July 19, 1932. F. R. PORTER 1,867,590

AUTOMATIC VARIABLE SPEED MECHANISM

Filed March 24, 1930

Fig. 1,

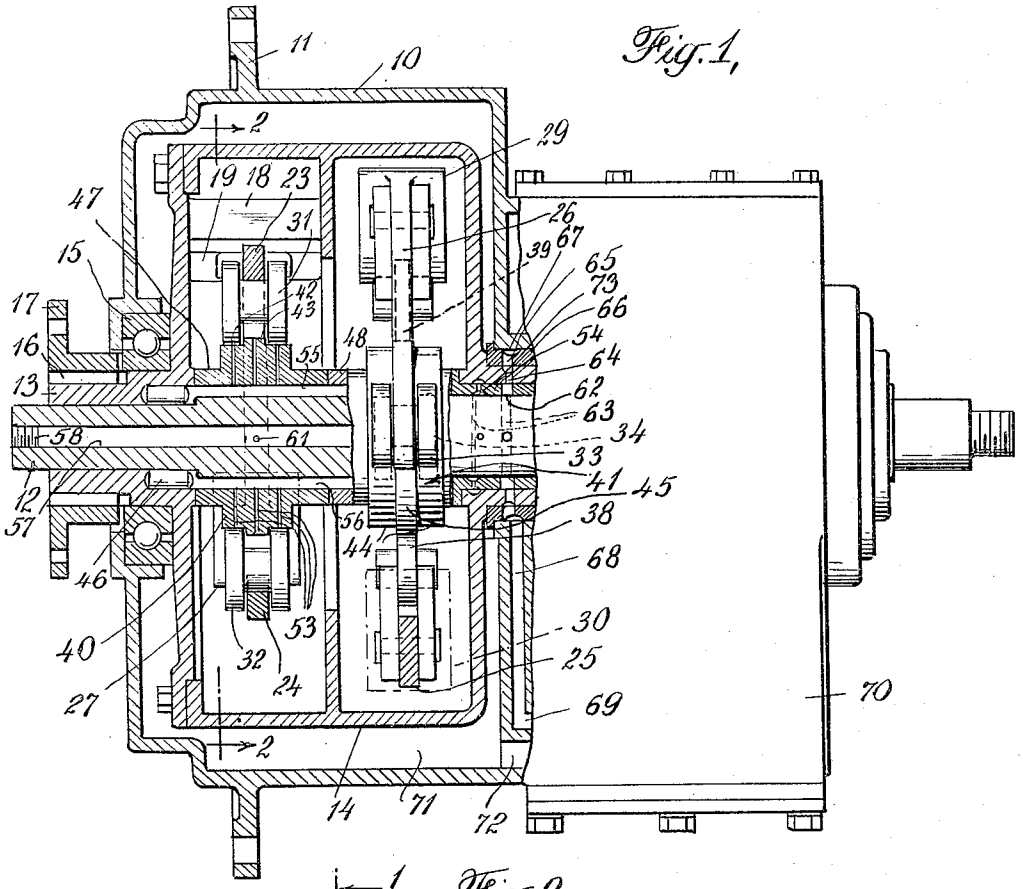


Fig. 2,

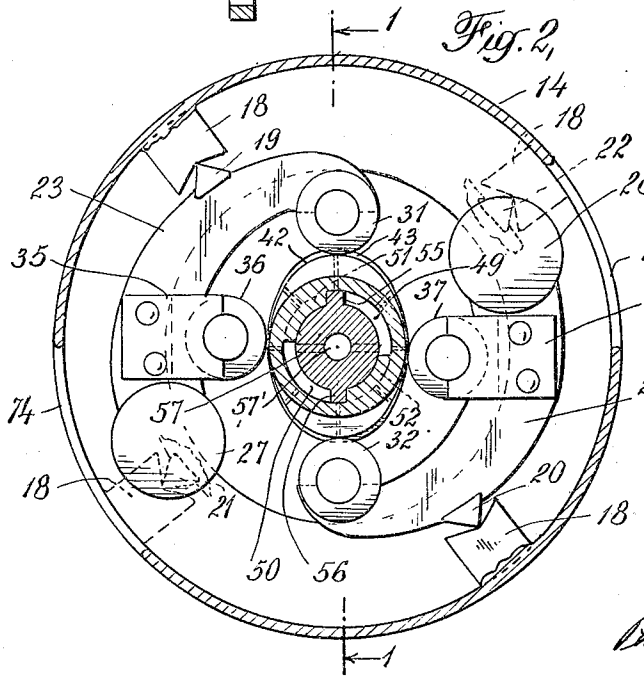
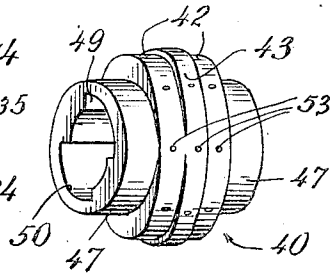


