Oct. 29, 1957 C. T. WEYMANN 2,811,051

AUTOMATIC CHANGE-SPEED DEVICE

Filed Oct. 30, 1953 5 Sheets-Sheet 1

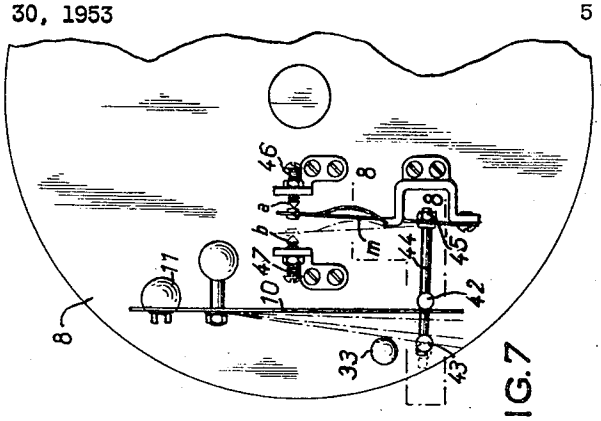


FIG. 7

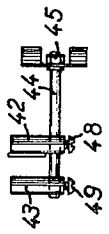


FIG. 8

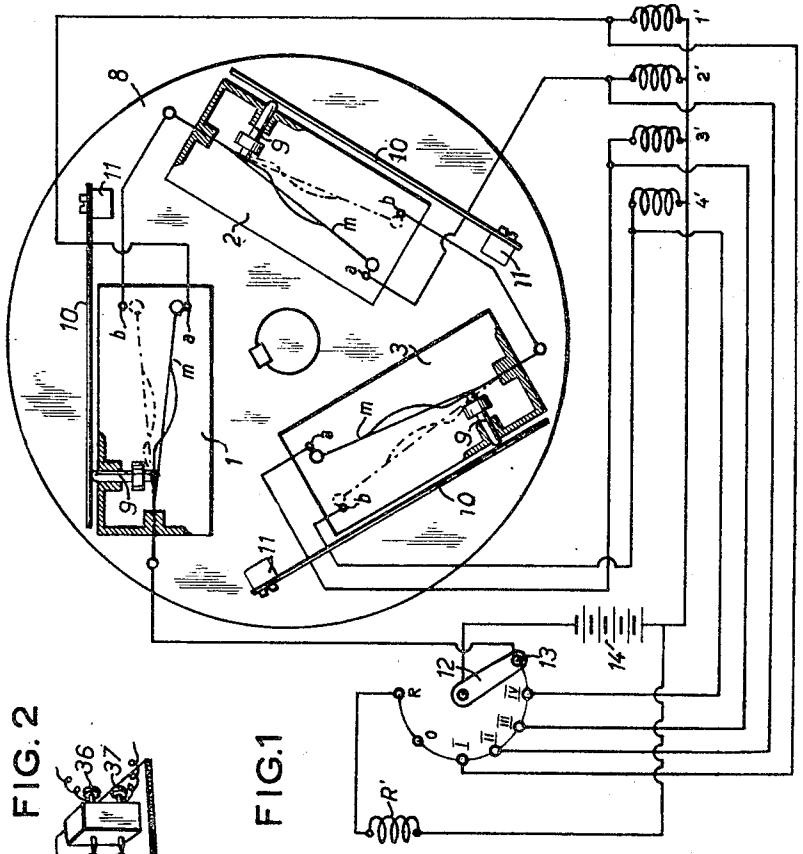


FIG. 1

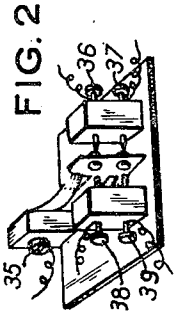


FIG. 2

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AUTOMATIC CHANGE-SPEED DEVICE

