

C. M. CONRADSON.  
SPEED CHANGING MECHANISM.

APPLICATION FILED FEB. 29, 1904.

4 SHEETS—SHEET 1.

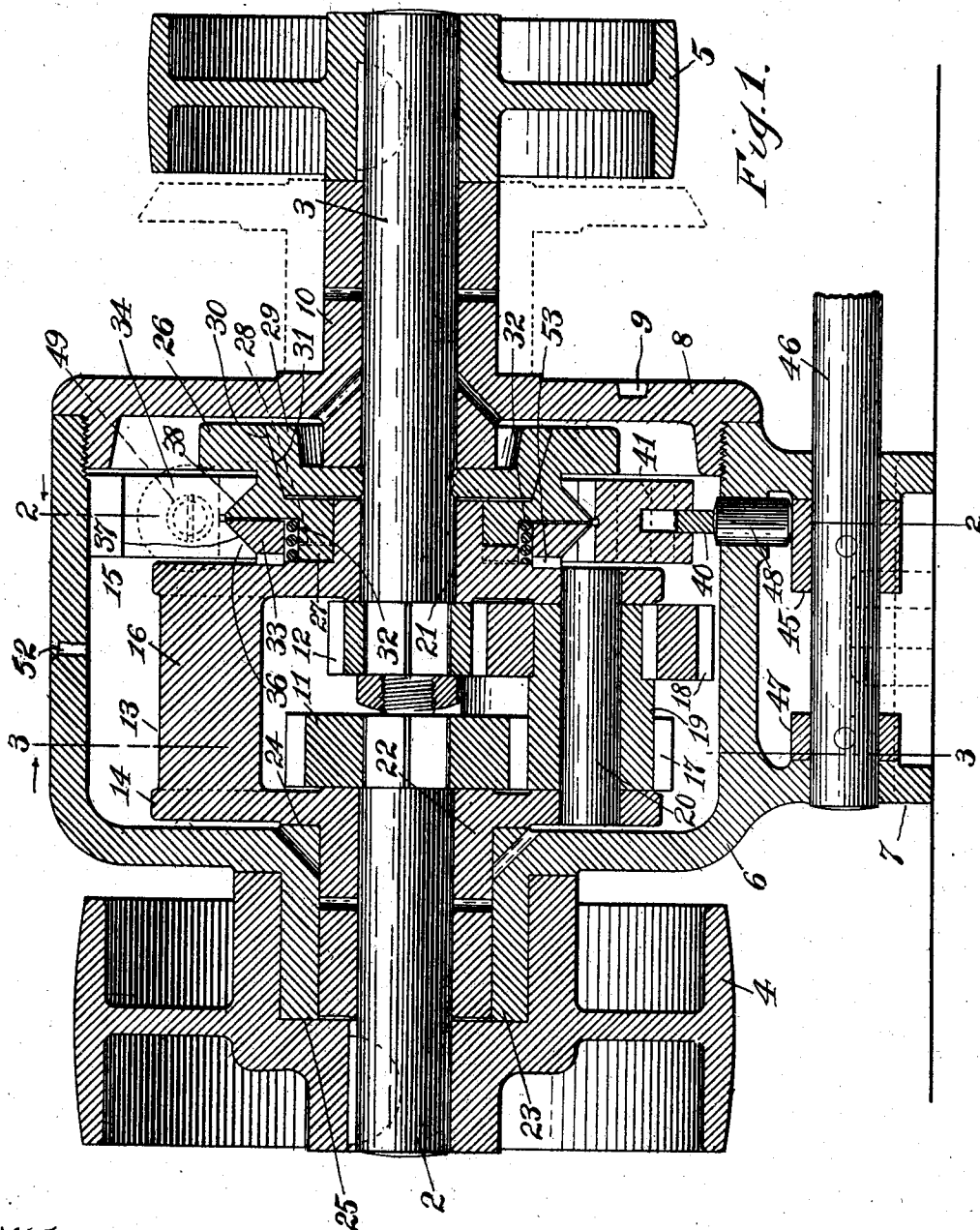


Fig. 1.

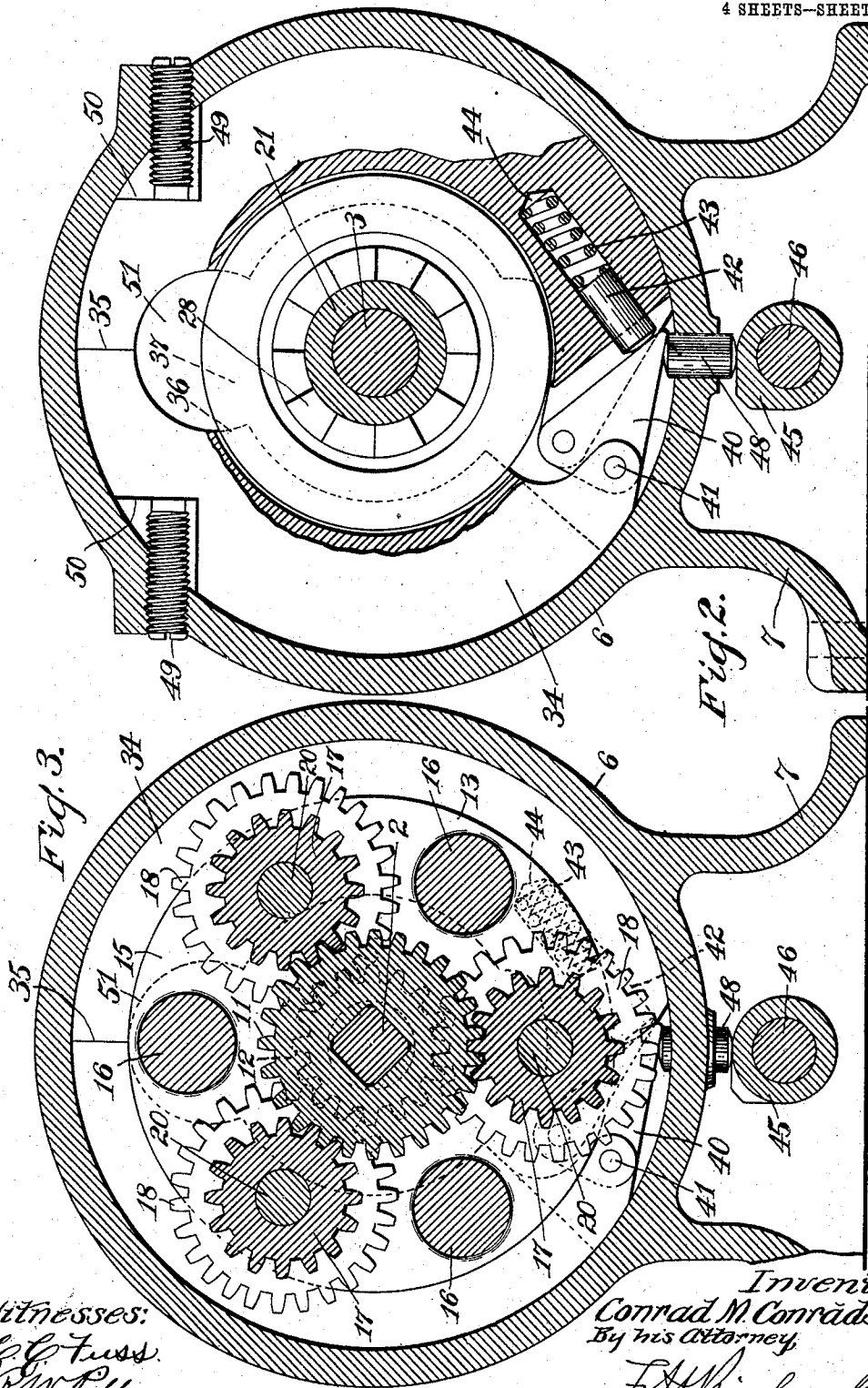
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*Conrad M. Conradson*  
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*F. H. Richards.*

