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Control system for an automatic door

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FIG. 1

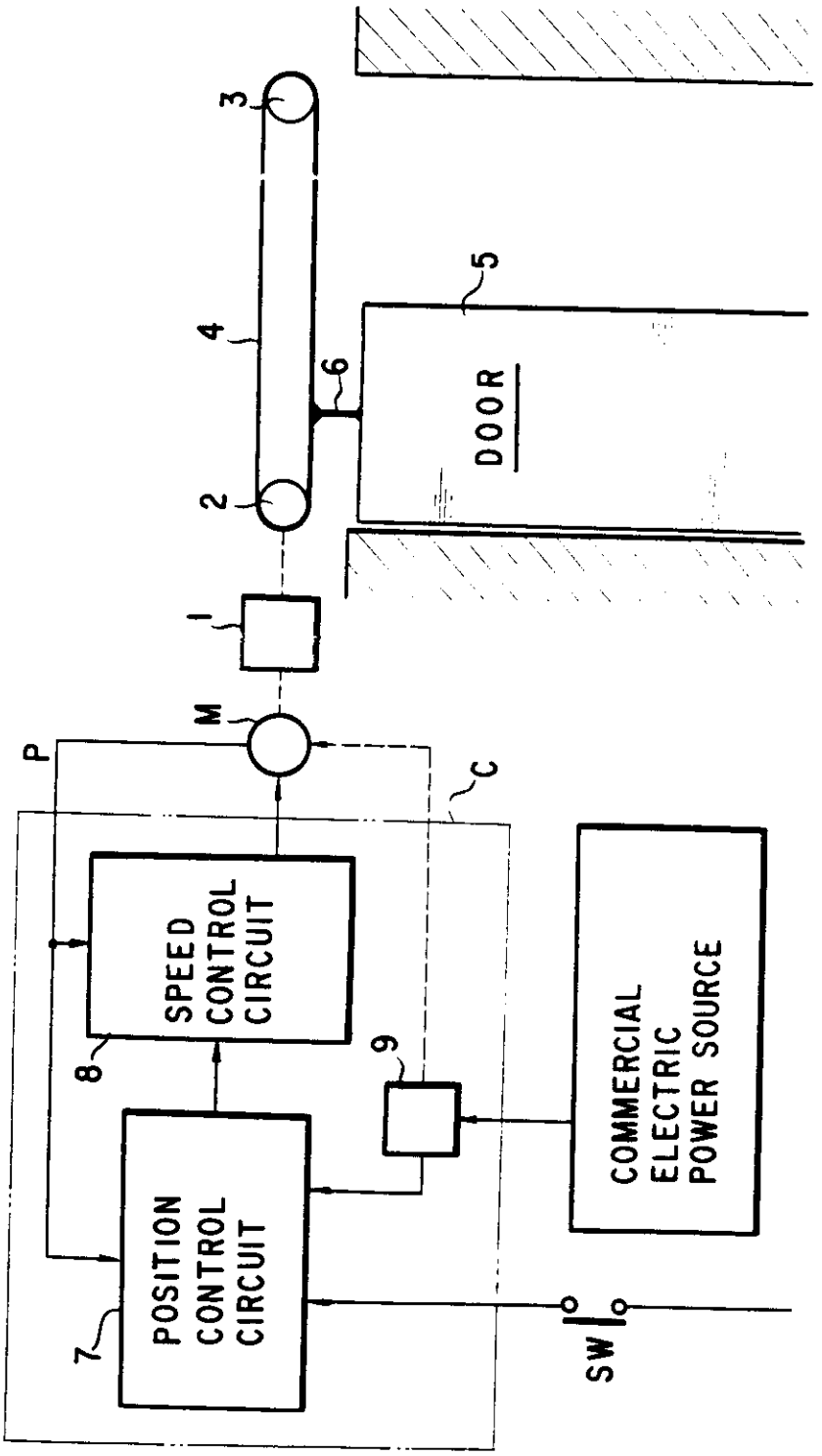
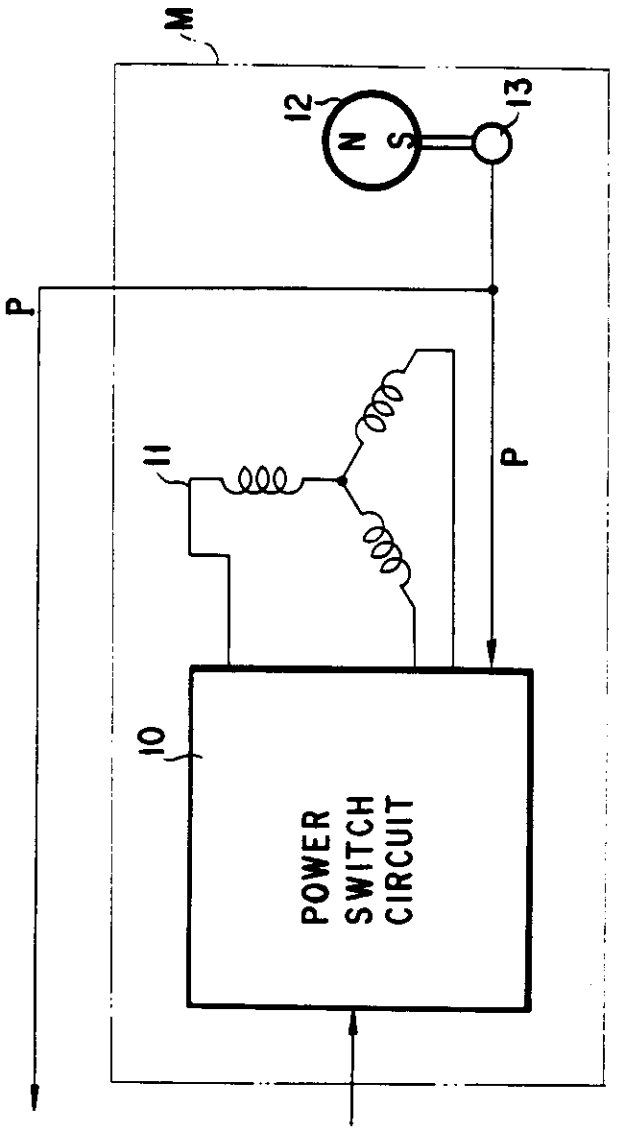

