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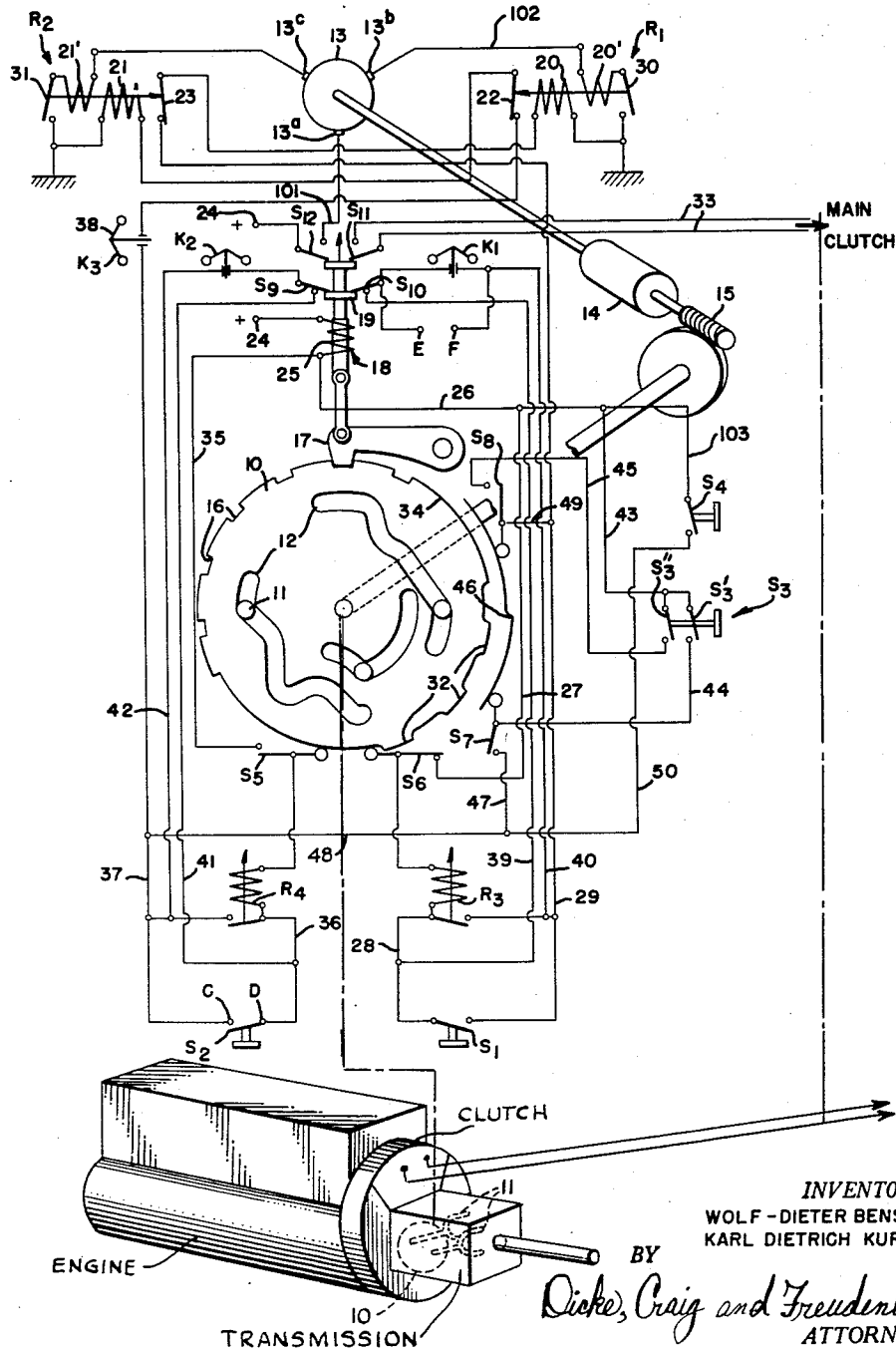
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ELECTRIC SHIFTING ARRANGEMENT FOR CHANGE SPEED TRANSMISSIONS

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2 Sheets-Sheet 1

Fig. 1.



