PATENT SPECIFICATION (11) 1 567 173

1 567 173

(21) Application No. 24376/76 (22) Filed 11 June 1976
(31) Convention Application No. 645 045
(32) Filed 12 June 1975 in
(33) Belgium (BE)
(44) Complete Specification published 14 May 1980
(51) INT CL³ F16H 5/50; B60K 41/08; F16H 5/48
(52) Index at acceptance
F2D A005 A007 A022 C033 C036 C037 C044 C059 C060 C079 C080 C081 C084 C096 C100 C120 C122

(19)

(54) AUTOMATIC RATIO SELECTOR FOR CHANGE-SPEED TRANSMISSIONS OF CIVIL ENGINEERING OR MATERIALS HANDLING EQUIPMENT

(71) We, SOCIÉTÉ ANONYME C.E.T.I.M., a Belgian body corporate of Rue de la Digue, 11 4600 CHENEE, Belgium, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to an automatic ratio selector for use in constant-mesh change-speed transmissions for civil engineering or materials handling equipment.

According to the present invention, we provide an automatic ratio selector for use in constant-mesh change speed transmissions for civil engineering or materials handling equipment, comprising an output-driven tachometer which, to automatically engage successive ratios according only to information received from an inductive sensor measuring output speed of the equipment is connected to a ratio selection electrical contactor and to an auxiliary electrical contactor arranged to operate solenoid valves which are arranged to control pneumatic ratio selection actuators, and which is also connected to solenoid valves arranged to control a pneumatic acceleration actuator to increase the speed of an engine at a time when a downshift to a lower ratio takes place and to control a pneumatic deceleration actuator to reduce the speed of an engine at a time when an upshift to a higher ratio takes place.

When the present ratio selector is in use, correctly timed selection may be carried out automatically for the ratios and for forward neutral and reverse modes, avoiding stresses and overloads often encountered when such conventional equipment is operated conventionally. The most suitable ratios are determined automatically; wear on the mechanical parts and failure of transmission and other components are much reduced and in particular no longer result from incorrect handling; also, consumption of fuel and lubricant is appreciably reduced.

According to a further feature of the present invention, we provide an assembly of a ratio selector as defined above, and a forward, neutral, reverse selection device which comprises a forward-neutral-reverse selection electrical contactor and an auxiliary electrical contactor connected by a delay device to solenoid valves which are arranged to control a pneumatic forward-neutral-reverse selection actuator and to control the deceleration actuator during a change between forward and reverse.

In the present assembly, the deceleration actuator may, if desired, be arranged in turn to shut off a fuel injection pump.

The invention will now be more particularly described with reference to the accompanying drawing, wherein:— the Figure illustrates diagrammatically the present ratio selector.

Referring to the drawing, a selector comprises a contact tachometer A connected *via* a D-A converter (not shown) to an inductive speed sensor B which is linked to a power take-off shaft, indicated at C, of a change-speed gearbox, a manually operable forward-neutral-reverse selection switch D with three pairs of contacts (forward D1: neutral D2; reverse D3), and, connected to this switch D, an auxiliary forward-neutral-reverse selection relay E with an electronic delay device F and solenoid valves G controlling, when the ratio selector is in use, a pneumatic forward-neutral-reverse selection actuator and electropneumatic valves H, I, respectively, controlling respectively an engine decelerator and a pneumatic engine accelerator and a manually operable ratio selection switch J with three pairs of contacts (first ratio locked, J1; first and second automatic, J2: all ratios automatic,

J3) connected to the tachometer A, whereto there is connected an auxiliary ratio selection relay K with solenoid valves L controlling a pneumatic ratio selection actuator. Thus the tachometer A is connected to a valve arranged to control the engine acceleration actuator to increase the speed of an engine at a time when a change to a lower ratio takes place.

Diodes M are provided at various places in two circuits (a forward-neutral-reverse selection circuit and a ratio selection circuit).

Contacts of the tachometer A are broken down as follows:—

A1: 24 volt, positive
A2: 24 volt, negative
A3: first ratio signal
A4: second ratio signal
A5: third ratio signal
A6: deceleration signal
A7 and A8: first ratio locked
A8 and A9: automatic
A10: inductive sensor, positive
A11: inductive sensor, negative
A12: 24 volt, negative
A13: acceleration signal
A14 and A15: first and second ratio automatic.

To switch on an electrical circuit as a whole, contact is made at a terminal N, and current flows through the contacts A1 and A2 of the tachometer A.

Mode selection (forward, reverse, neutral) takes place as follows:

To engage the forward mode, an operator places the switch D in the position D1. The current then flows from D1 to E and across points 31—32 to one of the diodes M, which prevents inappropriate reverse current flow. The current is therefore fed to the solenoid valve G.

Simultaneously, the current flows from the point 31 to the delay device F at *a* by way of one of the diodes M and to connected points 15—16, and then a point 21 before arriving at the distributors H. Being energized, the solenoid valves G operate the pneumatic decelerator which, by reducing the engine fuel supply, prevents any engine acceleration.

At the end of a delay period contact of the delay device changes over from 15—16 to 15—18. Current therefore flows to solenoid valve G1 of G and enables a pneumatic actuator to select the forward mode, and deenergise H.

To engage the reverse mode, the contactor D is placed in the position D3. A circuit identical to that for the forward mode is established through points 41—42 of E, leading to solenoid G.

Simultaneously, the current flows from the point 41 to the delay device F at *a* across one of the diodes M and to connected points 25 and 26, and then to the point 21 to arrive at the engine decelerator valve H.