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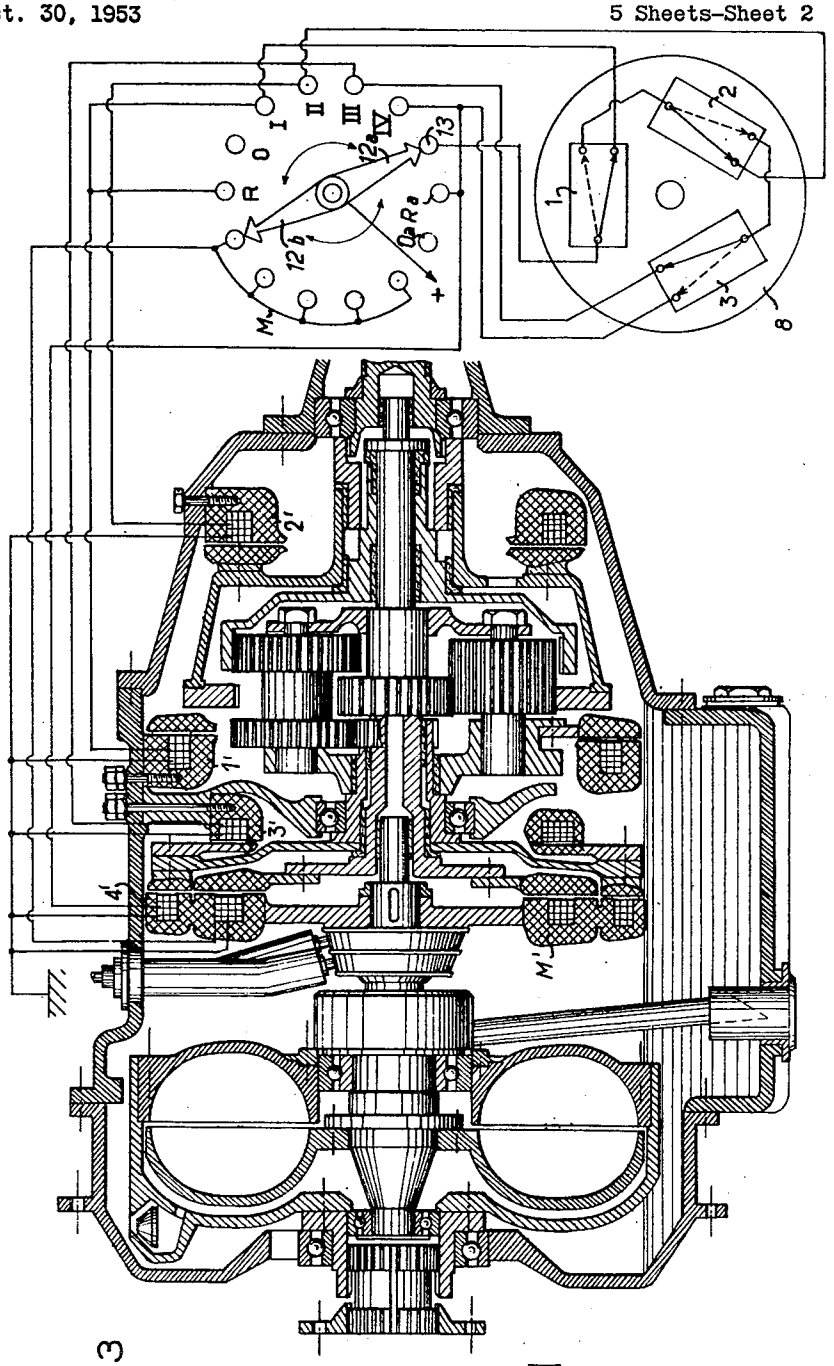


FIG. 3

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AUTOMATIC CHANGE-SPEED DEVICE

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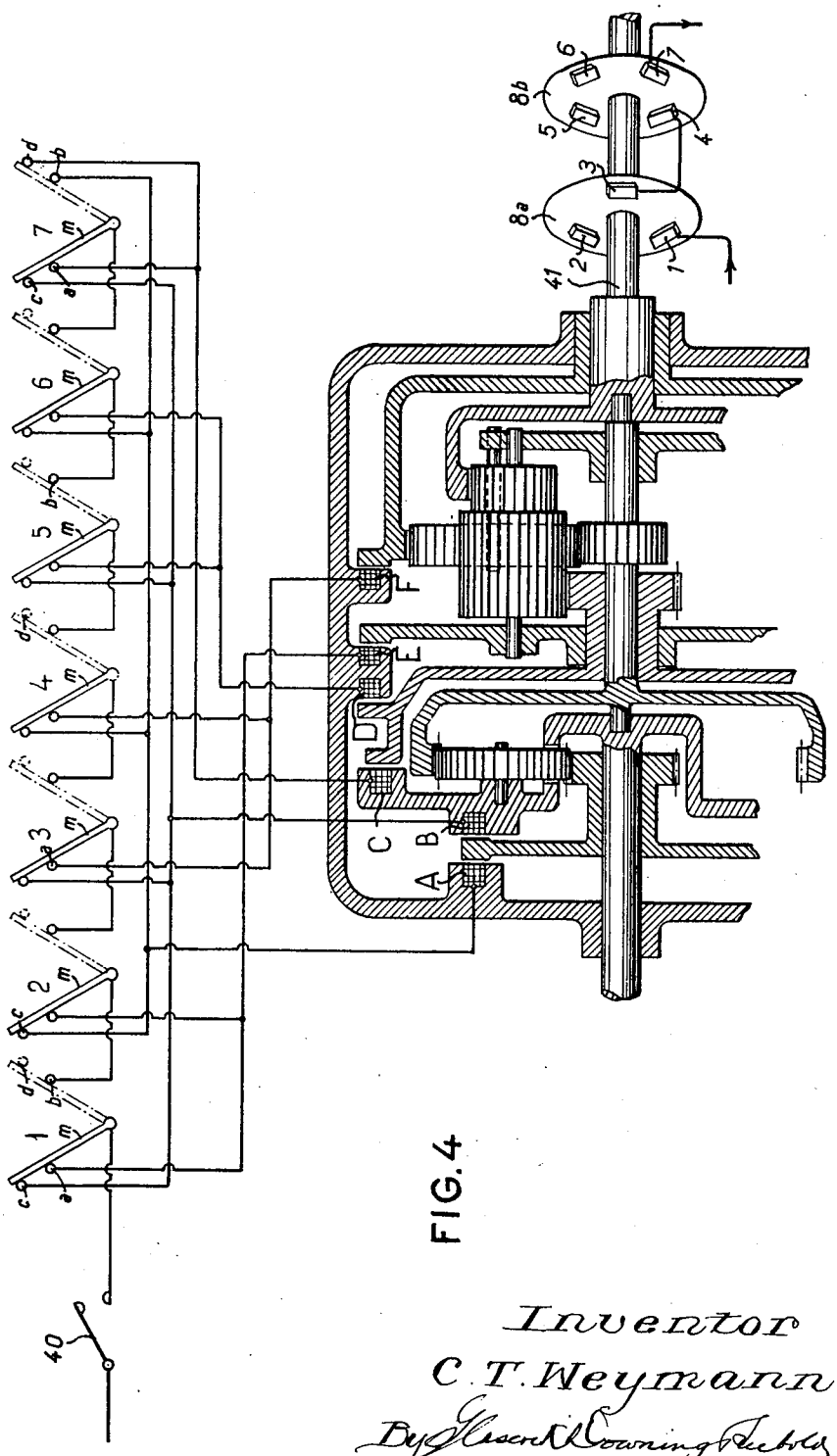


