secondary lobes of the main pattern so that the observer does not hear false bearing indications. The observer hears the 600-c/s modulation note followed by a fade-out of this modulation and then a group of bearing announcements interleaved with the code name. The middle announcement of the group is the course he has to steer in order to home on the beacon. The accuracy of this type of beacon is ± 5 deg up to 110 miles at 10,000-ft altitude.

This Section of the paper would not be complete without reference to a rotating beacon called "Bernhard" used by the Germans for air navigation during the latter stages of the war. The aircraft component, called "Bernhardine," comprised a

in the band 30–33.5 Mc/s and radiates two transmissions which are 10 kc/s apart and tone-modulated. The lower aerial consists of two groups of four vertical elements, fed in anti-phase to give a minimum signal along the line normal to the array. This aerial provides the azimuth bearing indication. The upper aerial consists of three vertical elements fed in phase and providing a directional pattern giving a maximum signal along the line normal to the array (Fig. 6). This aerial provides the signals which print bearing on the tape. Two 5-kW transmitters, contained in the building beneath the array, feed the two aerials.

The receiving equipment follows normal practice except that filters separate the modulation channels. The derived signals, after amplification, are used to operate the teletypewriter, which works on the German Hellschreiber system.

The lower aerial radiates a continuous tone-modulated signal. During rotation of the beacon this signal is shown on the tape as a horizontal line about ½ in wide. The signal amplitude falls to zero when the aerial is normal to the observer, thus marking a distinctive "V" notch on the tape. The upper aerial radiates an impulse-modulated signal which prints below the bearing-indication trace a complete scale with bearing readings and the code letter of the station. Alternatively, short messages may be sent on the upper aerial which are recorded in the same manner (see Fig. 7). The accuracy of the system is stated to be ½–1 deg, and the range depends upon flying altitude. Typical ranges provided by the equipment are 130 miles at 3,000 ft and over 300 miles at 25,000 ft.

receiver and a teletypewriter of small dimensions and provided the user with bearing indications printed on a tape.

A view of the ground beacon is shown in Fig. 5. This is a large rotating steel frame which carries the aerials and the transmitter equipment and turns at 2 r.p.m. The beacon operates

Fig. 5.—Bernhard station.

ranges provided by the equipment are 130 miles at 3,000 ft and over 300 miles at 25,000 ft.

(4.4) Hyperbolic Systems

Particulars of hyperbolic systems of navigation such as Gee and Loran, which depend upon the transmission of time-locked pulses from widely separated transmitting stations, have been published elsewhere. The c.w. counterpart of these systems is exemplified by the Decca Navigator and the Post Office position indicator. The former is a frequency-multiplex system and the latter is a time-multiplex system. Both systems are able to provide comparable service and differ only in the technique employed.

The Decca Navigator provides facilities for the navigation of aircraft and ships at short and medium distances, and depends for its operation upon the transmission of c.w. phase-locked