

HISTORY
OF SHELL OFFSHORE SEISMIC OPERATIONS
IN THE UNITED STATES

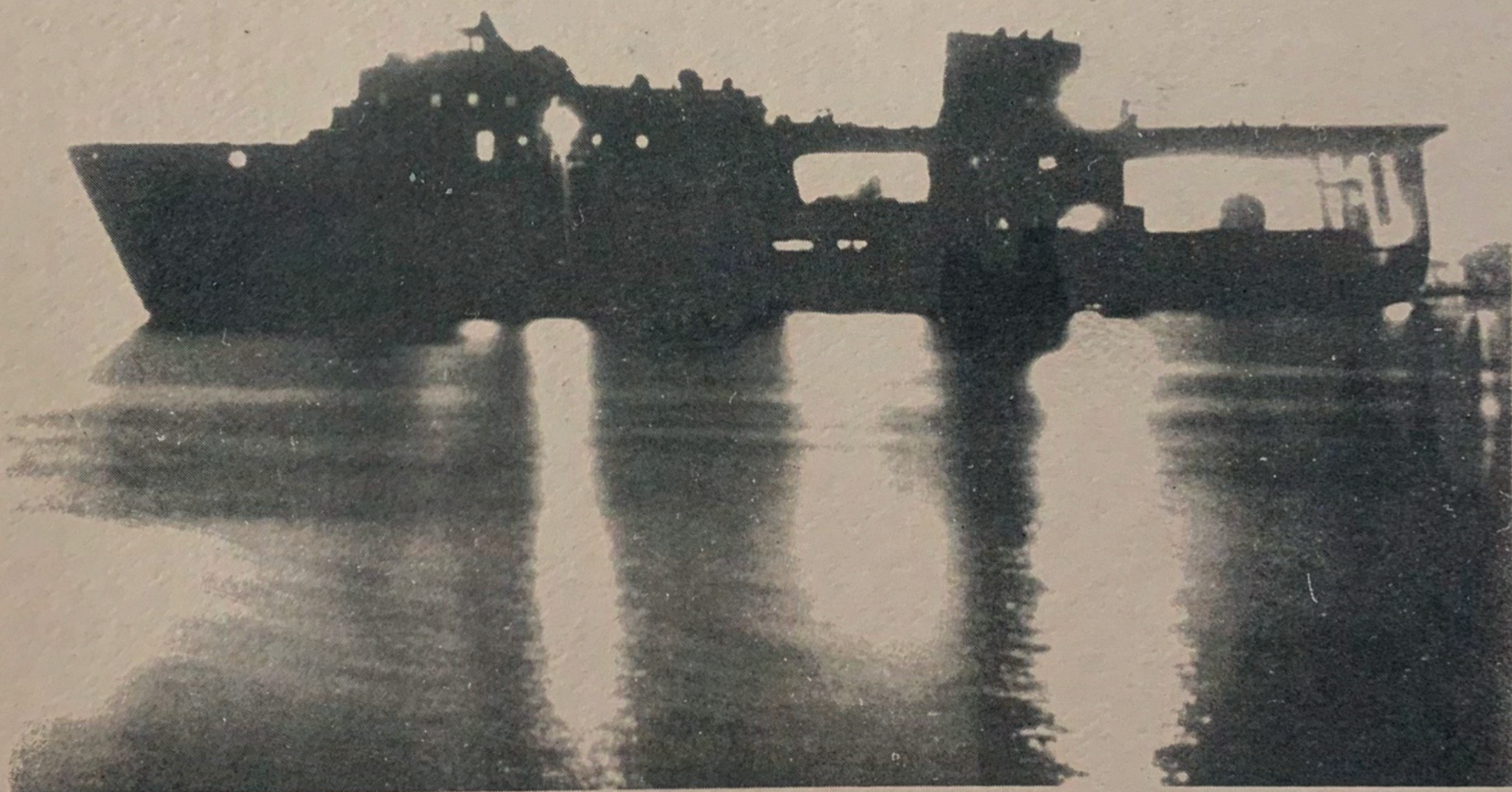


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Shell Oil Company

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Many of the people who started Shell's offshore seismic work have retired or are deceased, but a few who worked in the early days are still with Shell. Senior and younger personnel have supplied their recollections for the compiling of this history. They are acknowledged at the end of this introduction.

