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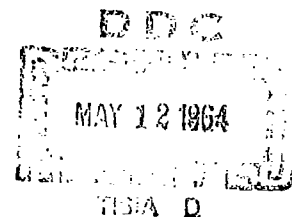
EXPERIMENTAL DAPHNE II EQUIPMENT USED ON THE SUBMARINE TEST OF AUGUST 1963

(UNCLASSIFIED TITLE)

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SOUND DIVISION

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U. S. NAVAL RESEARCH LABORATORY
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ABSTRACT

This report describes the experimental DAPHNE II Acoustic Torpedo Countermeasure System as installed on the USS SEAFOX, SS402, in August 1963. Installation details, electronic generation techniques, and acoustic parameters are given. Preliminary results of the tests have been reported elsewhere.

PROBLEM STATUS

This is a report on the equipment used on the first DAPHNE II field trip on a submarine in August 1963. Work on the problem is continuing.

AUTHORIZATION

NRL Problem 55S01-22
BuShips Project SF 011-03-02-2375

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EXPERIMENTAL DAPHNE II EQUIPMENT USED ON THE SUBMARINE TEST OF AUGUST 1963

BACKGROUND

Based on successful test of the DAPHNE concept using stationary acoustic arrays, it was decided to build an experimental model for installation on a submarine. The purpose of this model was to generate desired DAPHNE signals to evaluate the concept of a submarine-hull-mounted acoustic homing torpedo countermeasure. Of necessity, the design was a compromise between desired performance, cost, and timeliness. In addition NRL considered it desirable to evaluate existing torpedo intercept techniques, since intercept knowledge is the key to good countermeasure performance. Accordingly, the NOL PUFFS and the USNUSL DUGG-1C equipment were also installed, along with the DAPHNE II. NRL also performed some intercept experiments using DAPHNE transducers as intercept receivers.

MECHANICAL

The first shipboard installation of the DAPHNE II equipment was made on the USS SEAFOX, SS402, a guppy type submarine (Fig. 1), at the U. S. Naval Torpedo Station, Keyport, Washington, in mid-August 1963. The Naval shipyard at San Francisco designed, fabricated, and mounted the necessary support structures for the sonar domes and equipment racks used aboard the USS SEAFOX. The Naval Research Laboratory furnished the electronics, transducers, and domes.

A special hatch cover was required to facilitate the numerous cable entries through the pressure hull. NRL purchased a standard torpedo loading hatch cover from the USS QUEENFISH. This cover was then modified and fitted with thirty cable stuffing tubes. Twenty of these were size B fittings and ten were size C. All cables used on this project entered the pressure hull through this hatch cover. The hatch cover was mounted and tested by the San Francisco Naval Shipyard personnel at Keyport. NRL utilized fourteen of these

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special cable fittings, while NOL and USNUSL used four fittings each for their cables. This left spare entry tubes for additional cables. Figure 1 shows the locations of the transducers used in these tests. Figure 2 shows the above-deck wiring and the wiring configuration through the hatch cover.

ACOUSTICS

Two types of transducers were used in these tests. One type was the Mk-4 torpedo target simulator transducer with its mounting assembly. The Mk-4 is a cylindrical magnetostrictive type with a 360-degree horizontal donut beam pattern. These transducers were used on the submarine sail and the after deck. The second type was a Mk-37 torpedo transducer, with its mounting bracket and sonar dome. The Mk-37 transducer is a four-section magnetostrictive type transducer with a 40-degree (null-to-null) main lobe. Both of these transducers have resonant frequencies of 60 kc. Figure 3 shows their location on deck.

Each of the six domes contained six Mk-37 transducers which were arranged to afford the optimum acoustic coverage. The transducers in the forward pair of domes were aimed to give forward coverage and at a 0-degree elevation angle. The transducers in the rear domes were aimed to give aft coverage with the same 0-degree elevation angle. The transducers in the middle pair of domes were aimed to give 360-degree azimuth coverage and were elevated at a 15-degree angle to obtain surface effects. These transducers were production models already in use by the Navy. They were not optimized for use with this system; however, their use was necessary due to the press of time and budgetary considerations. Figure 4 shows the acoustic pattern of both types of transducers and their source levels as used on the submarine.

ELECTRONICS

NRL used four racks of electronic equipment for their tests; NOL had three racks. These racks were located in the forward torpedo room on the port side. Figure 5 shows the arrangement

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of the equipment, as it was installed aboard the submarine. The 4.5 kw of line power required was supplied by a 10-kw, 3-phase, 60-cycle, 120-volt ac generator located in the afterpart of the sub. A distribution box was connected for use in the forward torpedo room. NOL also used this generator for their power requirements. USNUSL used available sonar power for their equipment.

NRL designed several special circuits for use on this project. Commercial equipment was used whenever possible to save time and and design cost. A block diagram (Fig. 6) shows the equipment as it was connected for use on the first DAPHNE II submarine trial. Following is a list of commercial and NRL built equipment. A description of each type, listing any modifications or changes will be given later.

