June 16, 1931. M. L. F. VON BROEMBSEN 1,810,450

VARIABLE SPEED GEAR MECHANISM

Filed Jan. 6, 1930

Fig. 1.

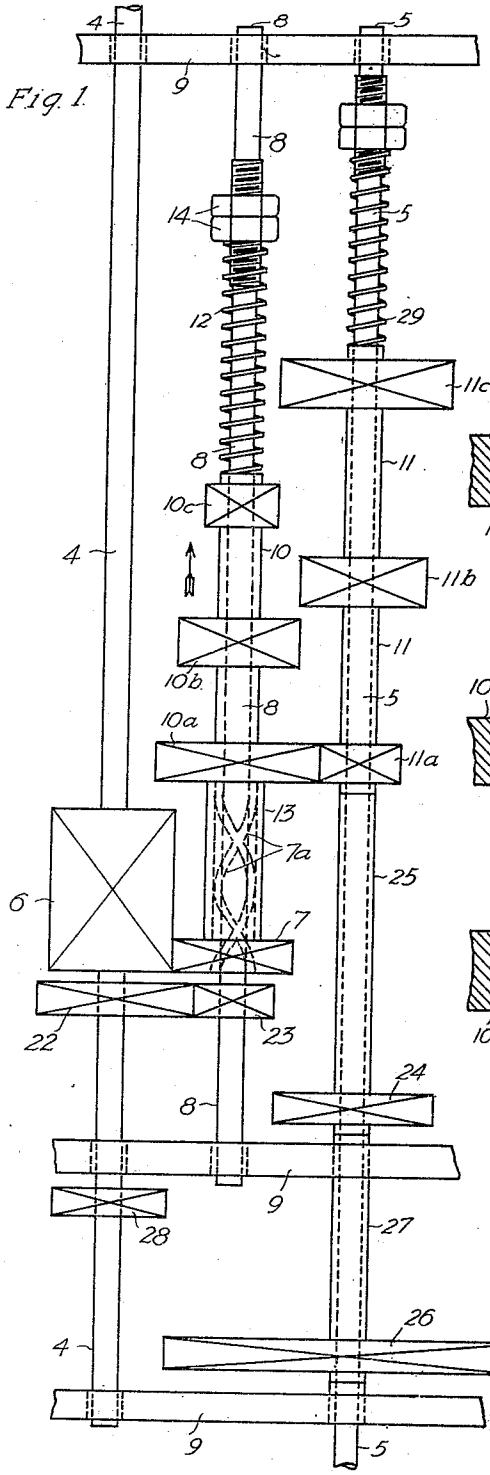


Fig. 2.

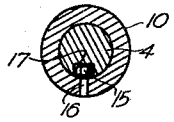


Fig. 3.

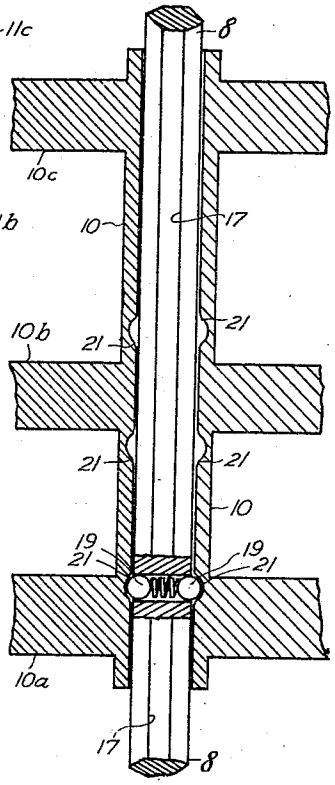
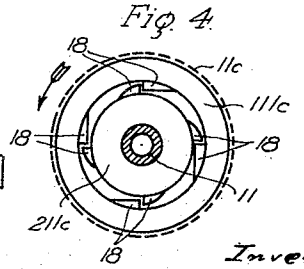


Fig. 4.



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UNITED STATES PATENT OFFICE

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VARIABLE SPEED-GEAR MECHANISM

Application filed January 6, 1930. Serial No. 418,911, and in South Africa November 28, 1929.

The object of the invention is to provide an improved variable speed-gear mechanism which will operate automatically under variations in the load, and will be found particularly suitable for use in self-propelled road vehicles, mills and other machines for dealing with widely-fluctuating loads, and the like.

