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ELECTRONIC TRACKING SYSTEM FOR SOLAR PHOTO VOLTAIC PANELS

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ABSTRACT

The photo voltaic cell, which converts the solar energy to a more convenient form, has been given a due focus in the recent years. Its performance could be boosted by making it to track the sun. But such a tracking system should be less expensive and simple to operate. A method to track the sun discontinuously with in a certain deviation angle has been developed and tested.

A simple electro-hydraulic on-off control system was used on a Photo Voltaic panel to make it track the sun. The system is basically an uniaxial tracker with the other axis to be manually adjusted. It has an electronic eye to detect the sun, allied driver circuitry and an automated hydraulic valve and ram assembly, tilting the P.V. panel to track the sun. The sun seeker or the electronic eye was tested for its response characteristics to track the sun with a least poiting error. Similarly the weight added on the solar panel to improve the hydraulic response of the control system, was also optimised to give the best performance.

The tracking system was set to track the sun East - West, with the second axis tilted at 35 deg North - South on December 10 and compared with a similar panel set without the tracking system. Both the panels were electrically loaded and their energy output characteristics were recorded. Since the tracking system in unaiaxial and could not accommodate the azimuth changes, the pointing error was also recorded periodically.

The study showed that the elevation error was restrained because of the positive tracking cycles of the system and was in perfect synchronization with the on-off signals of the control system. The peak power obtained from the tracking solar panel was 103 to 120 W against that of 80 - 109 W in the non-tracking panel at a solar intensity of 75 - 90 mW cm^{-2}.

KEY WORDS: Solar tracking, P-V panel, Pointing error

The photo-voltaic cell, which converts the solar energy into a more common utility, has been given a due focus in recent years. Its performance could be improved by making it track the sun. But the tracking mechanism should be less expensive, have a simple construction and be operated by a small power. A method to track the sun discontinuously by detecting it within a certain deviation angle has been suggested and tested for performance against a non-tracking P.V. panel.

Mosi *et al.*, (1977) explained a solar energy collector equipped with a discontinuous tracking device. Edwards (1978) designed a computer system controllinga paraboloid collector. Carden (1978) described a similar work on a system for steering a two axis mirror by means of shared computer based controllers. Spielberg (1989) experimented with an inexpensive dual axis solar tracker for P.V. modules and concluded that a 40% improvement is possible.

MATERIALS AND METHODS

Description of the System

A hinged frame supporting the P.V. modules is counterweighed and is restrained by a hydraulic ram assembly pin-connected between the frame and the structure. The ram's outlet is connected to an oil reservoir through an automated solenoid valve. The valve on opening allows the oil to escape into the reservoir, thus tips the module down. At the start of the day oil could be loaded into the ram from the tank through a one way suction port to set the P.V modules facing east.

The detector or "seeker" has a photo-transistor, installed inside a collimator tube of 1/20 diameter to length ratio. The collimator's dimensions were so chosen to accommodate a wider detect angle. A wider angle is required since the system does not accommodate variation in