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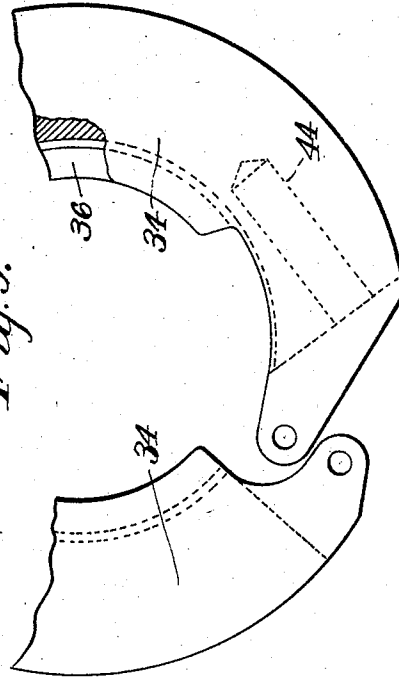
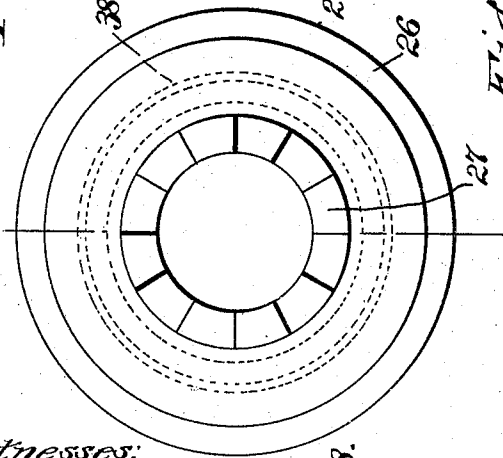
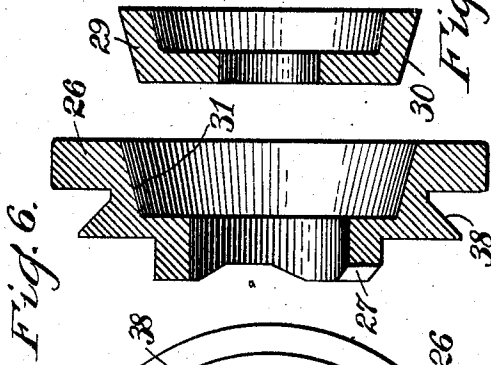
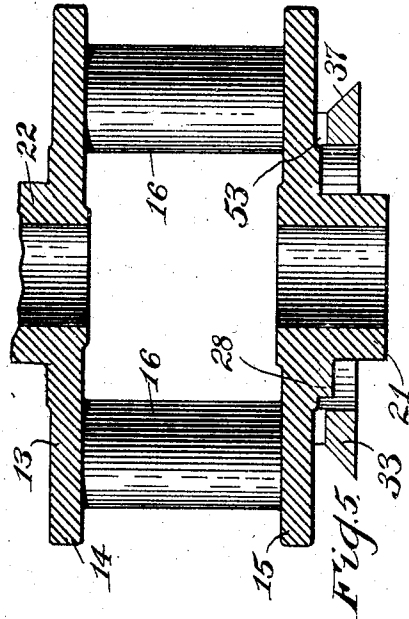
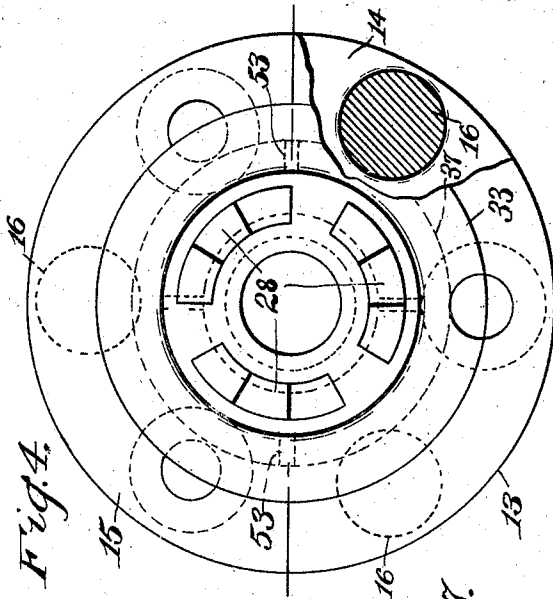
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4 SHEETS—SHEET 3.



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Fig. 8.

