As for reliability, during this season at least, the launch RAR stations had more technical troubles than did the SRB's. Most of the difficulties with the SRB's were due to noisy tubes or imperfectly soldered connections. It must be admitted, however, that a launch RAR station which is having trouble is silent, while the commonest ailment of an SRB is the emission of a steady series of chirps, which can interfere very seriously with returns from other stations. If that occurs, the offending SRB can only be silenced by pesronal attention from the survey ship.

Measurements made in the office show that with the keying circuit used on these SRB's there is a constant lag of 0.01 second in the return. With other keying circuits the lag may be appreciable.

It is occasionally necessary to moor an SRB in a position where there is danger of its being struck by passing ships. It is suspected that such an accident may have happened to the one which was lost. To diminish that risk, experiments were made with a light on the superstructure. A small 6 volt light in a Fresnel lens was mounted on the top of the antenna frame and lighted from dry cells within the drum. A relay was arranged so as to turn on the light whenever the transmitter was actuated. Since the noise of the propellor of any ship within about a mile will actuate the SRB, an almost steady light will be shown from the buoy which should prevent the ship's collision with it. Two SRB's were equipped with such lights. It was necessary to install choke coils in the wires to the light to avoid detuning the antenna. Type Bl telephone relays were used and they worked reasonably well.

It is difficult to estimate the money saving resulting from the use of SRB's. With no real data on the cost of the units, it is estimated that the value of material and labor in each buoy would not exceed $ 150. A set of batteries costs about $ 15.00 and will probably last all season.

Against these low costs must be set the fact that an SRB can not be ordered from station to station as can a launch but must be carried to its station by an otherwise unproductive trip made by the survey ship.

Before the present season and the development of the automatic SRB, station launches have been used as R. A. R. stations and since these launches must be large enough to be anchored on exposed offshore stations, it seems reasonably certain that statistics will show that the use of SRB's substantially reduces the cost of R. A. R. operations with no sacrifice in accuracy of control.

SONO-RADIO BUOY

by

GEORGE D. COWIE, H. and G. ENGINEER,
U. S. Coast and Geodetic Survey.

(Reproduced from *Field Engineers Bulletin,* N° 10, Washington, December 1936, p. 147).

This new type of buoy was first tested in actual field work in 1936 on the Atlantic and Gulf Coasts. It was hoped that their performance would be so successful that sono-radio buoys could replace station ships for R. A. R. work at a considerable saving in cost of operation, and would eliminate the necessity of such dangerous assignments for the smaller vessels of the service.

The buoy as now constructed on the Ship *Lydonia* is similar to a two drum survey buoy, minus the target. The purpose of the lower drum is to furnish buoyancy only, the upper one containing the radio parts. An antenna coupler in a capped water-tight pipe is located on the buoy frame just above the drum and this is connected to an eighteen foot copper tube antenna mounted on insulators on the buoy upright. The same type of hydrophone used on the Atlantic Coast station ships was used with the buoy. It was mounted, however, on a triangular frame with rubber suspension and secured to the buoy anchor cable about 30 feet down from the buoy itself.

A counter weight of two car-couplers was necessary to keep the buoy upright. This increased the weight of the sono-radio buoy to approximately 750 pounds, about all that the *Lydonia's* boom could safely handle. The buoy was anchored with the usual survey-buoy ground tackle.

The operation of the buoy is similar to the operation of a station ship. The bomb signal is picked up by the hydrophone, causing an electrical wave to be conducted to the audio amplifier, passing through a keying-tube and put on the air through a crystal-controlled transmitter tube. The power (about 5 watts) is supplied by dry batteries whose life is about 2½ months.

As the *Oceanographer* and the *Lydonia* were working in adjoining areas it was necessary that each ship use crystals of different frequencies in their sono-radio buoys to avoid interference. The frequency used by the *Lydonia* was 4.160 kilocycles.

Before the buoy is placed on station the sensitivity of the bomb amplifier is adjusted so that it will not be actuated by ordinary water noises. This degree of sensitivity is determined by experimentation with a buoy in the water and subsequently by electrical measurements.

The radio signal strength of the buoy is such that it can be recorded regularly by chronograph at distances of seventy-five miles.

During the 1936 field season in the approaches to New York Harbor the *Lydonia,* using four sono-radio buoys, anchored them in 19 different locations. At no time however were more than three buoys in simultaneous operation. These buoys were anchored in depths of from 10 to 20 fathoms and were used to control R. A. R. work in the areas outside that which could be surveyed by visual fix control on a single line of survey buoys located approximately ten miles off shore.