A speed-gear mechanism according to the invention comprises a driving-shaft, a driven-shaft, a lay-shaft geared to the driving-shaft and adapted to be geared to the driven-shaft at a plurality of various gear-ratios successively, and means upon the lay-shaft adapted to operate automatically to vary the ratio at which it is geared to the driven-shaft, according to the variations in the load applied to the latter.

Further, according to the invention, the ratio at which the lay-shaft is geared to the driven-shaft is varied by the operation of a member mounted upon the former and caused to traverse the same by, and in proportion to, the load applied thereto.

One embodiment of the invention, as applied to a variable gear mechanism for automobiles and the like, is illustrated diagrammatically in the accompanying drawings, whereof Fig. 1 is a plan of the mechanism, Fig. 2 a section of the lay-shaft sleeve showing the method of its mounting upon the lay-shaft, Fig. 3 a longitudinal section of the lay-shaft sleeve showing the locating device thereof, and Fig. 4 is a detail view showing the free-wheel device of one of the driven-shaft pinions.

Referring to the drawings, 4 indicates the clutch-shaft of the vehicle, i. e., the driving shaft of the gear, and 5 indicates the Cardan shaft or the like, which constitutes the driven-shaft of the gear. The driving torque is transmitted by the shaft 4 through the pinions 6, 7 to a lay-shaft 8, revolubly mounted in bearings provided in the casing 9. Keyed slidably upon said lay-shaft is a sleeve 10 whereon are fixed three pinions 10*a*, 10*b*, and 10*c*, of successively decreased diameter, and mounted upon the shaft 5 in proximity to said lay-shaft is a similar sleeve 11 also carrying three gear-pinions 11*a*, 11*b*, and 11*c*, of successively increased diameter, the arrangement being such that as the lay-shaft sleeve is slid axially in the direction of the arrow against the pressure of a spring 12, the pinions 10*a*, 10*b* and 10*c* each engage in turn with the corresponding pinions 11*a*, 11*b*, or 11*c*, thus transmitting the driving torque to the shaft 5.

In order that the sliding movement of said lay-shaft 10 may be controlled by the load upon, and therefore the resistance to rotation of, the shaft 5, the pinion 7 (hereinafter termed the "lay-shaft pinion") is splined helically upon the lay-shaft, as shown at 7*a* in such manner that, when rotated by the driving-shaft pinion 6, the load causes the lay-shaft pinion 7 to traverse the helical thread 7*a*, and by means of a sleeve-like distance piece 13 interposed between the pinion 7 and the sleeve 10, the latter may be caused to slide against the pressure of the regulating spring 12. Lock-nuts 14 screwing upon the shaft 8 are provided for the purpose of adjusting the pressure of said spring 12 as required, and the arrangement is such that for a maximum load (i. e., when the resistance to rotation of the shaft 5 is greatest) the lay-shaft pinion 7 will traverse the thread 7*a* to the utmost extent, when the pinions 10*c* and 11*c* will be engaged and the gear-ratio of the mechanism consequently reduced to a minimum. E. g. when starting the vehicle under load, the lowest gear-ratio 10*c*, 11*c* will probably come into action.

As the load gradually decreases, e. g., as the vehicle attains speed, or otherwise, the sleeve 10 is correspondingly forced back by the spring 12 so as to bring a higher gear-ratio into operation, and when the load becomes a minimum, the pinions 10*a* and 11*a* are engaged, to produce the highest gear-ratio, the pinion 7 being traversed along the thread 7*a* to its initial position.

It will be understood that the pinion 6 is made sufficiently wide to ensure its meshing with the pinion 7 at all points in the range of axial movement of the latter.

The lay-shaft sleeve 10 is preferably keyed upon the shaft 8 by means of a plu-

rality of rollers 15 mounted upon pins 16 fixed radially in the sleeve 10 and co-acting with a longitudinal key-way or groove 17 in the shaft 8, as shown in Fig. 2.

It is found that, in order that the operation of the gear may be as smooth as possible, it is necessary that there should be always at least one pair of pinions of the reduction mechanism in mesh, and the spacing of the pinions 10*a*, 10*b* and 10*c* is therefore so arranged that, in the sliding movement of the sleeve 10 to change gear, before the pinions 10*a* and 11*a* become disengaged, the adjacent pair 10*b* and 11*b* is partially engaged, and similarly before the pinions 10*b* and 11*b* become disengaged the pair 10*c* and 11*c* is partially engaged, thus providing a continuous path for the driving torque and preventing the load from being released at any instant of the operation. In order to prevent the gear from jamming, each of the pinions 11*b* and 11*c* is provided with a free-wheel or ratchet device whereby the torque is always transmitted through the gears of higher ratio when two pairs are simultaneously engaged as above, by reason of the fact that the sleeve 11 is thus allowed to over-run the ratchet pinions 11*b* or 11*c*. Conveniently, said free-wheel device may be as illustrated in Fig. 4, in which the pinion 11*c* is shown formed of two concentric members 111*c* and 211*c* provided with inter-engaging spring-pressed pawls 18.

