# Submarine "Wireless" Signaling

THE subject of safety of submarines at sea is of vital importance, especially in the present submarine warfare, in which many of these under-sea fighters are participating.

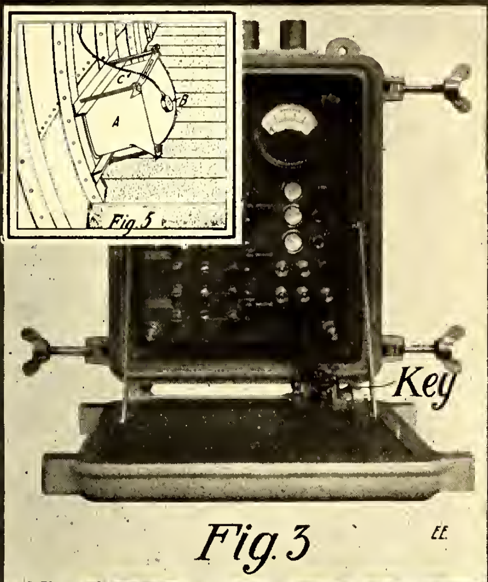
It is well known that wireless telegraphy is now the most important factor of communication on our present ocean steamers and battleships, which aids their navigation and safety at sea; but when we come to the submarines, the wireless used on these craft cannot now be directly adapted to the under-sea fighters, as the etheric waves produced by the ordinary wireless apparatus cannot travel very far in water, and therefore other means of signaling becomes necessary. Many forms of apparatus were invented and used with considerable success, such as the submarine bell, which is still in service; but the distance traveled by the sound is so small that it is practically useless.

These methods were rarely used, however, until finally an Austro-Hungarian physicist, H. Christian Berger, who realized the necessity for an efficient means of submarine signaling between moving undersea vessels, devoted his talents to the solution of the problem. He finally solved the problem by using the principle of longitudinal vibrations in a steel wire or strip set into vibration by frictional means.

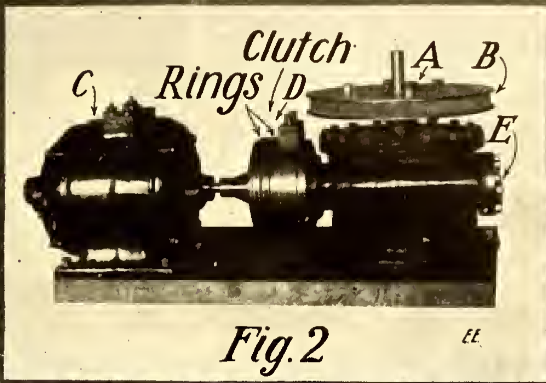
His first transmitter consisted of a piano wire, as at A in Fig. 1, which is here shown a ribbon of only 2 millimeters diameter, set into longitudinal vibration by a hand-driven silk wheel B moistened with alcohol; D is a sounding chamber, which is immersed in the water. With this apparatus Morse dot and dash signals were clearly heard for 3 kilometers (1.86 miles). The sound had the qualities of the ordinary etheric wireless, and it has therefore been called submarine wireless.

These experiments were conducted on the United States submarine E-1, and were so successful that the United States officials were encouraged to build a large apparatus, using a $\frac{1}{2}$-horsepower electric motor C, Fig. 2, to drive the exciter, and also the wire was substituted by a flat metallic ribbon having a thickness of $\frac{1}{16}$ inch and a width of $\frac{1}{2}$ inch.

The complete apparatus is shown in Fig. 2. A commercial type Morse key, Fig. 3, operates a magnetic clutch D on the shaft by pressing the key, thus supplying current to the electromagnets in the clutch and connecting the worm gear in case E, which is connected in turn to the felt-edged wheel A. This wheel contains a reservoir inside it, in which alcohol is placed in order to feed the felt continuously.




Above (Fig. 5) Receiving Microphone Installed on Shell of Submarine. Fig. 3 Shows Morse Telegraph Key and Switchboard for Transmitter.