<u>Commercial Equipment</u>	<u>Number Used</u>
Altec Lansing, 1570B amplifier	9
Eico, HF89 dual-channel amplifier	2
Frederick 201 pulse pattern generator	2
Lambda power supply	1
GR 1206B unit amplifier	1
GR 1210C oscillator	1
HP 5232A electronic counter	1
Tektronix RM-503 oscilloscope	1
Burroughs 1801 pulse operated relay units	10
Burroughs 9202 power supply	2
Quan-Tech power supply	1
<u>NRL Designed and Built Equipment</u>	<u>Number Used</u>
Two-channel oscillator	1
Frequency selector switch	1
Two-channel level switch	1
Control panel	1
Power supply	1
36-card electronic switch	1
Display panel	1
Six-card clock	1
Two-channel receiver	1
Patch panel	1

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The basic DAPHNE II signal consists of two discrete frequencies, generated by the two-channel oscillator shown as the first element in Fig. 6. Each channel consists of a transistorized, crystal-controlled, Colpitts oscillator. The frequencies were 59.7 kc and 60.4 kc. Initially both frequencies are continuous wave and unmodulated. These frequencies are alternately selected by the frequency selector switch. This switch is a free running multivibrator which operates a relay with contacts connected to each channel of the oscillator.

The output of the frequency selector switch is then connected to a GR 1206B unit amplifier which serves as a signal level control and impedance matching amplifier. A 1.5-volt signal level is required for input to each of the two Frederick 201 pulse pattern generators (Fig. 7). These pattern generators function as electronic keyers which produce signal pulses of variable duration and repetition rate. At this point the signal outputs from the pulse pattern generators differ in pulse length and repetition rate, forming two channels.

Both channels are connected to a level switch, which provides the required attenuation for each channel. These level switches are resistance networks connected through small relays which are controlled by one of the pulse operated relay units, at a time programmed into the sequence. These switches reduce the input signal level to the Altec and Eico amplifiers so that the output power transmitted by the Mk-37 and Mk-4 transducers is 70 db during the low-power sequence. During the high-power sequence the Mk-37 and Mk-4 transducers transmit 110 db and 90 db respectively. At this point there are two channels, which will be referred to as the Mk-4 signal and the Mk-37 signal.

The Burroughs 1801 pulse-operated relay unit (Fig. 8) is one of twenty used in this system. These pulse-operated relays are units which provide precision relay control for the input signals to the amplifiers. This control is determined by the DAPHNE II sequence (Figs. 9 and 10) which is programmed into the pulse-operated relay units. It is possible to program (wire) these units to provide almost any combination of transducer selection, transmission time, and the overall period of the sequence. In Figs 9 and

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10, each block containing a number represents a pulse-operated relay unit and its time period. The top part of each diagram shows the high-power sequence in seconds. The bottom part shows the low-power sequence in seconds. The total time in this particular sequence is fourteen seconds. The numbers at the top of Figs. 9 and 10 indicate the transducers by section as located on the submarine. The transmission or on-time is shown in the column below the transducer section, with certain sections being on simultaneously. This number represents one cycle of the sequence, which is repeated until the run has been completed.

The pulse-operated relays are connected directly into the control panel. This panel serves as the control junction and distribution point for the DAPHNE II system. The incoming Mk-4 signal is distributed to the designated Eico power amplifier. The outputs of the four Eico power amplifiers are returned to the control panel where they are applied to the appropriate Mk-4 transducers. The Mk-37 signal from the output of the level switch is applied to nine Altec-Lansing amplifiers with parallel inputs. The outputs of the nine power amplifiers are connected to the control panel, where they are selected by relays in the control panel. Once selected, these outputs are connected to thirty-six electronic switches, which perform the power switching. Each power amplifier is connected to four specific switches. There is a switching card for each Mk-37 transducer, and these cards are built into a rack mount panel. Figures 11 and 12 show this panel and the thirty-six pulse transformers (one for each electronic switch). These switches make it possible for each Altec amplifier to drive four Mk-37 transducers successively with no dropout of transmitted power, thereby reducing the number of amplifiers required from thirty-six to nine.

Silicon-controlled rectifiers are employed in the circuit (Fig. 13) as the switching elements which are controlled by a pulse amplifier and pulse transformer connected to the controlled rectifier. The synchronization for the pulse amplifiers is provided by the six-card clock, consisting of a time base which is a low-

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frequency Wein bridge oscillator, shaping circuit, flip flops, and gating circuits. Each group of four transducers share a transmission period of 120 msec, resulting in a 30-msec pulse for each transducer. This 30-msec period is provided by the Wein bridge oscillator. The sine wave is then shaped into square waves which trigger a four-bit counter, which is composed of two flip flops, and gating circuits. This provides four synchronized outputs (Fig. 14) which are applied to the pulse amplifiers, which in turn control the controlled rectifiers. The pulsed power is then applied to the Mk-37 transducers through the patch panel, which programs the signal to the transducers. The transducers are connected by patch cording.

In a countermeasure a knowledge of the critical system outputs such as power, sequence operation, pulsing, etc. is a necessity. The visual display panel (Fig. 15) serves this function. Should the output power level change for any reason, or the sequence or pulsing characteristics vary, the operator can immediately spot the section in question by observing the intensity of the corresponding panel light.