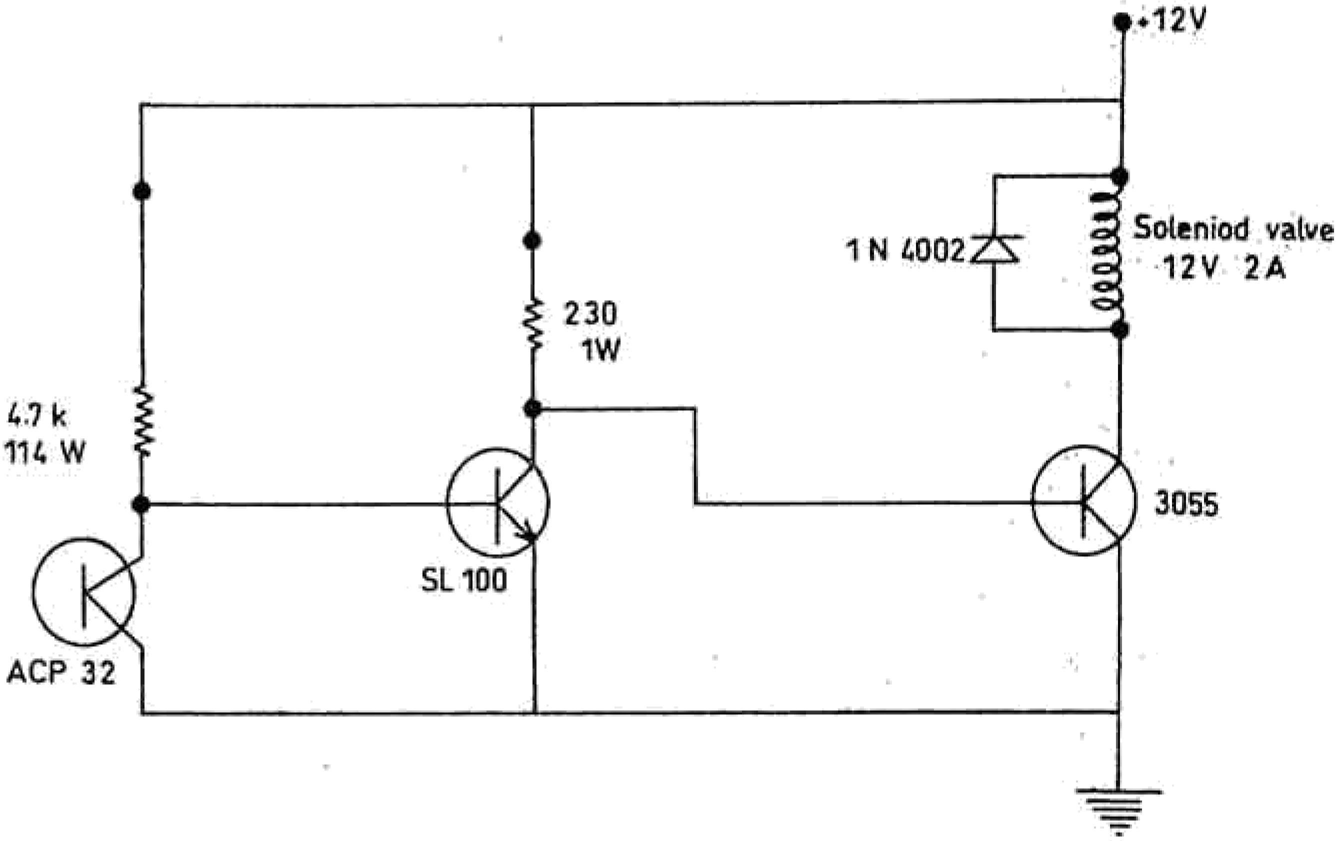

Fig. 1. Circuit diagram of the electronically controlled relief valve

azimuth angle during the day. The detector is centrally mounted on the module, tilted away at 45 deg to the module's vertical axis. This ensures commencement of a positive detect cycle at the dawn of the day.

When the sun moves into the detect zone of the "seeker", the radiation penetrates into the collimator and activates the photo-transistor. This, in turn, activates the solenoid valve through necessary drivers and power transistor network (Fig. 1). The valve allows the module to tilt away from the sun and the "seeker" also along with. Once the seeker comes out of its detect zone, the valve is closed and the module stops tilting. This cycle of events is repeated as a simple discontinuous feed back loop and the sun is tracked.

The Experiment

The tracking system was set to track east-west with the panel inclined at 45 deg North-South on December 10. It was compared with a conventional non-tracking panel tilted at 11 deg towards South.

The specifications of the P.V. modules, used in both the systems were :

Make	:	ARCO SOLAR
Module size	:	121.5 x 30.5 cm - 4 Nos.
Maximum power	:	43 W
Maximum current	:	2.4 A at 1000 W m^{-2} solar insolation
Maximum voltage	:	17.3 V
Short circuit current	:	27 A

RESULTS AND DISCUSSION

Response of the Hydraulic Circuit

The system response depended on the valve opening size and the counterweight. The former being constant, the counterweight was manipulated to acquire the required response. The

Table 1. Response of the hydraulic circuit

Counterweight (kg)	10.0	11.0	12.0	13.0	14.0
Time for 1 cm displacement of hydraulic ram (s)	25.0	22.8	16.6	14.5	12.4

