Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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FIG. 1.

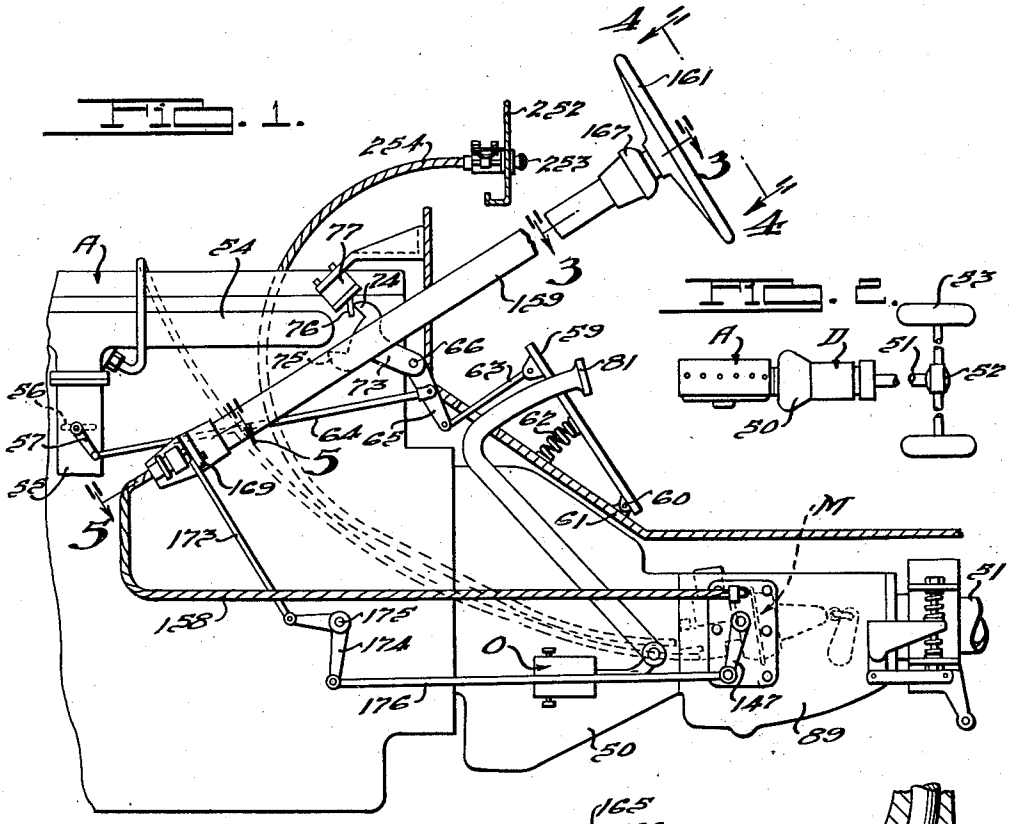


FIG. 2.

FIG. 3.

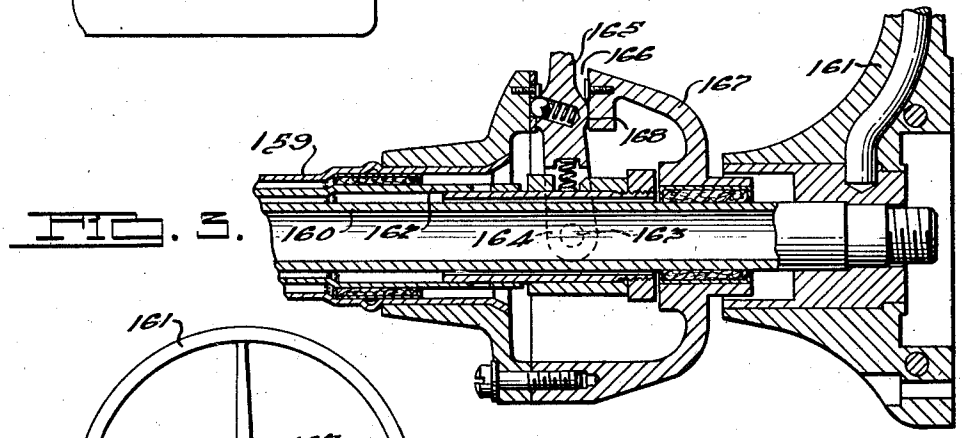
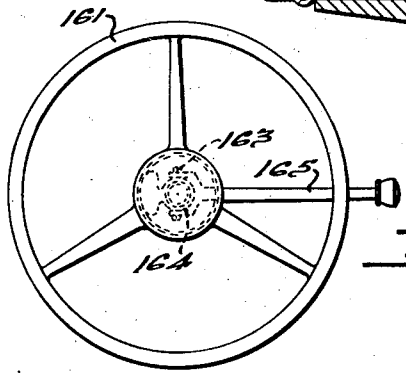


FIG. 4.



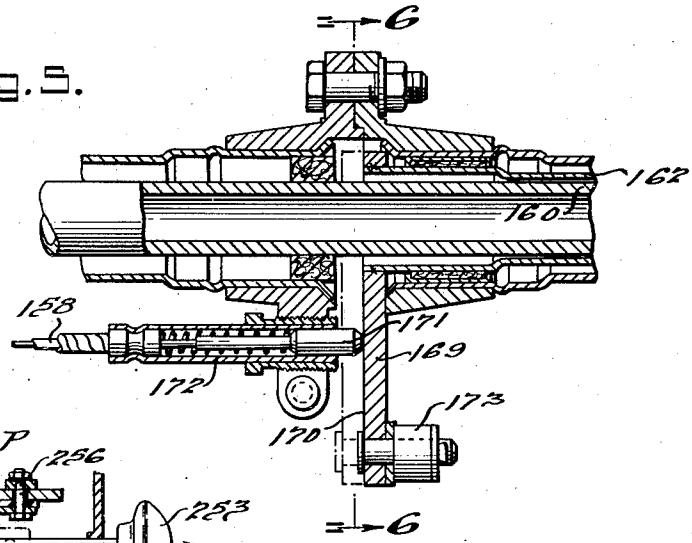
INVENTORS.
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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

Filed March 13, 1941 14 Sheets-Sheet 2

FIG. 5.



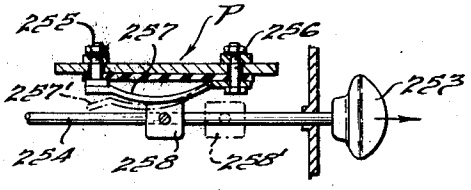
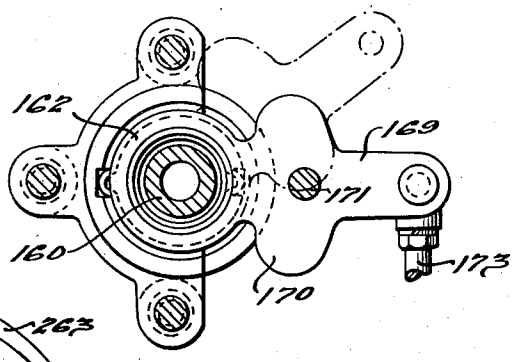
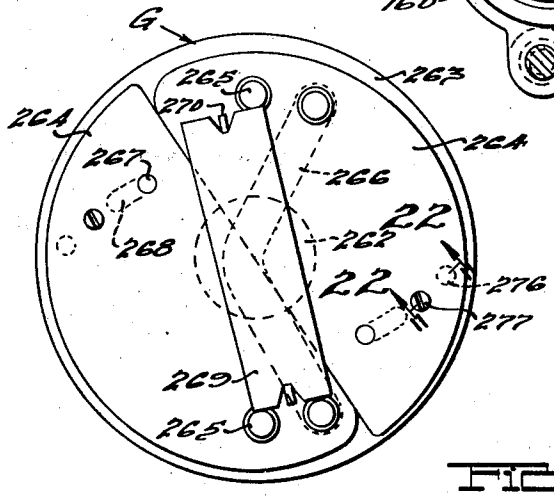


FIG. 7.

FIG. 8.





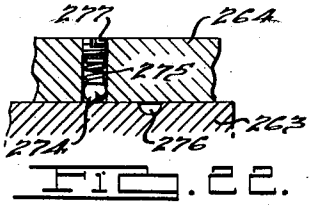


FIG. 22.

FIG. 21.

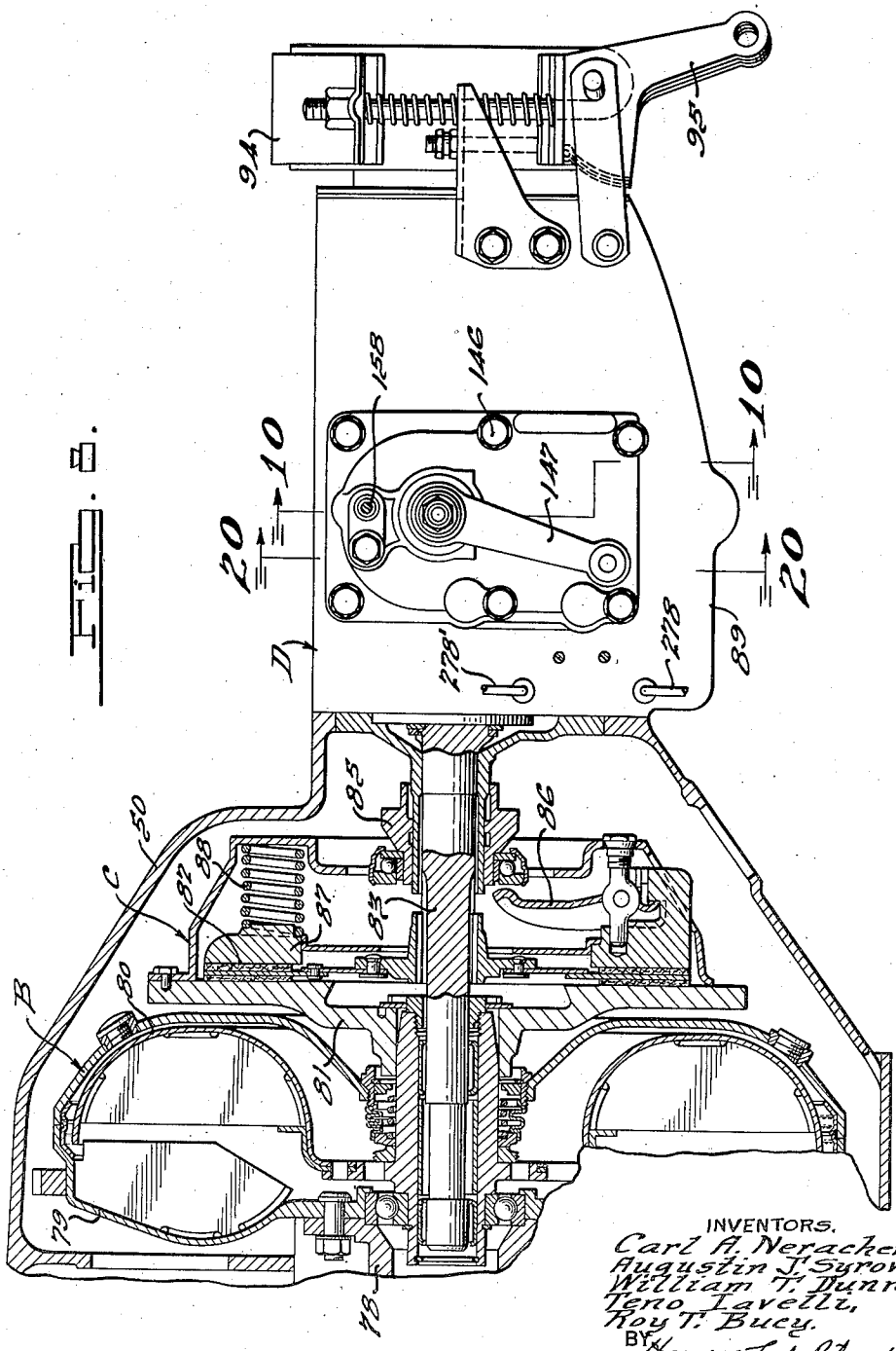
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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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Fig. 8.

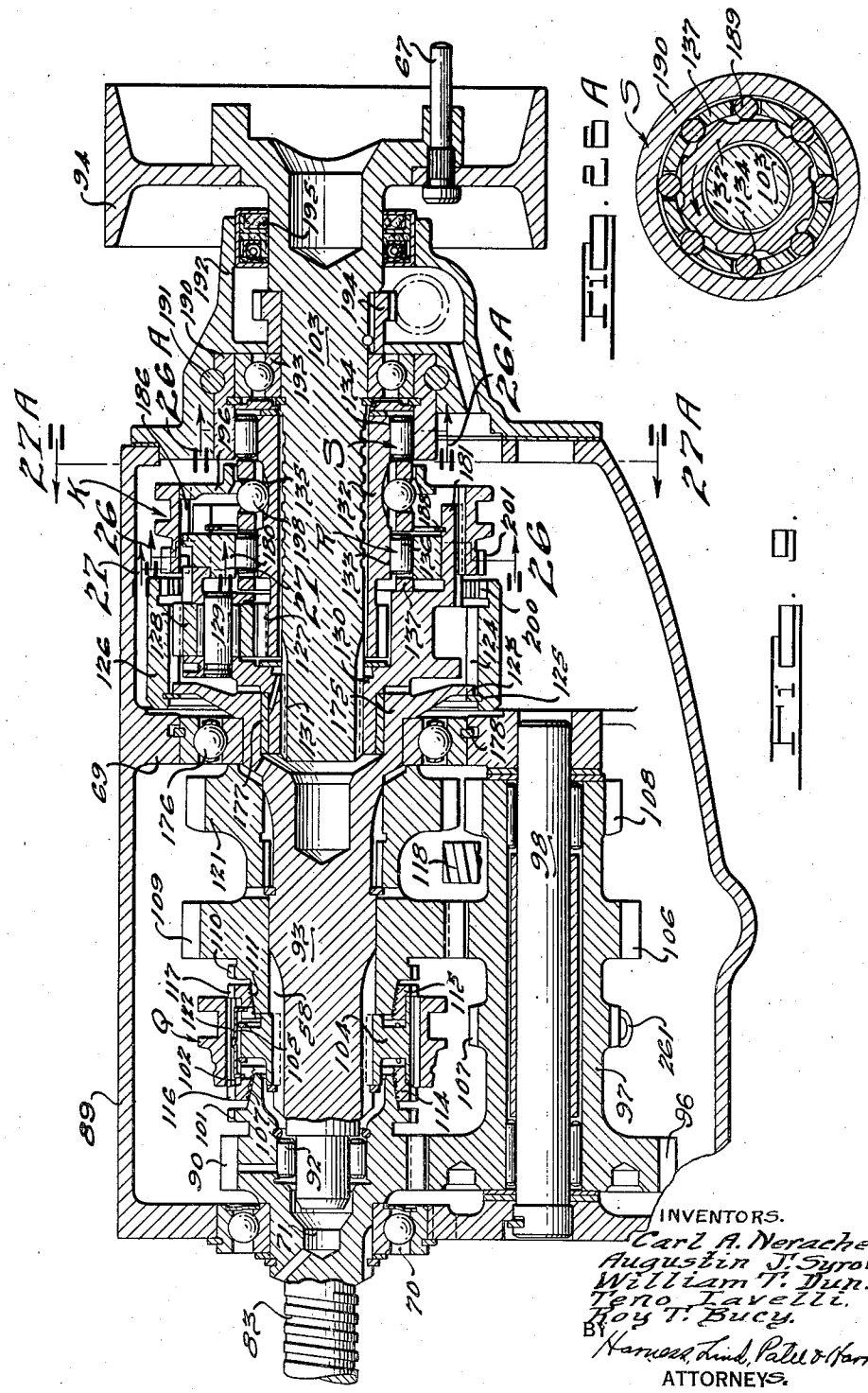


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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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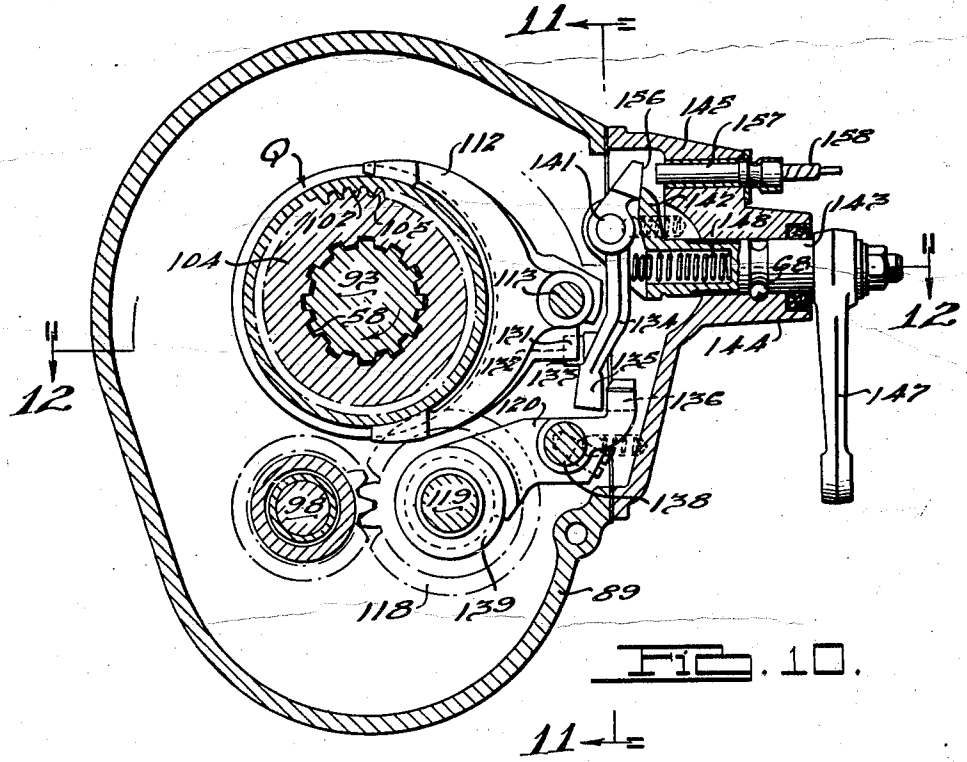


Fig. 10.

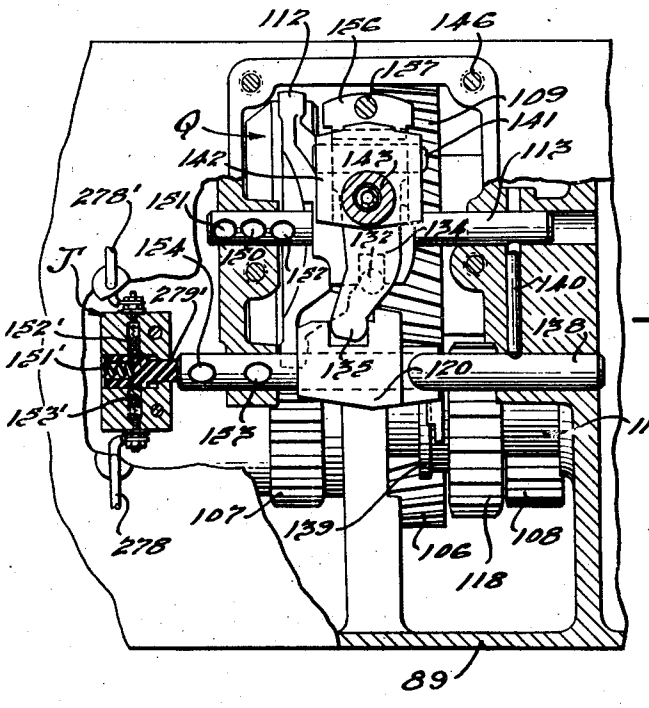


Fig. 11.

