G. K. GARVIN & E. J. McCLELLAN.

SPEED CHANGE GEARING.

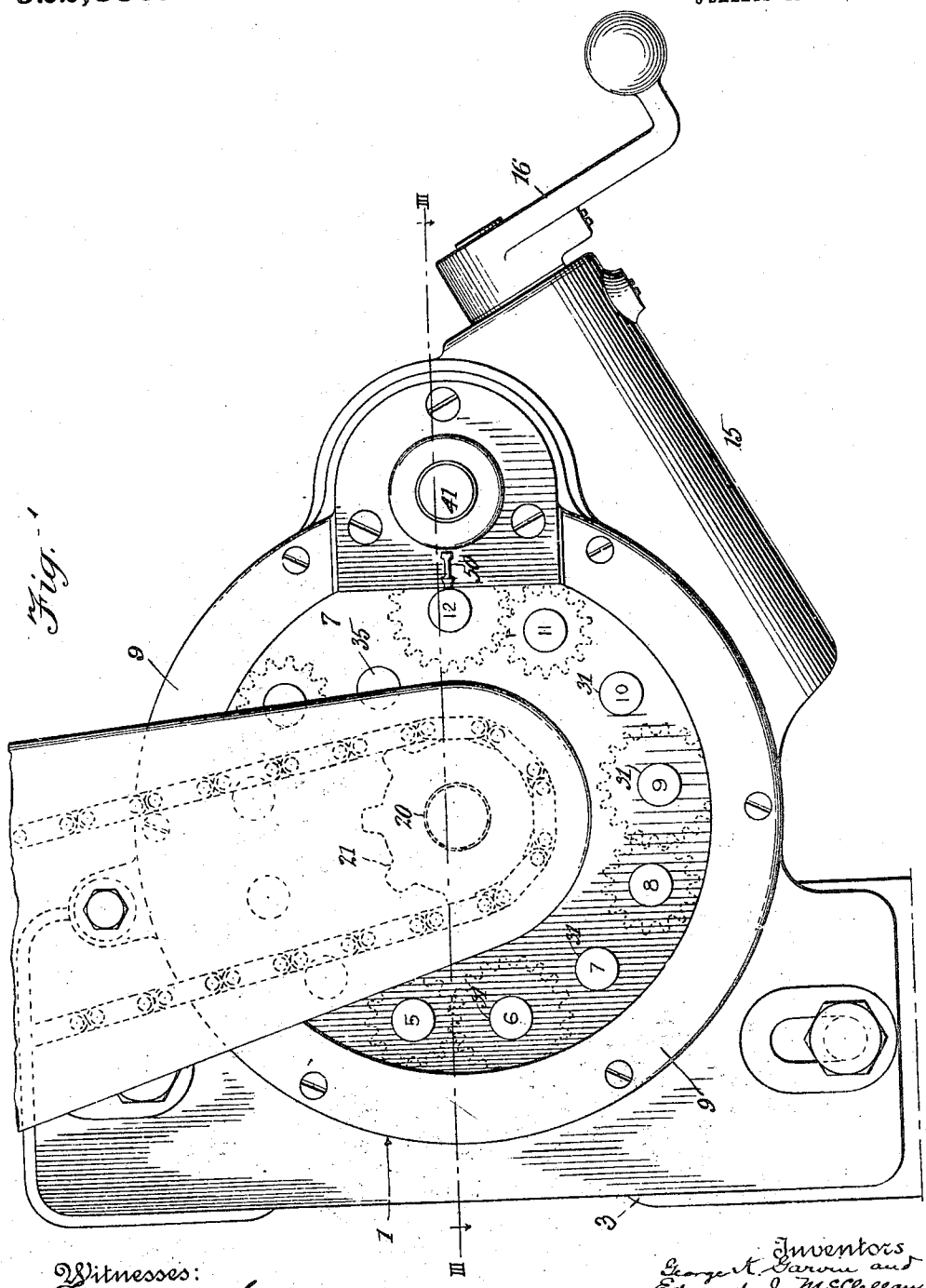
APPLICATION FILED JAN. 27, 1909.

