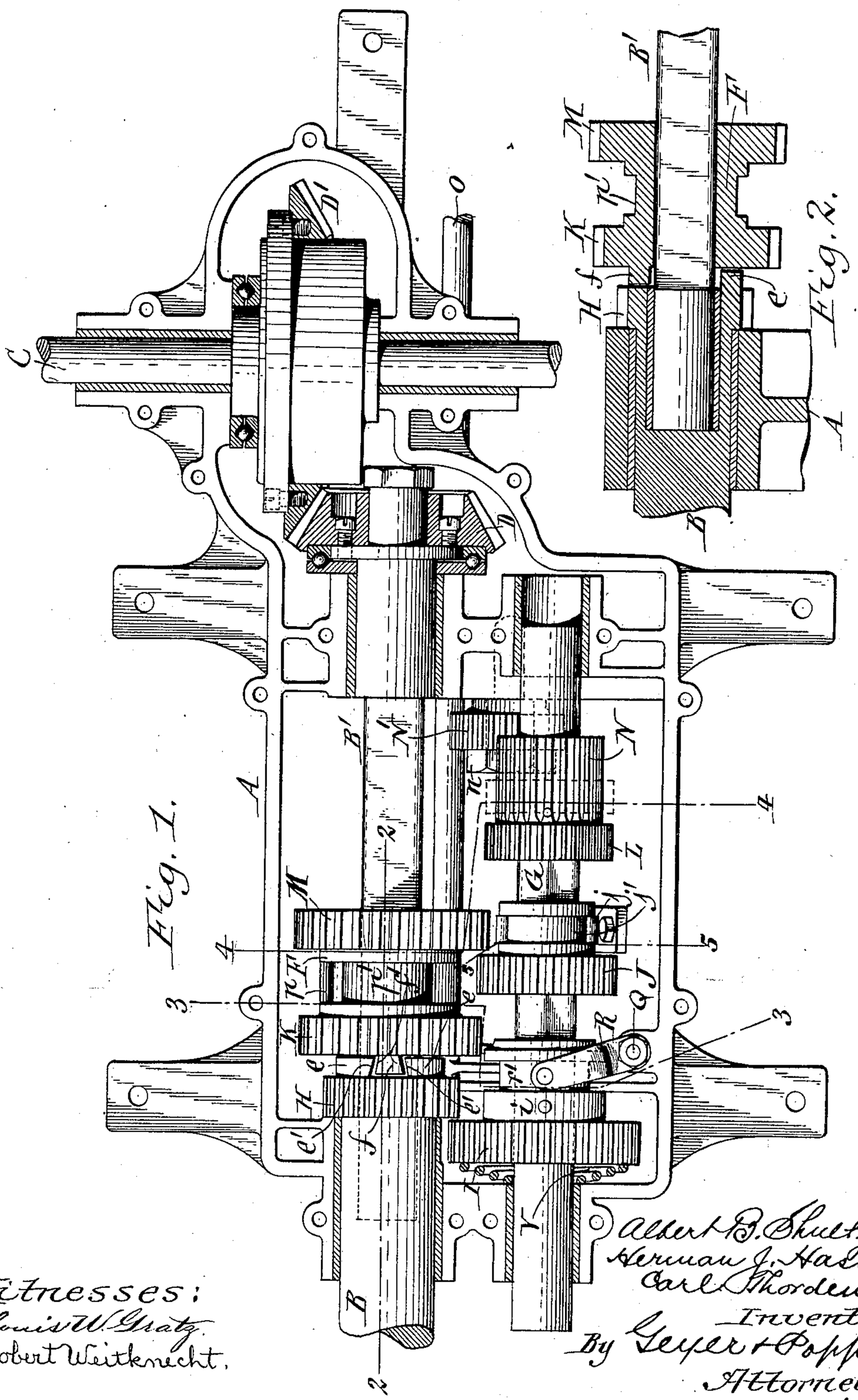
No. 754,905. PATENTED MAR. 15, 1904.

A. B. SHULTZ, H. J. HASS & C. THORDEN.

VARIABLE SPEED GEARING.

APPLICATION FILED OCT. 28, 1903.

NO MODEL. 3 SHEETS—SHEET 1.



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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3.

