Sept. 24, 1929. G. KRELL ET AL 1,729,220

SPEED TRANSFORMER

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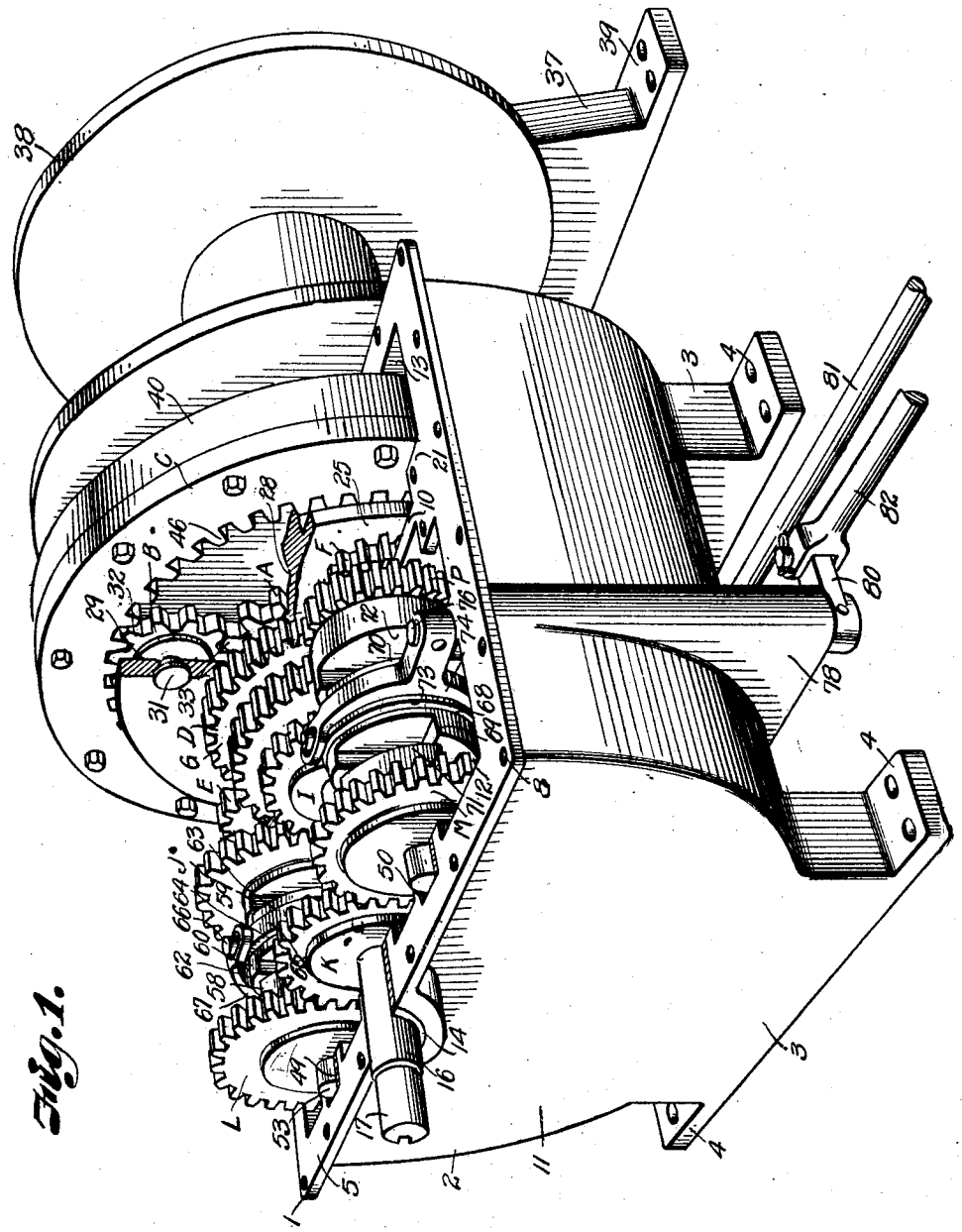

Fig. 1.

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Fig. 2.