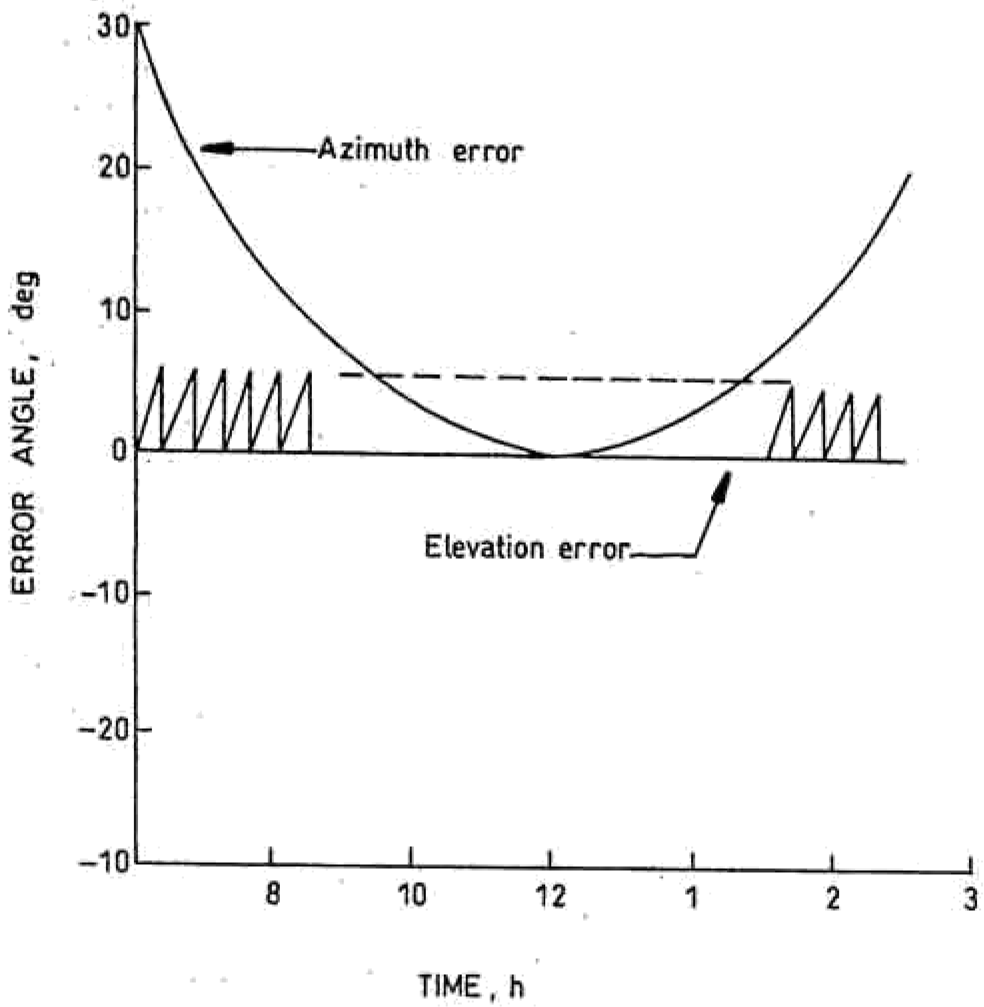

Fig. 2. Pointing Error

response of the system to various counterweights is shown in Table 1. The counterweight was chosen as 10 kg, the basic minimum necessary to overcome oil pressure and to avoid excessive pointing error.

The azimuth and elevation pointing error on December 10 when panel was set at 45 deg N-S tilt is shown in figure 2. Since system did not accommodate for azimuth changes, the respective error widely varied. But the elevation error is restrained due to positive tracking cycles and was in perfect synchronisation withthe on-off signals of the controller.

The energy gain of the tracking panel over the non-tracking panel was computed, in terms of the maximum power rating offered by both the systems at the same instants. The peak power in the tracking system is 103-120 watts against that of 82-109 watts in the non-tracking system, at a solar intensity of 75-90 mW cm^{-2}. This is 10 - 25% increase over the non-tracking system. The cost of the tracking system is Rs. 2250/-. The economic feasibility in adopting this system will improve much further, if used for tracking solar panels with higher power outputs.

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