INSTRUMENTS

RADIO ACOUSTIC RANGING CIRCUITS

by

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(Extract from the *Field Engineers Bulletin* N° 11, published by the U.S. Coast and Geodetic Survey, Washington, D.C., Dec. 1937, p. 99).

The accompanying circuit diagrams were drawn primarily for a revised edition of the RAR Manual now in progress. They represent what are believed to be ideal circuits rather than what are used by any one hydrographic surveying party. If entirely new equipment was to be built, these drawings would serve as a guide on how to start operations. Some portions of the circuits are taken from Pacific Coast procedure and others from Atlantic Coast practice, and the ensemble was made up of the best of each, with an attempt to bring everything up to date using the latest types of tubes and equipment.

For the benefit of those who are interested only in the general procedure and as a guide to the other more detailed wiring diagrams, Plate I was made to show the outline of the entire process. The upper portion shows the surveying ship equipment necessary for RAR. When the bomb explodes in the water, a hydrophone conveys the impulse to the bomb amplifier which makes it strong enough to operate a chronograph (See Plate II). A chronometer marks second intervals on the chronograph tape and immediately after the bomb signal is recorded, a switch is changed to connect the chronograph to the radio receiver so that the return radio signal may be recorded on the same chronograph tape. This receiver is generally equipped with a loud speaker so that the head phones are unnecessary. In order that there may be communication with the hydrophone stations a radio transmitter is necessary on the surveying ship. This transmitter is separate from the regular ship transmitter and receiver used for official communication with other ships and shore stations, receiving weather reports, distress signals, etc. The RAR transmitter and receiver are used for high frequencies, the standard ship equipment for low frequencies. It is also necessary to communicate with the bridge and either a speaking tube or telephone is used for this. A push button is used to operate an electric bell or buzzer to signal the bomber when to fire bombs, and the desired size of bomb is generally designated by the number of rings on the buzzer.

In the lower right of Plate I is shown an RAR station equipment. Such stations on the Pacific Coast are almost always shore stations, but on the Atlantic Coast the same equipment is on a "station ship" since shore stations were never successful on the Atlantic Coast. In either case a hydrophone is hung in the sea with a cable to the bomb amplifier from which the amplified sound may be heard and it also passes to a radio transmitter which is actuated automatically by the bomb signals. It is this radio signal which returns to the ship to actuate the chronograph. Since communication between the RAR station and the ship is necessary, a radio receiver is provided, which, with the key-operated transmitter supplies high frequency radio communication between them whether the RAR stations are on shore or afloat.

The story of the floating RAR station is probably already past history. The first such stations were the *Ranger* and *Echo* working in Florida waters with the *Lydonia* in March 1930, and probably the last such were the *Gilbert* and *Welker* working in Delaware waters with the *Oceanographer* during the summer of 1937.

The successor to the floating RAR station is the sono-radio buoy. My first idea of this was to use a small floating audio amplifier and transmitter on the Pacific Coast to be attached to the regular hydrophone for the purpose of sending a weak radio signal to the shore station which would automatically transmit a stronger radio signal to the ship on a different frequency. This arrangement would have eliminated the difficulty of laying heavy cable through the surf between the hydrophone and the shore station. I proposed this idea in December 1931. I was asked why it could not be used on the Atlantic Coast also. My feeling at the time was that the radio signals would not be strong enough for more than about five miles. Anyway the sono-radio buoy is now a fact, amply proved by the results of the past two seasons.