CONCLUSION

As can be seen, this DAPHNE II system is strictly experimental, consisting largely of commercial or production equipment, integrated with the necessary NRL designed circuitry. Since the purpose of this equipment was to assess the DAPHNE concept, no consideration was given to weight and space problems other than to assure that the inboard mounted components would pass through a submarine hatch. The equipment served its purpose, since it generated the required signals throughout the tests without any operational failures.

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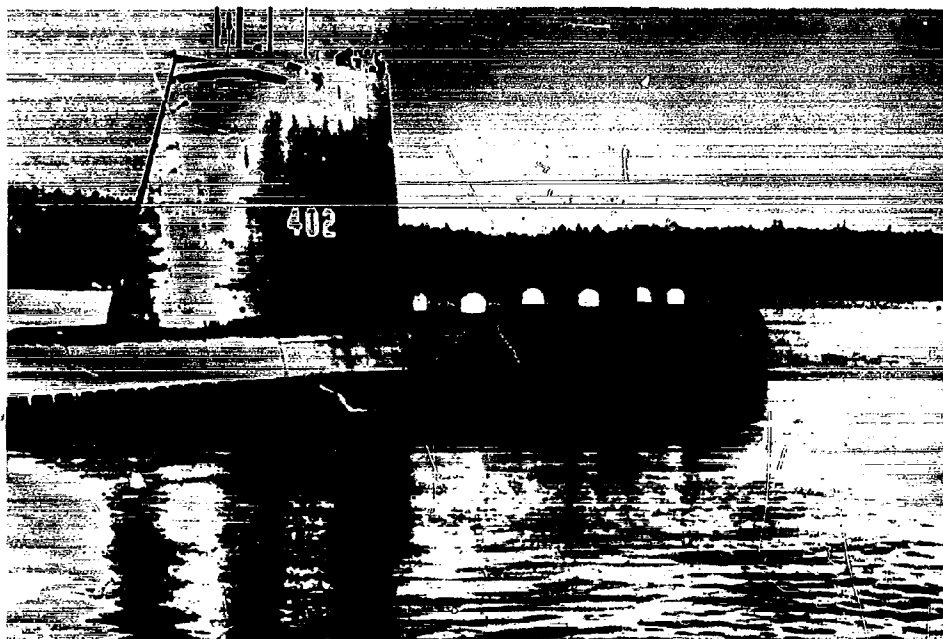


Fig. 1 - DAPHNE II equipment on the USS SEAFOX

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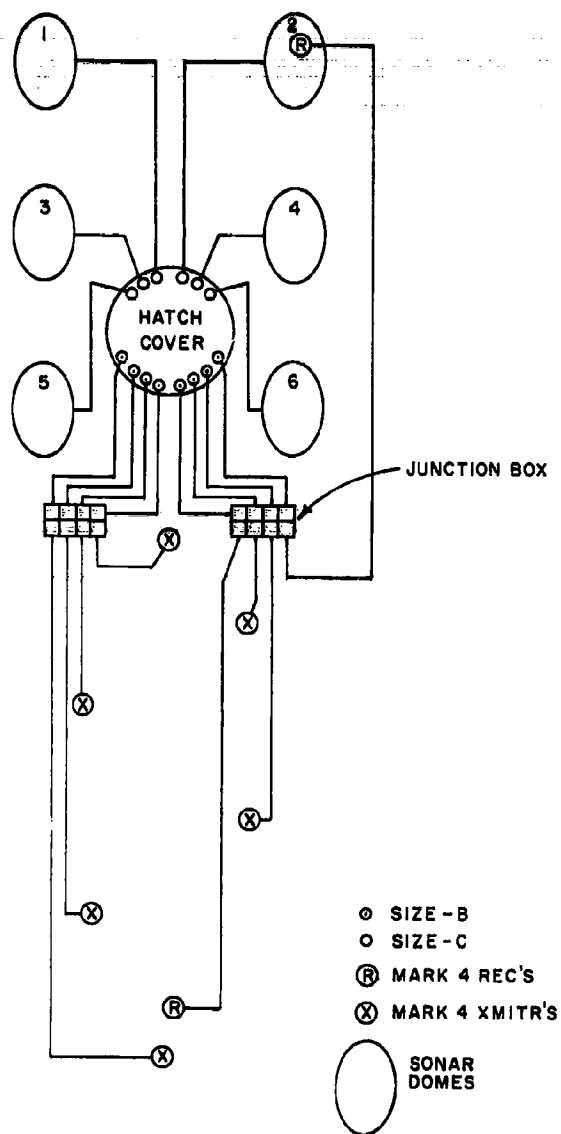


Fig. 2 - Wiring diagram (hull)