Table 1 lists offshore seismic party chiefs who implemented the various technological advancements of the past fifty years. This list has been compiled from the memories of a number of people and therefore, like the rest of this history, may not be totally accurate or complete. We apologize for any errors or omissions. These party chiefs, their crews, R&D personnel, Head Office Field Engineering, management, and many other categories of personnel share credit for meeting the challenges of a new field in petroleum exploration.

INTRODUCTION

This document summarizes how Shell Oil Company has used seismology to find offshore petroleum, from the first operation in 1936 near Corpus Christi, Texas, to the present operations off all coasts of the U.S. mainland and Alaska.

Seismology, the science of using sound waves to determine what lies below the earth, was first tried in England in 1851. During World War I, the German army listened to earth vibrations in order to track gun batteries of the Allied army. Modern petroleum seismology began in 1920 when refraction techniques were applied to identify oil-containing geological structures near Hamburg, Germany. During 1923-1924, the same methods were used onshore, in Mexico and East Texas.

Shell's first operation offshore the United States took place in 1936. The work was an innovative and unauthorized extension of an onshore crew's program to continue tracking a promising structure into the water. They used small rented boats and adapted to the water techniques employed on land. The crew mapped a considerable area into 60-foot deep water. Chapter 1 tells about this first water operation.

The rest of Shell's offshore history is largely related in chronological order. It includes key people involved, as remembered by those who contributed to this history, and methods and equipment used, including a varied collection of boats and ships. These range from converted shrimp boats and World War II vessels in the early days, to modern ships designed specifically for seismic work beginning in 1965.

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Although the people, ships, and equipment have changed over the years, the basic principles of offshore seismology remain the same: to generate, receive, process, and interpret the strongest, best-controlled and most-well-defined seismic signals possible.

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The transactions also commented that "the accuracy of a marine survey can be controlled approximately to the same degree as possible on land" and also that "the cost per profile or per mile is comparable to that obtained on land" "Land" meant truck-mounted operations in the New Orleans area that were not in marshes or swamps.

1948-1950: Bellaire Research Center Experimental Crew

In 1948, the Bellaire lab bought three boats that were veterans of World War II. They were the *Mary G*, a 104-foot air/sea rescue craft, and the *Ruth* and the *Wilma*, 85-foot crash boats. The lab formed an offshore crew for developing new methods of recording. The crew worked for two years and then transferred the boats to Party 88. Some of the equipment developed and tested was:

- o Sled-float cable and seismometer system
- o Refraction and water-break hydrophone units
- o High-frequency water-break galvanometers
- o Var camera records
- o DUAL RADAR for survey system
- o Paslay cable system and reel for letting out
 lead-in while boat was moving
- o High-voltage shooting boxes
- o High-frequency radios

Some of the people responsible for this development were: Dr. E. Merten, Dr. C. Fay, Dr. S. Kaufman, Captain Ben Champion of the *Mary G*, Captain Rip Ryan of the *Wilma*, Captain Dave Campbell of the *Ruth*, Monroe Boatman, Floyd Davis, Harold Miller, Mabe Cain, Jerry Toups, Dick Haase, Arnold Brodnax, and Bill Nance.

The *Mary G* is pictured in Figure 19, and Rip Ryan, her captain, is in Figure 20. The *Wilma* is shown in Figure 21.

Solving Problems in the New Seismic Program

This history of Shell's offshore operations is filled, from beginning to end, with examples of drawing-board plans that encountered operational problems. Some of these problems were solved in the field with great ingenuity. Others were solved by engineering, research, and laboratory work.

The 1948 Geophysical Conference transactions comment: "Since our marine exploration program emerged suddenly from a semi-experimental stage to that of full-scale operations, it was necessary to develop many phases of the techniques employed during the course of the survey"

The following two sections describe early problem-solving (1946-49) in the field and through research teamwork.



Figure 19 - 1949: *Mary G*, 104-foot air/sea rescue boat, used as shooting boat by Bellaire Research Center experimental crew.