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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

Filed March 13, 1941 14 Sheets-Sheet 6

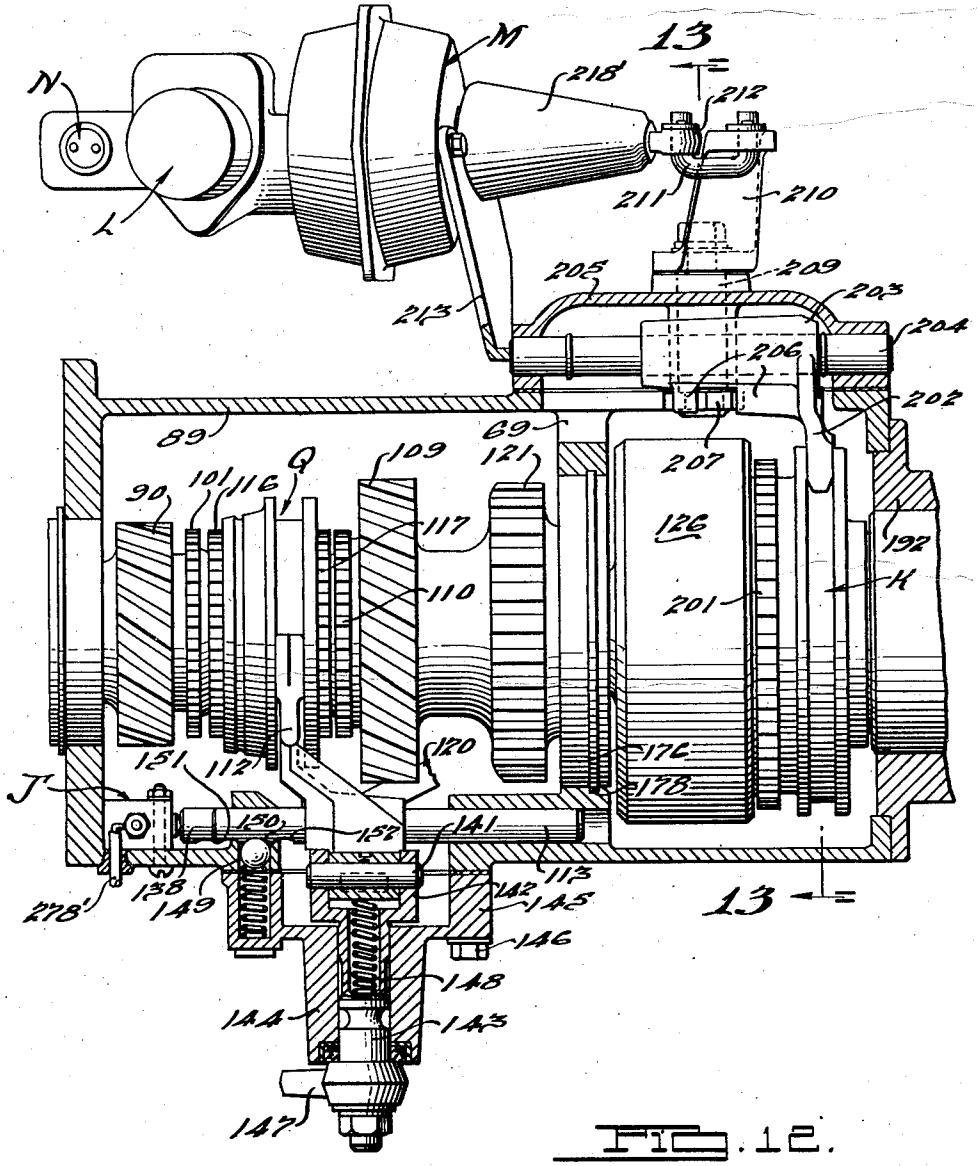


FIG. 12.

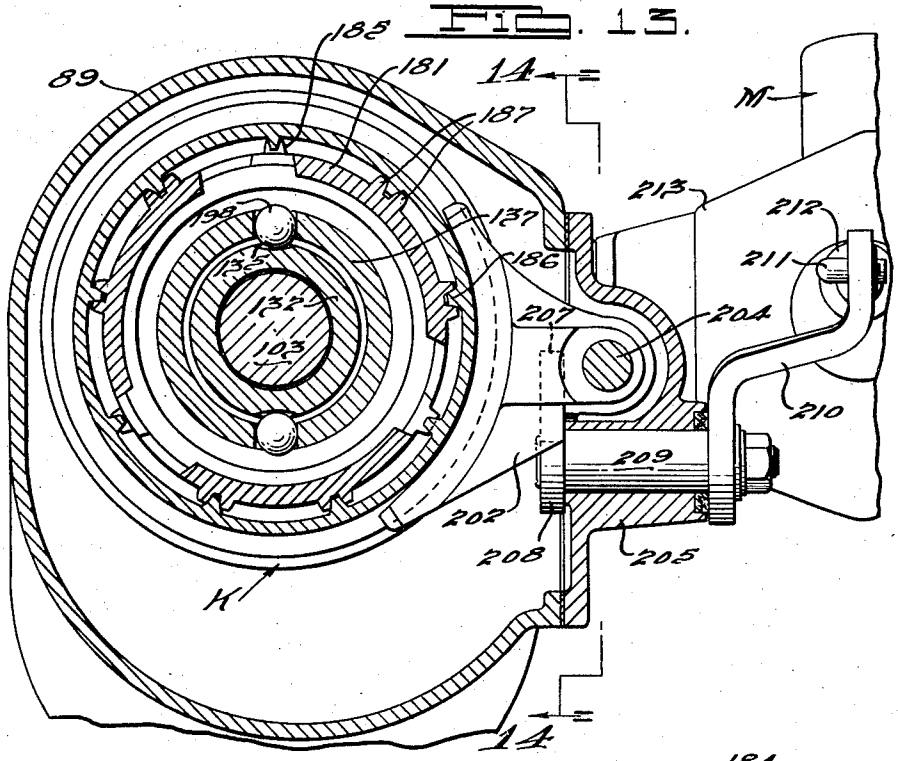
INVENTORS.
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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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FIG. 13.



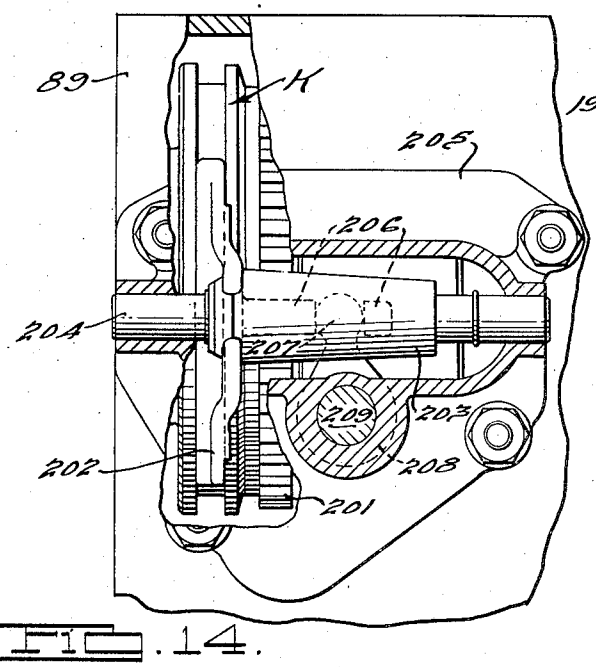


FIG. 14.

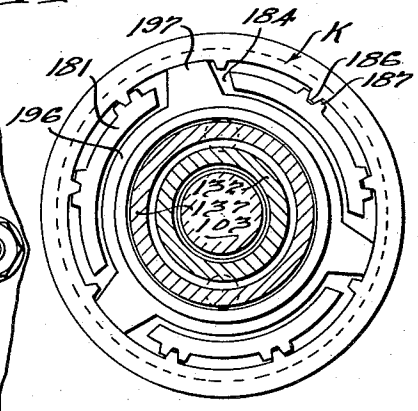


FIG. 27A.

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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

Filed March 13, 1941 14 Sheets-Sheet 8

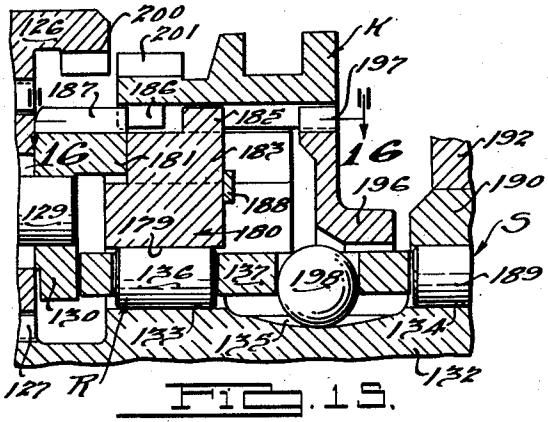


FIG. 15.

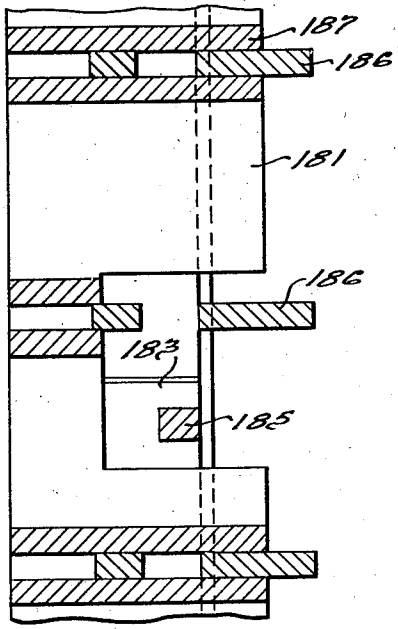


FIG. 17.

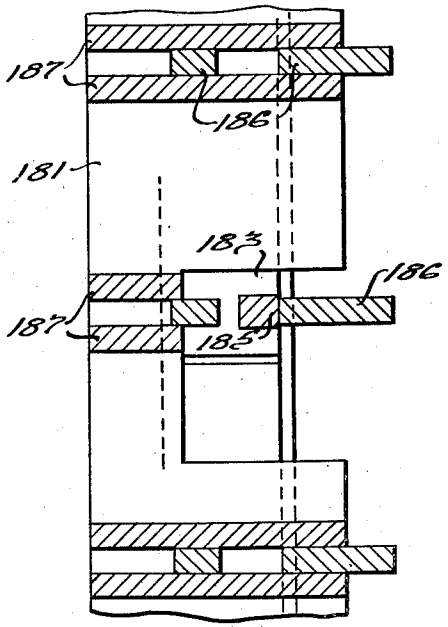


FIG. 16.

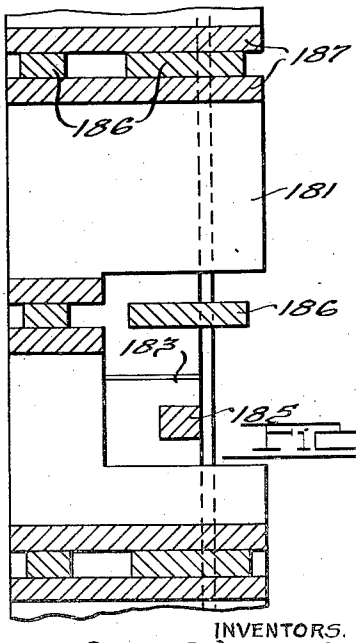


FIG. 18.

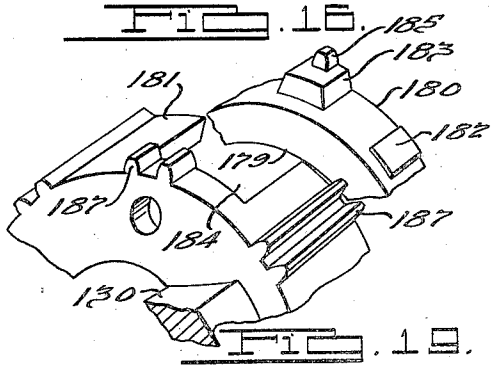


FIG. 19.

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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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FIG. 20.

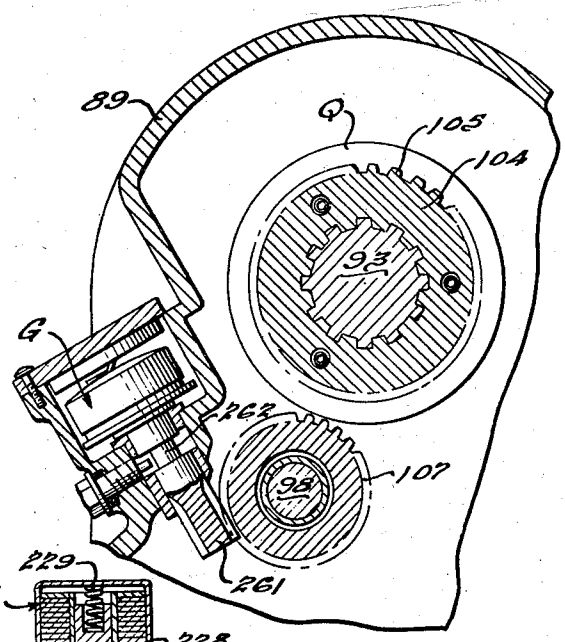
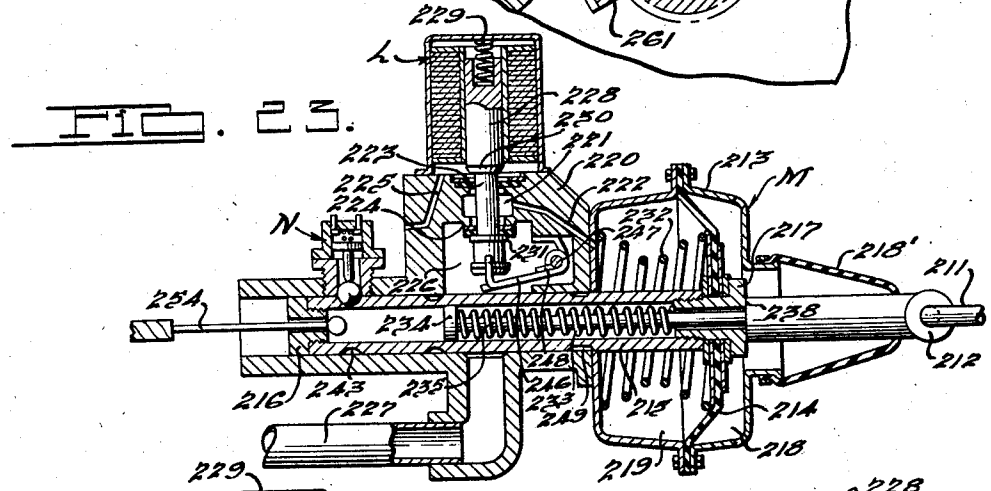
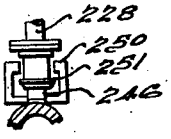


FIG. 23.





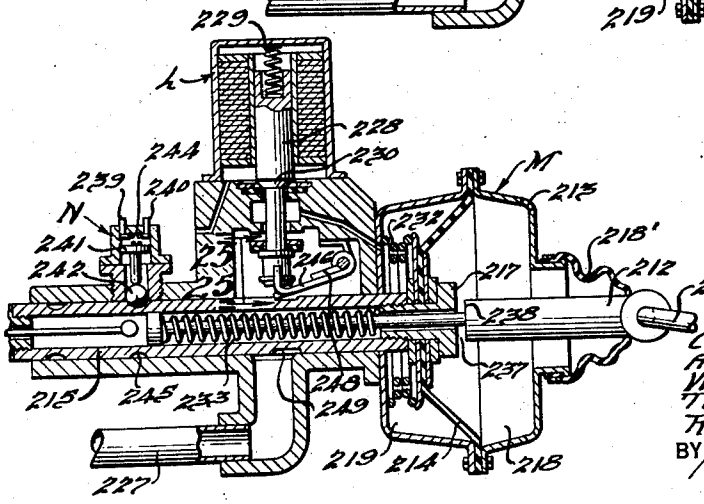


FIG. 25.

FIG. 24.

INVENTORS.
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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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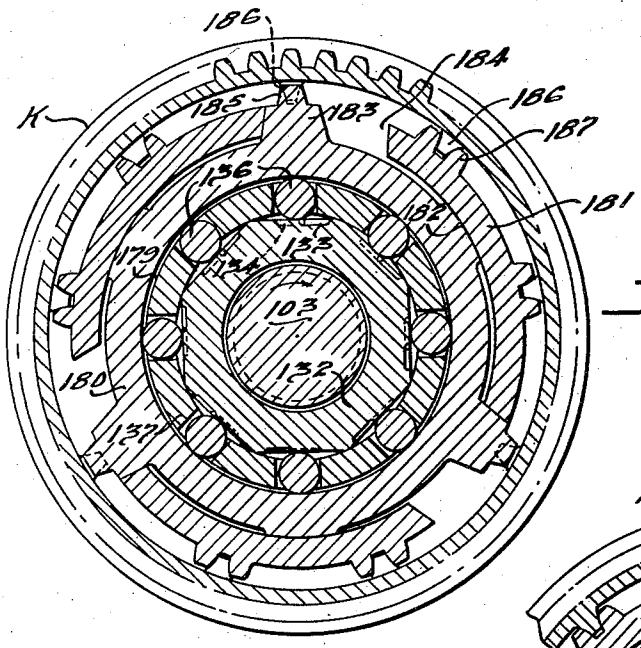


FIG. 26.

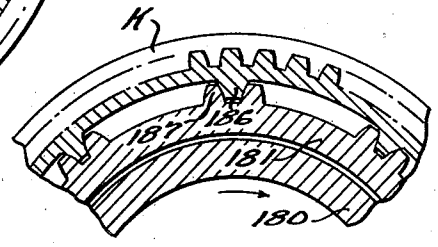


FIG. 27.

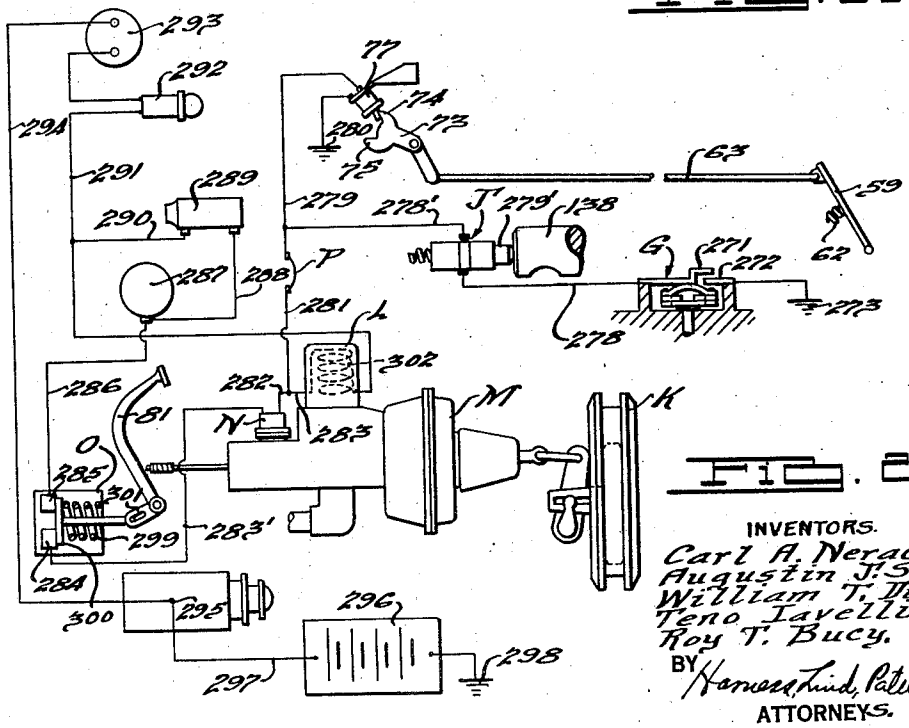


FIG. 28.

