A Four Channel Photoelectric Photometer

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ABSTRACT

A simultaneous four channel photoelectric photometer has been used successfully by astronomers

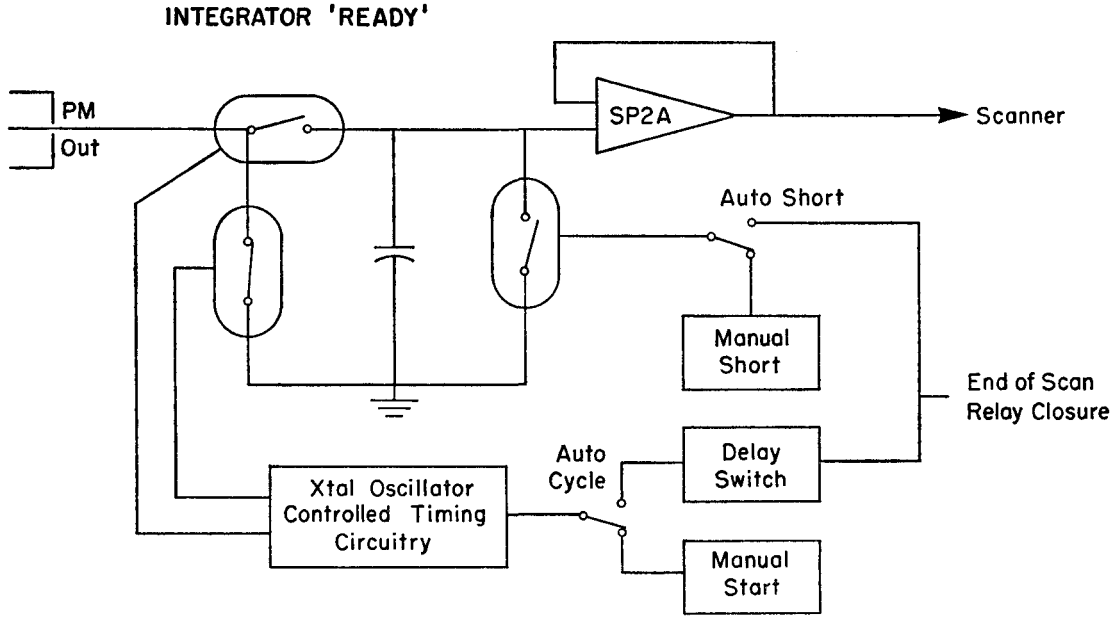

Fig. 1

at the Dominion Astrophysical Observatory in the past three years to measure the colours of some 2000 stars. The optics consist of a small grating spectrograph with quartz lenses. Windows in the focal plane of the camera isolate four spectral regions and the light is fed to separate EMI photomultipliers. The photometer is not designed for very faint star observations, consequently D.C. techniques are used. Although the photomultipliers are not refrigerated, a 2 per cent precision is possible in the measurement of the colours of a star of V = 12 in a 1 min integration with a 16-inch telescope. Provided stars are bright relative to the sky background, measured colours are insensitive ($\pm 0^m01$) to transparency variations of up to three magnitudes caused by normal light cloud. The outputs of the photomultipliers are integrated on capacitors and timing is controlled by a crystal oscillator. An integrator and associated control circuitry are shown schematically in Figure 1. The integrators are read automatically by a digital voltmeter and the results together with time and other data are punched out on paper tape. A block diagram of the data acquisition system is given in Figure 2. After conversion of the tape to a card deck the data is processed in the computer. The system has proved to be very stable and mean errors in single observations of each colour are between 0^m004 and 0^m007. The most time consuming part of the process is in the careful editing and sieving of the results for erroneous data generated by line voltage spikes, mispunches, and observer mistakes.