922,880.

Patented May 25, 1909.

3 SHEETS—SHEET 1.

Fig. 1.



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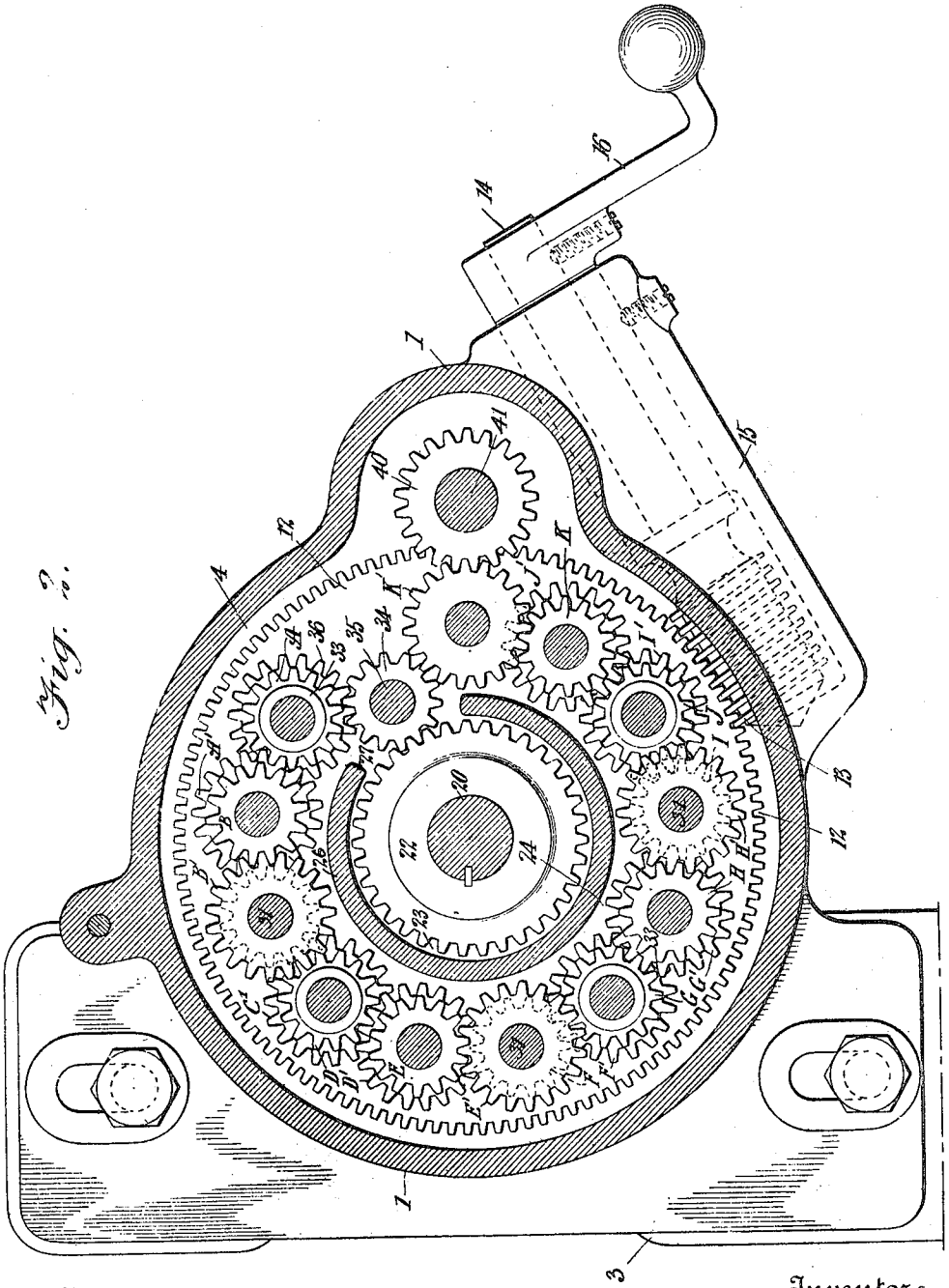
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3 SHEETS—SHEET 2.