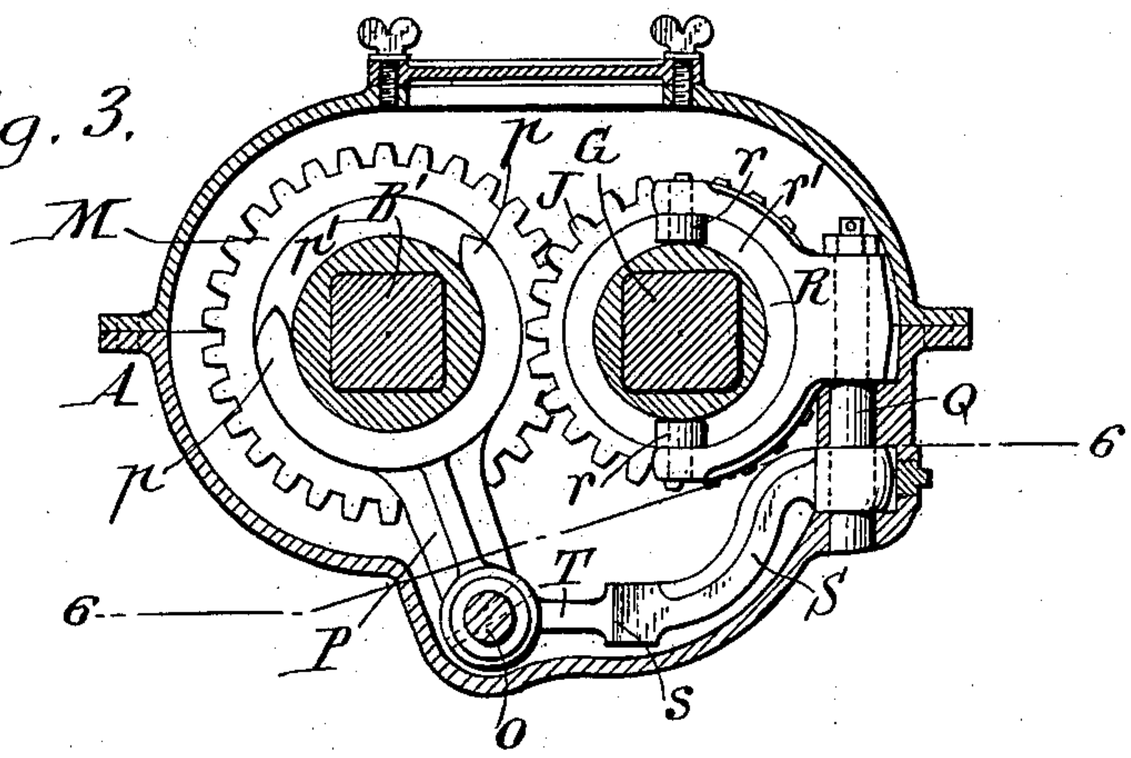


Fig. 4.

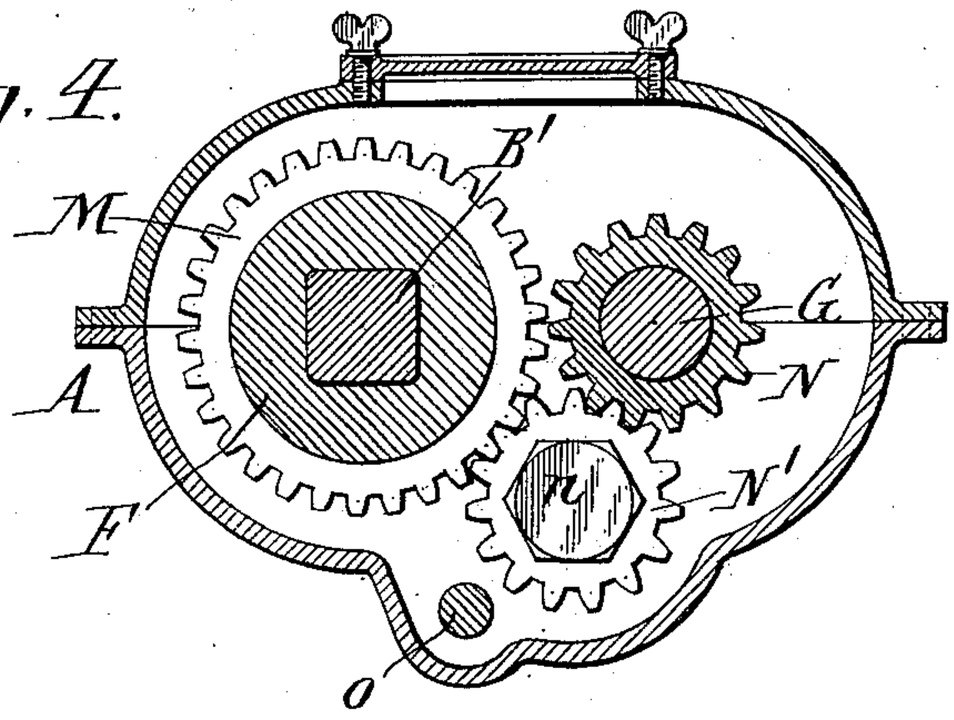


Fig. 5.

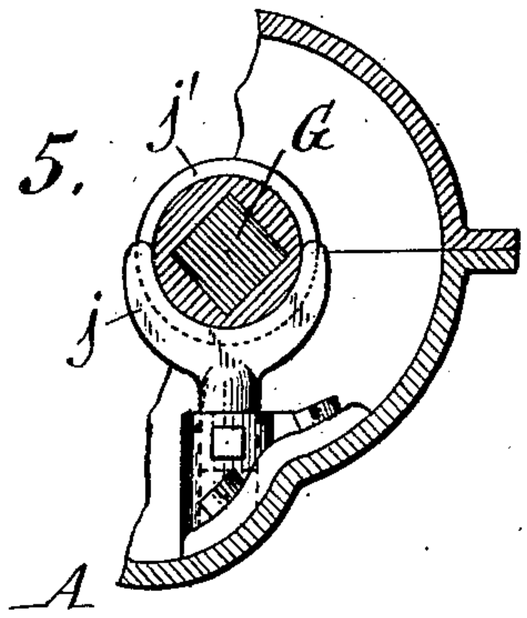
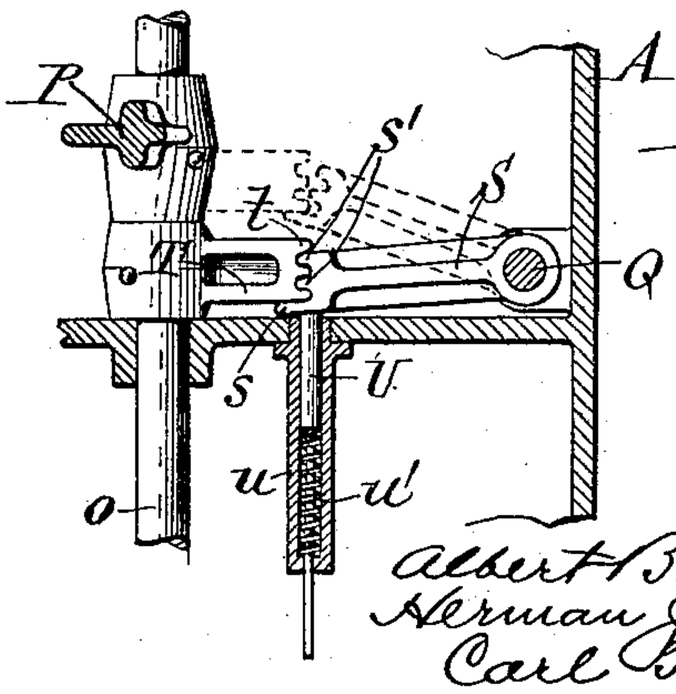