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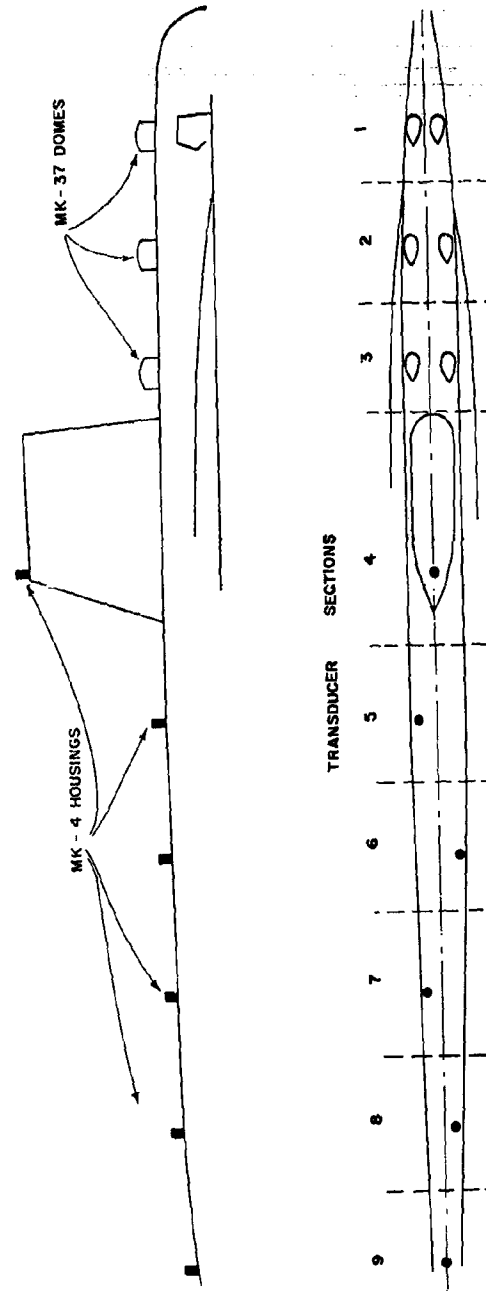


Fig. 3 -- Hull diagram

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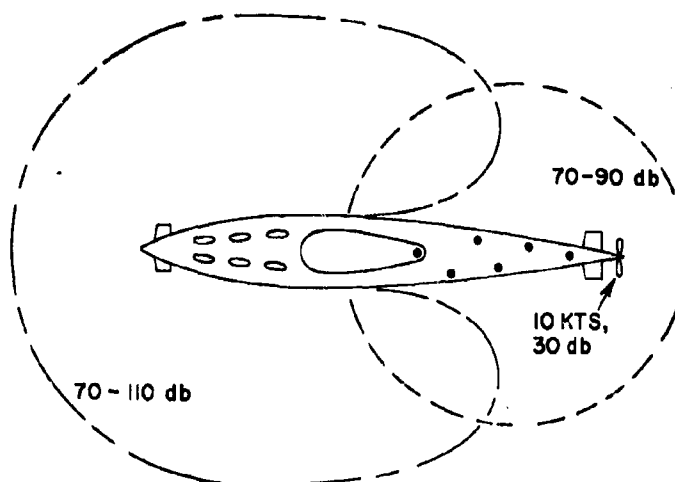