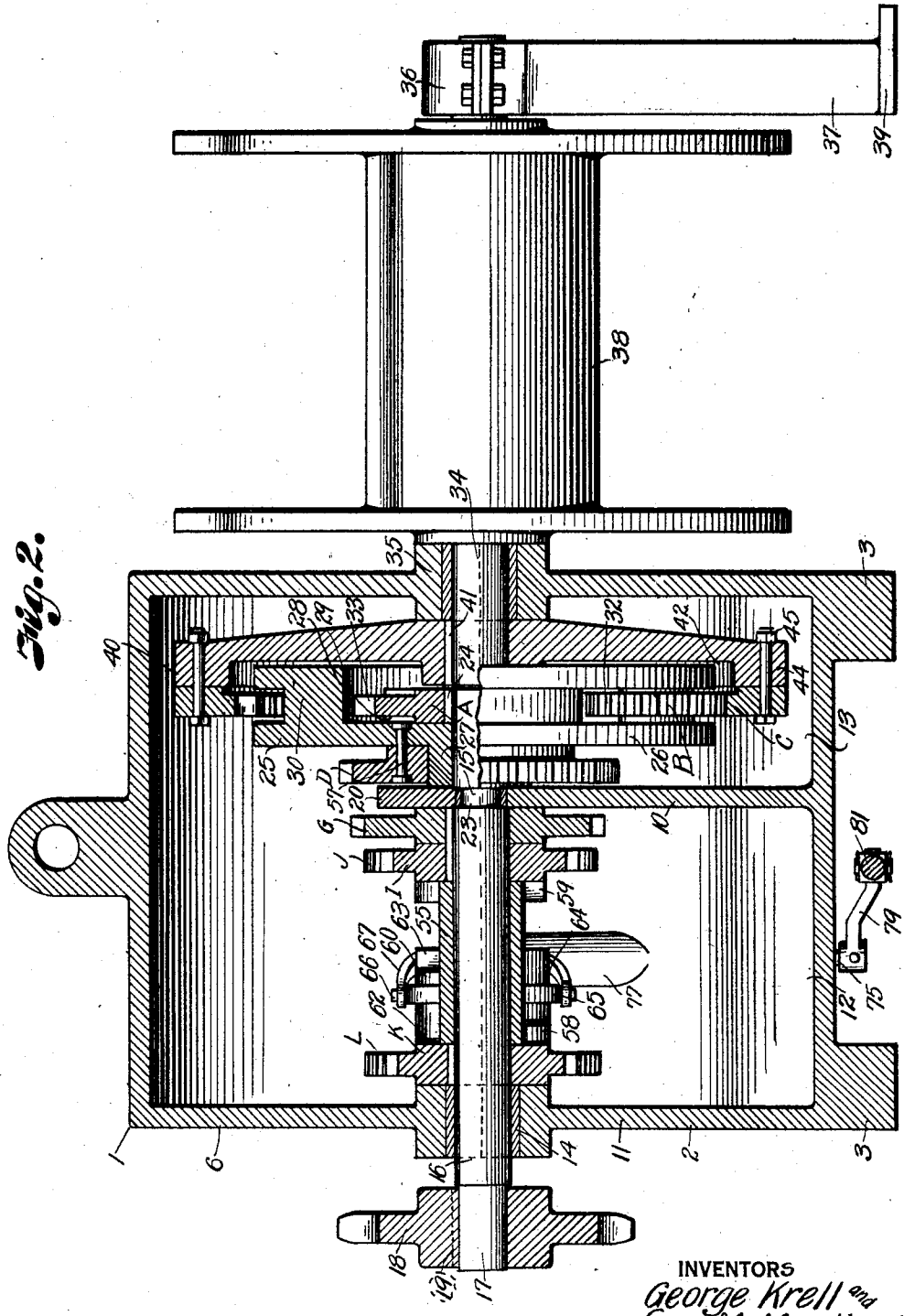

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Fig. 5.

