Table 4. The photographic *JF* system (Couch & Newall 1980)

Band	Photographic	Photoelectric EMI 9658 AM(S-20) +	λ_{eff} Å	$\Delta\lambda$ Å
J	IIIaJ + GG 385	GG385 (2mm) + BG 28 (2mm)	4385	1050
F	IIIaF + RG 630	RG630 (3mm) + BG 20 (3mm) + BG 38 (1mm)	6676	500

A photoelectric hour-angle solar guider

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For studying a particular feature on the solar disc, it is necessary to keep the image of the sun fixed with respect to the instrument over the duration of the observations. However, the atmospheric refractions, irregularities in the drive system and the misalignment of the polar axis of the coelostat cause the image to drift from its position. The drift due to misalignment of the polar axis can be made negligible by accurately aligning the polar axis. However, the drift of the solar image due to atmospheric refraction and irregularities in the drive system is not easy to correct manually. We have designed an hour-angle guider to apply automatic corrections for drift in the east-west direction.

The hour-angle guider is a system giving a 50 Hz sine-wave output. The frequency of the output signal changes depending upon the direction of the drift of the solar image. The first mirror of the coelostat rotates with half the rotational velocity of the earth with the help of a synchronous motor. If there is any displacement of the image in the east-west direction, the speed of the motor is automatically changed to compensate for the drift.

A block diagram of the hour-angle guider is shown in figure 1. The image position sensor system consists of two photodiodes placed on the eastern and the western limb of the solar image. The relative displacement in the east-west direction of the image

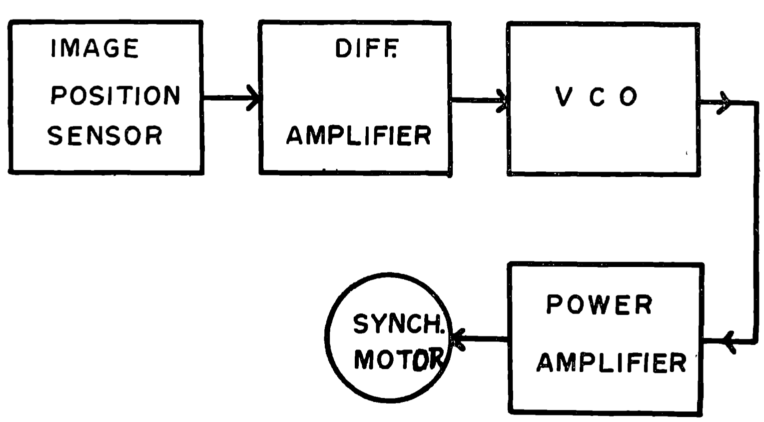

Figure 1. Block diagram of photoelectric hour-angle guider.

with respect to the two diodes produces variations in the light flux falling on the photodiodes, which convert these variations into electrical signals. The outputs are fed into the inverting and noninverting inputs of an operational amplifier which is used as a differential amplifier. The output of the differential amplifier is then applied to the gate of a field effect transister (FET) of a voltage-controlled oscillator (VCO). The channel resistance of the FET changes depending upon its gate voltage. The frequency output of the VCO changes with the change in the channel resistance of FET. The output signal of the VCO is fed to a power amplifier. The required speed control is achieved by driving a synchronous motor with the output of the power amplifier.

The schematic circuit diagram of the photoelectric hour-angle solar guider is shown in figure 2. When the photodiodes (GP 120) receive equal amounts of light flux, the output of the differential amplifier should be zero in ideal case; but in actual practice as the characteristics of the two photodiodes may not necessarily be identical, a