Fig. 3,



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AUTOMATIC VARIABLE SPEED MECHANISM

Application filed March 24, 1930. Serial No. 438,441.

This invention relates to automatic variable speed mechanism and has particular reference to mechanism for automatically changing the speed of a driven member in accordance with the resistance to which the driven member is subjected.

In my prior patent No. 1,759,466, issued May 20, 1930, of which this application is a continuation in part, there is described a variable speed mechanism of the type to which the present invention has reference and to which the present invention may be applied. In this prior application, a plurality of variable motion cams are mounted upon the shaft which is adapted to be driven, and an hydraulically controlled back-lash or lost motion means is interposed between the cams and the driven shaft. Variably engaging each of these cams at various angular positions are a plurality of rocker arms having weighted portions and pivoted upon the driving member, preferably in the plane of rotation thereof. As the driving member rotates the rockers follow the configuration of the cams so that the rockers oscillate pendulously until they develop sufficient centrifugal force to rotate the cams and driven shaft, overcoming the resistance to which the latter is subjected. As the rockers move around the cams the necessary recovery stroke, which would ordinarily be accompanied by a power loss, is utilized to rotate the cams in a direction opposite to the rotation of the driven shaft, i. e., relative motion with respect thereto or back-lash, so that the working faces of the cams are automatically lengthened and the recovery faces of the cams are automatically shortened, this back-lash being controlled hydraulically by oil supplied under pressure, which also serves to lubricate the working parts of the mechanism. During sudden changes in speed or during times when the engine is idling or when the rockers pass over the peaks of the cam there is a tendency for the rockers to "jump" the cams, resulting in a shock as the rockers leave and return to the cam surfaces.

The present invention utilizes the principle of operation of the mechanism of my copending application and its principal object is to provide mechanism of the type described having means for obviating the jumping tendency of the rockers and for maintaining smooth and uniform operation of the mechanism during all conditions of usage to which the mechanism may be subjected, as, for example, on an automobile in substitution of the usual manually operable transmission.

This and other objects of this invention are obtained in a preferred embodiment thereof consisting of one or more cams mounted upon a shaft in such a way as to drive the shaft in one direction and having a limited back-lash or lost motion with respect to the shaft in the opposite direction.

The cams are preferably double cams, having one track for engagement by the leading roller of a weighted rocker pivoted to the driving member, and another track for engagement by the trailing roller of the rocker. Two or more rockers, displaced angularly with respect to each other, are adapted to engage the same cam, each having a leading and a trailing roller for engaging the two tracks of the double cam. This double cam may be considered as consisting of two cams engaged severally by two rollers of the rocker. The leading roller of the rocker preferably follows a cam having acceleration and deceleration faces for obtaining and controlling the pendulous action of the rockers in accordance with the principle of operation of the mechanism, while the trailing rocker roller preferably follows a cam generated by the trailing roller as the leading roller leads the former around the driven shaft. Thus the trailing roller, in following its cam, causes the leading roller to closely follow or hug its cam, and vice versa, so that neither roller can jump its cam during sudden speed changes or when the engine is idling, or when the rollers round the peak of the corresponding cam, whereby smooth and noiseless operation are obtained, and no losses in power can take place for that reason.

