

Nov. 10, 1953

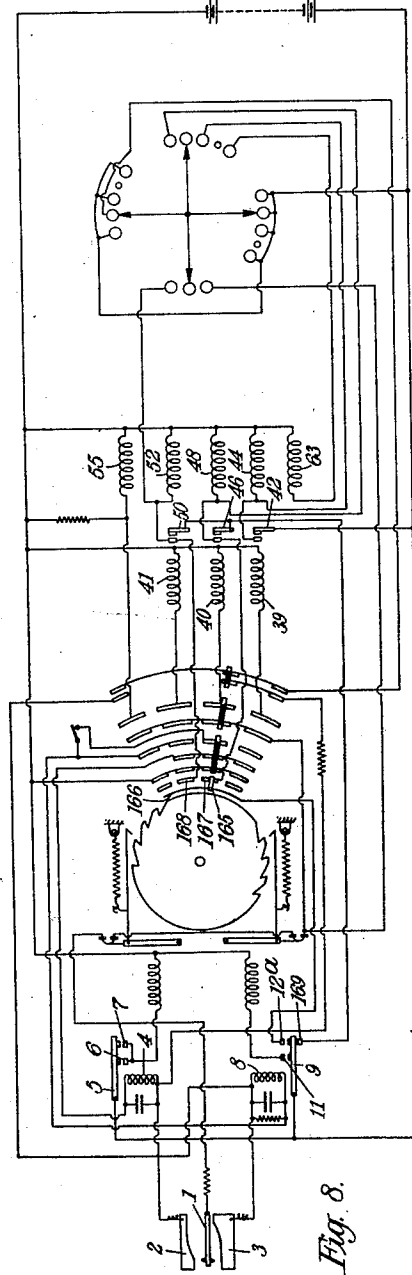
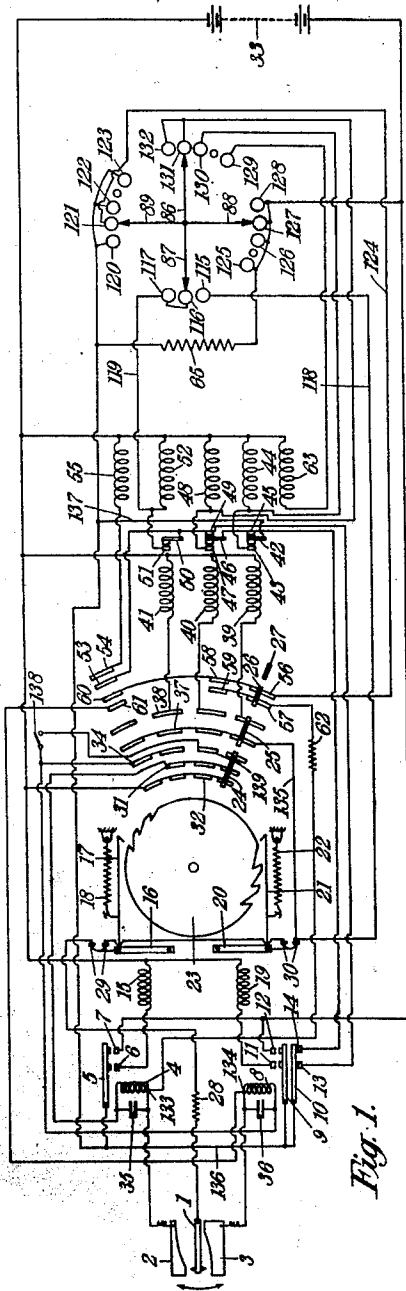
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2,658,408

ELECTRICAL CONTROL MEANS FOR CHANGE-SPEED GEARING

Filed May 31, 1951

4 Sheets-Sheet 1



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ELECTRICAL CONTROL MEANS FOR CHANGE-SPEED GEARING

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4 Sheets-Sheet 2

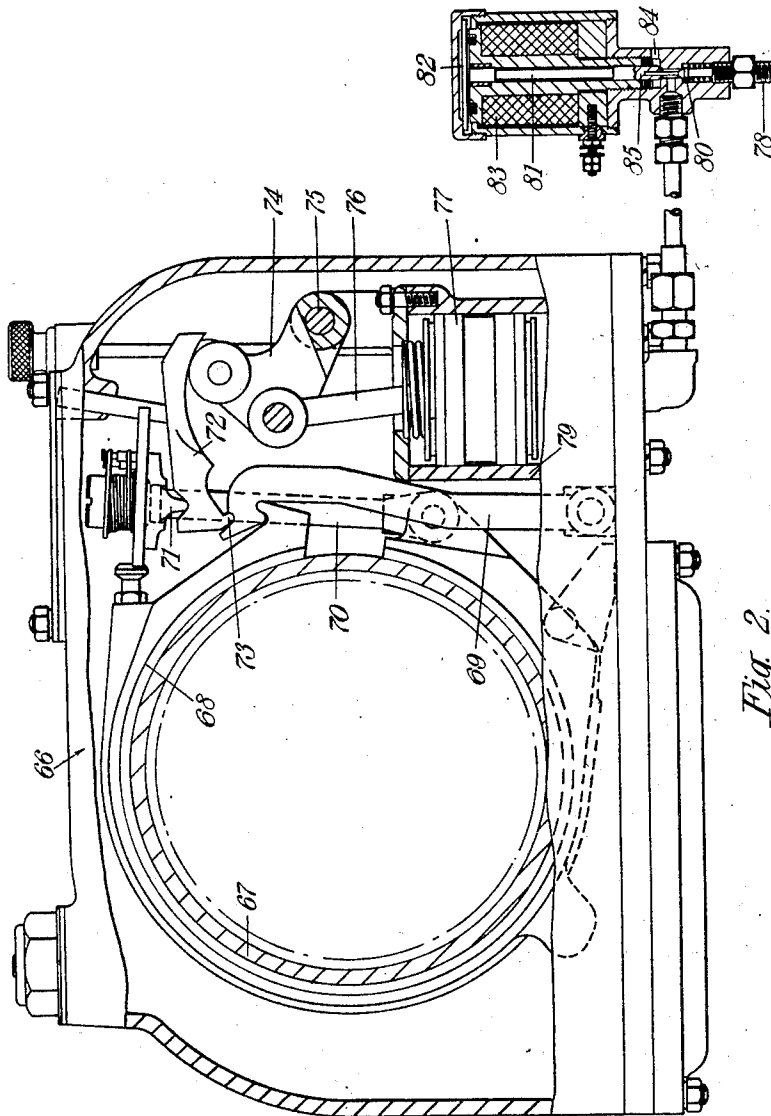


Fig. 2.