Fig. 2.



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3 SHEETS—SHEET 3.

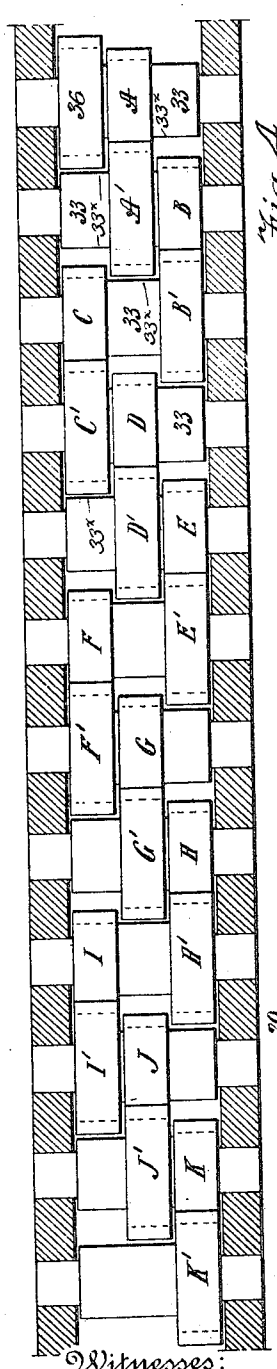


Fig. 4.

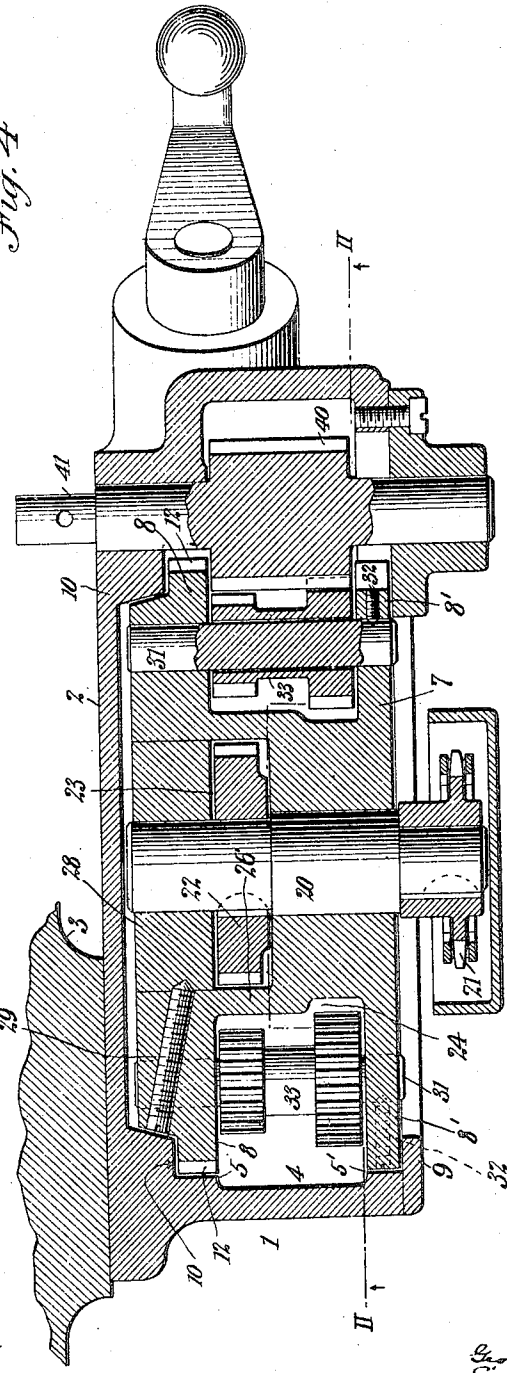


Fig. 3.

