Field Failure Protection for DC Motors

The speed of a DC motor is extensively used for industrial applications where a precise speed control and a constant torque are desired. It is inversely proprotional to its field current. In case of field current failure, the motor speed will rise to dangerously high level. A field failure protection is therefore necessary to cut off the armature supply in case of field current failure.

The basic circuit of the field failure protection uses an ordinary 6V electromagnetic relay of the open type with 10

amps rated sturdy contacts. This relay can be used on a manual autotransformer-controlled DC drive. This motor has a shunt field current of 1.13 amps at 220V DC. A 5-ohm (25-watt) wirewound resistor (R1) connected in series with the motor field produces a 5.6-volt drop across resistor (R1) as long as the field current exists, thus energising the 6V DC relay connected across the resistor as shown in Fig. 1.

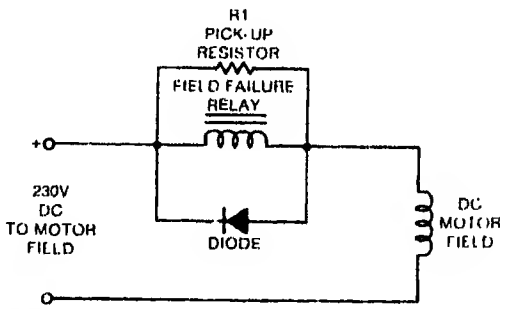

Fig. 1

In case the motor field current fails due to any fault, the voltage drop across resistor (R1) will be zero which de-energises the relay (FFR) and cuts off the armature supply.

The circuit diagram of a manual autotransformer-controlled DC drive of a 230V, 5HP DC motor with a separately excited shunt field of 230 volts (1.13 amps) and the FFR (field failure relay) circuit are shown in Figs 2 and 3 respectively. When the start pushbutton S2 is pressed, the contactor C is energised through S2 (N·O contact), limit

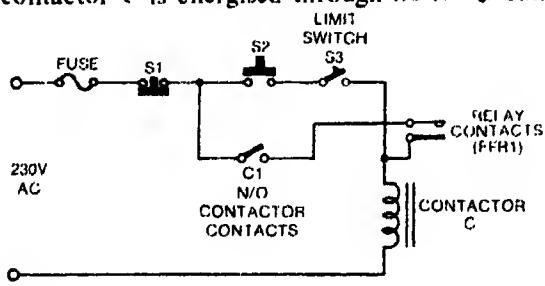

Fig. 2

switch S3 and stop pushbutton S1 (N/C contact).

The limit switch S3 is actually a part of the autotransformer, and it is so mounted that its contacts remain closed only when the autotransformer setting is at zero position. At all other settings of the autotransformer, the limit switch contacts remain open. This is a safety device introduced, so that the motor can be started only from the minimum position of the autotransformer setting, thereby starting at reduced voltage and current. If the motor is started on a high armature voltage, the starting current will be very high, especially if started on load, as is usually the case.

