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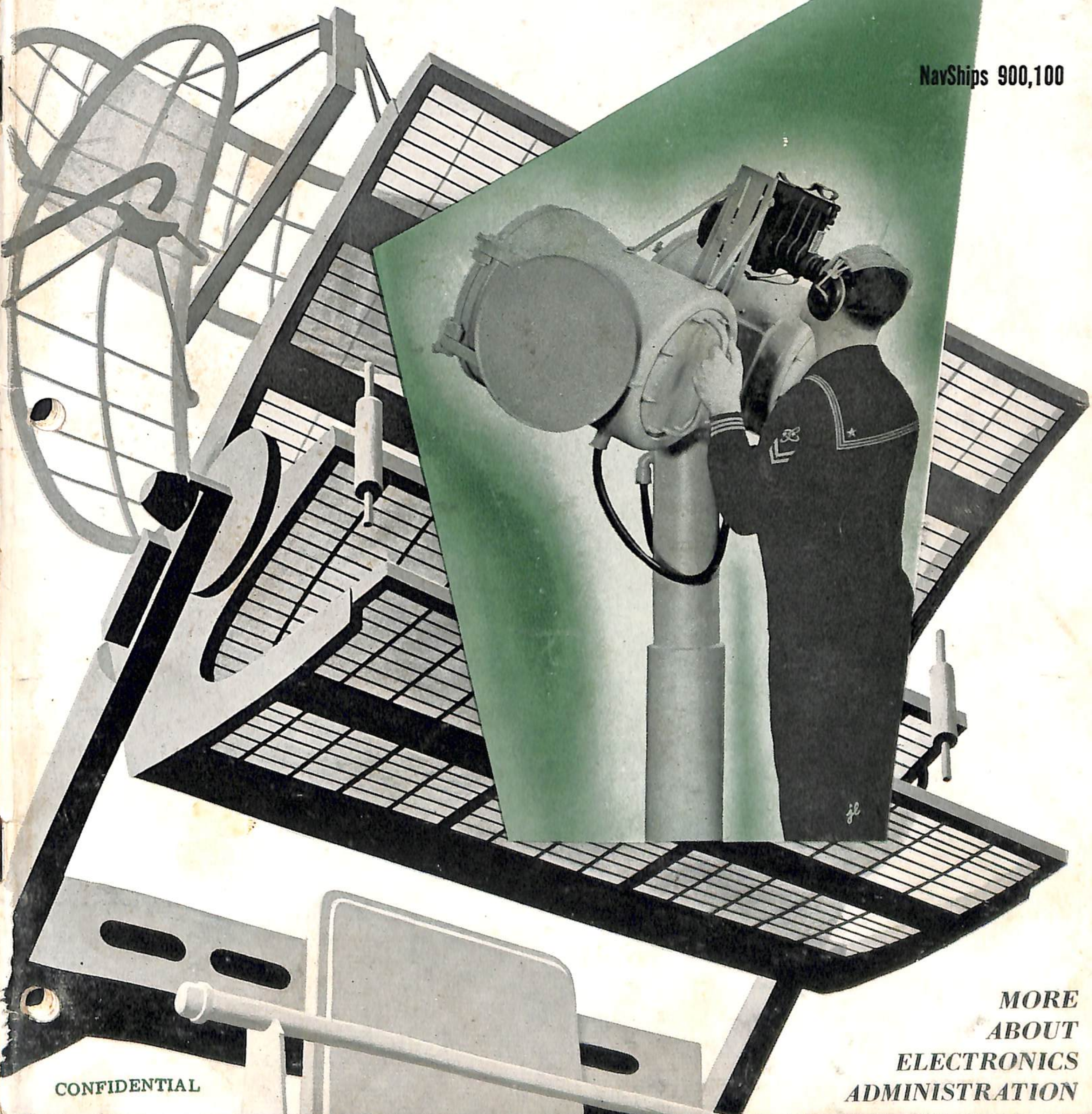
BUSHIPS

JUNE 1950

ELECTRON

NavShips 900,100



MORE ABOUT ELECTRONICS ADMINISTRATION

CONFIDENTIAL

TIME IS RUNNING OUT FOR THE CARELESS!

DEATH by electrocution has recently removed another technician from active duty. The need for caution at all times, and particularly when working with energized equipment must be borne in mind by every person working with electrical or electronic gear. Too often, the penalty for haste or carelessness is death.

The recommended procedures and precautions to be observed when measuring high voltages are given below. This is the right way, the safe way, the only way these measurements should be made.

Voltages over 300 volts shall be measured as follows:

1- Deenergize the equipment, shorting terminals to be measured to ground to discharge any capacitors connected to these terminals.
2- Connect meter to terminals to be measured using a range higher than the expected voltage.
3- Energize the equipment and read the meter WITHOUT TOUCHING IT while the power is on.
4- Deenergize the equipment and short terminals to ground before disconnecting meter.

NOTES:

1- MAKE SURE you are NOT GROUNDED whenever using measuring equipment or adjusting major equipment. For example: hand rails, exposed metal, decks, equipment frames.
2- Ground case of test equipment whenever possible and before starting measurements where test equipment must be held or adjusted during the measurement.
3- DO NOT FORGET that high voltages may be present across terminals that are nominally low voltage. Be careful even when measuring low voltages.

DON HESTER

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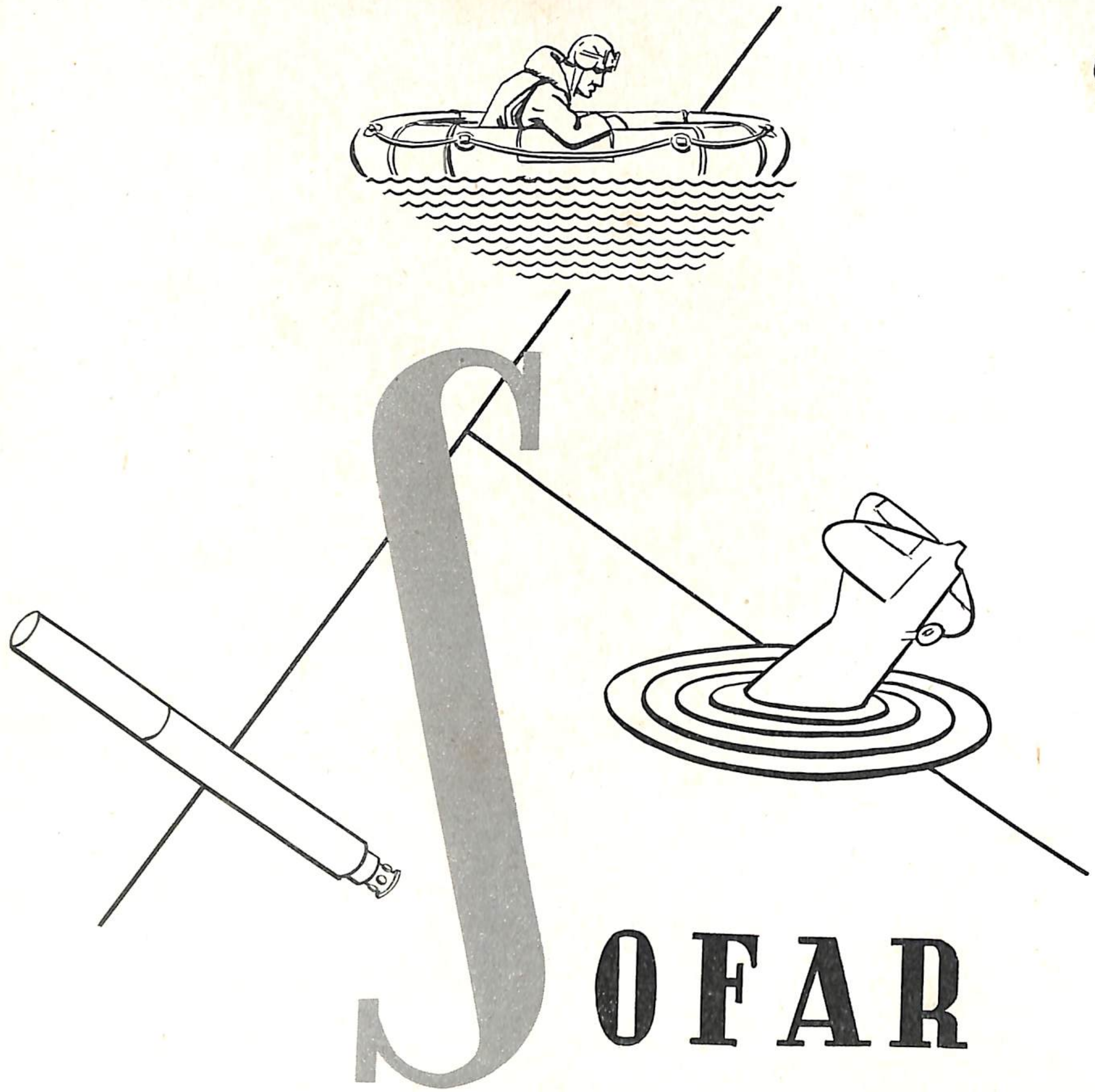
and forwarded via the commanding officer. Whenever possible articles should be accompanied by appropriate sketches, diagrams, or photographs.



SOFAR

by

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SOFAR, from the initial letters of the words SOund Fixing And Ranging, is the code name of an air-sea method now being rapidly developed. Its operation depends on the existence, deep down in the ocean, of a layer of water forming a natural "sound channel," along which sound travels with very little loss in intensity. Sound transmissions along the natural sound channel have been detected and identified over distances of thousands of miles; for example, from Hawaii to the California coast.

When the method is fully in operation, survivors at sea from an abandoned ship or plane will drop a sofar bomb set to explode near the axis of the sound channel. The sound waves from the explosion, after traveling along the channel, will be picked up at three or more widely spaced shore stations by hydrophones placed on the sea bottom at the depth of the axis. The differences in arrival time of the signals at the stations will enable the position of the bomb explosion to be fixed as the point of intersection of two hyperbolas.

The Natural Sound Channel

The existence of a natural sound channel, which occurs at depths varying from about 100 to 700 fathoms in different parts of the ocean, was first experimentally demonstrated during World War II. The sound channel is a result of the different velocities of sound in different ocean strata. In water the velocity of sound decreases with decreasing temperature and increases slightly with increasing pressure. Hydrostatic pressure increases steadily with depth while temperature, generally speaking, decreases; these two factors therefore have opposing effects. Their combined effect on the velocity of sound in the ocean is shown graphically in Figure 1.

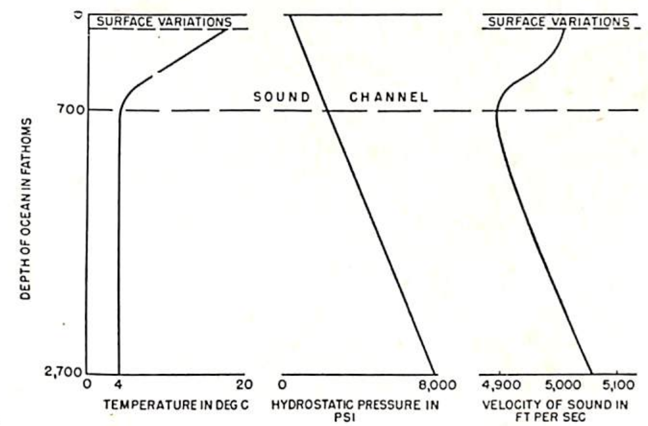


FIGURE 1.

At depths less than that of a certain critical layer of water, temperature variation is relatively more important than pressure change, and sound velocity consequently decreases with depth; below this layer temperature remains substantially constant but because of increasing pressure sound velocity increases. The critical layer is therefore a layer of minimum sound velocity.

If a sound source is placed near the critical layer, sound waves propagated at angles (smaller than a certain limiting angle) above and below the horizontal will be curved back towards the horizontal level (see Figure 2). This is because sound waves, like those of light, follow Snell's law of refraction, and in traversing media of different velocities of propagation are bent toward the medium of lowest velocity. The critical layer therefore forms a natural sound channel, and sound originating in it spreads horizontally in much the same way as sounds in air echo down a narrow canyon.

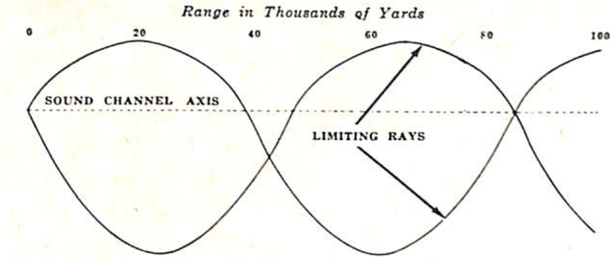


FIGURE 2.

The Characteristic Sofar Signal

A sound-channel signal, when it is received at a great distance from the source, has some typical characteristics. For example, a sound wave leaving the source at an angle to the horizontal smaller than the limiting angle, crosses and recrosses the channel axis until it is finally received by the hydrophone. In this way there are, theoretically, an infinite number of sound paths between the source and the receiver. Furthermore, the direct path—that is, the horizontal—is the slowest because a ray following it travels entirely in the stratum of lowest velocity. The total multipath effect is that the arriving signal begins at low intensity, gradually builds up into a loud crescendo and then abruptly terminates (see Figure 3). The cutoff in the characteristic sofar signal is so distinct that there is very little chance of mistaking it, and its occurrence can be timed to 0.1 second. The normal build-up time for long-distance signals is about 1.2 seconds per 100 miles of distance from the source to the receiver.

History of Sofar

The study of long-range underwater sound transmissions began in 1944, when the Woods Hole Oceanographic Institution and the U.S. Navy Underwater Sound Laboratory carried out tests to determine the attenuation of low frequency sound signals in the sound channel. It was shown that at distances of 900 miles, signals were still well above the ambient noise level. Early in 1945

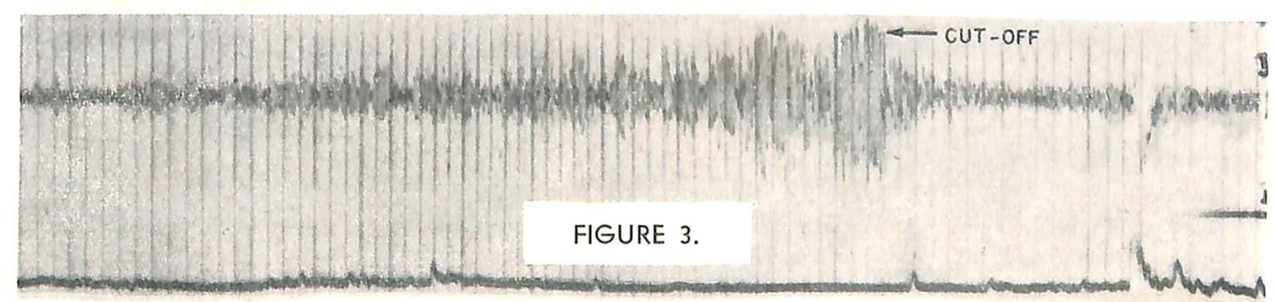


FIGURE 3.

an experimental shore station was set up in the Bahamas to test bombs and detonators, hydrophones, cables, and monitoring equipment, and also to determine the effects of sea-bottom topography on signals. The experimental results were promising, and triangulation tests were made later in the year to locate bomb explosions, using the Bahamas shore station and two U.S. Navy ships as the three stations of a sofar network. Bombs were dropped from the surface of the ocean and from the air. Some equipment difficulties were encountered but the fixes were reasonably accurate, and in the summer of 1946 a decision was made to proceed with the installation of a permanent sofar network in the Northeast Pacific. It was realized that this represented a major undertaking, involving extensive hydrographic surveys of proposed station sites, improvement of equipment and techniques, and the continuation of fundamental research. In 1947 the work was, in the main, transferred to the U.S. Navy Electronics Laboratory, which has borne the primary responsibility since that time.

Installation of the Northeast Pacific sofar network has recently been completed and the network is ready for continuous operation as an air-sea rescue system as soon as sufficient trained Naval personnel are available.

The Northeast Pacific Sofar Network

Originally it was intended to set up sofar shore stations at Monterey and Point Arena in California and at Kaneohe and Hilo in the Hawaiian Islands. However, at Hilo hydrographic conditions were unfavorable and terminal facilities inadequate, so the Hilo project was abandoned. The Monterey station was completed, but unfortunately signals received by it did not have the characteristic sofar pattern, particularly the sharp cut-off needed for accurate timing. It was found that reverberations from the walls of a submarine canyon in which the Monterey hydrophones were located were the cause of the abnormal signal characteristics. Since accurate signal timing is vital, the Monterey station was dismantled and replaced by a station at Point Sur, California.

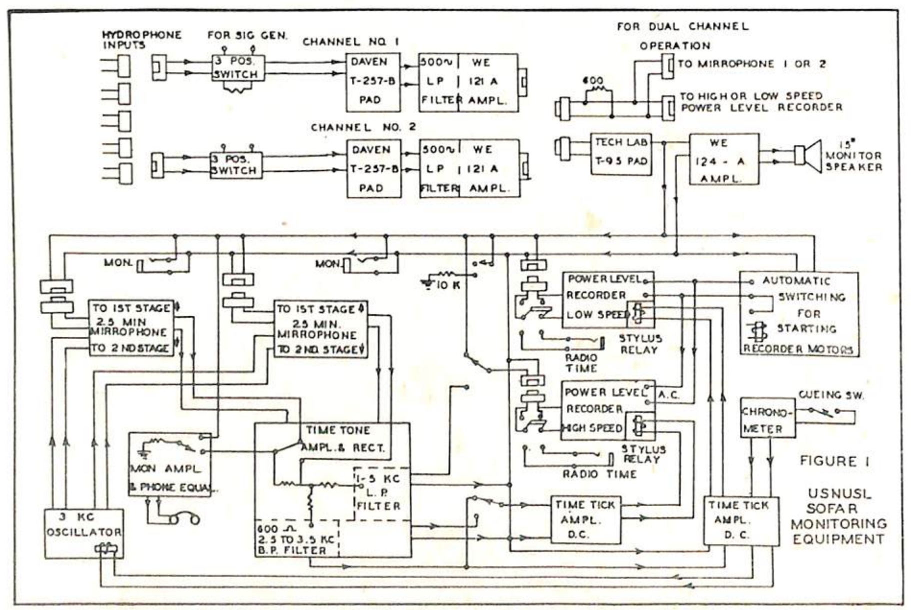
The Point Sur station and the two at Point Arena and Kaneohe have been completed, and the group of three makes up the Northeast Pacific network. Each of the three stations has been intensively tested individually, and shown to provide satisfactory signal reception. The group has also been tried out as a network by dropping about 150 test bombs between the California coast and Hawaii. The average error between the sofar fixes and the observed positions of the ship dropping the bombs was about 3 miles. These results were satisfactory, and the network will soon be put into continuous service. However, more trials of the network are being made by means of test cruises in other areas. In addition, spot tests will be made using aircraft and surface vessels as opportunities permit.