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UNITED STATES PATENT OFFICE.

GEORGE K. GARVIN AND EDWARD J. McCLELLAN, OF NEW YORK, N. Y.

SPEED-CHANGE GEARING.

No. 922,880. Specification of Letters Patent. Patented May 25, 1909.

Application filed January 27, 1909. Serial No. 474,539.

To all whom it may concern:

Be it known that we, GEORGE K. GARVIN and EDWARD J. McCLELLAN, citizens of the United States, residing at the city of New York, in the borough of Manhattan and State of New York, have invented certain new and useful Improvements in Speed-Change Gearing, of which the following is a full, clear, and exact description.

Our invention relates to speed change gearing, particularly for machine tools and other apparatus where a positive feed or drive through widely varying speed ranges is required.

Among other systems of gearing which have been proposed for the above purpose are arrangements of gears in an angularly adjustable drum, the power being delivered at different points determined by the angular adjustment of the drum. So far as we are aware, these systems have usually given changes in arithmetical rather than geometrical progression and have required an excessive number of gears. By our present invention the number of gears is limited to the lowest number which is theoretically possible to give the different speeds desired. We have also designed a practical construction in which the change from one speed to another is easily effected, and in which the adjustment is fixed by no other manipulation than the simple turn of a crank through a single revolution or other unit number of turns.

With the foregoing and other objects in view, our invention consists in the features of construction and combination as hereinafter set forth and claimed.

In the drawings: Figure 1 is a side elevation of a speed change gear mechanism embodying the principles of our invention; Fig. 2 is a vertical sectional view of the same; this section is taken on the line II—II of Fig. 3 looking in the direction of the arrows; Fig. 3 is a section on the line III—III of Fig. 1, looking in the direction of the arrows, and Fig. 4 is a partly diagrammatic developed sectional view to illustrate the working of the transmission.

Referring to the drawings in which like parts are designated by the same reference sign, 1 denotes a frame or casing of generally circular outline with a flat rear face 2, which may be bolted or otherwise secured to any supporting frame or part 3. The casing 2 has an interior hollow chamber 4 with two annular or interiorly cylindrical coaxial surfaces 5, 5'.

7 denotes a drum having the general form of a spool or reel with a pair of side flanges 8, 8' which fit snugly within the surfaces 5, 5' and establish a bearing engagement therewith. In this relation the drum 7 is maintained and guided by a cap-ring 9, secured upon the open side of the casing 1 and lapping over the exposed edge of the flange 8' so as to maintain the drum 7 against longitudinal displacement in an outward direction. On its opposite side the drum has a thrust bearing engagement at 10 to limit its endwise movement in the chamber 4. One of the flanges 8 is toothed on its periphery to form a gear 12 adapted to mesh with a worm 13. The worm 13 is fixed to a spindle 14 guided to have a rotative but not a longitudinal movement in a boss 15 of the casing 1.

16 denotes a crank secured to the spindle 14 outside the boss 15 so as to rotate the spindle, and angularly displace the gear 12 through any desired range of adjustment.

The drum 7 has a central or axial hole in which rotates a shaft 20, driven from a sprocket or other driving connection 21, outside the casing.

22 is a gear keyed to the shaft 20 in a central chamber 23 of the drum 7. As a mechanical feature of the construction it may be mentioned that the chamber 23 is formed with a removable round block 28 upon one side to permit the insertion of the gear 22, the block being afterward fixed in place by a set screw 29. The chamber 23 is separated from the outside annular recess 24 of the drum, which is formed between the flanges 8, 8', by a comparatively thin annular wall 26. This wall is obviously necessary in order to hold the flanges 8, 8' together, but it does not extend through a complete circumference, being cut away or interrupted on one side at 27 (see Fig. 2).