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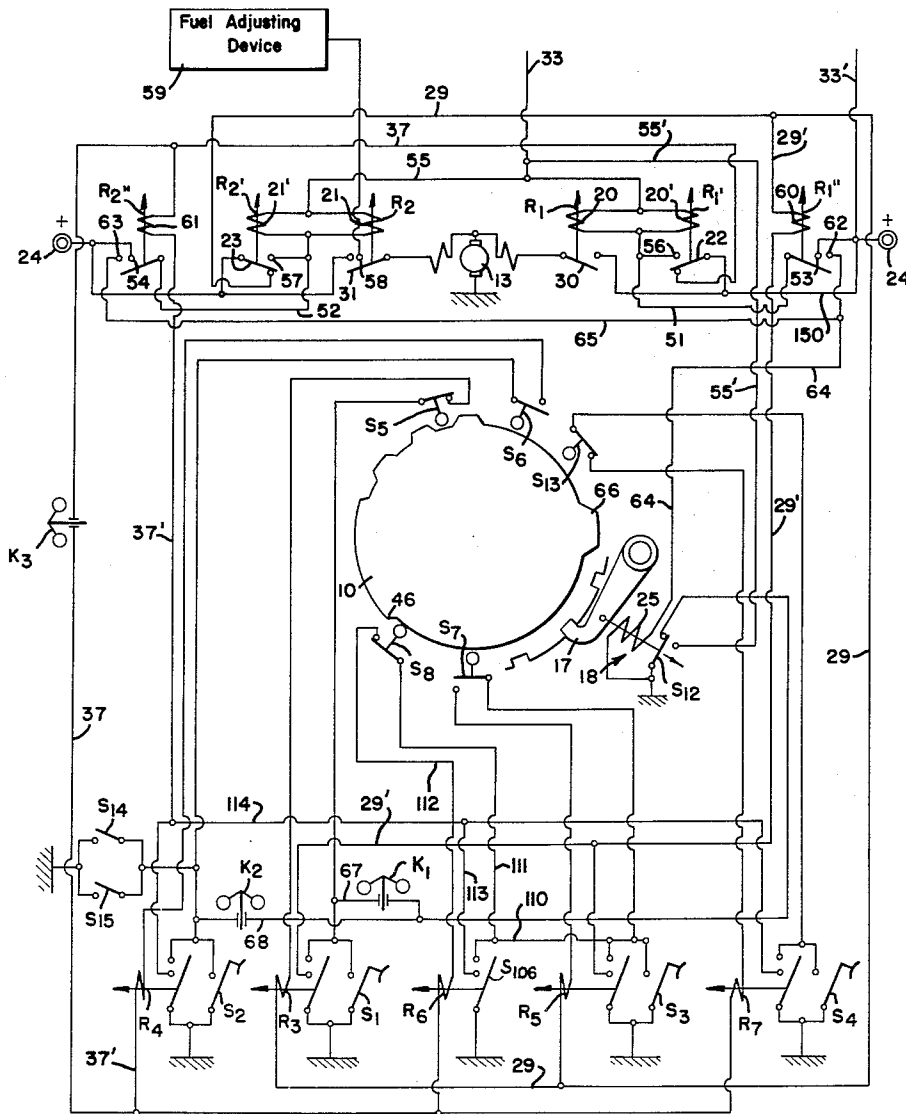
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2 Sheets-Sheet 2

FIG. 2.



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ELECTRIC SHIFTING ARRANGEMENT FOR CHANGE SPEED TRANSMISSIONS

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The present invention relates to an electric shifting arrangement for change speed transmissions, especially for motor vehicles, in which the shifting members, for example, the shifting forks are guided within the transmission in a rotatable guide disc member which is adapted to be selectively driven in either direction of rotation by an electric motor over a high speed reduction gear, for example, over a worm gear drive.

In a prior-art shifting arrangement of the type described hereinabove, the guide disc member is driven directly from an electric motor over a worm gear drive. The driving motor is thereby directly controlled by the shifting impulses in the actuating or engaging circuits thereof. A disengageable clutch is thereby arranged between the guide disc member and the worm gear drive of the prior art. However, this prior-art arrangement is disadvantageous because of the presence of transmission shocks which occur as a result of the inertia or mass of the driving motor. Furthermore, the exact positioning of the guide disc member in the individual shifting position after disengagement of the clutch is connected generally with difficulties.

The present invention aims at an elimination of the aforementioned disadvantages as well as at a simplification of the shifting arrangement. The problems connected therewith are solved in accordance with the present invention by providing the guide disc member along the periphery thereof with a number of notches or detents corresponding to the respective shifting positions for purposes of accurately positioning the same in the individual shifting positions thereof while a latch member adapted to be actuated by a lifting magnet energized with the aid of the shifting impulses is adapted to engage in these detents or notches, and by arranging a slip-clutch between the electric motor energized by the shifting impulses, on the one hand, and the guide disc member, on the other, for purposes of avoiding any shocks in the drive arrangement for the guide disc member.

According to one embodiment of the present invention, the energizing coil of the lifting magnet may be operatively interconnected into the control circuits for both shifting directions, while the lifting magnet is adapted to be controlled directly by the shifting impulses and the energizing circuit of the motor is adapted to be controlled indirectly by a switch or relay which is actuated by a switching device, preferably by a multi-pole switch member operatively connected with the lifting magnet.

According to another embodiment of the present invention, the energizing coil for the lifting magnet is arranged in parallel to the energizing circuit of the motor, and both circuits are adapted to be controlled indirectly by means of relays from the control circuits for both shifting directions whereby the energizing circuit of the motor is adapted to be switched indirectly by means of a relay over a switch coordinated to or operatively connected with the lifting magnet. This switch, in addition to controlling the energizing circuit of the motor, may also control simultaneously therewith in both

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embodiments according to the present invention the energizing circuit of an automatically actuated main clutch which is thereby controlled in the same sense, i.e., that upon energization of the lifting magnet the main clutch is also disengaged.

The construction in accordance with the present invention provides a simple shifting arrangement readily supervised and serviced and reliable in operation by means of which an accurate positioning of the guide disc member in the individual shifting positions thereof as well as a shock-free drive with sufficient shifting forces may be realized.

In the first embodiment of a shifting arrangement according to the present invention as mentioned hereinabove, a relay is arranged in the energizing circuit for the motor in each direction of rotation whereby each relay is controlled by the corresponding control circuit for the respective shifting direction. Each relay may be provided with two energizing coils and with two contacts of which one each opens upon energization while the other one closes upon energization. The last-mentioned contact and one winding or coil thereby serve for holding purposes of the relay whereas the other winding or coil is arranged in the control circuit for the same shifting direction and the first-mentioned contact as lock-out contact in the control circuit for the other shifting direction.

In the other embodiment according to the present invention, a further relay is connected in parallel with the relay provided for each direction of rotation in the energizing circuit of the motor which further relay is also controlled by the switch or contact at the lifting magnet. This further relay is operative over additional contacts as holding relay for the energizing circuit of the motor. Furthermore, it is simultaneously also effective with a construction as reversing switch as lock-out switch for the control circuit of the other shifting direction.

