

March 25, 1941.

O. MYLIUS

2,235,943

CHANGE GEARING

Filed Jan. 16, 1939

2 Sheets-Sheet 1

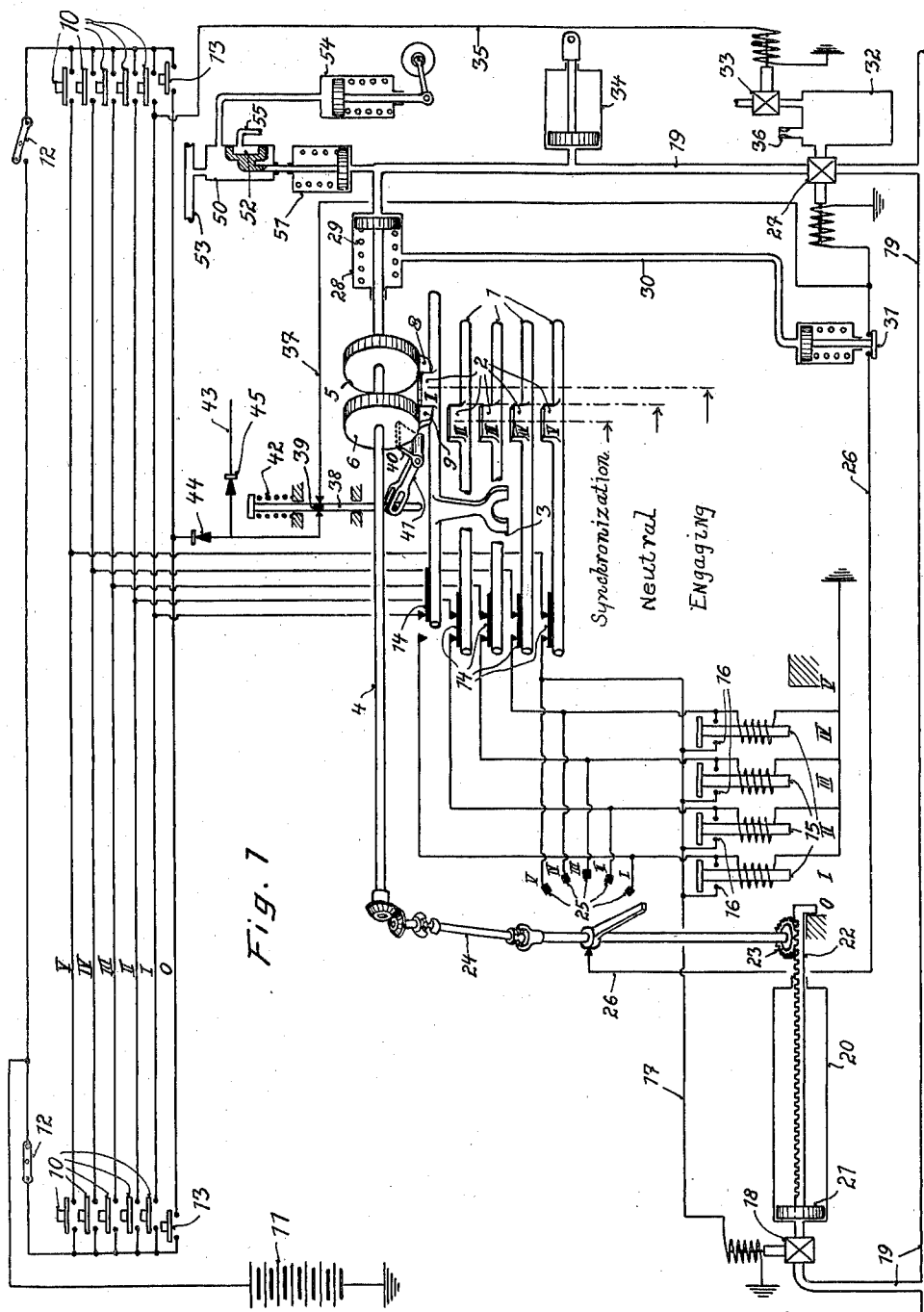


Fig. 7

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Fig. 2

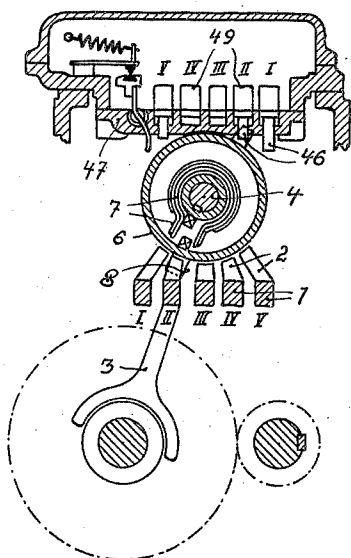


Fig. 3

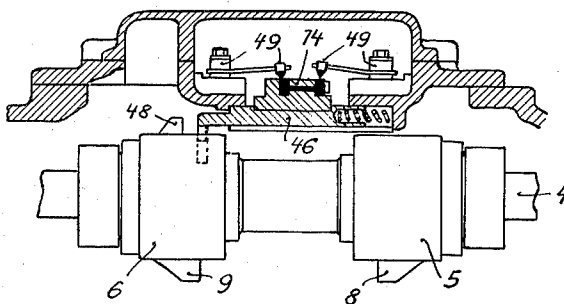


Fig. 4

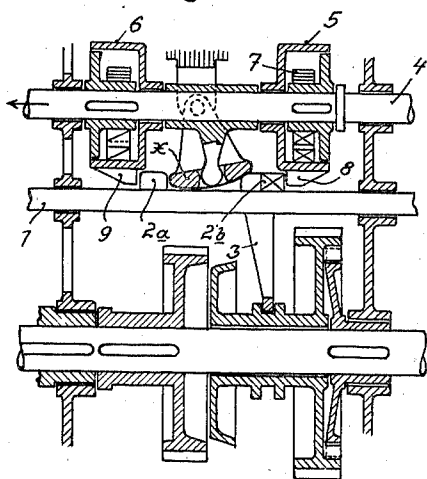


Fig. 5

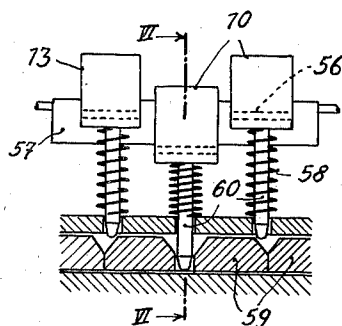
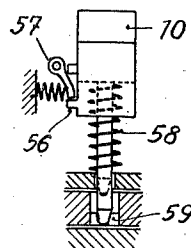


Fig. 6



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UNITED STATES PATENT OFFICE

2,235,943

CHANGE GEARING

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In Germany January 24, 1938

6 Claims. (Cl. 74-334)

The invention relates to a change-speed toothed gearing with semi-automatic engagement and disengagement of the individual speeds by operating electric contacts at the driving position, in which the individual speeds include clutches by which the speeds are synchronised after preselection and before engagement. It is specially applicable to gearing in which a shaft which is preselected by rotation carries lugs which in the axial displacement of the pre-selector shaft first move the striker rod of the speed which is to be engaged in one direction to effect a synchronisation of the speed and subsequently move it in the other direction to effect the actual engagement of the gearing for that speed. An example of such gearing is the Mylius gearbox, which is described in "Diesel Railway Traction," supplement to "Railway Gazette" July 9, 1937, pages 86 to 89.