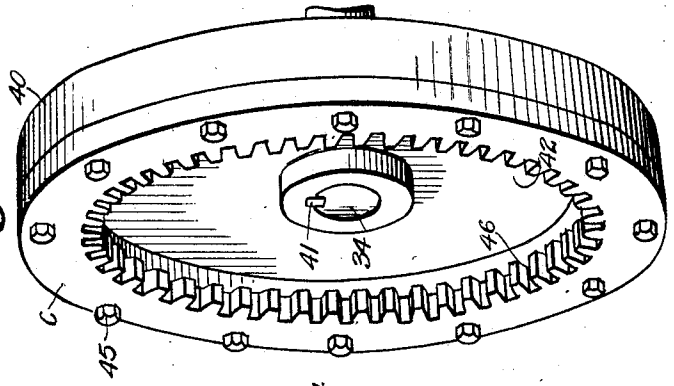

Fig. 3.

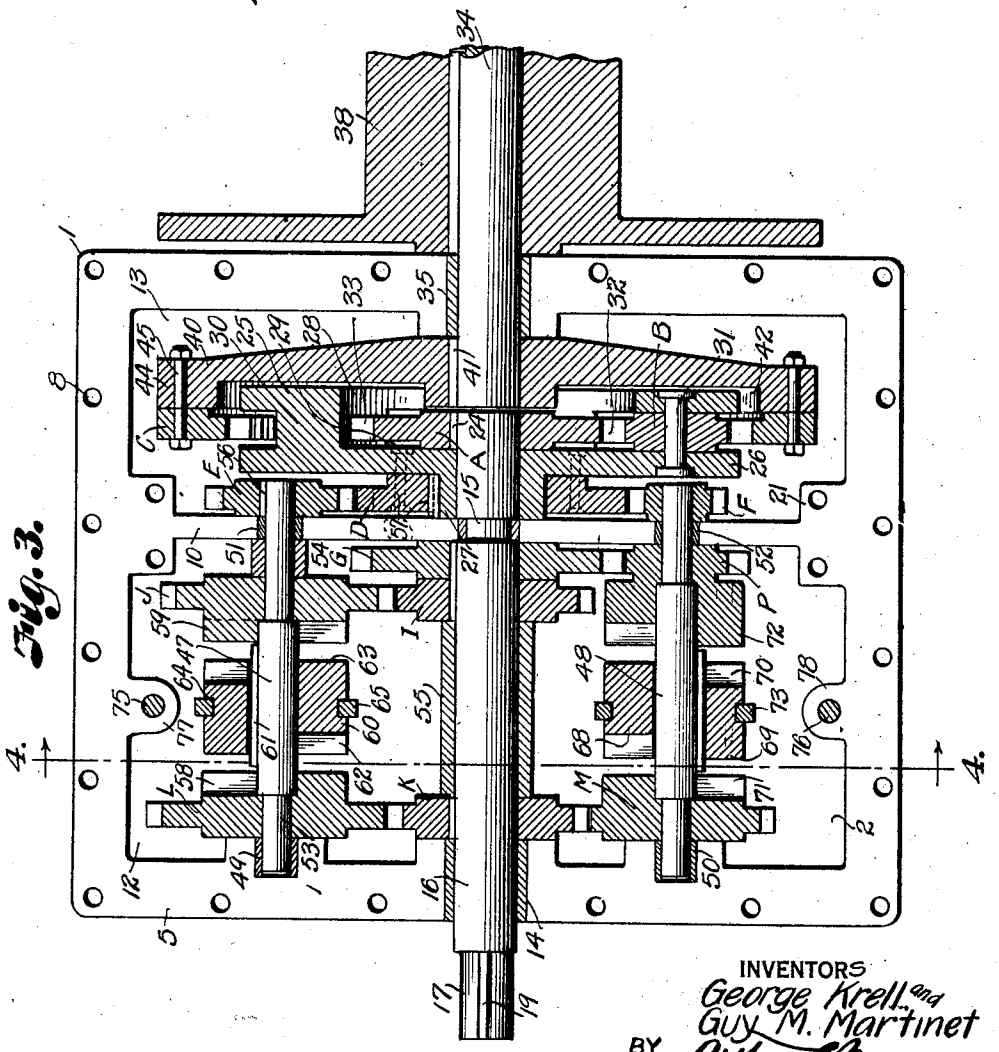

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Fig. 6.