3
4
5
6
DOOR
2
1
M
P
C
SPEED CONTROL CIRCUIT
8
9
COMMERCIAL ELECTRIC POWER SOURCE
POSITION CONTROL CIRCUIT
7
SW

FIG. 2



CONTROL SYSTEM FOR AN AUTOMATIC DOOR

The present invention relates to a control system for controlling operation of an automatic door.

Heretofore, as a control system for an automatic door, there have been known various systems such as a control system including limit switches for detecting a position of a door, a control system in which a rotation detector is provided on a rotary shaft of a drive motor or another rotary shaft and numerical control of the drive motor is effected on the basis of the detected rotational data, a control system in which teeth on a timing belt for coupling a drive motor to a door are detected and counted and numerical control of the drive motor is effected on the basis of the counted data, or the like.

However, in these known control systems in the prior art it was necessitated to provide any type of door position detector means separately from drive means for a door, hence a number of component parts of the system could not be reduced, and so, it was difficult to achieve simplification of the construction and reduction of a manufacturing cost.

It is an object of the present invention to provide a control system for an automatic door that is free from the above-described shortcoming in the prior art.

Another object of the present invention is to provide a control system for an automatic door in which there is no need to provide door position detector means separately from drive means for a door and hence reduction of manufacturing cost can be achieved.