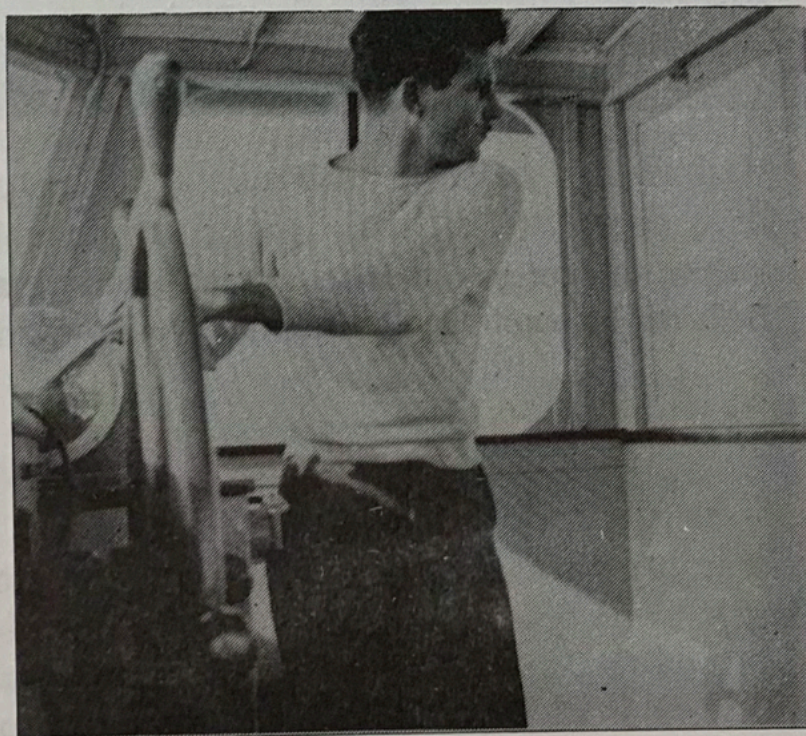


Figure 20 - 1949: J. E. "Rip" Ryan, Captain of the *Mary G*.