At the end of a delay period, contact changes over from 25—26 to 25—28, and the current flows to the solenoid valve G4 of G and, by way of a pneumatic actuator, selects the reverse mode, and de-energises H.

A transition from the forward to the reverse mode and *vice versa* can take place only below a pre-determined speed, at which the terminal A12 of the tachometer A can transmit a negative 24-volt potential to earths of G, so rendering them operative.

To engage the neutral mode, the contactor D is placed in the position D2. The current then flows from D2 to the contactor E at points A—B. As a result, normally closed contacts of E become normally open and, conversely, previously normally open contacts become normally closed. The current now flows from 13—14 through one of the diodes M to G2 of G and from 23—24 to G3 of G, thereby selecting neutral.

With reference to automatic selection of ratios, this involves three positions: "first ratio locked", wherein a first ratio of the equipment is locked, so preventing the equipment from exceeding the maximum speed possible with this ratio; "first and second automatic", wherein the first ratio and a second ratio are selected automatically according to output speed, without intervention by the operator, and the maximum possible speed is that of a "second gear" ratio; and "all ratios automatic", wherein all the ratios are engaged automatically, being selected according to output speed.

To engage "first ratio locked", the contactor J is placed in the position J1. Contact is therefore made in the tachometer A at between A7—A8, the terminal A3 being thereby maintained permanently energised. The current now flows from A3 to the contactor K at the points 31—32 to arrive at one of the diodes M and then at the solenoid valve L3 of L.

Simultaneously, the current flows from the point 31 to the solenoid valve L1 of L, so enabling a pneumatic actuator to select the first ratio solely by virtue of the permanent energisation of the contact at A3.

To engage "first and second automatic", the contactor J is placed in the position J2. The contacts J2 are closed, and contact is then made between contacts A14, A15.

When a machine is set in movement in first ratio, the inductive sensor B, having detected the speed of the power take-off shaft C of the gearbox, feeds this information to the tachometer A, and when the predetermined output speed for shift to second ratio is attained contact is made at

A6 (engine deceleration signal) and acts on the distributor H, which by means of a pneumatic actuator overrides the operator's control of engine speed during the pre-determined delay period which is required for the change from the first ratio to the second. A capacitance of 1,000 μF is associated with the contact A6 to keep it effective so that the second ratio is selected before the decelerating valve H is de-energised.

During this delay, the feed of potential from N to the engine decelerating contact A6 and first ratio contact A3 is disconnected, and the second ratio contact A4 is energised. The current now flows from A4 to the contactor K at the points A—B. As a result the normally open contacts of K becomes closed and the normally closed contacts become open. The current now flows from 13—14 through one of the diodes M to reach the rotenoid valves L2 of L and from 23—24 to reach L3 of L. The actuator engages the second ratio without intervention by the operator, and at the end of the delay period the contact A6 is de-energised to release the decelerating actuator H and return the engine speed control to the operator.

The load on the equipment may cause a drip in speed demanding a change to a lower ratio. At the time of such a change of ratio, acceleration is required to increase the speed of the engine. This acceleration is effected automatically, as follows. The sensor B informs the tachometer A of the slowing down of the shaft by way of A13, which for a pre-determined period effects acceleration by way of the valve I and its pneumatic actuator. During this period contact is broken at A13 and A14 and is re-established at A3. The first ratio is then engaged, and at the end of the period the acceleration contact A13 becomes de-energised.

In order now to engage the "all ratios automatic" position, the contactor J is placed in the position J3. The contact J3 closes, and contact is then made between A8—A9.

As in the case of the "first and second automatic" position, the circuit is established according to information received from the shaft C by the tachometer A, which by the same process engages successive ratios up to a third ratio.

When this third ratio is engaged by means of the contact A5, the current flows from A5 to the contactor K at the points 41—42, by way of a diode M to the solenoid valve L2 of L, and from the point 41 of K to L4 of L. The third ratio is then engaged automatically.

Changing down through the ratios takes place in the same way as described with reference to the position J2.

The present ratio selector can be adapted to all types of equipment, since no modification of the original transmission components is called for. Only control linkages are partly replaced by actuators of an electropneumatic system.

WHAT WE CLAIM IS:—

1. An automatic ratio selector for use in constant-mesh change-speed transmissions for civil engineering or materials handling equipment, comprising an output-driven tachometer which, to automatically engage successive ratios according only to information received from an inductive sensor measuring output speed of the equipment, is connected to a ratio selection electrical contactor and to an auxiliary electrical contactor arranged to operate solenoid valves which are arranged to control pneumatic ratio selection actuators, and which is also connected to solenoid valves arranged to control a pneumatic acceleration actuator to increase the speed of an engine at a time when a downshift to a lower ratio takes place and to control a pneumatic deceleration actuator to reduce the speed of an engine at a time when an upshift to a higher ratio takes place.

2. An assembly of a ratio selector as defined in Claim 1, and a forward-neutral reverse selection device which comprises an electrical selection contactor and an auxiliary electrical contactor connected by a delay device to solenoid valves which are arranged to control a pneumatic forward-neutral-reverse selection actuator and to control the engine deceleration actuator during a change between forward and reverse.

3. An automatic ratio selector suitable for use in constant-mesh change-speed transmissions for civil engineering or materials handling equipment, substantially as hereinbefore described with reference to the accompanying drawing.

STANLEY, POPPLEWELL
FRANCIS & ROSS,
Agents for the Applicants,
Chartered Patent Agents,
1, Dyers' Buildings,
Holborn,
London EC1N 2JT.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1567173 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*