The shifting arrangement in accordance with the present invention may be constructed for manual actuation of the shifting impulses. In that case, an actuating switch, for example, in the form of a push button, is arranged in the control circuit for each shifting direction and a self-locking or self-holding relay provided with actuating means actuated by the guide disc itself is appropriately coordinated thereto in the holding circuit thereof.

An automatic actuation of the shifting impulse is also possible according to another feature in accordance with the present invention. For that purpose, a centrifugal governor is arranged on the transmission input shaft or is operatively connected therewith which is operative to control with a respective shifting switch or contact each a control circuit, possibly arranged in parallel to the manually actuated control circuit, for achieving an automatic shifting operation in the upward and downward direction. A further shifting contact arranged at the centrifugal governor opens up all control circuits for the downward shifting operation as soon as the centrifugal governor attains a predetermined rotational speed which lies below the maximum rotational engine speed by a factor corresponding to the step or change in the transmission ratio between the prevailing and next lower speed. This prevents an excessive rotational speed of the engine by preventing the engagement of too low a speed of the change-speed transmission.

In order to prevent faulty shifting operations, different shifting positions, for example, the reverse speed and the neutral speed, are adapted to be engaged only by means of special manually-actuated switches or engaging means, whereby holding relays which are possibly provided with special actuating or engaging means automatically actuated by the guide disc member in the respective shifting

positions are operatively connected with these actuating or engaging switches in the holding circuits thereof.

Accordingly, it is an object of the present invention to provide a shifting arrangement for change speed transmissions which obviates the disadvantages previously encountered with similar prior art shifting arrangements.

Another object of the present invention resides in the provision of a shifting arrangement which is electrically controlled by a guide disc member selectively controlling the shifting members such as shifting forks of the change speed transmission to engage the respective individual speeds thereof and which obviates the need for an accurate positioning of the guide disc member in the various corresponding shifting positions thereof.

Still another object of the present invention lies in the provision of a shifting arrangement for change speed transmissions of the type mentioned hereinabove which is simple in construction and reliable in operation and which minimizes shifting shocks during shifting operations of the transmission.

Another object of the present invention is the provision of an electrically controlled shifting arrangement for change speed transmissions which assures freedom from faulty operation while providing at the same time adequate forces to effect reliably the shifting operations necessary for proper functioning of the control system.

Still another object of the present invention is the provision of a shifting arrangement for change speed transmissions, especially motor vehicles, which is adapted to be manually as well as automatically operated.

These and other objects, features and advantages will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, two embodiments in accordance with the present invention, and wherein:

Figure 1 is a schematic diagram of a shifting arrangement for a change speed transmission in accordance with the present invention, and

Figure 2 is a schematic diagram of another embodiment of a shifting arrangement for a change speed transmission in accordance with the present invention.

The present invention is particularly applicable to a change speed transmission for a motor vehicle which also includes an automatically actuated main clutch. The various elements and circuits necessary for a complete understanding of the shifting arrangement in accordance with the present invention are shown more or less schematically in the two figures, while the actual change speed transmission with its shifting members and the main clutch of the vehicle are not shown herein since they may be of any conventional known construction which forms no part of the present invention.

Referring now to the drawing wherein like reference numerals are used throughout the two views to designate corresponding parts, the various speeds of the change speed transmission, indicated schematically, are shifted by means of a guide disc 10 which is provided with special guide means 12, for example, in the form of slots or the like for the shifting forks 11 serving as shifting members of the transmission. The guide disc 10 is adapted to be rotated in both directions of rotation thereof, the clockwise direction of rotation thereof corresponding, for example, to an upward shifting operation and the counterclockwise direction of rotation to the downward shifting operation. The guide disc 10 is driven from an electric motor 13 which is operatively connected with the guide disc 10 over a speed reduction gear providing a large speed reduction, for example, over a worm gear drive 15 and a slip clutch 14 adapted to provide a slippage under predetermined conditions. The slip clutch 14 is thereby used so as to permit the motor 13 to continue to rotate or run out for a relatively short period of time, for example, even after de-energization of the motor 13, necessitated by reason of the inertia of

the motor 13 making it impossible to stop the same instantaneously without transmitting thereby any shocks to the worm gear drive 15 and therewith to the guide disc member 10. The construction thereof in practice may also be made in such a manner that the guide disc 10 itself forms the worm gear wheel and accommodates or forms all of the other control cams or the like, as will be described more fully hereinafter.

Detents or notches 16 are provided along the periphery of the guide disc member 10 of which the number corresponds to the number of the shifting positions, i.e., for instance in the illustrated four-speed change speed transmission, a total of six notches 16. A latch member 17 is adapted to engage into the notches 16 under the influence of a spring or by gravitational force which is adapted to be lifted out of the notches 16 by a lifting magnet generally designated by reference numeral 18. A switching device 19 is connected with the armature of the lifting magnet 18 to which four switches S_9 , S_{10} , S_{11} and S_{12} are coordinated. The switch S_{12} is thereby arranged in the energizing circuit 101 of the motor 13 leading from the positive terminal 24 of the power supply, such as the battery over switch S_{12} to a terminal 13a of the motor 13 so that the latter is energized only directly upon energization of energizing coil 25 of the lifting magnet 18. One control circuit each to be described more fully hereinafter is provided for the upward and downward shifting operations respectively, and the energizing coil 25 of the lifting magnet 18 is operatively interconnected in both of these control circuits, as will appear more fully from the ensuing description.