FIG. 4

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FIG. 6.

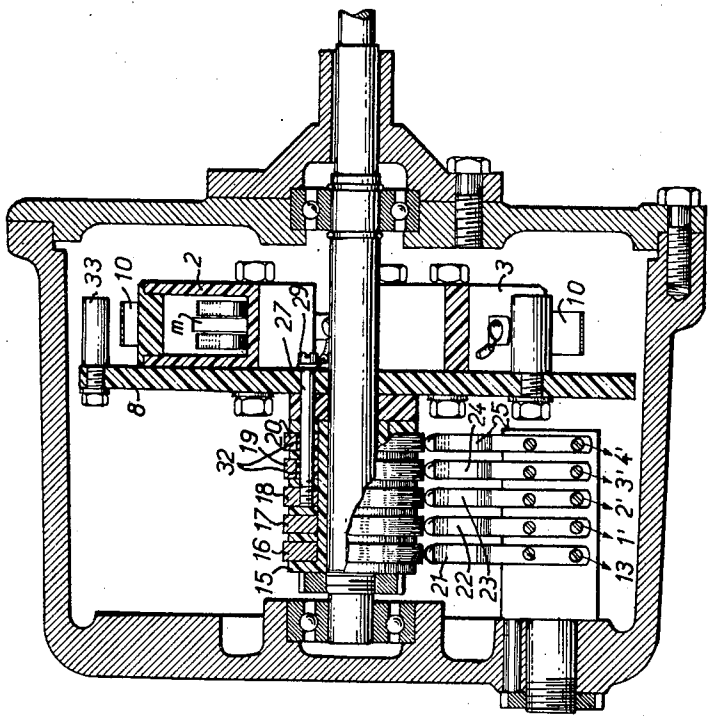
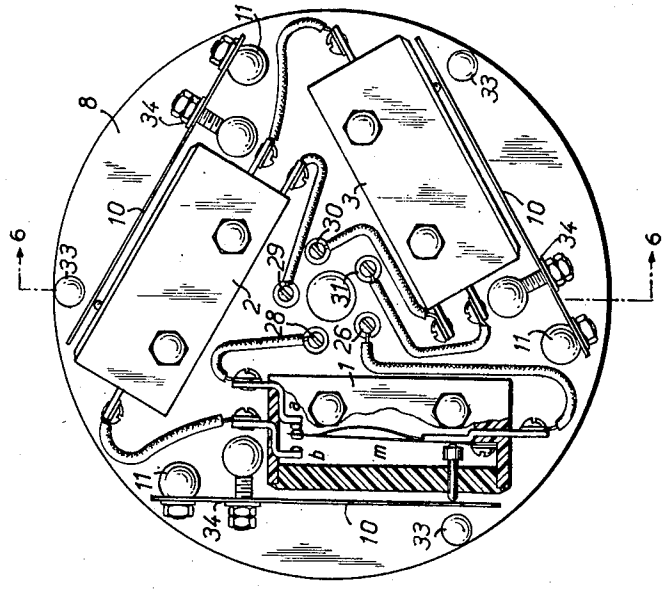


FIG. 5.



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AUTOMATIC CHANGE-SPEED DEVICE

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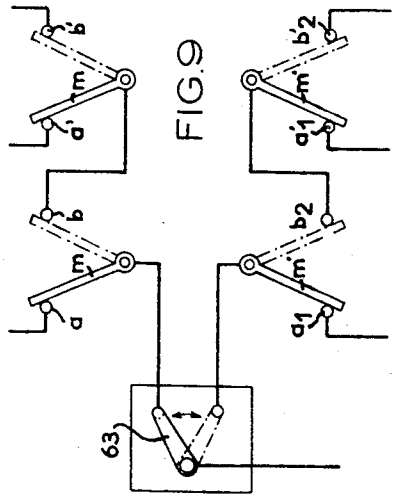