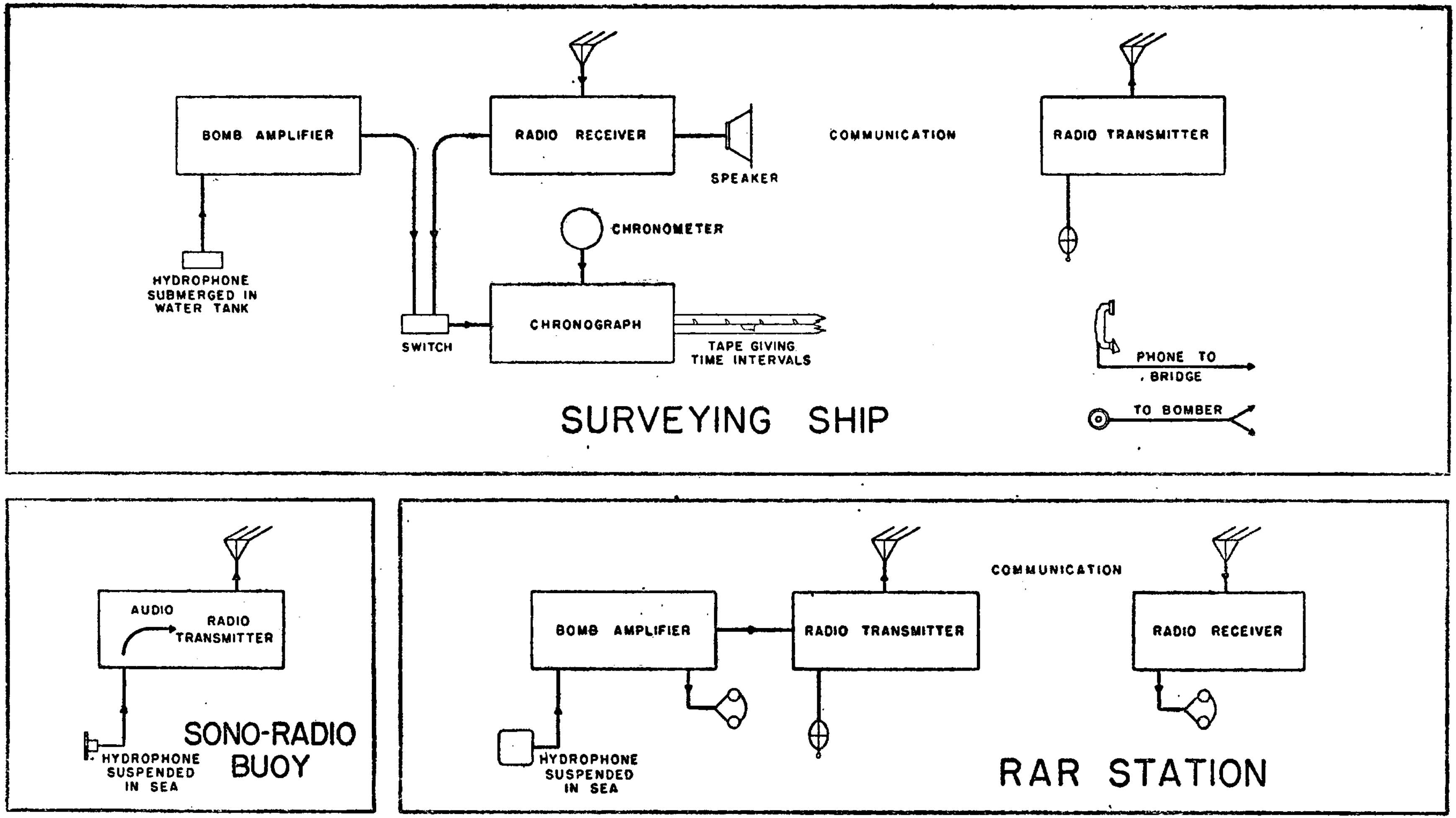