Fig. 6.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 8.

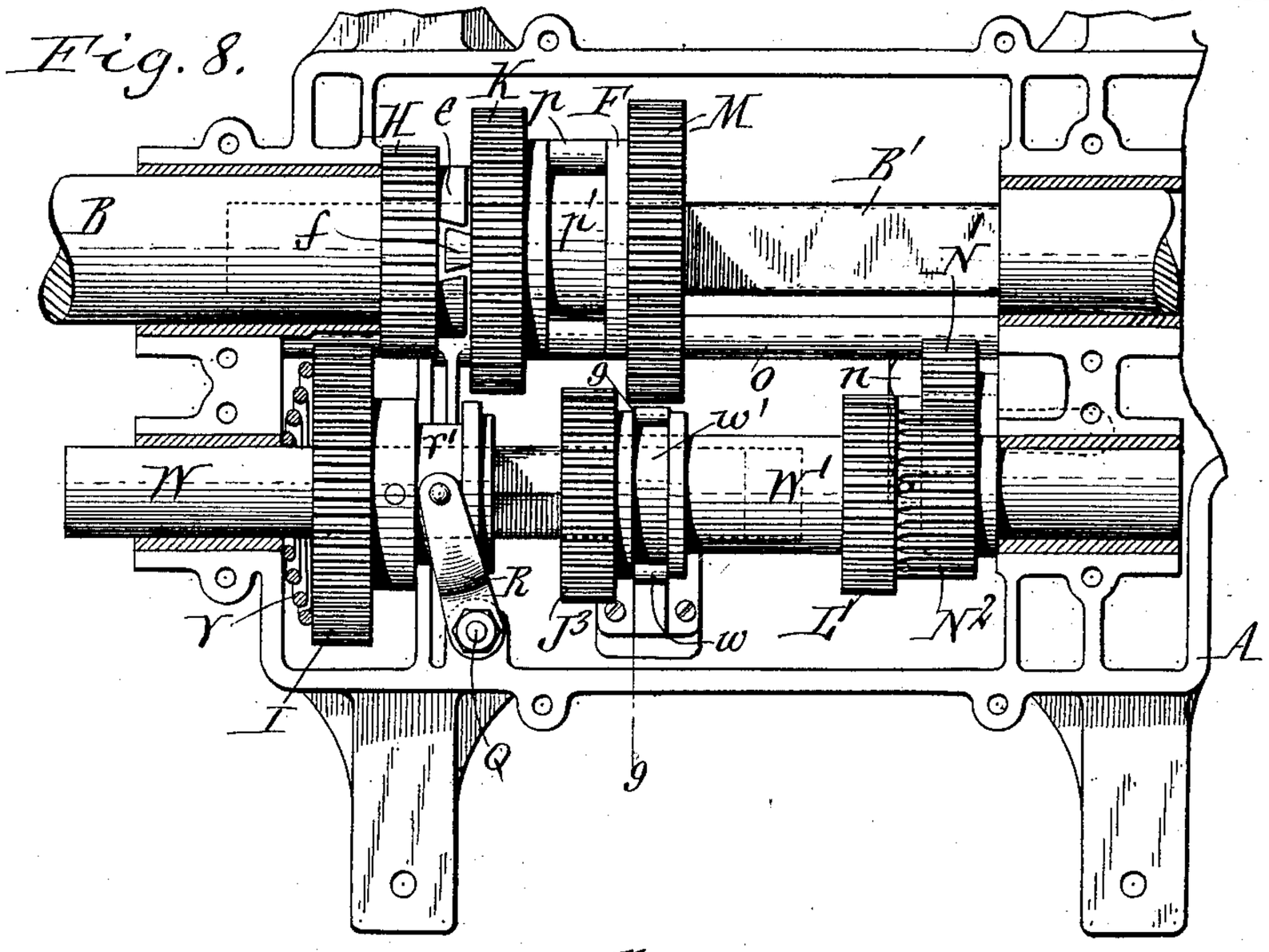


Fig. 7.