The object of the present invention is to make these preselection, synchronisation and engagement operations which occur in timed sequence, automatic in such a way that by simply closing electric contacts at the driving position the desired speed is automatically subjected to the sequence of individual operations up to engagement. A further object is to obtain a complete independence of the sequence in which the speeds are selected with this automatic control, and thus to enable a change directly to neutral from any speed which is engaged or is being synchronised.

With these objects in view, according to the invention the movements of engagement and disengagement of the individual gears are controlled by electric contacts in a speed change circuit operated at the driving position, these contacts effecting a preselection of the individual speed by electromagnetic and/or electropneumatic servo-mechanisms by means which also complete the circuit of similar servo-mechanisms which in one direction of movement effect a synchronisation of the speed and in the opposite direction of movement effect the actual engagement of the gearing for that speed by automatically releasing energy derived from the latter servo-mechanisms.

These electromagnetic and electropneumatic servo-mechanisms operate on a pre-selector shaft actuating the striker bars of the individual gears, the pre-selector shaft being rotatable for the pre-selection and being axially displaceable in one direction for synchronisation and in the opposite direction for the final engagement of the gear. The rotation as well as the axial dis-

placement of the pre-selector shaft are each effected by a single servo device, the action of which can be limited by stops in a selective manner so that the rotation gives the desired gear pre-selection and the axial movement gives the synchronisation position, the neutral position or the engaged position.