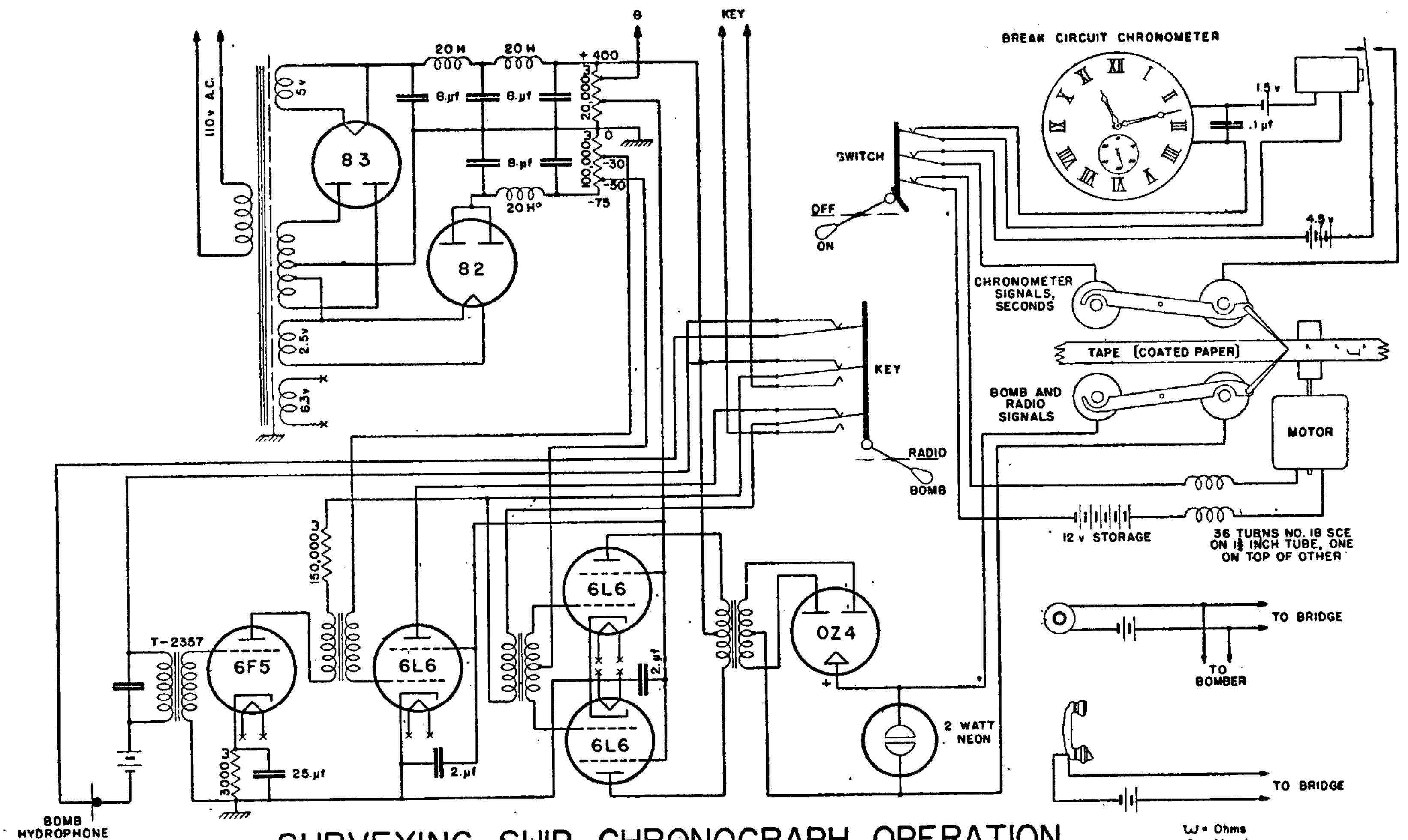