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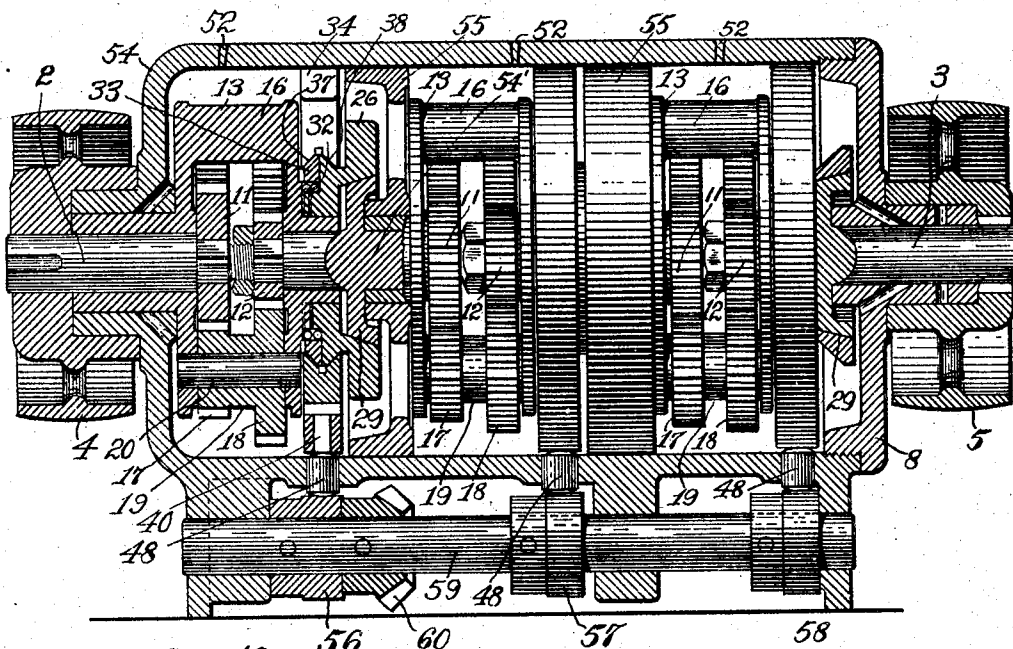


Fig. 10.

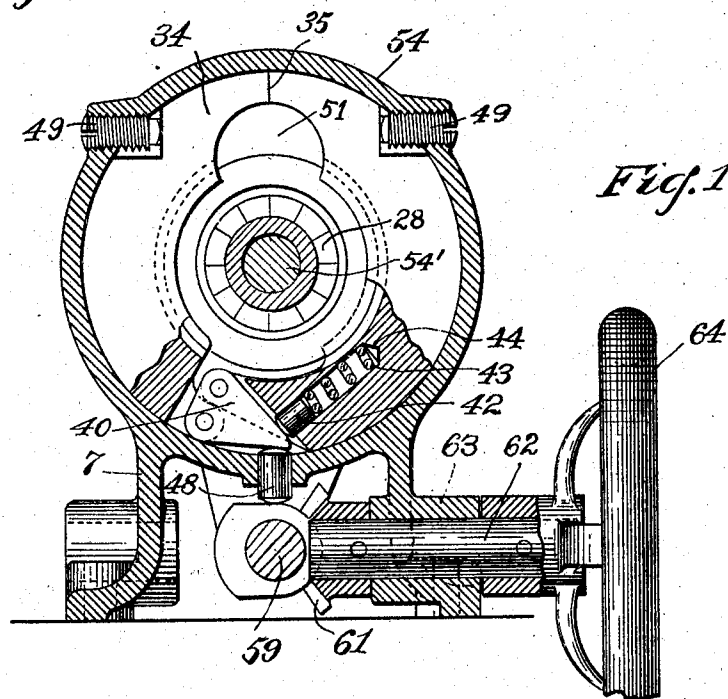


Fig. 11.

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# UNITED STATES PATENT OFFICE.

CONRAD M. CONRADSON, OF WARREN, PENNSYLVANIA.

## SPEED-CHANGING MECHANISM.

No. 800,268.

Specification of Letters Patent.

Patented Sept. 26, 1905.

Application filed February 29, 1904. Serial No. 195,707.

*To all whom it may concern.*

Be it known that I, CONRAD M. CONRADSON, a citizen of the United States, residing in Warren, in the county of Warren and State of Pennsylvania, have invented certain new and useful Improvements in Speed-Changing Mechanism, of which the following is a specification.

The present invention relates to a simple, compact, and durable mechanism for effecting at will any one of various predetermined velocity ratios of a driven member relatively to a driver.

While the present speed-changing mechanism is applicable to a wide variety of uses and adaptations, the specific embodiment thereof disclosed in the present specification and drawings is particularly designed for use in machine-tool constructions for driving parts which it is desired shall be capable of movement at relatively different speeds or velocities, the change from one velocity to another being under manual or automatic control. The organization constituting the present invention readily lends itself to the obtainment of a variety of speeds sufficient to cover all requirements, while the ratio between the minimum and the maximum speed of the driven part is capable of variation to any desired extent within the limits of construction.

The embodiment disclosed herein is particularly suited to the driving of machine-tools and possesses the features of ample and complete lubrication, reversibility of motion, compactness, symmetry, capacity of attachment in any desired position, and it may be readily coupled to an electric motor or other driving means. It is, moreover, so designed as to permit it to be economically manufactured, while the changes in the speed may be effected by hand or by mechanism (and from a distance, if desired) and such changes readily indicated.

The present mechanism comprises a driving and a driven shaft projecting from a casing or head within which the speed-changing device or devices are inclosed, and which latter may be so positioned from the exterior of the casing as to give the desired predetermined ratio of speed between the shafts.

This speed-changing device comprises in a general way a train of gearing interposed between the said shafts and effecting a change in the relative speed by conversion from a simple or direct transmission-train into a revolving-axis one, and vice versa. The change

from one to the other is conveniently accomplished from the exterior by a suitable cam or cams.

Such a device constitutes one of the units of the present mechanism, and by combining a suitable number of these units substantially in the manner hereinafter disclosed a comparatively large number of speed changes may be effected, the means for accomplishing such results being conveniently in the form of suitably designed and related cams.

In the drawings accompanying the present specification there is set forth an embodiment of the present invention.

In the drawings, Figure 1 is a longitudinal section thereof, the plane of the section corresponding with the coincident axes of the driving and driven shafts. Fig. 2 is a sectional view on the plane of the line 2 2 in Fig. 1, the brake-band being shown in elevation, but with parts thereof broken away to show parts lying beyond. The clutch-ring is also supposed to be entirely removed the better to illustrate the clutch-ring-engaging teeth of the gear-carrier. Fig. 3 is a sectional view on the plane of the line 3 3 in Fig. 1 looking in the direction of the arrow adjacent to that line. Fig. 4 is an elevational view of the carrier for the sets of gears, and which carrier when in motion serves to give an orbital movement to the gears. Part of the end plate or head of the carrier is broken away to show one of the cross connections between the two heads of the carrier. Fig. 5 is an axial sectional view of such carrier, parts being broken away. Fig. 6 is an axial sectional view of the clutch-ring. Fig. 7 is a similar view of the cooperative clutch part or disk secured to the driven shaft. Fig. 8 is an elevational view of the clutch-ring indicated in Fig. 6, the view being from the left of that figure. Fig. 9 is an enlarged detail view of the two end portions of the brake-band to which the brake-band-operating lever is pivoted. Fig. 10 is a view similar to Fig. 1, but upon a somewhat smaller scale, showing that modification of the aforesaid mechanism in which a plurality of units are associated with each other for the purpose of increasing the range of possible speed changes which can be effected. Fig. 11 is a sectional view of the modification indicated in Fig. 10, this sectional view being similar to that indicated in Fig. 2. A hand-wheel for actuating the cam-shaft is indicated, while the cam illustrated in outline is some-

what different in configuration from the cam indicated in Fig. 2 in order that the operation of such cam shall be prolonged.