Between the flanges 8, 8' and within the annular recess 24 there are fixed a plurality of short studs 31, rigidly secured at one or both ends in the flanges by the set screws 32. These studs 31 constitute journals for a plurality of gear spindles 33, having gears and pinions which intermesh around the circumference of the drum in a continuous series having certain characteristics. The prominent principles involved in this gear train are shown in Fig. 4. Before referring to this figure, it is, however, to be mentioned that

an idler 34 is provided on an additional fixed stud 35 in permanent mesh with the gear 22 through the opening 27. This idler 34 meshes with the first gear 36 of the train 33 (refer to Fig. 4). The gear 36 has a pinion A which meshes with a gear A′ on the second gear spindle 33, which in turn has a pinion B. The pinion B meshes with the gear B′ on the third gear spindle 33, which in turn has a pinion C meshing with a gear C′ of the fourth gear spindle 33. This relation is continued throughout the series and may be readily traced by the letters D D′, E E′, F F′, G G′, H H′, I I′, J J′ and K K′, denominating the successive gears of the driving train established.

In order to secure a proper driving train as above defined, without interference between the various gears, each gear spindle 33 has a reduced portion $33^{\times}$ which is situated opposite the large gear of the adjacent spindle with the pinion of which it is in meshing relation; that is to say, the second gear spindle 33 has a reduced portion opposite the gear 36, the third gear spindle has a reduced portion opposite the gear A′, the fourth gear spindle has a reduced portion opposite the large gear B′, and so on. In order to get the most compact disposal possible, the gear spindles are made in identical recurring groups of three, the first, second and third spindles being like the fourth, fifth and sixth, respectively, and so on. Within any such group of three the large gears follow one another in increasingly offset relation in successive stages from one side to the other. The pinions of the various gear spindles, and their reduced portions $33^{\times}$ are, of course, positioned to accommodate the large gears. These relations are readily apparent from Fig. 4 and it will be seen that owing thereto all the gears and pinions of the series are confined between two planes which are spaced apart by a distance about three times the width of the gears employed. This distance determines the width between the flanges 8 and 8′. The most prominent and characteristic feature of these gears and their method of mounting, lies in the fact that their peripheries are all tangent within a circle concentric with the axis of rotation of the drum 7, and that each gear spindle has its large gear at least about twice the depth of a tooth larger than the pinion. These large gears are preferably identical in size and pitch throughout the series, in which case their axes as well as their peripheries are in a circle concentric with the axis of the supporting drum 7. These characteristics constitute an important point in our invention and lead to a special function or result as follows: 40 is a gear having a broad face or the equivalent thereof extending entirely across between the flanges 8, 8′, and having a pitch and axis of rotation adapted to permit it to mesh with any given one of the large gears 36, A′, B′, C′, D′, E′, F′, G′, H′, I′, J′ or K′, just mentioned. Owing to the relation of these large gears just above referred to, together with the breadth of gear 40, said gear 40 will mesh with all these large gears if it meshes any one of them, by merely angularly adjusting the drum 7 on its axis. It is therefore obvious that when the crank 16 is turned to displace said drum angularly, that the large gears 36, A′, B′, etc., above enumerated, are brought successively into mesh with the gear 40. The gear 40 is fixed on a spindle 41 in the casing 1, from which the motion is communicated to any driven device or mechanism.

The use and operation are as follows: Power being communicated to the sprocket wheel 21, the shaft 20 and the gear 22 are caused to rotate at a fixed uniform speed. This rotation is communicated to the idler 34 and the gear 36, which are permanently in mesh with one another, and with the gear 22. From the gear 36 the power is transmitted through the entire train of gears shown in Fig. 4, and above described, and it will be observed that each gear spindle 33 in the advancing series, rotates more slowly than the one which precedes it. The diminution of rotative speed is in a geometrical ratio throughout the series; that is to say, each gear spindle has a speed value equal to that of the preceding one, divided by a given factor. If the speed reduction is equal to two-thirds between each pair, it is evident that the ninth gear spindle of the series has a speed about one thirty-eighth that of the first gear spindle, being about the value of the fraction two-thirds to the ninth power. If the reduction factor is one-half, and there are eleven pairs, the total speed reduction would be over two thousand fold, indicating the comparatively wide ranges available with an apparatus embodying the present invention. It is also to be noted that in practically all machine tool work, feed values should be changed by factors in geometrical progression rather than by a difference or addition, as with arithmetical progression. The power is delivered through any selected large gear of the series by merely angularly adjusting the drum 7 so that such gear is in mesh with the delivery gear 40. If desired the delivery gear 40 may be meshed with the initial gear 36, in which case it has the same tooth velocity as the driving gear 22; or its speed can be reduced through successive changes to any value within the limits above referred to. The changes from one speed ratio to another are effected by a unit number of turns of the crank 16. We prefer to have the worm 13 of such a pitch that one turn will be just sufficient to pass from one meshing relation to another. It is evident that equal angular displacements of the drum are required