Station Equipment and Installation

Earlier work and testing of the Northeast Pacific stations have shown that the primary requirements for sofar monitoring equipment include: (1) sensitive response from 30 to 500 cycles; (2) minimum self-noise in the amplifiers; (3) provision for switching from one hydrophone to another, with means for introducing a signal generator for equipment calibration and maintenance; and (4) suitable means for recording cutoff time of the signal (to 0.1 second), and for chronometric verification by introducing Station WWV time signals.

The salient features of the equipment developed to satisfy these requirements are shown in simplified block diagram form in Figure 4. Preamplifiers (not shown in Fig. 4) are located at the beach and connect to shore station equipment (Fig. 5) comprising electrically in-

FIGURE 4.



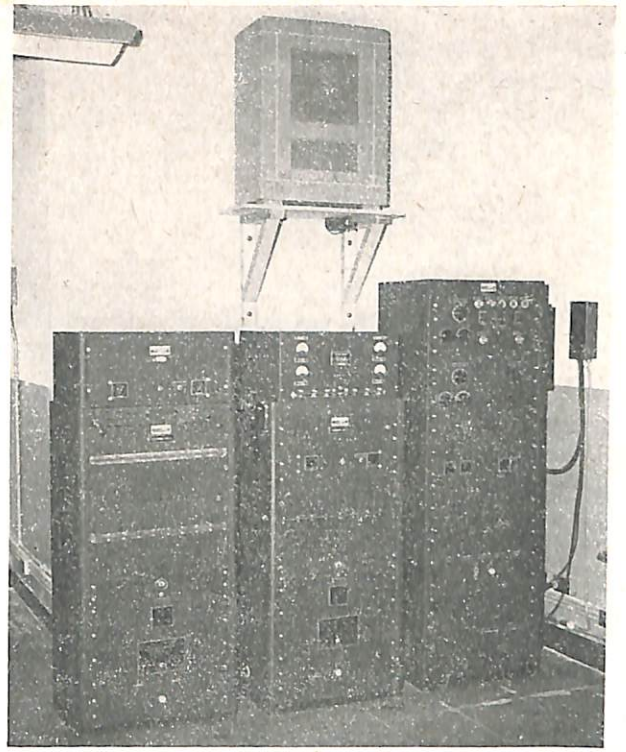


FIGURE 5.

tegrated receiving, recording, and timing units, capable of continuous operation.

The amplifier equipment, which is in duplicate, consists of the beach preamplifier, a 600-ohm attenuation pad, a 500-cycle low-pass filter, and a line amplifier, feeding into the power-level recorders.

The two graphic power-level recorders are put into operation by an automatic switching device actuated by the incoming signal. The signal is also fed to another amplifier which drives a speaker for aural monitoring. A continuously operating magnetic-tape recorder is provided to record the signal before its amplitude is sufficient to actuate the automatic switching device. When a signal is received the operator must manually switch off the operating recorder before 2½ minutes have elapsed or the signal is erased.

A standard Navy break-circuit chronometer affords time indexing to 0.1 second by actuating a stylus on each power-level recorder through a d-c time-tick amplifier. Another time-tick amplifier keys a 3-kc oscillator which provides time-indexing signals to the magnetic tape recorder.

The recorded signal may be played back to the power-level recorders, time ticks being furnished by a band-pass filter and rectifier unit which separates the recorded 3-kc time signals and operates the indexing stylus. A complete record of the signal is thus provided.

At least two deep-sea piezoelectric hydrophones, placed at the depth of the sound channel, are used for each station. From the hydrophones, heavy armored cables, which may be as much as 20 miles long, lead to the monitoring equipment. A special cable-laying ship is required for cable installation, and an oceanographic survey ship first makes a detailed hydrographic survey to find the most favorable location for the hydrophones and the best cable route to shore. Both ships make use of shoran navigational control to insure accuracy of installation. Bottom character, bottom topography, currents, wave conditions, temperature gradients and other factors have to be determined and evaluated.

During installation of the Northeast Pacific stations it was found that voltages high enough to mask sofar signals were induced in the cables between the beach and the monitoring equipment as a result of ground potentials set up between power-line grounds and the sea. The interference was made negligible by amplifying the sofar signal at the beach before transmitting it to the amplifier of the shore station. The use of beach amplifiers is now standard practice.

Sofar Ordnance

Up to the present, various bombs have been used to produce the sound signals eventually picked up by the monitoring equipment. The bomb currently being manufactured carries a main charge of 4 pounds of TNT, and is fitted with six diaphragms each designed to rupture at a specific depth of water. Rupture of any diaphragm actuates the detonator. The diaphragms are protected by caps, and in operation the appropriate cap is removed to arm the bomb so that it will explode at the desired depth.

Problems

Research is being prosecuted to improve station equipment in general, so as to provide simple and trouble-free operation.

Among individual items of equipment, cables have caused the most grief, and a number of cable failures occurred during the installation of the Northeast Pacific network. In some cases open circuits developed; in others the cables remained electrically good but became physically snarled, leading to early failure. The cables have to withstand the forces of tides and currents and also rubbing action, sometimes against a rough, abrasive, coral sea bottom. The Bureau of Ships is now engaged in establishing the specifications of a submarine cable with suitable physical characteristics for use at sofar stations.

An attack is also being made on more fundamental problems: for example, shadow zones are being studied to find how they affect signal character, the sofar attenuation constant is being determined so as to establish the optimum weight of bomb explosive, and basic oceanographic and sound-transmission data are being steadily gathered and analyzed.

by
Cdr. H. E. Thomas, SE, USNR
EO, Staff, Commander Service Force, Atlantic

MORE about ELECTRONICS ADMINISTRATION

In the December 1949 Electron appeared an article by LCdr S. A. Sherwin, USN, entitled "Electronics Administration." This was followed by an article of similar nature written by LCdr. W. E. Scott, USN., entitled "You Can Maintain Your Electronic Equipment," which appeared in the February 1950 Electron. Although these discussions were published in the Electron, they did not necessarily represent the opinion or policy of the Bureau of Ships but only the thoughts of the respective authors. These articles were published to stimulate thought and discussion on this vital subject and the response has been very satisfactory. To offer as wide a field of thought as possible on this subject, the following article written by Cdr. H. E. Thomas, SE, USN is printed herein.

It is doubtful if there is anyone associated with the Navy in any respect who is not aware of the fact that there is an electronics problem in the Navy. The full extent of the problem, including all the various aspects of it, are less well known. For this reason it behooves those of us who are in daily contact with the problem to make very certain that wrong impressions are not created as a result of our opinions, oral or written.

It is always difficult to make any significant changes in the Navy. Admiral Mahan says in his classic work that military men generally have been slow to study and use each new weapon. Electronics is no exception. There are proponents and opponents, each with their opinions regarding the electronics problem and the steps required for a proper solution. It is considered that Lieutenant Commander Walter E. Scott's article "You CAN Maintain Your Electronic Equipment" has tended to oversimplify the electronics problem to such an extent that it becomes a potent weapon in the hands of electronics' opponents. Furthermore, it is directly counter to recent recommendations made to the Chief of Naval Operations by the Commander-in-Chief, U.S. Atlantic Fleet, and unfortunately was published almost coincidentally with the submission of these recommendations.

Because of the untimely appearance of Mr. Scott's article and because of its propensity for misleading otherwise capable individuals, it becomes necessary to examine the validity of some of Mr. Scott's statements by comparing them with known facts.

In the second paragraph appears a statement that "some of our ships are in excellent condition electronically." If this statement applies to destroyers, it is not true. The Commander Service Force, U. S. Atlantic Fleet, has been in the business of electronic rehabilitation in all ships of the Atlantic Fleet since March of 1949, and during that time approximately seventy percent of the total have been rehabilitated. If Mr. Scott's statement were true, then surely one of those ships in excellent condition should have been discovered. Actually, among the rehabilitated destroyers, the ship in best condition required more than one hundred fifty man-hours of work. Of further interest, it may be noted that the destroyer which should have been in best condition was rehabilitated in May 1949 and was again worked on in October 1949. Total man-hours involved were four hundred forty-eight.

In the same paragraph Mr. Scott attacks the administration and supervision in the ships, indicating that improvement in the efficiency of administration and supervision will largely eliminate the problem of electronic maintenance. In an organization as large as the Navy, with the numerous individuals involved, it seems rather difficult to assume that the command responsibility is better or worse than it has been in the past or will be in the future. The Navy will probably always have some excellent, some average and some poor skippers. The writer will not quibble over any attempt to improve the efficiency of the ship's administration, however it should be apparent that attempts of this nature are not apt to solve the electronics problem.

In the third paragraph, Mr. Scott states "the condition of the electronic equipment is representative of the amount of supervision exercised by the command" and "discrepancies are not necessarily the result of a shortage of trained men, nor due to the lack of the ability of the men we have." Improved supervision will help a little in improved conditions, but the experience gained during the past few months indicates that invariably the ships with their equipment in the best condition are those which have one or two really competent ET's aboard. There is no substitute for *ability*. Utopian supervision will not aid incompetent ET's in the maintenance of even the simplest equipments.

In the remaining paragraphs, except the last, there is much that is true and Mr. Scott has quite effectively brought out several points that should be kept in mind. However, he makes one statement which should be challenged. He writes "it's not clear that we need them," referring to more officers in the Navy. Whether or not we need more officers is debatable of course, but if the actual needs of the Navy are to be met, there seems little doubt that more officers is the only answer. One fact is indisputable—the Navy must have more technical talent. This requirement is currently being met by the employment of civilian technicians. Furthermore, experience shows a continuing need for these technicians or a reasonable substitute for them. The technical talent required by the Navy cannot be obtained by recruiting capable technical personnel as enlisted men. Such individuals will not accept the status of an enlisted man. Therefore, the Navy can either continue to employ civilian technicians or recruit suitable individuals in officer status and guarantee them careers comparable with other officers. The latter is the least expensive. The only other alternative is to permit the equipment to slowly deteriorate.

Mr. Scott's last paragraph needs little comment. His statement that "we have . . . the know how" is definitely not true. If it were even partially true, the electronics problem would not be the item of major concern that it it today.

These comments could be concluded at this point, but the gravity of the electronics problem warrants additional comments, particularly on a phase of the problem not usually given much consideration.

Directly or indirectly, the government is spending hundreds of millions of dollars annually on research. This program continues to develop new and extremely complex items, all of which may or may not have direct applications in the Fleet. In any event the present economy program prevents development and engineering required to bring these items to the stage of practical usage and replacement of obsolescent equipments presently in the Fleet. In other words, the Navy has, behind an economic dam, an expanding high potential of completely strange and complex electronic items of all kinds. A sudden outbreak of war will burst this dam and immediately the Navy will face the necessity of using a flood of new equipments to their maximum effectiveness. These equipments will be little better than "bread board" layouts because the time element will not permit the engineering required to reduce many of the complexities. The maintenance problem will be staggering. To meet this problem, the equipments must be maintained by personnel who have actually had a part in their development and engineering.

It is this writer's firm conviction that a truly prepared Navy must not only solve the relatively minor problem of maintaining its present equipments in satisfactory condition, but it must also have enough technical talent continuously available to cope with the conditions which must be met in the event of war. This requirement can only be met by a group of highly skilled technical officers whose normal peacetime duties require a rotation between ships of the Fleet and laboratories and factories ashore. On sea duty, these officers must be capable of maintaining all electronic equipments at peak performance, and on shore duty they must be capable of contributing to the design and production of new equipments, thus providing a very desirable liaison between designer and consumer.

If the Navy should elect to solve tomorrow's problem in some such fashion as indicated above, today's problem would cease to exist.

CONFIDENTIAL

MARK V
IFF/UNB SYSTEM

This is the third in a series of discussions devoted to describing the operational and electrical characteristics, capabilities, and limitations of units and combinations of units utilized in the Mark V IFF/UNB System. In previous articles on this subject we have endeavored to present the general aspects of the entire Mark V IFF System and describe the electrical operation of Interrogator-Responsors and Transpondors, the basic components of any IFF System. Throughout these articles there has been frequent reference made to interconnection assemblies although little has been written concerning their operation and importance in any Mark V IFF System. This discussion will embrace the electrical and, to a certain degree, the operational features of two different types of interconnection assemblies. It is pointed out that even though a Mark V IFF combination can be composed of only an I-R with associated display, or an I-R associated with a radar, the full operational capabilities are not realized until some type of interconnection assembly is interposed between the radar and the I-R. These units afford certain advantages which are not available otherwise, as the reader will find when he completely understands the many ramifications of a Mark V IFF System.

There are three basic types of interconnection assemblies currently employed in Mark V IFF installations: 1—AN/UPA–9. 2—AN/UPA–15. 3—AN/UPA–16. The first of these two were chosen for a detailed description since it is believed that if the reader digests the operation of both of these, he will have no trouble in understanding the operation of the latter. However, the AN/UPA–16 will be briefly described so that the technician will have as complete a picture as possible of all three units.

Interconnection Assembly AN/UPA–9

The Interconnection Assembly AN/UPA–9 is composed of two major units, IP–9(XN–1)/UPA–9 Indicator and SN–50(XN–1)/UPA–9 Synchronizer, hencenections between the two units and connections to other forth referred to as the Indicator and Synchronizer respectively. Figure 1 is a block diagram of the inter-concomponents utilized with the UPA–9. The equipment is

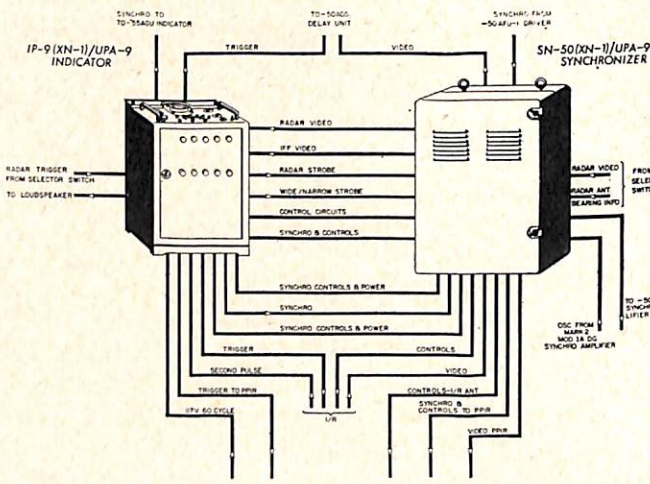


FIGURE 1. Interconnection Display Assembly, AN/-UPA–9, showing relationship of units and all major interconnections between them and to external units operated with the assembly.

designed to operate with a selected radar, an Interrogator-Responsor, and a directional I-R antenna. It is designed to provide the following: (a) Complete control of the associated Mark V IFF System, including the IFF antenna. (b) Complete identification information for which the Mark V is designed, including range and bearing information. (c) Combinations of Radar, IFF, and strobe signals for PPI display. (d) Interconnecting terminals for the Mark V System. In a previous article, there was presented a general description of the UPA–9 but for purposes of refreshing the reader, certain pertinent details are repeated herein.

The UPA–9 has control of all interrogation modes; IFF, PI, and FLI. EMER replies and PI replies are decoded and converted to characteristic EMER and PI signals for PPI display. Slow-code information can also be taken from all replies and read by the use of earphones or loudspeakers or observed visually on the Indicator A-scope. Radar or identification signals can be displayed individually or collectively on the A-scope of the Indicator or on the associated PPI (VJ). Ranging of signals is accomplished by a strobe (range gate) which can be positioned along the sweep with a calibrated range crank incorporated in the Indicator. This strobe signal can also be used to trigger a fast sweep (expanded sweep) about 15,000 yards in length, thereby making it possible to view just a portion of the operating range. Control of the IFF antenna can be selected by this equipment, there being three methods of antenna control; 1—Slave to the associated radar. 2—Manual control through the medium of the bearing cursor on the associated VJ. 3—Automatic variable rotation from the Indicator. The IFF antenna can be rotated in either TRUE or RELATIVE bearing. The Mark V system of which the UPA–9 is a component can be operated purely as an identification system entirely separated from a radar equipment through a switching arrangement on the UPA–9 Indicator. When operating in this fashion, the equipment becomes self-triggering. Briefly the AN/UPA–9 components perform the following functions, listed under Indicator and Synchronizer, respectively:

Indicator:

(1) Counts down radar triggers.
(2) Delays and chops counted-down triggers for I-R operation.
(3) Provides triggers for PPI repeater(s).
(4) Generates A-scope sweep and intensifying voltages.
(5) Generates strobe signals.
(6) Provides calibrated variable delay for strobe signal (ranging).
(7) Provides video and sweep switching to display both Radar and IFF signals on A-scope.
(8) Controls interrogation.

Synchronizer:

(1) Accepts only PI and EMER replies which are correctly arranged in accordance with Mark V IFF/-UNB requirements.
(2) Decodes accepted PI and EMER replies for PPI display.
(3) Amplifies and mixes radar video, IFF video, decoded PI, decoded EMER, and strobe video for PPI display.
(4) Widens plain IFF replies for PPI long-range scales to afford better signal-to-noise characteristics.
(5) Accepts IFF signals within the strobe (range gate) for slow-code reproduction.
(6) Generates audible buzz from IFF signals within the strobe.
(7) Discriminates IFF pulse-widths lying in the strobe.
(8) Generates audible signals from discriminated IFF signals.
(9) Generates azimuth gate from radar and IFF antenna synchro information.
(10) Provides d-c voltages for the indicator with the exception of high-voltage for the A-scope.
(11) Provides system interconnecting terminals.

