of the transmission housing 10. A suitable dirt cover and grease retainer 78 of flexible material may be provided. The lower end of the lever 75 may be provided with a suitably shaped extension 75^a shiftable into engagement with a slot or recess 79 formed on a block 80 fixed on a shifter rail 81, or shiftable into engagement with similar slots or recesses 82, 83, and 84 formed on a block 85 fixed on a shifter rail 86, said shifter rails being slidably supported in the end walls 10^a and 10^b of the transmission housing. A suitable interlock, indicated at 87, may be provided to prevent more than one shifter rail from being moved at a time. The shifts for the various speeds are precisely the same as has already been described in connection with Figures 1 to 6.

In construction disclosed in Figure 7 the power-input shaft has been extended all the way through the transmission housing, said shaft being journaled in suitable bearings 88, 89 in the walls 10^a and 10^b respectively. Journaled on the shaft 13, intermediate the gear and clutch member 23 thereon and the wall 10^a of the transmission housing may be an intermediate shaft 14^b. The shaft 14^b functions the same as the shaft 14 in Figure 1, the purpose of the extension therethrough being to provide a constant source of high speed power take-off in addition to the power take-off provided through the back-gear shaft.

Figures 9 to 13 of the drawings disclose another embodiment of the invention. The numeral 110 is a transmission housing similar to that disclosed in Figure 1. Rotatably journaled in a suitable bearing 112 at the top of the housing 110, is a power-input shaft 113 which may be coupled or clutched to a power source or engine (not shown).

An intermediate shaft 114, on the same axis with the power-input shaft 113, is journaled at one end in a suitable bearing 115 within a counterbore 116 in the end of the input shaft 113, and is journaled at its other end in a bearing 117 mounted in the casing 110. Secured to the shaft 114 adjacent the right-hand end thereof is a gear 118, said gear being prevented from lateral movement by means of a circular key 119 and from rotational movement by teeth 114^a on said shaft serving as splines. The gear 118, and a circular key 120 secured to an extension of the intermediate shaft 114, prevent lateral movement of said shaft 114. Slidably mounted on the intermediate shaft 114 so as to rotate in driving engagement therewith is a combined gear and clutch member 121, which may be used for a series of operations presently to be described. Said combined gear and clutch member has clutch teeth 121^a, adapted to engage with a clutch member 113^a on the end of the input shaft 113, and also has external gear teeth 121^b.

Located at a suitable distance below the intermediate shaft 114 is a power output shaft 122, journaled in bearings 123 and 124 in a bevel gear housing 111. Secured to the shaft 122 at the end adjacent the shaft 114 is a driving spider 126, which is essentially a cylinder having a plurality of external splines 127. The splines 127 are interrupted at a point adjacent the left-hand end of the cylinder to define a continuous cylindrical surface 128.

Slidably mounted on the spider 126 so as to rotate therewith are relatively large gears 129 and 130, the interior bores of which are provided with spline-ways 131 and 132 to cooperate with the splines 127. The arrangement is such that the gear 130 may be moved out of engagement with

the splines 127 into the space 128ª defined by interruptions in said splines, for the purpose of utilizing said gear as an oil-thrower at all times when the gear and clutch member 121 is being driven, either directly through the input shaft 113, or indirectly through a back-gear train presently to be described.

Referring to Figures 10 and 11, adjacent the intermediate shaft 114, is a back-gear shaft 134, suitably journaled in bearings 135, 135 in the transmission housing 110. Gears 136 and 137, which may be integral with each other, are keyed to the shaft 134 in such a manner that said gear 137 may be in constant mesh with a gear 113ᵇ on the power input shaft 113. The back-gear shaft 134 may be extended rearwardly above the differential at 134ª to provide a constant source of power take-off.

Integral with the power-output shaft 122, at a point intermediate the bearings 123 and 124, there may be a bevel-gear 138 adapted to mesh with a bevel-gear 139 of a type commonly used in differentials in the automotive industry.

