Filter disc rotator

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Abstract. A filter disc rotator has been designed and developed in the electronics laboratory of UPSO for photometric observations. A stepper motor is used to rotate the filter disc in the forward as well as in the reverse directions. A start signal is required to drive the stepper motor to rotate the filter disc. As the filter comes in front of the diaphragm, its position is sensed by the photosensors and displayed on the observer panel and simultaneously a stop signal is generated to stop the motor. The observer can select the required filter at any time and may control the disc rotator remotely.

Key words : stepper motor—filter disc

1. Description

The filter disc contains six large holes for fitting the filters at equal angular distance. Five required filters (UBVRI) are fitted in five holes while one hole is left clear. On the central line of each filter hole, small holes of size about 1 mm diameter are made as shown in figure 1. At one side of these holes, an elongated light source is mounted and at the other side, four sensors are placed. Three of these are used for sensing the type of the filters while fourth one is used to sense the filter position. The filter disc is rotated with the help of a four phase stepper motor having a gear assembly as shown in figure 2. The circuit diagram for driving the stepper motor is shown in figure 3.

The circuit consists of an oscillator, up/down counter, stepper motor driver, filter position sensing circuit and a display circuitry.

Ic 555 is used as an oscillator to generate a pulse train. The rate of pulse generation can be controlled with the help of the potentiometer VR1 (figure 3). Thus the rotation speed of the filter disc can be changed.

An up/down counter is used to rotate the motor in clock-wise and anticlockwise directions.

Exclusive OR gates (Ic 7486) are used to generate proper logical sequence, as shown below, to derive the stepper motor.

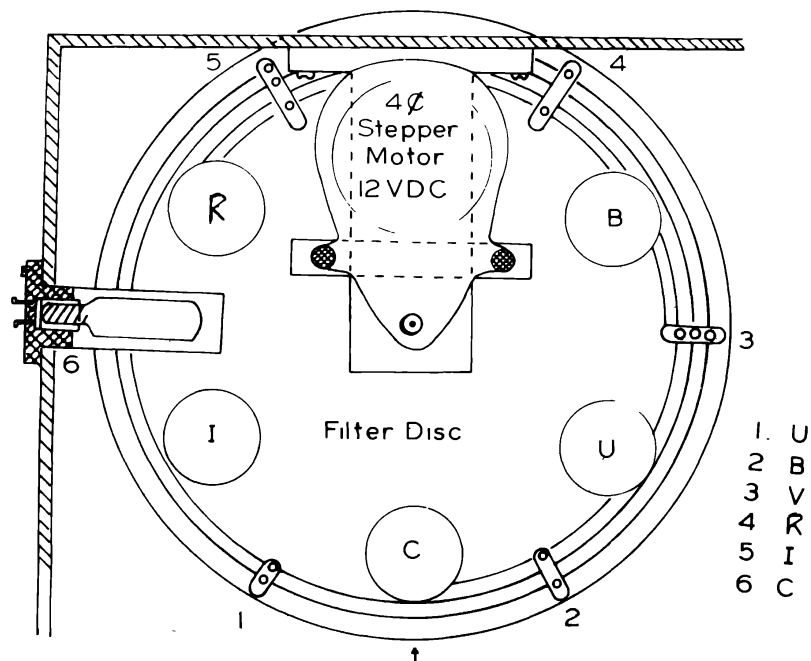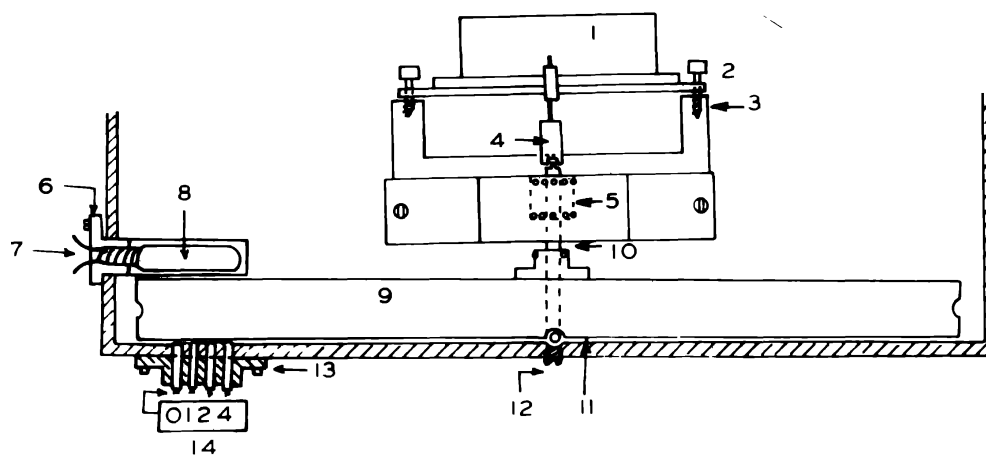| Counter output		Motor control sequence			
B	A	1	2	3	4
0	0	0	1	1	0
0	1	0	0	1	1
1	0	1	0	0	1
1	1	1	1	0	0

Figure 1. Plan view of the filter disc with stepper motor.

(1) 12V 2W D.C. motor Rot. Rev. RPM; (2) Screw to mount the motor; (3) Spring; (4) Coupling; (5) Bearing;
      0-9   1/2   PPS 0-300
(6) Fiber coller; (7) Lamp holder; (8) Lamp 6.3V 2W; (9) Filter disc; (10) Shaft mounted with filter disc; (11) Steel
ball; (12) Adjustable screw; (3) Block for photo diodes; (14) Photo diodes.