Two embodiments of the invention will now be described below with reference to the accompanying drawings:

Fig. 1 shows diagrammatically by way of example a change speed mechanism including only those parts which are necessary for performing the speed change operations, the actual gearing being omitted.

Fig. 2 is a cross section,

Fig. 3 is a longitudinal section through a modification of the control contacts for the various speeds,

Fig. 4 shows in vertical section a part of the control members for the restoration of the engaged speed to the neutral position,

Fig. 5 is a diagram illustrating the electric locking of the speed switches at the driver's position, and

Fig. 6 is a section along the line VI—VI of Fig. 5.

In the first place, the following explanation is given so that the various operations which have to be performed may be more readily understood:

Each speed has a striker bar 1 which on the one hand is equipped with a lug 2 (Fig. 1) or lugs 2a, 2b (Fig. 4) and on the other hand with a striker fork 3. A rotatable and axially displaceable preselector shaft 4 is disposed above all the striker rods. Carried on the shaft 4 and held against axial displacement thereon are the lug drums 5 and 6 for synchronising and for engaging the speeds. By means of torsion springs 7 (Figs. 2 and 4) the drums 5 and 6 can be rotated from a rest position constituting the neutral position through an angle corresponding to the angular movement of the shaft 4 for the preselection operation so as to position lugs 8 45 and 9 in front of or behind the lugs 2b and 2a on the striker bars (see Fig. 4).

For engaging a given speed, the preselector shaft 4 is first rotated to rotate the synchronising drum 5 so that its lug 8 lies in the path of the lug 2 of the striker bar of the speed which is to be engaged. Then the preselector shaft 4 is displaced axially to the left. In the first part of the movement until the neutral position is reached the synchronising drum 5 with its lug

8 move idly. The lug 8 then engages behind the lug 2 of the striker bar which is to be actuated and in the further axial movement of the shaft 4 this striker bar is moved to the left so that the 5
striker fork 3 also displaces its associated clutch sleeve to the left and the friction element of the clutch is urged into the synchronising position. Before the commencement of this operation a link motion x (Fig. 4) has disengaged the speed 10
which previously was in engagement by displacing the corresponding striker bar to the left into the neutral position. The axial displacement of the preselector shaft 4 beyond the neutral position has the result that the lug 5 of the engaging drum 6, which previously bore against the lug 15
2a of the previous speed under the tension of the torsion spring, is now turned into the path of the lug 2 of the striker bar 1 of the gear which is now to be engaged, by the release of spring tension. In the subsequent axial displacement of the preselector shaft 4 to the right after the synchronisation, the lug 9 engages with the striker bar 1 of the speed which is now to be engaged and thus causes the dogs of the clutch in question to be moved into the engaged position. As 25
the part which is to be moved into engagement has approximately the same speed of rotation as the driving part due to the preparatory synchronisation, the engagement is effected without difficulty. During this movement to effect the engagement, the above-mentioned link motion x moves to the right again into a position which makes it possible to restore the engaged speed to the neutral position again on the next speed 30
change operation.

The automatic speed change operations according to the invention are effected by the following means:—

In a rail vehicle intended for travel in either 40
direction and having a driver's position at each end, a speed change switch 10 which is supplied with current from the battery 11, is provided at each driver's position. Each switch 10 is provided with contact levers or buttons corresponding to the number of speeds as well as a main 45
switch 12 and an emergency switch 13. The switch contacts 10 and the emergency switch contacts 13 are so arranged that on operating one switch contact, the previously operated 50
switch contact is automatically released.