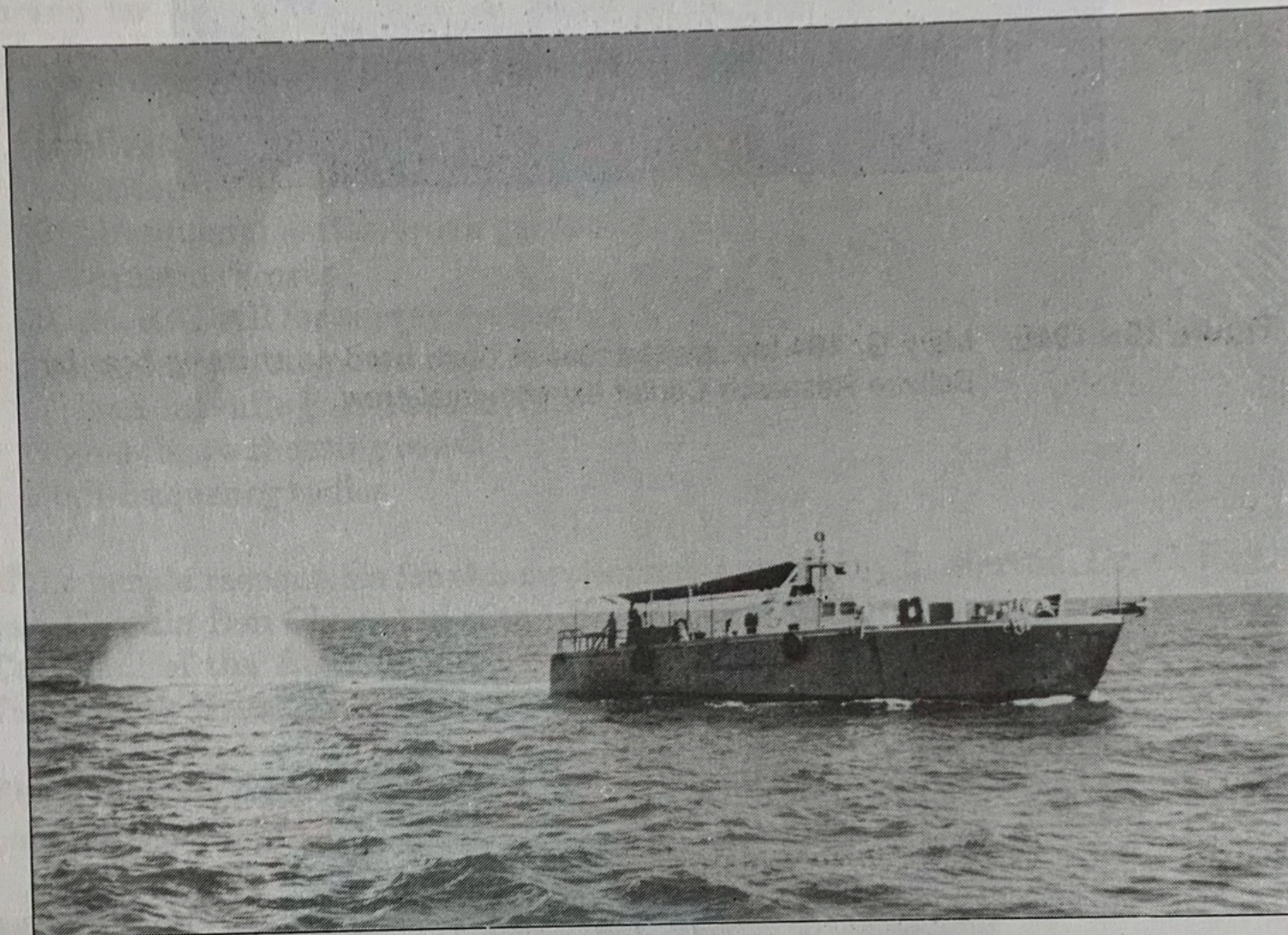


Figure 21 - 1948: Wilma, 85-foot air/sea rescue boat, used as a shooter boat by Bellaire Research Center experimental crew.

The Air-Bubble Problem: An example of technology that evolved in the field was that which solved the air-bubble problem. From the beginning in 1946, air bubbles created by each exploding charge collapsed and expanded as they rose to the surface of the water. This caused reverberations that distorted the recording.

By 1947, the crews had hit upon a plan to eliminate the bubble problem. They floated the charges about 4 feet below the water, rather than letting them sink to the bottom. For floats, they used anything buoyant, including driftwood and empty 1-gallon syrup cans. Then they got fancier and used air compressors to inflate balloon floats. They also used "turkey bags," synthetic fiber bags which they inflated by waving them back and forth in the wind. They couldn't use heavy weights that wouldn't drift because Louisiana law specifically prohibited such--they could damage fishermen's nets.

Generally, these floating charges were primed and thrown overboard just before shooting because semi-permanent buoys set in advance frequently were destroyed or moved by fishermen. The Geophysical Conference transactions mention "... fishermen, whose hostility to geophysical exploration has been a constant hindrance to operations."

Cable Problems: From the beginning of operations when the cable was dragged along the sea bottom, the cable snagged debris and often broke. In 1948, a team at Bellaire Research Center, directed by Dr. E. Merten, came up with a solution, which was equipping the cable with sled-type floats on which the seismometers were mounted. The floats kept the seismometers 18 inches off the bottom. This not only reduced the snagging and breaking, but also improved seismic records by reducing the noise that traveled along the water bottom when a charge was detonated. (At that time, 10 data traces were being recorded.)

In 1949, the lab team also developed a float sled that brought the cable to the surface during tow to its next location. In 1949, the continuous cable was replaced with one made up of 200-foot sections.

In 1950, an important improvement in the cable design was instigated, the Paslay cable. The cable was developed by Seismic Engineering Company. This was an oil-filled cable, which had a neutral buoyancy that allowed it to be balanced perfectly from end to end at virtually all depths required. In addition, each of the cable-streamer sections contained 20 hydrophones at 10-foot intervals. These improved the quality of seismic recordings. Operations with the Paslay cable are reported in the next section of this chapter.

1949-1951: Offshore Texas Operations Begin

In 1949, Shell seismic Party 88 began operating out of Corpus Christi. In 1950 the sled cable was replaced with a Paslay streamer cable and Nitramon explosives. They used the same minesweepers and other craft employed offshore New Orleans since 1947. Personnel were as follows: 14 marine, 6 SHORAN, 45 seismic, and 9 office. The field party worked only during daylight in two shifts of 7 days on and 7 days off.