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4 Sheets-Sheet 3

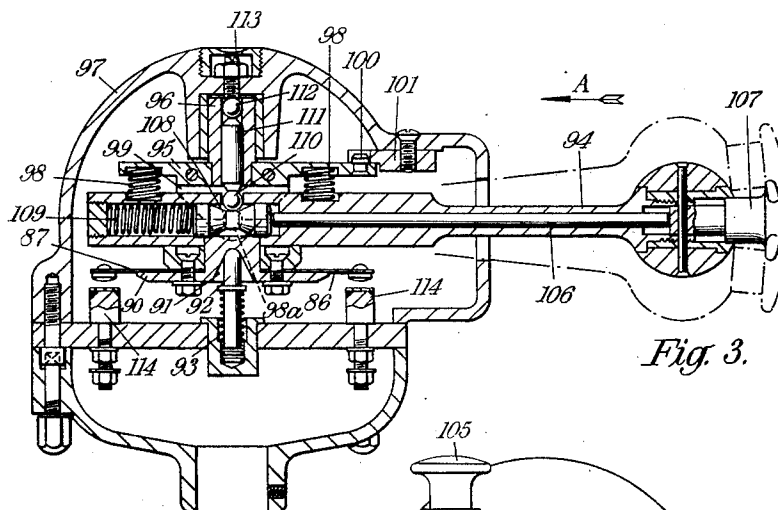


Fig. 3.

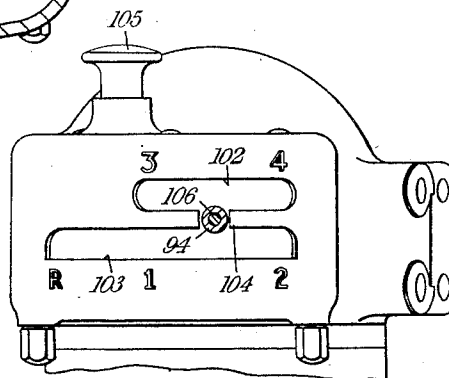


Fig. 4.

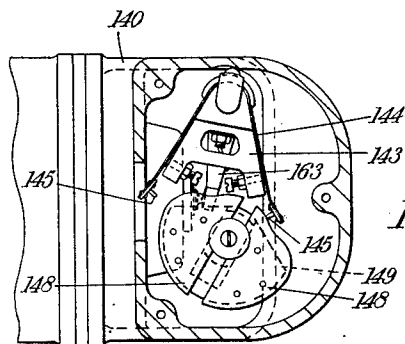


Fig. 7.

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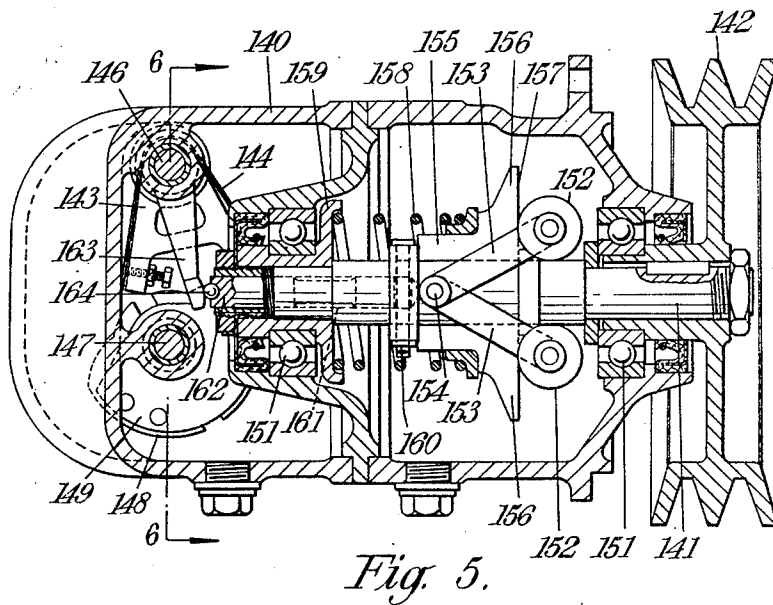
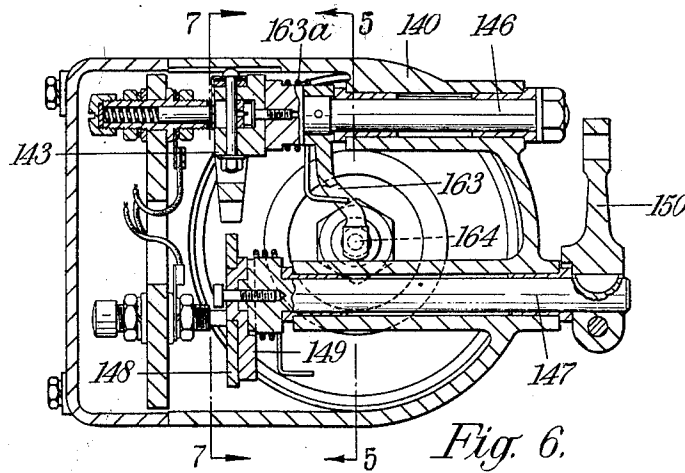
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ELECTRICAL CONTROL MEANS FOR CHANGE-SPEED GEARING

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4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

2,658,408

ELECTRICAL CONTROL MEANS FOR
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Claims priority, application Great Britain
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21 Claims. (Cl. 74-472)

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This invention relates to electrical control means for change speed gearing of the kind comprising electrical circuits controlled by contact members or switches and means controlled or actuated by said circuits for automatically effecting the engagement of either a higher or a lower gear in accordance with the closing or opening of one or other of said circuits. The invention may be applied with particular advantage to arrangements of the above kind including electrical contact members movable relatively in two directions, movement in one direction being in accordance with the speed of a part of the transmission and movement in another direction being in accordance with the fuel supply or throttle opening of an internal combustion prime mover, as described for example in British patent specification No. 457,269. The invention may be applied to gearing provided with any convenient means for effecting the changes in gear ratio, such for example as fluid actuated devices controlled by electro-magnetically operated valves, and such devices may be employed to actuate the brakes of epicyclic gears affording the required ratios, although the invention is not restricted to the use of such actuating means.