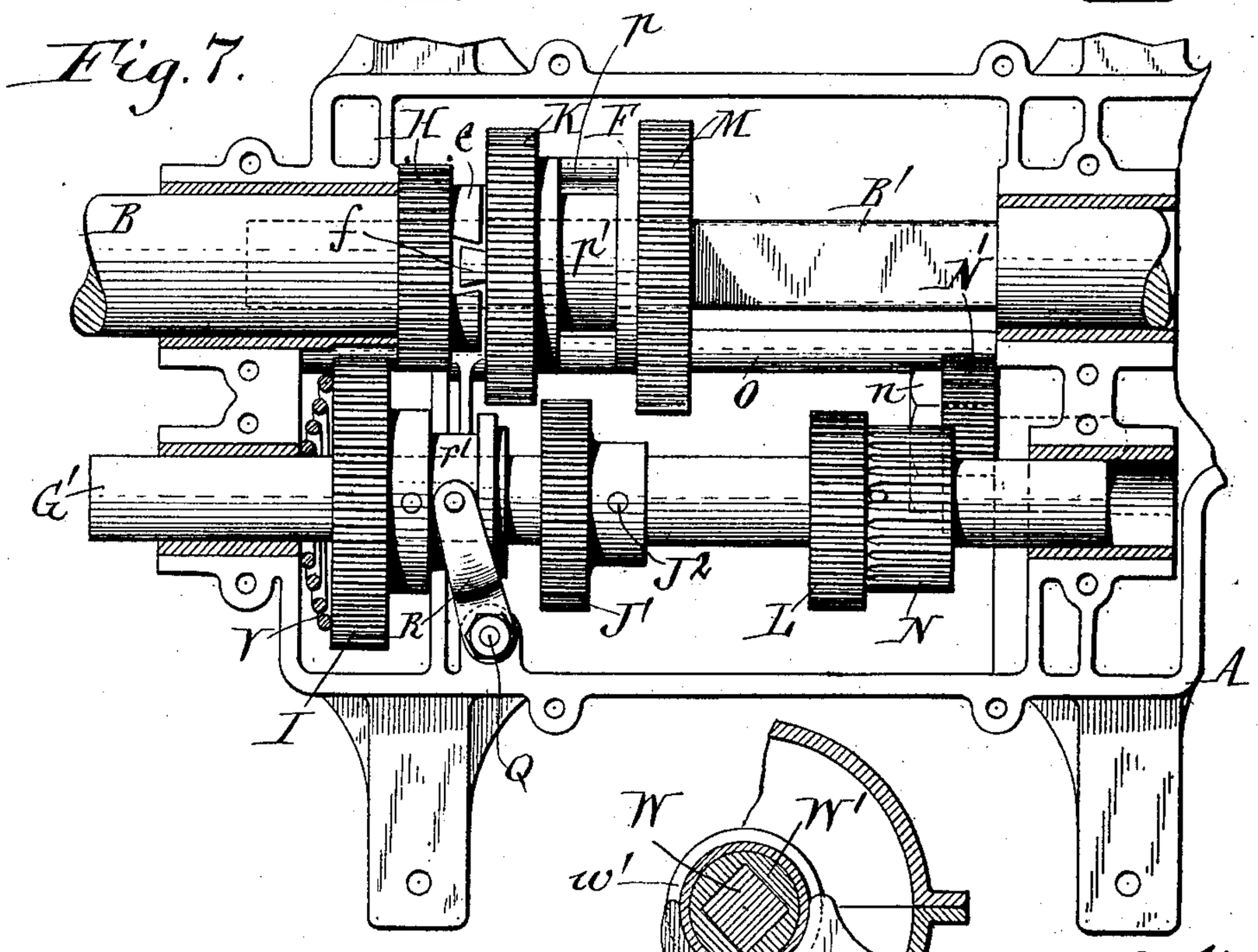
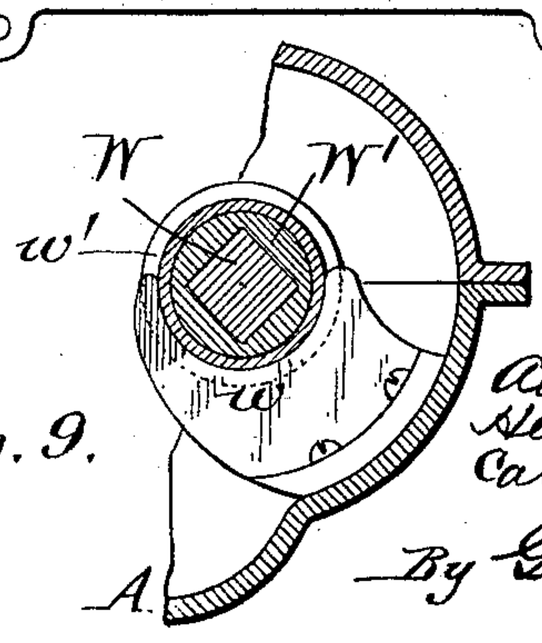


Fig. 9.



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No. 754,905. Patented March 15, 1904.

UNITED STATES PATENT OFFICE.

ALBERT B. SHULTZ, HERMAN J. HASS, AND CARL THORDEN, OF BUFFALO, NEW YORK, ASSIGNORS TO E. R. THOMAS MOTOR COMPANY, OF BUFFALO, NEW YORK.

VARIABLE-SPEED GEARING.

SPECIFICATION forming part of Letters Patent No. 754,905, dated March 15, 1904.

Application filed October 28, 1903. Serial No. 178,870. (No model.)

To all whom it may concern:

Be it known that we, ALBERT B. SHULTZ and HERMAN J. HASS, citizens of the United States, and CARL THORDEN, a subject of the King of England, all residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Variable-Speed Gearing, of which the following is a specification.

This invention relates to a variable-speed gearing which is more particularly designed for use in automobiles, but which may also be used for other purposes.

The object of this invention is to produce a variable-speed gearing of this character which is simple and durable in construction, reliable and noiseless in operation, and not liable to get out of order.