The program started at the Mexican border with shooting of refraction fans that had a 37,000-foot radius. In the office, templates were used to lay out the program. (See Figure 22 showing a fan pattern.) To mark the centers of the fans, buoys were set, held in place by 200-pound mushroom anchors. The buoys also served as triangulation locations for SHORAN base stations on the boats.

At first, a special refraction unit with three amplifiers was used, but an AVC reflection-refraction unit proved more satisfactory. One Fay-type geophone modified for marine use and two hydrophones mounted on floats were used as detectors. (See Figure 22.)

Seven traces were recorded--three for initial arrivals of energy, three for water breaks obtained through separate amplifiers which allowed only high-frequency energy to pass, and one for the shot break. More technical details are documented in *Transactions of the Geophysical Conference, Part IV*, Shell Oil Company, Houston, January 15-19, 1951.

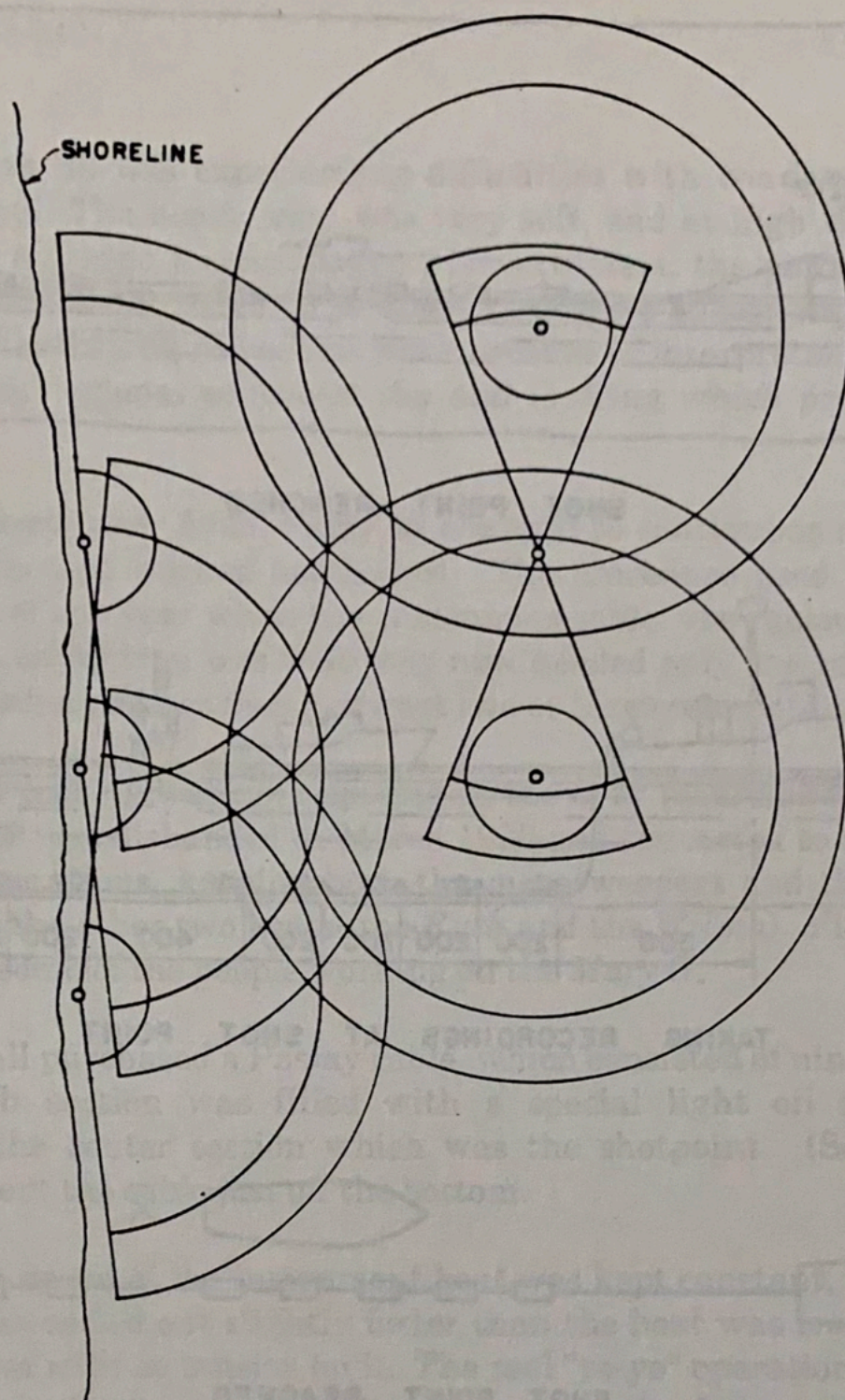
Later, in 1949, a second marine party, Party 129, was formed by splitting Party 88 and hiring new personnel; Paul Revere was Party Chief. Each party used one minesweeper and one crash boat. The air/sea rescue boat, with crew of 11, was shared as a spare. Party 88 continued its refraction work. Party 129 had a staff of 15 marine, 2 SHORAN, 23 seismic, and 11 office personnel.

