XIV. VISUAL REPLACEMENT PROJECTS

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A. OPTICAL COMPONENTS FOR TRAVEL AID

A major delay in progress on the travel aid has resulted from continued difficulties with the optical components. The optical system, as described in the Quarterly Progress Reports for October 15, 1954 and January 15, 1955, has proved quite adequate for the obstacle detection function. However, it has not been found satisfactory for step-down detection under the variety of conditions which must be encountered in the practical use of a travel aid. As previous reports have frequently suggested, the dynamic range requirement for the step-down detection signal (because of extreme variations in the reflectivity of the terrain) is 50-55 db. This is admittedly a difficult figure to attain. However, for the operation of the detector to be reliable, the attenuation of the signal produced by a step-down of two inches in height or more must be at least a few decibels greater than the attenuation produced by any other characteristic of the terrain, such as puddles. In other words, the vanishing of the signal when the instrument encounters a step-down must be practically absolute. This can only be achieved if the image space within which reflected light can reach the step-down detection photo cell is very nearly identical with the geometric image space defined by the optical system.

In the present receiving system for obstacle and step-down detection, the evacuated bulb type PbS photo cells formerly employed have been replaced by improved versions of the older "button cell" used in our earliest models. These new button cells have characteristics equal or superior to the evacuated bulb type and serve to eliminate the risk of multiple reflections occurring inside the glass bulb. The active area (0.004-0.065 inch) is sharply delimited by a deposition of gold more than 1.0 μ thick. The entire cell is covered (to prevent entrance of moisture) by a mica window 0.001 inch thick. Thus these cells would seem to be quite adequate optically. The system incorporates provisions for accurately centering the active area of the cell on the axis of the mirror and for properly focusing the mirror.

Calculation indicates that, with the step-down detection system properly adjusted, its operation should be satisfactory if a mirror could be obtained with a circle of confusion as small as 0.002 inch. As a previous report stated, the present mirrors have circles of confusion at least five times this diameter. Doubtless the machining that had to be done on these mirrors has made conditions even worse. We are advised by competent lens designers that it is possible to produce a glass parabolic mirror meeting our specifications, but the cost is far too high for anything beyond one or two laboratory models of the travel aid. It has therefore been concluded that we must now investigate the possibilities of using some other optical arrangement, such as a Schmidt system, for the step-down detection receiver.

B. AUTOMATIC SCANNING

Considerable effort has been devoted to the problem of devising a means for automatically scanning the travel aid optical system in azimuth. The obvious scheme of using a small, low-power-drain motor with a gear train and crankshaft had to be rejected early in the work because no assembly could be found or designed which would fit into the space allowable for the scanning mechanism. One scheme, which works quite well but consumes too much power, is shown in Fig. XIV-1. The driving unit is a small solenoid (A) which carries a spring "bumper" assembly (B). On the front of (B) is mounted a thin plate of phosphor-bronze (C) which makes contact with a gold strip just behind it when a force of about one gram is applied to it. This arrangement serves as a switch to energize the solenoid. Since the solenoid requires a current of about one ampere at 1.5 volts, the contact resistance of the switch must be very low even with slight contact pressure – hence the use of the combination of gold and phosphor-bronze. Assume that the crank arm (D) mounted on the optical system is moving counterclockwise from (P) toward (Q). Just before it reaches the mid-point (M) of its motion, the ball bearing on the end of (D) will touch the phosphor-bronze plate (C) closing the solenoid contact. The system will swing on past (M) by inertia, but as it continues to swing toward (Q) the plunger of the solenoid will keep the bumper (B) against the end of the crank arm, pushing with increasing force as it nears the forward end of its stroke. Thus the oscillating optical system receives an acceleration as the end of the crank arm moves away from (M) toward (Q). A similar acceleration is imparted to the system

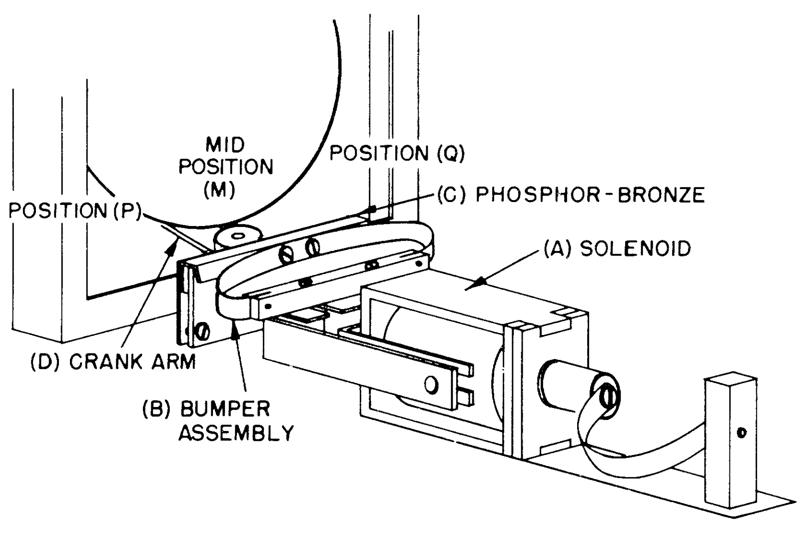

Fig. XIV-1
Automatic scanning mechanism.