INVENTORS.
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William T. Wynn,
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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

Filed March 13, 1941 14 Sheets-Sheet 11

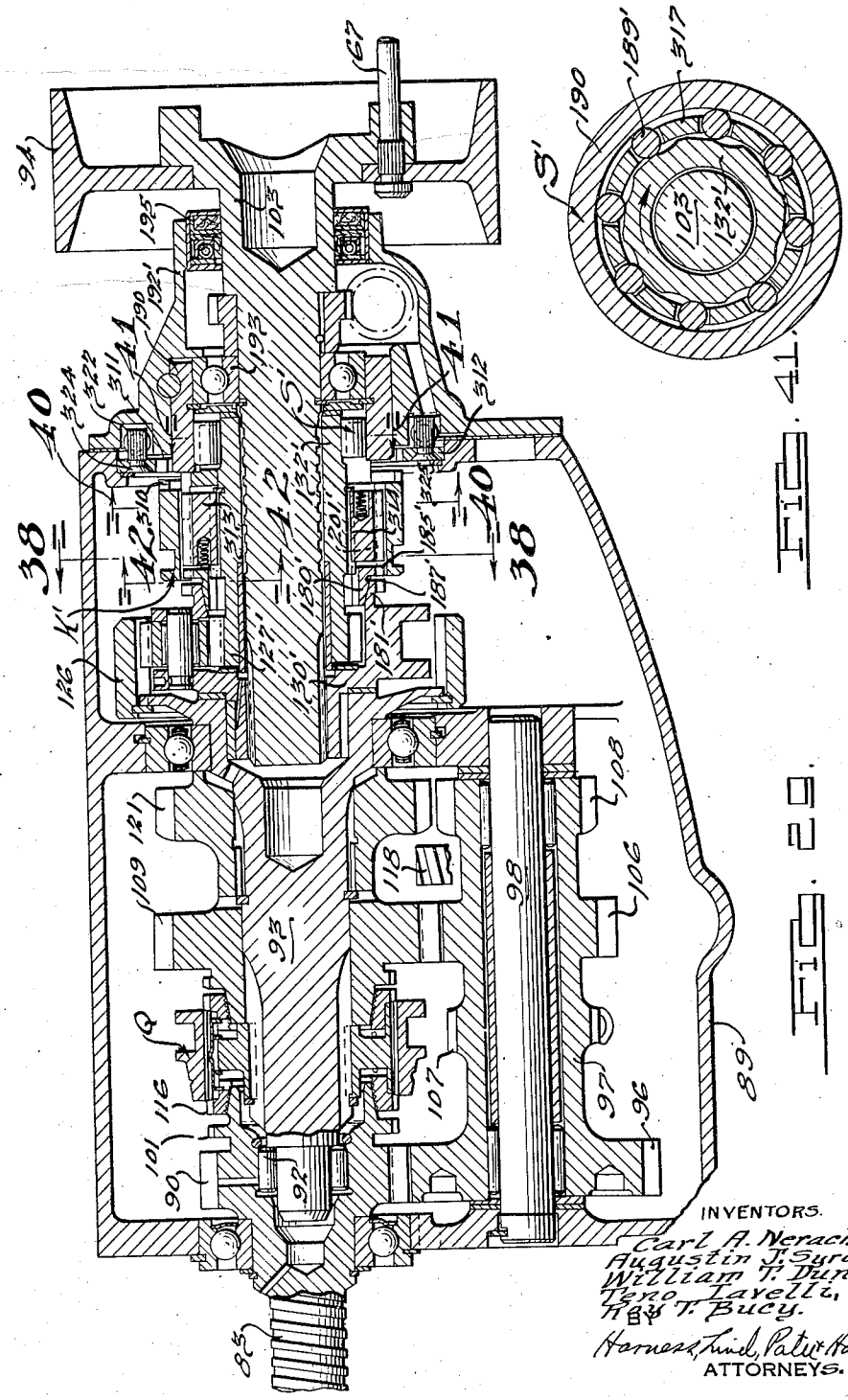


FIG. 41.

FIG. 29.

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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

Filed March 13, 1941 14 Sheets-Sheet 12

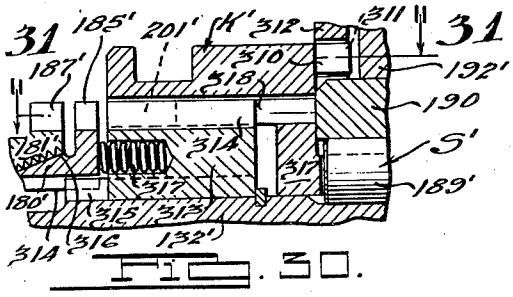


FIG. 30.

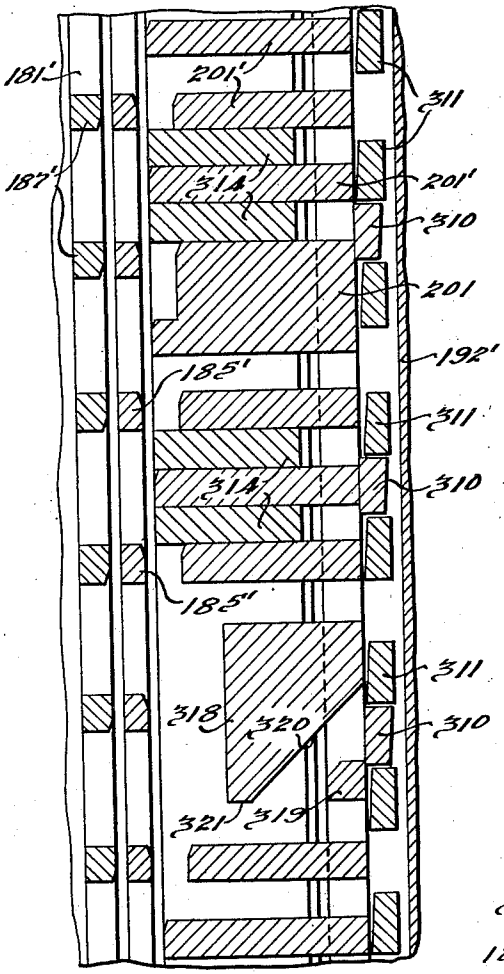


FIG. 31.

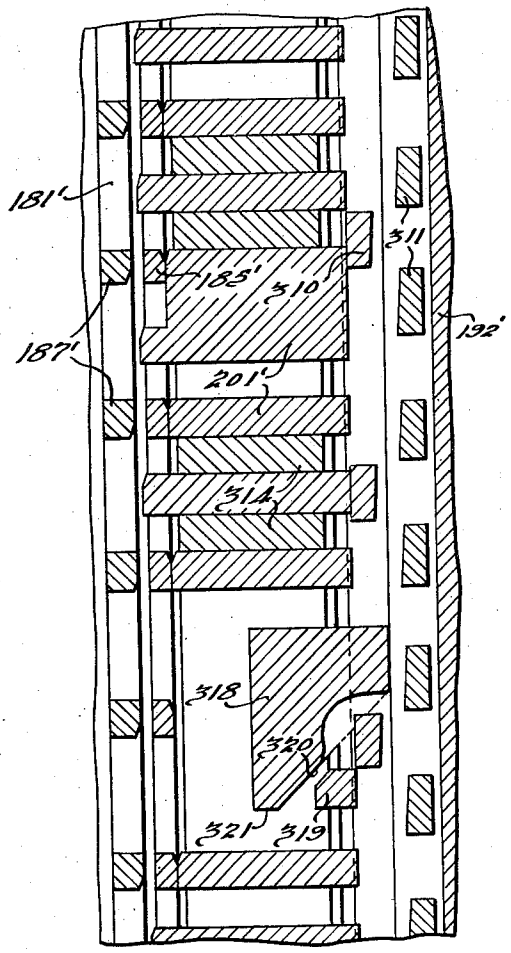


FIG. 32.

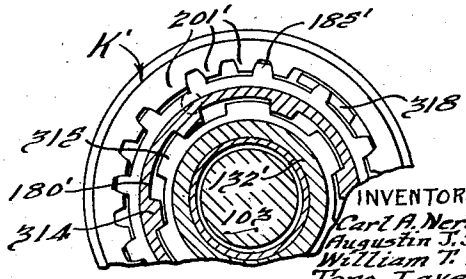


FIG. 42.

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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

Filed March 13, 1941 14 Sheets-Sheet 13

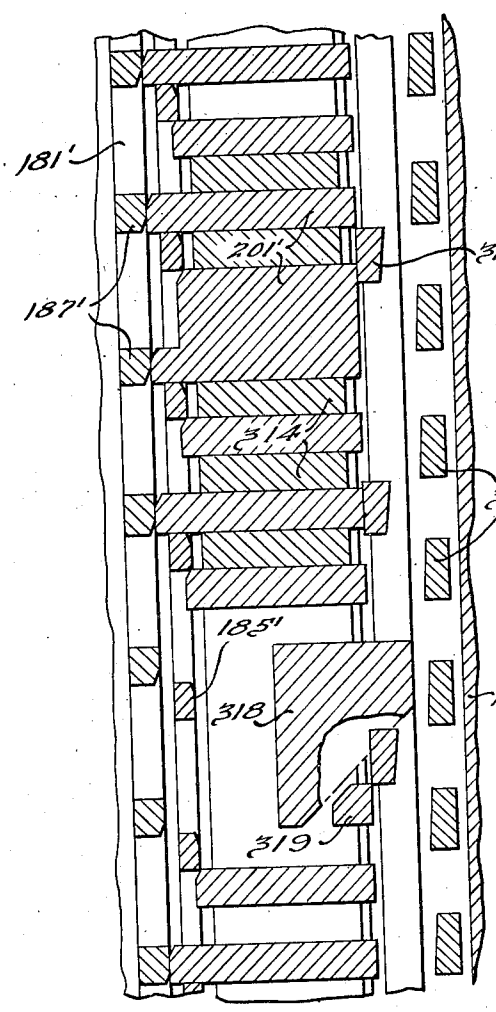


FIG. 33.

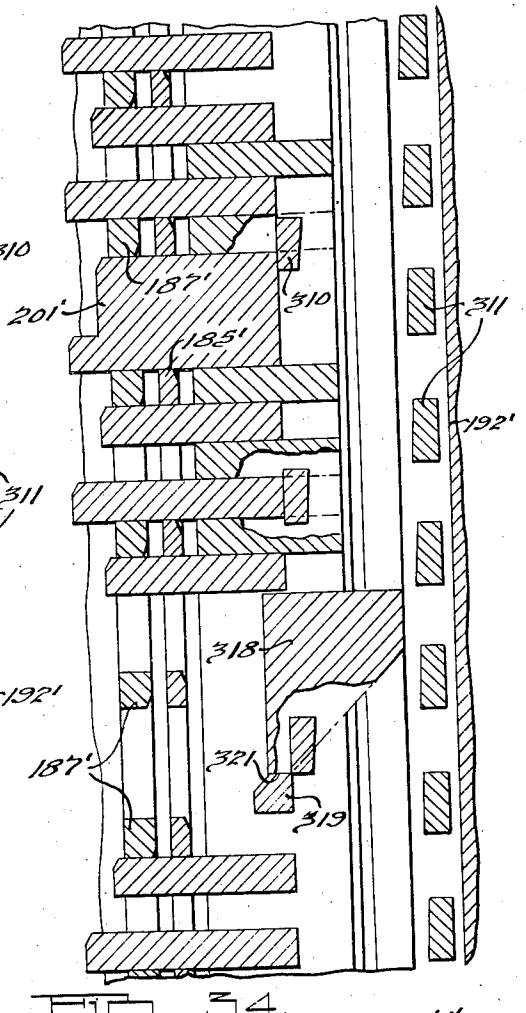


FIG. 34.

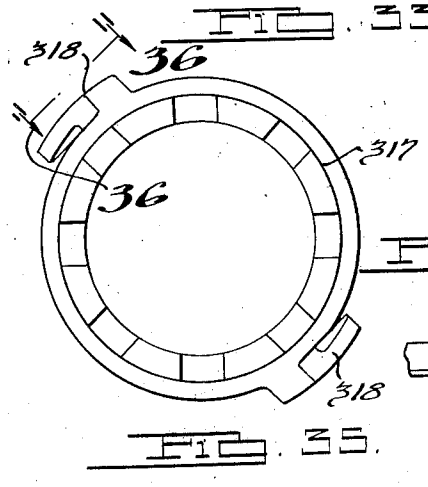


FIG. 35.

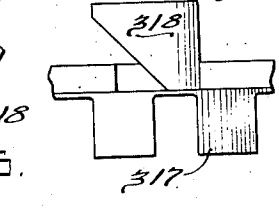


FIG. 36.

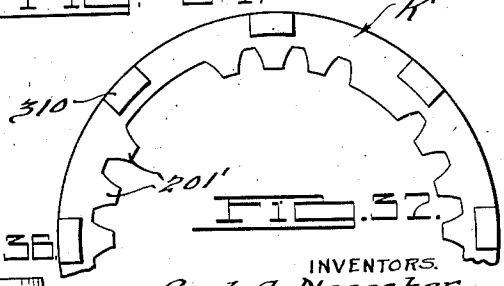


FIG. 37.

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Nov. 2, 1943. C. A. NERACHER ET AL 2,333,115

POWER TRANSMISSION

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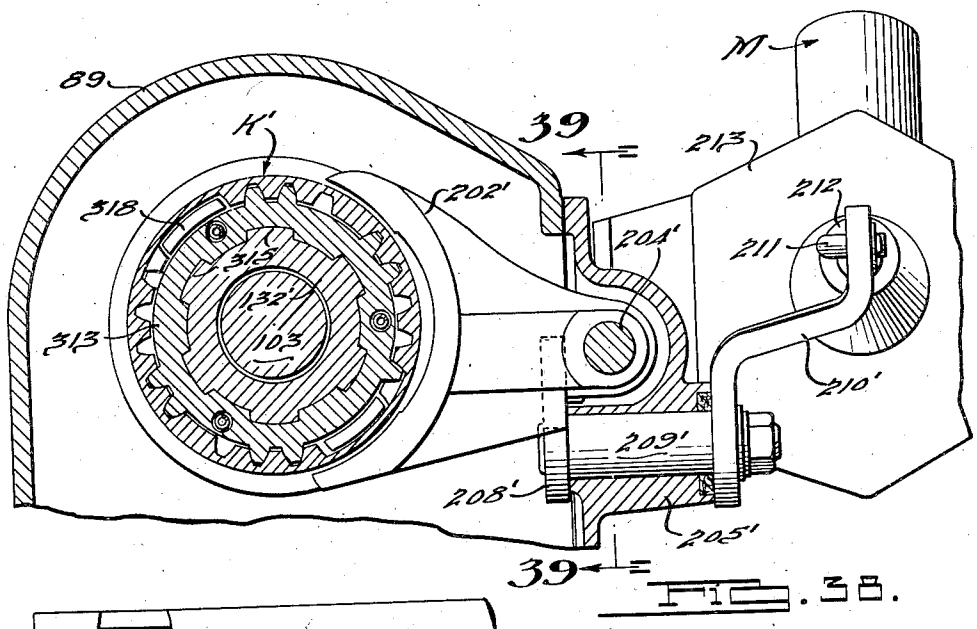


FIG. 38.

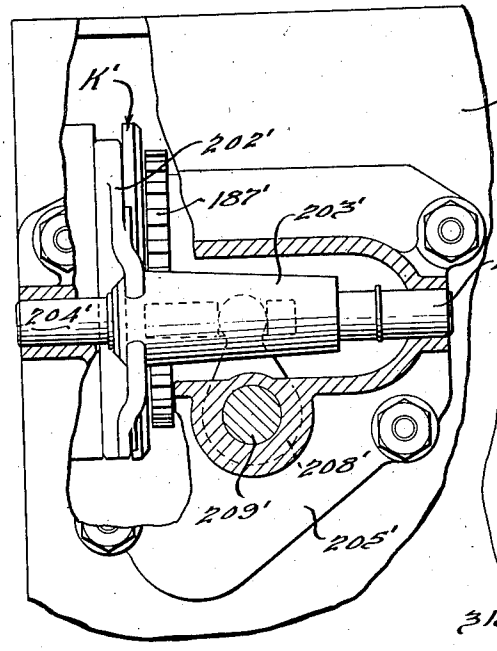


FIG. 39.

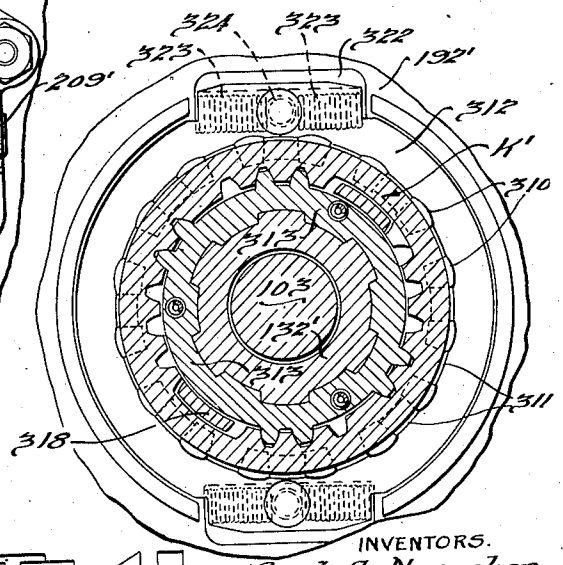


FIG. 40.

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Patented Nov. 2, 1943

2,333,115

UNITED STATES PATENT OFFICE

2,333,115

POWER TRANSMISSION

Carl A. Neracher, Augustin J. Syrovy, William T. Dunn, Teno Iavelli, and Roy T. Bucy, Detroit, Mich., assignors to Chrysler Corporation, Highland Park, Mich., a corporation of Delaware

Application March 13, 1941, Serial No. 383,190

30 Claims. (Cl. 74—472)

This invention relates to power transmissions and refers more particularly to improved driving systems for motor vehicles.

It is an object of our invention to provide a transmission system affording improved characteristics of change speed control with a comparatively simple mechanism capable of long life.

Another object of our invention is to provide a transmission affording improved means for changing speed ratios through the medium of positively engaging clutch means having synchronous control for insuring clutching without shock or ratcheting noise.

A further object is to provide an improved system of vehicle drive incorporating both manual and automatic change speed control affording improved vehicle driving functions.

We have provided an improved drive system incorporating a fluid coupling and kickdown transmission so constructed as to provide great flexibility of car control with very little effort such that nearly all driving may be done without manipulation of clutch pedal or gear shift levers and at the same time affording flexibility of car control best suited to the changing requirements of torque multiplication and other power transmitting characteristics. Our driving mechanism affords improved quietness and smoothness of car operation and facilitates manipulation of the car especially under heavy traffic conditions.

We preferably employ a relatively fast axle such that, when the transmission is in direct, the overall drive is the practical equivalent of an overdrive without driving through gear trains at such time. This is practicably obtainable without sacrificing car performance by our improved synchronous clutching means which automatically responds to manipulation of the accelerator pedal for stepping the speed ratio up or down.

With our transmission it is practicable for the driver to stay in a selected speed ratio setting while stopping, and thereafter obtain rapid car starting accelerations under favorable torque multiplication, and faster ratio boulevard or country drive conditions without operating the clutch pedal or the gear shift lever.

We have provided a manual selection of high and low ranges in our transmission, but in most instances the low range is in the nature of an emergency low and when the fluid coupling is employed very desirable car accelerating characteristics are obtained by manual selection of the high range.

According to the present embodiment of our invention, we have provided a transmission employing countershaft and planetary gearing and providing four forward speeds and reverse. Manual selection of the countershaft gearing may be made to high and low ranges, in each of which an automatic shift in the planetary gearing occurs to a faster drive ratio and back to the selected range, the automatic shifting being effected by natural functional manipulation of the accelerator pedal.

Additional features of our invention are found in the provision of a simple vacuum actuated servo-motor for shifting the power operated portion of the transmission, the said servo-motor being controlled by a solenoid of simple construction.

Other novel and improved features of construction and functional operation will become apparent from the following description, which describes two illustrative embodiments of the invention, reference being had to the accompanying drawings, in which

Fig. 1 is a side elevational view of the power plant and transmission for a motor vehicle.

Fig. 2 is a plan view somewhat diagrammatically illustrating the power transmission assembly in relation to the vehicle driving ground wheels.