Fig. 4 - DAPHNE II acoustic beam patterns

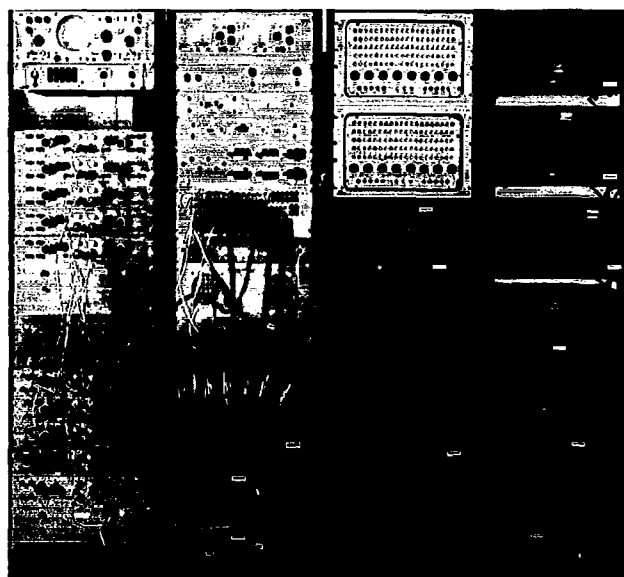


Fig. 5 - Daphne electronics

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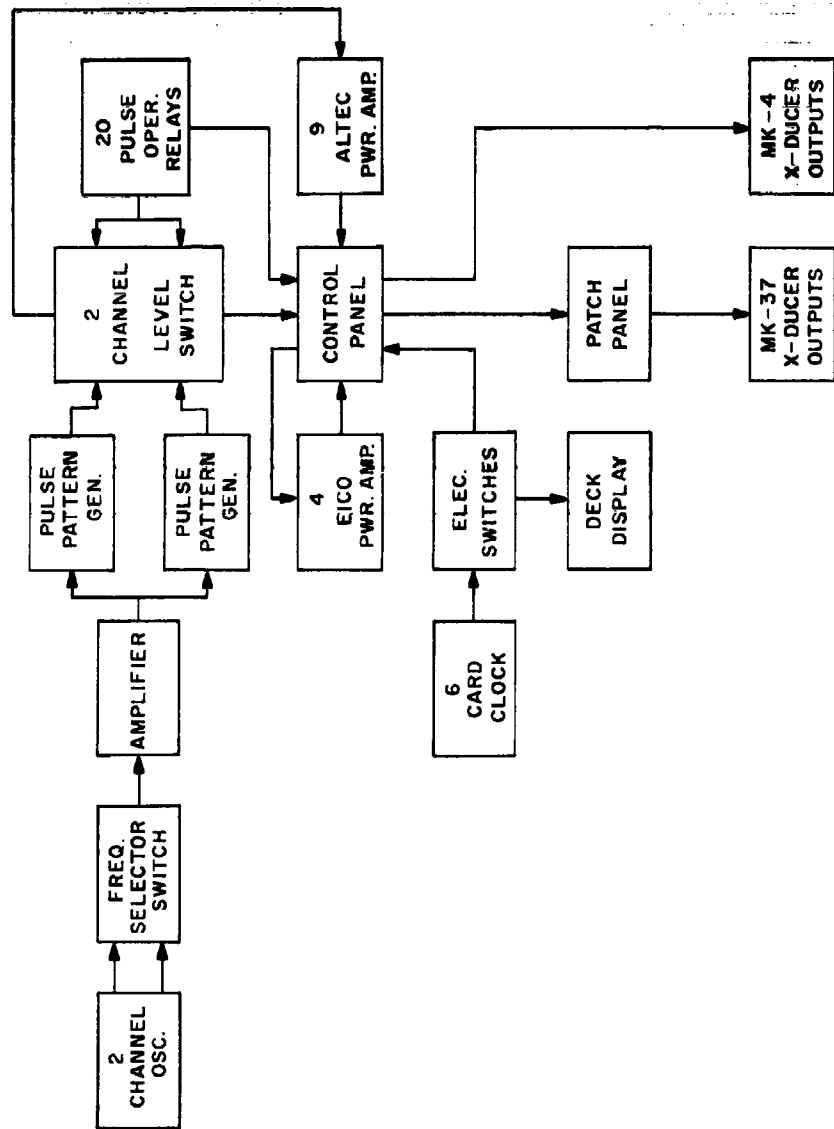


Fig. 6 - Block wiring diagram

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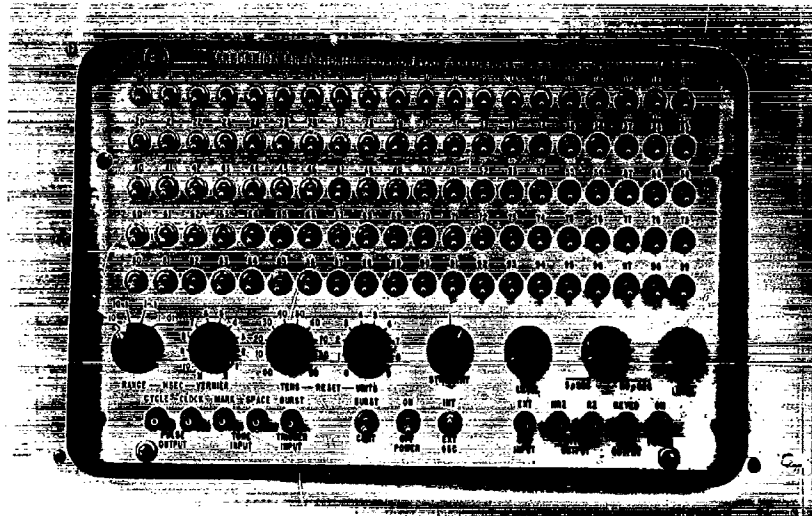