In the accompanying drawings, consisting of three sheets, Figure 1 is a sectional top plan view of a speed-varying gearing embodying our improvements. Fig. 2 is a fragmentary vertical longitudinal section in line 2 2, Fig. 1. Figs. 3, 4, and 5 are vertical cross-sections in lines 3 3, 4 4, and 5 5, Fig. 1, respectively. Fig. 6 is a fragmentary horizontal section in line 6 6, Fig. 3. Fig. 7 is a top plan view, partly in section, showing a modified construction of our invention. Fig. 8 is a top plan view showing another modification of our invention. Fig. 9 is a fragmentary cross-section thereof in line 9 9, Fig. 8.

Similar letters of reference indicate corresponding parts throughout the several views.

Referring to Figs. 1 to 6, A represents the frame or casing on which the variable-speed gearing is mounted and which may be of any suitable construction.

B represents the main driving-shaft, which may be driven by a motor of any suitable kind in a well-known manner and which is journaled in the frame.

B′ represents the driven shaft, which is rotated at variable speeds from the driving-shaft and from which the motion is transmitted to the parts to be operated in any suitable way. The driven shaft is arranged axially in line with the driving-shaft and journaled at its rear end in a bearing on the frame, while its front end is preferably journaled in the rear end of the driving-shaft, as shown in Fig. 2. The means shown in the drawings for transmitting the motion of the driven shaft to the parts to be operated comprises a transmitting-shaft C, arranged transversely in the rear of the driven shaft B′, and intermeshing bevel gear-wheels D D′, mounted, respectively, on the rear end of the driven shaft and the transmitting-shaft.

For the purpose of rotating the driven shaft at the same speed as the driving-shaft the shafts may be directly connected by a clutch or coupling, which may be variously constructed. The preferred form of clutch for this purpose shown in the drawings consists of coöperating clutch-teeth *e f*, mounted on the opposing ends, respectively, of the driving and driven shafts. The teeth *e* are preferably formed on the front end of the driving-shaft, and the teeth *f* are formed on the front end of a sleeve F, which is mounted on the driven shaft so as to be capable of sliding lengthwise thereon, but compelled to turn therewith. This connection between the sleeve F and the driven shaft may be effected in different ways, but preferably by making that part of the driven-shaft between its bearings square or flat-sided and engaging the same with a correspondingly-shaped bore in the sleeve F, as shown in Figs. 3 and 4. The sleeve F when moved into its foremost position, as shown in Fig. 1, engages its teeth *f* between the teeth *e* of the driving-shaft, whereby the latter and the driven shaft are directly connected and rotated at the same speed. Upon shifting the sleeve F rearwardly sufficiently to disengage its teeth from the teeth of the driving-shaft the direct connection between the driving and driven shaft is broken.

In order to prevent the clutch-teeth when engaged from being separated accidentally by the lateral pressure against each other, the coöperating sides of the teeth are undercut or beveled, so that they recede from their front ends toward their rear ends, and the body of

the teeth have a dovetail shape. This formation of the teeth causes their inclined faces when engaged to draw the teeth together and effectually prevents the same from separating, which would be liable to occur if the faces of the teeth were straight or worn off, so as to produce an outwardly-inclined bevel on the same.

For the purpose of rotating the driven shaft at different speeds from the driving-shaft the movement of the latter is transmitted to the former by a speed-varying mechanism, which comprises a counter-shaft and a plurality of pairs of differential gears. In the drawings a speed-varying device is shown which reduces the speed of the driven shaft below that of the driving-shaft, the same being constructed as follows: G represents a counter-shaft arranged adjacent to the opposing ends of the driving and driven shafts and journaled at its ends in bearings on the frame, so as to be capable of axial or longitudinal movement therein. H represents a primary gear-pinion turning with the driving-shaft and preferably formed integrally therewith in rear of its clutch-teeth. I represents a primary gear-wheel which serves to connect and disconnect the driving and counter shafts. This gear-wheel is secured to the counter-shaft adjacent to the primary pinion, so as to be compelled to rotate and move axially therewith. In the inoperative position of the primary gear-wheel the same is arranged in front of or forwardly out of line with the primary pinion, as shown in Fig. 1, in which position the connection between the driving and counter shafts is broken. Upon shifting the primary wheel rearwardly, so that its teeth engage those of the primary pinion, the rotation of the driving-shaft is transmitted to the counter-shaft at a reduced speed. J represents a secondary gear-pinion mounted on the counter-shaft in rear of the primary wheel. The secondary pinion is held against axial movement with the counter-shaft by means of a fork *j* on the frame engaging with an annular groove *j'* in the hub of the secondary pinion; but the latter is compelled to turn with the counter-shaft by making the bore of the pinion square and the part of the counter-shaft which slides in the same of corresponding shape in cross-section. K represents a secondary gear-wheel movable on the driven shaft and adapted to connect the same with or disconnect the same from the secondary pinion. The secondary gear-wheel is preferably mounted on the front end of the sleeve F, whereby this gear-wheel is compelled to turn with the driven shaft, but is free to slide axially thereon. In the position of the parts shown in Fig. 1 the secondary wheel is moved forwardly on the driven shaft and out of engagement from the secondary pinion, whereby the transmission of motion from the counter-shaft to the driven shaft through the secondary wheel and pinion is broken. Upon moving the secondary wheel rearwardly so that it meshes with the secondary pinion a driving connection is established between the counter-shaft and driven shaft, whereby the latter is rotated at a slower speed than the former. The relation of the secondary wheel and pinion is such that the sleeve F, carrying this wheel, moves rearwardly a sufficient extent to disengage its clutch-teeth from those of the driving-shaft before the secondary wheel and pinion intermesh.

When the primary wheel is moved rearwardly on the counter-shaft into mesh with the primary pinion and the secondary wheel is moved rearwardly on the driven shaft into mesh with the secondary pinion, motion is transmitted from the driving-shaft to the driven shaft and the parts connected therewith at a reduced speed.