Fig. 3 is a sectional view of the remote control hand shift mechanism taken as indicated by line 3—3 of Fig. 1.

Fig. 4 is a top plan view of the Fig. 3 mechanism taken as indicated by line 4—4 of Fig. 1.

Fig. 5 is a sectional view along line 5—5 of Fig. 1 showing a portion of the remote control shift.

Fig. 6 is a detail sectional view taken as indicated by line 6—6 of Fig. 5.

Fig. 7 is an enlarged, sectional view of a portion of the dash mounted control of Fig. 1.

Fig. 8 is an enlarged side view, partly in section and partly in elevation, showing the Fig. 1 power transmission.

Fig. 9 is a sectional elevational view through the speed ratio changing transmission which is illustrated in elevation in Fig. 8.

Fig. 10 is a transverse sectional view looking rearwardly as indicated by line 10—10 of Fig. 8, showing the transmission portion of the remote shift mechanism.

Fig. 11 is a detail sectional view taken as indicated by line 11—11 of Fig. 10.

Fig. 12 is a plan view, partly in section, taken along line 12—12 of Fig. 10.

Fig. 13 is a detail sectional view, taken along line 13—13 of Fig. 12.

Fig. 14 is a detail view along line 14—14 of Fig. 13.

Fig. 15 is an enlarged detail view of the power actuated clutch sleeve and its associated blocker mechanism.

Fig. 16 is a sectional plan view of the clutch and blocker teeth as viewed along line 16—16 of Fig. 15, the teeth being shown in blocked position.

Fig. 17 is a view similar to Fig. 16, showing the teeth in unblocked position.

Fig. 18 is a similar view, showing the teeth in engaged or driving position.

Fig. 19 is an exploded view, in partial perspective, of the carrier and blocker members.

Fig. 20 is a fragmentary sectional view taken along line 20—20 of Fig. 8.

Fig. 21 is an enlarged plan view of the Fig. 20 governor mechanism.

Fig. 22 is an enlarged fragmentary sectional view along line 22—22 of Fig. 21.

Fig. 23 is a sectional view through the vacuum operated servo-motor illustrated in elevation in Fig. 12.

Fig. 24 is a similar view showing the servo-motor in its actuated position.

Fig. 25 is a detail section along line 25—25 of Fig. 24.

Fig. 26 is an enlarged section taken along line 26—26 of Fig. 9.

Fig. 26A is a sectional view along line 26A—26A of Fig. 9.

Fig. 27 is an enlarged detail section taken along line 27—27 of Fig. 9.

Fig. 27A is a sectional view along line 27A—27A of Fig. 9.

Fig. 28 is a wiring diagram of the transmission control mechanism.

Fig. 29 is a longitudinal sectional view of a modified form of the invention.

Fig. 30 is an enlarged sectional detail of the clutch sleeve and associated mechanism of Fig. 29.

Fig. 31 is a plan view in section of the clutch and blocker teeth, taken along line 31—31 of Fig. 30, the teeth being shown in underdrive position.

Fig. 32 is a view similar to Fig. 31, showing the teeth in drive block position.

Fig. 33 is a similar view showing the teeth in unblocked position just prior to engagement of the sleeve.

Fig. 34 is a similar view showing the teeth in engaged or driving position.

Fig. 35 is a detail view of the overrunning roller cage of Figs. 29 and 30.

Fig. 36 is a view along line 36—36 of Fig. 35.

Fig. 37 is a partial elevation of the sleeve as viewed from the rear end thereof.

Fig. 38 is a sectional view along line 38—38 of Fig. 29.

Fig. 39 is a view along line 39—39 of Fig. 38, parts being broken away to show sectional details.

Fig. 40 is a sectional view along line 40—40 of Fig. 29.

Fig. 41 is a sectional view along line 41—41 of Fig. 29.

Fig. 42 is a fragmentary sectional view along line 42—42 of Fig. 29.

We have illustrated the principles of our invention in connection with a motor vehicle drive wherein the usual engine A transmits its drive through clutching means B, C, within casing 50, the drive then passing through the change speed transmission D and propeller shaft 51 (Fig. 2) to the differential 52 and thence to the vehicle ground wheels 53 where it is desired to drive the rear wheels according to present day practice.

By preference, the arrangement is such that a "faster" rear axle ratio is afforded than is generally customary so that when the transmission is in direct drive, the car is driven in the equivalent of an overdrive ratio between the engine A and wheels 53. Our arrangement provides such conveniently operable kickdown or shift to a reduction drive from direct that the aforesaid arrangement is practicable thereby obtaining advantages of economy, long life and quietness of operation without the disadvantages of sluggish operation which is especially objectionable in city driving.

The engine A has the customary intake manifold 54 and carburetor riser 55 containing a throttle valve 56 operable by a lever 57 throughout a range of movement between the illustrated closed throttle position for engine idling and wide open throttle position. Lever 57 is adapted to be adjusted by a driver operable accelerator pedal 59 pivotally mounted at 60 on the toe board 61 to swing downwardly against a restoring spring 62 thereby to thrust through a system of pivotally jointed links 63, 64 and a connecting lever 65, the latter being pivotally supported at 66.

The lever 65 has fastened thereto a second lever 73 directed forwardly to provide spaced fingers 74, 75 in the path of an actuator 76 of a snap switch 77 which controls the kickdown shift mechanism.

The kickdown shift mechanism operates in response to manipulation of the accelerator pedal 59 to substantially wide open throttle position whereupon the engine is momentarily unloaded as by shorting the ignition thereof and disengagement of the synchronous clutch sleeve which constitutes the automatic shiftable member in the transmission is effected to change the transmission driving ratio from direct to underdrive. The throttle being open under such conditions will cause the engine to rapidly speed up as soon as the ignition circiut has been restored and the underdrive mechanism will automatically become effective as will be presently made apparent. The ignition circuit, after interruption during kickdown, is not dependent upon restoration of the pedal 59 but is restored by other means which will be described.

We preferably transmit the drive from the engine A to the transmission D through disengageable clutch means comprising a fluid coupling B of the kinetic type, preferably in conjunction with a releasable clutch C of conventional design, the latter being employed to facilitate manual shifts in the transmission D and to accommodate stopping of the car in gear without tendency of the coupling B to cause creep particularly in such instances where the engine idle is set high as during winter starting.

The engine crankshaft 78 drives the coupling impeller 79 to circulate the coupling fluid in the passages of the impeller and thereby to drive the runner 80 in the well known manner. The runner 80 drives the member 81 of the friction clutch C which may be of any commercial design. The driven clutch disk 82 is fixed to an intermediate drive shaft 83 and is drivingly disengaged by depressing clutch pedal 84 (Fig. 1) which slides the throw-out member 85 forwardly to operate lever 86 for unloading the clutch driving pressure plate 87, springs 88 loading this plate and engaging the clutch when pedal 84 is released.

Shaft 83 extends rearwardly into housing 89 of transmission D (Fig. 9) where it is formed with a main drive pinion 90 and a set of external clutch teeth 101 which are adapted to slidably engage internal clutch teeth 102 formed on the synchronous coupling clutch sleeve Q. A ball bearing 70 journals the shaft 83 in the casing 89 as illustrated.

Piloted in the hollow portion 71 of the rearward end of the shaft 83 by means of a bearing 92 is a shaft 93 having splined thereto at 58 a hub 104 formed with external teeth 105 slidably engaged with the internal teeth 102 of the shiftable clutch sleeve Q. The latter is adapted to be shifted forwardly or rearwardly by means of a shift yoke 112 fixed to a longitudinally extending shift rail 113 (Fig. 10) disposed on the left side of shaft 93 (as viewed when looking forwardly of the vehicle).

The intermediate transmission driven shaft 93 is adapted to drive the tailshaft 103 by means about to be described, the latter being in turn adapted for connection to the propeller shaft 51, fastening means 67 being provided. Tailshaft 103 is also adapted to carry a brake drum 94 having braking mechanism generally designated by reference numeral 95 operably associated therewith.

The drive pinion 90 is continuously meshed with a gear 96 which forms one of the gears of a countershaft cluster 97 rotatable on a countershaft support 98. The cluster 97 includes a gear 107 which drives a governor mechanism G (Fig. 20). The cluster 97 is further formed with gears 106 and 108. Gear 106 is in constant mesh with a gear 109 which is freely journaled on the shaft 93 and a gear 108 is adapted to mesh with a shiftable idler gear 118 when the latter is slid rearwardly on its countershaft 119 by means of a shift yoke 120 (Fig. 10). At such time idler gear 118 is also meshed with a gear 121 fixed to the shaft 93.

A pair of synchronizing blocker rings 114 and 115 are respectively disposed between the hub 104 and gears 109 and 90 and are driven with hub 104 with slight rotational clearance. These blockers have cam teeth 116 and 117 respectively having pitch circles the same as that of sleeve teeth 102 and teeth 101 and 110, the latter being formed integrally on the forward face of gear 109. The blocker rings 114 and 115 are provided with internal cone-shaped threaded surfaces which are adapted to frictionally engage the cone-shaped clutch surfaces 107 and 111 respectively formed integrally on the gears 90 and 109. If desired, energizing springs 122 may be provided between the blockers to lightly urge them into engagement with the cone surfaces 107 and 111 respectively so that the blocker teeth 116 and 117 are misaligned with the sleeve teeth 102 thereby preventing shift of the sleeve Q so long as the parts to be engaged are rotating at different speeds. These synchronizing blocker rings are more fully described and claimed in the copending application of Otto E. Fishburn, Serial No. 180,840, filed December 20, 1937, and reference is made thereto for a more complete description of the synchronizing blocker action thereof.

When the sleeve Q is moved forwardly, the teeth 102 thereof engage the cammed ends of the blocker teeth 116 thereby urging the blocker under pressure into engagement with the cone-shaped clutch surface 107 whereupon gear 90 is synchronized with shaft 93 (main vehicle clutch C being released during manual shift of sleeve Q to facilitate this clutching action). The blocker 114 will then rotate slightly relative to hub 104 to permit the sleeve teeth 102 to pass through the blocker teeth 116 and engage teeth 101 thereby positively clutching shaft 93 with drive pinion 90. The rearward shift of sleeve Q to clutch with the teeth 110 of gear 109 is similarly synchronously effected under control of the blocker ring 115.

The shift yoke 112 (see Figs. 10 and 11) is provided with a boss 131 below rail 113, this boss having a slot 132 adapted to be engaged by an inwardly extending pin 133 carried by a lever 134. The latter has a lower end 135 adapted to engage a slot 136 provided in the yoke 120 which is fixed to the reverse shift rail 138, the latter being disposed in the casing 89 parallel to and below the rail 113. The yoke 120 encases the hub portion 139 of the shiftable reverse idler gear 118. The rails 113 and 138 are interlocked by a plunger 140 shown in Fig. 11 which prevents simultaneous displacement of said rails from neutral position.

Lever 134 is supported between its ends by a pin 141 disposed parallel to and above rail 113, this pin being carried by the yoked inner end 142 of shaft 143 rotatably mounted in the boss 144 of cover 145, the latter being secured by fasteners 146 to casing 89. The shaft 143 has its axis extending across the axis of movement of the rails 113 and 138 and has a lever 147 fixed to its outer end outside of the cover 145. The spring 148 is disposed in a bore suitably formed in the shaft 143 and reacts on the shaft at its outer end while the inner end yieldingly urges the lever 134 clockwise (Fig. 10) about the pin 141 tending to maintain pin 133 engaged in slot 132 and end 135 free from slot 136. A spring pressed ball detent 149 (Fig. 12) yieldingly maintains rail 113 in neutral, forwardly (to clutch sleeve Q with teeth 101), or rearwardly (to clutch sleeve Q with teeth 110) by engagement of this ball detent by the rail recesses 150, 151 and 152, respectively. The reverse shift rail 138 has neutral and reverse position recesses 153 and 154 respectively adapted for engagement by a similar spring pressed ball detent (not shown).

The upper end of lever 134 has a side face 156 engageable with the inner end of a plunger 157 slidable inward through cover 145 by a Bowden wire operated mechanism 158. When the wire 158 is pushed inwardly of the cover, the plunger 157 engages the face 156 of lever 134 and swings the lever counterclockwise about the pin 141 so that the end 135 engages slot 136 while pin 133 disengages from slot 132. When in such position the shaft 143 may be rotated through the intermediary of the shift lever 147 to shift the reverse shifter rail 138 rearwardly thereby meshing reverse idler gear 118 with gears 108 and 121 respectively for reverse driving. The plunger 157 maintains a sliding engagement with the face 156 during this rotation of shaft 143. The latter is retained against endwise displacement in the cover 144 by suitable means such as the pin 68.

The remote control mechanism for operating the shift lever 147 and Bowden wire mechanism 158 will now be described, reference being made to Figs. 1, 3 to 6, inclusive, and 10 to 12, inclusive. As may be seen from Figs. 1 and 3, the fixed steering post 159 of the vehicle housing the usual steering shaft 160 is operated by the hand engageable steering wheel 161. Rotatably journalled within the post 159 is a hollow shaft as-

sembly 162 connected by pivot pins 163 with the yoked inner end 164 of a manually operable shift lever 165 which extends outwardly through an arcuate opening 166 formed in the head 167 which is fixed to post 159. Movement of lever 165 fore and aft about the axis of shaft 162 will oscillate this shaft about its axis while movement of the lever up and down will rock the lever about a fulcrum 168 to cause reciprocation of shaft 162 along its axis.

At the lower end of shaft 162, there is a lever 169 fixed thereto, this lever having an intermediate inside face portion 170 always engaged by the upper end of a plunger 171 fixed to the upper end of the Bowden wire 158. A spring 172 operates to yieldingly urge plunger 171 upwardly into engagement with lever face 170 as shown in Fig. 5. A link 173 has its forward end pivotally engaged with the outer end of the lever 169, the rearward end of this lever being connected to a bellcrank lever 174 pivotally mounted on the engine A at 175. The bellcrank operates a second link 176 which has articulated connection with the shift lever 147.

In order to shift the sleeve Q into engagement with the teeth 110 of the low speed drive gear 109, the driver disengages the main vehicle clutch C by depressing pedal 84 and then swings lever 165 in a counterclockwise direction about the axis of the steering column as viewed in Fig. 4. This action pushes the lever 147 rearwardly through the intermediary of the links 173 and 176 and shifts rail 113, yoke 112 and sleeve Q rearwardly engaging the teeth 102 of the latter with the teeth 110. Clutch pedal 84 is then released for drive of the vehicle in low speed range. Swinging of lever 165 clockwise as viewed in Fig. 4 will swing lever 164 forwardly thereby swinging the lever 113 and sleeve Q forwardly to thereby clutch the teeth thereof with the teeth 101 of drive pinion 90 to establish a direct drive connection between the shafts 93 and 83.

In order to effect reverse drive setting of the transmission as so far described, the lever 165 is first rocked upwardly about the fulcrum 168 to thereby push shaft 165 downwardly of the steering column and cause lever portion 170 to operate through the Bowden wire 158 to swing lever 134 counterclockwise about the pin 141 thereby engaging the end 135 with slot 136 of yoke 120 and disengage pin 133 from engagement with the slot 132 of boss 131 carried by shift yoke 112. The lever 165 may then be swung counterclockwise of the steering column to cause the lever 147 to rock lever 134 rearwardly and effect rearward shift of rail 138 thereby meshing idler gear 118 with gears 108 and 121. Clutch C which is preferably released during manual shifting of sleeve Q and reverse idler gear 118 may then be engaged and the vehicle driven in reverse.

From the foregoing, it will be apparent that drive from the engine crankshaft 78 may be transmitted through the fluid coupling B and friction clutch C to the driven shaft 93 which may be driven at the speed of the shaft 83 and in the same direction; at a reduced speed and in the same direction with respect thereto; or at a reduced speed in a reverse direction with respect thereto.

Referring now again to Fig. 9, it will be seen that the shaft 93 terminates at its rearward end in an enlarged hollow portion 175 and is supported in the casing 89 at this point by means of an anti-friction bearing 176, the casing 89 being suitably formed at this point with a wall 69 for receiving the outer race of the bearing. A snap ring 178 engages a suitable recess in the wall portion 69 for retaining the bearing in position.

On the rear side of the partition wall 69, the portion 175 of the shaft 93 flares outwardly still further and is formed on its outer peripheral portion with spline teeth 123 which are adapted to engage a set of internal teeth 124 formed on an annulus gear 126. A snap ring 125 engages a slot cut in the gear and retains the gear against forward displacement.

The annulus gear 126 comprises the driving gear of a planetary gearset which also includes a sun gear 127 rotatably carried on the tail shaft 103 and a set of planet gears 128, the latter being rotatably mounted on axles 129 carried by a carrier 130. The latter is splined on the tailshaft 103 at 131 and is separated from the enlarged portion 175 of the shaft 93 by an anti-friction bushing 177 which permits relative rotation between the shaft 93 and the sun gear.

The sun gear 127 is provided with an integral elongated rearwardly extending control portion 132. This control portion or sleeve is in turn provided with a forwardly disposed set of overrunning clutch cams 133 (Figs. 9, 15 and 26), a rearwardly disposed set of overrunning clutch cams 134 (Figs. 9, 15, 26 and 26A) and a pair of diametrically oppositely disposed, saucer-like depressions 135 (Figs. 9, 13 and 15). The cams 133 and 134 respectively comprise elements of a pair of overrunning clutch and brake devices referred to generally by letters R and S.

The clutch R also comprises a set of rollers 136 carried by a cage 137, the rollers being adapted to wedge between the cams 133 and the inner cylindrical surface 179 of a blocker member 180. The latter is carried by a sleeve-like extension 181 formed integrally on the planet carrier 130 (see Figs. 15, 19 and 26) and is disposed internally thereof. The blocker member 180 is provided with a plurality of bearing surfaces 182 which rotatably engage the inner cylindrical surface of the extension 181 and with a plurality of spokes 183 which extend radially outwardly through slots 184 in the extension 181.

The slots 184, of which there are preferably three corresponding in number to the spokes 183, are larger than the spokes as clearly shown in Figs. 19 and 26. The clearance between the sides of the slots 184 and the spokes 183 permits the blocker member 180 to "clock" between two extreme rotative positions relative to the carrier 130. The blocker is shown in Fig. 26 in its blocking position, the teeth 185 thereof, which are formed as integral extensions of the spokes, being positioned such that they engage certain of a set of teeth 186 internally formed on a slidable clutch sleeve K. The clutch sleeve K is slidably carried on the carrier extension 181, the latter being provided with a set of external teeth 187 which mesh with certain of the sleeve teeth 186 as shown in Figs. 26 and 27. The blocker 180 is adapted for rotation clockwise of Fig. 26 to unblock shift of the sleeve K forwardly along the teeth 187 as will be presently explained. A snap ring 188 carried by the carrier extension 181 retains the blocker 180 against rearward endwise displacement.

The teeth 186 of the clutch sleeve K which are adapted to be engaged by the blocker teeth 185 are cut away to accommodate the blocker teeth as shown in Figs. 9 and 15. The blocker teeth 185 are of substantially the same pitch diameter as the sleeve teeth 186 and the cut-away slots in the sleeve teeth provide adequate clearance to per-

mit the blocker member 180 to freely "clock" between its blocking and non-blocking positions.

The rear overrunning device S includes a set of overrunning rollers 189 adapted to wedge between the cams 134 (which are similar to the cams 133 but oppositely directed) and the inner cylindrical surface of a shell 190. The latter is fixed by pins 191 to the casing 192 which is suitably fastened to the rear end of the casing 89. The shell 190 carries the outer race of an anti-friction ball bearing 193 which journals the rear end of the tail shaft 103. A speedometer drive gear 194 is fixed on the shaft 103 in rear of the bearing and a seal 195 is provided for sealing the housing against oil leakage in accordance with conventional practice.