A switch S_1 is provided in the control circuit for the upward shifting operation and a switch S_2 in the control circuit for the downward shifting operation for purposes of manual actuation thereof. Self-locking or holding relays R_3 and R_4 provided with separate engaging or actuating switches S_6 and S_5 , respectively, actuated by the guide disc member 10 provided with appropriate cams are operatively connected with or coordinated to the switches S_1 and S_2 in the holding circuits thereof.

The selection of the direction of rotation of the motor 13 corresponding to the desired shifting direction also has to take place by the control circuits. For that purpose, two relays R_1 and R_2 are operatively connected with or coordinated to the windings (not shown) of motor 13. Each relay R_1 and R_2 is provided with two energizing windings 20, 20' and 21, 21', respectively, and two switch members 30, 22 and 31, 23, respectively, of which one switch member each opens upon energization of the corresponding relay whereas the other one closes upon energization thereof. The coil 20 of the relay R_1 is arranged in the control circuit for the upward shifting operation and the coil 21 of the relay R_2 in the control circuit for the downward shifting operation. The other coils 20' and 21' are arranged as holding windings in series with the corresponding switches 30 and 31 operative to close upon energization so that the respective relay is automatically kept energized as soon as the motor 13 is supplied with current flowing through the corresponding winding. The switches 22 and 23 which open upon energization are operatively connected as lock-out switches in the control circuit for the other shifting direction respectively.

Manual operation

In the position of the various parts illustrated in Figure 1, the transmission is in the neutral position thereof. If now, for example, for purposes of shifting in the upward direction into the first speed, the push-button switch S_1 is actuated, then a control circuit is closed from the positive terminal 24 of the battery over energizing coil 25 of the lifting magnet 18, lines 26 and 27, the closed disengaging switch S_6 , the holding relay R_3 , line 28, the switch S_1 which is now closed, line 29, closed lock-out contact 23 at the relay R_2 and the energizing winding

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20 of relay R_1 to ground with which the negative terminal of the battery (not shown) is connected. As a result thereof, lifting magnet 18 and the relay R_1 now are both energized and thereby attract the armature members thereof whereby the energizing circuit for the motor 13 is closed over switches S_{12} , line 101, motor terminals 13a and 13b, line 102 and contact 30 now closed to provide a direction of rotation of the motor 13 corresponding to the upward shifting operation of the system. At the same time, the lifting magnet 18 thereby lifts the latch member 17 and the motor 13 rotates the guide disc 10 in a clockwise direction into the position thereof corresponding to the next speed.

During actuation of the push-button S_1 , the holding relay R_3 has also been energized as a result of the closure of series circuit described hereinabove. Consequently, control current is also permitted to flow through the circuit from the disengaging switch S_6 over relay R_3 directly to line 29 thereby effectively forming a circuit in parallel with push button S_1 so that the switch S_1 may again be released without interrupting the continued flow of control current in the control circuit described hereinabove. This means in effect that the switch S_1 has to be actuated only for a short period of time in order to initiate the upward shifting operation and thereby shift the transmission to the next higher speed. De-energization of the control circuit described hereinabove takes place only when the disengaging switch S_6 is opened by one of the cams 32 provided on the guide disc member 10 whereby opening of switch S_6 causes de-energization of relay R_3 . As a result thereof, the energizing coil 25 of the lifting magnet 18 is also de-energized. However, the armature thereof may return into the initial position thereof when the next notch or detent 16 of disc member 10 is positioned accurately below the latch member 17 whereupon the latter may return into the lowered position thereof illustrated in Figure 1. Return of the latch member 17 to the lower position thereof causes opening of switch S_{12} whereupon the motor 13 is again disconnected from the power supply and comes shortly thereafter to a stop. However, the cam portions 32 on disc member 10 are so located that the disengaging switch S_6 has already moved off the corresponding cam member 32 again when the notch 16 is accurately positioned underneath the latch member 17 to permit the latter to assume its lower position and is thereby again placed into readiness for the next upward shifting operation.

The switch S_{11} is actuated by the switching member 19 during each actuation of the lifting magnet 18 in the same sense as the motor switch S_{12} whereby switch S_{11} closes a circuit for actuating the automatically controlled main clutch of the vehicle over lines 33. In this manner, a disengagement of the main clutch during each transmission shifting operation is achieved.

The upward shifting operation into second speed takes place in an analogous manner. If the switch S_1 is pushed in for a longer period of time, then a shifting operation through several speeds, for example, from first into third speed may be achieved. The upward shifting operation takes place only up to the highest speed of the transmission, in the instant case up to fourth speed thereof. In this fourth-speed position, the relatively wider cam portion 34 provided at the guide disc member 10 keeps the disengaging switch S_6 in the open position thereof so that the lifting magnet 18 can no longer be actuated over the control circuit of the upward shifting operation as described hereinabove even if the push button S_1 is depressed.

The manual downward shifting operation takes place in a corresponding manner over switch or push button S_2 , however, only from the second to fourth speed thereof as only in these speeds the normally open disengaging switch S_5 is closed by one of the cam portions 32.

If the push-button S_2 is actuated in any one of second

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to fourth speeds, then current flows from the positive terminal 24 over the energizing coil 25 of the lifting magnet 18, the line 35, the disengaging switch S_5 which is now closed to the holding relay R_4 and from holding relay R_4 over line 36 to the switch S_2 which has now been closed. The control current flows from switch S_2 over line 37, contact 22 to the energizing winding 21 of the motor relay R_2 and then to ground. The motor relay R_2 as well as lifting magnet 18 thereby attract the respective armatures thereof and motor 13 thereby rotates the guide disc 10 in the counterclockwise direction into a position for the next lower speed. The disengagement of the motor 13 as well as the readying of the control circuit for the next shifting operation takes place in an analogous manner as in the upward shifting operation by cams 32 cooperating with the disengaging switch S_5 .