It is an object of the invention to provide control means of the above kind which can in addition be manually controlled by selecting and engaging any desired gear irrespective of the particular gear engaged.

A further object of the invention is to enable control means of the above kind having automatic control in accordance with speed and fuel supply or throttle opening conditions of a prime mover to be manually instead of automatically controlled when required so that a desired gear ratio can be maintained irrespective of the aforesaid conditions, and to provide convenient and easily operable means for achieving this result. A further object is to provide alternative manual and automatic control means which may be exchanged with safety at any time while the transmission is in motion without risk of over-speeding the prime mover, such as might occur if on changing from manual to automatic control an inappropriate change to lower gear were produced. A further object is to provide an improved construction of manually operable switch for the above purposes. A further object is to provide an improved construction of governor actuated electrical contact members.

The invention consists in electrical control means for change speed gearing comprising elec-

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trical circuits controlled by contact members or switches, means controlled or actuated by said circuits for automatically effecting the engagement of either a higher or a lower gear in accordance with the closing or opening of one or other of said circuits, and manually operable selection switch means for interrupting said circuits and for selectively closing other circuits including electrical means for controlling engagement of different gear ratios, the arrangement being such that gear changing is effected either by the first said circuits or by the second said circuits according to the position of the selection switch means.

The invention also consists in electrical control means for change speed gearing comprising electrical contact members movable relatively in two directions, movement in one direction being in accordance with the speed of a prime mover or transmission part and movement in another direction being in accordance with the fuel supply or throttle opening of the prime mover, electrical circuits controlled by said contact members, means controlled by said circuits for automatically selecting and engaging different gear ratios in accordance with speed and fuel supply or throttle opening conditions, and manually operable selection switch means for interrupting said circuits and for selectively closing other circuits including electrical means for controlling engagement of the different gear ratios, the arrangement being such that gear changing is either automatic or manually controllable according to the position of said selection switch means.

The invention also comprises an arrangement according to either of the two preceding paragraphs in which the first mentioned contact members or switches control the circuits of relays for effecting operation of a selection switch, through ratchet or other means in one or other direction to close circuits for actuating different gear ratio engagement means, said relays being provided with time delay means, for example a shunt connected condenser or an additional short-circuited winding or induction sleeve so that they cannot operate successively within a predetermined period. The engagement of the selected gears is effected through the medium of electro-magnetic devices which are preferably energised by relays, thereby reducing the current to be carried by the contacts of the selection switch. These relays are also preferably provided with time delay means.

According to a further feature of the inven-

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tion, the manually operable selection switch is provided with a contact or contacts arranged to be automatically engaged each time the switch is operated to change the gear ratio, such engagement causing the closing of a circuit associated with the automatic selection switch to ensure the positioning of the latter in an intermediate gear position and thereby obviate inappropriate gear changes.

A current economising resistance may be included in the circuits of the gear engaging control devices, and means may be associated with the automatic and manual control circuits for short-circuiting said resistance at each gear changing operation. Thus in a preferred arrangement, means is provided for locking the operating handle of the manually operable selection switch in the selected positions, and the motion required to unlock the handle causes contact means to become operative and to effect the closing of a circuit or circuits when the handle is moved to another position and thereby short-circuit the resistance.

In the accompanying drawings,

Figure 1 is a diagram showing the connections of an electrical control means for change speed gearing arranged in accordance with the invention;

Figure 2 is a sectional elevation, with certain details omitted, of the brake actuating and control mechanism for an epicyclic gear box for use in conjunction with control means according to the invention;

Figure 3 is a sectional elevation of a manual selection switch constructed and arranged in accordance with the invention;

Figure 4 is an end elevation of the selection switch as viewed in the direction of the arrow A in Figure 3;

Figure 5 is a sectional elevation, taken on the line 5—5 of Figure 6, of a governor and throttle control mechanism constructed and arranged in accordance with the invention;

Figure 6 is a cross section of the mechanism of Figure 5;

Figure 7 is a section taken on the line 7—7 of Figure 6;

Figure 8 is a diagram showing the connections of a modified form of electrical control means.

In carrying the invention into effect according to one convenient mode, the connections for a control arrangement intended to be applied to an epicyclic gear box affording four forward gear ratios and reverse is shown in Figure 1. A governor actuated electrical contact arrangement is provided comprising a movable contact member 1 connected to a speed governor and displaceable in relation to a pair of shaped contact surfaces 2 and 3 which are themselves movable in a different direction in accordance with the fuel supply and throttle opening as described in British patent specification No. 457,269. The contact surface 2 is connected to the coil 4 of a change-up relay having a movable armature 5 controlling contacts 6 and 7. The contact surface 3 is connected to the coil 8 of a change-down relay having movable armatures 9 and 10. The armature 9 controls contacts 11 and 12 and the armature 10 controls back contacts 13 and 14. The contacts 6 and 7 of the change-up relay control the circuit of an electromagnet 15 having an armature 16 for actuating a ratchet pawl 17 loaded by a spring 18. The contacts 11 and 12 of the change-down relay control the circuit of an electromagnet 19 having an armature 20 for actuat-

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ing a ratchet pawl 21 loaded by a spring 22. The ratchet pawls 17 and 21 are arranged so that when operated they engage a ratchet wheel 23 to which is connected the contact arm of an automatic selection switch. This arm is not shown in Figure 1, but it carries four contact strips 24, 25, 26 and 27. Operation of the ratchets causes step by step displacement of the ratchet wheel 23 in one or other direction according to which ratchet is operated. The movable contact member 1 of the speed governor is connected through a resistance 28 and pairs of contacts 29 and 30, which are broken when the ratchets are operating, to one of a pair of contacts on a manual selection switch to be described hereinafter, which contacts are bridged when the said switch is in position for automatic operation, and the second of said contacts is connected to the positive side of the electrical supply which may conveniently comprise a battery. Thus the aforesaid relays can be energised through the governor actuated contacts 1 and 2 or 1 and 3 only when the manual selection switch occupies an appropriate position.