A suitable gear-shifting mechanism (not shown) may be provided to slide each of the gears 129 and 130 and the gear and clutch member 121 along their respective axes in any direction, either independently or in various combinations with each other. Thus it is possible to drive the intermediate shaft 114 at the same angular velocity as the power-input shaft 113, or said intermediate shaft may be driven at a different speed indirectly, through the back-gear train. With these two speeds of the intermediate shaft 114, and the various combinations of gear connections that may be made between the gears 118 and 121ᵇ on the shaft 114, and the gears 129 and 130 on the spider 126, there may be obtained at least one speed in reverse and at least four speeds forward.

In the description of a complete cycle of operation it will be assumed that the input shaft 113 and the back-gear shaft 134, through gears 113ᵇ and 137, are being constantly driven.

Figures 9, 10, and 11, in their full line positions, show the transmission in neutral. The driven gear 113ᵇ on the input-power shaft 113 meshes with a gear 137 on the back-gear shaft 134. Integral with the gear 137 there may be a smaller gear 136 adapted to mesh with the gear 121ᵇ on the intermediate shaft 114. This arrangement drives the shaft 114 at a lesser rotary speed than the input shaft 113, as is permitted by the bearing connection between said shaft 114 and said shaft 113. The gear 121ᵇ in turn drives the large gear 130, which, however, being out of engagement with the splines 127, is free to revolve on the bearing surface 128 in the space 128ª around the spider cylinder 126. This rotation of the gear 130 utilizes it as an oil-thrower, while the spider 126 and its connecting parts, including the gears 138 and 139, remain at rest.

The arrangement of the various gears for the reverse shift is best shown in chain-dotted lines in Figures 9 and 10. The clutch member 121ª is in driving connection with the input shaft 113 for the double purpose of driving the oil-throwing gear 130 and at the same time holding it out of the way of the gear 129. The latter gear is shifted to the left to mesh with the back-gear 136 and thereby drive the spider 126 in the reverse direction.

First or low speed may be obtained, with gear 121ª engaged with gear 136 and driving shaft 114, by shifting the large gear 129 to the full line position shown in Figure 12, gear 130 remaining the same and still acting as an oil-thrower. With the intermediate shaft being driven as described for neutral the gear 118, which may be of smaller pitch diameter than the gear 121ᵇ, meshes with the large gear 129. Said gear 129 being splined to the spider 126, the latter causes rotation of the gear 139 through splined shaft 122 and the bevel-gear 138. It will readily be seen that the slower speed of the spider 126 does not affect the rotation of the gear 139, since the latter is freely rotatable about said spider when the gear 130 is within the space 128ª.

Second speed may be obtained by shifting the gears 129 and 130 from the positions shown in full lines in Figure 12 to the positions shown in chain-dotted lines in Figure 12. In this condition the gear 130 may be moved into driving mesh with the gear 121ᵇ and splined connection with the spider 126.

When third speed is required the driving connection between the input shaft 113 and the intermediate shaft 114 must first be changed from indirect to direct. This is accomplished by, shifting the gear and clutch member 121 to the left, as shown in Figure 13, until its clutch member 121ª is in engagement with the clutch member 113ª on the input shaft 113. At the same time the gear 129 may be shifted to the right to mesh with the gear 118 as shown in full lines in Figure 13. This arrangement of the gears drives spider 126, and its related parts, in a manner similar to that described for first speed, except that the intermediate shaft by being driven at a greater angular velocity, drives the spider and its related parts at greater angular velocity more nearly approaching engine speed.

Fourth speed may be obtained with the same direct connnection from the shaft 113 to the intermediate shaft, but with the gear 129 shifted to left out of engagement with gear 118, and the gear 130 shifted to the left to fully mesh the gear 121ᵇ, as shown in chain-dotted lines, Figure 13. This brings the gear 130 to drive the spider 126 through its splined connection therewith.