PLATE I.

PLANCHE I



SURVEYING SHIP CHRONOGRAPH OPERATION

PLATE II.

PLANCHE II

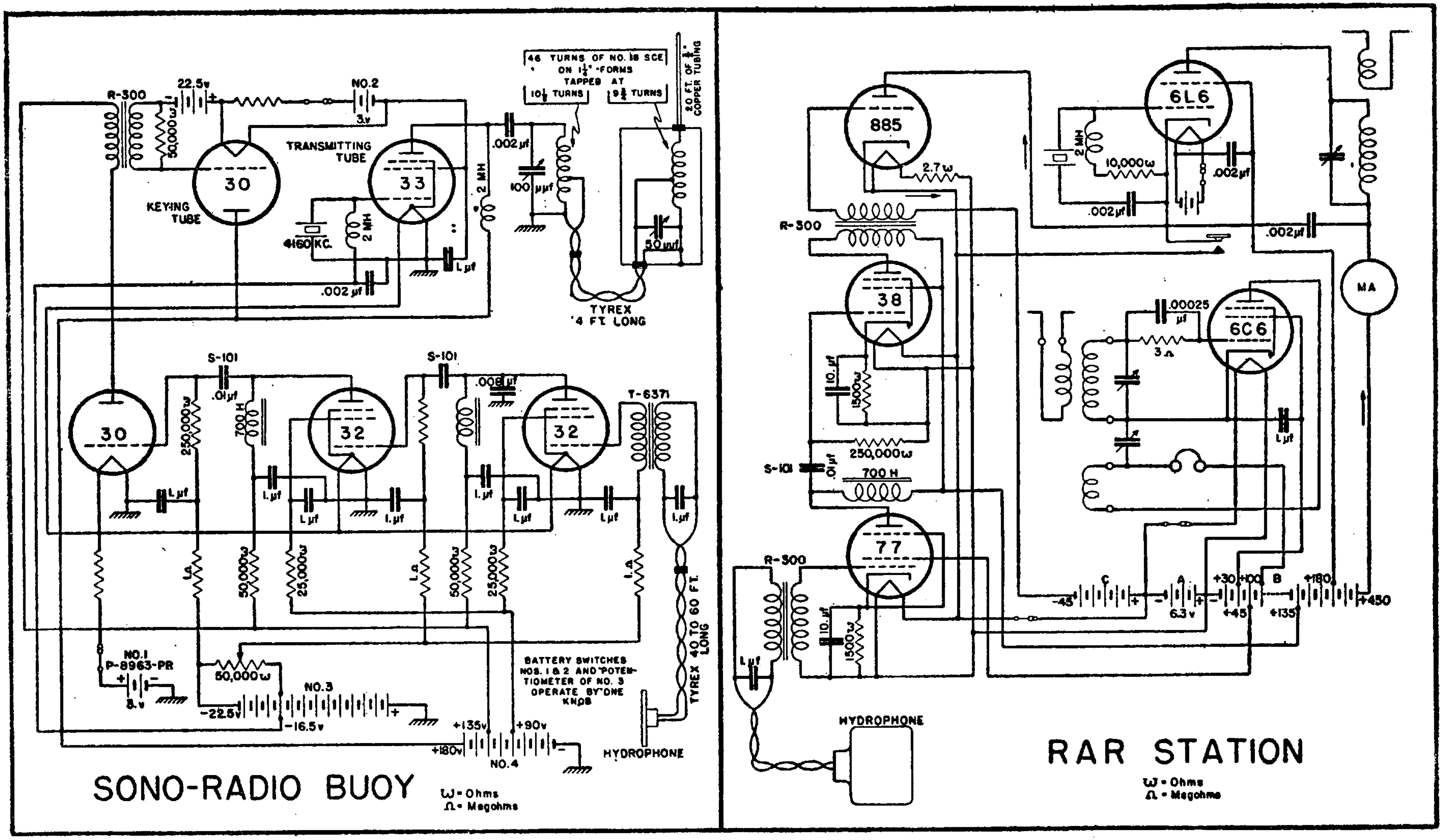
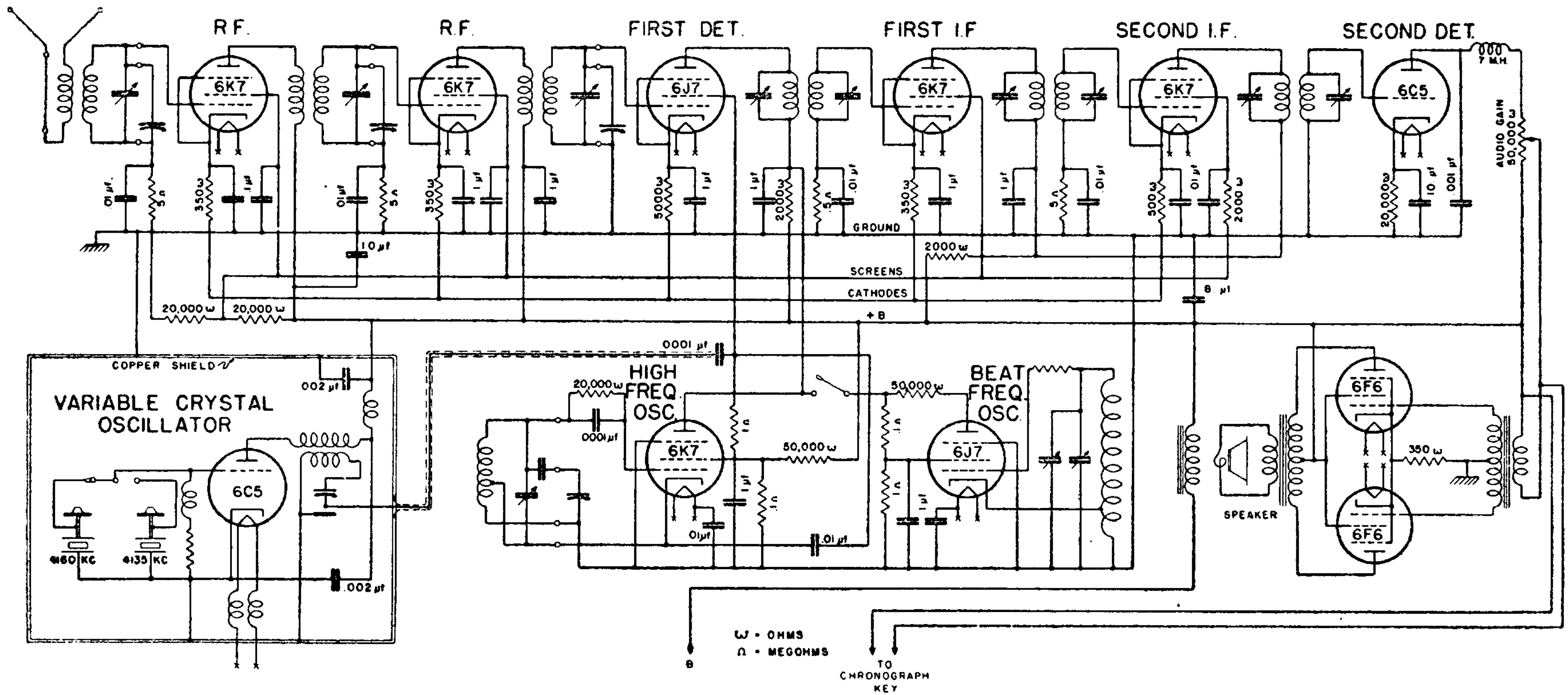