Automatic shifting operation

An automatic shifting operation controlled by the centrifugal governor 38 is coordinated to the manual shifting arrangement in accordance with the present invention described hereinbefore. The centrifugal governor 38 is operatively connected with the transmission input shaft and is provided with three shifting contacts K_1 , K_2 and K_3 . The shifting contact K_1 is arranged in a control circuit for the automatic upward shifting operation and is disposed in parallel with the switch S_1 . The centrifugal governor 38 thereby closes the contact K_1 above a predetermined rotational speed of, for example, 5500 r.p.m. In that case, the control current flows in a manner described hereinabove from positive terminal 24 through the energizing coil 25 of the lifting magnet 18, lines 26 and 27 into the line 28 and from there over line 39, the normally closed switch S_{10} and contact K_1 at the centrifugal governor 38 which has now been automatically closed into line 40 which is operatively connected with the line 29. As a result thereof, the automatic control circuit for the upward shifting operation is closed and lifting magnet 18 is energized and thereby causes the upward shifting operation in the manner described hereinabove. During energization of the shifting magnet 18, the normally closed switch S_{10} in the automatic control circuit is opened so that the disengagement after completion of the change in the engaged speed takes place in the manner already described hereinabove by relay R_3 in connection with the disengaging switch S_6 .

An automatic control circuit for the downward shifting operation is closed, for example, at a rotational speed below 1500 r.p.m. by the contact K_2 also arranged at the centrifugal governor 38. This last-mentioned control circuit is arranged in a circuit including line 41 connected to line 36, normally closed switch S_9 , shifting switch K_2 and line 42 connected to line 37, which is in parallel with the downward shifting switch S_2 and is operative in a similar manner. If, for example, in fourth speed, the rotational speed of the transmission input shaft falls below 1500 r.p.m. by reason of an incline, then the contact K_2 closes and control current is now permitted to flow through the energizing coil 25 of the lifting magnet 18, line 35, disengaging switch S_5 , holding relay R_4 into the line 36. From line 36, the control circuit flows over line 41 and switch S_9 , shifting switch or contact K_2 , now closed and line 42 into the line 37. As a result thereof, the control circuit for the downward shifting operation is closed so that the downward shifting operation can take place in the manner described hereinabove. Upon energization of the lifting magnet 18, the switch S_9 is opened by the shifting member 19 thereof and the automatic control circuit for the downward shifting operation is again interrupted so that after completing the change into the next speed, the disengagement of the downward shifting operation may take place again over switch S_5 and relay R_4 as described hereinabove.

A further shifting switch or contact K_3 which is inter-

connected into line 37 is also operatively connected with the centrifugal governor 38. The contact K_3 is normally closed and disconnects or opens up all control circuits for the downward shifting operation as soon as the centrifugal governor 38 attains a rotational speed which lies below the maximum engine speed by a factor corresponding to the change in adjacent transmission ratios. In that case, i.e., as contact K_3 opens, no downward shifting operation is any longer possible. This serves the purpose to prevent an excessive rotational speed of the engine over and above its maximum engine speed by a downward shifting operation into a speed of the change speed transmission which is too low.

In order to achieve certain shifting positions, separate switches are provided which are adapted to be actuated exclusively manually. For example, for purposes of engaging neutral position of the change speed transmission, a special switch S_3 is provided. The switch S_3 which is provided with two contacts S_3' and S_3'' is connected in a circuit which includes the line 26 and a line 43 connecting line 26 with both contacts S_3' and S_3'' . The switch S_3 is operative in connection with both control circuits whereby a respective control is locked depending on the shifting position. Lines 44 and 45 lead from contacts S_3' and S_3'' respectively to the locking switches S_7 and S_8 which abut against the circumference of the guide disc 10 and to which a separate cam portion 46 is coordinated. In the neutral position of the shifting arrangement illustrated in Figure 1, both normally closed locking switches S_7 and S_8 are opened. If one of the forward speeds is engaged, then switch S_7 moves off cam portion 46 and is thereby closed by reason of a corresponding position of the cam portion 46 which in the neutral position had kept the switch S_7 open so that with an actuation of the neutral switch S_3 only the control and energizing circuit for the downward shifting operation over lines 26 and 43, contact S_3' , line 44, switch S_7 and lines 47 and 48 is closed and the transmission is shifted downwardly into neutral. If, in contradistinction thereto, the transmission is engaged in the reverse speed thereof, then the switch S_8 moves off cam portion 46 and is thereby closed, whereas the switch S_7 remains open. In that case, only the energizing control circuit for the upward shifting operation can be closed over lines 26 and 43, contact S_3'' , line 45, switch S_8 and line 49 connected with line 29 so that only an upward shifting operation into neutral position can take place within the transmission.

For purposes of engaging the reverse speed, a separate switch S_4 is provided. The switch S_4 is also operatively connected with the line 26 over line 103. However, since in that case the downward shifting operation into reverse speed has to take place at all times, a cooperation with the switches S_7 and S_8 is not necessary. Consequently, switch S_4 is operatively connected directly over lines 103, 50 and 48 with the line 37 for the downward shifting operation.

Holding relays may be coordinated to the switches S_3 and S_4 in a manner similar to switches S_1 and S_2 and relays R_3 and R_4 so that with either of these two last-mentioned switches S_3 or S_4 only a relatively short depression of the respective switches is necessary in order to shift the transmission from a prevailing speed into the desired speed.