Indicator

Figure 2 is a functional block diagram of the Indicator Unit which will be used as a basic reference throughout

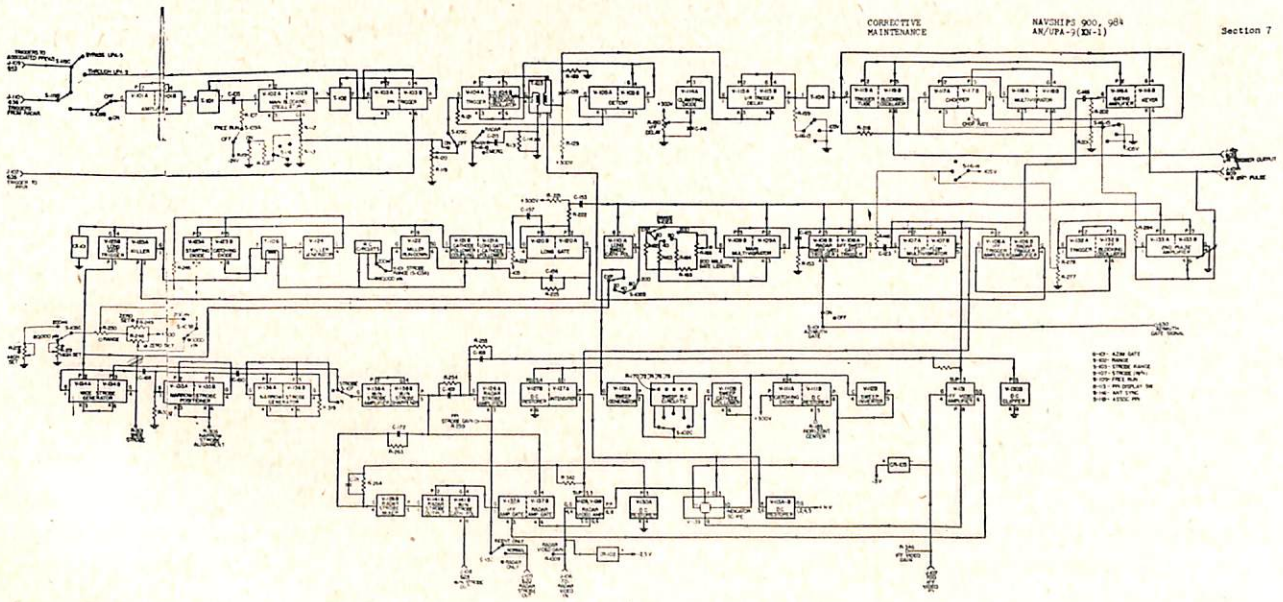


FIGURE 2. Functional servicing diagram of the Indicator Unit of the Interconnection Assembly AN/UPA–9.

the functional explanation of this unit. The incoming radar triggers enter the unit at J–110 and are coupled direct to switch S–119. Note that some plugs, jacks, and terminal numbers are underlined while others are not. Throughout the UPA–9 equipment the policy followed is that where a number is NOT underlined the signal (trigger, video, or synchro) is indicated as entering that unit, while an underlined number indicates the signal is leaving that unit. S–119 is included in the unit to permit by-passing the UPA–9 when it is desired to utilize the associated PPI (VJ) as a straight radar repeater and not with the Mark V IFF system. When the UPA–9 is switched into the system, the incoming trigger is passed through S–119 to S–109B. As mentioned previously, the UPA–9 can be operated with or without radar triggers. When operated with radar triggers, the incoming trigger is amplified in V–101, coupled through a transformer and applied to a blocking oscillator (V–102) which is operating as a single swing by virtue of a 24-volt bias on its grid. When operated without radar triggers, S–109 cuts off the incoming radar triggers and switches the 24-volt bias out of the grid circuit of the blocking oscillator, simultaneously switching in additional resistive components which permit the oscillator to operate as a free-running blocking oscillator. V–102 has two outputs, one to V–103 which is a cathode follower to supply PPI triggers, and the other through a section of S–109 to a count-down blocking oscillator circuit. V–103 provides two triggers, one to the associated PPI of the Mark V IFF System, the other to any remote PPI which may be connected in the system. This second PPI is normally not utilized except in special circumstances. The trigger to the countdown circuit is passed through a trigger tube V–104A before application to V–104B. V–104A and B are both biased to cut off by a voltage divider between B+ and ground. When the blocking oscillator is triggered by an incoming trigger pulse its grid will be driven to a negative value through the grid winding of the blocking oscillator transformer and the R-C circuit will hold this negative charge for a certain period of time. No other incoming pulses will trigger the blocking oscillator until the charge leaks off sufficiently to allow a new cycle of events to occur in the blocking oscillator. Since the incoming triggers must be of sufficient amplitude to overcome the negative bias on the grid of the blocking oscillator, the count down control R–120 (front panel control) can be adjusted to provide pulses in the region of 150-pps which is the optimum number for best operation. However, the countdown rate will always be a submultiple of the incoming pulse rate as a definite time has to elapse between each swing of the blocking oscillator. The above statements are true only when operating with radar synchronizing pulses. When operating the system as a "free run" by placing S–109A in the ON position, full amplitude triggers are delivered to the countdown blocking oscillator because S–109C effectively by-passes the countdown control and the countdown circuit will trigger with each incoming pulse. Obviously, the repetition rate of V–102 is adjusted for optimum reception rate when operating as a "free run" circuit which does not overload the countdown circuit. Still a third variable is possible in this circuit, when operating in the MANUAL position. Note that when S–116 (18) is placed in the MAN position an additional capacitor C–115 is placed in parallel with C–114 and R–131 which effectively limits the repetition rate of the countdown blocking oscillator to between 75 and 125 pps.

When the incoming pulse rate becomes excessive (500 to 1000) with the space between pulses smaller, a tendency to jitter would exist at some frequencies as the countdown oscillator might be triggered on adjacent pulses. For example if the incoming repetition rate is 810 pps the countdown circuit might jitter between 135 and 152 pps or between the 5th and 6th submultiples. To offset this possibility a "detent" circuit, V–105, is employed. This "detent" circuit is nothing more than an automatic biasing circuit which, in effect, varies the voltage present on the grid of the countdown trigger tube, V–104A. If a pulse rate is stabilized and no change is taking place, the countdown trigger will be operating, for example, on the 5th submultiple, so that the output repetition rate will be correct for the system. If the pulse rate tends to increase, the automatic biasing circuit will slowly increase the positive voltage on the grid of V–104A to a point where the countdown will be triggering on the 6th submultiple rather than the 5th in order to keep the output repetition rate correct. The circuit can be understood as being regenerative for some particular countdown submultiple and therefore requires a large change in incoming pulse repetition rate to overcome the regenerative effect and to enable the circuit to lock on the next higher or next lower submultiple, depending on increase or decrease of incoming pulse rate.

The countdown blocking oscillator has two outputs, one to the I-R trigger delay circuit and the other to the radar trigger amplifier. For the time being we will follow out the primary trigger channels, although the entire system interlocks and eventually all subsidiary circuits will be considered. The output counted-down pulses from the countdown oscillator are delivered to the grid of V–115A. V–115 is a conventional one-kick multivibrator except that an adjustable bias circuit is connected in the cathode circuit. This adjustable bias is in the form of a diode using a potentiometer (front panel control) as a cathode resistor. The overall function of the delay multivibrator in conjunction with the diode is to afford a front panel control for delaying the triggers to the I-R

a certain amount of time in relation to the basic radar triggers. As can be seen from Figure 2 the delay multivibrator is out of the circuit when operating in MANUAL by the application of a 105-volt bias through S–116 (13) to the grid of V–115B. In this connection the triggers are generated in the countdown oscillator, amplified in V–106B and coupled through V–116A to the trigger tube blocking oscillator V–119. In the other two conditions (RADAR and EMER) V–116A is cut off by a 105-volt bias applied through S–116(15). However, in these two conditions, the output of the delay multivibrator, differentiated, will overcome the bias on the trigger tube and blocking oscillator V–119, generating 2.5-microsecond trigger pulses for delivery to the I-R.

Since the UPA–9 is a single-mode system (only one mode of challenge at any time) provisions are made for interrupting the triggers to the I-R which will effectively "chop" the display on the associated PPI or A scope. The chopping is effected in this equipment by a multivibrator consisting of V–117 and V–118. Control of the amount of chop is exercised from the front panel by a "Chop Rate Control." The chopping multivibrator is a free-running square wave generator with the two halves of the multivibrator connected through cathode followers. The actual multivibrator is V–117 and the coupling tube V–118. Direct coupling is used between the multivibrator tube sections and their cathode followers, hence the cathode followers are operated between +300 volts and ground and the multivibrator tube sections are operated between ground and —305 volts. Voltage dividers are used in the cathode circuits of the follower tube to obtain optimum feedback voltage. The chop rate is controlled by adjusting the bias on V–117B through a front panel control.

Since IFF and radar signals are displayed alternately on the Indicator A-scope, an Eccles-Jordan or flip-flop multivibrator is utilized to provide this switching between the two. The operation of the flip-flop is indicative of zero range for both IFF and radar signals, therefore its output is used for triggering sweeps, triggering the ranging circuits, shifting the base line of the Indicator A-scope, and gaiting the IFF and radar video amplifiers.

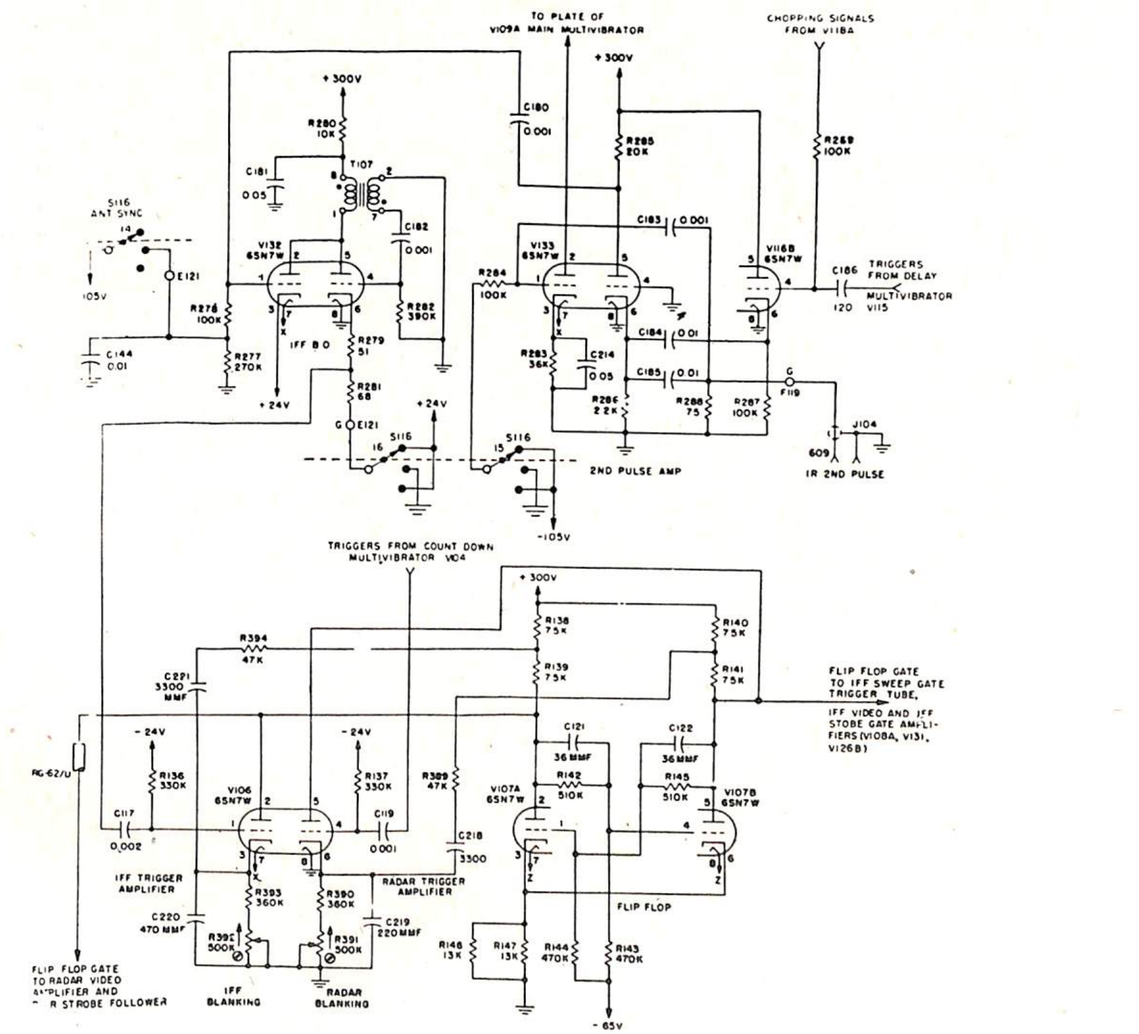


FIGURE 3. Schematic diagram of the gating circuits included in the Indicator Unit of the AN/UPA–9 Interconnection Assembly.

From Figure 2 we see that the cycling of IFF and radar displays is controlled by the countdown rate, therefore the timing of radar triggers (not to be confused with radar synchronizing pulses) is taken from the countdown blocking oscillator V–104B. These triggers are fed to amplifier V–106B, which is the radar trigger tube, its output being used to trip the flip-flop to the radar position. The timing of the IFF display is based on the second pulse of the paired pulses generated in the I-R. This pulse is shown entering the Indicator at J–104 on Figure 2. These incoming I-R second pulses, hereinafter referred to as DISPLAY TRIGGERS, are applied to the cathode (pin 6) and the grid (pin 1) of V–133 the second pulse amplifier (Figure 3). In RADAR and EMER operation V–133A is biased beyond cutoff by a —105 volts on the grid so the positive pulses have no effect on that stage. However, V–133B is conducting and the positive pulses applied to the cathode will cause a positive pulse to be developed in the plate circuit (pin 5) of V–133. This positive pulse is coupled to the grid (pin 1) of the IFF blocking oscillator V–132 which is normally at cutoff due to a +24 volts on the cathode. Since pins 1 and 5 of V–132 are tied together, the positive trigger on grid 1 will cause the oscillator to cycle and generate a pulse in the cathode circuit. When in MANUAL operation V–132A has additional bias (—105 volts) placed on grid 1 which places it far beyond cutoff. Thus this stage will not operate even when the positive pulse from V–133(B) is applied to its grid. However, the reader will note that V–132B cathode (pin 6) is switched from a +24 volt bias to ground when the equipment is switched to MANUAL. This makes V–132B a free-running blocking oscillator, generating triggers in the cathode circuit as in RADAR and EMER operation. Also note that V–133A is opened to permit the DISPLAY TRIGGERS to pass through and generate a negative pulse in the plate circuit which is used to trigger the main multivibrator V–109A which will be discussed later. During the periods when the I-R triggers are OFF due to the action of the chopping multivibrator V–117 and V–118, IFF triggers are taken from the trigger delay circuit, coupled through V–116B, a cathode follower, and applied to V–133.

Thus we have explained the generation of flip-flop and trigger voltages both in RADAR/EMER and MANUAL operating conditions. The triggers generated in the cathode of V–132B are coupled to the IFF Trigger Amplifier, V–106 (pin 1) while the radar triggers from

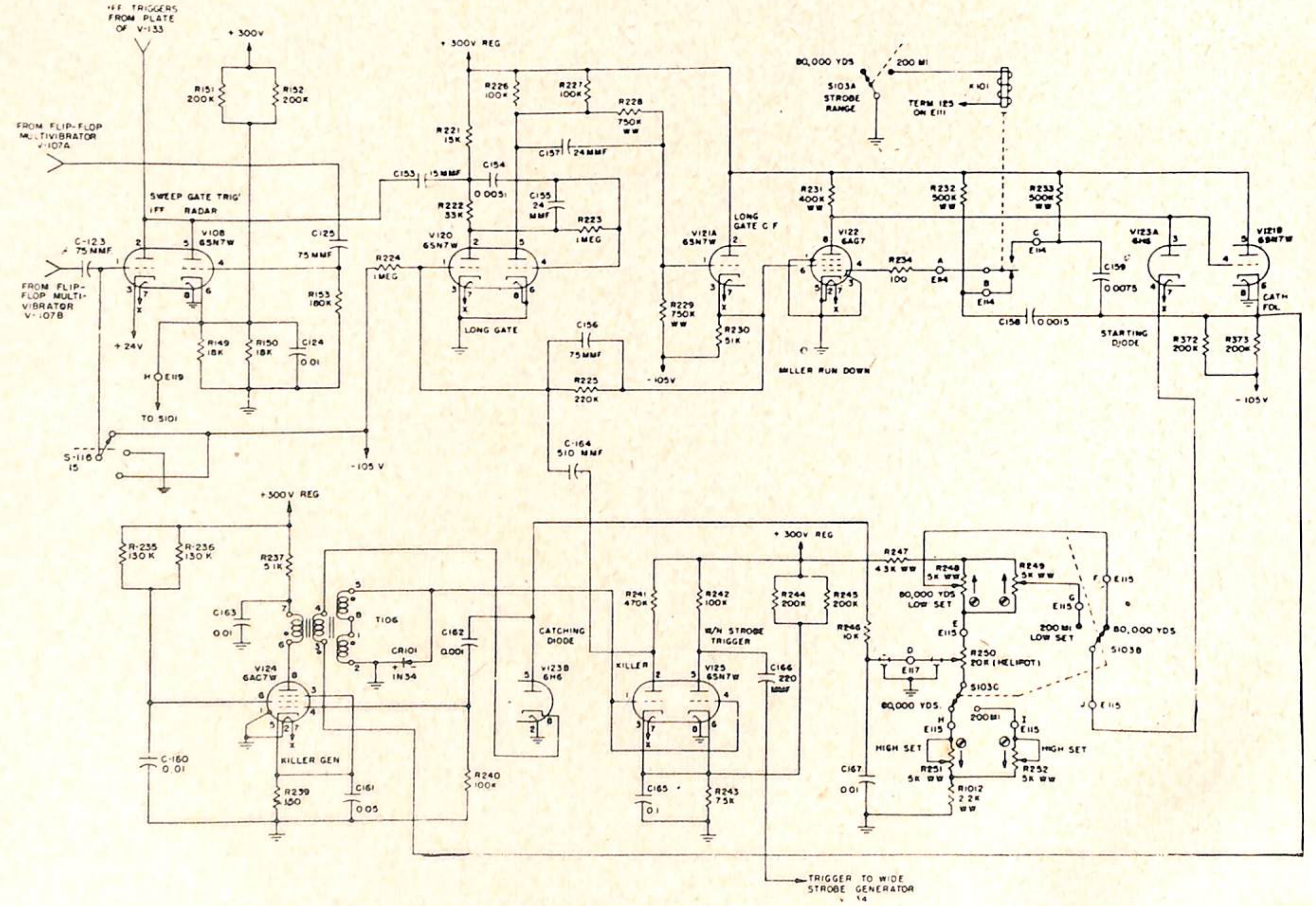


FIGURE 4. Schematic diagram of the ranging circuits used in the Indicator Unit of the AN/UPA–9 Interconnection Assembly.