According to the present invention there is provided a control system for an automatic door comprising:

a D.C. brushless motor comprising armature windings forming a stator, a field magnet forming a rotor, and a plurality of magnetic pole position detectors adapted to deliver respective series of magnetic pole position detection pulses indicative of rotor position and of speed and direction of rotation of the rotor for control of the motor;

said motor being coupled or adapted to be coupled to a door member via speed reduction means to transmit a driving power to said door member;

a position control circuit connected to said magnetic pole position detectors and responsive to said magnetic pole position detection pulses for determining the

position of said door member and thereby generating a speed command signal indicating the direction and magnitude of the speed of said door member; and

a speed control circuit responsive to said magnetic pole position detection pulses and said speed command signal for applying a drive control signal to said D.C. brushless motor so that said D.C. brushless motor may be driven at such rotational speed that said door member can be moved at the speed indicated by said speed command signal.

The invention will be described by way of example with reference to the acommpanying drawings, in which:-

Fig. 1 is a general system diagram showing one preferred embodiment of the present invention; and

Fig. 2 is a more detailed partial circuit diagram showing a construction of a D.C brushless motor contained in the control system shown in Fig. 1.

Referring now to Fig. 1, a D.C brushless motor M is coupled to a driving pulley 2 via a reduction gear 1, a door drive belt 4 is wrapped around the driving pulley 2 and a driven pulley 3, and a door 5 is connected to the belt 4 via a connecting member 6 so that the door 5 can be moved in the opening or closing direction by rotating the D.C brushless motor M in the normal or reverse direction, respectively.

In this D.C brushless motor M, as shown in FIg. 2, generally armature windings 11 form a stator and a field magnet 12 forms a rotor. In addition, three magnetic pole position

detectors 13 each constructed of a Hall effect element, a magnetic reluctance element or a photoelectric element are disposed on the stator at an angular interval of 120 ° (only one magnetic pole position detector 13 is illustrated in Fig. 2), so that three pulse trains having their phases shifted by 120 ° from one another are delivered from these magnetic pole position detectors 13 in response to rotation of the field magnet 12 forming the rotor. In a control circuit section enclosed by a chain line frame C, the angular position and rotational speed of the field magnet 12 forming a rotor are determined on the basis of the magnetic pole position detection pulses P consisting of these three pulse trains, and a drive control signal is applied to the D.C. brushless motor M on the basis of the position and speed data. In the D.C. brushless motor M, a power switch circuit 10 associated therewith (See Fig. 2) switches D.C. drive currents fed to the respective armature windings 11 in accordance with the drive control signal to generate a necessary drive torque.

The control circuit section C comprises a position control circuit 7, a speed control circuit 8 and a D.C. power supply circuit 9 which can be switched on and off externally of the control circuit section C. The magnetic pole position detection pulses P delivered from the magnetic pole position detectors 13 in the D.C. brushless motor M are input to the position control circuit 7 and the speed control circuit 8.

The position control circuit 7 has its power supplied from the D.C. power supply circuit 9, and is connected to an

access sensor switch SW such as a door mat switch, an infrared sensor, a capacitive sensor, etc. which senses access of a human body to an automatic door and issues an actuation signal for the position control circuit 7. This position control circuit 7 determines the direction of rotation of the motor M on the basis of the phase relations among the three pulse trains delivered from the respective magnetic pole position detectors 13, and also determines the position of the door 5 by counting up or counting down the pulses depending upon the direction of rotation (starting from a reference position of the door 5). It is to be noted that the pulses forming the three pulse trains are generated for every 1/3 revolution or 1/6 revolution of the rotor depending upon whether the pulses of one polarity or the pulses of both polarities are taken into consideration.

In the position control circuit 7 is internally stored a program of a predetermined sequence of operations for opening and closing the door 5 in response to the actuation signal sent from the access sensor switch SW. Hence, after the access sensor switch SW has sensed access of a human body to the automatic door, the position control circuit 7 issues a speed command signal indicating the direction and magnitude of the desired speed of the door 5 on the basis of the stored sequence program and the determined current position of the door 5, and this speed command signal is applied to the speed control circuit 8.