Such an arrangement is illustrated in the embodiment according to Figure 2. This embodiment is basically the same as that of Figure 1; however, all relays are arranged in this embodiment in parallel circuits so that any mutual influence or interference between relays is avoided. Furthermore, the control of the energizing current for the motor 13 and the lifting magnet 18 is also improved thereby.

The energizing circuit of the motor 13 is again controlled, corresponding to the desired direction of rotation, by two relays R_1 and R_2 provided with the switches or contacts 30 and 31 which close upon energization of

the respective relays. The energizing coils 20 and 21 of these relays R_1 and R_2 are connected with the positive terminal 24 of the battery, on the one hand, by parallel circuits including contact 53 of control relay R_1' and line 51 and contact 54 of control relay R_2' and line 52, and line 55 and, on the other, are both connected with the grounded negative battery terminal over line 55' and the automatically actuated switch S_{12} controlled by the lifting magnet 18. The lines 33 and 33' for the actuation of the main clutch also branch off from line 55 and the positive battery terminal 24. The contact 31 of the relay R_2 which determines the downward shifting operation, controls simultaneously over an additional contact 58 a member 59 schematically illustrated and of conventional construction for influencing a reduction in the amount of fuel supplied, for example, by making suitable adjustments in the fuel supply as determined normally by the gas pedal, throttle valve or adjusting rack of a fuel injection pump.

Relays R_1' and R_2' are coordinated to relays R_1 and R_2 as holding relays the energizing coils 20' and 21' of which are arranged in parallel with the windings 20 and 21 of relays R_1 and R_2 . The relays R_1' and R_2' are operative simultaneously with the contacts 22 and 23 thereof which open upon energization as lock-out switches for the other shifting direction. Additional contacts 56 and 57 are provided as holding contacts. Lines 29 and 37 for the control circuits of the upward and downward shifting operations are lead over the lock-out contacts 22 and 23 in the manner already described hereinabove in connection with Figure 1.

The energizing coils 60 and 61 of the control relays R_1'' and R_2'' are arranged over lines 29' and 37' in parallel with respect to the control lines 29 and 37 respectively. One or the other of lines 29' and 37' are closed and therewith supplied with current upon energization of any one of the relays R_3 to R_7 . The control relays R_1'' and R_2'' control over the contacts 62 and 63 thereof and over lines 64 and 65 the energizing coil 25 of the lifting magnet 18 as well as simultaneously therewith over contacts 53 and 54 the motor relays R_1 and R_2 as well as the holding relays R_1' and R_2' respectively.

Holding relays R_3 to R_7 are coordinated to all the switches S_1 to S_4 with the disengaging or locking switches S_5 to S_8 and S_{13} arranged in the holding circuits thereof. Two relays R_5 and R_6 with locking switches S_7 and S_8 are associated with neutral switch S_3 because neutral switch S_3 has to be able to initiate control impulses in one or the other shifting directions depending on the shifting position. All switches S_1 to S_4 , on the one hand, are connected to ground. On the other hand, switches S_1 and S_3 are connected over the engaging or locking switches S_5 and S_7 and the energizing windings of the corresponding relays R_3 and R_5 with the control line 29 for the upward shifting operation. The other switches S_2 and S_4 as well as the relay R_6 belonging to switch S_3 are connected in a corresponding manner with the line 37 for the downward shifting operation which may again be interrupted by the contact K_3 at the centrifugal governor 38. The switch S_4 for the reverse speed is coordinated to the disconnecting switch S_{13} which is actuated by the cam portions 66 at the guide disk member 10.

The contacts K_1 and K_2 at the centrifugal governor 38 control the automatically controlled control circuits 67 and 68 which are arranged in parallel circuits with respect to the switches S_1 and S_2 . The control circuits 67 and 68 are both operatively connected with the contact S_{12} at the lifting magnet 18 so that the switches S_{10} and S_{11} of the embodiment in Figure 1 may be dispensed with in this embodiment.

Furthermore, according to another feature of the present invention, it would be feasible to provide also an automatic downward shifting operation upon actuation of the brake, for example, by depressing the foot pedal. For that purpose, the downward shifting switch S_2 could

be bypassed by a further contact S_{14} which is arranged at the brake pedal and which is closed when the brake is actuated. Suitable devices may thereby be incorporated into the linkage between the brake actuating device and contact 14 so that the latter is closed only when the brake is engaged by a predetermined amount and/or in excess of a predetermined rate. A similar contact S_{15} may also be coordinated to the gas pedal as a so-called kick-down shifting switch in order to achieve a greater acceleration by shifting to a lower speed when the gas pedal is kicked down. Contact S_{15} is thereby also connected in parallel with the downward shifting switch S_2 .

Operation

The operation of the embodiment of Figure 2 corresponds to that of Figure 1. The transmission is, for example, in the first speed thereof and, the neutral switch S_3 is pushed down for a short period of time. Since in this first-speed position, the switch S_7 is open, whereas switch S_8 is closed, the relay R_6 is energized over lines 110, 111, 112, 37 and 22 and thereby attracts its armature. Energization of relay R_6 closes the switch S_{106} coordinated thereto and thereby closes the holding circuit for the relay R_6 over line 113 and the circuit containing lines 113 and 114, line 37', the energizing coil 61, line 37, contact 22 of relay R_1' and line 150 leading to the positive terminal 24 so that the control relay R_2'' is energized. As a result thereof, the lifting magnet 18 is supplied with current from terminal 24 over contacts 54 and 63, line 65, line 64 and switch S_{12} whereupon the latching member 17 is lifted out of recess 16 and the switch S_{12} is reversed. By the reversal of the switch S_{12} , the energizing circuit for both relays R_2 and R_2' are closed over the circuit including lines 55' and 55, windings 21 and 21', line 52 and contact 54 whereupon these relays R_2 and R_2' are closed and attracted their respective armatures. As a result thereof, the motor 13 is energized for a downward shifting operation and the lock-out switch 23 for the upward shifting operation is opened. The motor 13, therefore, rotates the guide disc 10 into the neutral position thereof.