V–104 are coupled to V–106 (pin 4). Both V–106A and V–106B are disabled for approximately 3300 microseconds after each triggering pulse through a feedback circuit from the flip-flop multivibrator which is triggered by the outputs of V–106. Individual cathode bias adjustments in the cathodes of V–106A and V–106B provide triggering and spacing adjustments. The technician is cautioned not to attempt adjustment of these controls unless he has been properly instructed as to the proper procedure.

The IFF and/or radar triggers from the flip-flop multivibrator V–107 or the second pulse amplifier V–133, are coupled through a trigger amplifier, V–108, to the long gate multivibrator V–120 (Figure 4). When the long gate multivibrator is tripped to the ON position it will be held ON until the ranging circuit has completed its time cycle, determined by the position of the Strobe (range) Crank. An examination of Figure 4 will show that the ranging circuit as a whole is a Phantastron Ranging Circuit and operates on the same principle as that described in the November 1945 ELECTRON, with slight modifications. A Range Helipot is the variable element in the ranging system and experience has found one fault in this unit. If jammed hard against the stops, the runner is inclined to jump the track and a complete disassembly is necessary to replace the unit in operation. Operating personnel and technicians are cautioned to handle this portion of the unit with a moderate amount of care in order to avoid several hours of lost operating time and labor in repairing same.

Figure 5 is the schematic of the wide/narrow strobe generator and strobe output circuits. The strobe generator circuit is triggered from the ranging circuit (Figure 4), the trigger being applied to a one-kick multivibrator V–134 whose output gate is approximately 50 microseconds in duration, adjustable by a bias control. The generation of the narrow strobe is accomplished by utilizing the differentiated leading edge of the wide strobe to trip a short delay (10 to 15 microseconds) multivibrator. The output of this multivibrator is differentiated and in turn triggers a one-kick multivibrator whose time duration is 10 microseconds. This 10-microsecond pulse is used as a narrow strobe in the Indicator. The purpose of the delay (10 to 15 microseconds) multivibrator is to facilitate centering the narrow strobe in the wide strobe. The output of either the wide or narrow

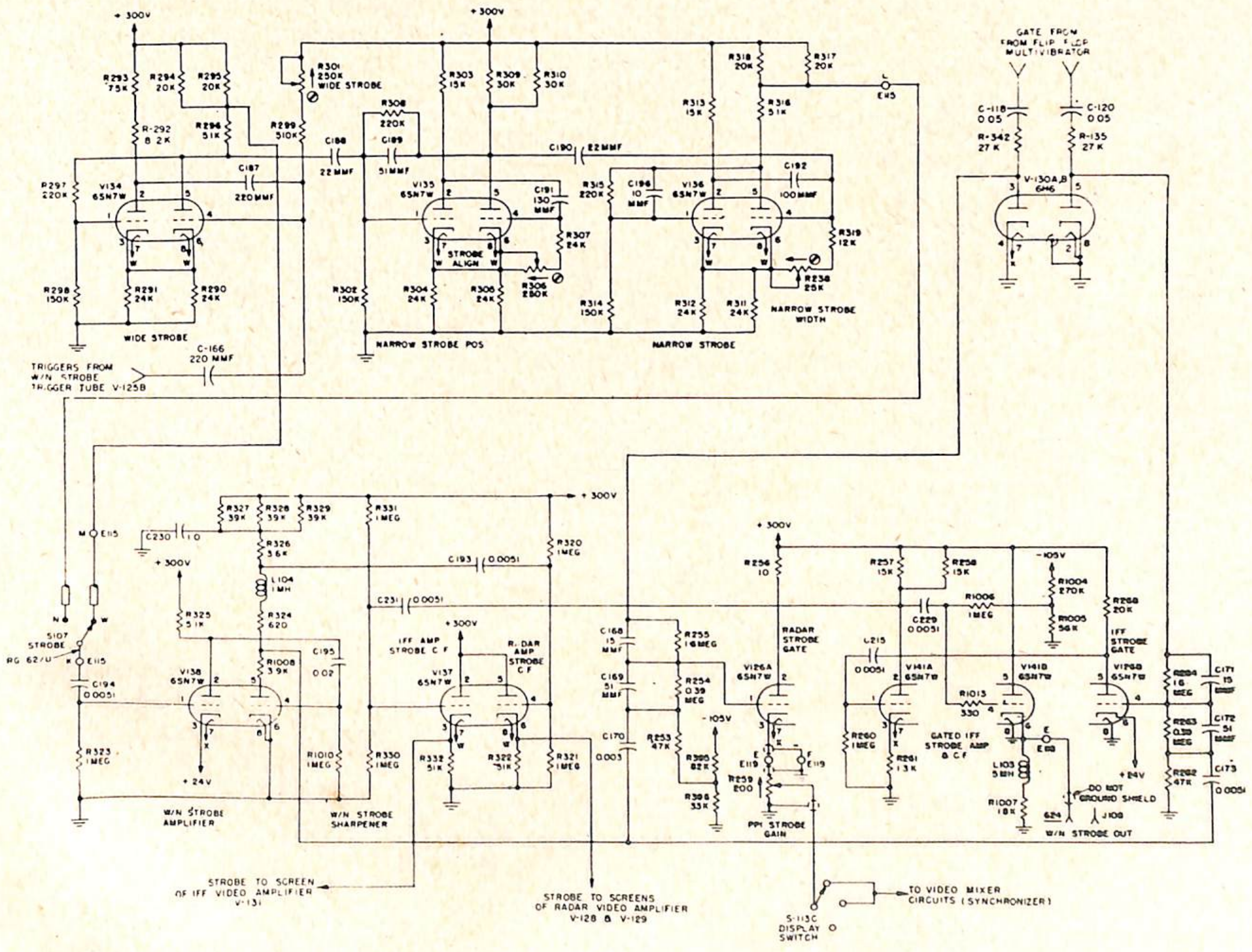


FIGURE 5. Wide/Narrow Strobe Generating and strobe output circuits of the Indicator Unit of the AN/UPA–9 Interconnection Assembly.

strobe generators is selected by a front panel control. This switch permits passing the desired strobe to the strobe amplifier V–138A. The strobe signals are then passed through an amplifier which by virtue of zero bias applies a limiting action and in effect sharpens the strobes before their application to the scope. Facilities are provided for mixing the strobe outputs with the radar and IFF video signals for presentation on the radar and IFF traces of the A-scope respectively. In addition the strobes are coupled through plugs, jacks, and coaxial cable to the associated PPI for use with the video presentation on that unit.

V–109 is the main multivibrator which provides the necessary gates for the various Indicator scope ranges. This circuit in conjunction with the sweep generator V–112 generates either 20, 40, 80, or 200 mile sweeps plus an expanded sweep of approximately 15,000 yards, see figure 2.

All operating controls for the entire UPA–9 (approximately 30) are located on the Indicator Unit. These controls operate both in the Indicator and the Synchronizer, but since the Indicator is located in CIC, it is obvious why all are grouped on one unit. In addition to these controls, the operator has jurisdiction over the various control boxes for the Interrogator-Responsor which is operated with the UPA–9 Assembly.

Synchronizer

The second unit of the AN/UPA–9 Interconnection Assembly is the Synchronizer. In general, this unit performs the following functions:

(1) Decodes PI and EMER video signals.

(2) Mixes video signals for presentation on the PPI scope(s).

(3) Generates audible slow code signals for reading on loudspeaker or headphones.

(4) Generates azimuth gate for use when operating in MANUAL.

(5) Contains power supply circuits for the entire UPA–9 except the A-scope power supply.

Figure 6 is a functional servicing block diagram of the Synchronizer and, as in the case of the Indicator, will be the basic diagram for reference throughout the detailed description which follows. The I-R video is introduced into the Synchronizer at J–401 and is coupled to the grid of video amplifier V–401B. Note that a potentiometer (R–402) is included in the input circuit. This potentiometer is screw-driver controlled and operates to adjust the amplitude of high-level video signals. If the incoming video signals are above 0.5 volts or less) a relay which is operated from the Indicator will eliminate the sensitivity control and apply the video signals at full amplitude to the grid of V–401B. The original decoder sensitivity adjustments are made, or should be, by the installing activity and technicians are cautioned not to attempt adjustments in this circuit unless they are thoroughly familiar with the requirements and procedures necessary to do so. Figure 7 is a schematic diagram of the PI and EMER Decoder Circuits and may be used as a detailed reference while following the operational discussion of this circuit.

The negative output from V–401B is applied to a limiter stage which limits by cutoff in the grid circuit. The positive video from V–402 is applied to a driver whose output feeds the first coincidence gate/amplifier V–405. The driver is transformer coupled to provide an undelayed video signal to the screen grid of V–405 and a delayed (8-microseconds) video signal to the control grid of V–405. Thus when a PI video signal is received it will be converted to a single pulse in the coincidence gate and applied to a single swing blocking oscillator

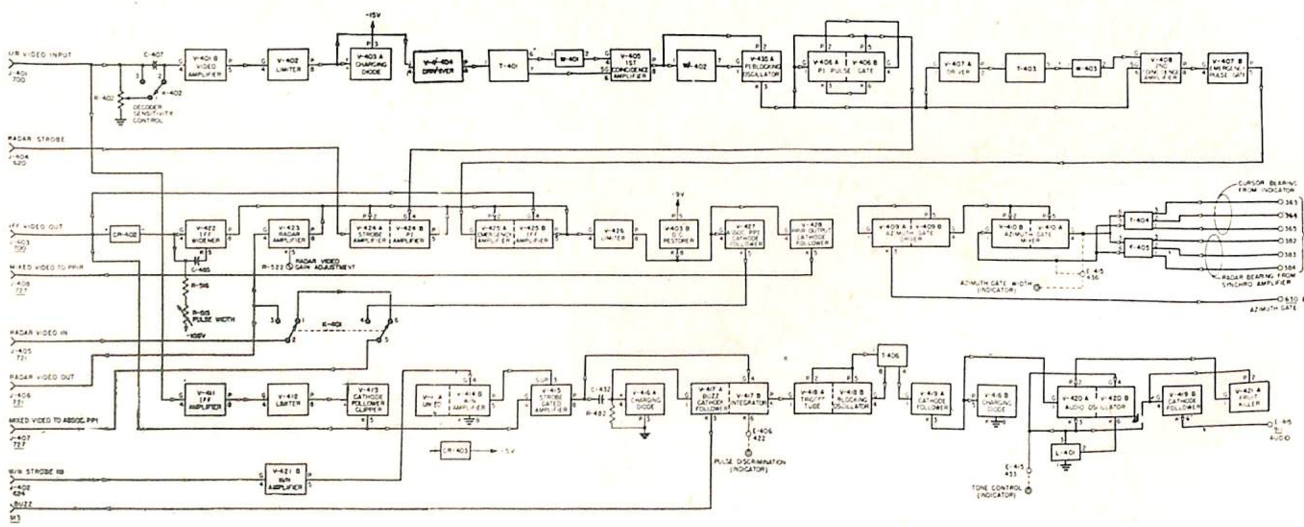


FIGURE 6. Functional Servicing Block Diagram of the Synchronizer Unit of the Interconnection Assembly AN/UPA–9.

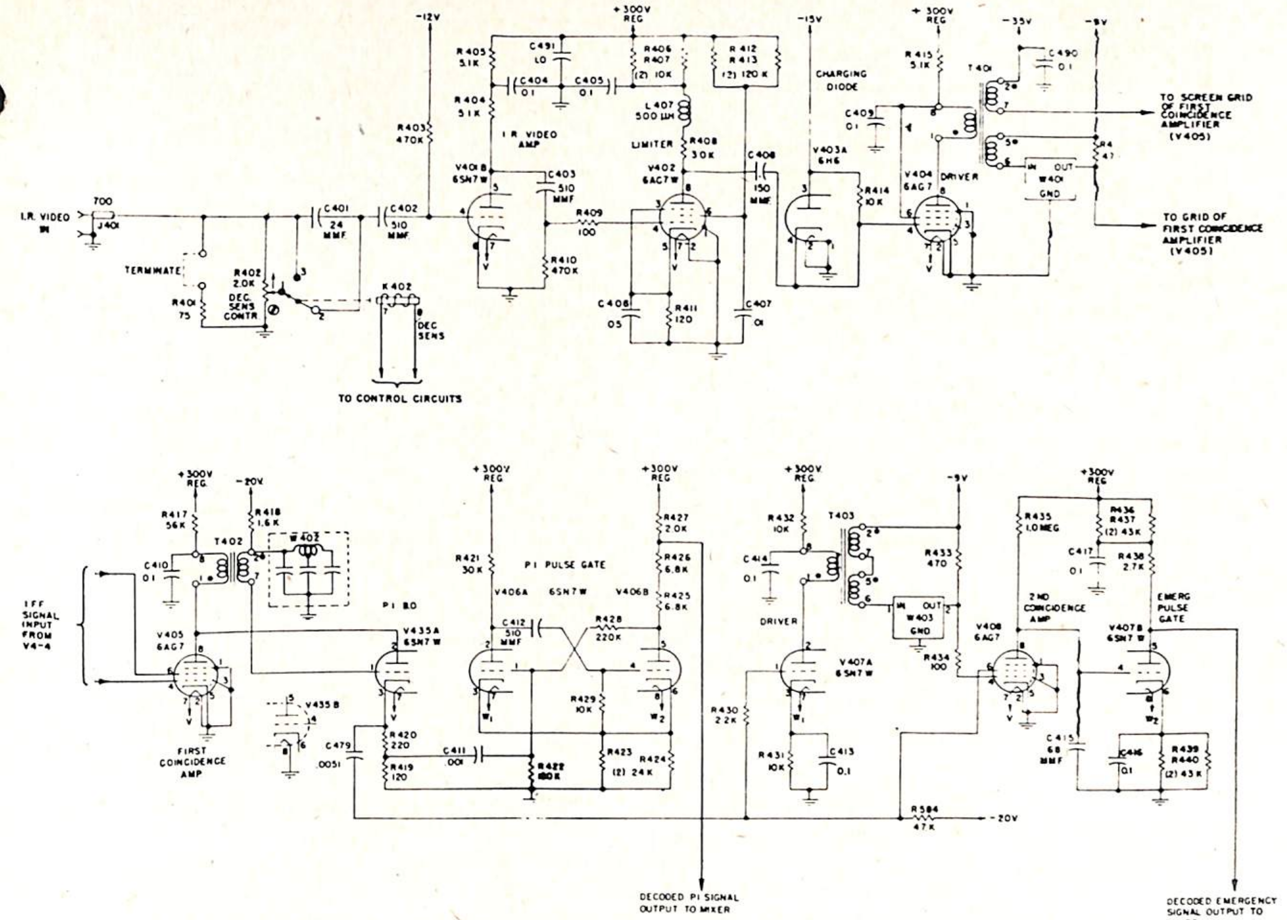


FIGURE 7. Personal Identification (PI) and Emergency (EMER) video decoder circuits of the Synchronizer Unit of the AN/UPA–9 Interconnection Assembly.

V–435A, with a pulse forming line (W–402) in the grid circuit designed to generate a pulse 2 microseconds in duration. The output of V–435A is applied to a PI pulse gate circuit (a one kick multivibrator) which generates a gate (wide pulse) approximately 15 to 17 microseconds in duration. The output of the multivibrator is applied to the PI amplifier V–424B. Note, however, that the output of the PI blocking oscillator V–435A is split between the PI pulse gate circuit and a second coincidence gate/amplifier V–408. One output from V–435A is coupled direct to the screen grid of V–408 while the same output is passed through a driver, V–407, and a delay circuit to the control grid of V–408. This coincidence gate operates in the same manner as the first coincidence gate except that a long pulse is generated in the plate circuit by virtue of a long-time constant integrator composed of C–415 and R–435. This integrated waveform is applied to the grid of V–407B and cuts the tube off for approximately 40 to 50 microseconds, developing in the output of V–407B a positive pulse of the same duration, which is applied to the EMER amplifier V–425A.

To clarify any misunderstanding regarding the usage of the above-described circuits, let us digress for a moment. Recall that PI video replies are 2 pulses spaced 8 microseconds apart while EMER replies are 4 pulses spaced 8 microseconds apart. One of the basic reasons for having PI and EMER, particularly the latter, is to instantly spot those replies when they appear on the PPI. Thus it was necessary to make them decidedly more outstanding than conventional replies. To accomplish this, the individual multiple pulse replies are transformed into long video blocks for presentation on a PPI. Therefore it can be seen why and how the coincidence amplifier/gates are utilized in the circuit. The PI gate eliminates the first of the two paired pulses and decodes on the second, while the EMER gate eliminates the first and second of the four pulses and decodes on the third.

In addition to the PI and EMER channels, the incoming I-R video is applied to the IFF amplifier (V–411) and through a limiter (V–412) to a cathode follower output stage (V–413). The cathode follower output is divided, one channel to the IFF video section and the other to the audio oscillator circuit for generating audible slow code. The channel to the video section provides an I-R video source for the A-scope on the indicator and also presents the choice of either unwidened (normal) or widened IFF pulses for the associated PPI.