during the next half cycle of its oscillation as the crank arm moves away from (M) toward (P). The rather large magnitudes of the energy pulses which have to be fed to the optical system to keep it oscillating are necessary to make up for the losses caused by damping by the two coaxial cables required for the photo cells in the receivers. If it were not for these cables, the optical system could be made resonant with a scanning period of 0.8 sec to 1.0 sec by a suitable spring, so that very little power would be required for scanning.

The power consumption of the present scanning mechanism is far too high – of the order of 600 mw. This is because the solenoid is drawing current for almost 40 per cent of the time. It should be possible to modify the design of the scanner to greatly decrease this "duty cycle." In fact, a design has already been tried which reduces the duty cycle to about 10 per cent, but its operation is not yet reliable.

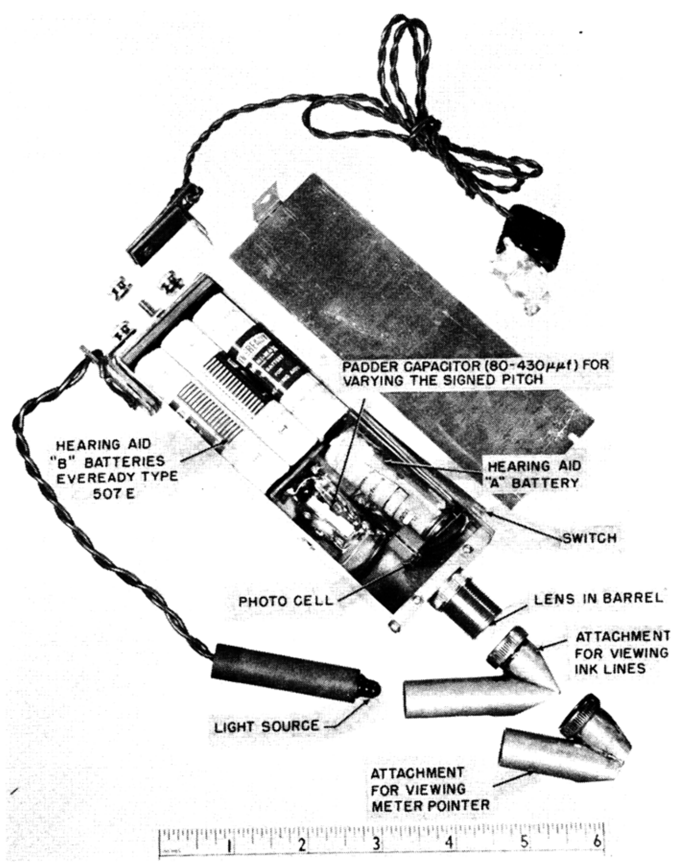

Fig. XIV-2
Optical probe.

C. IMPROVED OPTICAL PROBE

During the past year, many organizations for the blind have expressed increasing interest in the so-called "line and pointer locator" described in the Quarterly Progress Report for July 15, 1953 (p. 56). We accordingly decided a short time ago to attempt to improve the design somewhat and consider the problem of engineering a possible production model. An improvement far beyond what we had anticipated was obtained by the replacement of the PbS photo cell with a CdS cell (type CL1) manufactured by the Clairex Corporation of New York City. Samples of this cell were generously supplied to us by A. F. Deuth, vice president of the corporation. As a consequence of this remarkable improvement in sensitivity (change in cell resistance per unit change in light intensity), the auxiliary beat frequency oscillator and potentiometer could be entirely eliminated. The light source now employed is a General Electric type 222 prefocused pen-light bulb operated from a single Mallory type RM-12 mercury cell incorporated in the device. Since the nominal voltage of this lamp is 2.2 volts, it is being operated considerably below normal temperature, and hence should have a much longer life. According to the manufacturers' ratings, the RM-12 cell should operate this lamp for about 18 hours. The attachments for viewing ink lines and meter pointers are the same as in our former model, but the new model is sufficiently sensitive to be used for numerous other purposes. One application of immediate interest would permit blind telephone operators to quickly locate the positions of flashing lights on a switchboard. The device is also capable of "seeing" distant light sources, such as street lights, or even the moon, when the lens is focused properly. A photograph of the new version of the probe, with cover plate removed, is shown in Fig. XIV-2. Note the switch on the right-hand side near the front end, which is closed by pressure of the fingers on the device when it is held in the hand.

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