As soon as the neutral position is attained, the lock-out switch S_8 is opened by the cam portion 46 and the relay R_6 is thereupon de-energized. As a result thereof, the relay R_2'' is also de-energized whereupon energization of the lifting magnet 18 is also discontinued. The relays R_2 and R_2' however, remain energized over the holding circuit including contact 57 and switch 23 so that the motor continues to run for such length of time until the latch member 17 is permitted to engage in the notch or detent 16 corresponding to neutral position. Only then, upon reversal of switch S_{12} , relays R_2 and R_2' are also de-energized and therewith the motor 13 is de-energized.

Otherwise, the shifting operations to the higher and lower speeds as well as to the reverse speed takes place in the same manner as in connection with Figure 1.

While we have shown and described two embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of many changes and modifications within the spirit and scope of the present invention, and we, therefore, do not wish to be limited to the embodiments described and illustrated herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

We claim:

1. An electric shifting arrangement for change-speed transmissions, especially for motor vehicles, comprising shifting means for the change-speed transmission, rotatable guide means within said transmission for guiding said shifting means, electric drive means including an electric motor in series with speed reduction gear means for driving said guide means from said electric motor in either direction of rotation thereof, control means for producing electric shifting impulses, said guide means

being provided along the periphery thereof with a number of notches corresponding to the individual shifting positions, engageable means adapted to engage in a notch when properly positioned therebelow, and actuating means for selectively actuating said engageable means in the engagement and disengagement thereof in dependence on said shifting impulses.

2. An electric shifting arrangement for change-speed transmissions according to claim 1, wherein said control means includes means for selectively producing said shifting impulses.

3. An electric shifting arrangement for change-speed transmissions according to claim 1, wherein said control means includes means for automatically producing said shifting impulses in dependence on the rotational speed of the engine.

4. An electric shifting arrangement for change-speed transmissions, especially for motor vehicles, comprising shifting means, rotatable guide means within said transmission for guiding said shifting means, electric drive means including speed reduction gear means and slip clutch means for driving said guide means from said electric drive means in either direction of rotation thereof, control means for producing electric shifting impulses, said guide means being provided along the periphery thereof with a number of notches corresponding to the individual shifting positions, engageable means adapted to engage in a notch when properly positioned therebelow, and actuating means for selectively actuating said engageable means in the engagement and disengagement thereof in dependence on said shifting impulses.

5. An electric shifting arrangement for change-speed transmissions according to claim 4, wherein said control means includes means for selectively producing said shifting impulses and means for automatically producing said impulses in dependence on the rotational speed of the driving engine of the vehicle.

6. An electric shifting arrangement for change-speed transmissions, especially for motor vehicles, comprising shifting means, rotatable guide disk means within said transmission for guiding said shifting means, electric drive means including an electric motor operatively connected with speed reduction gear means and slip clutch means for driving said guide disk means from said electric motor in either direction of rotation thereof, means for producing electric shifting impulses, said guide disk means being provided along the periphery thereof with a number of notches corresponding to the individual shifting positions, latch means adapted to engage in a notch when properly positioned therebelow, and electromagnet means for selectively actuating said latch means in the engagement and disengagement thereof in dependence on said shifting impulses.

7. An electric shifting arrangement for change-speed transmissions according to claim 6, wherein said control means includes a control circuit for an upward shifting operation and a control circuit for a downward shifting operation of said transmission, energizing circuits for said electric drive means to produce rotation in either direction, one of said energizing circuits corresponding to the control circuit for the upward shifting operation and another energizing circuit corresponding to the control circuit for the downward shifting operation, said electromagnetic means including an energizing winding and an energizing circuit for said winding, and means connecting the energizing circuit for said winding in the control circuits for both shifting directions and for operatively connecting the energizing circuits with said control circuits to control said electromagnetic means directly by said shifting impulses and for controlling said energizing circuits indirectly by said shifting impulses.

8. An electric shifting arrangement for change-speed transmissions according to claim 7, wherein said connecting means includes switch means indirectly controlling the energizing circuits by said shifting impulses, and fur-

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ther switch means operatively connected with said electromagnetic means for actuating said first-mentioned switch means.

9. An electric shifting arrangement for change-speed transmissions according to claim 6, wherein said control means includes control circuits for each direction of shifting operation and energizing circuits for said electric drive means to cause rotation of said electric drive means in a direction corresponding to the respective shifting direction, and means including relay means in each of said energizing circuits and operatively interconnecting said circuits with each other for controlling a respective relay means directly by the corresponding control circuit.

10. An electric shifting arrangement for change-speed transmissions according to claim 9, wherein each relay means is provided with two energizing windings and two contacts, one contact each opening upon energization and the other closing upon energization of a respective winding.

11. An electric shifting arrangement for change-speed transmissions according to claim 10, further comprising holding circuit means including one of said energizing windings and one of said contacts while each of the other energizing windings for the same shifting direction and the other contact thereof are operatively connected in the control circuit of the other shifting direction and forming lock-out switch means.