The unwidened signal path is from V–413 to the grid of V–425B direct. The widened signal path is from V–413 to an IFF widener stage V–422. Figure 8 is a schematic diagram of the video amplifiers, mixer, and widening circuits. The IFF video applied to V–422 is widened in the input circuit by virtue of a variable long time constant circuit composed of C–485, R–516, and R–515. R–515 is a screw driver control located on the Synchronizer chassis and is the variable element in the widener circuit. Again the technician is cautioned to adjust this circuit only if he is properly instructed since an optimum point of adjustment is necessary due to the fact that above a certain point in widening, the signal-to-noise ratio becomes prohibitive and the PPI will present a poor definition.

In addition to the I-R video input to the Synchronizer, there are three other inputs, exclusive of synchro information. They are: 1—Radar Strobe. 2—Radar Video. 3—Wide/Narrow Strobe. The radar strobe is applied to a strobe amplifier V–424A. By observation of Figure 6 it can be seen that the plates of the IFF widener (V–422), the Radar Amplifier (V–423), Strobe Amplifier (V–424A), PI Amplifier (V–424B), EMER Amplifier (V–425), and the IFF Amplifier (V–425B) are tied together to permit mixing the various videos for presentation on the PPI. The radar video is brought into the unit and applied to a switch which is controlled by relay K–401 (control exercised from the Indicator). When operating the associated PPI in conjunction with a radar only (no IFF system in use), the radar video is by-passed through the Synchronizer by putting the switch on the BY-PASS UPA–9 position on the Indicator. The circuit may be traced on Figure 6. When operating in conjunction with an IFF system and a radar the switch is placed on THRU UPA–9 which mixes the radar video with the I-R video for presentation on the associated PPI and at the same time provides a radar video output for use on the A-scope of the Indicator.

The Wide/Narrow strobe input is used in conjunction with the I-R video to generate slow code signals to be monitored on a loudspeaker or in a pair of headphones. The I-R video from V–413 is applied to the control grid of the strobe gated amplifier V–415. This stage is normally biased beyond cutoff thereby preventing any conduction for I-R video except during periods when the

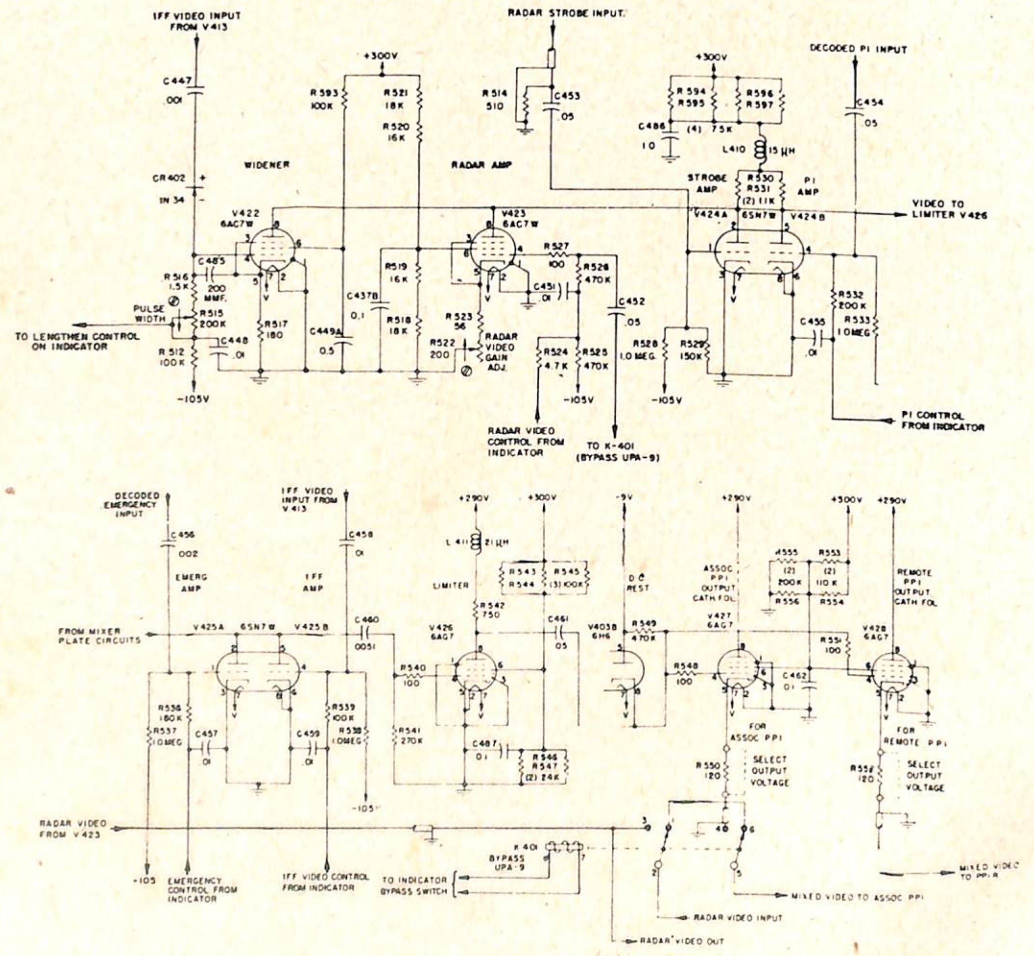


FIGURE 8. Video amplifiers, mixer, and widener circuits included in the Synchronizer Unit of the AN/UPA–9 Interconnection Assembly.

positive strobe gate is applied to the suppressor grid. One output of the strobe gated amplifier is to trigger the BUZZ generating circuit which is essentially an integrator, producing a long pulse for each pulse or series of pulses received. This audible BUZZ is delivered to the Indicator through the BUZZ cathode follower and a coaxial cable. A second output of the strobe gated amplifier is to trigger a blocking oscillator and cathode follower whose function is to generate pulses corresponding to dots and dashes which are used to key an audio oscillator to produce the morse code equivalents for audible reading. The so-called "Fruit Killer" (V–421A) withholds output from the audio oscillator for approximately 0.025 second at its start, so that fruit (interference and unwanted signals or voltage excursions) will not produce an output and only slow code from regularly occurring pulses of 40 pps or greater will be heard.

Azimuth gating voltages are used to blank the radar trace of the Indicator A-scope (in MANUAL operation only) when the IFF and radar antennas are out of agreement by an angle selected by the operator. These gating voltages are generated in the circuit consisting of V–409 and V–410. Briefly, this blanking is accomplished by comparing two of the three radar synchro voltages with corresponding IFF antenna synchro voltages, applying them to the grids of rectifiers, and mixing them. So long as all voltages remain in the same relationship, no gating voltage will be produced. The degree of angular displacement between the two antennas necessary to develop a gating voltage is determined by the amount of bias on V–410. This bias is variable through the medium of the Azimuth Discriminator Control located on the Indicator. From Figure 9 we see that the radar synchro

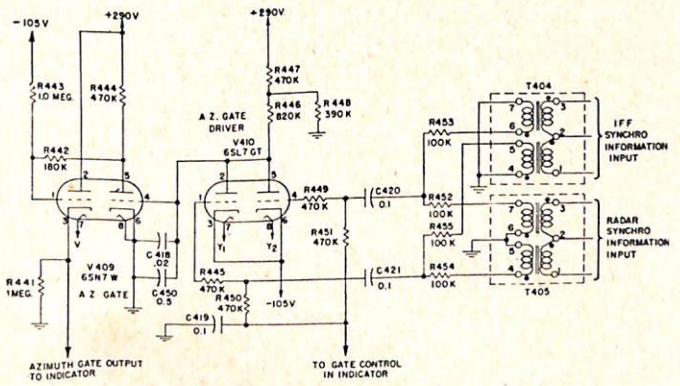


FIGURE 9. Azimuth Gating Circuit of the Synchronizer Unit of the AN/UPA–9 Interconnection Assembly.

voltages pass through T–405 and are isolated as two separate voltages. In a similar manner, the I-R synchro voltages pass through T–404 and are separated into two voltages. One of the radar voltages is connected in series with one of the I-R voltages. The two transformers are connected so as to cancel when the systems are in angular phase. If they are not in phase, the resultant voltage is applied to the grid of V–410B. A second pair of voltages from the two synchros are connected similarly and applied to the grid of V–410A. V–410 A and B plates are tied together and any dissimilarity between synchro voltages will be rectified and will appear as a d-c component in the output of V–410. This output is applied to a d-c amplifier V–409B and subsequently applied to cathode follower output V–409A.

The Synchronizer contains four power supplies which provide 1300 volts regulated, +300 volts unregulated, +290 volts unregulated, and bias voltages ranging from —140 volts to —5 volts with the —105 volt supply being regulated. These voltages are used in both the Synchronizer and the Indicator for B supplies and biasing voltages.

Interconnection Assembly AN/UPA–15

This interconnection assembly was designed to provide simultaneous availability of all three modes of interrogation used in the Mark V IFF/UNB System. This assembly is used in conjunction with the high-powered Interrogator-Responsor AN/CPX–3 to provide a very flexible, multi-control presentation, IFF arrangement. Actually simultaneous interrogation is misleading because the three modes are made available to any of six remote stations through the principle of time-sharing of interrogations and replies, however this will be described in detail later in this discussion. The AN/UPA–15 performs three major functions; 1—Accepts synchronizing pulses from the associated radar, generates and delivers triggers in all three interrogation modes to the Interrogator-Responsor on a time-sharing basis. 2—Separates the I-R video into four separate channels for use on remote presentations. 3—Provides control at each associated remote presentation for selecting the mode of interrogation and reply desired for that particular presentation without interference to other remote stations. To accomplish the above-listed major functions requires considerable circuitry which will be covered in the following paragraphs.

Figure 10 is a block diagram of the entire Interconnection Assembly AN/UPA–15 showing the relation of all units in an interlaced challenge system. Figure 11 is a block diagram of the Synchronizer (a unit of the Relay Assembly) which initiates the action upon receipt of a synchronizing trigger from the parent radar. For each synchronizing pulse, delayed triggers (delay controlled by the master control operator) are generated in three channels for triggering the I-R. Simultaneously with trigger generation, triple positive gates are generated which act as gating voltages to pass the triggers (in groups) to the I-R on one channel at a time. The total number of triggers supplied to an I-R equals the number of synchronizing pulses received by the Synchro-

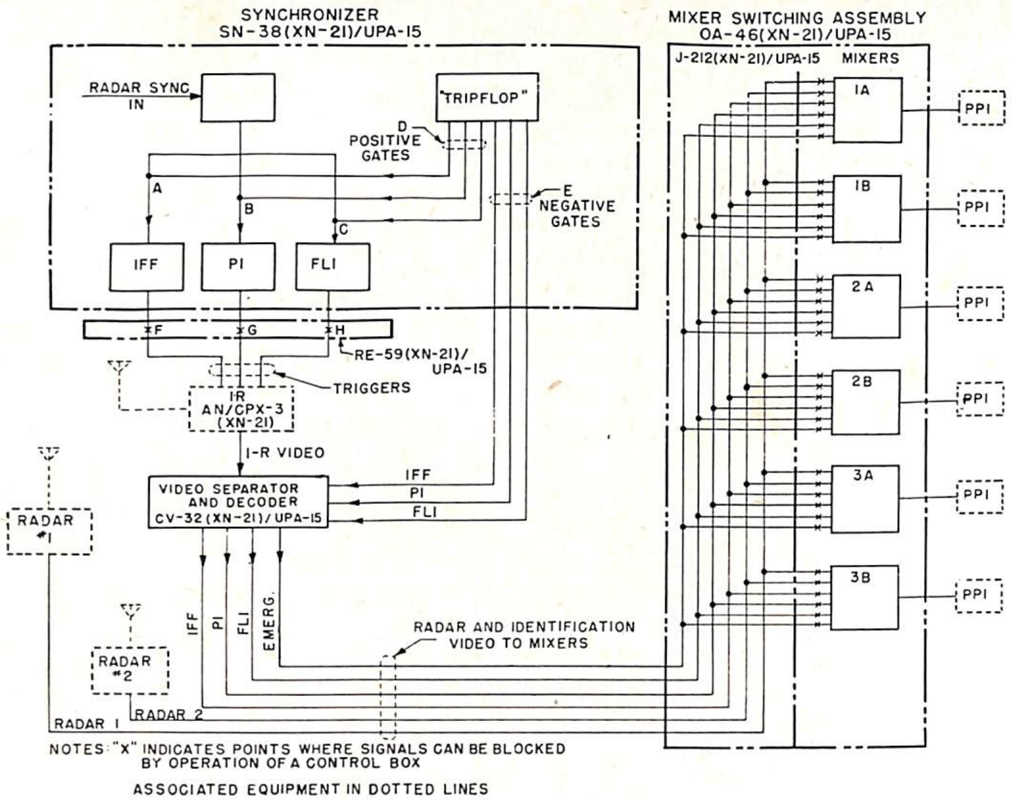


FIGURE 10. Block diagram of the Mark V IFF/UNB Interconnection Assembly AN/UPA-15(XN-21).

nizer, but the average rate on any one channel is one third of the input synchronization rate. Thus, the I-R receives a group of triggers, at the synchronization rate, on the IFF channel, followed by an equal number on the PI channel, and then the same number on the FLI channel. The number of consecutive triggers in each channel is controlled by the countdown ratio of the Synchronizer, which can be adjusted to 1:2, 1:3, 1:8, 1:16, and 1:32 with an input pulse rate of 360 pps. In addition to the positive gates for enabling the trigger circuits, the Synchronizer generates negative gates of equal length for use in the Video Separator and Decoder to enable the corresponding channel in that unit. Thus when the I-R is challenging in a certain mode, say IFF, the IFF channel only is enabled in the Video Separator and Decoder and allows no other mode signals to pass through during the IFF challenge period.

The incoming synchronizing pulses are applied to a trigger–blocking oscillator combination (Figure 11) for sharpening and application to the countdown multivibrator. This blocking oscillator may be operated as a single swing when external synchronizing pulses are being received or as a free-running oscillator when the unit is switched to self-triggering. When operated on self-triggering the repetition rate can be varied by a front panel (screwdriver) control from about 60 to 400 pps. The output of the blocking oscillator is used to trigger

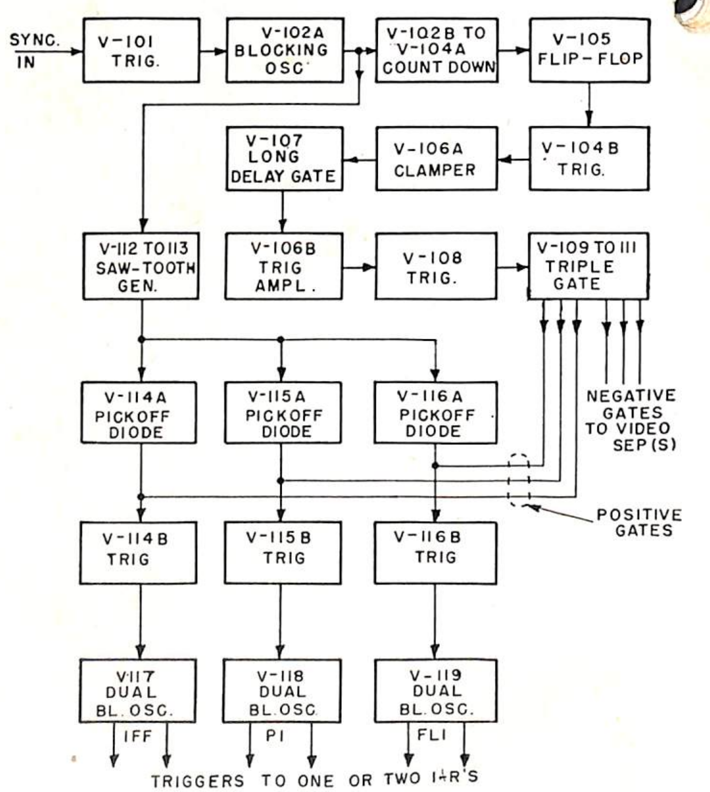
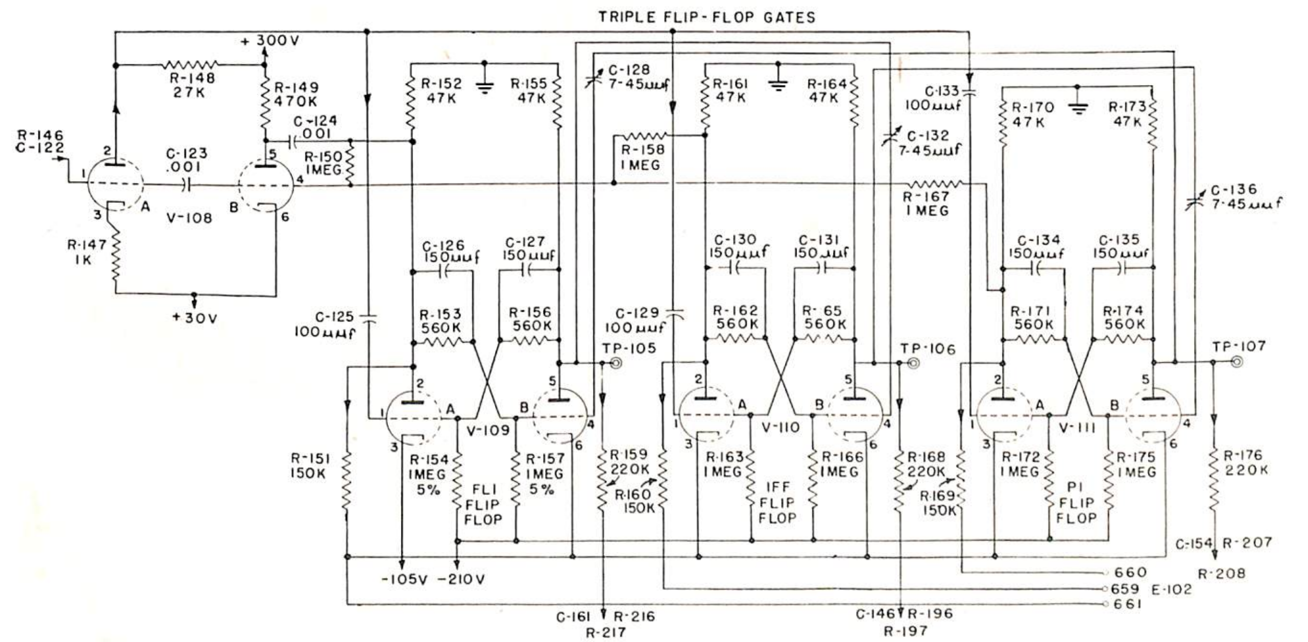


FIGURE 11. Functional block diagram of the Synchronizer Unit of the Interconnection Assembly AN/UPA-15(XN-21).

the countdown multivibrator whose time constants can be varied by a switching arrangement to permit a choice of five count-down ratios; 1:1, 1:2, 1:4, 1:8, and 1:16. Thus if the count-down ratio is set on 1:4 (position 3 on the selector switch) the multivibrator will be adjusted to generate a gate on each fourth pulse with the length of the gates equivalent in time to that between four trigger pulses. To insure that there will always be an over-all countdown of at least 1:2, a flip-flop multivibrator is included in the circuit immediately following the countdown multivibrator. This flip-flop effectively multiplies the countdown ratio of the countdown multivibrator by two in all cases and at the same time reduces the duty cycle of the following delay gate, V–107. Since it is necessary to have the gating change occur during the retrace time of the PPI sweep, this gate would have to be on longer than the sweep time, which would result in a duty cycle of over 80% if the countdown were 1:1. Thus by virtue of the flip-flop we establish the originally stated ratios of 1:2, 1:4, etc. The output of the flip-flop, as in any conventional flip-flop circuit, is a series of positive and negative square waves. The output is differentiated resulting in a series of positive and negative pips which are applied to a trigger tube, biased to cutoff by a positive cathode bias. Thus the positive triggers will pass through the trigger stage while the negative triggers will have no effect. V–106A in Figure 11 is a limiter to limit the amplitude of the negative pulses from the trigger so that all pulses applied to the delay gate are uniform in amplitude. The delay gate, V–107, is included in the circuit to delay the counted-down synchronizing pulses so that the change-over of the blanking waveforms, which are generated later, occurs between the end of the longest sweep on the PPI and approximately 300 microseconds before the next radar synchronizing pulse. The output of the delay gate is a series of flat-top positive pulses at the counted-down repetition rate, with the duration of the pulses determined by the setting of a DELAY CONTROL which is a screwdriver control. These flat top pulses are differentiated and applied to a trigger amplifier which reverses polarity and amplifies. The resulting output is a negative pulse followed by a positive and is applied to a trigger tube V–108, both sections of which are biased beyond cutoff. Thus the outputs of both sections of V–108 are negative pulses with greater amplification in the B section than in the A due to circuit components.