With the embodiment of the invention illustrated in Figures 14, 15, and 16 a very desirable result, that of providing at least four speeds forward and four in reverse, may be accomplished without the use of any more gears than were required in the previous embodiments of this invention. Such a result is desirable for the reason that there are numerous vehicles or mechanisms wherein a selection of reverse speeds may be useful, as for example gasoline rail cars, tractors, etc.

Referring to Figures 14, 15, and 16, the numeral 150 designates a transmission housing of suitable construction for any desired purpose. Rotatably journaled in suitable bearings 151, 151 at the top of the housing 150, and extending therethrough, is a power-input shaft 152 which may be coupled or clutched to a power source or engine (not shown). Slidably splined adjacent one end of said shaft 152 is a combined gear and clutch member 153.

Coaxially journaled on bearings 154 about shaft 152, adjacent one end thereof, is an intermediate shaft 155. Integral with the shaft 155, at the end adjacent the gear and clutch member 153 and engageable therewith there may be a clutch member 156. At the same end of said shaft and integral therewith there may be a gear 157. Also integral with the shaft 155, at the other end thereof, there may be a gear 158.

Suitably positioned below the power-input shaft 152 and the intermediate shaft 155 is a power-output shaft 159, journaled in bearings 160 in the transmission housing 150. The shaft 159 may extend through both ends of the housing to provide twin drives, as for example to the front and rear ends of a vehicle. Slidably splined on the output shaft 159 are gears 161 and 162, engageable with the gears 156 and 158 respectively on the intermediate shaft and with gears on a back-gear shaft presently to be described.

Adjacent the power-input shaft is a shaft 163 journaled in bearings 163a, 163a in the transmission housing 150. Keyed or splined to said shaft 163 there may be a back-gear shaft 164 having integral therewith gears 165, 166 and 167, the gear 166 being in constant mesh with the gear 156 on the intermediate shaft 155. The shaft 163 may be extended as at 168 rearwardly above the differential 169, through the differential housing 170 as shown in Figure 16, to provide a constant source of two speed auxiliary power take-off.

For the purpose of describing this embodiment of the invention it will be assumed as before that the power-input shaft 152 is constantly driven. The full-line positions in Figures 14 and 15 show all gears in neutral. The low speed of the intermediate shaft 155 is obtained when the gear and clutch member 153 is in the chain-dotted position shown in Figure 14, and the high speed is obtained when said member 153 is in the chain-dotted position shown in Figure 15.

First speed forward may be obtained by first shifting gear and clutch member 153 to the left into driving engagement with the gear 165 on the back-gear shaft 164, and then shifting gear 162 on the power-output shaft 159 to the left into engagement with gear 167 on said back-gear shaft.

Second forward speed may be obtained with the same driving connection between gear and clutch member 153 and gear 165, but by disengaging the gears 162 and 167 and shifting gear 161 on the power-output shaft into engagement with the gear 165 on the back-gear shaft 164.

Third speed forward may be obtained by first disengaging gears 161 and 165, shifting the gear and clutch member 153 out of engagement with the gear 165 on the back-gear shaft 164 and into clutching engagement with the intermediate shaft 155, by means of clutch member 156, to drive the back-gear shaft 163 at a higher rate of speed, and then shifting gear 162 into engagement with the gear 167 on the back-gear shaft 164.

Fourth speed forward may be obtained, with the same driving connection from the power-input shaft to the intermediate shaft 155 as for third speed, but by disengaging the gears 162 and 167 and shifting the gear 161 on the power-output shaft 159 into driving engagement with the gear 165 on the back-gear shaft 164.

The various speeds in reverse may be accomplished in much the same manner as were the forward speeds, except that the gears 161 and 162 on the power-output shaft are engaged directly with the gears 157 and 158, respectively, on the intermediate shaft 155, rather than engaging with the gears 167 and 169 on the back-gear shaft 164.

The first speed in reverse may be obtained by engaging the gear and clutch member 153 on the power-input shaft with gear 165 on the back-gear shaft, to drive the intermediate shaft at its low speed through the gears 166 and 157, and then shifting the gear 162 on the power-output shaft to the right into driving engagement with the gear 158 on the intermediate shaft.