Similar characters of reference designate corresponding parts in all figures.

Each unit of the present speed-changing mechanism comprises a driving and a driven part in the sense that motion is imparted to one and is taken from the other. These parts are in the illustrated form of the embodiment indicated in the nature of shafts, which for purposes, among others, of symmetry and convenience are disposed in line with each other. Interposed between the contiguous ends of these two shafts is the speed-changing device proper, the same comprising a train of gears by which motion is transmitted from the driving to the driven shafts. Such train of gears is capable of transmitting motion either as a simple train in which the axes of none of the gears comprised in the train moves or one in the nature of an epicyclic train, at which time one or more gears are carried around bodily, the moving axis traversing an orbital path about the aforesaid coincident axes as a center. The change from one species of transmitting device to the other is under the control of the operator, or of course the change from one to the other may be effected automatically. These and various other parts are disposed in a suitable head or casing particularly well suited for maintaining the efficient lubrication of the moving parts.

Referring specifically to that embodiment of the invention indicated in Figs. 1 to 9, inclusive, 2 may be regarded as the driving-shaft and 3 the driven shaft. The former is in this instance provided with a pulley 4, which, together with the pulley 5, affixed to the driven shaft 3, may or may not be used, according to the particular requirements in any given case. The said shafts are supported by a hollow head or casing in which the intermediate transmitting mechanism is located, this head being preferably suited for the holding of lubricant for the moving parts. In the form of such head or casing illustrated the same (designated by 6) is shown as of substantially cylindrical form, provided with a supporting foot or base 7, and as embodying a removable end plate 8, having a threaded engagement with the bore of the body of the casing, (one of the openings 9 for the engagement of a wrench being indicated.) An extension 10 in line with the axis of the casing constitutes a bearing or bearing-support for the driven shaft 3.

Secured to the contiguous ends of the two shafts are gear-wheels 11 and 12, respectively, coupled together by a train of gearing. Such train of gears in the form thereof found convenient and applicable for the purposes of the present embodiment consists of a set of gears moving in unison with each other and meshing the one with the gear 11 and the other with the gear 12.

It has already been stated that the intermediate train of gears is capable of not only acting as a simple transmitting-train—that is to say, one in which the axes of the parts constituting said train remain stationary relatively to the casing—but also as a train in which the axis of said set of connecting-gears has an orbital movement in a circular path about the common axis of the driving and driven shaft as a center. As a convenient construction for permitting the connecting-gears to function in either of these ways, the same are mounted on a suitable carrier which is here journaled to rotate about the same axis as either the driving or the driven shaft. When, therefore, the carrier is held against rotation, motion is transmitted from the gear on the driving-shaft through the set of connecting-gears (whose common axis is then stationary) to the gear on the driven shaft. If, however, a rotary movement of the carrier takes place, the motion of the driven shaft is in general the resultant of the rotary movement of the connecting set and the translational movement of their common axis—that is, their revolution in a circular path.

In the form of invention herein illustrated when the carrier is permitted to rotate and is locked to the driven shaft the driven shaft is rotated at the same rate of speed as the driving-shaft, the connection between the two shafts, however, being through the train of gear at all times whether the carrier is held from rotation or is caused to rotate.

In the particular form of the carrier illustrated the same (designated by 13) comprises end disks or heads 14 and 15, separated from each other a sufficient distance to accommodate the gears 11 and 12 and connected together by the connecting-pieces 16.

It should here be stated that for purposes of symmetry, balance, and even driving a plurality of symmetrically-disposed transmitting-gear sets may be employed. I may use three sets of such gears, in which event there may be three of the connecting-pieces 16, as indicated clearly in Fig. 3. Each set of transmitting-gears comprises a gear 17, meshing with the gear 11, and a gear 18, meshing with the gear 12. Both gears 17 and 18 of each pair or set thereof are indicated as being rigid, with a sleeve 19 working between said heads 14 and 15 of the carrier and mounted upon a shaft 20, extending between and secured to said heads.

A practical means for rotatably supporting the aforesaid carrier comprises a projecting hub 21 on the head 15, which is loosely mounted upon the inwardly-projecting end of the driven shaft, and a projecting hub 22, rotatably mounted within a laterally-extending bearing 23 of the casing 6. Within the bore of the projecting hub 22 the driving-shaft 2 is mounted for rotation relatively thereto.

It may here be premised that any consid-

erable end play of the carrier 13 is objectionable, tending to cause an improper action of the speed-changing device by reason of the faulty functioning of parts hereinafter to be described. For the purpose, therefore, of confining the carrier to rotation in a single plane transverse to the axis of the shafts the means illustrated may be adopted—that is to say, the head 14 of the carrier may be provided with a bearing-face to work against a corresponding bearing-face upon the casing 6—(see, for instance, the joint 24,) these bearing-faces being kept in substantial contact by the radial face (see 25) within the bore of the pulley 4, which contacts with the radial face at the end of the extension-bearing 23 of the casing.

It is apparent from the foregoing construction that if the carrier 13 is held against rotary movement and the shaft 2 be actuated a rotary movement will be imparted by the transmitting-gears to the driven shaft 3 with a velocity ratio dependent upon the proportions existing between the diameters of the meshing gears, and any desired ratio within the limits of construction of the device may be attained by using gears of the necessary relative diameters. If, on the contrary, the carrier is compelled to execute a rotary movement about its axis while the connected gears 17 and 18 are rotating about their common axis, the resultant motion, it is apparent, will in general be one compounded of the two movements of rotation and revolution. A convenient means for restraining at will this carrier against rotary movement and likewise freeing the same and permitting it to rotate comprises a brake device actuatable from the exterior of the casing and serving when in its operating or braking position to hold the carrier rigid with reference to the casing. The organization is such in this instance that upon the release of the braking device an automatic locking of the carrier to the driven shaft results, compelling thereafter the carrier to accompany the driven shaft in its rotation. This automatic connection is accompanied without shock or noise—a desirable mode of operation in many instances where the present invention is applicable—for example, by some form of friction device or clutch. The construction of the friction-clutch illustrated comprises a shiftable clutch member which normally—that is to say, when the brake device is in its operative or non-braking position, (the carrier 13 at such times being free to rotate)—is in its clutch-closing position, this latter position being preferably assured simultaneously upon the release of the brake by means such as a spring. When, however, the brake is applied to stop the rotation of the carrier, such braking action is accompanied by the disengagement of the shiftable clutch member from its cooperative member, leaving the driven shaft free for actuation from the driving-

shaft through the medium of the axially-immovable gears 17 and 18.