Welded or otherwise suitably attached to the clutch sleeve K is a control ring 196. The latter has a plurality of spokes 197 extending radially outwardly through the slots 184 for attachment to the sleeve and the ring portion thereof is of annular form and of such internal diameter that it clears the carrier 137 when the sleeve K is in disengaged position, as shown in Figs. 9 and 15, and engages balls 198 when the sleeve is in engaged position.

The balls 198, of which there are preferably two disposed in diametrically opposed relationship, are carried by the cage 137, only enough clearance being provided therebetween to permit free rotation of the balls.

The saucer-like depressions 135 in the sun gear control sleeve 132 are so disposed with respect to the cams 133, 134 respectively of the overrunning devices R and S, that when clutch sleeve K is in engaged position, the cage 137 is held in such position by the balls 198 that rollers 136 of overrunning device R are engaged and rollers 189 of overrunning device S are free. As will be clear from the drawings, movement of sleeve K forwardly to engaged position will also carry ring 196 forwardly and balls 198 will be engaged thereby. This feature will be hereinafter more fully explained.

The annulus gear 126 is provided with an overhanging toothed portion 200, the teeth of which are adapted to be engaged by external teeth 201 carried by the clutch sleeve K. When the teeth 200 and 201 are in mesh, the annulus gear 126 and the planet carrier 130 are locked together and a 1 to 1 ratio drive is transmitted from shaft 93 to shaft 103. Release of sleeve K will cause reverse rotational tendency of sun gear 127 and as overrunning device S prevents reverse rotation of the sun gear, said gear will provide reaction for the planet gears and a reduced speed drive will be transmitted from shaft 93 to shaft 103.

Clutch sleeve K is shiftable by power actuated means under the influence of a shift yoke 202 which rotatably engages the same in the usual manner. The yoke 202 has an integral elongated boss portion 203 which is slidably carried on a shift rail 204, the latter being mounted in a pair of axially aligned bosses of a cover 205 fastened to the casing 89 on the right hand side thereof (looking forwardly of the vehicle) as illustrated in Figs. 12, 13 and 14. The yoke boss portion 203 has integrally formed thereon a pair of spaced lugs 206 adapted to receive between them the rounded end 207 of a shift lever 208 carried by a shaft 209. The latter is rotatably carried in a suitable bore in the cover 205 and at its outer end carries a second shift lever 210. The upper end of the lever 210 is operably connected by a link 211 with the operating rod 212 of the prime mover motor M.

The prime mover motor M in the present embodiment is of the so-called vacuum type as the fluid medium used on the motor piston is rendered effective by subjecting the piston to the vacuum of the intake manifold of the engine. Thus, a chamber or cylinder 213 houses a piston 214 of the diaphragm type, the latter being fixed to a hollow piston rod 215 which has the front and rear abutment members 216, 217 assembled therewith in fixed relationship. Air under atmospheric pressure is unrestrictedly present in the chamber 218 as the flexible dirt seal 218' is not air tight. The other chamber of the vacuum motor 219 is selectively placed in communication with either a source of pressure fluid different from atmospheric pressure such as the intake manifold of the engine A or else with the atmosphere when the chamber 219 is vented.

The motor housing 220 slidably receives the front end of the piston rod 215 and has a chamber 221 which is open to chamber 219 by a passage 222. Upper and lower valve seats 223, 224 define passages for respectively controlling the venting and vacuum supply to chambers 221 and 219. A second passage 225 through the motor housing 220 connects the chamber 221 with the outside atmosphere under certain conditions of operation and the chamber 221 is placed in communication with the low pressure of the intake manifold under other conditions of operation by way of chamber 226 and passage 227.

In order to control the admission of vacuum or atmospheric pressure into the chamber 219, we have provided an electrical solenoid L having an armature plunger 228 yieldingly urged downwardly by a spring 229. This armature plunger has a lower extension formed with valve parts 230, 231 adapted respectively to engage the valve seats 223, 224 thereby to close and open the passages through said seats. In Fig. 23 the solenoid L is shown in energized condition, the armature 228 being raised against spring 229 thereby seating valve 231 and opening valve 230 thereby venting chamber 219 to the atmosphere by way of passage 222, chamber 221 and passage 225 and permitting piston 214 under certain conditions hereinafter set forth to move rearwardly under the action of a spring 232 to move clutch sleeve K to its disengaged position. This releasing movement of the sleeve K is limited by engagement of the ring 196 with the shell 190 as is clear from Figs. 9 and 15. In Fig. 24, the solenoid L is shown deenergized, the armature 228 having been lowered by spring 229 thereby closing valve 230 and opening valve 231 thus cutting off communication between the chamber 221 and the atmosphere and opening chamber 221 to the vacuum supply, vacuum always being present in chamber 226 during operation of the engine A. Lowering of the pressure in chamber 219 causes piston 214 to move forwardly compressing spring 232 and moving rod 215 forwardly or to the left as viewed in Figs. 23 and 24.

In order to provide a yielding power transmission between piston 214 and clutch sleeve K, a thrust transmitting compression spring 233 is disposed within the hollow rod 215, one end of the spring being seated on the abutment 217 and the other end being seated on a head 234 of a rod 235 which extends through spring 233 as a forward extension of the rod 212. It may thus be seen that when piston 214 is forced forwardly by the action of the pressure fluid thereon, rod

212 and sleeve K may move forwardly only to the blocked position of the sleeve while the piston 214 may continue movement to the end of its stroke accommodated by loading of spring 233 against the head 234. Then when the mechanism has functioned to synchronize the teeth 200, 201, as will be explained later on in the description, rod 212 will be actuated by the preloaded spring 233 to move the clutch sleeve K forwardly into engaged position, the teeth 201 thereof meshing with the teeth 200 of the annulus gear 126.

In Fig. 24, the rod 212 has moved forwardly to the limit of its travel, the sleeve K being fully clutched whereas the piston 214 has overtravelled rod 212 to the extent of the gap 237 between abutment 217 and the end of the enlarged portion of the rod 212. When, with the parts positioned as shown in Fig. 24, solenoid L is energized to vent chamber 219, it will be apparent that rod 212 may remain stationary while spring 232 moves piston 214 rearwardly until the abutment 217 engages the shoulder 238 of rod 212. This arrangement is utilized to effect unloading of the clutch teeth 200, 201 whereby sleeve K may be shifted out of clutching position as will be presently made clear. Therefore, after the piston has closed the gap 237 in unloading the clutch teeth, spring 232 thereupon moves the piston 214 to the Fig. 23 position releasing the sleeve K.

The unloading of sleeve K is accomplished by the momentary grounding or shorting of the engine ignition system under control of an ignition interrupting switch N. This switch has terminals 239, 240 open as shown in Figs. 23 and 24 for normal operation of the engine ignition system and closed to render the ignition system inoperative in conjunction with further controls to be described. The switch terminals are bridged and the switch thereby closed by a movable contact 241 in the form of a reciprocable plunger resting on a ball detent 242 which in Fig. 23 is seated in groove 243 of rod 215 thereby allowing switch spring 244 to hold contact 241 away from the terminals 239 and 240.

When the piston 214 is at the limit of its pressure fluid operated stroke (Fig. 24), a second groove 245 receives the ball 242 to allow switch N to remain open. However, whenever the piston moves between the Fig. 23 and Fig. 24 positions, switch N is closed and depending upon other conditions, the engine ignition may then be interrupted. Thus, when the motor M is vented in Fig. 24 position, the piston 214 in taking up gap 237 will cause switch N to close the switch, opening again at the completion of the rearward stroke of the piston.

In order to latch the sleeve operating means into clutch engaging position so that once the motor M has been operated by pressure fluid to engage the clutch sleeve K with the annulus gear 126, the sleeve will not thereafter tend to disengage because of variations in the pressure on opposite sides of the piston 214, a mechanism is provided which operates independently of the fluid pressure operated means. This mechanism also permits the pressure fluid to load the sleeve operating means for clutching shift in advance of actual clutching of the sleeve K so that loss of pressure fluid after loading will not effect the subsequent clutching engagement of the sleeve. This feature is particularly advantageous in connection with the use of intake manifold vacuum for operating the piston because the presence of a vacuum depends of course upon the throttle valve opening and accelerator pedal position.

The latching mechanism comprises a latch member 246 pivoted at 247 in chamber 226 and yieldingly urged downwardly by "rat trap" spring 248 so that when solenoid L is deenergized, the lower end of the latch will engage the forward end of a latch groove 249 in rod 215 when the piston 214 is urged forwardly on its power stroke, to thereby hold the piston in the Fig. 24 position independently of the continued presence of vacuum in chamber 219.

The latch member 246 has a pair of in-turned lugs 250 (Fig. 25) which when the parts are in their Fig. 24 position overlie a shoulder 251 formed on the lower end of the plunger 228, there being a clearance between the shoulder and lugs so that latch 246 may seat independently of the seating of the armature valve part 230 such that when the solenoid L is energized to vent motor M, the armature 228 will have a certain freedom of movement for a hammer-blow contact with the lugs 250 so as to insure release of latch 246 from groove 249.

As a means of manually engaging clutch sleeve K with the teeth 200 of the annulus gear 126 in cases where the vehicle battery is down and it is desired to start the engine by towing of the car, we have provided independent control devices operable by the driver and best shown in Figs. 1, 7, 23 and 24. The vehicle dash 252 carries a knob 253 connected to a Bowden wire mechanism 254 with the abutment 216 so that when the driver pulls the knob, the piston 214 will be moved forwardly the same as though pressure fluid was causing its power stroke and clutch sleeve K will be engaged.

Inasmuch as the solenoid L will ordinarily be energized at this time under the action of the governor control switch presently to be described, such that the latch 246 cannot function, it is desirable with our illustrated arrangement to render the latch operable as a function of actuating knob 253 so that the piston 214 will stay in the Fig. 24 position after the above described manual operation. To this end we have provided a dash switch P which comprises a pair of electrical terminals 255, 256 normally bridged to close the switch by a spring contact piece 257 held in position by a suitable dog 258 fixed to the Bowden wire 254. When the knob 253 is in its inoperative position as shown in Fig. 1, the contact piece 257 of switch P completes a circuit (to be described later) between terminals 255, 256 but when the knob is pulled out to effect manual clutching operation of the sleeve K, the dog 258 moves to the position 258' and contact piece 257 springs downwardly to the position 257' to open switch P which will thereby maintain solenoid L deenergized so that latch 246 may function.

Whenever the car is being driven, the countershaft cluster 97 is drivingly connected with the intermediate driven shaft 93 and this relationship is conveniently utilized for controlling the automatic operation of the sleeve K as a function of car speed in a manner now to be described. It is desirable to point out in passing that the speed responsive control means for the sleeve K about to be described may if desired be omitted although it is included by preference in order to improve the functional operating characteristics of the transmission.

Referring to Figs. 9, 20, 21 and 22, it may be seen that the cluster gear 107 drives a worm 261 having a shaft portion 262 which drives a gov-

ernor controlled speed responsive switch G which may be of any suitable type. The shaft 262 has a head 263 which carries a pair of weights 264 mounted thereon by pivot pins 265. The weights are constrained to swing in unison by reason of equalizer connection 266 and each weight has a stop pin 267 operable in a slot 268 in head 263. The weights are yieldingly urged inwardly by a flat leaf spring 269 which is bowed between stops 270 carried by the weights and after the shaft 262 during car acceleration has reached a predetermined desired speed of rotation, the weights swing outwardly thereby further bowing and tensioning the spring 269 to open the switch by forcing the contact piece 271 (shown diagrammatically in Fig. 28) to swing upwardly from the stationary contact 272 which is grounded at 273. The switch mechanism G is so constructed that a differential is effected in the operation thereof such that as the car is accelerated or brought to a stop the switch G is caused to close at a much slower car speed than that required to open the switch although such relationships may be varied as desired. However, for reasons presently apparent, we prefer to hold the switch G open during normal stopping of the car in traffic until the car in its direct speed ratio has been decelerated to a speed slightly less than the normal idling speed of the engine A in order that the reversal of torque necessary to unload the clutch sleeve K may be effected. Inasmuch as it is often desirable to provide for a change in the governor functions, a detent control is provided. Referring to Fig. 22, it may be seen that the governor weights 264 each carry a ball 274 loaded adjustably by a spring 275 such that as the weights swing outwardly, the balls 274 will enter notches 276 in the base 263 and serve to prevent return of the weights inwardly and closing of the switch until the desired low speed of the vehicle has been reached on bringing the car to rest. The provision of these ball detents 274 provide a convenient means of adjusting or changing the speed responsive operation of the governor mechanism by varying the position of the spring tensioning screws 277.

Referring now to the wiring diagram of Fig. 28, it may be seen that the circuit from contact piece 271 is taken through conductor 278, rail switch J and conductor 278' to a conductor 279 which leads to the kickdown switch 77 and thence to ground at 280. The switch J may be of any suitable form and is arranged to be closed by engagement of the forward end of reverse rail 138 with the plunger 279' thereof when the rail is in neutral position. The conductor 279 also leads to the dash switch P and thence by a lead 281 to the branch conductors 282 and 283. Conductor 282 leads to the ignition interrupting switch N thence by a conductor 283' to the switch piece 284 of a clutch pedal operated switch O, the purpose of which will be hereinafter set forth. This switch has its other contact piece 285 connected by a conductor 286 to the coil 289 and through leads 290 and 291 through the ignition switch 292, ammeter 293 and by way of lead 294 to a starter terminal 295 which is connected directly with the vehicle storage battery 296 by a conductor 297, the battery 296 being grounded at 298.

When the clutch pedal 81 is fully released, the contacts 284 and 285 of the switch O are bridged, a spring 299 holding the movable conductor 300 of the switch across the switch terminals. This conductor 300 is connected by a linkage 301 with the pedal 81 so that the switch A is open upon depression of the pedal and maintained open throughout the operating stroke of the pedal.

The aforementioned conductor 283 connects the conductor 281 with the actuating field winding 302 of solenoid L. It will thus be seen that several operating circuits are provided for causing operation of the prime mover motor M.

The main kickdown circuit which is established by closing of the kickdown switch 77 through full depression of the accelerator pedal 59 for energizing solenoid L to effect release of latch 246 and start the cycle of ignition interruption and release of the clutch sleeve K comprises ground 280, switch 77, lead 279, dash switch P, leads 281 and 283 to solenoid L, lead 291, ignition switch 292, ammeter 293, lead 294 and lead 297 to battery 296 and ground 298.

The kickdown ignition interruption circuit which effects grounding of the engine ignition when the kickdown switch 77 is closed comprises ground 280, leads 279, 281 and 282, engine ignition interrupting switch N, lead 283', clutch switch O and lead 286 to distributor 287, lead 288 to coil 289, leads 290, 291 to ignition switch 292 and thence as in the main kickdown circuit to ground 298. In connection with the ignition interrupting switch N, it should be noted that when the kickdown switch 77 is closed to establish the main kickdown circuit, the latch 246 is disengaged from notch 249 by reason of solenoid L being energized whereupon spring 232 moves piston 214 and rod 215 to take up the clearance 237 thereby closing switch N while sleeve K remains engaged. It is therefore apparent that the kickdown ignition interrupting circuit under control of the switch N is automatically established in response to closing the main kickdown switch 77 for establishing the main kickdown circuit.

The main speed responsive control circuit which energizes solenoid L at relatively low car speeds comprises ground 273, governor switch mechanism G, leads 278, 279, dash switch P and lead 281. From lead 281 the speed responsive control circuit continues just like the main kickdown circuit between solenoid L and ground 298. Likewise, the speed responsive control circuit for the ignition interruption extends from ground 273 through governor switch G and thence to lead 281 just as for the main circuit. From lead 281, the circuit comprises lead 282 to the ignition interrupting switch N and thence continues to ground 298 as above described.

Referring now to Figs. 15 to 18, inclusive, the latter three figures represent diagrammatically the positions of the teeth 185, 186, 187 under various conditions of vehicle drive. Fig. 16 shows these teeth as they are positioned during drive of the vehicle in underdrive with the sun gear 127 locked against reverse rotation by the overrunning device S. The sleeve K is in disengaged position and shift thereof to engage the teeth 200 of the annulus gear is blocked by the teeth 185 of the blocker 180 which abut the sleeve teeth 186.

Release of driving torque on the intermediate driving shaft 93 will cause the latter to fall off in speed and, if the speed of the vehicle is above the operating speed of the governor G, sleeve K will be biased toward engaged position by operation of the motor M. Shift of sleeve K will, however, be blocked by blocker teeth 185 until the speed of shaft 93 has dropped to that of shaft 103, whereupon shaft 103 will tend to overrun shaft 93 and the consequent reversal of torque will cause the sun gear 127 to tend to rotate forwardly (clockwise). Forward rotation of the sun

gear will cause rollers 136 of clutch R to wedge between cams 133 and the inner surface of the blocker 180 whereupon the latter will be rotated forwardly through the clearance 184 (Fig. 26) to unblocking position shown diagrammatically in Fig. 17. Sleeve K is now free to shift forwardly to engage or driving position which action is smoothly and quietly accomplished because of the synchronous rotation of shafts 93 and 103.

Shift of sleeve K to driving position, illustrated diagrammatically in Fig. 18, engages teeth 200 and 201 and locks the annulus gear 126 to the carrier 130 thereby establishing a 1 to 1 ratio driving connection between shafts 93 and 103, the sleeve K being locked in position by the latch 246 previously described.

The operation of the transmission is as follows:

With the car parked, the transmission D will, of course, be in neutral with the manually shiftable sleeve Q and the automatic shiftable sleeve K positioned as illustrated in Fig. 9. The ignition is off at switch 292, the solenoid L deenergized and the piston 214 of the motor M is in the Fig. 23 position, the spring 232 being free to maintain sleeve K in its disengaged position.

The engine A is normally started with the transmission in neutral. As soon as ignition switch 292 is closed preparatory to starting the engine, the solenoid L will be energized and will move the plunger 228 thereof upwardly to the Fig. 23 position holding latch 246 so that it is free of the rod 215 and thereby venting the chamber 219. It may also be noted that at this time the governor switch G is closed thereby establishing the main governor circuit by reason of which solenoid L is maintained energized as aforesaid. A coupling sleeve K remains in its rearward released Fig. 9 position.

To start in the lowest driving speed ratio ordinarily called first speed, the driver depresses clutch pedal 81 to release clutch C and then shifts the selector lever 165 forwardly to the low range thereby causing the manually shiftable sleeve Q to be shifted rearwardly into clutching engagement with the teeth 110 of the low speed drive gear 109. This shift is facilitated by release of clutch C which thereby disconnects the pinion 90 from the engine A and fluid coupling B whereupon the teeth 102 of sleeve Q may be silently meshed with the teeth 110 under control of the blocker synchronizing element 115.

Depression of the clutch pedal 81 opens the switch O but as the piston rod 215 does not move to close switch N, the switch O has no function at this time.

The driver then releases the clutch pedal 81 to engage the clutch C at the same time depressing the accelerator pedal 59 to start the car in first speed ratio. The drive in this speed ratio is speeded up as follows: Pinion 90 drives gear 96 and gear 106 which is rotatable therewith drives gear 109 which is coupled directly to the shaft 93 by the sleeve Q and the hub 104. Due to the fact that the sleeve K is in its disengaged position, drive of the annulus gear 126 causes the sun gear 127 to tend to rotate reversely whereupon the rollers 189 of overrunning device S wedge between the control sleeve portion 132 and the shell 190. Reverse rotation of the sun gear 127 being thus prevented, drive is transmitted through the planetary gearset to the tailshaft 103 through the carrier 130, the planetary gearset functioning to transmit an underdrive between the shafts 93 and 103. Under these conditions, the rollers 136 of the overrunning clutch device R are in such position that they permit free rotation of the blocker member 180 and the sleeve K relative to the annulus gear 126 and the sun gear 127. During the period in which an underdrive relation exists between the shafts 93 and 103, sleeve K is driven at the speed of the shaft 103 because of the fact that the sleeve is carried by the carrier 130 and the blocker member 180 also rotates at the speed of the shaft 103 being driven by the portion 181 of the carrier, the spokes 183 of the blocker being in engagement with the trailing sides of slots 184, thus maintaining the blocker in blocking position relative to the sleeve K, as illustrated in Fig. 26.