Party 129 began continuous reflection profiling off High Island the last week of July 1949. They situated SHORAN base stations along the shore. The SHORAN stations were mounted on Ford panel trucks, which towed canvas-covered trailers carrying the power units. The panel trucks were used to carry people back and forth to work each day, but the trailers were left on location. Reflectors, rotated manually by ropes, were placed on towers 87 feet high. A square shooting pattern was set up with 10,000 feet between lines and with additional lines where gravity leads showed places of interest.

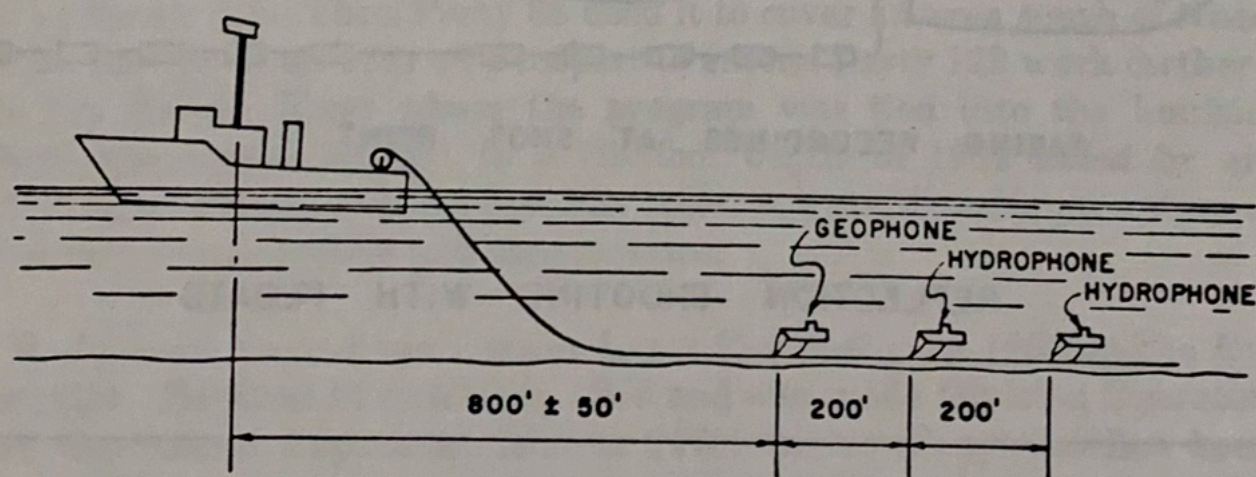
A 2000-foot continuous cable with geophone plugs 200 feet apart for 10 Fay-type geophones modified for marine use was mounted on floats. (See Figure 23.) This gave a 2000-foot spread with the shot points placed 1000 feet apart, to obtain a common point between succeeding spreads. Cast-iron weights clamped next to each geophone plug kept the cable on the bottom when the instrument boat stopped. The floats kept the geophones off the bottom when under tow. Two marker buoys were tied at the center of the cable. Charges were suspended 4 feet below the surface from balloons.

After reaching a shotpoint as directed by the SHORAN operator, the instrument boat backed down to take tension off the cable and allow it to settle to the bottom. During recording, the instrument boat often was carried off location by wind or currents, and the cable twisted during the maneuvering to move back on line at the next shotpoint. In good weather and when teamwork went smoothly, shots were fired every 3-4 minutes.