12. An electric shifting arrangement for change-speed transmissions according to claim 6, wherein said electric drive means includes energizing circuit means, wherein said control means includes control circuits operatively connected with relay means, and wherein said electromagnetic means includes an energizing winding arranged in parallel to the energizing circuit means for said electric drive means and is operative to be controlled by said relay means for both shifting directions, switch means operatively connected with said electromagnet means, and means including said relay means for indirectly controlling said energizing circuit means for said electric drive means over said switch means by said relay means.

13. An electric shifting arrangement for change-speed transmissions according to claim 12, wherein said relay means include one relay each for each shifting direction operatively connected with a corresponding energizing circuit means of said electric drive means, and a further relay operatively connected in parallel with each of said first-mentioned relays, said further relays being also controlled by said switch means operatively connected with said electromagnet means, each of said further relays including contact means operatively connected with said control means to serve as holding relay for the respective energizing circuit means of said electric drive means and as lock-out switch for the other shifting direction.

14. An electric shifting arrangement for change-speed transmissions, especially for motor vehicles having a main clutch, comprising shifting means, rotatable guide means within said transmission for guiding said shifting means, electric drive means including speed reduction gear means and slip clutch means for driving said guide means from said electric motor in either direction of rotation thereof, means for producing electric shifting impulses, said guide means being provided along the periphery thereof with a number of notches corresponding to the individual shifting positions, engageable means adapted to engage in a notch when properly positioned therebelow, electromagnet means for selectively controlling the engagement and disengagement of said engageable means by said shifting impulses, switch means operatively connected with said electromagnetic means to be actuated thereby, and means operatively connecting said switch means with said main clutch to disengage the main clutch upon energization of said electromagnetic means.

15. An electric shifting arrangement for change-speed transmissions according to claim 2, wherein said control means includes manually operated actuating means for in-

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itiating a shifting operation in either shifting direction, holding relay means operatively connected in parallel with a respective manual actuating means including a holding circuit, and automatically actuated disengaging means in said holding circuit adapted to be operated by said guide disk means.

16. An electric shifting arrangement for change-speed transmissions adapted to be shifted in an upward and downward direction, especially for motor vehicles, comprising transmission shifting means, rotatable guide disk means within said transmission for guiding said shifting means, electric drive means including an electric motor drivingly connected with speed reduction gear means and slip clutch means for driving said guide disk means from said electric motor in either direction of rotation thereof, circuit means for producing electric shifting impulses including control circuit means for each shifting direction, said guide means being provided along the periphery thereof with a number of notches corresponding to the individual shifting positions, electromagnetically engageable means adapted to engage in a notch when properly positioned therebelow, motor energizing circuit means for energizing said motor to rotate in either direction of rotation thereof, and means operatively interconnecting said motor energizing circuit means, said control circuit means and said electromagnetically engageable means to shift said transmission in one or the other direction upon energization of said motor energizing means and said electromagnetically engageable means.

17. An electric shifting arrangement for change-speed transmissions according to claim 16, wherein said circuit means for producing electric shifting impulses includes centrifugal governor means operatively connected with the transmission input shaft including a plurality of contact means, and means operatively connecting a respective one of said contact means in a corresponding control circuit means to automatically shift the transmission in the upward or downward direction in dependence on the speed of said transmission input shaft.

18. An electric shifting arrangement for change-speed transmissions according to claim 17, wherein said circuit means for producing electric shifting impulses includes manually actuatable switch means arranged in parallel with said contact means.

19. An electric shifting arrangement for change-speed transmissions according to claim 18, wherein one of the contact means of said centrifugal governor means is operative to open up both the manually operated and automatically operated control circuit means for the downward shifting operation of said transmission as soon as said centrifugal governor means attains a rotational speed which is below the maximum permissive engine speed by a factor corresponding to the step in adjacent transmission ratios.

20. An electric shifting arrangement for change-speed transmissions according to claim 17, wherein each automatically controlled circuit means controlled by said contact means includes lock-out switch means opening upon energization of said electromagnetically engageable means.

21. An electric shifting arrangement for change-speed transmissions according to claim 17, wherein said electromagnetically engageable means includes a two-pole switch operatively connected therewith, and wherein all of the automatically controlled circuit means are operatively connected with said two-pole switch.

22. An electric shifting arrangement for change-speed transmissions according to claim 16, further comprising manually actuated switch means for the neutral position of the transmission including contact means for each shifting direction, and circuit means interconnecting said contact means with said control circuit means and including selectively engageable means automatically actuated by said guide disk means in dependence on the shifting position and shifting direction thereof.

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23. An electric shifting arrangement for change-speed transmissions according to claim 22, further comprising holding relay means operatively connected in parallel with said manually actuated switch means and operatively interconnected with said automatically engageable means automatically actuated by said cam disk means.

24. An electric shifting arrangement for change-speed transmissions according to claim 16, further comprising a manually actuatable reverse switch to engage the reverse speed of the transmission, means including holding relay means operatively connected with said last-mentioned switch to enable engagement of the reverse speed only by actuation of said last-mentioned switch, and cam means at said guide means for rendering said reverse switch selectively effective and ineffective.

25. An electric shifting arrangement for change-speed transmissions according to claim 6, wherein said guide disk means forms itself said notches and is provided with

cam means for the selective control of said means for producing electric shifting impulses.

26. An electric shifting arrangement for change-speed transmissions according to claim 6, wherein said guide disk means is made of several disk portions each forming a part of the control surface of said guide disk means, said guide disk means including in addition to said notches cam means for operating said means for producing said shifting impulses.

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