Fig. 7 - Pulse pattern generator

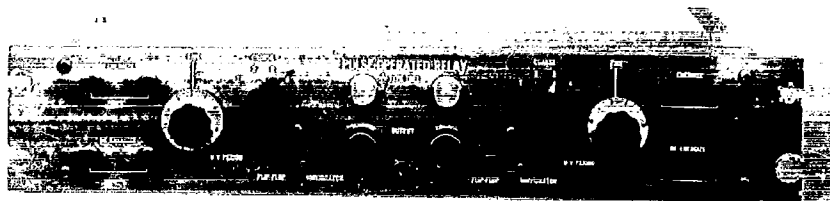


Fig. 8 - Pulse operated relay

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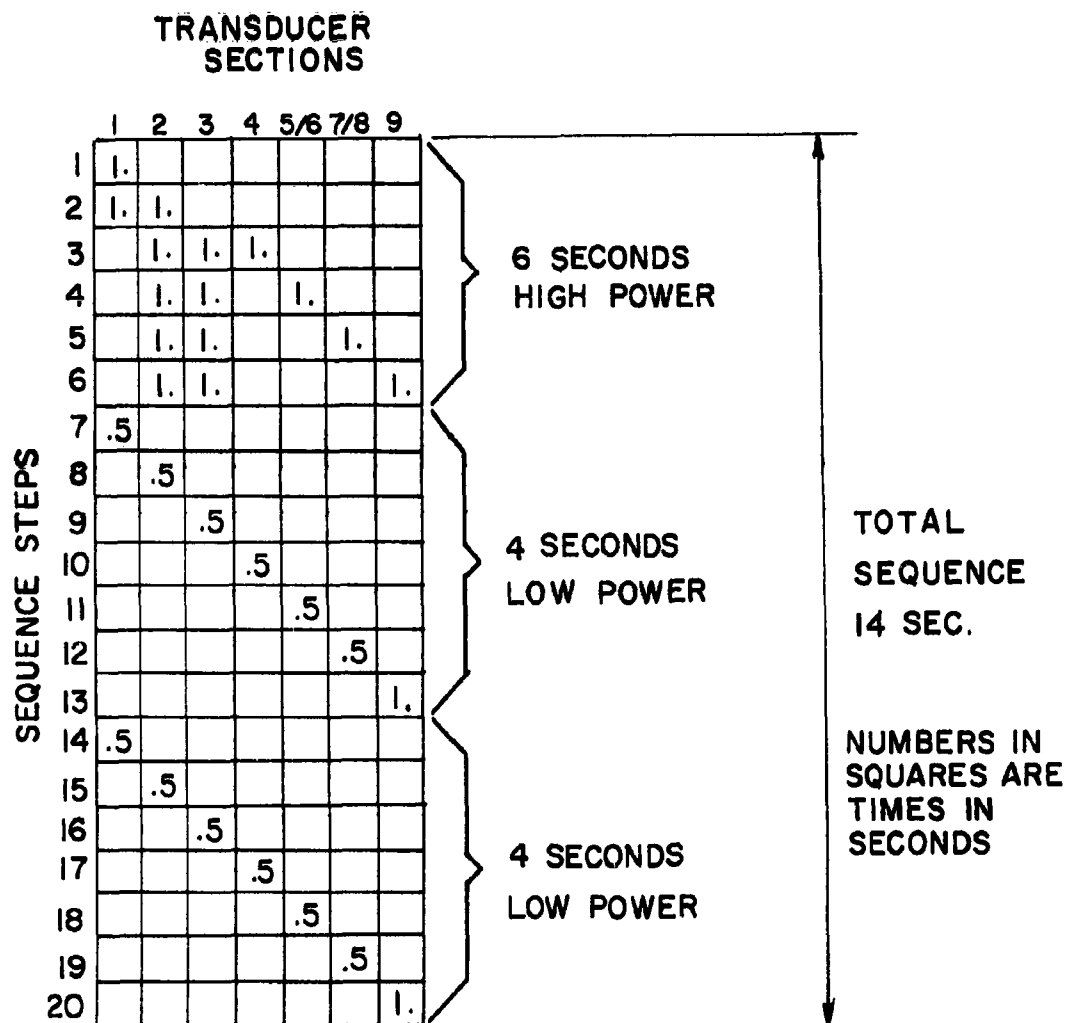


Fig. 9 - Daphne sequence

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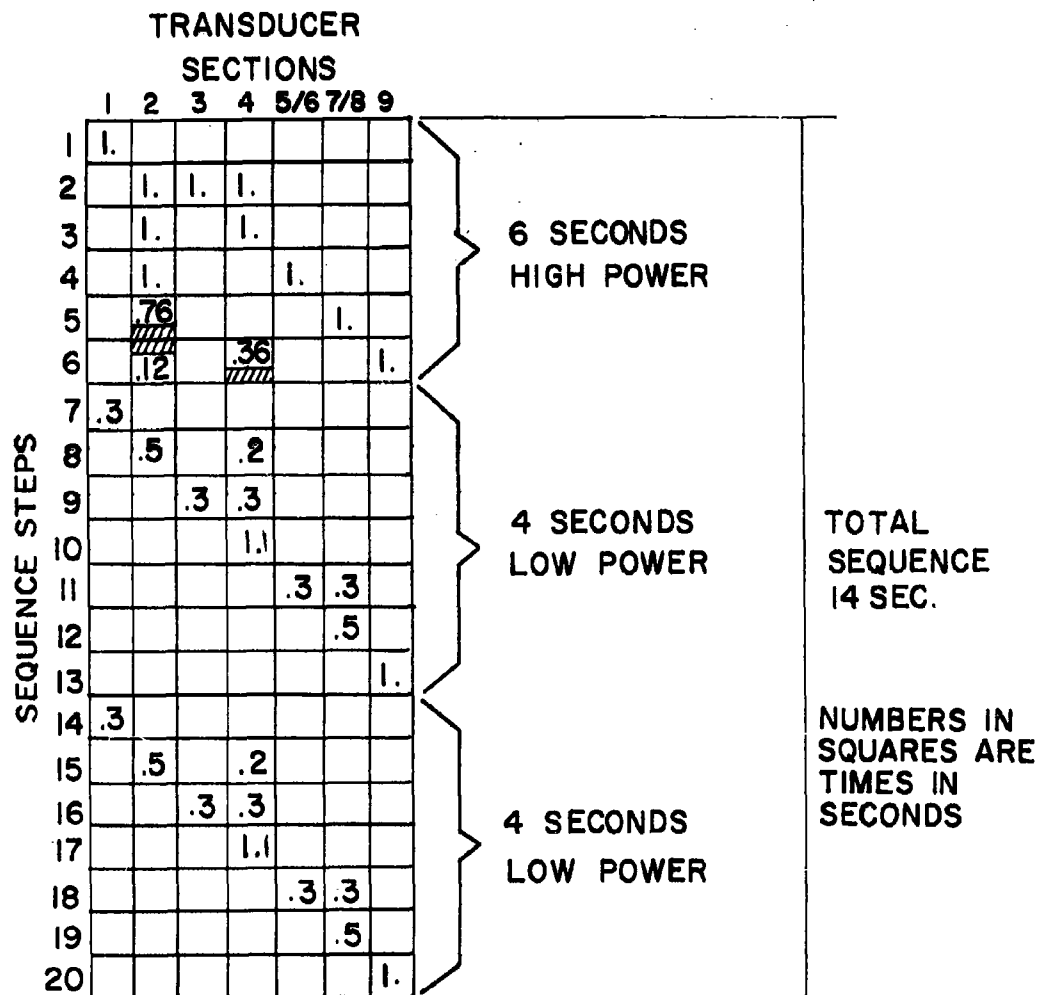