In Fig. 1, the mechanism is shown with the first speed engaged; consequently all other leads from the switch 10 to the gearing are interrupted, but the lead attached to the switch 55
contact for the speed I also carries no current, because the corresponding contact 14 on the striker bar 1 of the speed I is open. If now for example the second speed contact at the switch 10 is actuated, then the current flows over the leads 60
indicated by speed II and over the contact 14 on the striker bar 1 of the second speed and from thence to a solenoid winding around a bolt 15 which is thereby drawn downwardly. In this 65
lowermost position the incoming current passes over the contacts 16 and the lead 17 to the magnetically controlled valve 18. This valve admits compressed air from the conduit 19 into the compressed air cylinder 20 the piston 21 of which is thus moved to the right. The external 70
portion of the piston rod 22 is constructed as a rack bar which engages with driven element 23. The movement of the piston rod 22 to the right is limited by the downwardly moved bolt 15 of the second speed (speed II). The rotation of 75
the element 23 is transmitted to the preselector

shaft 4 by a flexible or Cardan shaft 24. Consequently the synchronising drum 5 is rotated so that its lug 8 lies in the path of the lug 2 of the striker bar 1 of speed II. As the lug 9 on the drum 6 is still in engagement with the lug 5
2 of the striker bar 1 of the previous speed, the drum 6 is not rotated, the rotation of the shaft 4 increasing the tension of the torsion spring 7. In this condition of the mechanism a step-by-step switch 25 carried on the shaft of the element 23 carries the current by way of the line 10
26 to the magnetically controlled valve 27. The compressed air from the conduit 19 can now enter the cylinder 28, the piston of which is carried on the preselector shaft 4. Consequently 15
the preselector shaft is displaced axially to the left and the lug 8 on the synchronising drum 5 when the drum 5 is in its neutral position encounters the lug 2 of the striker rod 1 of the second speed which is in the neutral position. At 20
the same time, the speed I is disengaged by the link motion x (Fig. 4). Thereupon the spring 7 rotates the drum 6 to bring its lug 9 into the path of the lug 2 of the striker rod 1 of the second speed. During the further progressive 25
displacement of the preselector shaft 4 to the left the lug 8 on the synchronising drum occasions the engagement of the friction clutch elements of the speed II into the synchronising position. 30

In this displacement to the left, the piston which is carried on the preselector shaft 4 and operates in the cylinder 28 tensions a spring 29. In the left-hand end position of the piston in the cylinder 28, the compressed air acting on the 35
piston is admitted to the conduit 30 for the purpose of actuating the pneumatic trip device 31 which interrupts the line 26 to the valve 27 and allows the compressed air in the cylinder 28 to escape into the expansion chamber 32. In this 40
way the tensioned spring 29 is released and it urges the preselector shaft 4 to the right. The lug 9 of the drum 6 then urges the second speed, which is now synchronised, to the right and thus engages the dog clutch. At the same time 45
contact 14 on the striker bar 1 of the second speed is displaced to the right to such an extent that the further supply of current from the speed control switch is interrupted.

This opening of the contact has the following 50
results: The entire circuit of the preselector control apparatus is without current. Consequently the valve 18 allows the compressed air in the cylinder 20 to pass into the surrounding atmosphere. Under the action of its spring, the piston rod 22 reverts to the position shown and in so doing rotates the preselector shaft 4 into the neutral position by way of the driven element 23 and the Cardan shaft 24. The corresponding bolt 15 moves upwards again. The 60
released drum 5 also reverts to the neutral position because its lug 8 is now free to move in front of the lug 2 of the striker 1; the lug 9 of the drum 6 on the other hand lies between the lugs of the adjacent striker bars which are not engaged and is thus prevented from moving out of the path of the striker bar 1 of speed II; in this way it maintains the second speed in the engaged position. 65

In the meantime the pneumatic trip device 31 70
has returned to the position shown and the line 26 is closed again, but as there is no current in this line there is no action on the magnetically controlled valve 27 and the passage of compressed air from the conduit 19 to 75

the cylinder 28 is prevented. On the other hand, the exhausted compressed air expelled from the cylinder 28 is directed into the surrounding atmosphere through the expansion vessel 32 and the open outlet valve 33.

It should be mentioned that simultaneously with the supply of compressed air to the cylinder 28 through the valve 27 as described, compressed air is also directed into the main clutch cylinder 34 which occasions the release of the main clutch during the synchronising and gear engaging operations. The main clutch is re-engaged by its operating springs as the pressure in the cylinder 34 falls due to the outflow of the compressed air through the valve 33.