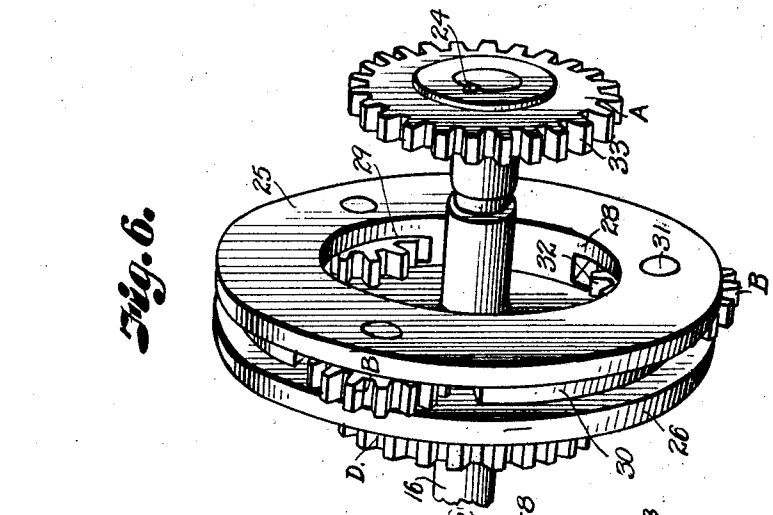
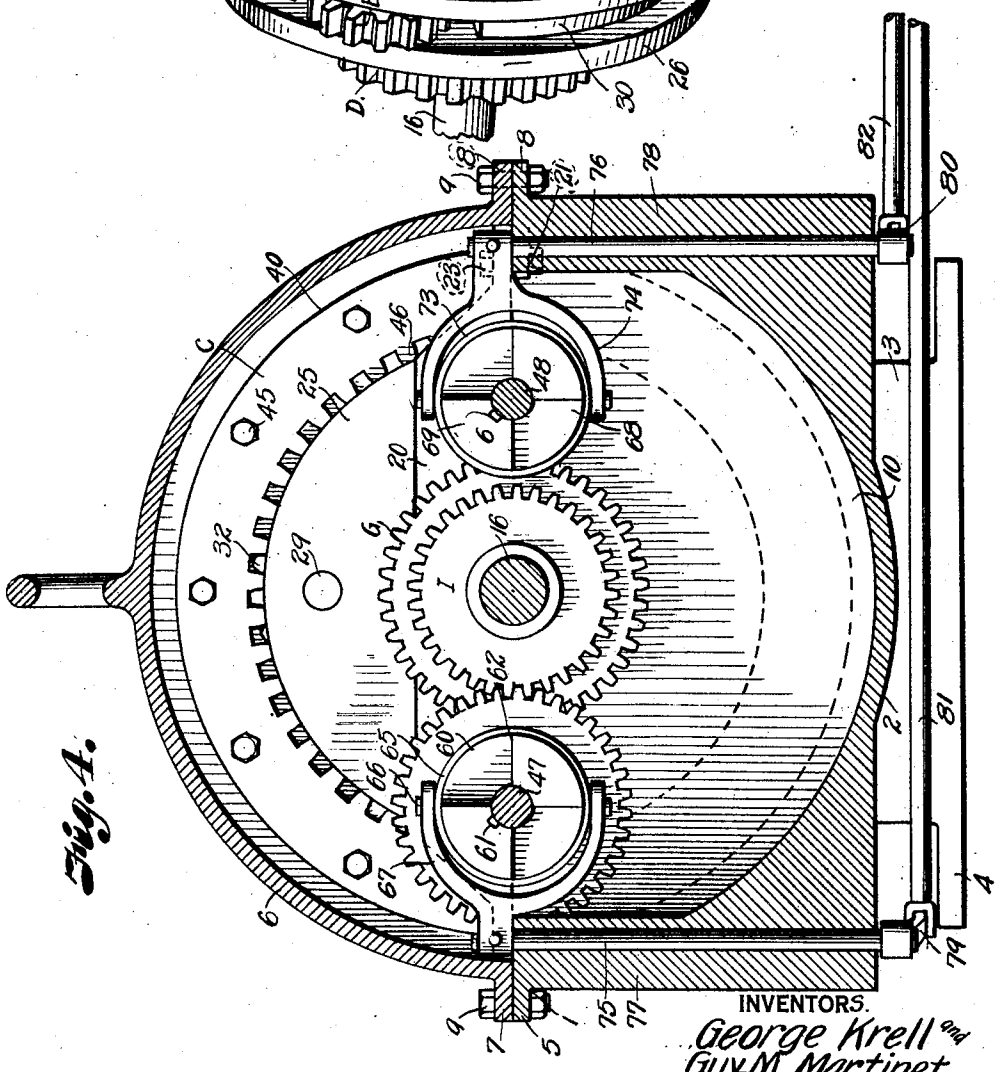