FIG.9

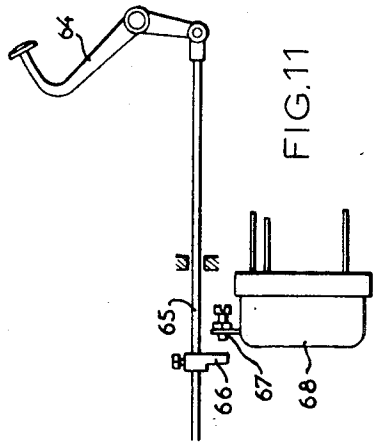


FIG.11

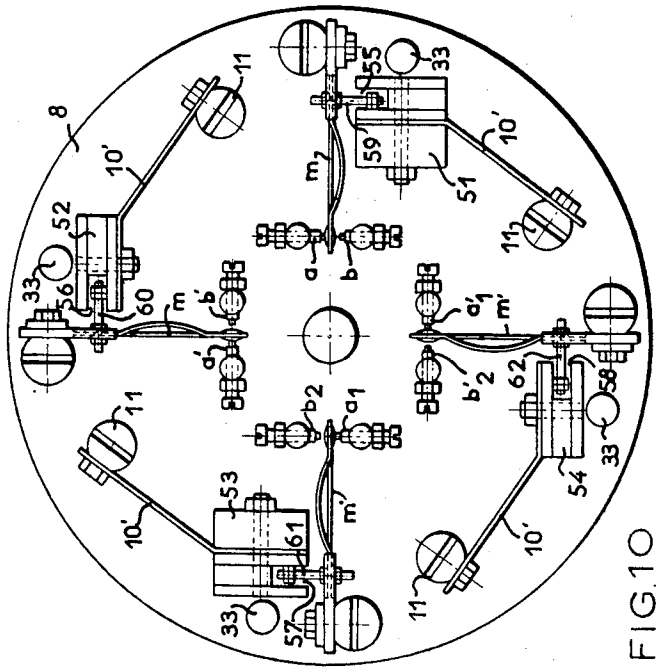


FIG.10

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United States Patent Office 2,811,051
Patented Oct. 29, 1957

2,811,051

AUTOMATIC CHANGE-SPEED DEVICE

Charles Terres Weymann, Neuilly-sur-Seine, France

Application October 30, 1953, Serial No. 389,438
Claims priority, application France October 31, 1952
5 Claims. (Cl. 74—752)

This invention relates to change-speed devices, in particular for motor-cars.

Still more particularly, the invention is concerned with electro-magnetic change-speed devices, but it may be adapted to any type of change-speed device, by merely providing the same with a convenient electro-magnetic or electric control system. Therefore, in the specification, the expression "electro-magnetic change-speed device" is intended to designate both an electro-magnetic system capable of changing a speed in response to energizing or de-energizing of one or more electro-magnets or relays, as well as a change-speed device of any type previously provided with such an electro-magnetic system or an equivalent electric circuit.

In an electro-magnetic change-speed device as described above, the feeding of one or more of electric circuits determines mechanical conditions corresponding to a predetermined transmission ratio between the driving and driven shafts of the speed box.

In the following specification, as well as in the appended claims, that or those circuits which are to be fed exclusively for ensuring the energizing of one or more electro-magnetic or electric devices to establish mechanical conditions corresponding to the *n*th speed will be called "the circuit of the *n*th speed." Under "completion of the circuit" should be understood the mechanical positioning of the contacts required for completing the relevant circuit, the same being alive or dead, while the expression "closing of the circuit" designates more particularly either the similar mechanical contact positioning at a time when a current flows through the relevant circuit, or the feeding of said circuit with an electric current a a time when said contacts have been previously suitably positioned.

The main object of the invention is to provide an automatically controlled electro-magnetic change-speed device, in which the completion of the circuit of a given speed is effected automatically under or against the action of centrifugal force generated at a predetermined number of turns of a rotary member operatively connected with the driven shaft of the gear box.

The automatic control means of the change-speed device according to the invention are essentially constituted by a number of reversible switches supported on at least one rotary member and the movable contacts of which are individually responsive to various values of the centrifugal force generated as said rotary member rotates, so that as said centrifugal force increases said reversible switches are successively operated and vice versa, each one of said switches completing, at rest, the circuit of a given speed and, when operated, the circuit of the immediately upper speed.

In a preferred embodiment of the invention, the reversible switches are of the micro-switch type which are very sensitive and the movable contacts of which may assume only two well-defined positions, which permits changing the speeds for accurate numbers of turns per

minute of the rotary member or members on which the switches are mounted.

A more particular object of the invention is to provide a change-speed device of the type described, in which each micro-switch is individually adjustable, both for actuation and resetting, which permits modifying at will the two values of the velocity of the vehicle at which the immediately upper and immediately lower speed, respectively, are automatically switched on.

Another object of the invention is to provide in a same vehicle, machine tool, or the like, two different automatically controlled electromagnetic change-speed devices according to the invention, each one of which is adjustable for a given range of speed switching, a two-way general switch being moreover provided to feed selectively one of said devices, e. g. under the control of an accelerator pedal. This arrangement permits for example driving a car at will, with two different degrees of smoothness.

Other advantages and objects of the invention will be better understood with reference to the accompanying drawings which illustrate by way of example some practical constructions of the improved automatic change-speed device according to the invention.