Second reverse speed may be obtained, with the intermediate shaft still engaged for low speed thereof, by disengaging the gears 162 and 158 and shifting the gear 161 on the power-output shaft into driving engagement with the gear 157 on the intermediate shaft 155.

Third reverse speed may be obtained by shifting the gear and clutch member 153 out of engagement with the gear 165 and into clutching engagement with the intermediate shaft 155, by means of clutch member 156, said intermediate shaft at its high speed, then disengaging the gears 161 and 157, and shifting the gear 162 on the power-output shaft into driving engagement with the gear 158 on the intermediate shaft 155.

Fourth reverse speed may be obtained with the same clutching engagement to the intermediate shaft 155 as for third reverse speed, but by disengaging the gears 162 and 158 and then shifting the gear 161 on the power-output shaft into driving engagement with the gear 157 on the intermediate shaft 155.

This four speed forward and reverse transmission is adapted to be used with any conventional bevel geared axle wherein the direction of drive may be determined by the position of the driven bevel gear 171, shown in Figure 16. That is, the direction is determined by whether said bevel gear is positioned on the right or left side of the driving bevel pin 172, said bevel gear 171 being in driving engagement with a bevel pinion 173 on the power-output shaft 159. It should be understood therefore that the forward speeds described above can be changed to reverse speeds and the reverse speeds to forward speeds by changing the positions of the final bevel gears.

It is very desirable to provide an auxiliary power take-off shaft which can be operated independently of the axle drive, for coupling connection to auxiliary machinery such as combine harvesters, corn binders, etc. Furthermore, it is also desirable that such power take-off shaft be driven at more than one speed so that variations in engine speed can be compensated for. The arrangement shown in Figures 14, 15 and 16 provides a new and simplified two speed power take-off construction, the power take-off shaft being driven at one speed when the combined gear and clutch member 153 on the power-input shaft is in driving engagement with the gear 165 on the back-gear shaft, and at a higher rate of speed when said gear and clutch member 153 is in clutching engagement with the intermediate shaft 155.

Figures 17, 18 and 19 illustrate another type of gear-shifting mechanism which may be adapted for use in connection with the transmission first described, although it may also be adapted for use with other types of transmissions having a large number of speed changes. The arrangement of the gears, shafts, etc., in Figures 17 and 19 is substantially the same as that shown in Figures 1, 2 and 3 except that the power-output shaft 24 has been set back in order to provide clearance between the bevel-gear 41 and an extension 14d on the intermediate power transmission shaft 14. This extension 14d may extend rearwardly above the differential, through the differential housing (not shown), to provide a source of two-speed power take-off, the speeds thereof being selective when the transmission is in neutral, and non-selective when the transmission is otherwise in use.

Referring to Figures 17 and 19, removably mounted at the top of the transmission housing 10, as by screws 180, is a shifter-cradle 181 having channels 182 and 183 therein, said channels being separated by a rib 184. Slidably mounted in the channels 182 and 183 are shifter-rails 185 and 186, respectively. The shifter-rail 185 is provided with a notch 187, and the shifter-rail 186 is provided with suitably spaced notches 188, 189, and 190, the notch 189 being located adjacent the notch 187 on the shifter-rail 185 when the mechanism is in neutral condition. On the rib 184, suitably spaced to be adjacent the notches 188, 189 and 190 when the mechanism is in neutral condition, are slots 191, 192 and 193 respectively. The slot 192 may be slightly raised to identify it during the shifting operations, as it is only used for changing the power take-off speeds in the neutral condition of the transmission. Fixed on the outside wall of the channel 182 is a member 194 from which may be forced a spring-pressed ball 195 into notches 196, 197, 198 and 199, respectively, in the shifter-rail 185 to hold the latter in its various shift positions. A similar member 200, fixed on the outside wall of the channel 186, is adapted to press a ball 201 into notches 202, 203 and 204, respectively, in the shifter-rail 186 to determine the various shift positions thereof. Extending downwardly from the shifter-rail 185, through an opening 205 in the channel 182, is a shifter-fork 206 adapted to engage the gear and clutch member 34. The shifter-rail 186 is similarly provided with a shifter-fork 207, extending downwardly, through an opening 208 in the channel 183, to engage with the gear and clutch member 21. Pivotally mounted in the transmission housing cover 209 is a downwardly extending shifter-lever 210, having a spring-pressed extension 211 at the lower end thereof, said extension being adapted to be used and engaged with the various notches in the shifter-rails.