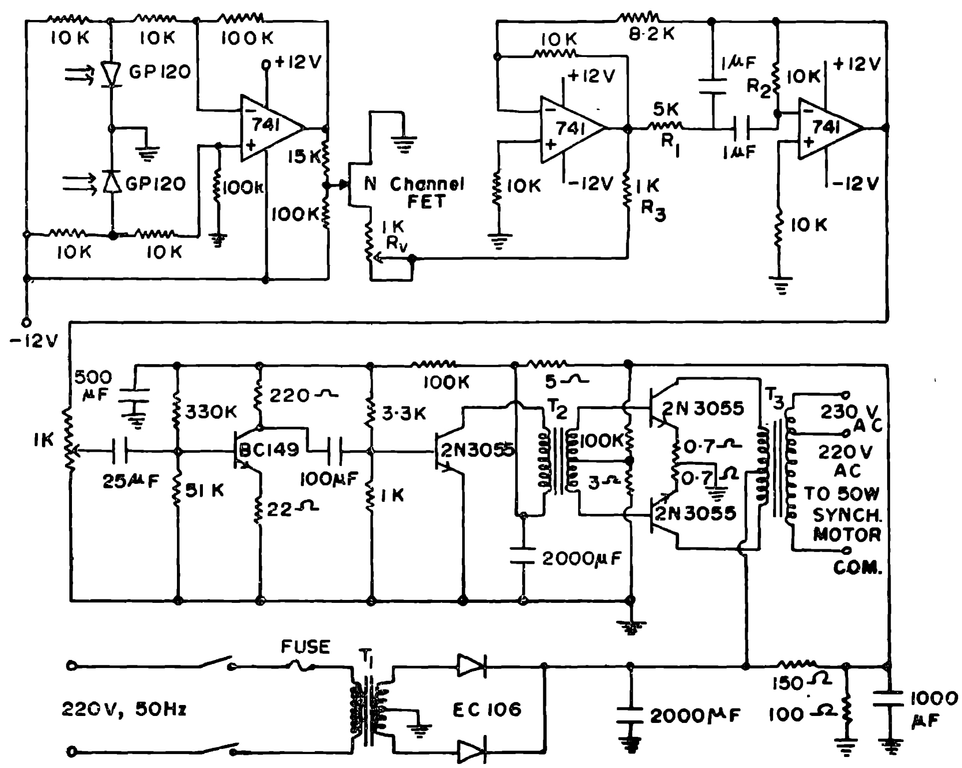

Figure 2. Schematic circuit diagram of the photoelectric hour-angle solar guider.

voltage V_1 appears on the gate of the FET which is responsible for a change in its channel resistance. The resistances R_3, R_V and the channel resistance of the FET are adjusted to control the frequency of the VCO. The frequency of the VCO can be calculated from

$$f = \frac{1}{2\pi C}\sqrt{\frac{R_1 + R_3'}{R_1 R_2 R_3'}},$$

where $R_3' = R_3 + R_V +$ channel resistance of the FET, and $C = C_1 = C_2 = 1\ \mu$F.

Initially; when the two photodiodes receive equal amounts of light flux, the frequency of the VCO is adjusted to 50 Hz by means of the potentiometer R_V. This 50 Hz signal is amplified by a power amplifier to run a 220V, 50 Hz synchronous motor of the coelostat. If one photodiode receives higher light flux as compared to the other the gate voltage of the FET is either positive or negative with respect to V_1 depending upon the direction of the displacement of the solar image. In case it is positive, the channel resistance of the FET is reduced, and correspondingly the frequency of VCO increases. This causes the synchronous motor to run faster until the photodiodes receive equal amounts of light flux. Similarly, if the other photodiode receives more flux than the first one, the gate voltage of the FET is negative with respect to V_1. The frequency of the VCO would then decrease and consequently the speed of the synchronous motor reduces until both the photodiodes again receive equal amounts of light flux. Thus, the image of the sun is always kept at a fixed position.

The above guider is being used successfully with a 46-cm coelostat for the last two years. A similar instrument can be designed to guide the solar image in declination too, controlling the position of the second mirror of coelostat.

The author is thankful to Dr H. S. Mahra and Dr L. M. Punetha for helpful suggestions and discussions. Thanks are also due to Shri R. C. Pant, Senior Technician, for his help in fabrication.