The relay coil 4 is connected to a series of contacts 31 on the automatic selection switch which can be connected by the switch strip 24 to contacts 32 which are connected to the negative side of the supply battery 33. Similarly the relay coil 8 is connected to a series of contacts 34 which can also be connected by the switch contact strip 24 to the negative side of the supply. The switch arm has four positions corresponding to first, second, third and fourth speeds, the reverse being obtained by manual control only. In Figure 1 the lowest radial line of contacts occupied by the switch contact strips 24, 25, 26 and 27 corresponds to first speed, the line of contacts above it to second speed, the line above that to third speed and the upper line to fourth speed. It will be seen that the series of contacts 31, 32 and 34 are so arranged that in each end or limit position of the switch arm the circuit of one of the relay coils 4 or 8 is interrupted. The arrangement is such that if the automatic selection switch is in a position corresponding to second speed for example, and the engine speed rises to a predetermined value, the governor actuated contact member 1 will move to close the circuit of the change-up relay 4 which causes actuation of the magnet 15 and ratchet 17 to move the automatic selection switch arm to the next position corresponding to third speed. If, however, the switch arm is already in fourth speed position, there is no contact of the series 31 connected to the relay coil 4 and hence the relay cannot be energised. The same considerations apply when changing down, since the lowest contact of the series 34 has no connection with the relay coil 8. The relay coils 4 and 8 are shunted by condensers 35 and 36 so that a time lag of a few seconds is introduced which prevents successive operations within a shorter time interval.

The contact strip 25 of the ratchet switch arm controls series of contacts 37 and 38. The contacts 37 are connected through the manual selection switch to the positive side of the battery 33, this connection being made only when the said switch is in position for automatic operation as will be described hereinafter. The contacts of series 38 are connected respectively to the coils 39, 40 and 41 of three valve controlling relays corresponding to first, second and third speeds. These relays are preferably equipped with induction sleeves to provide a time delay

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in their operation. The relay coil 39 can actuate a movable contact 42 to make with a fixed contact 43 connected to an electromagnet 44 to bring in the first speed gear as hereinafter described. The movable contact 42 also has a back contact 45 which is connected to the back contact 14 of the change-down relay 8. The movable contact 46 of the relay 40 is arranged to make with a fixed contact 47 connected to an electromagnet 48 for bringing in the second speed gear. The movable contact 46 also has a back contact 49 and is connected to the back contact 45. The back contact 49 is connected to the back contact 13 of the change-down relay 8. The relay 41 has a movable contact 50 connected to the back contact 49 of relay 40 and is arranged to make with a fixed contact 51 which is connected to an electro-magnet 52 for bringing in the third speed. The movable contact 50 is also connected to a contact 53 in the automatic selection switch. When the switch arm is in fourth speed position, this contact 53 is connected by the contact strip 27 to a contact 54 which is itself connected to an electromagnet 55 for bringing in the fourth speed, this being effected, it will be noted, without the intervention of a relay.

The contact strip 26 of the ratchet switch controls a series of pairs of contacts 56, 57; 58, 59; and 60, 61 which correspond to first, second and fourth speeds respectively. The contacts 56, 58 and 60 are connected together and to an appropriate contact in the manual selection switch. The contacts 57 and 59 are connected through a resistance 62 to the end 133 of change-up relay coil 4. The contact 61 is connected to the coil of the change-down relay 8. A fifth electro-magnet coil 63 is provided for bringing in the reverse gear. All the electro-magnet coils are connected on one side to the negative side of the battery 33. The electro-magnet coils 44, 48, 52 and 55 are connected on the other side through the interconnected relay contacts and an economising resistance 65 to the positive supply through appropriate contacts in the manual selection switch. The contacts 7 and 12 on the change-up and change-down relays 4 and 8 are arranged to short-circuit the resistance 65 when either one of the relays is energised so that the current in the selected solenoid coil is a maximum at this time. As soon as the relay has caused operation of the appropriate ratchet, the contacts 29 or 30 on the ratchet are broken so that the relay is de-energised after the previously mentioned time delay and the resistance 65 is re-introduced into the selected electromagnet circuit, thereby diminishing the current flowing.

It will be understood that the electro-magnets previously referred to are arranged to operate hydraulic or pneumatic valves controlling hydraulic or pneumatic pistons for applying the brakes and/or clutches to epicyclic gears and thereby engaging the corresponding gear ratio of the gear box. A convenient arrangement for this purpose is illustrated in Figure 2. A gear box indicated generally at 66 is of the usual epicyclic type and has a brake drum (not shown) with brake band 68 and line 67, one end of which is anchored by a link 69. The other end of the brake band is connected to a link 70 having a head 71 bearing on a lever 72 fulcrumed at 73 on the link 69 and bearing at its other end on a bell crank 74 pivoted at 75 and connected by a rod 76 to a pneumatic piston 77. Air from a supply pipe 78 is admitted to the operating cylinder 79 under the control of a spring loaded valve

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80 connected by a spindle 81 to an armature 82 arranged to be actuated by the electro-magnet coil 83 to open the valve 80. An exhaust outlet 84 is controlled by a valve member 85. An arrangement of this kind is employed for bringing in the four forward speeds and the reverse gear.

The manually operable selection switch is shown in Figures 3 and 4 and the contact arrangement is shown in Figure 1. The movable part of the switch comprises four contact or brush arms 86, 87, 88 and 89, two of which are shown in Figure 3. These arms are in electrical connection and are arranged in the form of a cross upon a plate 90 which is supported by means of a central recess 91 upon a central pivot 92 which is vertically movable against a loading spring 93. A handle 94 is located upon the plate 90 and is secured thereon by an upper plate 95 rotatably seated in a central sleeve 96 in the switch casing 97 and connected to the lower plate 90. Springs 98 are interposed between the upper plate 95 and the handle body, and the latter is also connected by horizontal pivots 98a to side plates 99 of the upper plate 95. A pin 100 in the upper plate 95 is engageable in any one of a series of indexing recesses in a member 101 secured to the casing 97. The handle 94 projects laterally through an opening in the casing wall, which opening is of gate form as shown in Figure 4 and comprises spaced parallel slots 102 and 103 connected intermediately by a short vertical slot 104. The upper slot 102 has markings 3 and 4 indicating third and fourth speeds. Instead of 4 the marking A may be employed to indicate automatic control. The lower slot 103 is marked R, 1 and 2 for reverse, first and second speeds. A spring loaded pin 105 is mounted in the casing to prevent inadvertent movement of the handle to reverse position. The arrangement is such that the handle 94 can be rocked about its pivot pins 98a for passing through the gate slot 104 and can be moved laterally in either of the slots 102, 103 and indexed in the marked positions. A rod 106 is slidable longitudinally in the handle and is displaceable by a button 107 in the handle end. The rod 106 engages a double conical or equivalent cam-shaped member 108 located in an enlarged bore in the handle body and loaded by a spring 109. The member 108 is engaged by a ball 110 located in an aperture in the handle body wall, the ball being engaged by a pin 111 engaging a second ball 112 located within the sleeve 96. A screw 113 on the casing 97 abuts the ball 112. This ball and pin arrangement is aligned with the spring loaded supporting pivot 92. The arrangement is such that pressure on the handle button 107 displaces the cone member 108 and thereby forces the contact plate 90 downwardly by depressing its supporting pivot 92. This motion also brings with it the upper plate 95 and releases the pin 100 from the indexing recesses in the member 101, thus enabling the contact plate to be angularly adjusted to another position. Four groups of contact studs are arranged beneath the contact arms, and two of these studs are shown at 114 in Figure 3.

