Chapter I

INTRODUCTION

1.1 Statement of the Problem

There are many sources of natural energy, the most common of which is an organic fossil fuel. But, because of its limited reserves and the continuously rising consumption, the amount of available fossil fuel is decreasing rapidly and will be gone from the earth in the near future. Thus, men face two alternatives, either to look for new sources of natural energy or to reduce its consumption. As the latter proves to be politically and economically undesirable, the effort is directed towards finding a fuel substitute. In this respect, the plentiful solar radiation seems to be an ideal choice. Everyday the sun moves from the East in the morning to the West in the evening. The maximum radiation occurs mid-day when the solar radiation is perpendicular to the surface of the earth. Hence, to acquire maximum energy, a tracking system must be designed and constructed in such a way that it follows the sun movement.

1.2 Objective

This thesis intended to present a design and construction of an automatic solar tracking system. The system will track along the movement of the sun by using two solar cells as a detector. The requirement is to control the flat plate (solar array) to lie in the position perpendicular to the solar radiation all day.

1.3 Basic Concept of an Automatic Tracking System[12]

Servomechanisms prove their usefulness in applications where it is necessary to duplicate at remote distances physical motions without using any mechanical linkages between the controlling device and the device being controlled. The basic concept of an automatic tracking system is the same as a remote-control positional servo - mechanism. The schematic diagram is shown in Figure 1.1 (a) .

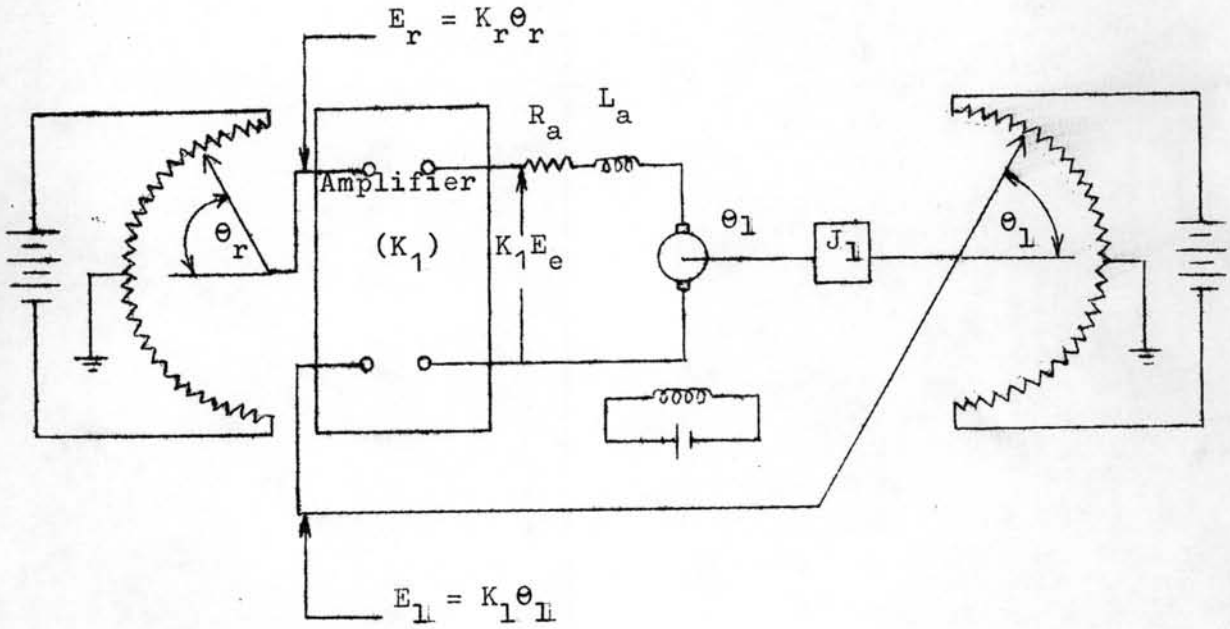
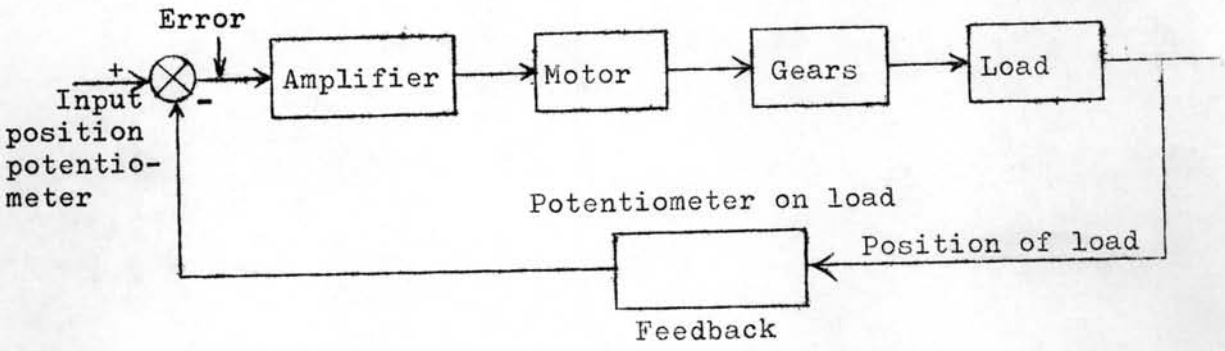