The next circuit in the line (Figure 12) is rather unique in its arrangement, consisting of three complete Eccles-Jordan (flip-flop) multivibrators operating from a single trigger source. Note that all plate resistors of the flip-flops are returned to ground and the cathodes are connected to a —105 volt supply. This is done to obtain gating voltages at a convenient d-c level. In normal operation, two of the three A-sections of the flip flops are cut off and the other is in full conduction. Conversely, one of the B-sections is cut off and the other two are in conduction. When the equipment is first energized, there are eight possible combinations of conduction that may occur in the "Trip-flop." Only two of these, however, require special consideration. The first case is when all three A-sections are conducting. Under these conditions, V–108B (trigger tube) is prevented from passing triggers by a negative grid bias,

FIGURE 12. Detailed schematic diagram of the triple Eccles-Jordan (flip-flop) multivibrator gate generating circuit—"Trip-flop."



developed across the plate loads of the A-sections and applied to the grid of V–108B. This bias is maintained so long as any one of the A-sections are conducting. The first negative trigger from the plate of V–108A is applied to all three A-section grids, cutting off the A-sections and reducing the circuits to the equivalent of the second starting condition, with all three A-sections cut off. In this condition V–108B has no grid bias from the "Trip-flop" and the next positive pulse from V–106B, applied to the grids of V–108 results in negative pulses to the grids of V–109A, V–110A, and V111A from V–108A. In addition a negative pulse is applied to the grid of V–109B from V–108B. However, as pointed out previously the pulse from V–108B is larger in amplitude than that from V–108A thus V–109B is cut off and V–109A becomes conducting which places a bias on the grid of V–108B. This bias is maintained so long as any of the A-sections are conducting. The "Trip-flop" is now in a condition for normal operation. The next trigger from V–108A is applied to the three A-section grids, cutting off V–109A (V–110A and V–111A are already off), and V–109B becomes conductive. The resulting voltage drop at the plate of V–109B (Figure 13) is coupled to the grid of V–110B causing V–110 to flip over. The voltage rise at the plate of V–110B is coupled to the grid of V–111B but has no effect because V–111B is conducting. In a similar manner, the second negative trigger cuts off V–110A, causing the tube to flip over. The voltage drop at the plate of V–110B is coupled to the grid of V–111B causing it to flip over. The voltage rise at the plate of V–111B has no effect on V–109B because this tube is conducting. In the same way, the third pulse causes V–111 and V–109 to flip over. From Figures 11 and 13 it can be seen that the negative gates from the plates of V–109A, V–110A, and V–111A are supplied to the Video Separator and Decoder (through 150,000-ohm resistors). If one or more of these leads are grounded beyond the isolating resistors the flip-flops will continue to operate. The positive gates from the plates of V–109B, V–110B, and V–111B are coupled through 220,000-ohm resistors to trigger tubes V–114B, V–115B, and V–116B for unblanking in sequence the blocking oscillators which generate the I-R synchronizing pulses.

It will be noted from Figure 11 that the output of the input blocking oscillator V–102A, is coupled to a saw-tooth generator composed of V–112A, V–113, and V–112B. This circuit generates a linear sweep approximately 30 microseconds in length for each incoming radar synchronizing pulse or each internally generated trigger when operating as a self-triggered unit. This saw-tooth voltage is applied to the plates of diodes V–114A, V–115A, and V–116A. The cathodes of these three tubes are connected to a bleeder which includes a 10,000-ohm potentiometer located in the Master Control Box designated IFF DELAY. This control is designed in such a manner that the cathode voltages of the three diodes can be varied but still maintain constant the voltage differences between them. As can be seen from Figure 14 as the delay control is moved, the pick-off point for the three diodes is changed, thus providing a method of delaying the I-R triggers in respect to the synchronizing pulses.

As the sawtooth waveform is applied to the three diode plates, a sawtooth waveform is generated in each cathode as the conduction point is reached. This waveform will correspond to that part of the plate waveform of each tube above the conduction point. Although these pulses differ in amplitude by the amount of cathode voltage difference, they will be differentiated to form flat-top pulses of equal amplitude but of different duration. This flat-top pulse is again differentiated to form the characteristic positive and negative pulses which are applied to the grids of the trigger tubes V–114B, V–115B, and V–116B. Only one of these stages will be unblocked at any instant by virtue of application of the positive gate from the "Trip-flop." While one trigger tube is unblocked, the other two are cut off, thus only one mode of triggers can pass until the next change in the "Trip-flop" waveform cuts that trigger stage off and unblocks another. The outputs from V–114B, V–115B, and V–116B trigger the three blocking oscillators V–117, V–118, and V–119 respectively. Note that both sections of each blocking oscillator are used to permit furnishing trigger outputs on both cathodes These dual triggers are used in a special arrangement where two separate I-R's are employed such as in a "High-Low" radar system where two radar antennas are operated back-to-back, one for low angle detection and the other for high angle detection. In such a system, individual interrogation systems are required. This discussion will not cover the details of such a complex installation. Figure 15 is a diagram showing the timing sequence between the original synchronizing triggers and the resultant output triggers to the I-R.

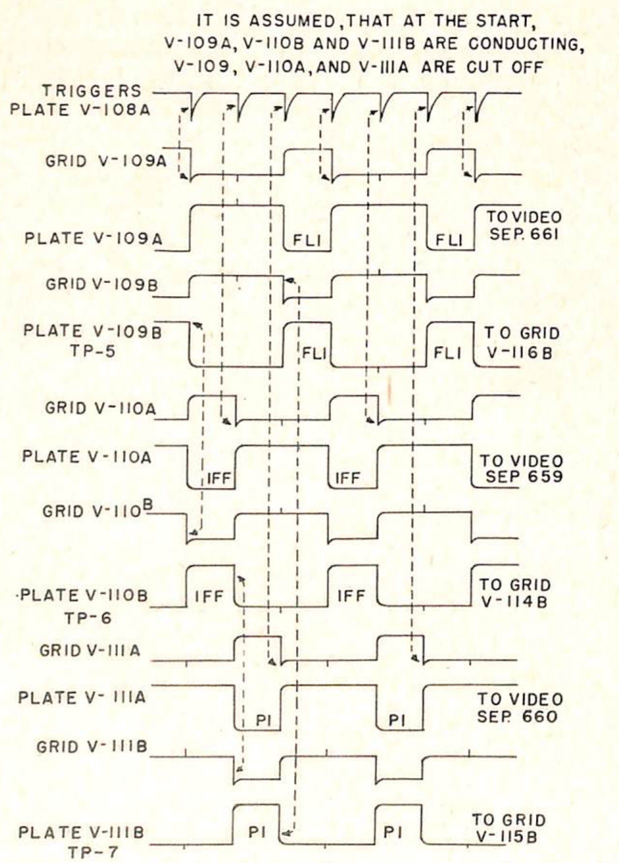


FIGURE 13. Idealized waveforms generated at various points in the "Trip-flop" gating circuit of the Synchronizer Unit of the Interconnection Assembly AN/UPA–15(XN–21).

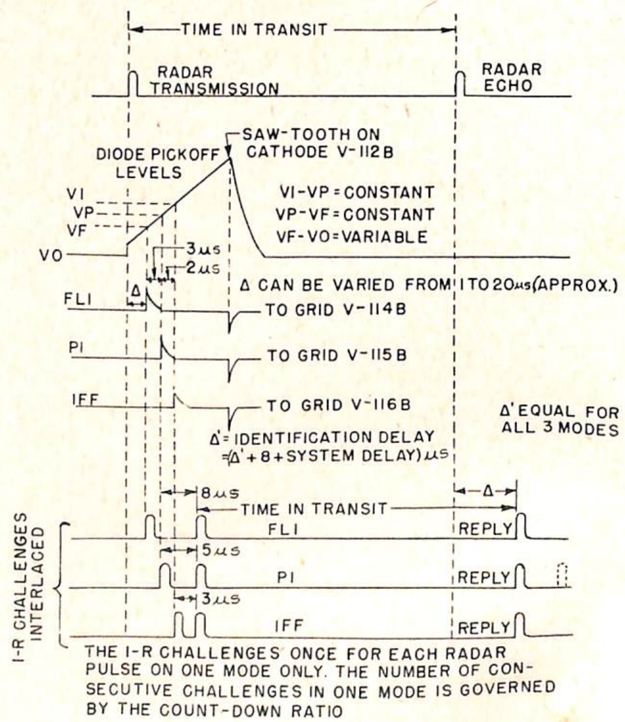


FIGURE 14. Idealized waveforms illustrating the timing of I-R triggers and equalization of code spacing in the Synchronizer Unit of Interconnection Assembly AN/UPA–15(XN–21).

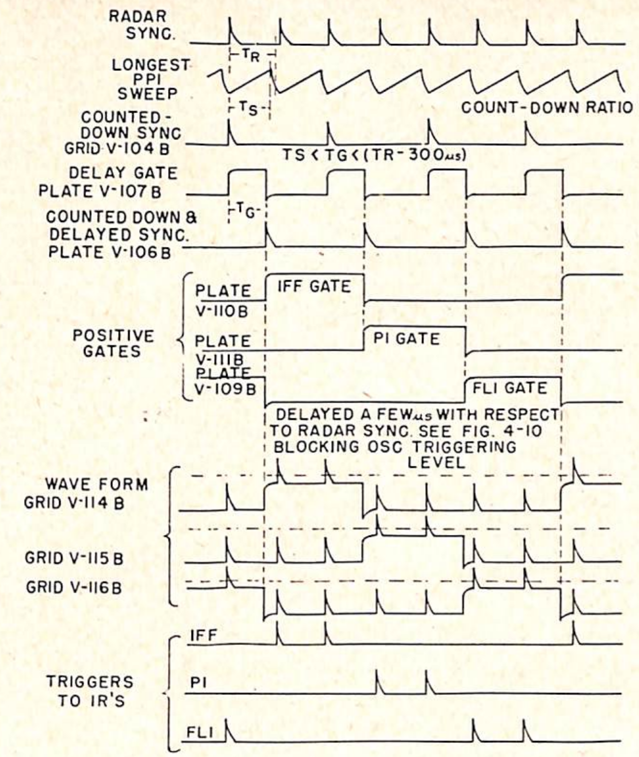


FIGURE 15. Sequence of events showing timing between the input synchronizing pulses and the output I-R trigger pulses generated in the Synchronizer Unit of the Interconnection Assembly AN/UPA–15(XN–21).

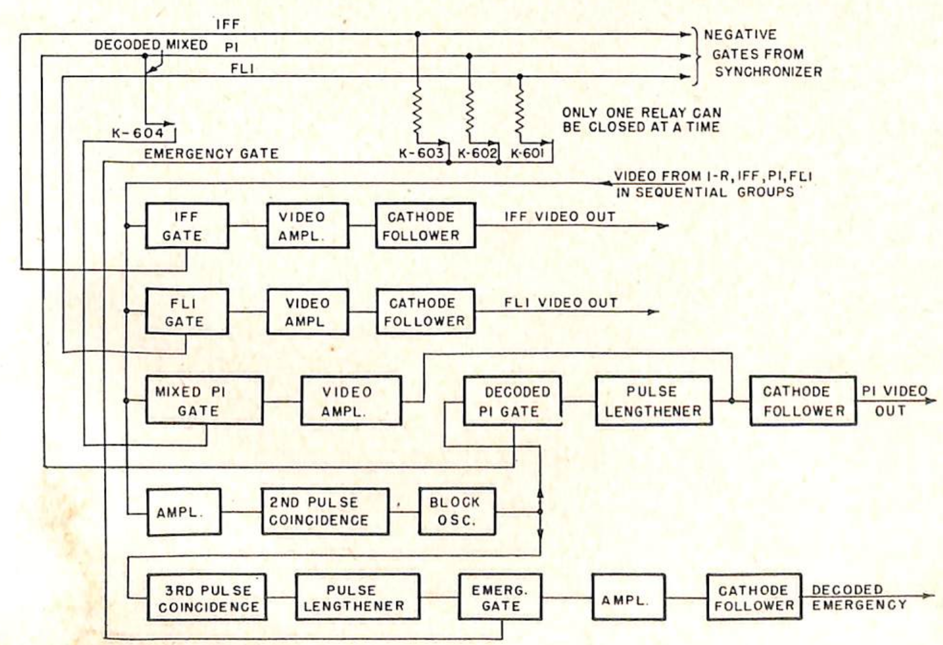


FIGURE 16. Functional block diagram of the Video Separator and Decoder of the Interconnection Assembly AN/UPA–15(XN–21).

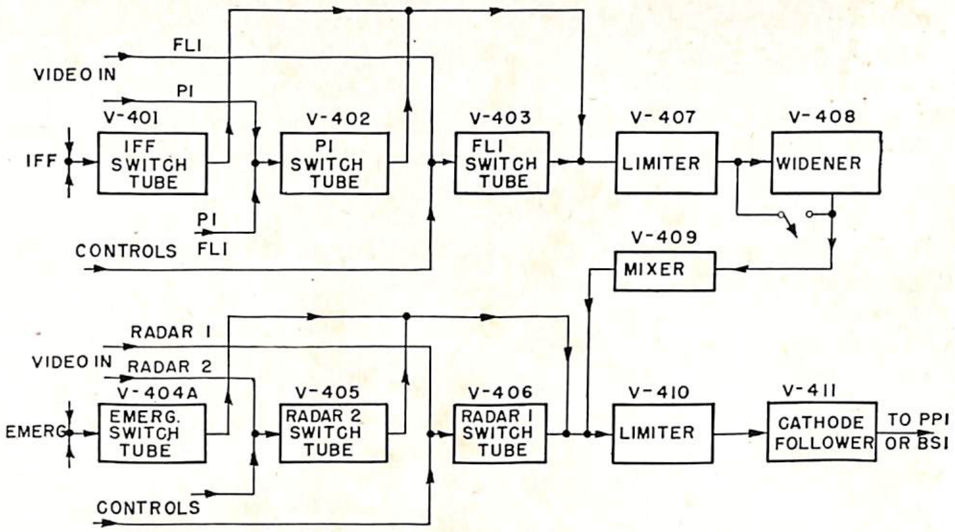


FIGURE 17. Block diagram of one Mixer Unit utilized in the Display Interconnection Assembly of the Interconnection Assembly AN/UPA–15.

The second unit contained in the Coordinator Assembly is the Video Separator and Decoder. This unit receives the video replies from the I-R on one common coaxial cable, and separates them into four channels, IFF, PI, FLI, and EMER so that they can be displayed individually or collectively on any or all of the remote presentations. Figure 16 is a functional block diagram showing the inputs, functions, and outputs of the unit. In addition to the video separation operation, PI and EMER replies may be decoded as explained previously for a distinct presentation on the PPI scopes. The three negative gates which are generated in the "Trip-flop" of the Synchronizer are utilized in the Video Separator and Decoder to unblank their respective channels. These gates have identical timing with the positive gates that are used to unblank the trigger circuits in the Synchronizer, therefore during the period that the IFF channel is unblanked in the Video Separator, the Synchronizer is generating triggers for the I-R only in the IFF mode and the video from the I-R will consist of replies to IFF challenges only. Similarly, only PI and FLI replies will be supplied to the Video Separator when the PI and FLI unblanking gates, respectively, are present. Connections are made in the Video Separator and Decoder so that when emergency replies are received, the EMER video will be gated through the unit regardless of what mode of challenge is in use, as can be seen from Figure 16. Decoding of PI and EMER replies is accomplished in the same manner as in the UPA–9 and no further discussion on that phase is deemed necessary. The four video outputs, IFF, PI, FLI, and EMER are connected to individual jacks on the Video Separator and Decoder. The outputs from these jacks are carried by coaxial cable to the Display Interconnection Assembly.