The aforesaid shiftable clutch member comprises in the construction illustrated a clutch-ring 26, mounted on the carrier and axially movable with reference to the aforesaid hub 21 of the latter. The ring is, however, compelled to rotate with the carrier by means of engaging teeth 27, which fit into the spaces between teeth 28, extending from the head 15 of the carrier. The side walls of these teeth are somewhat inclined to the axial line of the shafts to function by a cam-like action in forcing the movable clutch member against the cooperative member.

Secured to the driven shaft is a cooperative clutch member consisting of a friction-disk 29, having a conical friction-surface 30 of proper inclination, and engageable with which surface is a corresponding surface constituting the wall of a tapering recess 31 in the friction-ring 26. The angle of the friction-surface is such as to provide ample driving power when the friction-ring is forced into engagement—that is, toward the right in Fig. 1—with the friction-disk 29 by means of the aforesaid cam-acting teeth.

The brake-surface of the carrier is formed on the periphery of a projection 33 of the latter, and in this instance said surface not only constitutes a frictionally-retardant surface for engagement with the brake-band, but also operates as a reaction-face in a manner such that as the brake-band is forced toward its engaging position therewith the clutch or friction ring is simultaneously by the wedging action exerted by cooperative faces on the brake-band and the clutch-ring drawn away from the friction driving-surface 30 of the friction-disk 29. Specifically, the brake-band 34, which is here made in two substantially semicircular parts abutting along a pair of their contiguous edges; (see the line 35,) is provided on its inner face or edge with a V-shaped notch 36, which fits over the oppositely-inclined peripheral faces 37 and 38 of the projection 33 and the friction-ring 26, respectively.

The brake-band is actuated to contract and expand the diameter of its bore through the medium of an actuating-lever 40, let into slots in the ends of the brake-band and to which each end of the band is pivoted. (See the pivot-pins 41.) For assuring a disengaged position of the combined brake and actuator band a plunger 42, backed by a spring 43 and both located in a recess 44 in the brake-band, tends to so position the lever 40 as to cause the maximum expansion of the brake-band. An opposite movement of the lever 40 to contract the internal diameter of the brake-band and effect its engagement, as aforesaid, is conveniently effected from a cam 45, mounted upon a shaft 46, journaled in the foot 7 of the casing and provided with a collar 47, which,

in conjunction with the hub of the cam, restrains the longitudinal movement of the shaft. A transmitting-plunger 48 is in this instance interposed between the operative surface of the cam and the projecting point of the lever 40. This cam-shaft may be actuated in any desired manner. For the purpose of taking up wear and adjusting the position of the brake-band I may employ adjusting-screws 49 49, entering tapped holes in the casing and abutting against respective reaction-faces 50 on the two sections of the band, the latter being cut away at 51 to permit the adjusting-screws to act with an efficient leverage in effecting adjustment.

The operation of each such unit of the present speed-changing mechanism may be briefly described as follows: Assuming the cam-shaft 46 is in its position such that the brake-band 34 is released, the spring 32 will have forced the clutch or friction ring 26 forward and the cam-actuated teeth engaged the friction driving-surface thereof with the corresponding surface of the friction-disk 29. The rotating pulley 4 will cause, through the engaging gears 11 and 17 12 and 18 the rotation of the driven shaft 3 and also the carrier 13. This rotary movement of the latter revolves the pair of rotating gears 17 and 18 in a circular path around the common axis of the driving and driven shafts as a center, the resultant motion being that arising from the movement of the parts as they all move in unison. If the cam-shaft is now turned so that the cam thereon operates in the described manner to contract the brake-band, the friction-ring 26 is drawn backward out of engagement with the friction-disk 29 and the carrier 13 is ultimately held rigid relatively to the casing by the engagement of the brake-band with the brake-surfaces 37 and 38 of the aforesaid extensions 33 of the carrier and friction-ring. The transmitting-gears 17 and 18 then act as a simple transmitting set, rotating about an axis fixed relatively to the casing and transmitting motion from the driving to the driven shaft with a velocity ratio determined by the proportion existing between the diameters of the gears.

As it is desirable that the casing 6 shall constitute a lubricant-reservoir, (an opening 52 being provided for the introduction of the lubricant,) suitable channels and passage-ways will of course be provided for leading the lubricant to the moving surfaces. These will ordinarily vary with the particular construction of the parts, and their location is best left to the designer. Suffice it here to say that passages 53 serve to convey the lubricant to the sliding surfaces of the engaging teeth of the carrier and the clutch-ring.

If but a single unit, such as has already been described, is used, it is apparent that with any given set of gears between the driving and driven shafts but two relations of speed be-

tween such shafts may be obtained—one when the brake-band is out of operation and the other when it is functioning to hold the gear-carrier in the manner described. In order to increase the possible number of velocities ratios that can be obtained, a number of such units may be combined, the driven shaft of one unit constituting the driving-shaft of the unit directly combined with it. If under such circumstances the proportions between the gears of one unit differ from the proportions between the gears of another unit, it is plain that a number of speed changes may be obtained dependent upon the number of units employed and the number of different combinations which may be made between them, in further explanation of which this matter will be again adverted to.