Fig. 4.



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Patented Sept. 24, 1929 1,729,220

UNITED STATES PATENT OFFICE

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SPEED TRANSFORMER

Application filed March 19, 1928. Serial No. 262,968.

Our invention relates to a speed transforming mechanism and particularly to an apparatus of that character adapted for use in connection with standard oil well drilling rigs for letting in and pulling casing, tubing, tools or for other hoisting purposes; the principal object of the invention being to provide a speed transformer for transmitting the power of a prime mover, such as an explosion engine or an electric motor, at variable forward and reverse speeds to adapt the power to widely variant power and speed requirements incident to oil well practice or for other service where variable speed changes are desired.

In accomplishing this and other objects of the invention we have provided improved details of structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of a variable speed transformer constructed according to our invention shown associated with a hoisting drum, the cover of the transformer being removed to illustrate the gearing.

Fig. 2 is a longitudinal vertical sectional view of the apparatus, the hoisting drum being shown in elevation.

Fig. 3 is a horizontal sectional view through the gearing of the transformer.

Fig. 4 is a vertical cross sectional view on the line 4—4, Fig. 3.

Fig. 5 is a detail perspective view of the orbit gear and its carrier mounted upon the variable speed shaft.

Fig. 6 is a similar view of the planetary and sun gears through which power is translated to the orbit gear.

Referring more in detail to the drawings by numerals of reference:

1 designates the transformer housing which includes a semi-cylindrical base member 2 having supporting legs 3 adjacent its ends provided with feet 4 by which the transformer may be secured to a foundation or other anchoring support. Extending around the upper edge of the base member is an outwardly projecting flange 5 for seating a cover member 6. The cover member 6 is similar in shape to but inverted on the base member and is provided with a complementary flange 7 having apertures 8 aligning with similar apertures 8′ in the base flange to receive bolts 9 for securing the cover to the body member to enclose the gearing and retain a lubricant therefor, as hereinafter described. The base member 2 is provided with an integral partition 10 extending transversely thereof and cooperating with the outer end wall 11 of the housing for supporting the transformer shafts and for dividing the housing into a clutch compartment 12 and a planetary gear compartment 13.

Journaled in a bearing 14 on the end wall 11 of the housing and in an aligning bearing 15 in the partition 10 is a drive shaft 16, which projects from the housing through the bearing 14 and is provided with a reduced end 17 carrying a sprocket wheel 18 fixed to the shaft by a spline 19 and whereby the shaft 16 may be operatively connected with a prime mover (not shown). The bearing 14 for supporting the power end of the shaft is preferably formed in the housing so that the lower half of the bearing is carried in the base member and the upper half in the cover portion to provide for easy removal of the shaft upon removal of the cover member.

The bearing 15 is of smaller diameter than the shaft and is also formed so that the lower half is in the partition and the upper half or cap portion is formed in a bar 20 which extends along the top edge of the partition and is secured at its ends to lugs 21 projecting inwardly from the walls of the housing in alignment with the top edge of the partition, by bolts 22. The shaft is provided with a groove 23 which is received by the reduced bearing 15 with the sides of the groove engaging the bearing for preventing longitudinal play of the shaft in the housing.

The shaft 16 projects beyond the bearing 15 into the planetary gear compartment 13 and carries at its end and spaced from the partition a sun gear A, which is fixed to the shaft by a spline 24.