The Display Interconnection Assembly of the Interconnection Assembly AN/UPA–15 contains three separate drawers, each containing two identical mixer units. In addition a Rectifier Power Unit type PP–199(XN–21)/UPA–15 is located in the base of the assembly. Figure 17 is a block diagram of one Mixer Unit showing the four I-R video inputs plus the radar video input. Each mixer contains five switch tubes or gates for the IFF, PI, FLI, EMER, and RADAR video inputs respectively. Control leads, terminating in the remote control box associated with the individual mixer, allow the operator to select one or more videos for display. Normally all channels of video are blocked in each mixer by virtue of a high bias on each grid. The control circuits operate by grounding this bias either directly or through a variable resistor to permit adjustment of video gain. When the operator challenges on any one of the three identification modes, the mixer control circuit for that mode is automatically grounded and the replies of that mode channel are passed through the switch tube and appear at the output of that unit for delivery by coaxial cable to the presentation associated with the remote control box being used. Other switches are provided on each control box for the purpose of placing a bias on the RADAR and EMER switch tubes when it is desired to prevent these videos from appearing on the scope presentation. Normally the EMER and RADAR video switch tubes are open to pass video whereas the IFF mode switch tubes are normally off except when the bias is removed by the appropriate switch on the control box. The EMER and RADAR video switch tube controls are in the form of snap switches which must be held on for the period during which the operator wishes to block those videos from appearing on the scope presentation.

Interconnection Assembly AN/UPA–16

The third in the series of interconnection assemblies employed in the operational evaluation of the Mark V IFF/UNB is the type AN/UPA–16. This assembly performs the same basic functions as the AN/UPA–9 and AN/UPA–15 but lacks some of the refinements and advantages offered by those two units. The AN/UPA–16 is a single mode system designed to accept triggers from an associated radar, generate and deliver triggers to an Interrogator-Responsor, and prepare the IFF replies for display on the radar scopes. It also includes features for audible and visual presentation of slow code. The entire AN/UPA–16 consists of seven major units: 1—SN-28/-UPX Coordinator Unit. 2—KY–12/UPX Audio Decoder Range Unit. 3—KY–13/UPX Video Decoder Unit. 4—SA–67/UPX Video Switching Unit. 5—C–249/UPX Challenge Control Box. 6—ID–143/UPX Remote Indicator. 7—C–248/UPX Audio Decoder Control Box.

The remainder of this article is devoted to the two major types of test equipment utilized to maintain all units of the system at optimum operation.

AN/UPM-4(XN-21)

The AN/UPM–4 is a transportable test equipment designed to perform any or all maintenance checks on components of the Mark V IFF/UNB System. Due to its weight and bulk it is primarily intended as a service-shop test instrument, being installed as a semi-permanent fixture. However, it has been used at times as a transportable equipment for certain installations in the Mark V IFF/UNB System, particularly those in fire control directors. The entire AN/UPM–4 is composed of an Oscilloscope Unit TS–491(XN–21)/UPM–4, a Radio Frequency Test Unit TS–492(XN–21)/UPM–4, a Rectifier Power Unit PP–206 (XN–21)/UPM–4, and an Accessories Case CY–536(XN–21)/UPM–4. The first and second named units are contained in drawers which occupy a common cabinet with the Oscilloscope Unit occupying the upper half and the R-F Test Unit the lower half. The Rectifier Power Unit is in a separate cabinet which may be secured to the Oscilloscope Unit/R-F Test Unit cabinet. The Accessories Case, as the name implies, contains all the cables, fittings, probes, etc. necessary in the application of the equipment for test purposes. The design, construction, and layout of the AN/UPM–4 permits a maximum of usefulness in performing the various checks, tests, and measurements required in the Mark V IFF/UNB System. Some of the major servicing operations possible are listed below.

(1) Tests on Transpondors and Beacons:
 (a) Transmitter power output.
 (b) Transmitter frequency.
 (c) Receiver sensitivity.
 (d) Receiver frequency and bandwidth.
 (e) Receiver decoding.
 (f) Slow code indication.

(2) Tests on Interrogator-Responsors:
 (a) Transmitter power output.
 (b) Transmitter frequency.
 (c) Transmitter "fast" coding.
 (d) Receiver sensitivity.
 (e) Receiver frequency and bandwidth.
 (f) Adjustment of receiver rating waveforms
 (g) Adjustment of receiver GFC waveforms.
 (h) Adjustment of receiver video response.

The AN/UPM–4 is designed to operate from a 47- to 2400-cps, 115-volt (± 15%), single-phase alternating current power source.

Oscilloscope TS–491 General

The Oscilloscope Unit is the initiating unit in the (3.5-, 12-, 50-, 500-, and 2600-microseconds) which may be presented on a 3-inch cathode ray tube as an "A" type trace. The sweep frequency is dependent on the length of sweep in use, with actual repetition rates of 50 to 4100 when 3.5-, 12-, or 50-microsecond sweeps are used, 50 to 1300 for 500-microsecond sweeps, and 50 to 280 for 2600-microsecond sweeps. The start of the sweep may be delayed from 3 to 175 microseconds with respect to the synchronization pulse by virtue of a sweep delay circuit whose use is optional. If the sweep delay circuit is switched out, the delay between synchronizing pulse and start of sweep is less than 0.7 microseconds. The unit also generates sweep markers of varying intervals dependent on the sweep in use as illustrated in Table 1 which follows.

TABLE 1

Sweep Duration (Microseconds)	*Marker Interval (Microseconds)*	*Marker Oscillator Frequency*
3.5	0.1 or 1	20 kc.
12	1	10 Mc and 1 Mc
50	5	1 Mc
500	50	200 kc.
2600	50	20 kc.

The normal video sensitivity of the oscilloscope ranges from one volt per inch vertical (peak) to 20 volts per inch (peak). These ranges are controlled by five positions of a six-position selector switch. The other three ranges are 2, 5, and 10 volts per inch. The sixth position on the switch increases the sensitivity so that one inch vertical deflection is obtained when the input voltage is 0.2 volt peak.

Two types of pulses are available from the Oscilloscope Unit, suppressor pulses and trigger pulses. The positive suppressor pulses are undelayed in respect to the synchronizing pulses, and range from 10 to 30 volts amplitude when working into 500 ohms in parallel with 175-uufd. The trigger pulses may be delayed or undelayed in respect to the synchronizing pulses. They are also positive pulses and may be from 50 to 100 volts in amplitude when working into 500 ohms in parallel with 175-uufd or not less than 10 volts when working into 75 ohms in parallel with 1100-uufd. When the trigger delay is in the 175-microsecond position, the delay is continuously variable with respect to the synchronizing pulse, from 3 to 175 microseconds. When in the 500-microsecond position, the delay is continuously variable from approximately 150 to 500 microseconds.

R-F Test Unit TS–492 General

The R-F Test Unit TS–492 contains the coder, radio frequency signal generator, wavemeter, demodulator, video calibrator, and the pulse counter. The coder produces positive or negative polarity pulses with variable amplitude (from 0 to 60 volts) to be used externally, and negative polarity pulses with fixed amplitude for use in modulating the r-f oscillator in the signal generator. The coder pulses simulate the interrogating and reply pulses of the various units comprising the Mark V IFF/UNB System. No facilities are provided for generating Morse code but the circuitry is arranged to provide a choice of 1 or 2.5 microsecond pulses at the option of the operator. Seven different modes of output pulses are offered through the MODE SELECTOR switch, as follows:

MODE SELECTOR position	*Type of Output*	*Pulse Duration (microseconds)*	*Pulse Spacing (microseconds)*
XMIT IFF	Paired	Between 0.7 & 1.2	2.5±0.05 to 3.5±0.05
XMIT PI	Paired	Between 0.7 & 1.2	2.5±0.05 to 3.5±0.05
XMIT FLI	Paired	Between 0.7 & 1.2	7.5±0.05 to 8.5±0.05
REPLY IFF	Single	0.09 ±0.05 to 1.3±0.05	
REPLY SLO	Single	2.25±0.25 to 2.75±0.05	
REPLY PI	Paired	Between 0.09 and 1.3	7 +0.10−0.05 to 9+0.05−0.10
REPLY EMER	Quadruple	Between 0.09 and 1.3	7 +0.10−0.05 to 9+0.05−0.10

The r-f signal generator employs a capacity-tuned half-wave-line oscillator having an electrostatic piston-type attenuator. A calibrated r-f output from 15 to 115 db below one volt rms is supplied at the S-G OUT jack on the front panel of the unit. The output level may be read direct from the attenuation dial, with the output held constant over the entire frequency range by virtue of an automatic-level control system. The signal generator is modulated by pulses from the coder so that the pulsed r-f output has the same spacing characteristics as the coder. The duration of the pulsed r-f output is within 0.2 microseconds of the duration of the coder pulses. The type of modulation desired is selected by the MODE SELECTOR on the front panel. For setting or reading frequency, a calibration chart is furnished which may be read to within ± 5 Mc. For extreme accuracy in setting the frequency of the signal generator, it is necessary to use the wavemeter which can be heterodyned with the signal generator.

The demodulator consists of an attenuating network whose r-f output is applied to a lighthouse type of diode. The video output of the diode is applied to the vertical input of the cathode ray tube in the Oscilloscope Unit permitting the monitoring of r-f envelopes and the measurement of r-f power applied at the demodulator terminals. This circuit also permits duplexing the output of the r-f signal generator and the r-f output from the equipment being tested. Two input jacks are provided for introduction of r-f energy from equipment under test. The R-F IN jack is employed where r-f power in the order of 35 watts (pulse) or less may be expected, while the H-P IN jack is employed where r-f power up to 3500 watts (pulse) may be expected. The pulse power introduced into the test unit, after being demodulated, may be viewed on the oscilloscope and measured in terms of db above one watt by means of special calibration curves furnished with the equipment.

The wavemeter is a quarter-wave resonant cavity with a screw-driven tuning plunger operated by a front panel control. Resonance is indicated by a front panel meter, which is also used in the pulse counter and video calibrator circuits which will be discussed presently. An r-f input switch permits selection of either externally or internally generated r-f signals for coupling to the wavemeter for measurement. Frequencies measured by the wavemeter are accurate to within plus or minus 0.7 Mc. Calibration charts are furnished which can be read to within 0.1 Mc. The sensitivity of the wavemeter is such that at least a 25% deflection is given on the indicating meter when r-f pulse power of 0.5 watt is applied. A sensitivity control, designated WAVEMETER SENSITIVITY, provides for decreasing the sensitivity so that not more than 90% deflection is indicated when 35 watts of r-f pulse power is applied at the R-F IN jack or 3500 watts pulse power is applied at the H-P IN jack.

A pulse counter circuit is incorporated in the R-F Test Unit in the form of a direct reading meter with two scales provided, 0 to 500 and 0 to 5000, through a front panel control. This pulse counter is triggered by pulses generated in the coder unit. The counter indicates the recurrence frequency of either externally or internally generated synchronization pulses, with an accuracy within plus or minus 10%.

A video calibrator circuit, which is triggered from the pulse counter circuit, produces an output pulse of rectangular form, positive in polarity and known peak amplitude. The duration of the pusle is 2.5 microseconds. By means of a front panel control, VIDEO SELECTOR, the output of the calibrator may be set at one, two, five or ten volts peak. These amplitudes are accurate to plus or minus three percent. The output level may be set from the front panel using the same indicating meter that serves as the pulse counter and as the resonance indicator of the wavemeter.

Rectifier Power Unit PP–206 General

The Rectifier Power Unit supplies the following voltages for use throughout the entire AN/UPM–4 Test Set:

(1) 425-volt unregulated "B" supply.
(2) Regulated 300-volt "B" supply.
(3) Heater voltages.
(4) 24-volt d-c supply for operation of the air-circulating blowers.
(5) Minus 27-volt bias supply.

The Rectifier Power Unit operates from a single-phase, a-c 47 to 2400 cps source with power consumption approximately 365 watts at 47-cps and 330 watts at 2400-cps. Facilities are provided through a front panel switch to permit adjustment of the tapped primary of the power transformer for 10% above or below the normal 115-volts input.

An overall functional block diagram of the AN/UPM–4 (Figure 18) will assist the reader in following

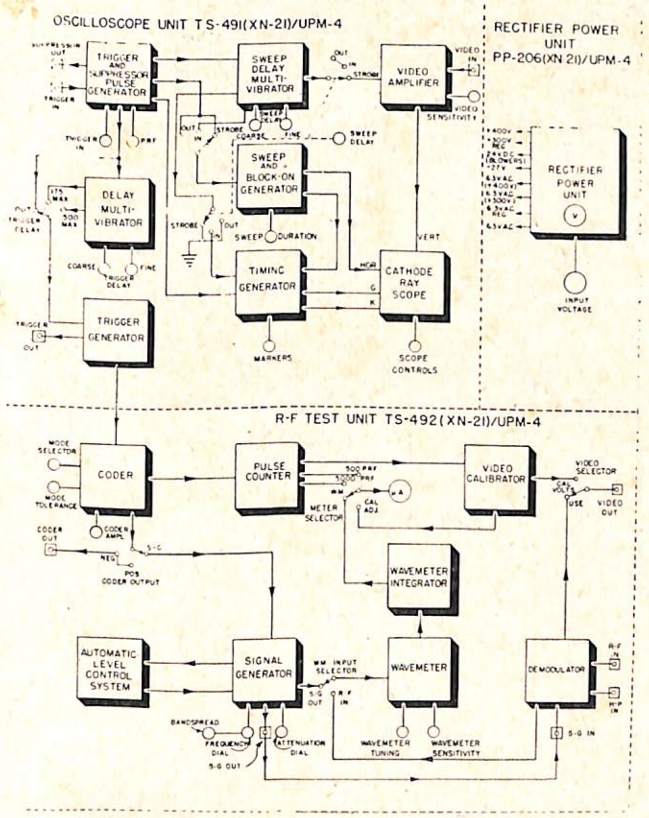


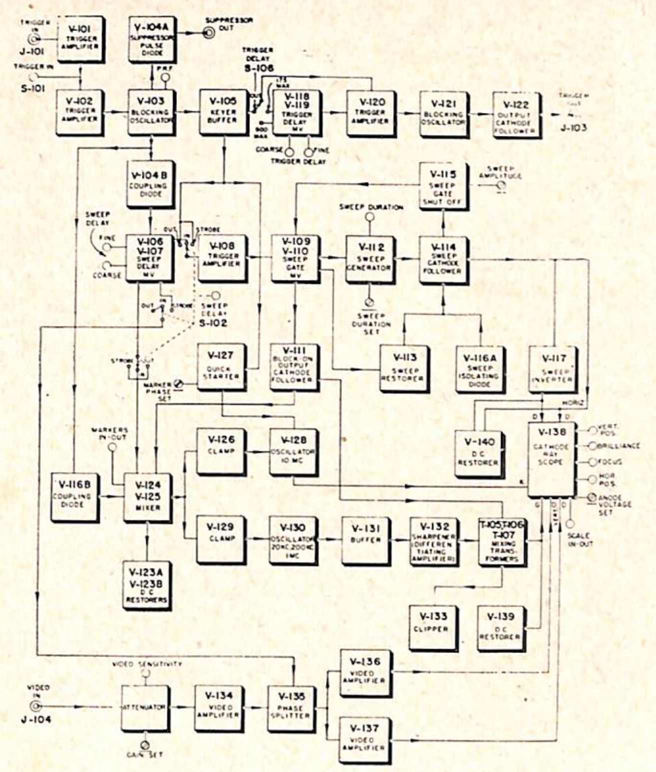
FIGURE 18. Functional block diagram of the transportable test equipment AN/UPM–4(XN–21).

the sequence of events throughout the discussion which follows. However, this block diagram is included only to illustrate the tie-up between the Oscilloscope Unit and the R-F Test Unit while individual block diagrams of each of those units will be used as basic references.

Oscilloscope Unit TS–491—Detailed

From Figure 19 it can be seen that the incoming triggers from the equipment under test are introduced into the AN/UPM–4 at J–101 (TRIGGER IN) and applied to a trigger amplifier V–101 through a two-position switch which permits using either positive or negative trigger input. V–101 is biased so that either a positive or negative pulse applied to the grid will cause a current increase or decrease respectively in the plate circuit. The plate circuit contains the primary of a transformer in series with the plate load, whose secondary is center tapped, as shown in Figure 20. Thus regardless of the polarity of input trigger, a positive pulse will always appear at the grid of V–102 another trigger amplifier. Since the plates of V–102 and V–103 (blocking oscillator) are connected together, when V–102 conducts a pulse will be generated in the blocking oscillator and applied to a buffer (V–105) across a diode V–116A. This diode generates a positive pulse in the cathode circuit which may be used as a suppressor pulse or as a trigger, as desired. Note that when the equipment is switched to INT SYNC the grid circuit of V–102 is grounded and the bias on V–103 is removed, effectively changing the blocking oscillator from a single swing to a free running oscillator, whose repetition rate is determined by the dual potentiometer R–113.

V–105 is a thyratron and is used to provide isolation between the blocking oscillator and the following circuits. This stage is normally non-conducting, being fired



FIGUR) 19. Detailed functional block diagram of the Oscilloscope Unit TS–491(XN–21)/UPM–4 of the AN/UPM–4 test equipment.