As soon as the contactor C is energised, its contacts C1-C3

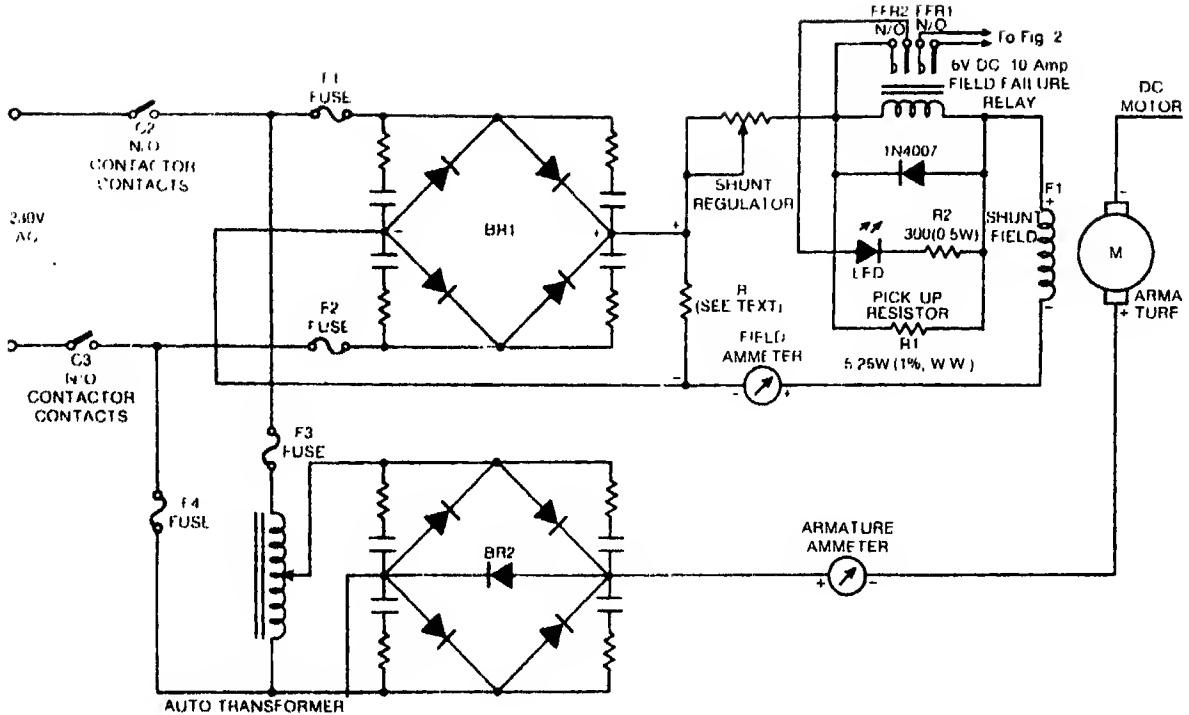
FFR2 FFR1
N/O N/O
To Fig 2
6V DC 10 Amp
FIELD FAILURE
RELAY
DC
MOTOR
F1
FUSE
C2
N/O
CONTACTOR
CONTACTS
240V
AC
BR1
1N4007
SHUNT
REGULATOR
R2
300(0 5W)
SHUNT
FIELD
F1
LED
M
R
(SEE TEXT)
PICK UP
RESISTOR
R1
5 25W (1%, W W)
ARMA
TURE
F2
FUSE
FIELD
AMMETER
C3
N/O
CONTACTOR
CONTACTS
F3
FUSE
F4
FUSE
BR2
ARMATURE
AMMETER
AUTO TRANSFORMER

Fig. 3

are closed. A 230V AC is now available at the autotransformer input terminals, and a 230V DC via full-wave bridge rectifier BR1 and series resistor R1 to the motor field winding.

As soon as field current flows, the drop across R1 energises the FFR. FFR has got two pairs of N O contacts, FFR1 and FFR2, which now close. FFR1 when closed provides a retaining supply to contactor C through its own contact C1, and becomes independent of S2 (which can now be released) and S3.

The motor can now be started by increasing the autotransformer setting whereby the output through the bridge rectifier BR2 applies a DC voltage to the motor armature to smoothly start the motor at a speed depending upon the setting of the autotransformer. In case of field current failure, FFR drops and contactor C opens to disconnect armature supply.

The FFR2 contacts (which are optional, but are useful as shown here) provide an LED indication that the FFR is operating. Alternatively, an ammeter can be used in the field circuit to show that the field current is flowing.

The RC network across the diodes is for surge protection of the diodes only. Usually a wirewound resistor (20k, 25W if the field excitation voltage is 230V DC) is connected across the rectifier output to the highly inductive field winding, whereas a fifth diode is connected with reverse polarity across the bridge rectifier (BR2) output to the armature.

Note that R1 (5-ohm), connected in series with the field winding will have negligible effect in the field current (field resistance being above 200 ohms). However, if one wishes to

reduce the voltage drop across R1, two 5-ohm, 15W resistors may be used in parallel, and the FFR replaced by a 3V DC-operated relay which is available with some manufacturers.

Note: EFY is not responsible for any malfunctioning in the circuit as the same has not been tested in our lab.

E. AUGUSTINE