L represents a tertiary pinion which is secured to the counter-shaft in rear of the secondary pinion and which is of somewhat smaller diameter than the latter. The tertiary pinion is adapted to intermesh with a tertiary gear-wheel M, which is arranged in rear of the secondary gear-wheel and is of somewhat larger diameter. The tertiary wheel is mounted on the rear end of the sleeve F, so as to move lengthwise therewith on the driven shaft in unison with the secondary wheel. When the counter-shaft is moved rearwardly for engaging its primary wheel with the primary pinion, the tertiary pinion is shifted from the position shown in full lines to the position shown in dotted lines in Fig. 1, in which latter position the relation of the secondary and tertiary wheels and pinions is such that both of these gear-wheels cannot engage their respective pinions at the same time. Upon moving the sleeve F rearwardly until the secondary wheel has cleared its companion pinion and the tertiary gear-wheel has been engaged with its pinion the primary gear-wheel and pinion are still in mesh and the driven shaft is rotated from the driving-shaft at a speed which is lower than that at which it is rotated when the secondary gear-wheel and pinion are in mesh.

N N′ represent a pair of main and intermediate reversing gear-pinions which coöperate with the tertiary gear-wheel for rotating the driven shaft in a direction opposite to that of the driving-shaft. The main reversing-pinion N is secured to the counter-shaft in rear of the tertiary pinion and preferably formed on the same hub with the latter. The intermediate reversing-pinion N′ meshes with the lower part of the main reversing-pinion N and is pivoted on the frame by means of a stud, arbor, or screw *n*. Upon moving the sleeve F rearwardly, so as to disengage the tertiary wheel M from the tertiary pinion L, and engaging said wheel with the intermediate pinion N′ while the primary gear-wheel and pinion are in mesh, the driven shaft is

rotated at a comparatively slow speed in a direction opposite to that of the driving-shaft. The main reversing gear-wheel N is of such length that the same will always remain in mesh with the reversing-pinion whether the counter-shaft is moved forward or backward.

When it is desired to again turn the driving-shaft forwardly at the highest speed, the sleeve F, carrying the gear-wheels K M, is moved into its foremost position, in which its clutch-teeth engage those of the driving-shaft, and the primary wheel is shifted forwardly out of engagement from the primary pinion.

It will be observed that the counter-shaft is inoperative when the highest speed is transmitted and only comes into service when it is desired to reduce or reverse the motion derived from the motor.

The means for shifting the counter-shaft G and the sleeve F, together with the wheel and pinions connected therewith, in the manner hereinbefore described is constructed as follows: O represents a longitudinally-movable shipper-rod which is arranged parallel with the shafts and guided in the frame. This rod may be shifted by any suitable means within convenient reach of the attendant when the variable-speed gearing is employed in an automobile. The secondary and tertiary gear-wheels are compelled to move lengthwise with the shipper-rod, but capable of rotating independently thereof, by means of a fork having its arm P connected with the shipper-rod, while its jaws *p* engage with an annular groove *p'* in the shifting sleeve F. Q represents an upright rock-shaft, which is journaled in a bearing in the frame on the outer side of the counter-shaft and at right angles thereto. This shaft is coupled at its upper end with the primary gear-wheel, so that the latter is compelled to move with the rock-shaft, but is capable of turning independently thereof. This coupling is preferably effected by means of a rock arm or fork R, secured to the upper end of the rock-shaft and having its jaws provided with rollers *r*, which engage with an annular groove *r'* in the hub of the primary gear-wheel. S represents a rock-arm secured to the lower end of the rock-shaft and projecting toward the shipper-rod. The free end of this rock-arm is provided with teeth *s s'*, forming a gear-segment adapted to be engaged by the coöperating teeth *t* of a tappet T, which is secured to the adjacent part of the shipper-rod.

When the gear-wheels are in their foremost position, in which the driven shaft is coupled directly with the driving-shaft and the primary gear-wheel is disengaged from its pinion, as shown in Fig. 1, the shipper-rod is likewise in its foremost position and the tappet and gear-segment are in mesh, as shown in Fig. 6. The movement of the parts in this direction may be limited by various means, but is preferably effected, as shown in the drawings, by engagement of the hub of the tappet with the adjacent part of the frame and also by engagement of the sleeve F with the rear end of the driving-shaft.

For the purpose of reducing the speed or reversing the movement the shipper-rod is moved rearwardly. During the first part of the rearward movement of the shipper-rod the gear-segment is also moved in the same direction by the tappet, whereby the primary gear-wheel is engaged with its pinion, the clutch-teeth are disengaged, and the secondary gear-wheel is engaged with its companion pinion on the counter-shaft, thereby effecting the first downward step or reduction in the transmission of speed. Upon continuing the rearward movement of the shipper-rod the tappet clears the segment and moves rearwardly independent of the latter, whereby the primary gear wheel and pinion remain in mesh, while the secondary gear-wheel is disengaged from its pinion and the tertiary gear-wheel is engaged either with the tertiary pinion for reducing the transmission of speed another step or with the intermediate pinion N' for reversing the movement. During the first part of the subsequent forward movement of the shipper-rod the tertiary gear-wheel is disengaged from the intermediate pinion and engaged with the tertiary pinion, and during the middle part of this movement the tertiary gear-wheel and pinion are disengaged and the secondary gear-wheel and pinion are engaged. During the last portion of the forward movement of the shipper-rod the secondary gear-wheel and pinion are disengaged, while the clutch is coupled and the rock-shaft is turned forwardly by reason of the tappet engaging with the gear-segment, whereby the primary gear-wheel is disengaged from its pinion. By means of this slack connection between the devices for shifting the sleeve F and the devices for shifting the counter-shaft rotation of the latter and the parts connected therewith is therefore prevented at all times, except when the same are engaged in reducing the speed or reversing the movement, thereby avoiding unnecessary wear of the parts and loss of power and also eliminating the noise which is produced by the rotation of idle gear-wheels.