In the event that the driver holds the accelerator pedal depressed so that the car is accelerated in first speed ratio at a speed sufficient to cause the governor switch G to open, the solenoid L will be deenergized and the core 228 thereof will move downwardly under the influence of the spring 229 to latch the piston rod 215 at the end of its pressure stroke but it is to be noted that while the accelerator is depressed, the manifold pressure will not ordinarily be sufficient to operate the piston 214. If, however, the engine continues to drive the car in first speed ratio above the speed at which the governor switch G opens and the accelerator is at least partially released sufficiently to cause pressure fluid operation of the piston 214, then the piston will move from its Fig. 23 position to its Fig. 24 position compressing spring 232, the groove 249 receiving the latch 246. Although the piston 214 moves forwardly through its full power stroke and compresses the spring 232 to thereby urge clutching engagement of the sleeve K with the teeth 200 of the annulus gear 126, the rod 212 will move forwardly only slightly at this time because the sleeve K will move forwardly only slightly if at all to take up the clearance which may exist between the long teeth 186 thereof and the blocker teeth 185 which under the presently described conditions, are in the position shown in Fig. 16. Actual clutching of sleeve K will take place when the blocking teeth 185 are caused to move forwardly to their Fig. 17 position which action will take place when the shafts 103 and 93 are allowed to synchronize in response to release of the accelerator pedal.

In order to facilitate a discussion of the control functions, it will be assumed that the governor switch G is so arranged with relation to the particular vehicle and transmission illustrated that this switch will open when the car is driven in first speed ratio at about 7 M. P. H. Obviously this relationship may be varied as desired but, as a result of experience, this particular relationship has been found to be ideal. The governor switch G is preferably arranged to close when its drive shaft 261 slows down from above the aforesaid critical opening speed to a speed corresponding to a car speed that is below the assumed 7 M. P. H. when the vehicle is being driven in second speed ratio, the detent means illustrated in Fig. 22 functioning under these conditions to control the operating functions of the governor mechanism. In the preferred embodiment of our transmission now being described, we have arranged the gearing and governor operations such that the governor switch G will open during car acceleration in first and third speed ratios respectively at 7 and 15 M. P. H., the switch closing on stopping the car in fourth or direct and second speed ratios respectively at approximately 7 and 3 M. P. H. In such instance, we prefer to use an axle ratio of

3.54 to 1 and transmission ratios as follows: first speed ratio 3.06 to 1, second speed ratio 1.97 to 1, third 1.55 to 1, fourth or direct speed ratio 1 to 1 and reverse speed ratio 3.26 to 1.

The drive in first speed ratio is a free-wheeling drive below 7 M. P. H. car speed because within such limits the governor switch G remains closed and solenoid L is thereby energized to maintain motor M vented, the driven shaft **103** being free to overrun the intermediate driving shaft **93** by automatic release of the overrunning device S in response to coast of the vehicle.

When the vehicle is driven above 7 M. P. H. in first speed ratio, the governor switch G opens thereby deenergizing the solenoid L as aforesaid and upon release of the accelerator pedal **59**, the pressure is rapidly lowered in the manifold **54** and consequently in the chamber **219** of the motor M and the rod **215** will be shifted forwardly if it has not already been shifted forwardly during the drive in first speed ratio as frequently occurs because if the vehicle is not accelerated at excessive speed, sufficient vacuum will exist in the manifold **54** to cause operation of the diaphragm piston **214**.

Release of the accelerator pedal **59** under the foregoing conditions while the vehicle is travelling above 7 M. P. H. in first speed ratio will cause an automatic shift of the sleeve K to establish second speed ratio. The shift of sleeve K occurs when the shaft **93** slows down to approximately the speed of the shaft **103**. Release of the accelerator pedal will cause an instantaneous reversal of the driving force through the planetary gearset and the tailshaft **103** will momentarily become the driving shaft while the intermediate shaft **93** will tend to decrease in speed due to slowing down of the motor. Under such conditions, the annulus gear **126** will drop off in speed and will become momentarily the reaction element of the planetary train instead of the driving element. The planet carrier **130** which is splined to the tailshaft **103** at **131** will then begin to drive the sun gear **127** forwardly (clockwise) the control sleeve portion **132** thereof overrunning the shell **190** through the rollers **189** of the overrunning brake device S. The control sleeve portion **132** of the sun gear will then immediately become drivingly locked to the blocker member **180** through the action of the rollers **136** of the overrunning clutch R which will wedge into driving engagement. Blocker member **180** will then tend to be driven by the shaft **103** and will rotate forwardly slightly with respect thereto to take up the lost motion incident to the clearance **184** provided between the blocker member **180** and the carrier **181** and sleeve K, the latter two elements, of course, being relatively non-rotatable due to the constant meshing engagement of the teeth **186** and **187**. This slight forward rotation of the blocker member from its Fig. 16 position to its Fig. 17 position will unblock the teeth **186** of the sleeve K and permit the sleeve to move forwardly under the action of the spring **233** (Fig. 23) which was previously loaded by forward movement of the piston **214** and rod **215** thereby engaging the teeth **201** of the member K with the teeth on the overhanging portion **200** of the annulus gear **126**. At this stage, the shaft **103**, the blocker **180**, the sleeve K and the annulus gear **126** are all rotating forwardly in synchronism, thus engagement of the teeth **200** and **201** is accomplished positively and silently.

Opening of the engine throttle by depression of the accelerator will now cause the vehicle to be driven forwardly with the planetary gearset locked up to rotate as a unit thereby providing a 1 to 1 driving ratio between the shafts **93** and **103**. As the shaft **93** is still being driven at a reduced speed ratio with respect to the shaft **83**, the transmission is now in its second speed ratio position.

Under certain conditions of operation, it may occur that the teeth **200** will be in such position with relation to the teeth **201** that these two sets of teeth will abut and forward movement of the clutch sleeve K will be blocked during release of the drive as described. In such case, at the instant the driver opens the throttle to accelerate the vehicle, there will be a tendency for the annulus gear **126** to rotate forwardly with relation to the clutch member K and very slight relative movement of these parts will unblock the teeth which will slide into mesh under the influence of the pressure of the spring **233** to thereby establish direct drive between the shafts **93** and **103**. If desired, either or both sets of teeth may be slightly beveled to facilitate meshing.

During the above described cycle of operation, the overrunning rollers **136** and **189** of the overrunning devices R and S will have a definite relation because of the disposition of the cams **133** and **134**, respectively, which is illustrated in Fig. 26. These cams are so disposed with respect to one another that the rollers **136** will always be in non-driving position during the period rollers **189** are wedged to the shell **190** and rollers **189** will be held in their neutral position during the period of lock-up of the rollers **136** with the members **132** and **180**.

This feature is of paramount importance in the operation of the transmission as it prevents an uncontrollable no-back condition which might occur if the car were driven against an obstruction with sufficient force to spring the bumper thereof. Under such conditions with the transmission in gear, backward thrust would be exerted on the vehicle by the bumper which would tend to turn the tailshaft **103** reversely and wedge both sets of overrunning rollers into lock-up position, thereby making it impossible for the driver to manipulate the sleeve Q out of mesh due to the frictional load of the teeth of the engaged gears and clutches in the transmission. In the arrangement just described, such an uncontrollable no-back condition can never occur because of the action of the control ring **196** (Figs. 9, 15 and 27A).

Upon movement of the clutch sleeve K forwardly to clutch with the annulus gear **126**, the ring **196** is also carried forwardly to engage the balls **198**. The relationship of the balls **198** with respect to the saucer-like depressions **135** provided in the member **132** and the roller cage **137** is such that the cage **137** is maintained in such position that the rollers **189** are in their neutral positions when the ring **196** is in engagement with the balls. In the ordinary operation of the transmission, the balls **198** are in the saucers **135**, the rollers **189** are free and the rollers **136** are engaged when the sleeve K moves forwardly. However, should the cage **137** be in such position that the rollers **189** are engaged or in such intermediate position during forward movement of the sleeve K, the cage **137** will be rotated to the proper position, i. e., with rollers **189** free and rollers **136** engaged by the action of the ring **196** during forward movement of the sleeve.

The drive in second speed ratio passes from the pinion 90 through the cluster 97, sleeve Q and hub 104 to shaft 93 thence to the shaft 103 through annulus gear 126 and carrier 130 which are clutched together by the sleeve K. This drive is a two-way drive with the sun gear control sleeve 132 overrunning the reaction shell 190 through the action of the rollers 189 and the clutch member K is maintained in engaged position by the latch 246 so long as the ignition switch 292 is on. The engine may be used as a brake during coasting and second speed ratio, the car driving the engine approximately twice the speed of the tailshaft for the particular gear size illustrated.

Coasting in second speed ratio below approximately 3 M. P. H. will cause the sleeve K to be automatically shifted back to its disengaged position. In order to accomplish this, it is desirable to provide some means for momentarily reversing the direction of the torque at the teeth 201 so that the sleeve K will be unloaded and its release on stopping of the vehicle assured. This arrangement provides automatic step-down of the transmission in response to stopping the car so that the drive on subsequent depressing of the accelerator pedal for accelerating the car will have the benefit of a torque multiplication in the transmission. In order to bring this about, the governor switch G is properly arranged so that on stopping the car in second speed ratio, the switch will not close until the engine is operating at a speed preferably just below its idling speed.

Thus, on coasting down to a stop (or to a speed sufficiently low so that it is desirable that a lower gear ratio be established through the transmission) the governor switch G closes at a time when the engine is trying to turn up to its normal idling speed. When the switch G closes, the main governor circuit comes into action to energize the solenoid L thereby releasing latch 246 whereupon spring 232 moves rod 215 to take up the clearance 237 and close the ignition control switch N. This brings the governor controlled ignition circuit into action to interrupt the ignition whereupon the drive of the engine ceases for an instant and the direction of torque at the teeth 201 is reversed whereupon the spring 232 acts to disengage the sleeve K and move it rearwardly to its disengaged position. When the piston 214 reaches its Fig. 23 position, switch N is again opened thereby restoring the ignition and the engine immediately comes up to its idling speed. This entire cycle occurs so quickly that the engine does not stall and the driver is not conscious of the interruption of the ignition. Of course, if the car coast in second speed ratio drive does not go below 3 M. P. H., the governor switch G remains open and acceleration of the car will take place in second speed ratio without shift back to first being effected.

In shifting from low range to high range in the manually controlled portion of the transmission, third speed ratio will be established if the shift is made below approximately 15 M. P. H. because the governor switch G will maintain motor M vented and clutch sleeve released. However, if this shift is made above 15 M. P. H., fourth or direct speed ratio drive will be established because the governor switch G will be open and the latch 246 will function to hold rod 215 in the Fig. 24 position.

Assuming that the shift from low range to high range is made when the car is travelling below 15 M. P. H. in second speed ratio drive, the driver depresses clutch pedal 81 to release main clutch C and then moves the selector lever 165 rearwardly to high range position thereby to shift the manually operable sleeve Q forwardly under control of the blocker synchronizer 114 to clutch with teeth 101 of pinion 90 whereby shafts 83 and 93 are directly connected through the sleeve Q and the hub 104. The driver then releases the clutch pedal 81 and depresses the accelerator pedal 59 to drive the car in third speed ratio. The sleeve K will be released at this instant because the governor switch G maintains the solenoid L energized. The drive in third speed ratio is transmitted from the main driving pinion 90 directly to the intermediate driving shaft 93 through the sleeve Q and thence through the planetary gearset, the sun gear 127 being locked against its backward rotational tendency by the overrunning devices S and the tailshaft 103 being driven at an underdrive with respect to the shaft 93 through the planet pinions 129 and the carrier 130.

If, on the other hand, the car is travelling above 15 M. P. H. in second speed ratio when the shift from low range to high range is made, the governor switch G will remain open and the solenoid L deenergized thereby maintaining the parts in the Fig. 24 position with the sleeve K engaged. In shifting to high range under these conditions, the driver depresses the clutch pedal 81 to release the main clutch C and shifts the selector lever 165 rearwardly to high range as before, whereupon the clutch sleeve Q will be clutched with the pinion 90 and the shift will be made from second speed ratio to fourth or direct speed ratio, skipping third speed ratio.

The illustrated gears are of such size, as has been pointed out above, that in accelerating the car in third speed ratio, the critical speed of the governor switch G is approximately 15 M. P. H. instead of 7 M. P. H. as in first speed ratio. It should also be noted that the governor is driven at the same speed with respect to the shaft 93 in first and second speed ratios as well as in third and direct speed ratios. Thus, it may be seen that the drive in third speed ratio below 15 M. P. H. is accompanied by free-wheeling accommodated by the overrunning device S and under these conditions, the governor switch G remains closed thereby maintaining the solenoid L energized and the sleeve K disengaged.

When driving in third speed ratio above 15 M. P. H., the governor switch G is open, solenoid L is deenergized and direct drive is automatically obtained in response to release of the accelerator pedal for accommodating synchronous clutching of the sleeve K in a manner exactly similar to that described above in connection with the description of the shift from first speed ratio to second speed ratio. At the same time, vacuum will be supplied to the motor M to latch rod 215 in its Fig. 24 position or the rod 215 may be latched by vacuum operation prior to release of the accelerator pedal. Once the rod 215 is latched, the spring 233 is compressed and the sleeve K will be moved to engaged position under the action of this spring independently of vacuum conditions thereafter existing in the intake manifold. Under such conditions there is no free-wheeling in the ordinary sense, the overrunning devices R and S allowing the shafts 93 and 103 to synchronize whereupon the clutch sleeve K is almost instantaneously engaged.

Thus, it may be seen that the shift from third

speed ratio to direct drive is obtained automatically in response to release of the accelerator pedal while the vehicle is being driven at a speed in excess of approximately 15 M. P. H., the blocker 180 being moved to its Fig. 17 unblocking position under the action of the overrunning device R to permit the sleeve K to move forwardly to engaged position, as illustrated in Fig. 18, under the force of spring 233 as aforesaid.

Fourth speed ratio or direct drive is a two-way drive and passes from the pinion 90 directly to the shaft 93 through the clutch sleeve Q and the hub 104 thence directly to the shaft 103 through the annulus gear 126 and planet carrier 130 which are locked together by the sleeve K. If the car is allowed to coast below approximately 7 M. P. H. in fourth speed ratio, the governor switch G will close and establish the governor controlled ignition circuit and energize solenoid L, whereupon, as before, clearance 237 is taken up to close switch N, thereby establishing the governor controlled ignition circuit at the instant when the engine is trying to come up to its idling speed. The resulting momentary reversal of torque will release the sleeve K and the transmission will drop back to its third speed ratio with the various parts as illustrated in Fig. 23.

If desired, the car may be started from rest in third speed ratio by releasing main clutch C and shifting the selector lever 165 rearwardly into high range. The solenoid L under such conditions remains energized under control of the governor switch G and on releasing the clutch pedal 81 and depressing accelerator pedal 59, the blocker 180 will lag the sleeve K and prevent its shift forwardly during acceleration of the car in third speed ratio above the speed at which the governor switch G opens, viz., above 15 M. P. H. until the accelerator pedal is released, whereupon direct drive will then be established upon synchronization of the shafts 93 and 103.

The kickdown control functions to step down the drive from direct to third speed ratio if the car speed is above 7 M. P. H. or from second to first speed ratio if the car speed is above 3 M. P. H. and, of course, depending on the setting of the manually shiftable sleeve Q.

Assuming that the vehicle is being driven in direct speed ratio above the critical speed of the governor switch G, that is, 15 M. P. H., then third speed ratio will not ordinarily be obtained by automatic operation of the transmission control system until the speed of the vehicle has dropped to approximately 7 M. P. H. as has been described. However, the driver by obtain third speed ratio immediately at any speed above the critical operating speeds of the governor by depressing the accelerator pedal 59 to wide open throttle position, whereupon kickdown switch 77 will be closed and the main kickdown circuit will be established. This results in energization of the solenoid L which raises latch 246 and allows spring 232 to move the rod 215 rearwardly to take up the gap 237. This closes switch N to establish the kickdown ignition control circuit which thereby interrupts the ignition and unloads the clutch sleeve K which thereupon immediately is shifted rearwardly from its Fig. 24 position to its Fig. 23 position, the ignition being restored upon the ball 242 dropping into the foremost groove 243. The engine then rapidly speeds up under wide open throttle conditions and the reaction through the planetary gearset immediately causes lock-up of the overrunning brake device S, the balls 198 having been released by movement of the ring 196 rearwardly along with the sleeve K. This whole cycle of kickdown operation takes place very rapidly and smoothly and is entirely responsive to the natural movement of the accelerator pedal downwardly into the kickdown position. The kickdown function is conveniently used as a fast accelerating drive for obtaining more favorable torque multiplication as, for example, when climbing hills, passing other cars, etc. When the accelerator pedal is released, a direct drive is automatically synchronously obtained providing, of course, that the vehicle is still travelling above the critical operating speed of the governor, i. e., 15 M. P. H. By preference, the direct drive is not restored after kickdown until the accelerator pedal 59 is substantially fully released, it being noted from the drawings that the finger 76 of the kickdown switch 77 will not be engaged by the finger 74 until the accelerator pedal is substantially fully released. This prevents undesired operations of the kickdown mechanism and changes in the speed ratio within a narrow range of accelerator pedal movement and makes it possible for the driver to control the speed of the car in third speed ratio by normal operation of the accelerator pedal even though the vehicle is travelling at a speed in excess of the critical operating speed of the governor operating mechanism. Therefore, the kickdown switch 77, when closed, maintains the solenoid L energized and the solenoid is not deenergized to latch the piston 214 until the accelerator is substantially fully released, this release also serving to instantly cause the vacuum to operate the piston 214 forwardly.

When driving the car in second speed ratio above approximately 3 M. P. H., the accelerator pedal may be depressed in a kickdown range to effect release of the sleeve K and first speed ratio drive will be immediately established in a manner similar to that just described. Likewise, second speed ratio will be reestablished upon release of the accelerator pedal during travel of the vehicle at a speed in excess of the critical speed of the governor which, in this case, is 7 M. P. H.

In order to drive the car in reverse, the driver releases the main clutch C and shifts the selector lever 165 from neutral upwardly into its upper path of movement and then rearwardly to mesh the reverse idler gear 118 with the gears 108 and 121. Upon restoration of the drive through the main clutch C, the reverse drive then passes from the pinion 90 to gear 96 thence through gears 108, 118 and 121 to shaft 93.

As will be apparent from Figs. 11, 12 and 28, shifting of the reverse rail 138 rearwardly to mesh the reverse idler gear will open switch J, the plunger 279' thereof moving rearwardly through the action of the spring 151' to open the circuit between the switch contact plungers 152' and 153', respectively. As will be clearly seen from the circuit diagram of Fig. 28, opening of the switch J will break the circuit to ground from the solenoid L and the latter will thereby be deenergized and will remain in this condition so long as the rail 138 is in reverse speed position. Deenergization of the solenoid L will, of course, open the chamber 219 of the motor M to the vacuum of the intake manifold and piston 214 will move forwardly and load the spring 233. If the blocker 180 happens to be in such position that the sleeve K is un-

blocked, then the latter will move forwardly into engagement with the teeth of the annulus gear 126 where it will be latched in engaged position by the latch 246 and the planetary gearset will be locked up to provide a 1 to 1 ratio drive between the shafts 93 and 103. However, should the blocker 180 be in blocking position at the time reverse rail 138 is shifted to establish reverse drive, sleeve K will not shift to engaged position until shaft 93 has been rotated reversely by engagement of the main clutch C. As soon as shaft 93 begins to rotate in reverse or in a counterclockwise direction as viewed from the front of the vehicle, the clearance 184 between the blocker member 180 and portion 181 of the carrier will be taken up immediately due to lock-up of the rollers 136 of overrunning clutch R and the blocker member will be moved to non-blocking position, thus permitting clutch member K to shift forwardly into engagement with the teeth 200. This sequence of shifting takes place very rapidly and in no way effects the immediate rearward movement of the vehicle. It may thus be seen that the reverse drive is a direct drive so far as the planetary gearset is concerned, this unit being locked up to rotate at 1 to 1 ratio in response to opening of the switch J or immediately as the vehicle starts to drive in reverse should the engagement of the clutch member K be prevented by the blocker.