Referring to Figure 1, three contact studs 115, 116 and 117 comprise one group and are disposed at a level such that they will only be contacted by the arm 87 when the handle 94 is in the upper slot 102 of the gate, this being determined by the corresponding inclination of the contact arm plate 90. The stud 115 is a fourth

speed or automatic control stud and is connected by a line 118 through the contacts 29 and 30 to the governor controlled contact member 1. The stud 116 is a neutral stud and is connected to the third speed stud 117 and thence by a line 119 to the positive side of the third speed electro-magnet 52. A second group of four studs comprises a neutral stud 121 which is connected by a line 124 to the contacts 56, 58 and 60 of the automatic selection switch which are only contacted by the strip 26 when the arm is in first, second, or fourth speed positions. This neutral stud 121 is contacted by the arm 89 when the neutral stud 116 is contacted by the arm 87. The studs 120, 122 and 123 are all connected to the contact arms 5, 9 and 10 of the change-up and change-down relays. This second group of contacts are engageable by the contact arm 89 in either the upper or lower slot position of the handle 94. A third group of contacts comprises four studs 125, 126, 127 and 128 all connected to the positive side of the supply battery 33 and the economising resistance 65. These studs are arranged so that they are only engaged by their contact arm 88 when the button 107 of the handle 94 is depressed as is necessary when changing the handle position, and when contacted they short-circuit the resistance 65 when the circuit of the selected electro-magnet is closed, the resistance being re-introduced when the button is released. A fourth group of contacts comprises contact studs 129, 130, 131 and 132 which are arranged so that they are only engaged when the handle 94 occupies the lower slot. The end or reverse stud 129 is connected to the positive side of the reverse gear electro-magnet 63. The first speed stud 130 is connected to the positive side of the first gear electro-magnet 44. The neutral stud 131 is connected to the end stud 132 and to the positive side of the second speed solenoid 48. Thus when the arm 86 contacts with the appropriate stud of the fourth contact group, the circuit of either the reverse, first or second speed electro-magnet will be completed through the corresponding stud of the second group (120, 122 or 123) which is connected through the resistance 65 to the positive side of the battery 33. The arrangement is such that when the switch handle 94 is moved to fourth speed or automatic control position, automatic control is afforded from first to fourth speeds. Movement of the switch handle to reverse, first, second or third speed positions interrupts the automatic control circuits and closes the electro-magnet circuit of the selected gear to engage the same, the economising resistance 65 being short-circuited by contacting of the studs 125, 126, 127 or 128 as long as the handle button 107 is depressed. Also the contacts of the groups are so arranged that a neutral contact is made when moving the handle through the gate from any one of the positions 1, 2, 3 or 4 (A) to any other of said positions.

It will be seen that with the manual selection switch in neutral position there is no electrical connection to the contact 115 which is connected to the governor member 1, nor is there any electrical connection to contacts 130, 132, 117 or 129 because the arm 88 does not make with any of the supply contacts 125, 126, 127 or 128 unless the button of the switch handle is depressed, and the contact arm 89 lies on a contact 121 which is not connected to the supply. Thus

none of the electro-magnets is energised and no gear is engaged.

It is not possible to move the switch arm 94 without first pressing the button 107, and this action causes the arm 88 to engage contact group 125, 126, 127, 128. Thus when the switch arm is moved to any one of the positions R, 1, 2 or 3, the four contact arms are electrically connected to the positive side of the battery and the arm 86 or 87 will carry the connection to the appropriate contact and current flows directly to the appropriate electro-magnet winding, the circuit of which is completed through the common connection to the negative side of the battery. When the button 107 is released in the selected gear position the direct connection with the battery is interrupted by disengagement of the arm 88 with its group of contacts, but a reduced current is maintained through the arm 89 which is then engaged with one of the contacts 120, 122 or 123 which are connected through the economising resistance 65 to the positive side of the battery. Thus having first applied the full battery voltage to the appropriate electro-magnet to ensure its positive actuation, a reduced current is then maintained to hold the magnet in its actuated position. This enables a relatively small magnet to be used without overheating when energised for long periods.

It is desirable that during manual control of the gear box as described above, the ratchet switch for automatic selection should be in third gear position, in order that when it is brought into effect by reverting to automatic control it will not immediately actuate a gear ratio which might be too low or too high for the speed of the vehicle at the time of gear change. If the ratchet switch should be in first or second speed position when the automatic control is discontinued by moving the manual selection switch to a selected position the switch arm will of necessity be moved through the neutral position with the button 107 depressed. This will complete a connection from the positive side of the battery through contact 127, arm 88, arm 89, contact 121, and contact strip 26 on ratchet switch arm to the end 133 of the winding of the change-up relay, and thence through contact strip 24 of the ratchet switch and contacts 32 to the negative side of the battery. The change-up relay 4 is thus energised to complete a circuit from the positive side of the battery through relay contacts 7, contact arm 5 and contact 6 to magnet winding 15 and thence to the negative side of the battery. The magnet 15 is thus energised and moves the ratchet switch one step in a change-up direction, for example from first speed to second speed position. The next operation of the manual selection switch through the neutral position will repeat the energising of the change-up relay 4 and move the ratchet switch to third speed position. Further movement of the manual selection switch can have no effect upon the change-up relay since the contact strip 26 on the switch arm will not make the necessary contact.