In order to ensure that the various pinions of the lay-shaft sleeve 10 enter properly into mesh with the cooperating pinions of the sleeve 11, the sleeve 10 is provided with a locating device, as shown in Fig. 3, whereby it is constrained to occupy one of the definite gear-positions by the action of a pair of spring-pressed balls 19 mounted within a slot 20 formed diametrically in the lay-shaft 8, and co-acting with three circumferential grooves 21 provided upon the interior of the sleeve 10 so as to form abutments for said balls 19.

If desired, an auxiliary non-automatic forward gear may be provided, consisting of a separate pinion 22, fixed upon the driving-shaft 4, engaging with an idler pinion 23 loosely mounted upon the lay-shaft 8, and a pinion 24 keyed upon the driven-shaft 5 adapted to be slid into engagement with said idler pinion 23 by means of a suitable hand lever (not shown). For this purpose it is also necessary to provide the driven-shaft sleeve 11 with means whereby it may be slid totally out of engagement with the lay-shaft sleeve 10. Conveniently, the pinion 24 is provided with a sleeve-like extension 25 which, when said pinion 24 is engaged, abuts against the end of the sleeve 11 and moves the same endwise to the necessary extent. In this case the sleeve 11 is, of course, keyed upon the shaft 5, preferably in a manner similar to that employed for the sleeve 10, as hereinbefore described.

Similarly, if it is desired to provide a hand-operated reverse gear, a pinion 26 having a sleeve-like extension 27, may be keyed upon the shaft 11 in such manner that, when slid upon said shaft to engage a reverse-gear pinion 28 provided upon the driving-shaft 4, all the remaining driven-shaft gears will be pushed well out of engagement. Preferably, a spring 29 is provided for the purpose of returning the sleeve 11 to its initial position when either the auxiliary forward gear pinion or the reverse gear pinion is disengaged.

It will be understood that any number of different gear-ratios may be provided by modifying the number of pinions upon the sleeves 10 and 11; indeed the more ratios there are, the smoother will be the operation of the device.

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

1. An automatically variable speed-gear mechanism, comprising a driving-shaft, a driven-shaft, a lay-shaft, means for gearing the lay-shaft to the driven-shaft at a plurality of various gear ratios successively, a pinion splined helically upon the lay-shaft and geared to the driving-shaft, and gear-changing mechanism operable by the traversing movement of said pinion upon the lay-shaft under variations in the load applied to the driven-shaft.

2. An automatically variable speed-gear mechanism, comprising a driving-shaft, a driven-shaft, a lay-shaft, a pinion splined helically upon the lay-shaft and geared to the driving-shaft, a plurality of gear-pinions fixed upon a sleeve slidably mounted upon the lay-shaft, a corresponding plurality of gear-pinions carried by a sleeve keyed upon the driven-shaft and adapted to be engaged successively by the pinions of the lay-shaft sleeve as the latter is caused to slide by the traversing movement of the splined pinion, and a spring for controlling the movement of said lay-shaft sleeve.

3. An automatically variable speed-gear mechanism, comprising a driving-shaft, a driven-shaft, a lay-shaft, geared to the driving-shaft, means for gearing the lay-shaft to the driven-shaft at a plurality of various gear-ratios successively, means upon the lay-shaft, operable under variations in the load applied to the driven-shaft, for automatically varying the ratio at which the lay-shaft is geared to the latter, an auxiliary hand-operated forward gear and means for maintaining the remaining gears out of engagement during the engagement of said forward gear.

4. An automatically variable speed-gear

mechanism, comprising a driving shaft, a driven shaft, a lay shaft geared to the driving shaft, means for gearing the lay shaft to the driven shaft at a plurality of various gear ratios successively, a pinion splined helically upon the lay shaft, mechanism operable by the traversing movement of said pinion upon the lay shaft under variations in the load applied to the driven shaft for automatically varying the ratio at which the lay shaft is geared to the latter, a reverse gear and a reverse pinion, and means for maintaining the remaining gears out of engagement during the engagement of said reverse gear.

In testimony whereof, I affix my signature.

MAXWELL L. F. von BROEMBSEN.