The expansion vessel 32 has the effect that the compressed air in the cylinder 28 after the synchronising operation can be expelled rapidly under the action of the piston which is acted on by the spring 29, the expansion vessel 32 acting as a receiver. The capacity of the vessel 32 and the cross-section of the aperture of its outlet valve 33 are so chosen that it accommodates the contents of the cylinder 28 with a minimum rise in pressure which enables the spring 29 to urge the piston in the cylinder 28 rapidly to the right to ensure quick engagement of the second speed. This minimum pressure is however large enough to oppose a certain resistance to the springs of the main clutch, to allow the engagement of the main clutch to occur smoothly with the gradual escape of the compressed air from the cylinder 34 by way of the expansion vessel 32 and the valve 33.

The described speed-change operation is repeated for each change upwardly or downwardly in the same way; it is immaterial whether the change is direct from speed I to speed II or to another speed.

For engaging the first speed, particularly when the vehicle is at rest when starting up, additional means are provided to ensure a particularly smooth engagement of the main clutch on starting. For this purpose, use is made of the outlet valve 33 which is controlled by the current in the lead 35 and which while the first speed is being engaged is throttled or closed so that the air in the expansion vessel 32 can only emerge through a nozzle 36 of smaller cross-section.

In order in an emergency or for particular working requirements to disengage the gearing from that speed which has just been engaged or is being synchronised, and to set it in neutral, a lead 37 is taken from the emergency switch 13 by way of a contact breaker 38 directly to the valve 27. The contact breaker 38 is maintained by spring action so that its contact bridge 39 ensures the passage of current from the emergency switch 13 to the valve 27. Thus if in any setting of the gearing other than the neutral position the emergency switch 13 is actuated, then the current passing through the contact bridge 39 causes the valve 27 to open and compressed air enters the cylinder 28 as well as the clutch cylinder 34.

Assuming that the gearing is set as shown in Fig. 1 with speed I in engagement, then on actuating the emergency contact 13 the speed I is disengaged and brought into the neutral position in the manner described above due to the admission of compressed air into the cylinder 28. In this neutral position the further axial displacement of the preselector shaft 4 is however arrested as the synchronising drum 5— which in this case is not preselected and thus

is in the neutral position—is held by the engagement of its lug 8 with a lug not shown in the drawings. At the same time, in this neutral position the lug 9 of the drum 6 is released from the lug 2 of the striker bar of speed I and also rotates into the neutral position where it also is held by means of a stop, not shown. The gearing is thus in the neutral position, all speeds are in the neutral position and the preselector shaft together with its two drums (synchronizing and engaging) is in the neutral position as well as in the neutral angular position. It is then only necessary to release the compressed air from the cylinder 28.

This is occasioned by a double-armed lever, the righthand arm 40 of which lies in the neutral range of the lug 9 of the drum 6 and the lefthand arm 41 is provided with a slot embracing the contact breaker 38. If, as described above, in the operations resulting from the actuation of the emergency contact, the last movement is the movement of the lug 9 of the drum 6 into the neutral angular range, then the lug 9 urges the arm 40 of the double lever upwards against the action of its spring 42 and the left-hand arm 41 draws the contact breaker 38 downwardly so that the supply of current through the lead 37 is interrupted at the contact bridge 39. Consequently the valve 27 is de-energised and allows the compressed air to escape from the cylinder 28 and the cylinder 34 into the receiver 32. The gearing is thus thrown entirely out of operation.

The same effect is also obtained if the gearing happens to be in the synchronising operation when the emergency contact is operated. In this working condition, the supply of current to the preselected speed which is being synchronised is first interrupted at the switch 10 on operating the emergency contact 13. Consequently, all the elements participating in the preselection (bolt 15, valve 18, piston 21, switch 25 and preselector shaft 4) revert to their neutral positions. However, until these return movements are completed, the cylinder 28 remains subjected to pressure because current is still supplied to the valve 27 by the emergency contact lead 37 and the interrupter 38. With the restoration of the preselector shaft 4 into the neutral angular setting, the drum 6 is also restored because in the synchronising position it does not abut against the lug 2 of the striker bar, so that the lug 9 which thus rotates into the neutral angular range actuates the double-armed lever 40, 41 precisely as described above, for changing from the engaged condition to neutral; thus the further supply of current through the line 37 to the valve 27 is interrupted and the compressed air can escape from the cylinder 28. The preselector shaft 4 can revert to its axial neutral position in which first the lug 9 of the drum 6 and then the lug 8 of the drum 5 is held by the stops (not shown) in the neutral angular position. In this way the gearing is thrown entirely out of operation.