If the ratchet switch had been in fourth speed position when automatic control was discontinued, the ensuing movements of the manual switch arm 94 would complete a circuit through the ratchet switch contact strip 26 and contact 61 to the end 134 of the change-down relay coil 8, and thence through the coil to contact 24, through contact strip 24 to contacts 32, and thence to the negative side of the battery. Op-

eration of the change-down relay 8 which ensues will complete a circuit from the positive side of the battery through relay contacts 11 and 12 and contact arm 9 to the magnet winding 19 and thence to the negative side of the battery. The operation of the magnet 19 will then move the ratchet switch one step to third speed position.

Considering now the functioning of the automatic control, let it be assumed that the ratchet switch is in third speed position when the manual selection switch is moved to position 4 or A. This completes a circuit from the positive side of the battery through contact 128, arm 88, contact 115, line 118, line 135, ratchet contact strip 25, contact 38, relay winding 41 and thence to the negative side of the battery. The relay is thereby energised to complete a secondary circuit from the positive side of the battery through contact 128, arm 88, arm 89, contact 129, line 136, contact arm 10, contact 13 (or alternatively line 137, contacts 42, 45, 46, 49), contacts 50 and 51 of third speed magnet relay and through magnets 52 to the negative side of the battery, thereby engaging the third speed. When the button 107 is released by the operator, the circuit from the battery is completed through the resistance 65 as previously explained. If the vehicle is stationary when the automatic control is selected, or if for any other reason the engine speed is low enough to close the change-down contacts 1, 3 in the governor switch, current will flow from the positive side of the battery to the resistance 65 (the handle button 107 being assumed released) to contact 120, arm 89, arm 87, contact 115, contacts 30 and 29, governor contact arm 1, governor contact 3, the change-down relay coil 8, contacts 34, contact strip 24, contacts 32, and thence to the negative side of the battery. The change-down relay 8 is thereby energised and the condenser 36 is charged, the relay in turn closing and completing a circuit from the positive side of the battery through the relay contact 12, contact arm 9, contact 11, magnet coil 19 and thence to the battery negative, thereby operating the ratchet switch to move its arm one step down to second speed position, thereby transferring the circuit from the third speed relay winding 41 to the second speed relay winding 40. The contacts of the second speed relay 40 will thereby be closed to complete a circuit from the positive side of the battery through the change-down relay contact 12 and contact arm 9, line 136, line 137, relay contacts 42 and 45, relay contacts 46 and 47, the second speed magnet winding 43 and thence to the negative side of the battery. When the contacts 46 and 47 are closed, the contacts 46 and 49 are opened. Simultaneously with the closing of the change-down relay contacts 12, 11 and 9, the back contacts 13 and 14 are opened, thereby interrupting the circuit of the third speed magnet relay contacts 50 and 51, so that while the induction sleeve provided on the winding of the third speed relay winding 41 retains its contacts 50, 51 in closed condition for the required period for a changing-up operation (about $\frac{1}{2}$ second), the circuit supplying these contacts is instantaneously broken by the aforesaid back contacts 13, 14 of the change-down relay, and the lag which is inherent in the action of the relay is prevented from being effective in the third speed magnet winding 52 which it has been controlling. The operation of the ratchet switch causing the change-down operation to take place has previously opened the contacts 30 and interrupted the circuit to the governor switch contacts 1 and 3 and the change-

down relay coil 8 and its condenser 36 so that the latter commences to discharge through its relay coil and holds the relay closed for a predetermined period (about two seconds). When this relay opens the circuit to the change-down magnet 19, the ratchet contacts 30 will again be closed and the governor switch member 1 will again be connected to the positive side of the battery and is ready for a further operation should the engine speed and throttle position be such as to close its contacts. A manual switch 133 is provided and connected to the contact 139 which is similar to contacts 34 but occupies the second speed position of the ratchet switch contact strip 24. When the manual switch 133 is opened, the circuit through the change-down relay 8 will be broken when the ratchet switch arm reaches the second speed position and a further change-down cannot then occur.

If the engine speed rises sufficiently to close the governor switch contacts 1 and 2, a circuit is completed from the positive side of the battery through the economising resistance 65, the contact 120 of the manual selection switch, the switch arms 89 and 87, the contact 115, contacts 30 and 29, governor switch arm 1, governor switch contact 2, the change-up relay winding 4 and its condenser 35, the contacts 31, the ratchet arm contact strip 24, the contacts 32 and thence to the negative side of the battery. The consequent operation of the change-up relay closes a circuit from the positive side of the battery through the change-up relay contacts 7, 5 and 6 through the magnet coil 15 to the negative side of the battery. The ratchet switch is thereby moved up one step, for example from second to third position. The movement of the ratchet arm contact strip 25 transfers the supply from the relay coil 40 to the relay coil 41. The relay contacts 46, 47 remain closed for about half a second, maintaining the circuit through the second speed magnet 43 for this period after the actuation of the third speed magnet 52. It is to be noted that the circuit which supplies the relay contacts 50, 51 is not interrupted when changing-up as it is when changing-down. The operation of the ratchet switch when changing-up opens the contacts 29 and thereby interrupts the circuit to the governor switch arm 1 and thence through the contact 2 and the change-up relay 4 and its condenser 35. The condenser then commences to discharge through the relay winding 4 and maintains the relay contacts closed for approximately two seconds. During this period the aforesaid contacts 29 remain open and render the governor switch inoperative. This provides sufficient time for the engine speed to accommodate itself to the new gear ratio before the governor switch becomes operative again. When the next upward change to fourth speed takes place, the ratchet switch contact strip 25 interrupts the circuit of the third speed relay coil 41 and the ratchet switch contact strip 27 occupies a position bridging the contacts 53 and 54, thereby closing a circuit from the positive side of the battery through the change-up relay contacts 7 and 5, the line 136, the back contacts 13 and 14 of the change-down relay, the contacts 53 and 54 previously mentioned, the fourth speed magnet 55, and thence to the battery negative. In the fourth speed position of the ratchet switch the contact strip 24 interrupts the circuit of the change-up relay winding 4 and no further change in the upward direction of the switch can take place.

It is to be noted that the main purpose of the

magnet relays 39, 40, 41 is to provide a slight overlapping of the magnet operations when changing-up as distinct from changing-down. For this reason the fourth speed magnet is not provided with a relay since no higher speed is provided. If the relays are needed to relieve the ratchet switch of heavy current, then a simple relay without an induction sleeve could be provided for the fourth speed magnet, its contacts replacing the existing contacts 53, 54 of the ratchet switch and its winding being connected between the ratchet switch arm contact corresponding to contact 33 but in fourth speed position, and the battery negative.