One-Half H. P. Magnetic Clutch and Molecular Friction Wheel With Oil Immersed Worm Drive for Transmitter.

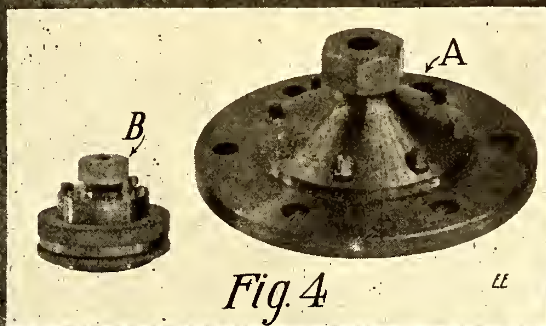
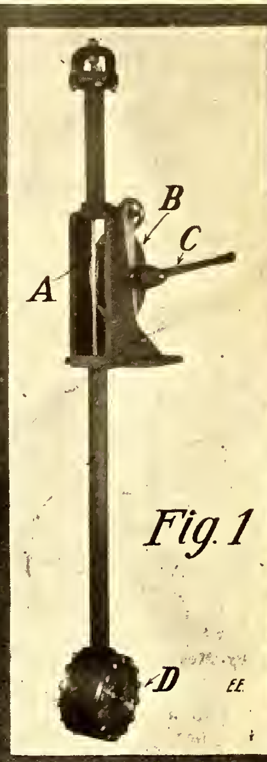



Fig. 4. One Type of Super-Sensitive Microphone Used to Pick Up Vibrations Transmitted through the Water.




Hand-Driven Form of Submarine Transmitter.

The operation of same is as follows: The clutch is connected and the steel ribbon is next stretched and placed near the felt wheel so it touches same. The motor is next started by pressing the Morse key. The felt wheel is set in motion, according to the current sent through the magnetic clutch, which is operated by the key and consequently produces friction on the ribbon, which is caused to rapidly vibrate. These vibrations are sent out on air waves and cause the hull of the boat to vibrate, and finally are communicated to the water. The water is thus also set into vibration and these vibratory tones are received by another vessel containing the proper receiving apparatus. The distance that these waves travel depends entirely upon the number of vibrations which the steel wire or ribbon emits.

The receiving apparatus consists of a receiving tank, super-sensitive microphone, telephone receiver and battery. The receiving tank is placed on the hull of the boat as shown in Fig. 5 at A, and it is filled with water. The microphone transmitter B, Fig. 5, is placed in firm contact with the receiving tank and connected in series with a telephone receiver and battery by waterproof copper wires. The transmitter is then covered with a thick steel plate A. See Fig. 4.

The incoming waves or vibrations caused by the transmitter are caught by the receiving tank, and the microphone intercepts these faint vibrations, which vary the resistance in the telephone circuit, thereby giving the exact sounds as produced at the transmitting station. The water in the tank acts as a conducting medium between the hull of the submarine and the sensitive microphone transmitter, just as the ether acts as a conducting medium in aerial wireless telegraphy.

With this system signals were audibly read at a distance of 10 knots. The secret of the extraordinary efficiency of this system lies in the fact that the vibrations used are longitudinal and the stresses set up molecular. Unlike a plucked violin string, where the pitch depends on the tension, the pitch in longitudinal vibrations is independent of its tension.

As friction is always rhythmic, the exciter or felt wheel throws the wire into intense longitudinal oscillations, and a clear and absolutely uniform musical note is produced in the water. In order to produce a note of 1,000 vibrations per second, most suitable for microphones, the wire is cut for one-half a wave length. As the velocity of sound in steel is about 16,000 feet per second, the wire would be 1/2,000, or about 8 feet in length, and this would generate a sound wave of about 4.7 feet in water. So it must be quite evident that to transmit these vibrations for eight or 10 miles a longer wire must be used, or else a shorter wire having a greater tension. Therefore more power is required to set this wire in vibration.

This method of signaling has been approved by marine officials, and many of these apparatus are being used by Uncle Sam's submarines, with good success.