throughout the series to effect the speed changes. This is due to the equal spaced apart relations of the studs 31, the various pinions A, B, C, etc., being of equal size so as to permit an equal spaced apart disposition of the studs 31. In adjusting from one speed ratio to another the idler 34 is carried to new angular positions on its driving gear 22, but obviously meshes equally well for its driving function at whatever angle it may be placed. We have described the mechanism as though it were only for use with the shaft 20 as a driving member and the shaft 31 as a driven member. This has been purely for the purpose of clearness, as the apparatus works equally well considering the shaft 31 as the driving member and the shaft 20 as the driven member. We do not accordingly desire to be limited or restricted to either plan of operation.

Any desired indexing means may be used for registering the particular speed ratio which is obtained by any adjustment. I have illustrated an index mark 50 on a stationary part of the frame and which may be employed as a reference point in conjunction with the studs 31, which may be punched or denominated with different inscriptions indicative of the speed obtained for each adjustment. In the drawings the reference mark 50 is opposite the twelfth stud 31, corresponding to the twelfth or lowest speed obtainable. The other adjustments produce the different speeds in order, corresponding to the marks appearing on the ends of said studs 31. In place of figures indicating the mere order or sequence of the speeds, it is obviously possible to directly denominate the speed ratios by fractions or decimals.

What we claim, is:

1. In a speed change gearing, a drum having a central axis, a series of spindles having large gears and pinions, said gears having their peripheries tangent to an exterior circle concentric with the axis of said drum and each having its large gear meshing with the pinion of an adjacent spindle, a gear coaxial with said drum, an idler meshing therewith and coöperating with an initial spindle of said series, a permanently located gear, and means for bringing any one of said large gears in mesh with said permanently located gear.

2. In a speed change gearing, a drum having a central axis, a series of gear spindles each having a large gear and a pinion and a reduced portion, said large gears having their peripheries tangent to an outside circle concentric with the axis of said drum, each spindle having its large gear meshing with the pinion of the adjacent spindle on one side and opposite a reduced portion of the spindle on the other side, a gear coaxial with said drum, an idler meshing therewith and coöperating with a gear of an initial spindle of said series, a permanently located gear, and means for bringing any one of said large gears in mesh with said permanently located gear.

3. In a speed change gearing, a drum angularly adjustable on a central axis, a series of gear spindles with axes in a circle concentric with the axis of said drum, said gear spindles each having a large gear and also having a pinion in mesh with the large gear of an adjacent spindle, and also having a reduced portion opposite the large gear of an adjacent spindle on the other side, said large gears being of equal size and pitch throughout the series, and a permanently located gear meshing selectively with said large gears when said drum is angularly adjusted.

4. In a speed change gearing, a drum having a central axis, a series of gear spindles having their axes in a circle concentric with the axis of said drum, said gear spindles all having equal large gears and each having a pinion meshing with the large gear of the adjacent spindle, a gear coaxial with said drum, means meshing therewith to drive an initial spindle of said series, a permanently located gear, and means for bringing any one of said large gears in mesh with said permanently located gear.