In order to insure the proper engagement of the tappet with the segment during the last part of the forward movement of the shipper-rod, the foremost tooth *s* of the gear-segment is longer than the other teeth, *s'*. When the segment is shifted into its rearward position by the tappet, as represented by dotted lines in Fig. 5, and is left behind by the tappet during its continued rearward movement, the long tooth *s* of the segment stands in the path of the tappet, so that the latter during the

last part of its subsequent forward movement engages the long tooth and causes the segment and tappet to mesh properly.

The rearward movement of the counter-shaft and the parts connected therewith may be stopped by any suitable means, this being preferably accomplished by engaging the rear end of the reversing gear-wheel N with the adjacent part of the frame.

In the absence of any provision to prevent it the counter-shaft and parts mounted thereon when disconnected from the shipper-rod are liable to be shifted and disconnect the intermeshing gear-wheels and pinions by the jolting of the automobile which carries the gearing, and means are therefore provided for avoiding this result. As shown in the drawings, this is accomplished partly by a follower U, movable lengthwise in a guide *u* in the front part of the frame, and a spring *u'*, whereby this follower is yieldingly pressed against the front side of the segment. When the tappet leaves the segment while the gearing is being adjusted for the lower speed or for reversing the motion, the spring-pressed follower holds the segment in its rearmost position; but when the segment is moved forwardly by the tappet the follower recedes into its guide and compresses the spring, which is arranged in the guide. In addition to the spring-pressed follower U a spring V is arranged about the counter-shaft between the front side of the primary gear-wheel I and the adjacent front part of the frame, which spring assists in holding the counter-shaft yieldingly in its rearmost or operative position.

Instead of holding the secondary pinion against axial movement, as shown in Fig. 1, this pinion J' may be fixed on the counter-shaft G' by a pin J^2, as shown in Fig. 7, or otherwise, so as to cause the secondary pinion to move axially with the counter-shaft.

In the modified construction of our invention (shown in Figs. 8 and 9) the counter-shaft is composed of two telescopic sections W W', the front section W carrying the primary gear-wheel and being movable axially in its bearing, while the rear section W' has fixed thereon the secondary pinion J^3, the tertiary pinion L', and main reversing-pinion N^2 and is held against axial movement by a fork *w* on the frame engaging with an annular groove *w'* in the hub of the secondary pinion. The two sections of the divided shaft are compelled to turn together in any suitable manner—for instance, by making the rear end of the front section square and fitting the same in a corresponding bore in the front end of the rear section, as shown in Fig. 9.

We claim as our invention—

1. A variable-speed gearing comprising a driving-shaft, a pinion on the driving-shaft, a driven shaft, a clutch for connecting or disconnecting the driving and driven shafts, an axially-movable counter-shaft, a gear-wheel secured to said counter-shaft and movable into and out of mesh with the pinion on the driving-shaft, and gearing for operatively connecting the counter and driven shafts, substantially as set forth.

2. A variable-speed gearing comprising a driving-shaft, a pinion on the driving-shaft, a driven shaft, a clutch for connecting or disconnecting the driving and driven shafts, an axially-movable counter-shaft, a gear-wheel secured to said counter-shaft and movable into and out of mesh with the pinion on the driving-shaft, a pinion turning with the counter-shaft but held against axial movement therewith, and a gear-wheel turning with the driven shaft and movable axially thereon into and out of mesh with the pinion on the counter-shaft, substantially as set forth.

3. A variable-speed gearing comprising a driving-shaft, a pinion on the driving-shaft, a driven shaft, a clutch for connecting or disconnecting the driving and driven shafts, an axially-movable counter-shaft, a gear-wheel secured to said counter-shaft and movable into and out of mesh with the pinion on the driving-shaft, a pinion having a flat-sided bore which receives a correspondingly-shaped part of the counter-shaft for permitting the shaft to slide through the pinion but to compel these parts to turn together, a stationary fork which engages the annular groove in the hub of said counter-shaft pinion for holding the latter against axial movement with the counter-shaft, and a gear-wheel turning with the driven shaft and movable axially thereon into and out of mesh with the pinion on the counter-shaft, substantially as set forth.

4. A variable-speed gearing comprising a driving-shaft, a pinion on the driving-shaft, a driven shaft, a clutch for connecting or disconnecting the driving and driven shafts, an axially-movable counter-shaft, a gear-wheel secured to said counter-shaft and movable into and out of mesh with the pinion on the driving-shaft, a pinion secured to the counter-shaft, and a gear-wheel turning with the driven shaft and movable axially thereon into and out of mesh with the pinion on the counter-shaft, substantially as set forth.

5. A variable-speed gearing comprising a driving-shaft, a pinion on the driving-shaft, a driven shaft, a clutch for connecting or disconnecting the driving and driven shafts, an axially-movable counter-shaft, a gear-wheel secured to said counter-shaft and movable into and out of mesh with the pinion on the driving-shaft, an intermediate reversing-pinion, a stationary pivot for the reversing-pinion, a main reversing-pinion secured to the counter-shaft so as to move axially therewith and co-operating with said intermediate reversing-pinion, and a gear-wheel turning with the driven shaft and movable axially thereon into

or out of mesh with said intermediate reversing-pinion, substantially as set forth.