Figure 1.1 (a). A Schematic Diagram.

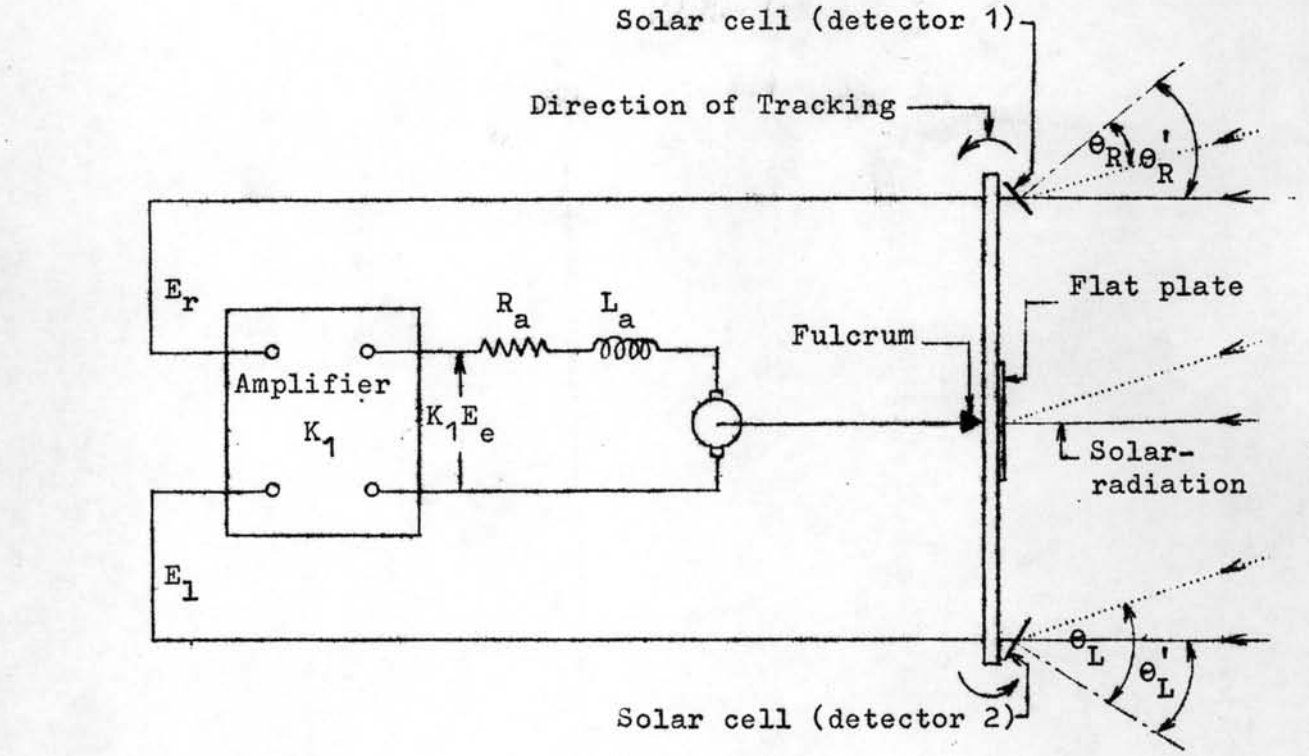


(b) Block Diagram

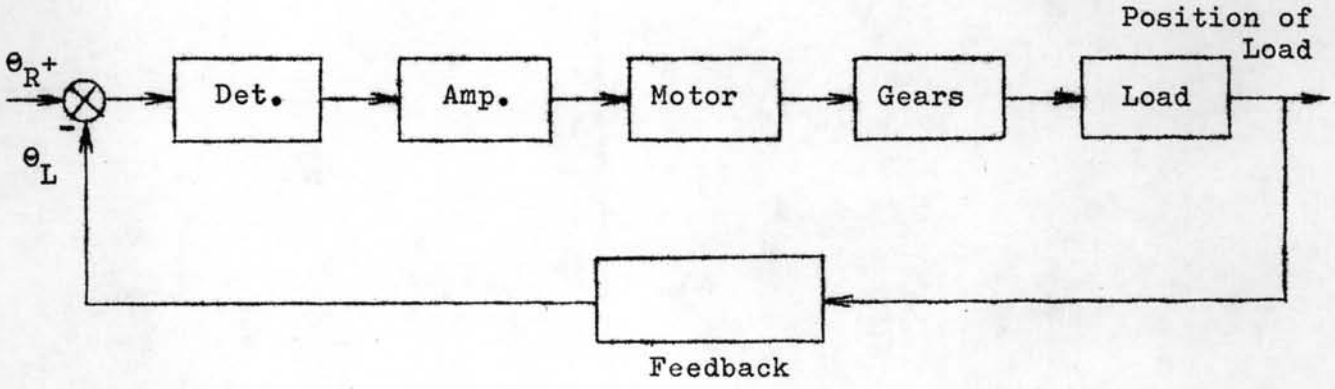
Figure 1.1. Remote Control Positional Servomechanism.

The wiper arm of the input potentiometer is positioned by the desired input position θ_r, so that the voltage E_r is proportional to θ_r (that is $E_r = K_r \theta_r$) . Similarly, the controlled shaft position θ_l determines the position of the wiper arm for the other potentiometer so that $E_l = K_l \theta_l$. The error signal $E_e = E_r - E_l$ is amplified by the amplifier with gain K_1, and the resultant voltage is applied to the terminal of a constant field d.c. motor so that $E_a = K_1 E_e$ the block diagram for this system is shown in Figure 1.1 (b) .

The preceding position controller may be converted to a solar tracking system by replacing the potentiometers with the solar cells as shown in Figure 1.2 .



(a)



(b)

Figure 1.2. A Solar Tracking Servomechanism

(Before the system starts tracking, $\theta_R' = \theta_L'$)

The detectors are positioned by the motor because they are fastened to the ends of the lever. When the sun moves to a new position (as shown in Figure 1.2 (a). by two dotted lines), the voltage E_r generated by detector1 is proportional to θ_R and the voltage E_l generated by detector2 is proportional to θ_L. The error signal $E_e = E_r - E_l$ is amplified by the amplifier; and the resultant voltage is applied to the motor so that $E_a = K_1 E_e$. The motor stops when there is no error signal; in other words the lever will move to the new position until $\theta_R = \theta_L$. The lever will be placed in a plane perpendicular to the solar radiation. The block diagram for the system is shown in Figure 1.2 (b) .

1.4 Outlines

Following the basic principles of the tracking system described in this chapter, the preliminary design which includes the system descriptions will next be given. In Chapter III, the selection of the circuit and its components employed in the system will be presented. Chapter IV describes the method of designing the complete system. The results and analysis together with details of experimental work will be discussed in Chapter V. This is followed by the discussion of the results in Chapter VI and the conclusion and recommendation in Chapter VII. The appendices contain other useful information relevant to the design of the tracking system.