Rotatably mounted upon the shaft between the partition and the sun gear A and retained in position thereby is a planetary gear housing 25, comprising a disk 26 having a projecting hub 27 on its outer face providing an ex-

tended bearing on the shaft, having a recess 28 in its inner face housing the sun gear A, and having a plurality of radial slots 29 extending through its rim portion 30 in alignment with the sun gear A.

Rotatably mounted on pins 31 that are mounted on and extend from the disk are planetary gear wheels B, which project into the slots and have teeth 32 meshing with teeth 33 on the sun gear A.

A variable speed or power take-off shaft 34 is rotatably mounted at one end in a bearing 35 located in alignment with the bearing 14 and in the opposite end wall of the housing in abutting alignment with the shaft 16, the opposite end of the shaft being supported in a bearing 36 carried upon a bracket 37 spaced from the housing to provide sufficient room on the shaft for a reel or drum 38, although any form of power take-off may be fixed to the shaft in place of the reel. The bracket 35 is provided with a foot flange 39 similar to the feet 4 on the transformer housing so that the bracket and the transformer housing may be secured to a common support.

The inner end of the shaft 34 projects through the bearing 35 and into the housing 1 and carries an orbit gear carrier 40 which is fixed to the shaft by a key 41. The orbit gear carrier comprises a disk of a somewhat larger diameter than the planetary gear housing and is recessed on its outer face, as at 42, to partially receive the planetary gear carrier or housing and to provide an outwardly extending peripheral flange 44 to which is secured a ring gear C by bolts 45. The ring gear C is mounted in the plane of the planetary gears and has inwardly projecting teeth 46 which engage with the teeth on the planetary gears to provide an orbit for the planetation of the planetary gears.

With the structure thus far described it will be seen that when power is applied to the sprocket and the shaft 16 is rotated to rotate the sun gear, the sun gear will drive the planetary gear carrier on the shaft 16 with the planetary gears traveling idly around inside the orbit gear C and that the movement of the power take-off shaft is zero.

Thus assuming that shaft 16 has a constant speed, that the sun gear A has twenty-four teeth, the planetary gears B twelve teeth and the orbit gear forty-eight teeth, the housing H will obtain a speed of $\frac{24}{24+12}$, or $\frac{2}{3}$ of a revolution to one revolution of shaft 16, and the rotation of gear C is zero.

If, under these conditions, the planetary gear housing is held against rotation so that the planetary gears cannot planetate, the sun gear A will rotate the planetary gears B upon their axes and the planetary gears B will rotate the orbit gear C; consequently the power take-off shaft will rotate at a speed lower than that of the drive shaft 16 and, using the same teeth ratios as before, the rotation of gear C on the power take-off shaft makes $\frac{1}{2}$ of a revolution to one revolution of the shaft 16 and in a reverse direction. Therefore, by increasing the speed of the housing 25 to more than $\frac{2}{3}$ the speed of shaft 16, the orbit gear C will rotate forwardly and by decreasing the speed of the housing 25 to less than $\frac{2}{3}$ speed of shaft 16, the orbit gear will rotate reversely.

It will be further noted that by varying the speeds of the housing above and below $\frac{2}{3}$ of the speed of shaft 16 (maintaining the speed of 16 constant), various forward and reverse speeds may be provided for the power take-off shaft.

In accomplishing this result we employ counter shafts driven from the shaft 16 at various speeds selective by the engagement of clutches at the will of the operator and by gearing the counter shafts to drive the planetary gear housing at various speeds above and below $\frac{2}{3}$ the speed of shaft 16.

In the device illustrated we have provided gearing to furnish high and low forward speed and high and low reverse speed, as now described.

Rotatably mounted in the housing at opposite sides of the shaft 16 are counter shafts 47 and 48 respectively, the outer ends of the shafts being mounted in bearings 49 and 50 in the outer end wall of the housing and the inner ends in bearings 51 and 52 in the partition, similarly to the mounting of the shaft 16.