It will be seen that the back contacts 45 and 49 of the first and second speed magnet relays are employed to provide a supply circuit from the line 137 through each relay to the next higher speed relay so that when changing-down, the incoming relay isolates the next higher speed relay so as to prevent its lag factor from being effective when changing-down. When changing-up, however, the incoming relay has an independent supply provided by the back contacts 13 and 14 on the change-down relay, as the outgoing relay remains closed for about half a second and is therefore unable immediately to supply the next higher speed relay through its back contacts.

The contact members 1, 2 and 3 which are moved in accordance with speed and fuel or throttle conditions to effect automatic gear changing may be arranged as described in British patent specification No. 457,269, but preferably the construction shown in Figures 5, 6 and 7 is employed. This comprises a casing 140 in which is rotatably supported a shaft 141 carrying a pulley 142 which is driven from the engine. The governor actuated member 143 is of generally V shape carrying a V-shaped spring 144 on which are mounted a pair of contact studs 145, and is mounted on a spindle 146 for angular motion. A second rotatable spindle 147 carries a pair of contoured contact plates 148 secured to an insulating base 149 and arranged between the aforesaid contact studs 145 which are in electrical connection. The spindle 147 has an arm 150 which can be actuated from the throttle control of the internal combustion prime mover, the arrangement being such that at different angular positions of the spindle 147, the contact surfaces of the contoured plates 148 are at different distances from the contact studs 145. The speed governor is of the centrifugal type and comprises the shaft 141 mounted in bearings 151. Two centrifugal weights 152 are connected by duplicate links 153 to a cross pin 154 extending through the shaft, the weights being shaped as rollers which lie one on each side of the shaft with their axes at right angles to the shaft axis. A collar 155 slidable on the shaft 141 carries two bearing members 156 which extend outwardly between the links 153 and are formed with bearing surfaces 157 preferably perpendicular to the shaft axis upon which the weights 152 can roll. The sliding collar 155 is loaded by a spring 158 which abuts against a second collar 159 fixed to the shaft. A cross pin 160 on the sliding collar 155 extends through a longitudinal slot in the shaft communicating with a bore 161 extending to one end thereof. Slidable longitudinally in the bore 161 is a rod 162, one end of which engages the cross pin 160 and the other end of which protrudes from the shaft and engages an arm 163 on the spindle 146 through a thrust ball 164. The arrangement is such that at a predetermined

speed of the shaft 141 the centrifugal weights 152 move outwards by rolling along the bearing surfaces 157 and thereby displace the sliding collar 155 against its spring loading. This movement displaces the rod 162 and moves the arm 163 of the V contact member 143 to bring one of the contact studs 145 into engagement with the adjacent contoured contact plate 148 and thereby operate the relay means for effecting a change to a higher gear ratio. When the speed falls to a sufficient extent the sliding collar 155 returns, permitting the V member 143 to move in the opposite direction under the action of a suitable return spring 163a so that contact is made with the other contoured plate and thereby causes a gear changing operation to a lower ratio. It will be understood that the two contact plates 148 correspond to the plates 2 and 3 of Figure 1, and the V contact spring 144 and studs 145 correspond to the contact arm 1 of said figure.

A modified form of control circuit, which may be employed in place of the circuit of Figure 1 when desired, is shown in Figure 8. The modified circuit is generally the same as that previously described, but the magnet relays 39 and 40 for the first and second speed magnets 44 and 48 have no back contacts. In place of these, the ratchet switch arm has a contact strip 165 which makes contact with a continuous fixed contact 166 connected to the change-down relay contact 12a, and with fixed contacts 167, 168 which occupy the second and third speed positions of the arm respectively and are connected directly to the second and third speed magnets 48 and 52, thereby providing a direct supply for the latter. The supply to the contacts 46 and 50 of these second and third speed magnet relays during a changing-down operation is interrupted by the back contact 169 on the change-down relay 8. Also during such operation, a supply is provided to the ratchet switch contact strip 165 through the contacts 9 and 12a on the change-down relay. Thus owing to the fact that the valve actuating magnets 48 and 52 are directly energised without the intervention of their respective relays when changing from a higher to a lower gear, there will be no lag or overlapping of these operations. The relay coils are provided with induction sleeves as in the previous example which afford a lag of about half a second in the operation of the relays, and this is effective when changing from a lower to a higher gear since the magnets are energised through the operation of their respective relays, and hence the desired operational overlapping is obtained.

The modified circuit also has no economising resistance 65 as in the arrangement of Figure 1, and hence additional short-circuiting contacts on the change-up and change-down relays are not required, thereby simplifying the circuit.

It will be seen that when using control means as described above with the selection switch set for automatic operation, an increase in engine speed to a predetermined value causes closing of the governor actuated switch and operation of the automatic selection switch to engage the next higher gear. The introduction of the higher gear reduces the speed of the engine temporarily and causes the governor actuated contacts to open. Converse operations take place when the engine speed falls and the gear ratios are progressively changed-down. If the arrangement is fitted to a vehicle having an automatic clutch or fluid flywheel, the vehicle may be brought to rest by applying the road wheel brakes and the engine

can continue to operate at idling speed although the low gear is engaged.

The invention provides a convenient and effective means enabling manual control of the gear changing operations to be substituted for automatic control when desired, as for example for the purpose of maintaining a low gear in engagement when the vehicle is descending a hill. The invention is not restricted to the example described, since different numbers of gears may be arranged to be controlled by both automatic and manual means. Also the actuation of the gear engaging means may be effected in various ways, for example directly by electro-magnetic means. Further, the invention is not restricted to automatic control dependent upon speed and fuel supply or throttle conditions. Thus instead of the governor actuated switch, a pair of push button switches may be provided for example, one controlling a change-up relay and the other a change-down relay or equivalent means, the remainder of the control arrangements being similar to those previously described.

What I claim is:

1. Change speed gearing having electrical control means comprising, in combination, two first circuits controlled by contact making members, means adapted to be controlled by a speed sensitive device driven from the input side of the speed gearing for actuating said contact making members to control said circuits alternatively, stepwise actuatable means controlled by one of said first circuits for effecting engagement of a next higher gear when actuated and controlled by the other of said first circuits for effecting engagement of a next lower gear when actuated, a manually operable selection switch means controlling said first circuits and having a plurality of positions, further circuits controlled by said selection switch means, and electrical means for controlling engagement of different gear ratios in said further circuits, whereby gear changing is effected either automatically or by manual selection according to the position of said selection switch means.