The operation of the Sono-Radio buoys was fairly successful. A few buoys remained in operating condition for over a month without attention. A few others failed immediately after they were placed on station, due to leakage or tubes burning out. At no time did the *Lydonia* attempt to get bomb returns for distances over fourteen miles, it being unnecessary for the work assigned. Results indicated however that quarter pint bombs could not be relied upon for results at distances greater than ten miles, but that at this distance quart bombs would generally give results. It is presumed that ridges and valleys in this reasonably shoal water cut down the range of bombs considerably. The *Oceanographer* bombed successfully at distances of 22½ miles in greater depths of water, and received returns on 1/4 pint bombs at distances up to 20 miles.

The accuracy of the distances obtained when using the Sono-Radio buoy was not all that could be desired. With the present type of buoy errors as great as 0.3 miles may be obtained when 1/4 pint bombs are used at distances of ten miles. While sufficient tests have not been made to warrant positive statements regarding the probable errors which may be encountered our experience in 1936 indicated roughly the following results: 1/4 pint bombs are generally satisfactory up to distances of 4 or 5 miles, 1/2 pint bombs up to distances of 7 to 8 miles, and quart bombs for distances up to at least 10 miles, with the probability that all these distances can be increased in water deeper than 20 fathoms, where there are no intervening shoals nor deep valleys. On a very few occasions when bombing close to the sono-radio buoys there have been indications that velocities of sound as great as 1575 meters per second would have to exist to make the bomb distance check the dead reckoning position. (This may be due to the sound passing through the mud bottom for part of the distance, as was found by Commander Swainson).

Where 1/4 pint bombs have been used at distances of ten miles they have frequently given too long a distance. The explanation may be that there is a lag in the radio buoy apparatus when the received sound is weak. Even at shorter distances returns are frequently received which are found subsequently to be in error. This condition may be due to incorrect tape recording, interference by static, unaccountable lags, wrong velocity of sound, possibly an indirect sound wave path, bottom conditions, i.e. shoals, valleys, mud bottom, etc., hence it is necessary to plot the returns from several bombs in order to be reasonably certain which results can be relied upon and which must be rejected. The courses steered and speed of the ship must be considered in connection with the R.A.R. distances. This makes it difficult to decide promptly what course the ship is making good, and just when to change course to cover the working area economically.

The cost of the material used in the buoys is quite small. Omitting labor costs it is approximately $200. per buoy, with small operating costs. With such a small investment there is no great need to skimp on the number of sono-radio buoys to be used during a season. As they are almost as easily established on station as survey buoys, using them at distances of ten miles or more apart calls for only a small expenditure in time in placing and locating them. On the *Lydonia's* project they were generally anchored within 500 yards of a located survey buoy and tied into the control by a range-finder distance, or depression angle, and compass bearing.

Those planted ten miles further seaward were generally located by bombed distances from two other located sono-radio buoys. Experience showed that this method was not the best, or that only quart bombs should have been used. In one case an extra line of survey buoy was extended to join up with an off shore radio buoy which was then located by taut wire distance and sun azimuth. As suspected from the errors indicated by the bomb arcs from the three radio buoys it was found that the bombed location of this buoy was about 0.3 mile in error.

As a preliminary plan for control of an area such as surveyed by the *Lydonia* this season it is suggested that a row of survey buoys be established parallel to the shore about ten miles off, sono-radio buoys at ten mile intervals along the line of buoys, and spur lines of survey buoys running to off-shore radio buoys (10 miles seaward) at intervals of 20 miles. As improvements in these buoys are made, or additional proof is given that quart or other sizes of bombs are accurate over longer distances the intervals between radio buoys may be gradually increased.

One of the principal advantages in the use of radio buoys is the fact that work in foggy or hazy weather, or at night if personnel is available, can be accomplished when no other field work can be done, and without the use of station ships and their personnel.

When sufficient proof of the reliability of these buoys has been obtained it may be possible to avoid use of the usual survey buoys and survey that area immediately beyond shore control by R. A. R. buoy control.

PROTRACTOR FITTING FOR WIRE DRAG

by

RAYMOND P. EYMAN, LIEUTENANT-COMMANDER

U. S. Coast and Geodetic Survey.

(Extract from *Field Engineers Bulletin,* N° 10, Washington, December 1936, p. 159).

In plotting drag work for the past summer one of the members of the party, Mr. Gregg ELLIOTT, Jr., improvised a simple device to be used with the regular three arm steel protractor for plotting the boat position, near buoy position, and direction to far