For a better understanding of this invention, reference may be had to the accompanying drawing, in which

Figure 1 is a partial section of the new automatic variable speed mechanism of this

invention as seen along the line 1—1 of Fig. 2;

Fig. 2 is a radial section of the rotating drum and its contents as seen along the line 2—2 of Fig. 1; and

Fig. 3 is an enlarged perspective view of one of the double cams.

In this drawing, numeral 10 designates the stationary casing of the automatic speed changing mechanism of this invention, this housing being secured by its lateral flange 11 to the bell housing normally enclosing the fly wheel and clutch of an automobile engine, for example. The casing 10 occupies the position of the usual transmission gear box of the present type of automobile and is adapted to be substituted therefor without other changes in the automobile.

Piloted in the end of the crank shaft, not shown, is the driven shaft 12 upon which is journalled the sleeve 13 of the rotatable drum 14, this sleeve 13 in turn being journalled in a ball or other anti-friction bearing 15 secured to the stationary casing 10. The drum 14 is driven by the automobile engine by means of a gear clutch 16, one element of which is secured by its flange 17 to the face of the fly wheel, and the other element of which is formed on the outer surface of sleeve 13. The provision of this gear clutch 17 enables the ready mounting and dismounting of the mechanism without disturbing the fly wheel, since the clutch 16 may be readily connected when the end of the driven shaft 12 is inserted in its crank shaft pilot. The gear clutch 16 also permits accurate centering of the mechanism without requiring special machining operations since the teeth of the clutch 16 permit a limited radial leeway.

The inner periphery of the drum 14 is provided with two pairs of grooved bosses 18, the bosses of each pair being spaced 180° apart, and the four bosses being mutually spaced 90° apart, as shown in Fig. 2. Lying in the grooves of each of these bosses are the knife blades 19, 20, 21, and 22 formed integrally with the curved rocker arms 23, 24, 25 and 26, respectively, and serving as the fulcrums thereof. These rocker arms are provided at the ends of their long arms with the weights 27, 28, 29 and 30, respectively, adapted to move pendulously about the respective fulcrum knife blades 19, 20, 21 and 22, and apertures 74 are provided in drum 14 to permit this pendulous movement of the weights.

The opposite ends of the rocker arms 23, 24, 25 and 26 are fitted with half-bearings in which are journalled the dumb-bell shaped rollers 31, 32, 33 and 34, respectively. Spaced from their respective knife blades and secured by rivets to opposite surfaces of rocker arms 23, 24, 25 and 26 are journal plates 35 constituting half-bearings in which are journalled the respective rollers 36, 37, 38 and 39.

As shown in Fig. 1, cams 40 and 41 are mounted axially along shaft 12. These cams are variable motion cams and have two working stroke and two recovery stroke curves. As shown particularly in Fig. 3, each of these cams 40 and 41 is actually a double cam, i. e., it has two cam surfaces designated on cam 40 as 42 and 43, and on cam 41 as 44 and 45. Cam 40 is engaged by the rollers or rockers 23 and 24, while cam 41 is engaged by the rollers of rockers 25 and 26. More specifically, the leading rollers 31 and 32 of rocker arms 23 and 24 engage the outer cam surfaces 42 of cam 40, while the respective trailing rollers 36 and 37 of these rocker arms engage the center cam surface 43 of cam 40. Likewise, leading rollers 33 and 34 of rocker arms 25 and 26 engage the outer cam surfaces 44 of cam 41, while the respective trailing rollers 38 and 39 of these rocker arms engage the center cam surface 45 of cam 41. It will thus be seen that each of the rocker arms is mounted upon a three point support, i. e., by its leading and trailing rollers upon the corresponding cam, and by its knife blade fulcrum upon the corresponding grooved boss 18 on drum 14. The rocker arms are accordingly held in place without using pins or other positive securing means, and need only be slipped in place while assembling, and may be as readily removed.

As shown particularly in Fig. 2, the cams 40 and 41, are broached axially to form two diametrically opposite grooves 49 and 50, these grooves having a width slightly exceeding ninety degrees. Connecting these grooves are the curved oil slots 51 and 52. Oil holes 53 connect the surfaces of the disc cams 40 and 41 with the oil slots 49 and 50 and oil grooves 51 and 52 whereby the surfaces of these cams and the rocker arm bearings are lubricated from within. As seen in Fig. 1, the hubs 47 and 48 of cams 40 and 41, respectively, occupy the space between the hub of sleeve 13 and the bushing 54 of bearing metal interposed between the front hub of drum 14 and the rear end of the hub 48 of cam 41.