In these drawings:

Fig. 1 is a diagrammatic sectional view of an automatically controlled electro-magnetic change-speed device according to the invention with a wiring diagram of an electro-magnetic system for a 4-speed box adapted to be actuated by said device,

Fig. 2 is a detail perspective view of a two-pole micro-switch adapted to be used with the device of Fig. 1,

Fig. 3 is an axial sectional view of a Cotal 4-speed box with one rearward drive provided with an automatic control according to the invention,

Fig. 4 is a diagrammatic axial sectional view of another existing 8-speed box provided with an automatic control according to the invention,

Figs. 5 and 6 are a top view and a cross-sectional view along line **6—6** of Fig. 5, respectively, of the automatically controlled change-speed device of Fig. 1,

Fig. 7 shows an alternative embodiment of one of the micro-switches of the device of Fig. 1, in which switching to the upper speed, and resetting to the original speed, take place at two different numbers of turns of the supporting rotary member,

Fig. 8 is a detail view of the actuating lever of the movable contact of the micro-switch of Fig. 7,

Fig. 9 is a wiring diagram of a double 3-speed device according to the invention,

Fig. 10 is a top view of a constructive embodiment of the device shown in Fig. 9, and

Fig. 11 shows diagrammatically a mode of control of a device such as shown in Figs. 9 and 10, from an accelerator pedal.

Referring first to Fig. 1, there are shown at **1**, **2** and **3**, three reversible micro-switches mounted on a common rotary member **8**. Each one of said micro-switches comprises a movable contact *m* adapted to be operated by a pushing rod **9** normally pressed by a spring leaf **10** mounted at one end, as shown at **11**, on the rotary member **8**, in such a manner as to hold the movable contact *m* in the full line position of Fig. 1. In this example, the micro-switches **1**, **2**, **3** are of the biassed type, so that, when the pushing rod **9** of one of them is not subjected to any action, its movable contact *m* is urged under its own elasticity into the position shown in dot-dash line in Fig. 1.

Thus, when the rotary member **8** is driven at a predetermined number of turns per minute, the centrifugal force acting upon the spring leaf **10** releases the pushing

rod 9 from the action of said leaf and the movable contact *m* is snapped into said dot-dash line position.

In this specification, in order to make the identification of the micro-switches and their contacts easier, said switches have been designated by reference numbers 1 to 7 (Fig. 4), the movable contact of each switch is designated by indicia *m*, while its fixed contacts are designated by indicia *a, b, c, d*. In Fig. 1, the movable contact *m* of each switch rests, in the position shown in full line, on a fixed contact *a*, and in the position shown in dotted line on a fixed contact *b*.

There is shown at 12 the rotary arm of a manually controlled 7-way selecting switch, having fixed contacts R, O, I. II, III, IV, respectively corresponding to a manual control of the speed box for rearward drive, out-of-gear condition and in I, II, III and IVth forward speeds; an additional fixed contact 13 is provided to feed the automatic control means according to the invention. 14 is the battery. 1', 2', 3', 4' and R' are five electro-magnets, which as mentioned in the preamble may be substituted for, within the scope of the invention, by any combination of electromagnetic means or electric circuit elements, and which permit establishing the mechanical conditions of the box corresponding to the four forward speeds and the rearward drive, respectively.

The movable contact 1*m* of the first switch is fed from the fixed contact 13 of the manual selecting switch. The fixed contacts 1*a*, 2*a*, 3*a* and 3*b* are respectively connected to the energizing coils of the electro-magnets 1', 2', 3', 4', respectively. The fixed contact 1*b* is connected with the movable contact 2*m* of the second reversible switch 2 and the fixed contact 2*b* is connected to the movable contact 3*m* of the third reversible switch 3.

A speed box provided with such an automatic control device operates as follows:

When the rotary arm 12 is brought to one of the positions R, I, II, III or IV a corresponding electro-magnet R', 1', 2', 3' or 4' is operated as in a conventional electromagnetic speed box.

Now, when the rotary arm 12 is brought on the fixed contact 13, the automatic control is switched on and operates as follows: assuming first that the rotary member 8 is at rest, as shown in Fig. 1, contact 12—13, as soon as established, operates electro-magnet 1' as follows: battery 14, contact 12—13 of the selecting switch, contact 1*m*—1*a*, electro-magnet 1', battery 14. The electro-magnet 1' operates and the speed box is switched into first speed. The rotary member 8 which, as mentioned in the preamble, is operatively connected with the driven shaft of the gear-box, is rotated. If the engine of the vehicle is speeded up, the rotary member 8 is accelerated, the strength of the spring leaves 10 of the three micro-switches are so adjusted that said switches 1, 2, 3 are successively actuated in this order as the rotational speed of member 8 increases, while they are successively reset into their original position in the reversed order 3, 2, 1 as said speed decreases. As a result, when the rotational speed of member 8 reaches a first predetermined number of turns per minute, due to, e. g., speeding up of the engine, the spring 10 releases the movable contact 1*m*, that is then snapped from contact 1*a* to contact 1*b*. The previously completed circuit is cut off and, hence, electro-magnet 1' releases. On the other hand, an operating circuit for electro-magnet 2' is completed as follows: battery 14, contact 12—13 of the manual switch, contact 1*m*—1*b*, contact 2*m*—2*a*, electro-magnet 2', battery 14. The electro-magnet 2' is operated and the speed box is switched into the second speed or second gear. If the number of turns per minute of the rotary member 8 is further increased, the reversible switch 2 is actuated in turn, the previously completed circuit is cut off, the electro-magnet 2' releases and the electro-magnet 3' is operated in turn as follows: battery 14, contact 12—13 of the manual selecting switch, contact 1*m*—1*b*, contact 2*m*—2*b*, contact 3*m*—3*a*, electro-magnet 3', battery 14. The electro-magnet 3' is operated and the speed-box is switched into third gear.