I have for the purpose of explaining the manner in which a plurality of units may be combined set forth in Figs. 10 and 11 three driving units, although it is apparent that either a greater or a lesser number may be used. The unit at the left in Fig. 10 is shown in section, while the two at the right are shown mainly in elevation. A casing of suitable size and construction and substantially similar to that described with reference to Figs. 1 to 9, inclusive, is designated by 54, projecting from opposite ends of which are a driving-shaft 2 and a driven shaft 3 and secured, respectively, to which are suitable pulleys 4 and 5. Each unit, as before, comprises gears 11 and 12 on the shafts meshing, respectively, with gears 17 and 18, this latter pair of gears being rigid with a sleeve 19, mounted upon a shaft 20, secured between heads 14 and 15 of a carrier 13. Connecting-pieces 16 extend between the heads of the carrier. Each unit has also a clutch-ring 26, cooperative with a friction-disk 29, toward which to engage therewith it is urged by a spring 32 and the aforesaid cam-acting teeth. Each carrier 13 also has an extension 33, having a conical surface 37, with which and with the conical surface 38 on the friction-ring the grooved brake-band 34 is adapted to cooperate in a manner already described. A short shaft 54', interposed between each adjacent pair of units, constitutes a driven member of one unit and acts as a driver for transmitting motion to the next succeeding unit. To each shaft 54' is secured the gear 12 of the unit with reference to which it acts as a driven member, the shaft also having affixed to it the friction-disk 29 of that unit and at its opposite end carrying the gear 11 of the next succeeding unit. The carrier 13 of this latter unit is rotatably mounted by means of its projecting hub 22 upon this shaft, these hubs (with the exception of that unit at the extreme right in Fig. 10) being in turn mounted in corresponding spiders or supports 55, secured in position within the casing.

Respective cams 56, 57, and 58, secured to a cam-shaft 59, mounted in the foot 7 of the



casing, are indicated for effecting the actuation of the respective brake-bands. A short plunger 48 bears against the actuating-surface of each cam and transmits an actuating movement to the corresponding brake-band transmitting-lever 40. The expanded or inoperative position of each brake-band 34 is, as before, assured by a plunger 42, backed by a spring 43, both of which are located in a recess 44 in the corresponding brake-band. It may be finally said that since the construction of each unit of the multiple-unit speed-changing mechanism may be substantially like that described with reference to the single-unit mechanism no further description is deemed necessary. Suffice it here to say the means for actuating the cam-shaft 59 (indicated in Fig. 11) comprises a bevel-gear 60, affixed to the cam-shaft and with which gears a corresponding bevel-gear 61, secured to a shaft 62, mounted in a bearing 63 in the foot 7. The shaft 62 has affixed to it an operating-wheel 64.

Assuming that the proportions between the gears 11, 12, 17, and 18 of each set are such that for a given angular velocity of the driving-shafts of the units relatively different velocities of the driven shafts would result, various combinations may be made in number such that with a multiple-unit mechanism comprising three units eight possible variations in velocity ratios between the driving and driven shafts 2 and 3 may be obtained, it being premised that the configuration of the respective cams 56, 57, and 58 is such as to effect the inoperative or operative position of the respective brake-bands required by each respective combination, the entire series of combinations being preferably accomplished during an angular movement of the cam-shaft not greater than one full turn. Thus, for instance, assuming all of the brake-bands to be contracted a certain relation for any given organization and proportion of parts will exist between the velocities of the shafts 2 and 3. If, however, all of the brake-bands are inoperative or expanded, a relatively different ratio of speed is obtained, as likewise if the brake-band of the unit at the extreme left in Fig. 10 is contracted and the other two open; again, if the middle brake-band is contracted and the other two open; again, if the brake-band of the unit at the extreme right in Fig. 1 is contracted and the other two open; again, if the brake-bands of the left-hand unit and of the middle unit are both contracted while that of the remaining unit is open; again, if the brake-bands of the middle unit and of the right-hand unit are both contracted and the other open, and again, and finally, if the brake-bands of the extreme right and left hand units are both contracted while that of the middle unit is open.

It is thus clear that the foregoing construction provides a simple, compact, durable,

cheaply-made and easy-operated mechanism for effecting at will within a small compass a comparatively great number of speed changes and that these changes are effected gradually in the sense of occurring without shock or noise, while they may be made to take place in either direction. Each velocity ratio which the mechanism is set for effecting at any instant may be readily discerned by an index which in this case is constituted by the particular angular position assumed by the hand-wheel 64.

Having thus described my invention, I claim—

1. A speed-changing mechanism comprising in combination a gear-carrier; a driving and a driven shaft projecting therefrom; a gear upon each shaft; gearing carried by the gear-carrier and in mesh with the gears upon the shafts coupling the two shafts together and within said carrier; clutch mechanism between one of the shafts and the carrier; and cam and plunger actuated mechanism for actuating said clutch for holding the axis of rotation of such gearing and for changing the same from a fixed axis of rotation to a translationally-movable axis, and vice versa, and in both of which axial conditions all the gearing is at work.

2. A speed-changing mechanism comprising in combination a gear-carrier; a driving and a driven shaft projecting therefrom; gearing coupling the two shafts together within said gear-carrier and carried by said carrier and a gear thereof fast on each; means to control said shafts and gears for holding the axis of rotation of such gearing and for changing the same from a fixed axis of rotation to a translationally-movable axis and vice versa and embodying a cam mounted in said carrier and actuatable from the exterior.

3. The combination, in a speed-changing mechanism, of a driving and a driven shaft, gears on said shafts; a carrier; gears mounted on said carrier and meshing with the gears on said shafts; means for locking said carrier against movement and for freeing the same; and means for compelling said carrier to rotate with said driven shaft and comprising a member fast upon the driven shaft and having a friction-face, a member having movement axially of the carrier and provided with a friction-face adapted to engage the former friction-face, and a number of abutments on the said member and upon the carrier said abutments adapted to cause said member to rotate therewith and the said abutments provided with cam-faces adapted to move said member axially to hold the engaging faces in engagement upon initial engagement thereof; and means to institute said initial engagement.

4. The combination, in a speed-changing mechanism, of a driving and a driven shaft, gears on said shafts; a carrier rotatable about the common axis of the shaft gears; mounted

on said carrier and meshing with the gears on said shafts; a brake device for locking said carrier against movement and for freeing the same; and means for compelling said carrier to rotate with said driven shaft and embodying a friction-clutch and a cam device to force the clutch into action.

5. The combination with a driving and a driven shaft, of a carrier; gears mounted in part on the carrier for transmitting motion from one shaft to the other; engageable and disengageable means for rotating the carrier; and a brake device for simultaneously disengaging the carrier from its rotating means and positively holding it against rotation.

6. The combination with gear-provided driving and driven shafts, of a carrier; gears mounted thereon for transmitting motion from one shaft to the other; engageable and disengageable means for rotating the carrier; and a cam-actuated brake device for simultaneously disengaging the carrier from its rotating means and positively holding it against rotation.

7. The combination of gear-provided driving and driven shafts; a carrier; gears mounted on the carrier for transmitting motion from the driving to the driven shaft; a clutch for engaging the carrier with one of said shafts; and a brake device movable in one direction to both engage with said carrier and disengage the clutch and movable in the opposite direction to both release the carrier and permit the engagement of the clutch.