The shaft 12 is provided with a pair of diametrically opposite key-like abutments 55 and 56 which are disposed in the annular grooves 49 and 51, respectively, of the hubs 47 and 48 of respective cams 40 and 41. The shaft 12 is drilled axially at 57, and the opening of this drill at the pilot end of shaft 12 is sealed by a plug 58. Interposed between the sleeve 13 and the shaft 12 is an overrunning clutch 46, which is adapted to connect the mechanism to the engine in the event that the velocity of the vehicle exceeds the speed of the engine such as when the vehicle is rolling down hill, or in other instances when the car speed exceeds that of the engine, and permits cranking of the engine while coast-

ing. This clutch also compensates for any hunting tendency of the mechanism when load conditions change within narrow limits. This overrunning clutch is supplied with lubricant from annular grooves 49 and 50 in cam 40. Similarly, oil grooves 49 and 50 and oil slots 51 and 52 in the hubs 47 and 48 of cams 40 and 41, respectively, are connected with the oil hole 57 of shaft 12 by means of drilled passageways 61. A similar drilled passage supplies oil from the oil hole 57 of shaft 12 to annular oil groove 73 in the rear bearing of drum 14, this passage being designated 62. Oil under pressure is supplied to axial oil hole 57 of shaft 12 through radial oil passage 63, annular space 64 at the end of bushing 54, radial oil hole 65 in bushing 66 and oil groove 67 in bushing 66. The oil supply groove 67 communicates with the radially drilled passage 68 in the partition of housing 10, this passage in turn communicating with a lateral passage 69 having communication with an oil pump, not shown, contained in housing 70 together with reversing gears, as illustrated in my aforementioned copending application, this pump drawing returned oil from the sump 71 in the bottom of housing 10 through passage 72.

In operation, the drum 10 is driven by the engine. If the torque of the engine is not sufficient to overcome the inertia of the vehicle, as when it is standing with the engine idling, the rollers of the rocker arms 23 and 24 follow double cam 40 and the rollers of rocker arms 25 and 26 follow double cam 41, the centrifugal force developed by the weights of the respective rocker arms being insufficient to drive the cams and the driven shaft 12. As the leading rollers 31, 32, 33 and 34 move over the peaks of cam surfaces 42 and 44, a reverse torque is set up which moves the cams 40 and 41 backwardly relatively to shaft 12 against the oil cushions 49 and 50.

This relative reverse movement or backlash between the cams and shaft places the oil in grooves 49 and 50 under pressure, whereby the considerable quantity thereof in these grooves is forced through the relatively small oil slots 51 and 52 which connect them, thus producing a throttling action which retards the movement of the cams relatively to the shaft with a hydraulic cushioning and braking action. Some of the oil is forced through radial holes 53 in the cams 45 and 46 to the surfaces thereof, whereby these surfaces are lubricated. The oil issuing from radial oil holes 53 is under considerable pressure and squirts out radially to impinge upon half-bearings of leading rollers 31, 32, 33 and 34 and trailing rollers 36, 37, 38 and 39 of the rocker arms, whereby these bearings, being open, are continually lubricated when the rocker arms are oscillated by the cams. The oil which is discharged in this manner as surplusage flows through the weight apertures 31 in drum 14 and collects in the sump 71 of casing 10.

Upon the return power stroke, the oil previously forced through slots 51 and 52 into the respective oil grooves 49 and 50 behind respective abutments 55 and 56, by the aforementioned reverse movement of the cams again acts as a cushion. As this oil is gradually squeezed back through oil slots 51 and 52, producing the desired effect, the shaft abutments 55 and 56 approach the corresponding cam hub abutments until they contact therewith to effect a positive driving connection between cams 40 and 41 and the shaft 12. It will be seen that inasmuch as the cams 40 and 41 are moved backwardly as the rocker arm rollers pass over the peaks thereof, the working face of the cam is lengthened whereby the power stroke of the mechanism is increased by the angle through which the cams are moved backwardly, so that there is no loss in power because of the backward movement of the cams. On the contrary, a corresponding increase of power is obtained, because the power stroke is lengthened to that extent.