The speed control circuit 8 calculates and determines the speed of the door 5 on the basis of the magnetic pole

position detection pulses P issued from the magnetic pole position detectors 13 in the D.C. brushless motor M, and as a result of comparison between the desired direction and magnitude of the speed of the door 5 indicated by the speed command signal applied from the position control circuit 7 and the current direction and magnitude of the speed of the door 5 determined by itself, it determines the necessary acceleration of the D.C. brushless motor M and issues a drive control signal having a polarity and a magnitude corresponding to the direction and magnitude of the necessary acceleration, which is applied to the D.C. brushless motor M so that the motor may be driven at such rotational speed that the door 5 can be moved at the desired speed indicated by the speed command signal.

In the control system for an automatic door having the above-described construction, when a human body comes close to the automatic door, the access sensor switch SW is operated and an actuation signal is applied to the position control circuit 7 in the control circuit section C. In response to the actuation signal, the position control circuit 7 generates a speed command signal on the basis of a stored program of the predetermined sequence of operations and the current position of the door 5 that is determined by itself on the basis of the magnetic pole detection pulses P, and applies the speed command signal to the speed control circuit 8, which in turn applies a drive control signal to the D.C. brushless motor M to open and close the door 5 according to the predetermined sequence of operations.

During the movement of the door 5, the pulses delivered from the magnetic pole position detectors 13 in the D.C. brushless motor M are applied to the position control circuit 7 as well as the speed control circuit 8 to be utilized for determination of the current position and the current speed of the door 5.

In addition, owing to the employment of the D.C brushless motor, the buzz noise generated by an A.C. motor in the automatic door in the prior art can be eliminated, and thereby noises generated upon opening and closing the automatic door can be reduced. Moreover, since control of a rotational speed and a torque of a D.C. brushless motor can be easily achieved, controllability of an opening/closing speed of the automatic door is excellent. In the case of employing an AC/DC converter as the D.C. power supply circuit 9, even in an area of a foreign country where the A.C. voltage of the commercial power line is different from that in Japan, the control system according to the present invention can be adapted to the different A.C. voltage in a relatively simple manner only by modifying the circuit of the AC/DC converter.

The principal advantage of the present invention resides in that owing to the use of a D.C. brushless motor as a drive source, the detection pulses issued from the magnetic pole position detectors which is inherently associated with the motor for controlling rotation of the motor, can be utilized for determining the position of the door hence there is no need to provide a position detector for the door separately

from the drive motor thus a number of component parts can be reduced, and thereby reduction of manufacturing cost can be realized.

CLAIMS

1. A control system for an automatic door comprising:

a D.C. brushless motor comprising armature windings forming a stator, a field magnet forming a rotor, and a plurality of magnetic pole position detectors adapted to deliver respective series of magnetic pole position detection pulses indicative of rotor position and of speed and direction of rotation of the rotor for control of the motor;

said motor being coupled or adapted to be coupled to a door member via speed reduction means to transmit a driving power to said door member;

a position control circuit connected to said magnetic pole position detectors and responsive to said magnetic pole position detection pulses for determining the position of said door member and thereby generating a speed command signal indicating the direction and magnitude of the speed of said door member; and

a speed control circuit responsive to said magnetic pole position detection pulses and said speed command signal

for applying a drive control signal to said D.C. brushless motor so that said D.C. brushless motor may be driven at such rotational speed that said door member can be moved at the speed indicated by said speed command signal.

2. A control system for an automatic door as claimed in Claim 1, in which the polarity and magnitude of the drive control signal applied from said speed control circuit to said D.C. brushless motor are determined depending upon said speed command signal and said magnetic pole position detection pulses.

3. A control system for an automatic door as claimed in Claim 1 or 2, in which said position control circuit is actuated in response to a signal generated by an access sensor switch which senses access of a human body to said automatic door.

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