8. The combination of a driving and a driven shaft; gears mounted on the respective shafts; a carrier; gears fast with each other mounted on the carrier and in mesh with the gears on the shafts for transmitting motion from the driving to the driven shaft; a clutch for engaging the carrier with one of said shafts; a brake device movable in one direction to both engage with said carrier and disengage the clutch and movable in the opposite direction to both release the carrier and free the clutch; and means for automatically causing the clutch to engage the carrier with its driver upon the release of said brake device.

9. The combination of a driving and a driven shaft; a carrier; a train of gears mounted on the carrier and on the shafts for transmitting motion from the driving to the driven shaft; a clutch for engaging the carrier with the driven shaft; and a brake device movable in one direction to both engage with said carrier and disengage the clutch and movable in the opposite direction to both release the carrier and permit the engagement of the clutch.

10. The combination of a driving and a driven shaft; a carrier; a train of gears mounted on the carrier and on the shafts for transmitting motion from the driving to the driven shaft; a clutch for engaging the carrier with the driven shaft; a brake device movable in one direction to both engage with said carrier

and disengage the clutch and movable in the opposite direction to both release the carrier and permit the engagement of the clutch; and means for automatically causing the clutch to engage the carrier with its driver upon the release of said brake device.

11. The combination of a driving and a driven shaft; a carrier; a train of gears mounted on the carrier and on the shafts for transmitting motion from the driving to the driven shaft; a friction-clutch for engaging the carrier with one of said shafts; and a brake device movable in one direction to both engage with said carrier and disengage the friction-clutch and movable in the opposite direction to both release the carrier and permit the engagement of the clutch.

12. The combination of a driving and a driven shaft; a carrier; a train of gears mounted on the carrier and on the shafts for transmitting motion from the driving to the driven shaft; a friction-clutch for engaging the carrier with the driven shaft; a brake device movable in one direction to both engage with said carrier and disengage the friction-clutch; and movable in the opposite direction to both release the carrier and permit the engagement of the friction-clutch; and means for automatically causing the friction-clutch to engage the carrier with its driver upon the release of said brake device.

13. The combination of a driving and a driven shaft; a carrier; a train of gears mounted on the carrier and on the shafts for transmitting motion from the driving to the driven shaft; a friction-clutch for engaging the carrier with the driven shaft; a brake device movable in one direction to both engage with said carrier and disengage the friction-clutch and movable in the opposite direction to both release the carrier and permit the engagement of the friction-clutch; and a cam device for causing the friction-clutch to engage the carrier with its driver upon the release of said brake device.

14. The combination of a driving and a driven shaft having coincident axes; a gear secured to each shaft; a carrier rotatable about an axis coincident with the coincident axes of said two shafts; a pair of gears rigid with each other and mounted upon said carrier and meshing respectively with the gears secured to said shafts; a clutch member mounted on said driven shaft; a cooperative clutch member mounted on said carrier; and means for withdrawing the clutch member on the carrier from engagement with its cooperative member and for thereupon positively holding said carrier against rotation.

15. The combination of a driving and a driven shaft having coincident axes; a gear secured to each shaft; a carrier rotatable about an axis coincident with the coincident axes of said two shafts; a pair of gears rigid with each other and mounted upon said carrier and

meshing respectively with the gears secured to said shafts; a clutch member mounted on said driven shaft; a cooperative clutch member on the carrier movable axially of the latter and compelled to rotate therewith; a spring and a cam device urging the axially-movable clutch member into engagement with its cooperative member; and means for withdrawing the clutch member on the carrier from engagement with its cooperative member and for thereupon positively holding said carrier against rotation.

16. The combination of a driving and a driven shaft having coincident axes; a gear secured to each shaft; a carrier rotatable about an axis coincident with the coincident axes of said two shafts; a pair of gears rigid with each other and mounted upon said carrier and meshing respectively with the gears secured to said shafts; a clutch member rigid on said driven shaft; a cooperative clutch member mounted upon said carrier; and means for withdrawing the clutch member on the carrier from engagement with its cooperative member and for thereupon positively holding said carrier against rotation; said clutch members having conical friction drive-surfaces.

17. The combination of a driving and a driven shaft having coincident axes; a gear secured to each shaft; a carrier rotatable about an axis coincident with the coincident axes of said two shafts; a pair of gears rigid with each other and mounted upon said carrier and meshing respectively with the gears secured to said shafts; a clutch member rigid with said driven shaft; a cooperative clutch member on the carrier movable axially of the latter and compelled to rotate therewith; a spring urging the axially-movable clutch member into engagement with its cooperative member; and means for withdrawing the clutch member on the carrier from engagement with its cooperative member and for thereupon positively holding said carrier against rotation; said clutch members having conical friction drive-surfaces.

18. The combination of a driving and a driven shaft having coincident axes; a gear secured to each shaft; a carrier rotatable about an axis coincident with the coincident axes of said two shafts; a pair of gears rigid with each other and mounted upon said carrier and meshing respectively with the gears secured to said shafts; a clutch member rigid with said driven shaft; a cooperative clutch member on the carrier movable axially of the latter and compelled to rotate therewith; a cam device urging the axially-movable clutch member into engagement with its cooperative member; means for withdrawing the clutch member on the carrier from engagement with its cooperative member and for thereupon positively holding said carrier against rotation; and a cam for actuating said means.

19. A speed-changing mechanism comprising in combination a driving and a driven shaft;

gears mounted thereon; transmitting-gears for transmitting motion from one shaft to the other; a carrier upon which said transmitting-gears are mounted and which is provided with a reaction-surface; a clutch-ring compelled to rotate with said carrier and free to move axially thereof, said ring being formed with a conical friction drive-surface and a reaction-surface; a clutch member secured to said driven shaft and provided with a conical drive-surface cooperative with said conical surface on the clutch-ring; a brake-band contractible into engagement with said reaction-surfaces on the carrier and on the clutch-ring; a cam device for effecting the engagement of said clutch-ring with said friction member on the driven shaft when the brake-band is expanded; and means for expanding and contracting the brake-band.

20. A speed-changing mechanism comprising in combination a driving and a driven shaft; gears mounted thereon; transmitting-gears for transmitting motion from one shaft to the other; a carrier upon which said transmitting-gears are mounted and which is provided with a reaction-surface; a clutch-ring compelled to rotate with said carrier and free to move axially thereof, said ring being formed with a conical friction drive-surface and a reaction-surface; a clutch member secured to said driven shaft and provided with a conical surface cooperating with said conical surface on the clutch-ring; a brake-band contractible into engagement with said reaction-surfaces on the carrier and on the clutch-ring; a spring for insuring the engagement on said clutch-ring with said friction member on the driven shaft when the brake-band is expanded; a casing in which said parts are mounted; a cam-shaft journaled in said casing; and a cam mounted on said shaft for expanding and contracting said brake-band.