2. Change speed gearing according to claim 1, in which the contact making members comprise two elements movable relatively in two non-parallel directions, movement in one direction being controlled by the speed sensitive device, and movement in the other direction being controlled by means responsive to the regulation of the fuel supply to the prime mover.

3. Change speed gearing according to claim 1, in which the stepwise actuatable means are arranged to actuate a switch mechanism alternatively in opposite directions for controlling different circuits for effecting engagement of different gear ratios.

4. Change speed gearing according to claim 1, comprising relays in said first circuits, and a selection switch operable alternatively in opposite directions by the stepwise actuatable means to close circuits for actuating the different gear ratio engagement means.

5. Change speed gearing according to claim 1, comprising relays in said first circuits, a selection switch operable alternatively in opposite directions by the stepwise actuatable means to close circuits for actuating the different gear ratio engagement means, and time relay means such as shunt connected condensers combined with the relays to prevent successive operation thereof within a predetermined period.

6. Change speed gearing according to claim 1, comprising electro-magnetic devices for controlling engagement of the selected gear.

7. Change speed gearing according to claim 1, comprising electro-magnetic devices for controlling engagement of the selected gears, and electrical relays controlling at least some of said devices.

8. Change speed gearing according to claim 1, comprising electro-magnetic devices for controlling engagement of the selected gears, electrical relays controlling at least some of said devices, and time delay means combined with said relays.

9. Change speed gearing according to claim 1, comprising electro-magnetic devices for controlling engagement of the selected gears, electrical relays controlling at least some of said devices, time delay means combined with said relays, and means for preventing said time delay means from being effective when changing from a higher to a lower gear.

10. Change speed gearing according to claim 1, comprising electro-magnetic devices for controlling engagement of the selected gears, electrical relays controlling at least some of said devices, time delay means combined with said relays, and contacts actuated by one of said relays in a circuit for isolating another relay corresponding to the next higher speed gear when the first said relay is energised, whereby the time delay of said second relay is rendered ineffective and there will be no overlapping of the different gear engagement periods when changing from a higher to a lower gear.

11. Change speed gearing according to claim 1, comprising electro-magnetic devices for controlling engagement of the selected gears, electrical relays controlling at least some of said devices, time delay means combined with said relays, an automatic selection switch operated by the stepwise actuatable means, relay means controlling said selection switch, and contacts actuated by said relay means for interrupting the supply of current to the relays controlling the said electro-magnetic devices.

12. Change speed gearing according to claim 1, in which the manually operable switch means has contact means automatically engageable each time the switch is operated to change the gear ratio, and a circuit closable by said contact means is associated with an automatic selection switch whereby the positioning of said selection switch in an intermediate position is ensured and thereby inappropriate gear changes are obviated.

13. Change speed gearing according to claim 1, comprising a plurality of gear engaging electrical control devices, a current economising resistance in the circuits of said devices, and means actuated in response to each gear changing operation for short-circuiting said resistance.

14. Change speed gearing according to claim 1, comprising a plurality of gear engaging electrical control devices, a current economising resistance in the circuit of said devices, means for locking the operating handle of the manually operable selection switch means in each selected position, means actuated by unlocking motion of the handle for closing contact means, and circuit means including said contact means for short-circuiting said resistance when the handle is moved from one position to another.

15. Change speed gearing according to claim 1, comprising a plurality of gear engaging electrical control devices, a current economising resistance in the circuit of said devices, an operating handle

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for the manually operable selection switch means arranged for guided movement in a slot of gate form, means for locking said handle in each selected position, means actuated by unlocking motion of the handle for closing contact means, and circuit means including said contact means for short-circuiting said resistance when the handle is moved from one position to another.

16. Change speed gearing according to claim 1, comprising a plurality of gear engaging electrical control devices, a current economising resistance in the circuit of said devices, an operating handle for the manually operable selection switch means arranged for guided movement in a slot of gate form, contact arms associated with the handle and rotatable thereby, means for locking said handle in each selected position, a spring loaded button in said handle for releasing the locking means, means actuated by unlocking motion of the handle for closing contact means, and circuit means including said contact means for short-circuiting said resistance when the handle is moved from one position to another.

17. Change speed gearing according to claim 1, comprising a plurality of gear engaging electrical control devices, a current economising resistance in the circuit of said devices, an operating handle for the manually operable selection switch means arranged for guided movement in a slot of gate form, depressible contact arms associated with the handle and rotatable thereby, means for locking said handle in each selected position, a spring loaded button in said handle for releasing the locking means and arranged to depress said contact arms when the button is operated, and contacts adapted to be made by depression of said arms for short-circuiting the resistance, the latter being re-introduced when the button is released.

18. Change speed gearing according to claim 1, in which the contact making members are movable relatively in two directions, movement in one direction being controlled by the speed sensitive device, and movement in another direction being controlled by means responsive to the regulation fuel supply of the prime mover, one of said members comprising a pair of electrically connected

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contacts mounted in spaced relation for angular movement in unison, and the other of said members comprising a pair of contoured contact plates mounted for angular movement and arranged so that the spaced contacts will make contact with one or other of the plates when relative movement takes place.

19. Change speed gearing according to claim 1, in which the contact making members are movable relatively in two directions, movement in one direction being controlled by the speed sensitive device, and movement in another direction being controlled by means responsive to the regulation of the fuel supply of the prime mover, said contacts comprising a pair of spaced and electrically connected contacts mounted on a V-shaped member for angular movement in unison, said V-shaped member being operable from the speed governor, and a pair of contoured contact plates mounted for angular movement and arranged so that the spaced contacts will make contact with one or other of the plates when relative movement takes place.

20. Change speed gearing according to claim 1, comprising a speed sensitive device having arms carrying centrifugal weights which have rolling engagement with a bearing surface on or associated with a member movable along the axis of weight rotation against resilient loading, the said bearing surface being transverse to said axis so that the displacement of the member is approximately proportional to the change in speed.

21. Change speed gearing according to claim 1, in which the stepwise actuatable means comprise oppositely acting ratchet means combined with a ratchet wheel operating a selection switch.

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