PLATE III.

PLANCHE III



RADIO RECEIVER

Plate IV.

Planche IV

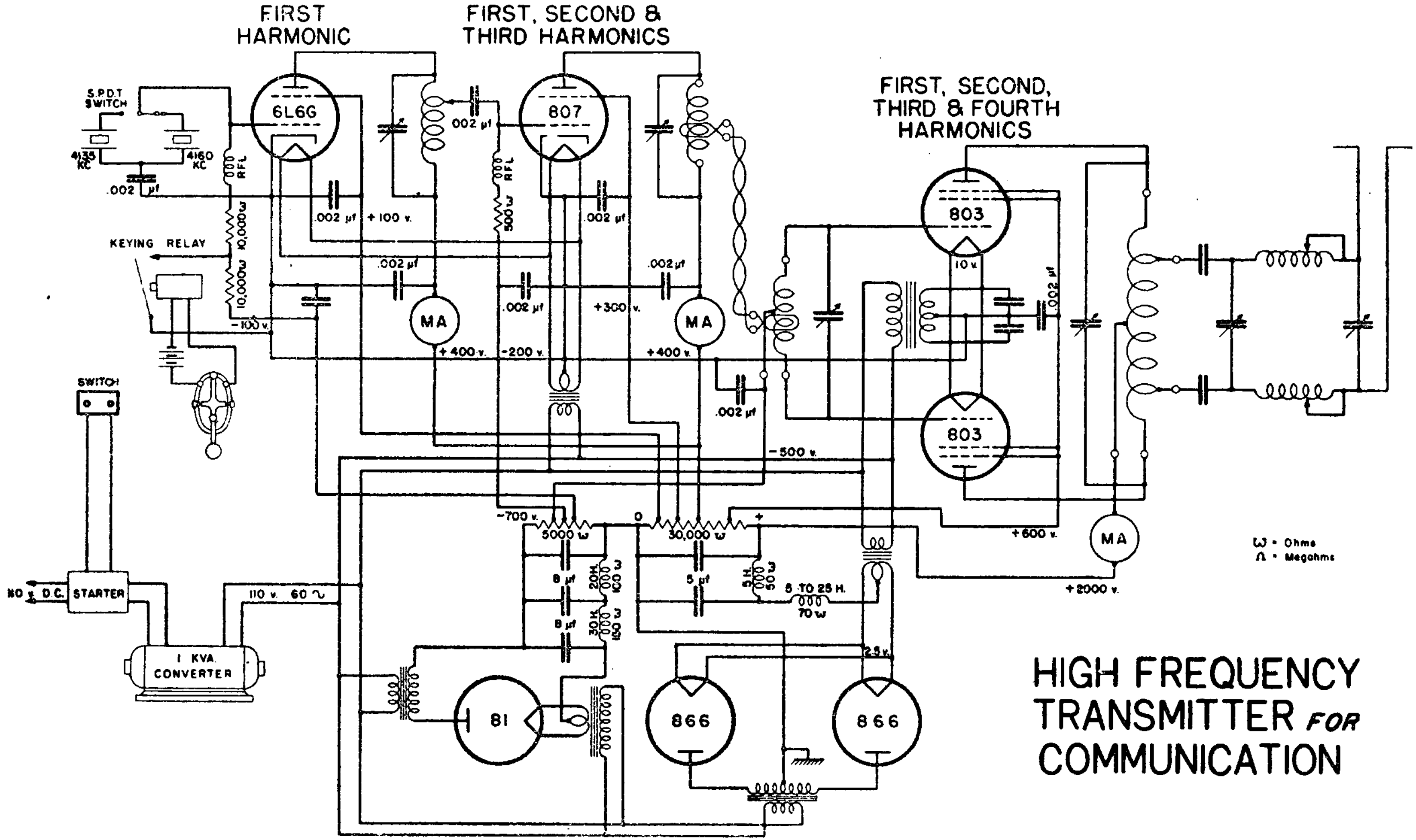
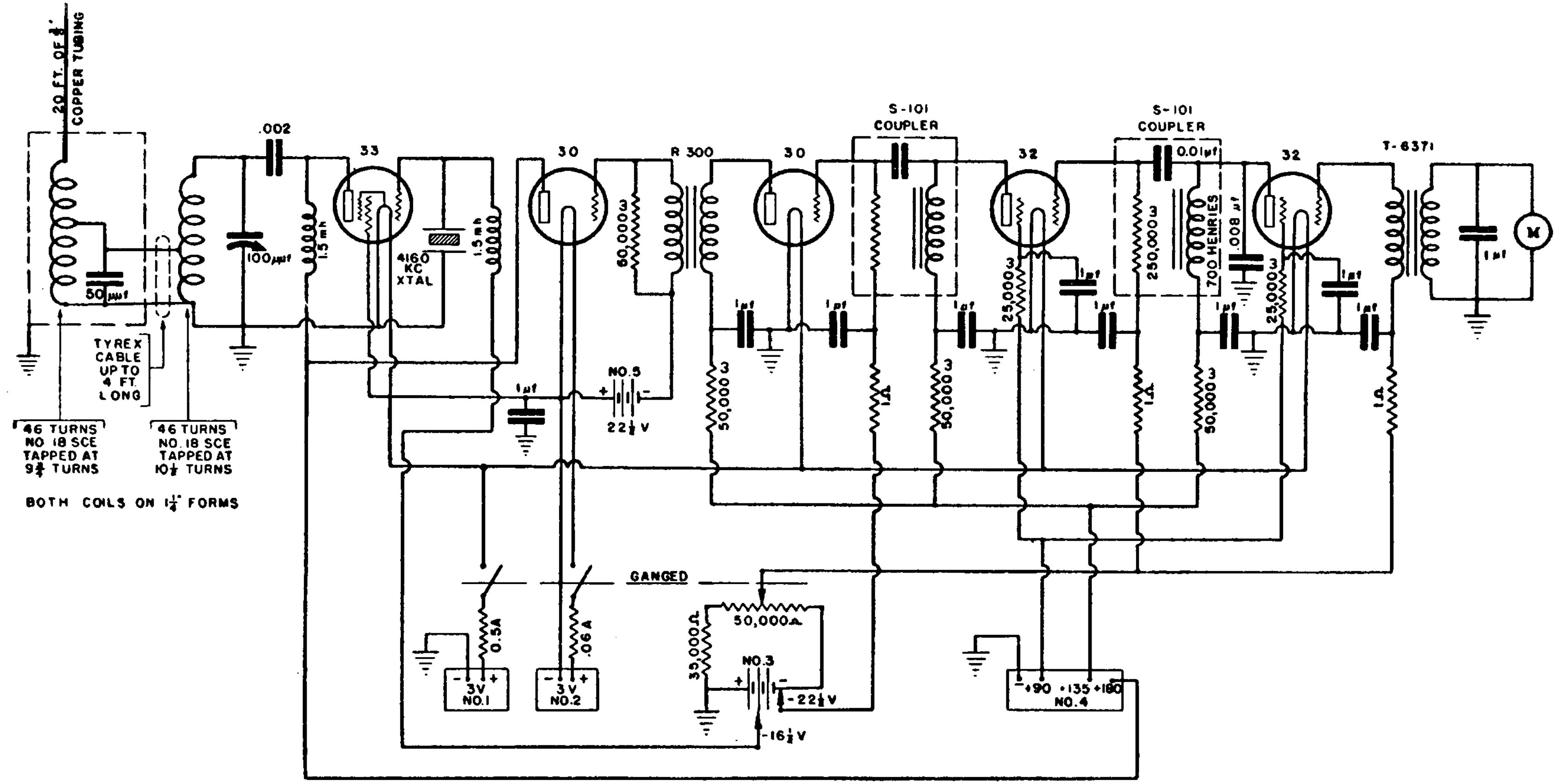


PLATE V.