When work off High Island was completed, Party 129 began the same reconnaissance pattern off Matagorda Peninsula.



REFRACTION FAN PATTERN



REFRACTION INSTRUMENT CABLE

Figure 22 - 1949: Diagrams of refraction fan pattern and cable configuration.

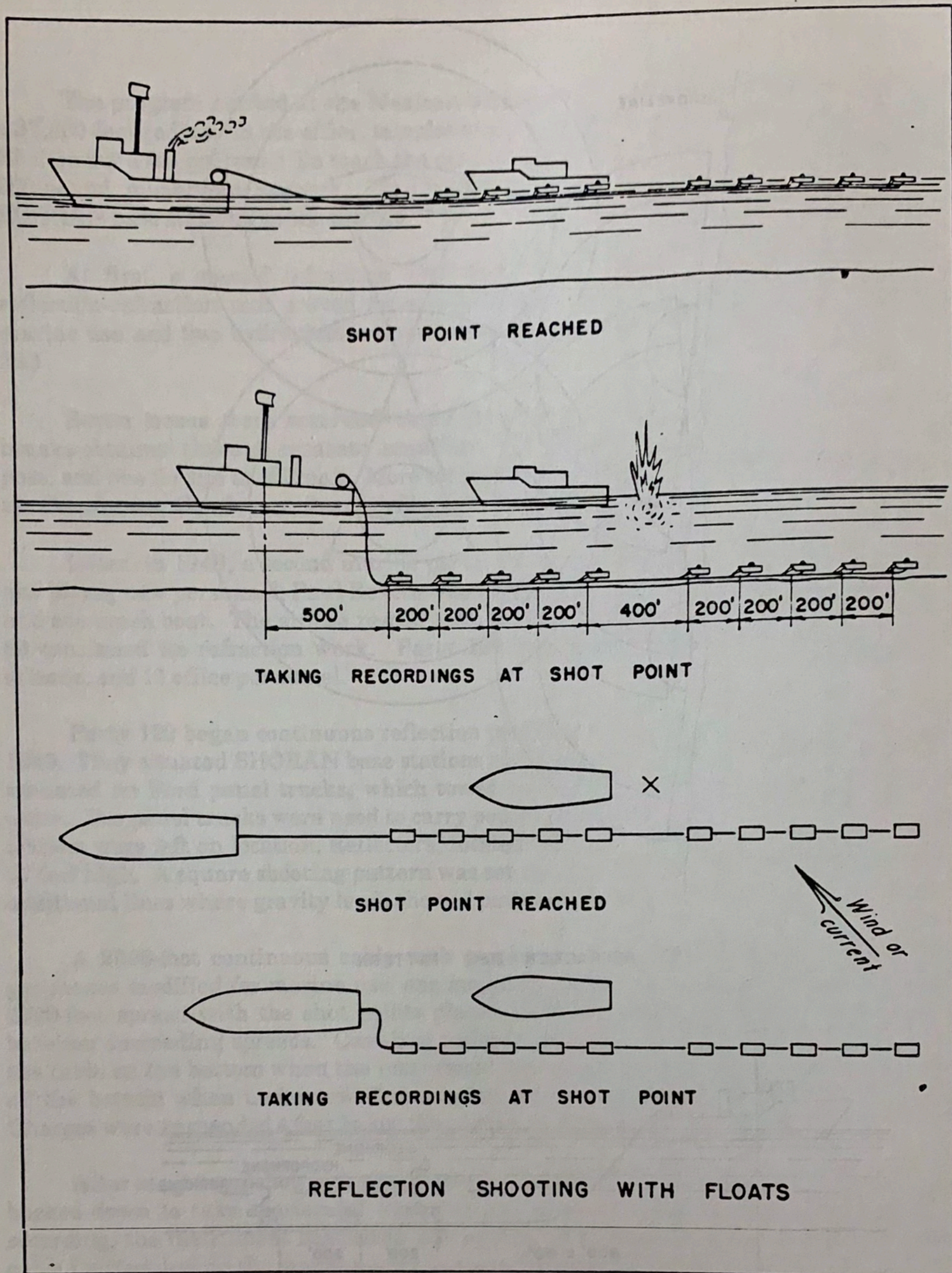


Figure 23 - 1949: Float-mounted cable for continuous reflection shooting.