Fig. 10 - Daphne sequence

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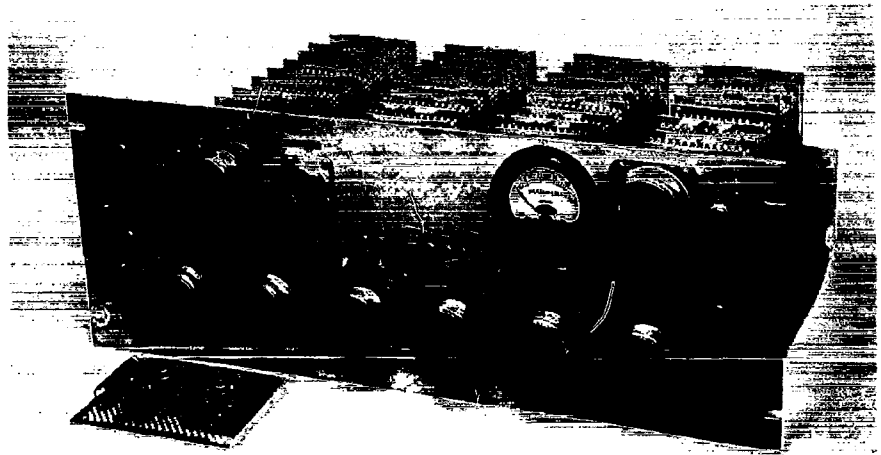


Fig. 11 - 36-card clock

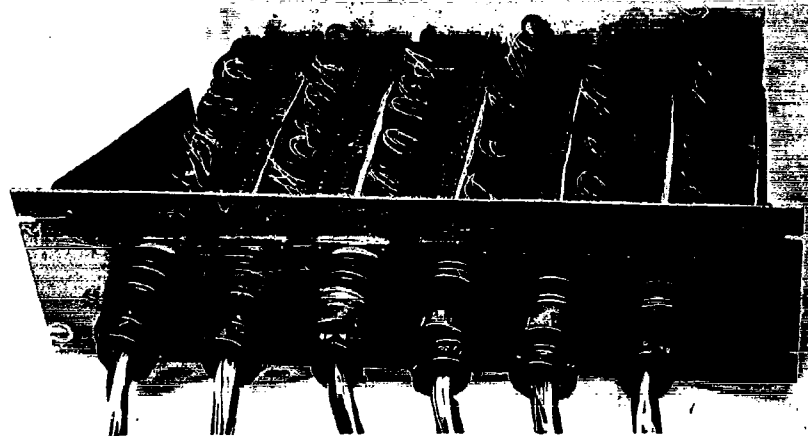


Fig. 12 - Clock pulse transformers

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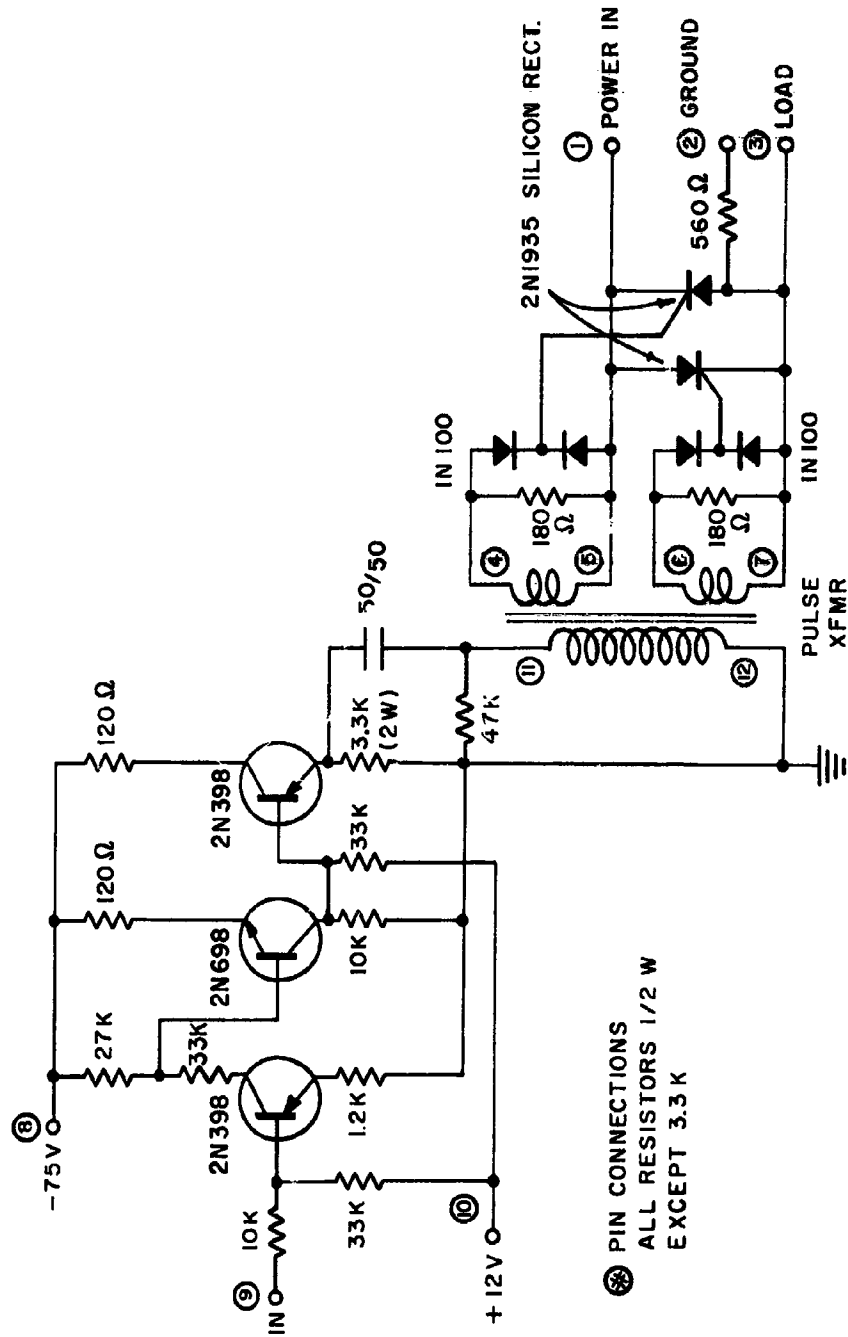