5. In a speed change gearing, a drum having a central axis, a series of gear spindles having their axes in a circle concentric with the axis of said drum, said gear spindles all having equal large gears and each having a pinion meshing with the large gear of the adjacent spindle, a gear coaxial with said drum, an idler meshing therewith and coöperating to drive a gear of an initial spindle of said series, a permanently located gear, and means for bringing any one of said large gears in mesh with said permanently located gear.

6. In a speed change gearing, a drum angularly adjustable on a central axis, a series of gear spindles with axes in a circle concentric with the axis of said drum, said gear spindles each having a large gear and having a pinion in mesh with the large gear of an adjacent spindle, said large gears being of equal size and pitch throughout the series, and a permanently located gear adapted to be meshed selectively with said large gears by the angular adjustment of said drum.

7. In a speed change gearing, a drum having a central axis, a series of gear spindles, large gears thereon of equal pitch having their peripheries tangent to an outside circle concentric with the axis of said drum, said large gears being arranged on the spindles in similar recurring groups of three, the large gears of each group being increasingly offset from one side toward the other, pinions on said spindles each meshing with the gear of an adjacent spindle, a gear coaxial with said drum, means meshing therewith to drive an

initial spindle of said series, a permanently located gear, and means for bringing any one of said large gears in mesh with said permanently located gear.

8. In a speed change gearing, a drum having a pair of flanges, studs extending between said flanges, gear spindles on said studs and having gears and pinions intermeshing in a continuous series around said drum, a gear coaxial with said drum, means meshing therewith to drive an initial spindle of said series, a permanently located gear, and means for bringing any one of said large gears in mesh with said permanently located gear.

9. In a speed change gearing, a drum having a central axis, a series of gear spindles having gears with their peripheries tangent to an outside circle coaxial with said drum, said gear spindles each having a pinion meshing with the large gear of an adjacent spindle, a gear coaxial with said drum, means meshing therewith to drive an initial spindle of said series, a worm-wheel and worm for angularly adjusting said drum, and a permanently located gear adapted to mesh selectively with said large gears when said drum is angularly adjusted.

10. In a speed change gearing, a drum having a series of intermeshing gears and pinions, and having an interior annular wall interrupted on one side, a gear within said wall, an idler meshing therewith and located at the interrupted portion of said wall and meshing with an initial gear of said intermeshing series, and a permanently located gear adapted to mesh successively with any one of said intermeshing gears when said drum is angularly adjusted.

11. In a speed change gearing, a drum angularly adjustable on a central axis, a series of gear spindles with axes tangent to a circle concentric with the axis of said drum, said gear spindles all having equal large gears and each having a pinion in mesh with the large gear of an adjacent spindle, a gear coaxial within said drum, an idler meshing therewith for driving an initial spindle of said series, and a permanently located gear with a broad face adapted to be selectively meshed with any of said large gears by the angular adjustment of said drum.

12. In a speed change gearing, a series of intermeshing gears and pinions having their axes all at equal distances from a given point, said gears and pinions being respectively of equal size throughout the series, whereby a constant ratio of speed variation is obtained between each pair, and a gear adapted to be meshed with any one of said first mentioned gears.

13. In a speed change gearing, a series of intermeshing gears and pinions with their axes all at equal distances from a given point, a gear adapted to be put in mesh with any of said first mentioned gears, and index means for denominating the particular speed or adjustment obtained in the resultant driving train.

14. In a speed change gearing, a drum having a central axis, a series of spindles having large gears and pinions, said gears having their peripheries tangent to an exterior circle concentric with the axis of said drum and each having its large gear meshing with the pinion of an adjacent spindle, a gear coaxial with said drum, an idler meshing therewith and coöperating with an initial spindle of said series, a permanently located gear, and means for bringing any one of said large gears in mesh with said permanently located gear.

In witness whereof, we subscribe our signatures, in the presence of two witnesses.

GEO. K. GARVIN.
EDWARD J. McCLELLAN.

Witnesses:
JOHN T. WILLIAMS,
CHAS. T. LUTHER.