Finally, if the rotary member 8 is still accelerated, the reversible switch 3 is operated in turn, while the preceding reversible switches 2, 1, remain, as will be easily understood, also actuated. The previously completed circuit is cut off at contacts 3*m*—3*a*, electro-magnet 3' releases, and an operating circuit is completed for electro-magnet 4' as follows: battery 14, contact 12—13 of the manual selecting switch, contact 1*m*—1*b*, contact 2*m*—2*b*, contact 3*m*, 3*b*, electro-magnet 4', battery 14. The electro-magnet 4' is operated and the speed-box is switched into fourth year. Thus, it may be seen that the automatic control means described above permits successive automatic switching of the gears as a function of the number of turns per minute of a rotary member.

It goes without saying that the same process of successive operation and de-energizing of the electro-magnets 4', 3', 2' takes place in a reversed order, as the number of turns per minute of the rotary member 8 decreases.

It is to be pointed out that the making and breaking of the contacts is purely mechanical and does not depend on the presence of the current in the circuit. As a result, if member 8 rotates for example at such a number of turns per minute that the circuit of the second speed would be completed, while the rotary arm 12 is not on the fixed contact 13, i. e., for example while the vehicle is driven by means of the usual manual speed lever, as soon as the rotary arm 12 is brought on the fixed contact 13, the mechanical conditions corresponding to the second speed will be instantaneously established. In other words, the automatic control device according to the invention ensures a mechanical pre-switching of the correct speed, even if the driver does not use the automatic control, and said speed is actually switched without any delay as soon as said automatic control is put into action.

In Figs. 5 and 6 is shown a practical embodiment of the automatic control system diagrammatically shown in Fig. 1.

As will be easily understood, since the reversible switches 1, 2, 3 are mounted on a rotary member 8, it is indispensable to establish the necessary connections through a commutator 15, the bars 16, 17, 18, 19 and 20 of which respectively cooperate with fixed brushes 21, 22, 23, 24, 25 connected with the fixed contact 13 of the manually selecting switch and the operating coils of the electro-magnets 1', 2', 3', 4', respectively.

Moreover, each bar 16 to 20 of the commutator 15 is in contact with a screw such as 27, the head of which constitutes a terminal for the rotary member 8, said terminals which are designated in Fig. 5 by 26, 28, 29, 30 and 31, are connected with the movable contact 1*m* and the fixed contacts 1*a*, 2*a*, 3*a*, 3*b*, respectively. For this purpose, the screw 27 of each commutator bar is threaded in the same, but passes freely through holes provided where required in the other bars, said holes being fitted internally with insulating sleeves, as shown at 32. There are moreover shown in Figs. 5 and 6, at 33, abutments for limiting the outward displacements of the spring leaves 10 under the action of the centrifugal force, and at 34 adjusting screws permit the varying of the strength of said spring leaves according to the three desired trigger values of the number of turns per minute of the rotary member for the three respective reversible switches.

Fig. 2 shows a two-pole reversible switch, which may be used in the device according to the invention when two contacts instead of one are to be established for each position of each switch.

It is clear that it is also possible to use multipole reversible switches in the case when the complexity of the electro-magnetic system to be controlled requires a great number of simultaneous connections. In the position shown in Fig. 2, the two-pole switch makes a contact between an input terminal 35 and two output terminals

36, 37. In the other position of the switch, both contacts 35—36 and 37 would be broken while two other contacts 35—38 and 39 would be made.

The Cotal speed-box shown in Fig. 3 comprises an electro-magnet M' which is to be energized for all forward speeds and four electro-magnets 1', 2', 3', 4', to be energized, respectively, at the same time as electro-magnet M', for establishing mechanical conditions corresponding to the first, second, third and fourth speeds, respectively. In this speed-box, the rearward drive is obtained by a simultaneous energizing of the electro-magnets 1', 4'. In this embodiment, the automatically controlled change-speed device according to the invention comprises, as previously, three reversible switches, 1, 2, 3 mounted on a common rotary member, but the manual selecting switch is provided with two diametrically opposed rotary arms, 12*a*, 12*b* and fourteen fixed contacts instead of seven. As in Fig. 1, these fixed contacts with which one arm 12*a* of the rotary contact cooperates are designated by R, O, I, II, III, IV, 13. Those fixed contacts which are diametrically opposed to R and O, respectively, have been designated by R*a*, O*a*, while the five other fixed contacts are connected and are designated by the general reference M. Otherwise, the device operates in the same manner as that of Fig. 1.