6. A variable-speed gearing comprising a driving-shaft, a primary pinion on the driving-shaft, a driven shaft, a clutch for connecting or disconnecting the driving and driven shafts, an axially-movable counter-shaft, a primary gear-wheel secured to the counter-shaft and movable into and out of mesh with the primary pinion on the driving-shaft, a secondary pinion turning with the counter-shaft but held against axial movement therewith, a secondary gear-wheel turning with the driven shaft but movable axially thereon into and out of mesh with the secondary pinion, a tertiary pinion and a main reversing-pinion secured to said counter-shaft, an intermediate reversing-pinion, a stationary pivot for the reversing-pinion and meshing with the main reversing-pinion, and a tertiary gear-wheel turning with the driven shaft but movable axially thereon into mesh with either the tertiary pinion or the intermediate reversing-pinion, substantially as set forth.

7. A variable-speed gearing comprising a driving-shaft, a driven shaft, a clutch for connecting and disconnecting the driving and driven shafts, a pinion arranged on the driving-shaft, a gear-wheel movable axially into and out of mesh with said pinion, a rock-shaft, a fork connected with said rock-shaft and engaging with an annular groove in the hub of said gear-wheel, a rock-arm also connected with said rock-shaft, a tappet which moves in unison with said clutch and engages said rock-arm for shifting said gear-wheel, and gearing operatively connecting said gear-wheel and driven shaft, substantially as set forth.

8. A variable-speed gearing comprising a driving-shaft, a driven shaft, a counter-shaft, a sleeve sliding on the driven shaft and provided with clutch-teeth adapted to be engaged with or disengaged from clutch-teeth of the driving-shaft, a pinion mounted on the driving-shaft, a shipper-rod, a fork connected with the shipper-rod and engaging with an annular groove in said sleeve, a gear-wheel mounted on the counter-shaft and movable axially into and out of engagement with said pinion, a rock-shaft, a fork secured to said rock-shaft and engaging with an annular groove in the hub of said gear-wheel, a rock-arm also secured to said rock-shaft, and a tappet secured to said shipper-rod and adapted to engage said rock-arm, substantially as set forth.

9. A variable-speed gearing comprising, a driving-shaft, a driven shaft, a counter-shaft, a sleeve sliding on the driven shaft and provided with clutch-teeth adapted to be engaged with or disengaged from clutch-teeth on the driving-shaft, a pinion mounted on the driving-shaft, a shipper-rod, a fork connected with the shipper-rod and engaging with an annular groove in said sleeve, a gear-wheel mounted on the counter-shaft and movable axially into and out of engagement with said pinion, a rock-shaft, a fork secured to said rock-shaft and engaging with an annular groove in the hub of said gear-wheel, a rock-arm also secured to said rock-shaft, a tappet arranged on the shipper-rod and adapted to engage said rock-arm, and a spring interposed between said gear-wheel and an adjacent stationary part, substantially as set forth.

10. A variable-speed gearing comprising a driving-shaft, a driven shaft, a counter-shaft, a sleeve sliding on the driven shaft and provided with clutch-teeth adapted to be engaged with or disengaged from clutch-teeth on the driving-shaft, a pinion mounted on the driving-shaft, a shipper-rod, a fork connected with the shipper-rod and engaging with an annular groove in said sleeve, a gear-wheel mounted on the counter-shaft and movable axially into and out of engagement with said pinion, a rock-shaft, a fork secured to said rock-shaft and engaging with an annular groove in the hub of said gear-wheel, a rock-arm also secured to said rock-shaft, a tappet arranged on the shipper-rod and adapted to engage said rock-arm, a spring-pressed follower engaging said rock-arm, and a spring interposed between said gear-wheel and an adjacent stationary part, substantially as set forth.

11. A variable-speed gearing comprising a driving-shaft, a driven shaft, a counter-shaft, a sleeve sliding on the driven shaft and provided with clutch-teeth adapted to be engaged with or disengaged from clutch-teeth on the driving-shaft, a pinion mounted on the driving-shaft, a shipper-rod, a fork connected with the shipper-rod and engaging with an annular groove in said sleeve, a gear-wheel mounted on the counter-shaft and movable axially into and out of engagement with said pinion, a rock-shaft, a fork secured to said rock-shaft and engaging with an annular groove in the hub of said gear-wheel, a rock-arm also secured to said rock-shaft and provided with a gear-segment, and a tappet arranged on the shipper-rod and having gear-teeth adapted to engage the teeth of said segment, substantially as set forth.

12. A variable-speed gearing comprising a driving-shaft, a driven shaft, a counter-shaft, a sleeve sliding on the driven shaft and provided with clutch-teeth adapted to be engaged with or disengaged from clutch-teeth on the driving-shaft, a pinion mounted on the driving-shaft, a shipper-rod, a fork connected with the shipper-rod and engaging with an annular groove in said sleeve, a gear-wheel mounted on the counter-shaft and movable axially into and out of engagement with said pinion, a rock-shaft, a fork secured to said rock-shaft and engaging with an annular

groove in the hub of said gear-wheel, a rock-arm also secured to said rock-shaft, a gear-segment arranged on said rock-arm and having its foremost tooth longer than its other teeth, and a tappet secured to the shipper-rod and having gear-teeth adapted to mesh with the teeth of said gear-segment, substantially as set forth.

Witness our hands this 23d day of October, 1903.

ALBERT B. SHULTZ.
HERMAN J. HASS.
CARL THORDEN.

Witnesses:
JULIUS M. EDSALL,
WALTER H. VAN DEUSEN.