21. A speed-changing mechanism comprising, in combination, a driving and a driven shaft; gears mounted thereon, transmitting-gears for transmitting motion from one shaft to the other; a carrier upon which said transmitting-gears are mounted and which is provided with a reaction-surface; a clutch-ring compelled to rotate with said carrier and free to move axially thereof, said ring being formed with a conical friction drive-surface and an inclined reaction-surface; a clutch member secured to said driven shaft and provided with a conical surface cooperating with said conical surface on the clutch-ring; a brake-band contractible into engagement with said reaction-surfaces on the carrier and on the clutch-ring; a spring for insuring and a device for effecting the engagement of said clutch-ring with said friction member on the driven shaft when the brake-band is expanded; a lever journaled to the opposite ends of said brake-band; a casing in which said parts are mounted; a cam-shaft journaled in said casing, and

a cam mounted on said cam-shaft and operative to actuate said lever.

22. In a speed-changing mechanism, the combination with a casing, of a driving and a driven shaft extending therefrom and disposed in line with each other; a carrier journaled on said shafts; gears secured to the contiguous ends of said shafts; a plurality of sets of symmetrically-disposed transmitting-gears mounted on said carrier, said carrier being provided with an inclined reaction-surface; a friction clutch-ring movable axially of the carrier and compelled to rotate therewith and provided with a conical friction drive-surface and an inclined reaction-surface; a cooperative clutch member secured to the driven shaft; a cam device urging said clutch-ring into engagement with the clutch member on the driven shaft; a divided brake-band adapted to cooperate with the inclined reaction-surfaces of the carrier and the clutch-ring; lever mechanism for expanding and contracting said brake-band; and a cam for actuating said lever.

23. In a speed-changing mechanism, the combination of a casing; a driving and a driven shaft extending therefrom and disposed in line with each other; a carrier journaled on said shafts; gears secured to the contiguous ends of said shafts; sets of symmetrically-disposed transmitting-gears mounted on said carrier, said carrier being provided with an inclined reaction-surface; a friction clutch-ring movable axially of the carrier and compelled to rotate therewith and provided with a conical friction drive-surface and an inclined reaction-surface; a cooperative clutch member secured to the driven shaft; a cam device urging said clutch-ring into engagement with the clutch member on the driven shaft; a divided brake-band adapted to cooperate with the inclined reaction-surfaces of the carrier and the clutch-ring; lever mechanism for expanding and contracting said brake-band; a spring adapted to force the contiguous ends of said brake-band apart and thereby cause the expansion of said band; and a cam for operating said lever mechanism against the tension of said spring.

24. In a speed-changing mechanism, the combination of a casing; a driving and a driven shaft extending therefrom and disposed in line with each other; a carrier journaled on said shafts; gears secured to the contiguous ends of said shafts; sets of symmetrically-disposed transmitting-gears mounted on said carrier, said carrier being provided with an inclined reaction-surface; a friction clutch-ring movable axially of the carrier and compelled to rotate therewith and provided with a conical friction drive-surface and a reaction-surface oppositely inclined to the reaction-surface on the carrier; a cooperative clutch member secured to the driven shaft; a cam device urging said clutch-ring into engagement with the clutch member on the driven shaft; an adjust-

able brake-band adapted to cooperate with the oppositely-inclined reaction-surfaces on the carrier and on the clutch-ring; lever mechanism for expanding and contracting said brake-band; a spring adapted to force the contiguous ends of said brake-band apart and thereby cause the expansion of said ring; a cam for operating said lever mechanism against the tension of said spring; and a casing in which the parts are mounted.

25. A speed-changing mechanism embodying a plurality of associated speed-changing units, each comprising a set of transmitting-gears, combined with a driving and a driven shaft for each unit, the driven shaft of one unit constituting the driving-shaft of the next adjacent unit, gears secured to said shafts and with which the transmitting-gears of the set engage; a carrier for each said set; clutches for connecting the carriers with the respective driven shafts; and means for locking and unlocking at will and in a predetermined order the respective carriers against movement and for actuating the clutches to connect the unlocked carriers to their respective driven shafts.

26. A speed-changing mechanism embodying a casing and a plurality of associated speed-changing units, each comprising a set of transmitting-gears, combined with a driving and a driven shaft for each unit, the driven shaft of one unit constituting the driving-shaft of the next adjacent unit; gears secured to said shafts and with which the transmitting-gears of the set engage; a carrier for each said set; clutches for connecting the carriers with the respective driven shafts; and means comprising cams and combined actuators and brake-bands for locking and unlocking at will and in a predetermined order the respective carriers against movement and for actuating the clutches to connect the unlocked carriers to their respective driven shafts.

27. In change-speed gearing, the combination of a driving-shaft, a driven shaft, gears, one of which is mounted upon each of said shafts, clutch members interposed between said shafts, one of said clutch members being movable, a disk attached to said movable clutch member for retracting the latter, a second disk, pinions mounted upon said second disk and adapted to transmit motion from one to the other of said gears, means whereby said disks are at all times prevented from relative rotary movements, a spring which is adapted to cause said clutch members to engage, and means for holding said disks from rotation.

28. In a change-speed gearing, the combination of driving and driven shafts, a gear mounted upon each of said shafts, a conical, friction-clutch member mounted upon each of said shafts, means for retracting the movable clutch member, a spring for advancing said movable member, said cones being of such a taper as to permit their efficient engagement by means

of said spring alone, a second disk, and a gearing on said second disk for transmitting motion from one to the other of said gears.

5 29. In a change-speed gearing, the combination of a frame, driving and driven shafts, gearing for transmitting motion from one to the other of said shafts, said gearing comprising a disk or disks, and means for holding said disk or disks from rotation, said means  
10 comprising substantially semicircular friction-bands, a screw on the frame, each of said bands being provided, at one end, with means for engagement with said screw, a space being left between the adjacent portions of the  
15 bands between said screws to permit adjustment of said bands toward and from each other, and means attached to the other end of said

bands for drawing said bands about said disk or disks.

30. In a change-speed gearing, the combination of a casing, driving and driven shafts at  
20 opposite ends of said casing, and a series of units of change-speed gearing, each of which has a connection with one of said shafts, or  
25 with each other, that is effected solely by a simple movement in the direction of the axes of said shafts, whereby said units may be successively removed from said case without being dismantled.

CONRAD M. CONRADSON.

Witnesses:

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