It will be easily understood that the above described rotary switch permits ensuring, for manual operation, the energizing of electro-magnet M', together with one of the electro-magnets 1', 2', 3', 4', while the contacts O and O*a* do not ensure any energizing, which corresponds to out-of-gear condition and on the contacts R and R*a* the simultaneous energizing of the electro-magnets 1' and 4', which corresponds to rearward drive. In automatic operation, due to the presence of the two arms 12*a* and 12*b* on the contacts 13 and M, respectively, the electro-magnet M' is energized together with (under the control of the automatic system and in the manner described in Fig. 1), one of the electro-magnets 1', 2', 3', 4' according to the number of turns per minute of the rotary member 8.

In the embodiment of Fig. 4, the speed-box which also corresponds to an existing type, comprises six electro-magnets A, B, C, D, E, F, and the following simultaneous energizing of certain of said electro-magnets ensure the switching of eight forward speeds or gears: first speed, B+E; second speed, A+E; third speed, B+F; fourth speed, A+F; fifth speed, B+D; sixth speed, A+D; seventh speed, B+C; eighth speed, A+C.

In this figure, only the automatic operation which is obtained by closing a switch 40 has been shown, the usual control by means of the hand speed lever being effected after cutting off said switch, e. g. as shown in Fig. 1. Furthermore, to make the wiring diagram clearer, the ground conductors of electro-magnets A to F have not been shown. In this embodiment there are shown seven two-pole two-way switches, which may be, e. g. of the type shown in Fig. 2, the three first switches being mounted on a first rotary member 8*a*, while the four other ones are mounted on a second rotary member 8*b*. On the other hand, both rotary members 8*a*, 8*b* have been shown keyed on the driven shaft 41 of the speed-box, but it is obvious that any other rotary members of the vehicle, even rotating at different number of turns per minute from the shaft 41, may be selected, the only essential condition being that said rotary member be operatively connected with the driven shaft of the gear-box. The distribution of the various switches may be clearly effected in any desired manner among one or more rotary members existing. Practically, however, it is preferred to select rotary members which rotate at number of turns per minute capable of ensuring a sufficiently responsive operation of the springs 10 of the switches.

In the upper portion of Fig. 4 is shown a wiring diagram for an eight speed-box of the type previously described. The current is taken-in on contact 1*m*. Contacts 1*a*, and 2*a* are both connected to electro-magnet E. Contacts 3*a* and 4*a* are both connected to electro-magnet F. Contacts 5*a* and 6*a* are both connected with electro-magnet D. Contacts 7*a* and 7*b* are both connected with electro-magnet C. Contacts 1*c*, 3*c*, 5*c* and 7*c* are connected to electro-magnet B. Contacts 1*b*, 2*b*, 3*b*, 4*b*, 5*b* and 6*b* are separately connected with the movable contacts 2*m*, 3*m*, 4*m*, 5*m*, 6*m* and 7*m*, respectively and contacts 2*c*, 4*c*, 6*c* and 7*b* are multiplied to electro-magnet A.

This device operates as follows:

When the rotary member 8*a* is at rest or rotates at a number of turns per minute lower than a first predetermined value, the movable contacts 1*m* to 7*m* are all in the position shown in full line, so that if, at this moment, the switch 40 is closed, the electro-magnets B and E are simultaneously energized as follows: battery, switch 40, contact 1*m*, 1*c*, electro-magnet B, ground and battery, switch 40, contacts 1*m*, 1*a*, electro-magnet E, ground.

When the rotary member 8*a* reaches the above mentioned first predetermined number of turns per minute, the movable contact 1*m* of the reversible switch 1 is snapped from the full line position to the dot-dash line position. The previously completed circuits are cut off, electro-magnet B releases, but electro-magnet E remains operated, while an operating circuit is established for electro-magnet A as follows: battery, switch 40, contact 1*m*, 1*b*, contact 2*m*, 2*c*, electro-magnet A, ground, while E remains operated as follows: battery, switch 40, contact 1*m*, 1*b*, contact 2*m*, 2*a* electro-magnet E, ground.

The operating circuits corresponding to the other combinations for the six other forward speeds are completed in the same manner as the reversible switches 2, 3, 4, 5, 6, 7 are successively brought from their full line to their dot-dash line positions, the establishment of each new configuration of the switches destroying at the same time the immediately preceding combination.

In the alternative embodiment shown in Figs. 7 and 8, the spring leaf 10 controlling the micro-switch has its free end sandwiched between the arms 42 and 43 of a yoke, the shank 44 of which is secured as shown at 45 on the movable contact *m* of the switch. This switch, which as previously is a snap-switch is preferably a micro-switch, the micromatic adjusting screws of which are shown at 46 and 47 and constitute at the same time the previously described fixed contacts *a* and *b*. In this embodiment the movable contact *m* is neutrally adjusted instead of being biased as in the previous embodiment. In other words, as long as its actuating yoke 42, 43 is not acted upon, it rests indifferently either on the fixed contact *a* or on the fixed contact *b* and to bring the movable contact from one of these positions to the other, it is necessary to act positively upon one arm of said yoke. On the other hand, in the position shown in full line of the spring leaf 10 which corresponds to a low or nil rotational speed of the rotary member 8, said spring leaf 10 takes a bearing on the arm 42 of the yoke and holds the movable contact *m* against the fixed contact *a*. As the rotational speed of the rotary member 8 increases, the free end of the spring leaf 10 is progressively displaced outwardly, but it travels first a neutral angle before coming into contact with the other arm 43 of the yoke due to the fact that said yoke remains in the position shown as a result of the neutral adjustment of the movable contact *m* of the reversible switch. If, when spring 10 has been brought into contact with arm 43 of the yoke, the rotary member 8 is further accelerated, the spring 10 as it is moved further outwardly, displaces the yoke, and causes the movable contact *m* to snap into the dot-dash line position against the fixed contact *b*. This snap actuation of the switch takes place at a first predetermined number of turns per minute. Conversely, as the rotary member 8 is slowed down, the elastic leaf