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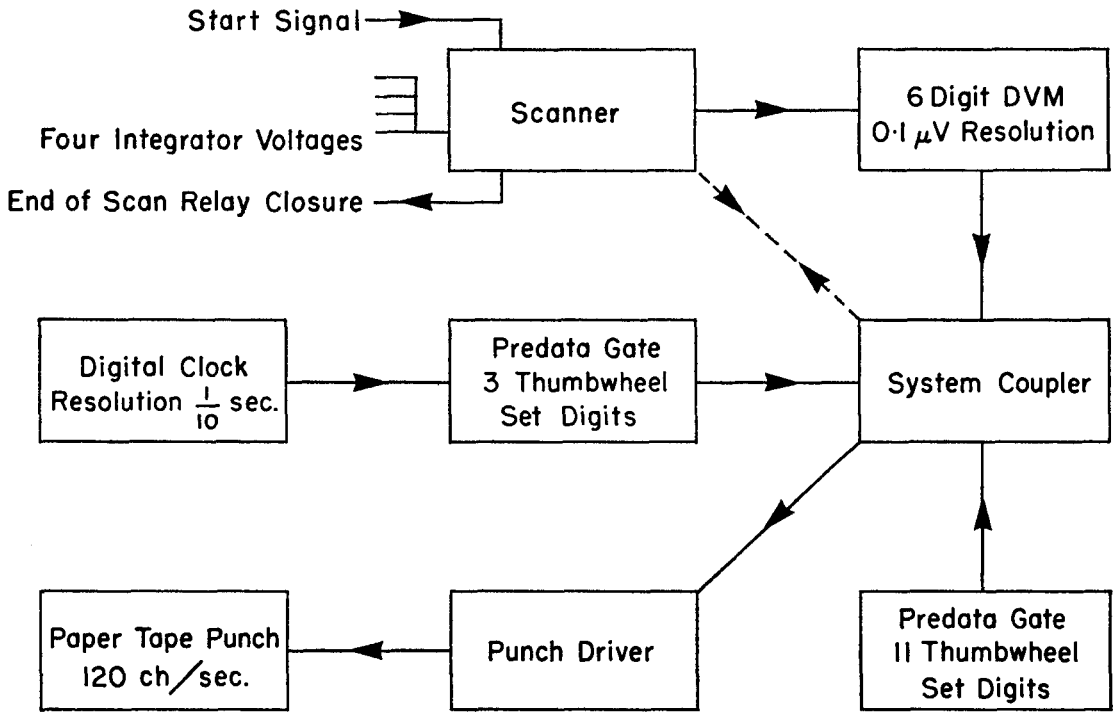

Fig. 2

DISCUSSION

L. W. FREDRICK: What is the integration time?

G. A. H. WALKER: We have used a minimum time of 5 or 10 sec, but we can go from 1 up to 999 sec.

R. E. NATHER: What is the transmission efficiency of your whole system compared with straight-through photometry?

G. A. H. WALKER: It seems to be extremely good. It's the same sort of miniature grating that Hoag is using, and we're using 1 cm beam diameter, and the grating efficiency is about 85 per cent.

J. TINBERGEN: Leiden Observatory has had a system very similar to yours running in South Africa since 1966. We agree about the programming effort necessary: about as much astronomer's time has to be invested as is saved on one year's observations. Therefore this sort of approach is worth the effort only for several years' run with the same or similar photometer. If you wanted to build a system like this again, would you agree that one should include a small computer rather than build everything hardware?

G. A. H. WALKER: I don't think I'd ever build it again! I hope to present tomorrow a paper on a 1400-channel photometer, and we do use a computer with that.

E. W. DENNISON: Is there any display of the count?

G. A. H. WALKER: I forgot to point out the digital voltmeter and digital clock on the slide. We don't have a monitor of the integration as such; it was originally in the system, but nobody seemed to require it. The scan can be slowed down so that you can watch the voltage from the individual photomultipliers.

P. J. TREANOR: What colour system does the four-channel photometer use, and what have you done about standards for the system?

G. A. H. WALKER: We call it the Victoria system! It matches the B and V of UBV; we isolate the higher members of the Balmer series, the Balmer continuum, and then, an additional complication, we introduce a mask into every other observation, to split B and V and get a much longer baseline for reddening and so on. It's a five-colour system in fact. We have a paper out now on standards, we've set up a self-consistent system and we've only tied it to B and V, the rest is our own.

W. LILLER: Can you give us a quantitative idea as to how free from cloud interference your colour measurements are?

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G. A. H. WALKER: We can observe through three magnitudes of cloud and the error is probably no worse than 0.01 magnitude, that may in fact be due to the faintness. The clouds have to be grey, we seem to have fairly grey clouds in British Columbia!

R. F. NIELSEN: Do you have any particular reason for using this rather unusual integrator-capacitor configuration, rather than using the capacitor in the feedback loop of the operational amplifier?

G. A. H. WALKER: Fortunately the photomultiplier has such an enormous impedance that you can treat it as a current generator, so one is not worried about the voltage appearing across the capacitor. If you use a Miller integrator of the Weitbrecht type, the leakage across most chopper-stabilized operational amplifiers is too great, but if you introduce 100 per cent feedback then you decrease the size of this by the total gain of the system. It's just a property of feedback. And because one isn't worried about the fact that the feedback voltage is rising, it's essentially a current integrator, not a voltage integrator.