PLANCHE V



U.S. COAST and GEODETIC SURVEY

R.S. Patton, Director

SONO-RADIO BUOY CIRCUIT

Used by *Lydonia, Hydrographer* and *Oceanographer*

1936

Few readers who have gone this far would care to follow details of the circuits as it would be rather technical reading. Attention is invited to one item, however, so that credit may accrue to the Coast and Geodetic Survey. In the lower left of Plate IV, labelled *Radio Receiver*, is shown a variable crystal oscillator. I used this method of radio reception on the *Oceanographer* during the summer of 1930 and it has been used continuously at radio station WSP since that time. The idea is to introduce a small amount of radio frequency voltage of nearly the same frequency as that being received, instead of using the beat frequency oscillator. Thus the crystal oscillator is much more constant, and varying the amount of radio frequency voltage introduced helps to keep down the effect of static and makes reception from the RAR stations and sono-radio buoys easier. The ships *Hydrographer*, *Lydonia* and *Oceanographer* have been using this system successfully during the past season. Like anything good, this has also been discovered by others and it is now on the market in some receivers. Its use will probably be extended to more of our equipment.

SONO RADIO BUOY

(Extract from an article by LIEUTENANT-COMMANDER JACK SENIOR,

Commanding officer, U.S. Coast and Geodetic Survey Ship *Lydonia*).

Information concerning the new Sono Radio Buoy which has been used during recent years by the U.S. Coast and Geodetic Survey for radioacoustic ranging in surveys out of sight of land, was given in *Hydrographic Review*, Vol. XIV, N° 2, November 1937, pp. 66, 258, 261.

In N° 11 of the *Field Engineers Bulletin* published by this Service in December 1937, Lieutenant-Commander Jack SENIOR, Commanding officer of the Surveying Vessel *Lydonia*, gives a number of additional details, from which the following have been extracted.

. . . .

Sono-radio buoys were used successfully in shallow water, i.e., in depths less than twenty fathoms. In shallow water over the irregular bottom encountered this season, the *Lydonia's* sono-radio buoys were effective for distances up to nineteen seconds (*) (approximately fifteen nautical miles). Over regular bottom, signals from greater distances were easily received and recorded; in the shallower areas, with intervening shoals, sound reception was more or less uncertain with a corresponding decrease in effectiveness of radio acoustic hydrography. Offlying shoals were sounded and developed using radio acoustic methods of control with an accuracy of position closely approximating that obtained by visual fixes.

. . . .

The party on the *Lydonia* also made the deep water survey of the continental slope and of the extension of the Delaware Submarine Valley. This survey was made on the scale of 1:120,000. Four sono-radio buoys, one of which was borrowed from the ship *Oceanographer*, anchored near the edge of the continental shelf, were used simultaneously during this survey. The positions of these four sono-radio buoys were determined by the party on the *Oceanographer* by taut-wire measurements and sun azimuths. Hydrography was accomplished offshore by the *Lydonia* out to the 1000 fathom curve, and in the vicinity of the Delaware Submarine Valley the survey was extended 40 nautical miles beyond the 1000-fathom curve into depths of 1,600 fathoms. This afforded a most critical test and at the seaward limits of the work radio-acoustic ranging was only moderately successful. Bomb returns were received successfully for distances up to about 60 seconds (approximately 50 nautical miles). The maximum distance signals were recorded from the sono-radio buoys was 72 seconds.

The apparent horizontal velocity of sound in sea water still remains a somewhat uncertain factor. In the shallow water over the "lumpy" bottom of the continental shelf and in the deep water of the continental slope with the many steep submarine gorges and extensive valleys, the true travel path of the primary sound wave is not known. Seasonal temperature changes

(*) It is customary in radio-acoustic surveying to speak of distances in travel time, sound in sea water traveling approximately 8/10 of a nautical mile a second.

(EDITOR).