10 travels first a neutral angle equal to the preceding one, between the time at which it leaves arm 43 and the time at which it comes into contact with arm 42. As a result, the resetting of the movable contact *m* of the switch from the position shown in dot-dash line to that shown in full line only takes place when the decreasing number of turns per minute of the rotary member 8 is slowed down to a second predetermined value lower than the first one.

As shown in Fig. 8 the arms 42 and 43 of the actuating yoke of the movable contact *m* may be provided with means for adjusting their position on the shank 44, said means being in the example shown constituted by screws 48 and 49. This arrangement permits determining at will the two different numbers of turns per minute of the rotary members at which the movable contact *m* will be snapped, on the one hand, from fixed contact *a* to fixed contact *b* and, on the other hand, from fixed contact *b* to fixed contact *a*.

In the embodiment shown in Figs. 9 and 10, there are provided two different sets of reversible switches, each set being adjusted for a given range of gear switching values of rotary member 8. In the example, shown, which is adapted to the double automatic control of a 3-speed box, the whole device comprises four switches, i. e. two sets of two switches. The first set shown in the upper portion of Fig. 9 has fixed contacts *a*, *b*, *a'*, *b'*. Contacts *a*, *a'*, *b'* respectively feed the operating circuits of the lowest, intermediate, and highest gears, while contact *b* of the left-hand switch is connected with the movable contact *m* of the right-hand switch. Similar connections are provided for the second set of two switches shown in the lowest portion of Fig. 9. Each set operates individually as previously described and the switching from one set to the other is effected by the driver by means of a general two-way switch, such as 63 (Fig. 9) or 68 (Fig. 11). The latter has its movable contact 67 controlled by an adjustable finger 66 mounted on the rod 65 of the accelerator pedal 64. Contact 67 is biassed into the position corresponding to the feeding of the set of centrifugally controlled switches which correspond to the "lower" range of gear-switching. With this arrangement, within a given portion of the angular stroke of pedal 64, the automatic drive remains smooth, while if said pedal is completely depressed, finger 66 snaps the movable contact 67 to the other set of reversible switches and the automatic drive becomes "higher."

As shown in Fig. 10, in this embodiment, to make the device more compact the casings of the micro-switches have been suppressed and, to reduce the direct action of centrifugal forces on the movable contacts *m* and *m'* the latter have been disposed radially. Moreover, weights 51, 52, 53, 54 are provided on the free ends of the spring leaves 10' secured on disc 8 by means of screws 11. As previously the movable contacts *m*, *m'* are biassed towards the fixed contacts *b*, *b'*, b_2, b'_2. The control of the movable contacts is ensured from the weights 51, 52, 53, 54 by means of yokes 55, 56, 57, 58, acting respectively upon fingers 59, 60, 61, 62 fixed on said movable contacts.

What is claimed is:

1. In combination with a change speed gear having input and output shafts, a plurality of gear trains arranged between said shafts, and electromagnets associated with said gear trains for varying the relative speeds of said shafts, an automatic change speed control device comprising a rotary member mounted to rotate with said output shaft, a series of two-way switches carried by said rotary member and having each an inner contact piece connected to the coil of a corresponding electromagnet, an outer contact piece, and an adjustable contact movable between said inner and outer contact pieces and operative responsive to centrifugal force to contact the outer contact piece when said output shaft rotates above a predetermined speed and to contact the inner fixed contact piece as long as said output shaft has not attained said predetermined rotational speed, a source of electric energy for energizing said electromagnets and having one pole connected to the coils thereof, means for connecting the outer contact piece of an ultimate one of said series of switches to the coil of a corresponding electromagnet and for connecting the movable contact of a first one of said series of switches to the other pole of said source, the movable contacts of all the other switches except said first one being connected to the outer contact piece of a preceding switch, and means for adjusting the movable contacts of all said switches so that they operate successively in response to different predetermined speeds of said output shaft.

2. An automatic control device according to claim 1, in which a cut-off switch is interposed in the feeding circuit of said first switch movable contact.

3. An automatic control device according to claim 1, in which the movable contact of each one of said switches is biassed into second-way position and in which said movable contact is held in first-way position, beneath a predetermined rotational speed of said rotary member, under the action of a spring leaf mounted at one end on said rotary member and so adjusted as to become inoperative at said rotational speed.

4. An automatic control device, according to claim 1, in which each one of said two-way switches is a neutrally adjusted snap-switch, the centrifugal force responsive means being constituted by a spring leaf operatively connected with a yoke, said movable contact being sandwiched between the arms of said yoke.

5. The combination as claimed in claim 1, in which said rotary member carries at least two of said series of two-way switches, and in which a control switch is provided to selectively connect the movable contact of the first two-way switch of each series to said other pole of the source of electric energy.

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