Fig. 13 - Electronic switch

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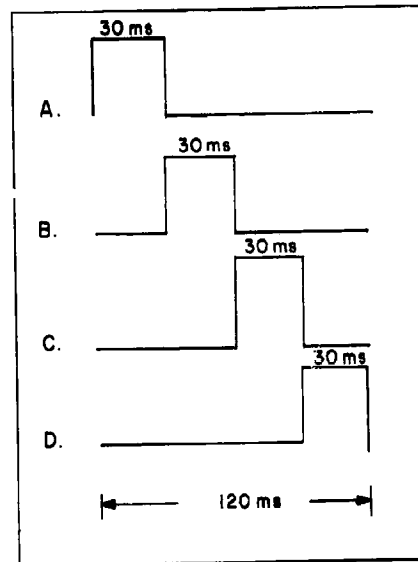
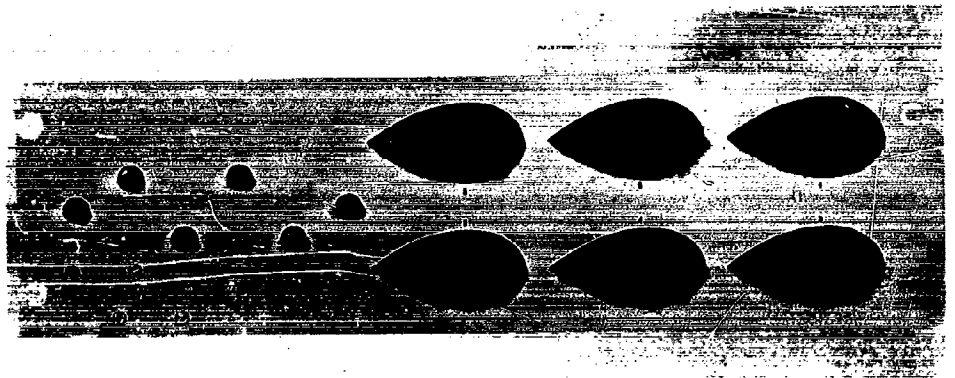


Fig. 14 - Synchronized outputs



15 - DAPHNE II monitor display panel

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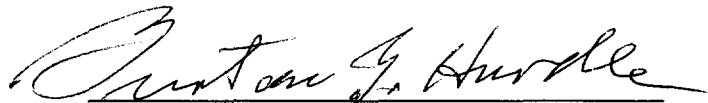
ATTN OF: Burton G. Hurdle (Code 7103)

SUBJECT: REVIEW OF REF (A) FOR DECLASSIFICATION

TO: Code 1221.1

REF: (a) "Experimental DAPHNE II Experiment Used on the Submarine Test of August 1963" (U), R.M. Haisfield, F.R. Alexander and B.J. Culverhouse, Sound Division, NRL Memo Report 1519, April 1964 (C)

1. Reference (a) describes the experimental DAPHNE II acoustic torpedo countermeasures system installed on USS SEAFOX SS402 during August 1963. Details of the system are included. Test results are not included.
2. The technology and equipment of reference (a) have long been superseded. The current value of these papers is historical.
3. Based on the above, it is recommended that reference (a) be declassified and released with no restrictions.



BURTON G. HURDLE
NRL Code 7103

CONCUR: Edward R. Franchi 9/11/2003
E.R. Franchi Date
Superintendent, Acoustics Division

CONCUR: Tina Smallwood 9/15/03
Tina Smallwood Date
NRL Code 1221.1