It is entirely possible and feasible to eliminate the switch J from the circuit and still provide reverse drive through the transmission. Elimination of the switch J would, of course, prevent deenergization of the solenoid L until a speed in excess of 7 M. P. H. has been reached in reverse and under these conditions, the drive between the shafts 93 and 103 will still be a 1 to 1 ratio drive even though the normal direction of rotation of the annulus gear 126 is reversed. This can be readily understood by referring to the drawing. Upon rotation of annulus gear 126 in reverse or counterclockwise as viewed from the front of the vehicle, sun gear 127 will tend to be rotated clockwise and will drive the blocker member 180 through lock-up of overrunning clutch R, the clearance between the blocker and the portion 181 of the carrier will thus be immediately taken up and the carrier and sun gear will both be rotated by the annulus gear at 1 to 1 ratio, the overrunning device S permitting overrun of the sun gear control sleeve 132 with respect to the shell 190. However, under such conditions, if the vehicle is accelerated in reverse and the drive of the motor is suddenly released by release of the accelerator pedal, the resulting reversal of torque caused by tailshaft 103 becoming temporarily the driving element will likewise reverse the forces through the planetary gearset and sun gear 127 will be rotated in a counterclockwise direction by the planet gears 128. This will cause overrunning clutch R to release and rollers 189 of overrunning device S to immediately lock the sun gear control sleeve 132 to the shell 190, the shafts 103 and 93 now being connected for underdrive during coasting in reverse. While this action is not particularly undesirable, it may occur that rapid reversal of the rotational tendency of the sun gear will cause lock-up of the overrunning device S against the shell 190 with sufficient force to damage some of the parts and for this reason, it is preferable to include the switch J in the control circuit so that whenever the transmission is shifted into reverse drive, clutch sleeve K will be shifted to engaged position.

Immediately that the reverse shift rail 138 is moved back to neutral position, the circuit through the switch J is reestablished and solenoid L is energized, thereupon releasing latch 246 and venting the motor M which disengages sleeve K. This action is readily accommodated at this time because the main vehicle clutch C is disengaged during manual shifting of the rail 138.

It sometimes happens that the vehicle battery is insufficiently charged to start the engine A and in such instances it is desirable to be able to start the engine by towing or pushing the car. In our transmission system, we have provided means for clutching the sleeve K with the teeth 200 without vacuum supply to motor M although this is not necessary to get the engine started through towing or pushing of the car because if manually shiftable sleeve Q is engaged to provide a drive between the shafts 83 and 93, rotation of tailshaft 103 will cause rotation of shaft 93 through lock-up of overrunning clutch R, the drive being thus transmitted being a 1 to 1 ratio drive. However, means has been provided for clutching up the sleeve K if desired and this is accomplished in the following manner. The driver pushes the dash mounted knob 253 which operates through the Bowden wire 254 and the head 216 (Fig. 23) to pull piston 214 forwardly to its Fig. 24 position, thereby loading the spring 233 and urging the clutch sleeve K forwardly. In order that the driver need not hold the knob 253 out during engine starting, the dash switch P is provided and this switch opens when the knob is pulled as indicated by the dotted line showing in Fig. 7 thereby breaking the main governor circuit so that the solenoid L is deenergized and the latch 246 will hold the piston 214 in Fig. 24 position. With the ignition turned on at switch 292 and clutch pedal 81 depressed, the car may then be towed or pushed. If, when the sleeve K was thrust forwardly, the blocker 180 was in such position that it prevented engagement of the sleeve, the blocker will be moved to non-blocking position as soon as the car starts to move forwardly as will be readily understood from the above description and sleeve K will be shifted to engaged position by the spring 233. The engine may then be started as soon as the car is under way by release of the clutch pedal and once the engine starts, the vacuum is available for supply to the motor M and the system will function normally upon release of the knob 253.

The knob 253 has a further advantage in that, if for any reason the control system should fail to operate, the knob 253 affords a means whereby the vehicle may be driven selectively under control of the lever 165 in second, fourth or reverse speed ratio with the knob 253 left in its outward position because once the sleeve K is clutched, it will stay in such position until the knob 253 is released and in the meantime the transmission may be operated as a two-speed and reverse transmission under control of the lever 165.

The significance of the clutch pedal operated switch O interposed in the ignition interrupting circuit is as follows: If the ignition is cut off at switch N at a time when the car is running up hill at a speed above the critical speed of the governor switch G, that is at a speed when the switch G is open, the sleeve K would remain in its forward clutching engagement with the annulus gear 126 as the car stops because solenoid

L remains latched as in Fig. 24. If the car at this time starts to coast backward, the coast load is imposed on the teeth of the clutch sleeve K and if the solenoid L were energized during stopping of the car prior to the beginning of its backward movement, latch 246 will be disengaged and piston 214 will move to take up the clearance 237 thereby causing operation of the switch N to interrupt the ignition. However, under such conditions, sleeve K will not be disengaged because of the coast load imposed on the teeth thereof and because no reversal of torque occurs. This means that the rod 215 will not move to reestablish the ignition system at switch N and the engine A will be stalled. Some means therefore must be provided to break the ignition ground circuit and restore the ignition system and this is the function of the switch O. By depressing the clutch pedal 81, switch O will be opened and the ignition will be restored to thereby permit the engine to be started.

Reference is now made to Figs. 29 to 42, inclusive, which illustrate a modified form of the invention. In the description of these figures, identical reference numerals have been used to designate parts which are identical with those used in the form described above.

The Fig. 29 transmission is housed in the same casing 89 used for the Fig. 9 form and the mechanism is identical except for that used to lock the sun gear and planet carrier together for direct drive and that used to provide the reaction for the underdrive.

The carrier 130' of Fig. 29 has a rearwardly extending portion 181' formed with integral teeth 187' which are adapted to engage teeth 201' of the shiftable clutch sleeve K' which, in this form of the invention, is shiftable forwardly by the motor M to clutch the sun gear and carrier together for direct drive instead of clutching the annulus gear to the carrier as in the Fig. 9 form.

The teeth 201' vary in length as illustrated diagrammatically in Fig. 31 and in some instances adjacent pairs of teeth are bridged so as to form a single tooth for purposes about to be described. It will be noted from examining Fig. 30 that Fig. 31 (and Figs. 32, 33 and 34 which correspond thereto) diagrammatically illustrates the positions of the clutching and blocker teeth when the sleeve K' is in underdrive (disengaged) position, and in addition, Fig. 31 illustrates the position of an additional set of teeth 310 carried by the sleeve, which teeth are adapted to mesh with a set of teeth 311 carried by a plate 312. The section line 31—31 on Fig. 30 indicates how the Fig. 31 view is taken.

The sleeve K' is shown in Fig. 29 in drive block position, which position is illustrated diagrammatically in Fig. 32. In Figs. 30 and 31, the sleeve is shown in neutral or underdrive position.

In the Fig. 29 form of the invention, the blocker member 180' has spline teeth 314 which loosely engage the spline teeth 315 of the sun gear control sleeve portion 132'. This is more clearly illustrated in Fig. 42. The blocker is further provided with a screw threaded clutch portion 316 which is urged into friction engagement with the rearwardly extending hollow portion of the carrier 181' by springs 317. The blocker 180' is thus urged to blocking position (as shown in Fig. 42) whenever the carrier 181' is rotating faster than the sun gear 127' which carries the hub 313 and the sleeve K' because of the clutch action at the surface 316 which imparts to the blocker a tendency to rotate.

Backward rotational tendency of the sun gear 127' during underdrive is prevented by the overrunning brake device S', the rollers 189' thereof locking the sleeve 132' against the shell 190 in response to tendency of the sun gear to rotate backwardly while the sleeve K' is disengaged.

The roller cage 317 (Figs. 35 and 36) is provided with a pair of integral wedge-shaped diametrically oppositely located control fingers 318. These control fingers are adapted to extend forwardly along the outer periphery of the hub 313, the teeth 314 thereof and the teeth 201' of the sleeve K' being cut away to accommodate the same. The sleeve is provided with a pair of short teeth 319 (Fig. 31) which are adapted to engage the inclined surface 320 of the control finger 318 upon forward shift of the sleeve. Thus, upon shift of the sleeve K' to engaged position, the cage 317 will be rotated counterclockwise (looking from the front of the vehicle) to move rollers 189' of brake S' into neutral and when the sleeve reaches engaged position (Fig. 34) the teeth 319 engage the axially disposed surface 321 of the finger 318 and the cage 317 is locked in neutral with the rollers 189' disengaged. This feature prevents accidental lock-up of the rollers 189' during driving in second or fourth speed ratios, which might occur if the vehicle collided with a solid object, and thus prevents a no-back condition from occurring.

As only a single overrunning device is used, some means must be provided for locking the sun gear 127' against free rotation during reverse driving in order that reaction may be provided for the planetary gearset. This is taken care of by the plate 312.

As shown in Figs. 30 to 34, inclusive, and 40, the plate 312 is carried by the rear end of the housing 89 adjacent the housing extension 192'. The latter has a pair of oppositely located pockets 322 in which are respectively disposed pairs of coil springs 323. The plate carries a pair of oppositely located pins 324 which are adapted to be received between the springs 323. A snap ring 325 (Fig. 29) retains the plate against displacement, the plate being mounted in the casing 89 for slight rotation relative thereto in either direction as permitted by the springs 323.

The teeth 311 carried by the plate 312 and the teeth 310 carried by the sleeve K' are of the well known "Maybach" type, that is, they are slightly ramped as illustrated in Figs. 31 to 34. The ramp on the teeth assists their engagement and, as the plate 312 can rotate with respect to the sleeve K', meshing of the teeth 310 and 311 under pressure of the return spring upon rearward shift of the sleeve is facilitated.

The sleeve K' is intended to be shifted by a motor M identical with that used in the Fig. 9 form, and the Fig. 28 control system may be used for controlling the motor. In this connection, it should be noted that the reverse rail switch J is unnecessary and may be omitted because the sun gear is locked against rotation in both directions by the teeth 310 and 311. However, if the switch J is included, the functional operation of the transmission is not materially altered, a higher ratio drive in reverse being provided because of engagement of the sleeve K' upon shifting into reverse.

The sleeve K' is controlled by a yoke 202' which has an integral boss 203' slidably carried on a rail 204' which is mounted in the cover 205'. The yoke is operably connected to the piston rod 212 of the motor M by means of lever 208', shaft

209' and lever 210' as will be readily understood.

The operation of the Fig. 29 modification is functionally identical to that of the Fig. 9 form of the invention. In describing the operation thereof, the description of the shifting functions of the manually operable sleeve Q and the reverse idler gear 118 will be omitted to save needless repetition.

Assuming that the vehicle is being driven forwardly in either high or low range as determined by the position of the sleeve Q and at a speed below the corresponding critical operating speed of governor switch G, the planetary gearset will be operating in underdrive and the sleeve K' will be in the position shown in Figs. 30 and 31. In this position the teeth 310 of the sleeve will be engaged with the teeth 311 of the plate 312 and a reduced speed ratio drive will be transmitted from the shaft 93 to the shaft 103 through the intermediary of the planetary gears, the sun gear 127' being, of course, locked against its backward rotational tendency by the plate 312.

Upon the vehicle reaching a speed in excess of approximately 7 M. P. H. in low range or in excess of approximately 15 M. P. H. in high range, governor switch G will operate to cause operation of motor M which will load the spring 233 to urge the sleeve K' forwardly. Forward shifting movement of the sleeve K' to mesh the teeth 201' thereof with the teeth 187' of the carrier 130' will, however, be resisted by the blocker 180', the teeth 185' thereof engaging the short sleeve teeth 201' as illustrated diagrammatically in Fig. 32. The sleeve K' under such conditions has moved from its Fig. 30 position to the position shown in Fig. 29 disengaging the teeth 310 from the teeth 311 preparatory to meshing the teeth 201' with the teeth 187' upon backward rotation of the blocker member 180' which occurs in response to release of the accelerator pedal.

It will be readily understood that during underdrive the sleeve K' together with the hub 313 and the sun gear 127' is stationary, the sun gear 127' furnishing reaction for the planetary gearset to provide the reduced speed drive. Upon forward movement of the sleeve K' from the position shown in Figs. 30 and 31 to the position shown in Figs. 29 and 32, which movement disengages the teeth 310 from the teeth 311, there is, of course, an immediate tendency for the parts 127', 313 and K' to rotate backwardly due to the drive of the annulus gear 126. However, this backward rotational tendency is resisted by the overrunning brake device S' which comes into operation immediately upon disengagement of the teeth 310, 311. Coil springs 323 function to permit disengagement of the teeth 310 from the teeth 311 even though there may be considerable torque load on these teeth at the instant that the governor control switch G opens.

Upon release of the accelerator pedal 59 to permit coast of the vehicle, the torque through the transmission is reversed and the tailshaft 103 becomes the driving shaft whereupon the shaft 93 and annulus gear 126 begin to rapidly fall off in speed and at the same time the sun gear 127' together with the hub 313 and the sleeve K' are accelerated forwardly. When the hub 313 reaches a speed that is substantially synchronous with the speed of the carrier 130', blocker member 180' is "clocked" from its leading position with respect to the spline teeth 315 of the sun gear control sleeve portion 132' to a lagging position with respect thereto which action unblocks the sleeve teeth 201' and permits the sleeve K' to move forwardly to engage the teeth 187'. In Fig. 33, the positions of the various teeth are diagrammatically illustrated at the instant that the blocker 180' has moved from the blocking position, illustrated in Fig. 32, and just prior to forward shifting movement of the sleeve K'. Fig. 34 illustrates the positions of the various teeth after forward shift of the sleeve K' to mesh the teeth 201' thereof with the teeth 187' of the carrier. Depression of the accelerator pedal will now cause the vehicle to be driven forwardly in second speed ratio or fourth speed ratio as the case may be, depending upon the position of the manually operable sleeve Q.

It will be noted from Figs. 31 to 34, inclusive, that the fingers 318 of the overrunning roller control cage 317 are moved from a position permitting engagement of the rollers 189' to a position preventing engagement of these rollers by the action of the teeth 319 during travel of the sleeve from its Fig. 33 position to its Fig. 34 position. In other words, the cage 317 is in such position that it will permit lock-up of the rollers 189' in all positions of the sleeve K' except when the latter is engaged with the teeth 187' and when the sleeve is in the latter position, the finger 318 rests against one side of the tooth 319 thereby to prevent any possibility of engagement of the rollers 189'.

Step-down operation of the sleeve K' in response to operation of the governor control switch G or the kickdown switch 77 is identical with that previously described for the Fig. 9 modification. Upon rearward shift of the sleeve K' in response to venting of the motor M accompanied by momentary reversal of torque through the transmission by shorting of the ignition will result in an underdrive speed relation being established between the shafts 93 and 103, the sun gear 127' being held against its backward rotational tendency upon resumption of the drive through the transmission by restoration of the ignition circuit through the operation of the overrunning brake device S'. Due to the fact that the teeth 310 and 311 are ramped, these teeth will engage in most instances upon rearward shift of the sleeve K in response to venting of the motor M, the plate 312 rotating slightly one way or the other as permitted by the springs 323 to permit meshing of these teeth. In such instances, the sleeve K' may be moved by the return spring 232 back to its Fig. 30 position. However, should the teeth 310 dead-end against the teeth 311, operation of the underdrive mechanism is still possible through the automatic lock-up of the rollers 189' of the overrunning brake device S' and upon the next reversal of torque through the transmission, the teeth 310 will slide into engagement with the teeth 311 unless, of course, the motor M is again energized to effect forward shift of the sleeve K'.

It sometimes happens that the vehicle is brought to a stop with the sleeve K' in underdrive position but with the teeth 310 thereof dead-ended against the teeth 311 of the plate 312 and the manually operable shift lever 165 manipulated to establish reverse drive through the transmission. Under such conditions, there is no drive through the transmission until the teeth 310, 311 are engaged, the overrunning device S' permitting free rotation of the sun gear 127' forwardly which is the rotational tendency thereof upon rotation of the shaft 93 in reverse. However, meshing of the teeth 311 will occur in-

stantly upon very slight movement of the sun gear 127' because the spring 232 is exerting full pressure on the yoke 202' and reverse drive will be instantly effected, the planetary gearset operating to provide the reduced speed drive between the shafts 93 and 103.

It frequently occurs during normal operation of the vehicle that the critical operating speed of the governor control switch G is reached during coast of the vehicle and under such conditions the sleeve K' will tend to move forwardly into clutching engagement with the teeth 187'. Full forward movement of the sleeve K' will, however, be prevented under these conditions by engagement of the longer of the teeth 201' with the blocker teeth 185', the blocker being of course in a lagging position relative to the spline teeth 315 as illustrated in Fig. 42. In order to engage the sleeve K' under such conditions, it is necessary to effect a second torque reversal cycle, which operation is accomplished as follows: Upon depression of the accelerator pedal, drive of the shaft 93 is resumed and in response to the resulting faster rotation of the carrier 130' with respect to the blocker 180', the latter is moved from engagement with one side of the spline teeth 315 to engagement with the other side thereof, which action causes blocker teeth 185' to unblock the long sleeve teeth 201'. However, the sleeve K' is permitted under these conditions only slight forward movement because the blocker teeth 185' are now in their drive block position (as distinguished from coast block position with the longer sleeve teeth 201' engaging the blocker teeth 185') and the sleeve K' is now in condition for forward shift to engage the teeth 187' in response to release of the accelerator pedal as aforesaid.

Thus, it may be seen that the shifting operation of the sleeve K' is under synchronous blocker control at all times and clashing of the teeth 201' with the teeth 187' is impossible under any conditions of vehicle operation.

It will thus be seen that we have provided a simple mechanism for providing four forward speed ratio drives in a motor vehicle, automatic operation of either of the two manually selectable ranges being provided in response to natural functional operations of the various vehicle controls.

We claim:

1. In a power transmission for driving a vehicle having an engine, a driving structure adapted to be driven by the engine; a driven structure adapted to drive the vehicle; means for driving the driven structure from the driving structure at a 1 to 1 speed ratio or at a speed ratio different from said 1 to 1 ratio; said means including a drive element adapted to be held stationary during said different speed ratio drive; a clutch member drivingly connected to the driven structure; a set of teeth on said driving structure; a set of teeth on said clutch member; said sets of teeth adapted for engagement upon movement of said clutch member toward said driving structure to establish said 1 to 1 speed ratio drive; an overrunning roller device adapted to hold said drive element against rotation during said different speed ratio drive; a second overrunning device adapted upon coast of vehicle for drivingly connecting said driving and driven structures and for synchronizing the same preparatory to establishment of said 1 to 1 ratio drive; a common control structure for said overrunning devices; and means operably associated with said clutch member for engaging said control structure upon movement of said clutch member into engagement with said driving structure for locking said control structure in such position that one of said overrunning devices is rendered inoperative.

2. In a power transmission for driving a vehicle having an engine, a driving structure adapted to be driven by the engine; a driven structure adapted to drive the vehicle; means for driving the driven structure from the driving structure at a 1 to 1 speed ratio or at a speed ratio different from said 1 to 1 ratio; said means comprising a planetary gearset having an annulus gear driven by the driving structure, a carrier connected to the driven structure and a sun gear; means for releasably holding said sun gear stationary during forward drive of the vehicle thereby to provide reaction for the gearset and for releasably clutching said sun gear to said carrier during coasting of the vehicle thereby to establish 1 to 1 ratio drive through the gearset comprising a pair of oppositely acting overrunning devices; clutch means for positively clutching said carrier to said annulus gear during coasting of the vehicle; and means operable in response to operation of said clutch means for locking said overrunning clutch devices in predetermined position.