From the neutral position, as is best shown in Figures 17 and 18, first and third speeds are obtained by first engaging extension 211 in the notch 187, sliding the rail 185 to the right to engage gear and clutch member 34 with gear and clutch member 31, sliding the extension 211 through slot 193 to engage the notch 190, then sliding the rail 186 to the right to engage gear and clutch member 21 with gear 37 for first speed, or to the left to engage it with gear and clutch member 23 for third speed. Second and fourth speeds are similarly obtained. Starting from neutral again the rail 185 is moved to the left until notch 187 is opposite notch 188, in which position the gear and clutch member 34 will be engaged with gear 18, then the extension is slid through slot 191 to engage with the notch 188 in the rail 186 to slide the latter to the right ot engage gear and clutch member 21 with gear 37 for second speed, or to the left to engage with gear and clutch member 23 for fourth speed. Reverse speed may be obtained by leaving the rail 186 in its neutral position and sliding the rail 185 to the extreme left to engage the gear 34 with gear 37, all other shiftable gears being in neutral position. The power take-off from the extension 14d on the intermediate shaft 14 may of course be utilized at any time when the intermediate shaft is being driven with the restriction that the speed thereof is determined by the speed of said intermediate shaft being transmitted to the power-output shaft at the time. However, when the transmission is otherwise in neutral at least two selective speeds of the power take-off may be obtained by sliding extension 211 over slot 192 to engage notch 189, then sliding the rail 186 either to the right to engage gear and clutch member 21 with gear 37 to obtain the low speed power take-off, or to the left to engage said member 21 with gear and clutch member 23 to obtain the high speed power take-off.

From this brief description of the construction and operation of the invention it is readily seen that, with the addition of one or more gears, many more speed changes may be accomplished without materially increasing the bulk of the mechanism. The embodiments of the invention herein described have all been designed to procure an under-drive, but with a few slight changes in the pitch diameters of the gears an over-drive may be obtained. The invention, in general, provides a transmission with a wide range of speed changes in both forward and reverse, and in a smaller space than has heretofore been accomplished with the conventional types of transmissions.

Modification may be resorted to without departing from the spirit of the invention or the scope of the appended claims, which are not limited wholly to the specific construction shown or to the exact procedure described.

What is claimed is:

1. In a change-speed gear transmission, a power-input shaft, an intermediate power-transmission shaft, a back-gear shaft in driving engagement with said intermediate shaft, means whereby said power-input shaft may drive said intermediate shaft either directly or indirectly through said back-gear shaft to obtain more than one speed of the intermediate shaft, a power-output shaft, gears on said intermediate shaft, gears on said back-gear shaft, shiftable gears on the power-output shaft engageable with said gears on the back-gear shaft to drive the output shaft at a different series of speeds in one direction for every speed of the intermediate shaft said shiftable gears on the output shaft being also engageable with said gears on the intermediate shaft to drive the output shaft at a different series of speeds in the other direction for every speed of the intermediate shaft.