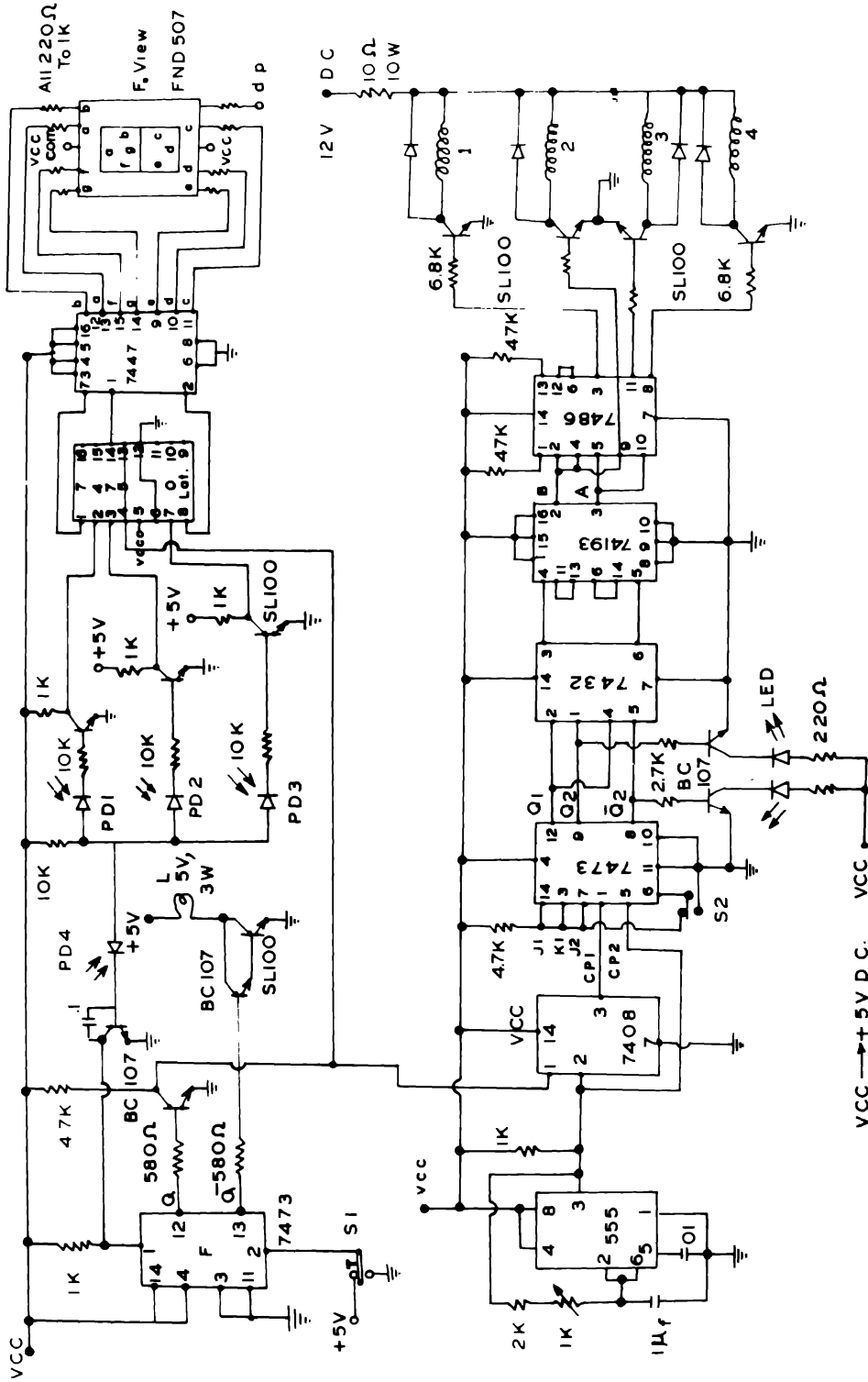Figure 2. Side view of the stepper motor gear assembly with filter disc.

Figure 3. Schematic circuit diagram for rotating the filter disc.

The display part of the circuit figure 3 is used to display the codes of the filters (i.e. the type of the filters which is in the path of the light beam).

The type of the filters are coded as :

Type of the filter	Code
U	1
B	2
V	3
R	4
I	5
Clear	6

2. Operation

In the beginning when the system is switched ON, there is a display of a numeral on the display panel according to the filter which is in front of the diaphragm of the photometer e.g. if V filter exists in front of the diaphragm, a numeral 3 will be displayed on the display panel. To change the filter, one has to push a switch S1. The flip-flop F will be in the reset state. The lamp L will glow and the gate of Ic 7408 will be enabled. It allows the pulses from the oscillator which are counted by the up/down counter Ic 74193. The output of the counter is converted into a logical sequence by the logical sequencer circuit to drive the stepper motor. As a result, the stepper motor starts to rotate in one direction and accordingly the filter disc is rotated. As the filter comes in its proper position i.e. in front of the diaphragm, the appropriate sensors are lighted by the lamp L through the small holes. Among the sensors (photodiodes) PD1, PD2 and PD3, the appropriate photodiodes conduct and proper BCD code is generated. This BCD code is latched by a latch (Ic 7475) and decoded by a seven segment decoder/driver (Ic 7447) and corresponding filter code number is displayed on the observer panel. Simultaneously, the photodiode PD4 conducts and a signal is generated to trigger the flip-flop F in the set state which puts the lamp L OFF and disable the gate of Ic 7408. Thus the pulses are stopped to enter the counter and the motor is stopped and the filter remains in its position until the observer wants to change it. By flipping the toggle switch S2, the direction of rotation of the filter disc can be changed.

The above filter disc rotator is presently being used on 104 cm telescope at UPSO, Naini Tal.