If the operator of the vehicle desires to start the same into operation, it is only necessary for him to advance the throttle in the usual way. The increased centrifugal force of the rotating weights 27, 28, 29 and 30 increases the pressure of the rollers upon the cams 40 and 41, until these cams are turned and with the shaft 12 start the vehicle into motion. As the speed of the vehicle increases, the speed of the driven shaft 12 approaches the speed of the engine, so that the rollers no longer move over the cams 40 and 41, but assume a position of relative rest and the entire mass rotates as a unit, transmitting full engine torque to the driving wheels. If the engine is throttled down the reverse action takes place, i. e., the rollers again move over the cams until a new condition of equilibrium between them is reached. A greater detailed description of this operation is contained in my aforementioned copending application.

During all conditions of operation, whether sudden changes of speed obtain or the engine is idling, the rollers hug the cams and no jumping with consequent shock and noise can take place, because the trailing rollers 36, 37, 38 and 39, in following the center cam surfaces 43 and 45 generated by their normal paths, hold their respective leading rollers 31, 32, 33 and 34 in contact with their corresponding cam surfaces 42 and 44. Each rocker arm thus has two rollers, leading and trailing, for bracing the same under all conditions, and each cam has two cam elements which form a double cam or two cams operating as a single unit.

While a preferred embodiment of this in-

vention has been illustrated and described herein, it is to be understood that the invention is not limited thereby, but is susceptible of extensive changes in form and detail within its scope.

I claim:

1. In a variable speed change mechanism, the combination of a driving member, a driven member, centrifugal means connected to one of said members, variable motion means connected to the other member, and leading and trailing elements mounted upon said centrifugal means and engaging said variable motion means.

2. In a variable speed change mechanism, the combination of a driving member, a driven member, centrifugal means connected to one of said members, variable motion means connected to the other member, lost motion means in the connections between said variable motion means and said other member, and leading and trailing elements connecting said centrifugal means to said variable motion means.

3. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal element connected to one of said members, a double cam connected to the other member and a plurality of rollers mounted upon said centrifugal element and simultaneously engaging spaced points on said cam.

4. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal element connected to one of said members, means comprising a plurality of cams connected to said other member, a plurality of spaced followers mounted upon said centrifugal element and severally engaging spaced points on said cams.

5. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal element connected to one of said members, a cam connected to the other of said members for joint movement therewith in one direction but having a limited relative movement with respect thereto in the opposite direction, and a plurality of followers mounted upon said centrifugal element and engaging spaced points in said cam.

6. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal rocker pivoted to one of said members, an open bearing on the rocker, a roller journalled therein, a cam connected to said other member and engaged by said roller, and means controlled by movement of said cam for directing a jet of lubricant to said open bearing.

7. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal rocker pivoted to one of said members, an open bearing on the rocker, a roller journalled therein, a cam connected to said other member and engaged by said roller, and means for spraying oil upon said open bearing.

8. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal rocker pivoted to one of said members, an open bearing on the rocker, a roller journalled therein, a cam connected to said other member and engaged by said roller, said cam having an oil reservoir, and means for supplying oil from said reservoir to said open bearing.

9. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal rocker pivoted to one of said members, an open bearing on the rocker, a roller journalled therein, a cam connected to said other member and engaged by said roller, lost motion means in the connections between said cam and said other member, and a body of oil in the connections between said cam and said other member and controlled by said lost motion means for supplying oil to said bearings.

10. In a variable speed change mechanism, the combination of a driving member, a driven member, a centrifugal rocker pivoted to one of said members, a cam connected to said other member, a plurality of bearing members on said centrifugal means and engaging said cam, an oil reservoir forming part of said cam, and means for exerting pressure on the oil in said reservoir for forcing oil to said bearing members.

In testimony whereof I affix my signature.

FINLEY R. PORTER.