The line 43 shown in Fig. 1 serves for setting the gearing in the neutral position independently of the driver. The control for this may for example be derived from motor control devices, the deadman's handle, or the like. The electric blocking devices 44, 45 prevent undesired feed back into the other leads.

The control for changing gear can be used not only for temporarily disengaging the main clutch but also for transitory interruption or limitation of the supply of gas to the engine. For this purpose use is made of the valve 50. A compressed

air cylinder 51 is connected to the pressure line between the cylinder 28 and the valve 27. The piston of the cylinder 51 displaces a slide 52 of the valve 50 so that the pressure medium which is controlled from the driving position through the conduit 53 cannot reach the apparatus 54 regulating the gas. At the same time the slide 52 opens the path 55 which leads from the apparatus 54 to the open air, so that under the action of its spring the apparatus cuts off the further supply of gas to the engine. All the above-mentioned parts revert to the position shown as soon as the compressed air escapes from the cylinder 28 and the cylinder 34.

Figs. 2 and 3 show an arrangement of the striker bar contacts 14 differing from the diagrammatic arrangement of Fig. 1 in that these contacts are not mounted directly on the striker bars but are carried on separate contact bars which resemble the striker bars but on a smaller scale. This arrangement has the advantage that the separate contact bars merely need execute the short to and fro movements which are necessary for making and breaking the contacts. In addition these separate contact bars can be arranged at a conveniently accessible position outside the gearing. It is true that contacts directly mounted on the striker bars could be arranged outside the gearing by extending the striker-bars out of the gear-box, but it remains necessary for the contact arrangement to be mounted on an axial extension of the striker bars.

In Fig. 2 the drum 6 is shown in cross section. The actual striker bars 1 are arranged in series side by side beneath it. The contact bars 46 which are carried in a guide block 47 are disposed above the drum 6. Fig. 3 shows that an auxiliary lug 48 for displacing the contact bars first travels freely in the axial synchronising movement of the preselector shaft and the contact bar 46 which is in the inoperative position bridging the contacts is not engaged until the neutral position is reached and then it is displaced to the right. Whereas in the position shown the two contact members 49 are still bridged by the contact bridge 14, the displacement to the right—corresponding to the engagement of the gearing—permits a spring to interrupt the contacts 49 as shown for example in Fig. 1 on the striker bar of speed I.

The arrangement of the striker bar 1 shown in Fig. 3 with reference to the preselector shaft 4 corresponds to the practical construction even when no contact bars 46 are provided (see Fig. 4, for example).

A considerable simplification of the speed-changing operations is afforded by the invariable restoration of the preselector shaft to neutral.

The switches 10 and 13 shown in Figs. 5 and 6 are constructed as press button switches. The lugs 56 on the press buttons are held in the lower, or "on," position by means of a pawl 57. As soon as a different button from that which was previously actuated is depressed, the pawls 57 are disengaged, so that the previously actuated press button is released and reverts to the "off" position under the action of its spring 58.

To prevent more than one button being depressed at a time, detents 59 are provided, which slide with respect to each other and leave room for only one contact pin 60.

The arrangement of the preselector mechanisms 15, 18, 21 and 25, is directly applicable for controllers, for apparatus serving to regulate the engine, and so on.

I claim:

1. In a semi-automatic transmission gear synchronizing and shifting system for engine driven vehicles, a plurality of transmission gears each having a shifting device connected thereto, a plurality of electric switches at the driver's station each for controlling a corresponding transmission gear, a preselection shaft, mechanism for preliminarily rotating said preselection shaft into one or another of a plurality of positions respectively for cooperation with the shifting device associated with a selected gear, electric circuits connecting said switches individually with said mechanism for preliminarily rotating the preselection shaft for actuating said mechanism, electric contacts each corresponding with a transmission gear, means operated by said preselection shaft, rotating means for closing one or another of said contacts in dependence on the rotation imparted to said shaft according to the gear selected, means controlled by said contacts for moving said preselection shaft axially after arriving at the rotational position adapted to cooperate with the shifting device of the selected gear to move the selected gear axially, a plurality of gear speed synchronizing clutches each corresponding with a transmission gear and each having a first part connected with its corresponding gear and a second part connected with the gear with which its respective gear is to be connected, said clutch parts being brought into engagement by the axial movement of the selected gear whereby the selected gear attains the speed of the gear to which it is to be connected, and means for automatically moving the selected gear axially in the opposite direction into engagement with the gear with which it is to be connected after attaining its speed.