3. In combination with a planetary gearset having an input annulus gear, an output carrier structure and a sun gear, means including an overrunning roller device for holding the sun gear against rotation in the direction of rotational tendency thereof caused by drive of the annulus gear; means associated with said carrier and annulus gear including a sleeve slidably carried by the carrier for clutching the same together thereby to provide 1 to 1 driving ratio, and means operably associated with said sleeve for rendering said roller device inoperable in response to operation of said clutching means.

4. In a vehicle power transmission, a casing; a planetary gearset mounted in said casing having an input annulus gear, an output carrier structure and a sun gear; a clutch member carried by said carrier and adapted when engaged to clutch said carrier to said annulus gear; said sun gear having an integral sleeve portion provided with a plurality of cams; a plurality of rollers disposed in operative relation with said cams and the casing, the said rollers and cams being so constructed and arranged that said sun gear is prevented from rotation in one direction; a cage for carrying said rollers; a plurality of balls carried by said cage; a plurality of depressions in said sleeve portion for receiving said balls when said cage is in such position relative to said sun gear that said rollers are disengaged; and means carried by said clutch member for retaining said balls in said depressions during engagement thereof.

5. In a power transmission for driving a vehicle having an engine, a driving structure adapted to be driven by the engine; a driven structure adapted to drive the vehicle; means for driving the driven structure from the driving structure at a 1 to 1 speed ratio or at a speed ratio different from said 1 to 1 ratio; said means including a planetary gearset having an annulus gear connected to said driving structure, a carrier connected to said driven structure and a sun gear; means for locking said sun gear against rotation in the direction of rotational tendency thereof caused by drive of said annulus gear, said means

being releasable to permit rotation of said sun gear in the opposite direction; a clutch sleeve carried by said carrier; a set of clutch teeth on said sleeve; a set of clutch teeth on said annulus gear; prime mover means for shifting said clutch sleeve to engage said teeth in response to attainment of a predetermined vehicle speed; and blocker means operatively associated with said carrier and sleeve for blocking shift of the latter during asynchronous rotation of said sleeve and annulus gear.

6. In a motor vehicle having an engine, a driving shaft adapted to receive drive from the engine and a driven shaft adapted to drive the vehicle, a set of clutch teeth rotatable with said driving shaft; a shiftable clutch member adapted for shifting under control of the vehicle driver to engage said clutch teeth thereby to directly connect said driving and driven shafts; reduction drive means disposed between said shafts, including an overrunning clutch interposed therein, adapted to operably drivingly connect said shafts for driving the driven shaft at a reduced speed relative to the driving shaft; said overrunning clutch being automatically operable during operation of said reduction drive to release said drive in response to coast of the driving shaft; power means for shifting said clutch member into engagement with said teeth when the speeds of said member and teeth are approximately synchronous; a second overrunning clutch drivingly connecting said clutch member and teeth in such manner that said teeth may rotate faster but not slower than said clutch member whereby synchronous rotation of said shafts during coasting is assured; said overrunning clutches being disposed in axial alignment and including a control element common to both; a plurality of balls carried by said control element and means carried by said clutch member adapted to engage said balls upon shift of said sleeve toward engagement with said teeth for holding said overrunning clutches in predetermined relative positions.

7. In combination with vehicle driving and driven shafts, a planetary gearset drivingly disposed between said shafts and operable to establish a reduction drive therebetween; said gearset including a reaction gear having a control portion; roller clutch means operably associated with said control portion for preventing rotation of said reaction gear in the direction of its rotational tendency during said reduction drive; a second roller clutch means operably associated with said control portion for drivingly connecting said reaction gear to one of said shafts upon coasting of the vehicle; a common cage for said overrunning clutches; a clutch member adapted for operation during coasting to establish a direct driving connection between said shafts; and means carried by said cage and adapted for engagement by said control portion and said sleeve upon drive-establishing operation of the latter for locking said cage in such position that said first overrunning clutch is rendered inoperable.

8. In combination with a planetary gearset having a reaction gear, means including a pair of oppositely acting overrunning clutch devices for holding said gear against rotation in one direction and for clutching it to another of the elements of said gearset in response to rotation of said gear in the opposite direction; a common control element for said clutch devices; a plurality of balls carried by said control member; a plurality of depressions in said gear for receiving said balls in one position only of said control element, and means for forcing said balls into said depressions thereby to control operation of said clutch devices.

9. In a vehicle having an engine, a driving shaft and a driven shaft, a transmission casing; planetary gearing drivingly disposed between said shafts in said casing including an annulus gear driven by said driving shaft, a carrier connected to said driven shaft and a sun gear; a shiftable clutch member carried by the sun gear; a set of clutch teeth carried by said carrier and adapted for engagement by said clutch member upon shift thereof toward said teeth; a one-way overrunning brake device operatively associated with said sun gear and casing for preventing rotation of said gear in the direction of its rotational tendency caused by drive of said annulus gear; and means comprising a control cage carried by said brake device and operably associated with said clutch member for rotation thereby when the latter is shifted whereby engagement of said brake device is controlled.

10. In a vehicle having an engine, a driving shaft and a driven shaft, a transmission casing; planetary gearing drivingly disposed between said shafts in said casing including an annulus gear driven by said driving shaft, a carrier connected to said driven shaft and a sun gear; a shiftable clutch member carried by the sun gear; a set of clutch teeth carried by said carrier and adapted for engagement by said clutch member upon shift thereof toward said teeth; a one-way overrunning brake device operatively associated with said sun gear and casing for preventing rotation of said gear in the direction of its rotational tendency caused by drive of said annulus gear; and means comprising a control cage carried by said brake device and operatively associated with said clutch member for controlling engagement of said brake device; said cage having ramped portions so constructed and so arranged with respect to said clutch member that said cage is rotated and said brake device is rendered inoperable in response to shift of said member to engage said teeth.

11. In a vehicle having an engine, a driving shaft and a driven shaft, a transmission casing; planetary gearing drivingly disposed between said shafts in said casing including an annulus gear driven by said driving shaft, a carrier connected to said driven shaft and a sun gear; a shiftable clutch member carried by the sun gear; a set of clutch teeth carried by said carrier and adapted for engagement by said clutch member upon shift thereof toward said teeth; a one-way overrunning brake device operatively associated with said sun gear and casing for preventing rotation of said gear in the direction of its rotational tendency caused by drive of said annulus gear; said brake device including a control finger operably associated with said clutch member and operable in response to shift of said member to engage said teeth to render said brake device inoperable.

12. In a vehicle having an engine, a driving shaft and a driven shaft, a transmission casing; planetary gearing drivingly disposed between said shafts in said casing including an annulus gear driven by said driving shaft, a carrier connected to said driven shaft and a sun gear; a shiftable clutch member carried by said sun gear; a set of clutch teeth carried by said carrier and adapted for engagement by said clutch member upon shift thereof toward said carrier; a brake device operatively disposed between said sun gear and the casing for preventing reverse rotation of the sun gear thereby to provide reaction for the planetary

gearing; said brake device comprising a set of rollers and a cage for maintaining said rollers in spaced relation; a control finger carried by said cage; a slot in said clutch member adapted to receive said finger; and means on said clutch member adapted to engage said finger thereby to control said brake device in response to shift of said member.

13. In a vehicle having an engine, a driving shaft and a driven shaft, planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier connected to the driven shaft and a sun gear; said sun gear being journaled on said driven shaft and having an elongated sleeve formed thereon; a hub member splined on said sleeve; a clutch member splined on said hub member for shiftable movement relatively thereto; clutch teeth on said carrier; clutch teeth on said clutch member adapted to engage the aforesaid teeth upon shifting of said clutch member; a casing for enclosing said members and gearing; means for restraining rotative tendency of said sun gear caused by drive of said annulus comprising an overrunning roller device operatively disposed between said sleeve and said casing; additional means for restraining rotative tendency of said sun gear comprising a plate carried by said casing and means on said clutch member for engaging said plate.

14. In a vehicle having an engine, a driving shaft and a driven shaft, planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier connected to the driven shaft and a sun gear; said sun gear being journaled on said driven shaft and having an elongated sleeve formed thereon; a hub member splined on said sleeve; a clutch member splined on said hub member for shiftable movement relatively thereto; clutch teeth on said carrier; clutch teeth on said clutch member adapted to engage the aforesaid teeth upon shifting of said clutch member; a casing for enclosing said members and gearing; means for restraining rotative tendency of said sun gear caused by drive of said annulus comprising a plate carried by the casing having means thereon for engaging said clutch member upon shift of the latter toward said plate whereby the sun gear is locked against rotation; and additional means for restraining said rotative tendency operable independently of said clutch comprising one-way brake means operatively disposed between said casing and said sleeve, said brake means including a control finger disposed in operative relation with the clutch member for actuation by the clutch member upon movement thereof to engage the carrier thereby to render the brake means inoperable.

15. In a vehicle having an engine, a driving shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with the sun gear; a plate carried by the casing; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage said plate; power means for shifting said clutch member in response to attainment of a predetermined vehicle speed comprising, a fluid operated motor; valving means for controlling application of fluid under pressure to said motor; electromagnetic means operably associated with said valving means and adapted to cause actuation of the valving means to vent and apply pressure fluid to said motor; means urging shift of said clutch member out of engagement with said carrier and into engagement with said plate when said motor is vented; means for controlling energization of said electromagnetic means in response to rotation of one of said shafts below a predetermined speed; and means operable by the vehicle driver for controlling energization of said electromagnetic means when said shaft is rotating above said predetermined speed.

16. In a vehicle having an engine, a driving shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with the sun gear; a plate carried by the casing; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage said plate; power means for shifting said clutch member in response to attainment of a predetermined vehicle speed comprising, a fluid operated motor; valving means for controlling application of fluid under pressure to said motor; electromagnetic means operably associated with said valving means and adapted to cause actuation of the valving means to vent and apply pressure fluid to said motor; means urging shift of said clutch member out of engagement with said carrier and into engagement with said plate when said motor is vented; means for controlling energization of said electromagnetic means in response to rotation of one of said shafts below a predetermined speed; means operable by the vehicle driver for controlling energization of said electromagnetic means when said shaft is rotating above said predetermined speed; and means controlled by the vehicle driver for effecting engagement of said clutch member with said carrier independently of the fluid operation of said motor.

17. In a vehicle having an engine, a driving shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with said sun gear; a plate carried by the casing; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage said plate; power means for shifting said clutch member comprising a fluid pressure motor having a piston operable by pressure fluid from a first position to a second position thereof; a spring yieldingly urging said piston to its first position; piston operated means for transmitting movement from said piston to said clutch member and adapted for movement from a first position to a second position for shifting said clutch member out of engagement with said plate and into engagement with said carrier; yieldable means operating to urge shift of said clutch member in response to operation of said piston by pressure fluid so constructed and arranged as to accommodate pressure fluid operation of said piston in advance of shift of said clutch member; and latch means operable automatically in response to said operation of the piston for latching said piston operated means in said second position.

18. In a vehicle having an engine, a driving

shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with the sun gear; a plate carried by the casing; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage said plate; power means for shifting said clutch member comprising a fluid pressure motor having a piston operable by pressure fluid from a first position to a second position thereof; a spring yieldingly urging said piston to its first position; piston operated means for transmitting movement from said piston to said clutch member and adapted for movement from a first position to a second position for shifting said clutch member out of engagement with said plate and into engagement with said carrier; yieldable means operating to urge shift of said clutch member in response to operation of said piston by pressure fluid so constructed and arranged as to accommodate pressure fluid operation of said piston in advance of shift of said clutch member; latch means operable automatically in response to said operation of the piston for latching said piston operated means in said second position; and manually controlled means operable by the vehicle driver for moving said piston operated means to its second position independently of the pressure fluid operation of said piston thereby to cause said yieldable means to urge shift of said clutch member.

19. In a vehicle having an engine, a driving shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with the sun gear; a plate carried by the casing; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage said plate; power means for shifting said clutch member comprising a fluid pressure motor having a piston operable by pressure fluid from a first position to a second position thereof; a spring yieldingly urging said piston to its first position; piston operated means for transmitting movement from said piston to said clutch member and adapted for movement from a first position to a second position for shifting said clutch member out of engagement with said plate and into engagement with said carrier; yieldable means operating to urge shift of said clutch member in response to operation of said piston by pressure fluid so constructed and arranged as to accommodate pressure fluid operation of said piston in advance of shift of said clutch member; latch means operable automatically in response to said operation of the piston for latching said piston operated means in said second position; valving means for controlling operation of said motor; vehicle speed responsive means for controlling operation of said valving means; and manually controlled means operable by the vehicle driver when the vehicle is traveling above a predetermined speed for controlling operation of said valving means.

20. In a vehicle having an engine, a driving shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with the sun gear; a plate yieldably carried by the casing and provided with a set of internal teeth; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage the internal teeth of said plate; yieldable means for normally maintaining said clutch member in engagement with said plate when the vehicle is traveling below a predetermined speed; pressure fluid actuated means for shifting said clutch member out of engagement with said plate and into engagement with said carrier in response to attainment of a predetermined vehicle speed; and blocker means operably associated with said clutch member for blocking engagement thereof with said carrier except when said member and carrier are rotating in synchronism.

21. In a vehicle having an engine, a driving shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with the sun gear; a plate carried by the casing; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage said plate; yieldable means for normally maintaining said clutch member in engagement with said plate when the vehicle is traveling below a predetermined speed; pressure fluid actuated means for shifting said clutch member out of engagement with said plate and into engagement with said carrier in response to attainment of a predetermined vehicle speed; said means including a vacuum motor and valving means for controlling the same; a solenoid for controlling said valving means; and a plurality of independently operable switches on said vehicle for controlling said solenoid.

22. In a motor vehicle having an engine and a power transmission, a planetary gearset operatively disposed between the engine and the driven portion of the vehicle for providing a plurality of speed ratio drives; clutching means including a shiftable clutch member for clutching two of the elements of said gearset together thereby to establish one speed ratio drive; holding means for holding one of the planetary elements against rotation thereby to establish a second speed ratio drive; said holding means being constructed and arranged for automatic engagement upon release of said clutch member and for automatic release upon engagement of said clutch member; means for shifting said clutch member comprising a motor operable to urge engagement of said clutch member in response to attainment of predetermined vehicle operating conditions; step-down means for urging release of said clutch member including means for providing diminution in engine torque; and means adapted for operation incidentally to bringing the vehicle to rest with said clutch member engaged for causing operation of said step-down means when the engine is operating at a speed below its normal idling speed.

23. The combination set forth in claim 22 wherein additional means is provided, operable at the will of the vehicle driver, for causing operation of said step-down means.

24. In a motor vehicle having an engine and a power transmission, a planetary gearset operatively disposed between the engine and the driven

portion of the vehicle for providing a plurality of speed ratio drives; clutching means including a shiftable clutch member for clutching two of the elements of said gearset together thereby to establish one speed ratio drive; holding means for holding one of the planetary elements against rotation thereby to establish a second speed ratio drive; said holding means being constructed and arranged for automatic engagement upon release of said clutch member and for automatic release upon engagement of said clutch member; means for shifting said clutch member comprising a vacuum motor operable to urge engagement of said clutch member in response to attainment of predetermined vehicle operating conditions; step-down means for urging release of said clutch member including means for providing diminution of engine torque; and means adapted for operation incidentally to bringing the vehicle to rest with said clutch member engaged for causing operation of said step-down means when the engine is operating at a speed below its normal idling speed.

25. In a motor vehicle having an engine and a power transmission, a planetary gearset operatively disposed between the engine and the driven portion of the vehicle for providing a plurality of speed ratio drives; clutching means including a shiftable clutch member for clutching two of the elements of said gearset together thereby to establish one speed ratio drive; holding means for holding one of the planetary elements against rotation thereby to establish a second speed ratio drive; said holding means being constructed and arranged for automatic engagement upon release of said clutch member and for automatic release upon engagement of said clutch member; means for shifting said clutch member comprising a vacuum motor; control means for causing operation of said motor to engage said clutch in response to attainment of predetermined vehicle speed; and electrically energized means for holding said clutch member in its engaged position independently of said motor.

26. In a motor vehicle having an engine and a power transmission, a planetary gearset operatively disposed between the engine and the driven portion of the vehicle for providing a plurality of speed ratio drives; clutching means including a shiftable clutch member for clutching two of the elements of said gearset together thereby to establish one speed ratio drive; holding means for holding one of the planetary elements against rotation thereby to establish a second speed ratio drive; said holding means being constructed and arranged for automatic engagement upon release of said clutch member and for automatic release upon engagement of said clutch member; means for shifting said clutch member comprising a vacuum motor; electrically energized means for controlling operation of said vacuum motor; vehicle speed responsive means for controlling operation of said electrically energized means; and manually operable means operable by the vehicle driver independently of said speed responsive means for controlling operation of said electrically energized means.

27. In a motor vehicle having an engine and a transmission including a planetary gearset, an annulus gear adapted to be driven by the engine; a planet carrier connected to the driven portion of the vehicle; a sun gear; releasable brake means for holding the sun gear against reverse rotational tendency caused by drive of the annulus gear; a shiftable clutch member internally splined on said carrier and having external teeth adapted to mesh with mating teeth formed on said annulus gear; means for shifting said clutch member into and out of mesh with said mating teeth; a blocker member carried by said carrier for limited rotation relatively thereto, said blocker member having teeth adapted to abut the spline teeth of said clutch member thereby to permit shift of the same when said carrier and annulus gear are rotating asynchronously.

28. In a motor vehicle having an engine and a transmission including a planetary gearset, an annulus gear adapted to be driven by the engine; a planet carrier connected to the driven portion of the vehicle; a sun gear; releasable brake means for holding the sun gear against reverse rotational tendency caused by drive of the annulus gear; a shiftable clutch member internally splined on said carrier and having external teeth adapted to mesh with mating teeth formed on said annulus gear; means for shifting said clutch member into and out of mesh with said mating teeth; a blocker member carried by said carrier for limited rotation relatively thereto, said blocker member having teeth adapted to abut the spline teeth of said clutch member thereby to prevent shift of the same when said carrier and annulus gear are rotating asynchronously; and means adapted for operation by said sun gear in response to forward rotational tendency thereof for rotating said blocker member through said limited rotation.

29. In a motor vehicle having an engine and a transmission including a planetary gearset, an annulus gear adapted to be driven by the engine; a planet carrier connected to the driven portion of the vehicle; a sun gear; releasable brake means for holding the sun gear against reverse rotational tendency caused by drive of the annulus gear; external spline teeth formed on said carrier; a clutch member having internal spline teeth adapted to slidably engage said external spline teeth; means on said clutch member for engaging said annulus gear to thereby lock said gearset for rotation as a unit; means for shifting said clutch member into and out of engagement with said annulus; a circumferentially disposed slot in said internal spline teeth; a radial slot in said carrier; a blocker member carried by the carrier for limited rotation relatively thereto and having a radially extending tooth adapted to project through said radial slot and into said circumferential slot in abutting relation with said internal spline teeth, means for maintaining said blocker tooth in said abutting relation during asynchronous rotation of said annulus and carrier; and means operable in response to forward rotation of said sun gear for rotating said blocker tooth out of abutting relation.

30. In a vehicle having an engine, a driving shaft and a driven shaft; planetary gearing drivingly disposed between said shafts including an annulus gear driven by the driving shaft, a carrier drivingly connected to the driven shaft and a sun gear; a casing for said gearing; a clutch member drivingly associated with the sun gear; a plate carried by the casing; said clutch member being adapted for shifting in one direction to engage said carrier and in the opposite direction to engage said plate; yieldable means for normally maintaining said clutch member in engagement with said plate when the vehicle is traveling below a predetermined speed; pressure fluid actuated means for shifting said clutch member out of engagement with said plate and into engagement with said carrier in response to attainment

of a predetermined vehicle speed; blocker means operably associated with said clutch member for blocking engagement thereof with said carrier except when said member and carrier are rotating in synchronism; and energy storing means operatively disposed between said pressure fluid means and said clutch member for permitting operation of said pressure fluid means in advance of shift of said clutch member.

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