2. In a change-speed gear transmission, a power-input shaft having a combined gear and clutch member slidable thereon, an intermediate power-transmission shaft having a clutch member and one or more gears thereon, a back-gear shaft having one or more gears thereon and adapted to be in driving engagement with said intermediate shaft, a power-output shaft having shiftable gears thereon, said gear and clutch member on the input shaft being adapted to be engaged with at least one gear on the back-gear shaft or clutched to said intermediate shaft, whereby both the back-gear shaft and the intermediate shaft can be selectively driven at more than one speed, said gears on said output shaft being selectively engageable with said gears on the back-gear shaft to obtain a different series of speeds in one direction for every speed of the back-gear shaft, or with said gears on the intermediate shaft to obtain a different series of speeds in the other direction for every speed of said intermediate shaft.

3. In a change-speed gear transmission, a power-input shaft having a combined gear and clutch member selectively shiftable thereon, an intermediate power-transmission shaft coaxially

journaled about said power-input shaft, a clutch member on said intermediate shaft, a back-gear shaft having a gear thereon engaging with a gear on the intermediate shaft, a second gear on the back-gear shaft, said gear and clutch member being selectively engageable with said second gear on the back-gear shaft to drive the intermediate shaft at one speed or engageable with said clutch member on the intermediate shaft to drive the latter at a second speed, a third gear on the back-gear shaft, a second gear on the intermediate shaft, a power-output shaft, a gear on the power-output shaft selectively shiftable into engagement with said third named gear on the back-gear shaft or with said second gear on the intermediate shaft to obtain one speed in one direction and one in the other direction for every speed of the intermediate shaft, and a second gear on the output shaft selectively shiftable into engagement with said second named gear on the back-gear shaft or with said first-named gear on the intermediate shaft to obtain one speed in one direction and one in the other direction for every speed of the intermediate shaft.

4. In a change-speed gear transmission, a power-input shaft, an intermediate power-transmission shaft, a back-gear shaft adapted to be in driving engagement with said intermediate shaft, a power-output shaft, gears on all said shafts, means for selectively engaging said intermediate shaft with said input shaft or engaging a gear on the input shaft with a gear on the back-gear shaft to drive said intermediate shaft at different speeds and thereby drive the back-gear shaft at different speeds, gears on said output shaft adapted to be selectively used and engaged with gears on said intermediate shaft to obtain a different series of output-shaft speeds for each intermediate shaft speed, and said gears on the said output shaft being adapted to be selectively used and engaged with said gears on the back-gear shaft to obtain a different series of output-shaft speeds for each back-gear shaft speed.

5. In a change-speed gear transmission, a power-input shaft, an intermediate power-transmission shaft, a back-gear shaft adapted to be an auxiliary drive, means whereby said power-input shaft may drive said intermediate shaft and said back-gear shaft at more than one speed, a power-output shaft, gears on said intermediate shaft, gears on said back-gear shaft, shiftable gears on the power-output shaft engageable with said gears on the back-gear shaft to drive the output shaft at a different series of speeds for every speed of the back-gear shaft said shiftable gears on the output shaft being also engageable with said gears on the intermediate shaft to drive the output shaft in opposite rotation at a different series of speeds for every speed of the intermediate shaft.

6. In a change-speed gear transmission, a gear mounted therein to be independently rotated at different speeds, a power input shaft on one center, means for connecting said gear to said power input shaft to be driven at one speed, means comprising a shaft and gearing on a second center for indirectly driving said gear from said input shaft at another speed, and a power output shaft on a third center and having thereon a gear for meshing with said independently rotated gear at either speed thereof, the first-named gear meshing with gearing on said second shaft and also meshing with gearing on said output shaft and adapted to drive the output shaft and be simultaneously driven by the second shaft.

7. A change speed gear mechanism comprising an input shaft on one center, a second shaft and gearing on a second center and an output shaft and gearing on a third center, gearing on said input shaft for meshing with the gearing on said second shaft to drive the latter at a plurality of different speeds, said second shaft having a power take-off portion whereby said second shaft may be adapted to drive an external power-operated device as desired at a plurality of different speeds, said input shaft gearing and said second shaft gearing being adapted to mesh with gearing on said output shaft to drive said output shaft at a plurality of different speeds in both directions of rotation.

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