2. A system according to claim 1 and in which the shifting devices associated with each transmission gear each comprises an axially movable striker bar having electric contacts thereon, said contacts being connected in the respective circuits to close said circuits when in disengaged gear position and disconnecting the respective circuits when in engaged gear position so as to de-energize said circuits.

3. A system according to claim 1 and in which the shifting devices associated with each transmission gear each comprises an axially movable striker bar having electric contacts thereon, said contacts being connected in the respective circuits to close said circuits when in disengaged gear position and disconnecting the respective circuits when in engaged gear position so as to de-energize said circuits, said striker bars lying parallel with said preselection shaft and being movable axially parallel to said shaft and in dependence thereon when said shaft is in rotational position corresponding thereto.

4. A system according to claim 1 and in which the mechanism for rotating the preselection shaft into the appropriate rotational position corresponding to the gear to be shifted comprises a pneumatic motor having a piston provided with an extending rack bar, a pinion engaging said rack to be rotated by longitudinal movement thereof, linkage for transmitting the rotation of said pinion to said preselection shaft, a plurality of magnetically controlled locking bolts adapted to extend into the path of movement of said rack bar to limit its movement, said bolts being provided with controlling magnets connected respectively in the circuits of said switches, a magnetically controlled air valve for supplying air for actuating said pneumatic motor,

and contacts on said bolts for supplying energizing current to the air valve magnet when any one of said bolts is in position to limit the movement of the rack bar.

5 5. A system according to claim 1 and in which the mechanism for rotating the preselection shaft into the appropriate rotational position corresponding to the gear to be shifted comprises a pneumatic motor having a piston provided with
10 an extending rack bar, a pinion engaging said rack to be rotated by longitudinal movement thereof, linkage for transmitting the rotation of said pinion to said preselection shaft, a plurality of magnetically controlled locking bolts adapted
15 to extend into the path of movement of said rack bar to limit its movement, said bolts being provided with controlling magnets connected respectively in the circuits of said switches, a magnetically controlled air valve for supplying air
20 for actuating said pneumatic motor, contacts on said bolts for supplying energizing current to the air valve magnet when any one of said bolts is in position to limit the movement of the rack bar, and each of the shifting devices associated with
25 each gear comprising a striker rod, the means for moving the preselection shaft axially into gear synchronizing position comprising a pneumatic motor, a magnetically controlled air valve for controlling the supply of air to said preselection shaft motor, said linkage having a contact arm actuated thereby, a contact crown having a
30 plurality of contacts in position to be engaged by said contact arm, a current lead connecting said arm with the magnet of the valve which controls air to the preselection shaft motor, the electric
35 circuits including current leads connecting the contacts of said contact crown to the respectively corresponding striker arms.

40 6. A system according to claim 1 and in which the mechanism for rotating the preselection shaft into the appropriate rotational position corresponding

to the gear to be shifted comprises a pneumatic motor having a piston provided with an extending rack bar, a pinion engaging said rack to be rotated by longitudinal movement thereof, linkage for transmitting the rotation of
5 said pinion to said preselection shaft, a plurality of magnetically controlled locking bolts adapted to extend into the path of movement of said rack bar to limit its movement, said bolts being
10 provided with controlling magnets connected respectively in the circuits of said switches, a magnetically controlled air valve for supplying air for actuating said pneumatic motor, contacts on said bolts for supplying energizing current to the air
15 valve magnet when any one of said bolts is in position to limit the movement of the rack bar, each of the shifting devices associated with each gear comprising a striker rod, the means for moving the preselection shaft axially into gear synchronizing position comprising a pneumatic motor, a magnetically controlled air valve for controlling the supply of air to said preselection shaft motor, said linkage having a contact arm actuated thereby, a contact crown having a plurality of contacts in position to be engaged by
25 said contact arm, a current lead connecting said arm with the magnet of the valve which controls air to the preselection shaft motor, the electric circuits including current leads connecting the contacts of said contact crown to the respectively
30 corresponding striker arms, the preselection shaft motor having a spring for moving the piston in the opposite direction as the air to move the shaft into gear engaging position, an opening in the preselection shaft motor for discharging air when the piston reaches the limit of its movement toward gear synchronizing position, and an interrupter actuated by air discharged through said opening for opening the electric lead to the magnet of the preselector shaft motor control valve.
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