The shaft 47 has reduced ends 53 and 54 for rotatably mounting a gear wheel L at its forward end and a gear wheel J at its rear end in mesh with aligning drive gear wheels K and I respectively, the gear wheels K and I being keyed on the shaft 16 and spaced apart by a sleeve 55 on the shaft, as best shown in Fig. 3, so that rotation of the shaft 16 will drive the gears L and J idly on the counter shaft. The counter shaft projects past the partition and carries a gear E fixed thereto by a key 56 and meshing with a gear D carried on the hub 27 of the planetary gear carrier or housing 25 and fixed thereto by bolts 57 which pass through the gear and through the disk of the gear carrier.

The gears L and J are each provided with facing clutch faces 58 and 59 so that either one may be selectively engaged by a clutch 60 slidably keyed on the shaft between the gears by a spline 61. The clutch member 60 comprises a cylindrical sleeve having clutch faces 62 and 63 at its ends complementary to the clutch faces 58 and 59 of the gears and is provided with a groove 64 for receiving a collar 65 having projecting pins 66 engaged by a clutch actuating yoke 67 so that the clutch may be slid into engagement with either one of the gears to cause the selected gear to drive the counter shaft and the planetary gear housing through the meshing

contact of the gear E with the gear D fixed on the housing 25. The number of teeth on the gear L differs from that on the gear M to provide two different speeds for the housing and differential speeds of the power take-off shaft.

Two additional speeds are likewise provided by the counter shaft 48 mounted in the housing on the opposite side of shaft 16 which is also provided with an idle gear M at the forward end meshing with the gear K previously described and a gear P on the opposite end meshing with a gear G keyed adjacent the gear I on the shaft. Either one of the gears M or P may be connected with the counter shaft by a sliding clutch collar 68 slidably keyed to the shaft and having clutch faces 69 and 70 for engaging clutch faces 71 and 72 on the gears M and P, in the same manner as the selection of the gears L and J on the opposite counter shaft.

The counter shaft 48 also projects beyond the partition and carries fixed thereto, on the projecting end, a gear F which meshes with the gear D on the planetary gear housing 25 previously described.

The clutch 68 is likewise provided with a ring 73 and yoke 74 similar to those of the clutch 60. The yokes 67 and 74 are each fixed to vertical rods 75 and 76 rotatably mounted in bosses 77 and 78 in the transformer casing and extending downwardly through the casing and fixed to the lower ends of the rods are actuating levers 79 and 80 connected to actuating rods 81 and 82 respectively, so that the rods may be reciprocated to move the yokes in an arc to slide the clutches into engagement with the gears to be selected.

Thus four speeds for the power take-off shaft are provided for any constant speed of the shaft 16.

Thus by utilizing a set of planetary gearing and by controlling the planetation of the planetary gears, we may obtain various speeds in either forward or reverse direction for the power take-off shaft.

What we claim and desire to secure by Letters Patent is:—

1. In a speed transformer, a housing having a partition therein spaced from an end wall of the housing, a drive shaft rotatably mounted in said end wall and partition, a driven shaft rotatably mounted in the end wall opposite to the first named end wall, a sun gear fixed on the drive shaft, a planetary gear carrier rotatably mounted on the drive shaft, planetary gears carried thereby and meshing with the sun gear, an orbit gear fixed on the driven shaft and meshing with the planetary gears, a counter shaft rotatably mounted in said first named end wall and the partition, driven gears loosely mounted on the counter shaft, complementary gears fixed on the drive shaft and meshing with the counter shaft gears, means for selectively connecting the counter shaft gears in driving relation with the counter shaft, and means operably connecting the counter shaft with the gear carrier to drive the said gear carrier.

2. In a speed transformer, a housing having a partition between end walls of the housing, a drive shaft rotatably mounted in an end wall and the partition, a driven shaft rotatably mounted in the wall opposite the first named end wall, a sun gear fixed on the drive shaft, a planetary gear carrier rotatably mounted on the drive shaft, planetary gears carried thereby and meshing with the sun gear, an orbit gear fixed on the driven shaft and meshing with the planetary gears, a counter shaft rotatably mounted in said first named end wall and the partition, gearing for operating the counter shaft from the drive shaft, and means operably connecting the counter shaft with the gear carrier to rotate the gear carrier.

In testimony whereof we affix our signatures.

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