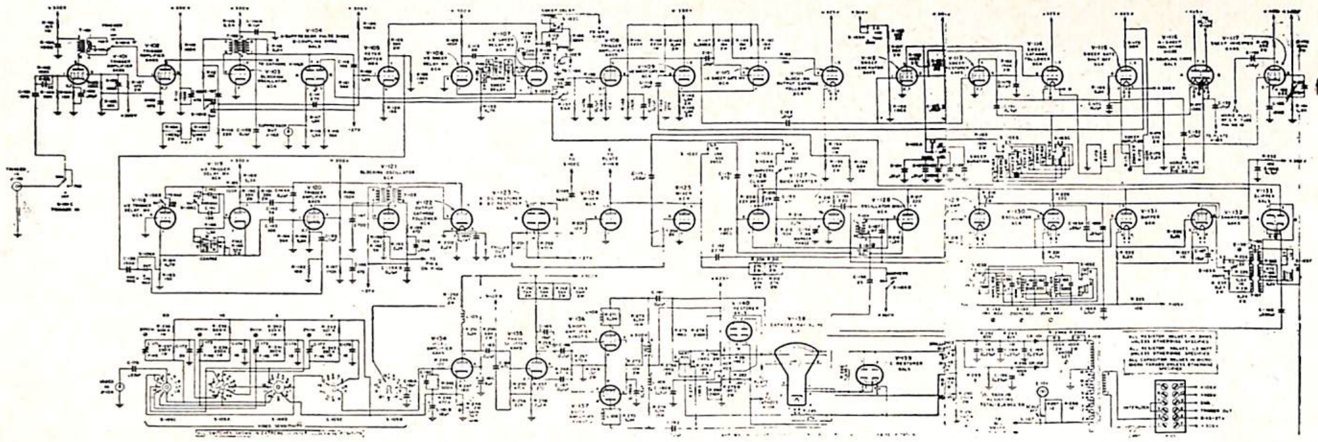


FIGURE 20. Schematic diagram of the Oscilloscope Unit TS–491 of the AN/UPM–4 Test Equipment.

by the positive pulse applied to its grid. Upon firing, a sharp positive pulse is generated in the cathode circuit and a sharp negative pulse in the plate circuit. The pulse from the cathode circuit is used to trigger the sweep gate multivibrator V–109/V–110 when S–102 is in the OUT or STROBE position. When markers switch S–104 is in the ON position, the pulse from V–105 cathode triggers the quick starter V–127. The negative pulse from the plate of V–105 triggers the delayed trigger multivibrator V–118/V–119, when the trigger delay switch is at either the 175 or 500 microseconds delay position. When this switch is OUT the negative pulse operates the trigger amplifier V–120.

The delayed trigger generator produces a trigger pulse of positive polarity which may be delayed from 3 to 500 microseconds, dependent on the setting of the delay switch and the amount of delay introduced by the coarse and fine controls provided. Trigger amplifier V–120, operated by either a delayed or undelayed trigger, furnishes a pulse to the blocking oscillator, V–121. Pulses generated in V–121 are coupled internally to the R-F Test Unit and also supplied to a front panel plug for use externally.

The sweep delay multivibrator V–106/V–107 is included in the unit to provide a delay of from 3 to 500 microseconds before the start of sweep. V–106 is normally off while V–107 is conducting. The multivibrator is triggered by a pulse from the grid winding of V–103 (T–102) coupled across diode V–104B so that only the negative excursion of the blocking oscillator pulse waveform will cause conduction through V–104B. This will apply a negative bias on V–107 cutting it off and allowing V–106 to come into conduction. This condition will exist until the negative pulse on the grid of V–107 leaks off and the multivibrator returns to its normal condition. The length of time is, of course, dependent on the adjustment of the delay controls on the front panel of the unit. The negative gate developed at the cathode of V–107 is used to trigger the sweep gate multivibrator V–109/V–110 when S–102 is in the IN position. The positive gate developed in V–107 plate circuit is applied to the grid of V–124 which acts as a mixer, producing a mixer gate for the timing oscillator clamp tubes, V–123 A & B. When the sweep delay selector S–102 is in the STROBE position, a portion of the positive gate from V–107 plate is also applied to a phase splitter V–135 in the video amplifier. This positive gate is differentiated with the result that a positive pip will serve no useful purpose but may be observed on the scope at the start of the sweep. The negative pip may be made to slide back and forth on the sweep from 3 to 500 microseconds. This is useful in that if the operator wishes to blow up a certain waveform appearing on a long sweep, while operating with SWEEP DELAY OUT he can move the strobe to the immediate left of the waveform, switch to SWEEP DELAY IN, then choose a shorter sweep for ballooning of the waveform. As can be seen from Figure 20 the sweep gate multivibrator is triggered by V–108 which in turn can be triggered by the positive pulse from the cathode of V–105 during SWEEP DELAY OUT conditions, or from the trailing edge of the negative gate developed at the cathode of the sweep delay multivibrator during SWEEP DELAY IN conditions. The sweep gate multivibrator will remain in a triggered condition, V–109 conducting and V–110 cut off, until a shut off signal is generated in V–115 and coupled back to the multivibrator.

The positive pulse from the plate of the gate multivibrator is coupled to the grid of V–111, whose output serves two purposes; 1) Intensifier gate for the cathode ray tube. 2) Mixer gate for timing oscillator clamp tubes. The negative gate produced at the plate of V–109 is applied to the grids of V–112 and V–113. The voltage at the plate of V–112 will start to rise and would continue in an exponential manner except for the unusual circuitry which makes the voltage rise extremely linear. When the sweep voltage has risen to a predetermined level, as adjusted by the sweep amplitude controls, V–115 will conduct and generate a negative pulse in its plate circuit. This negative pulse is coupled back to the grid of V–109 ($1/2$ of the sweep gate multivibrator) cutting it off and restoring the circuits to their original condition. The positive sweep from the cathode of V–114 is applied directly to one plate of the cathode ray tube and to the other plate through a sweep inverter, V–117, thereby affording push-pull sweep deflection.

As mentioned previously, marker pips are provided for use on the various sweeps available in the AN/UPM–4. The 0.1 microsecond pips are generated in a 10-Mc oscillator (V–128) and applied as a sine wave to the cathode of the scope tube. Therefore on the negative swings there will be a brightening on the scope, and on the positive swings, the scope will be cut off. This results in the appearance of a series of dots on the scope separated by blanking. The 1, 5, and 50 microsecond markers are generated in a different oscillator (V–130) by switching any one of three tuned circuits (1-Mc, 200-kc, and 20-kc) between grid and ground of the oscillator. When the markers switch is turned to the ON position, regardless of the sweep in use, a series of timing pips (either 1, 5, or 50 microsecond) will be applied to the grid as positive pulses. If the 3.5 microsecond sweep is in use, and the markers switch is turned ON, every tenth 0.1-microsecond pip will be brighter than the others due to the coincidence between that tenth pulse from the 10-Mc oscillator and the 1 microsecond markers being applied to the grid of the scope tube. When the sweep selector is in any other position than 3.5 the 10-Mc oscillator is not triggered and no 0.1 microsecond pips will be generated. When markers are being applied, a timing marker gate is generated by combining pulses in V–124, V–125, and V–116B, whose plates are connected together. The action in these tubes is as follows: A negative pulse from blocking oscillator V–103 is applied to the cathode of V–116B. When the sweep delay switch is in the IN position, a portion of the positive gate produced at the plate of V–107 is applied to the grid of V–124. A portion of the positive block-on gate developed at the cathode of V–111 is applied to the grid of V–125. As a result of the application of these three pulses there is developed at the combined plates of V–124, V–125, and V–116B a negative gate having a duration sufficient to unclamp the timing oscillators for the required time. When no markers are desired, the markers switch on the front panel is thrown to the OUT position. This removes the plate voltage from the timing marker gate (V–124, V–125, and V–116B) and disconnects the grid of the quick starter (V–127) from the Sweep Duration Selector.

An input attenuator, in the form of four ladder networks, is interposed between the VIDEO IN jack and the first video amplifier. This attenuator provides various degrees of vertical deflection sensitivity on the cathode ray scope. When the video sensitivity control is in the 20 (20-volts per inch) position all four networks are connected, in the 10 position—three networks are connected, in the 5 position—two networks are connected, and in the 2 position—one network is connected. When the video sensitivity control is placed in the 1 position, the video is connected through R–244 to the grid of V–124. When the control is placed in the 0.2 position (0.2 volts per inch), the resistance of the plate load is

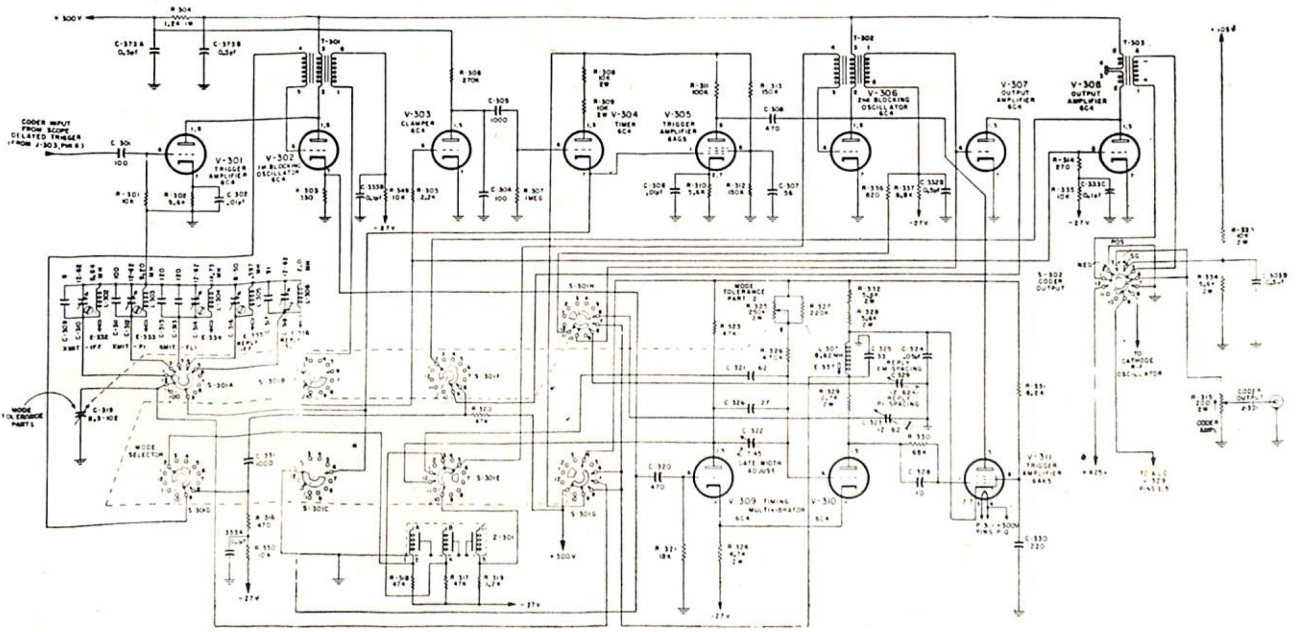


FIGURE 21. Schematic diagram of the Coder Unit of the R-F Test Unit TS–492(XN–21) of the AN/UPM–4 test equipment.

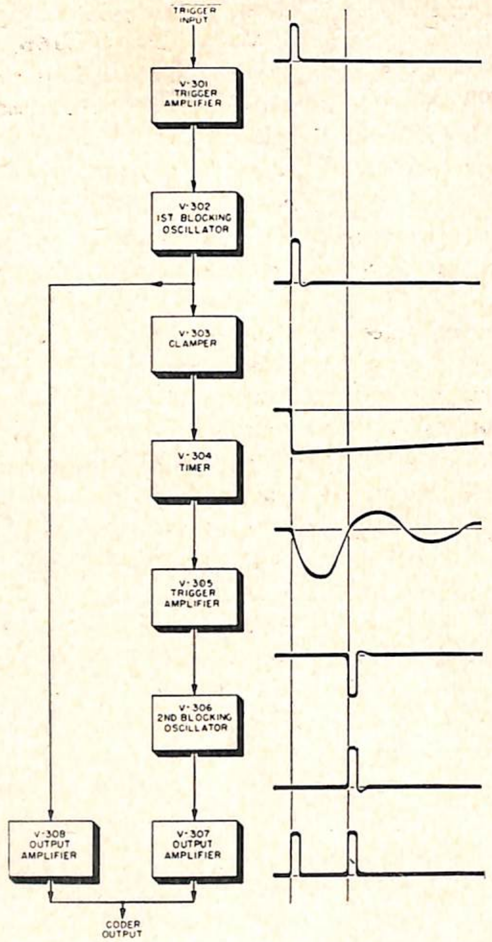


FIGURE 22. Block diagram showing arrangement of circuits and signal paths in the Coder Section of the R-F Test Unit TS–492 for generating paired pulses.

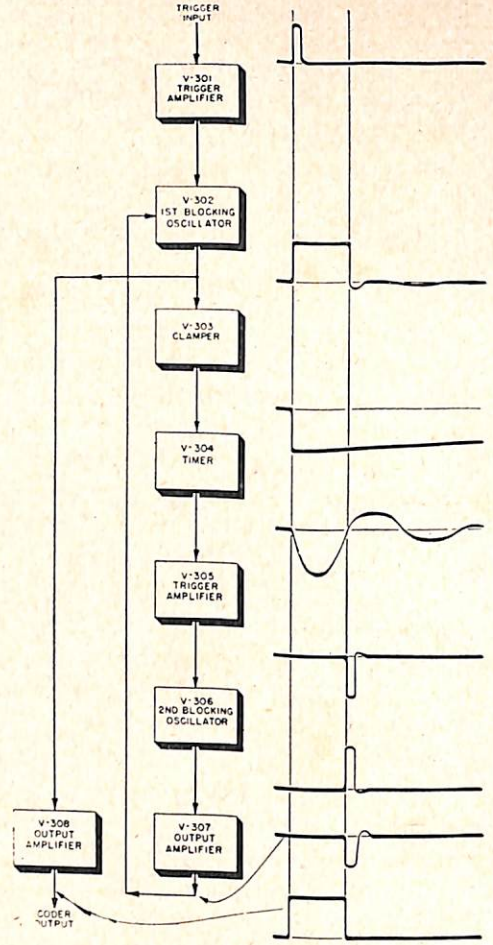


FIGURE 23. Block diagram showing arrangement of circuits and signal paths in the Coder Section of the R-F Test Unit TS–492 for generating single pulses.

effectively increased with the result that the amplification is increased approximately five times. To obtain uniform vertical deflection, a phase splitter (V–135) is utilized to provide two outputs, one from cathode, the other from plate to separate video amplifiers. The outputs from the video amplifiers (V–136 and V–137) are applied to the upper and lower vertical deflection plates respectively.

R-F Test Unit TS–492—Detailed

The trigger pulses from the delayed trigger generator, V–121, in the Oscilloscope Unit are applied to the Coder Unit in the R-F Test Unit. The unit is so connected that either positive or negative polarity output pulses are supplied at a front panel jack (CODER OUT) for external use. In addition to this external trigger source, the coder also provides negative pulses for modulating the R-F Signal Generator. Figure 21 is a schematic diagram of the Coder Unit and can be used to follow the sequence of events upon receipt of a trigger from the delayed trigger generator. Seven types of coder output pulses shown in the Table on Page 24 are produced by one of the three modes of coder operation as follows. The first mode is the generation of 0.7 to 1.2 microsecond paired pulses (XMIT PI, and XMIT FLI). Second mode of operation is the generation of 0.9 to 1.3 microsecond pulses and 2.25 to 2.75 microsecond pulses (REPLY IFF and REPLY SLO). The third mode is the generation of paired and quadruple 0.9 to 1.3 microsecond pulses (REPLY PI and REPLY EMER.) These three modes of operation are illustrated in Figures 22, 23, and 24 respectively. In Figure 22 the blocking oscillator tube output is divided, with one chain being undelayed and the other delayed through V–303, V–304, V–305, V–306, and V–307. The amount of delay can be either three, five, or eight microseconds depending on the type of output desired, IFF, PI, or FLI. In Figure 23 the action is similar except that the timer and associated circuits are used to determine the duration of a single pulse output, either 1 or 2.5 microseconds, depending upon whether the switch is placed in the REPLY IFF or REPLY SLO position respectively. The positive output from V–308 is obtained by transformer coupling in the plate circuit. Figure 24 shows the third mode of operation used to generate REPLY PI or REPLY EMER pulses.

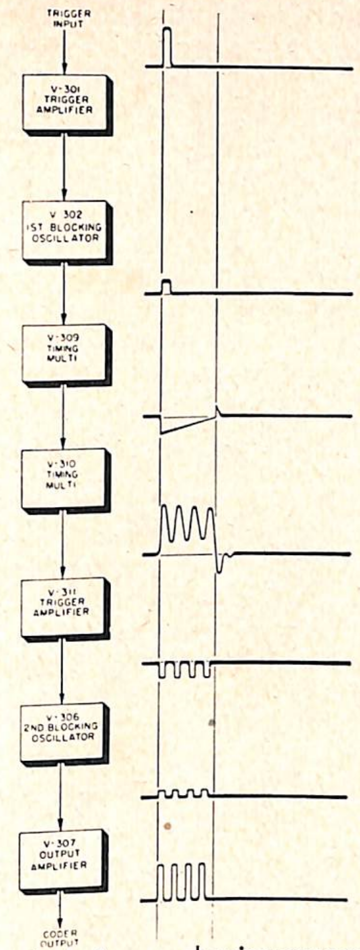


FIGURE 24. Block diagram showing arrangement of circuits and signal paths in the Coder Section of the R-F Test Unit TS–492 for generating EMER (four) pulses.

The trigger applied to V–302 causes that blocking oscillator to ring for a period of time between 0.9 and 1.3 microseconds. V–309 and V–310 constitute a timing multivibrator with a ringing circuit included in the plate of V–310. The ringing circuit is shocked into oscillation immediately upon triggering of the multivibrator and will continue to ring for a period equal to the length of the gate developed by the multivibrator. For REPLY PI the gate is of sufficient length to allow two oscillations to be superimposed, and for REPLY EMER, it is long enough to allow four oscillations to be superimposed. The period of oscillations may be varied from 7 to 9 microseconds by a control provided to adjust mode tolerance. The waveform generated in the timing multivibrator is applied to a trigger amplifier so biased that only the peaks of the oscillations will cause conduction. Thus V–311 generates two or four squared pulses depending upon the mode of operation (PI or EMER) and these are applied to a second blocking oscillator V–306. This blocking oscillator generates pair or quadruple pulses from 0.9 to 1.3 microseconds in duration and spaced 8 microseconds, which are applied to the output amplifier, V–307. The output of V–307 is transformer coupled to produce positive or negative pulses for application to the CODER OUT jack on the front panel.

The negative pulses from the coder unit are applied to the cathode of the R-F Signal Generator as shown in Figure 25. The signal generator is a type 6L4 acorn triode operating with its grid grounded. The resonant circuit is an open half-wave line tuned at the end by a

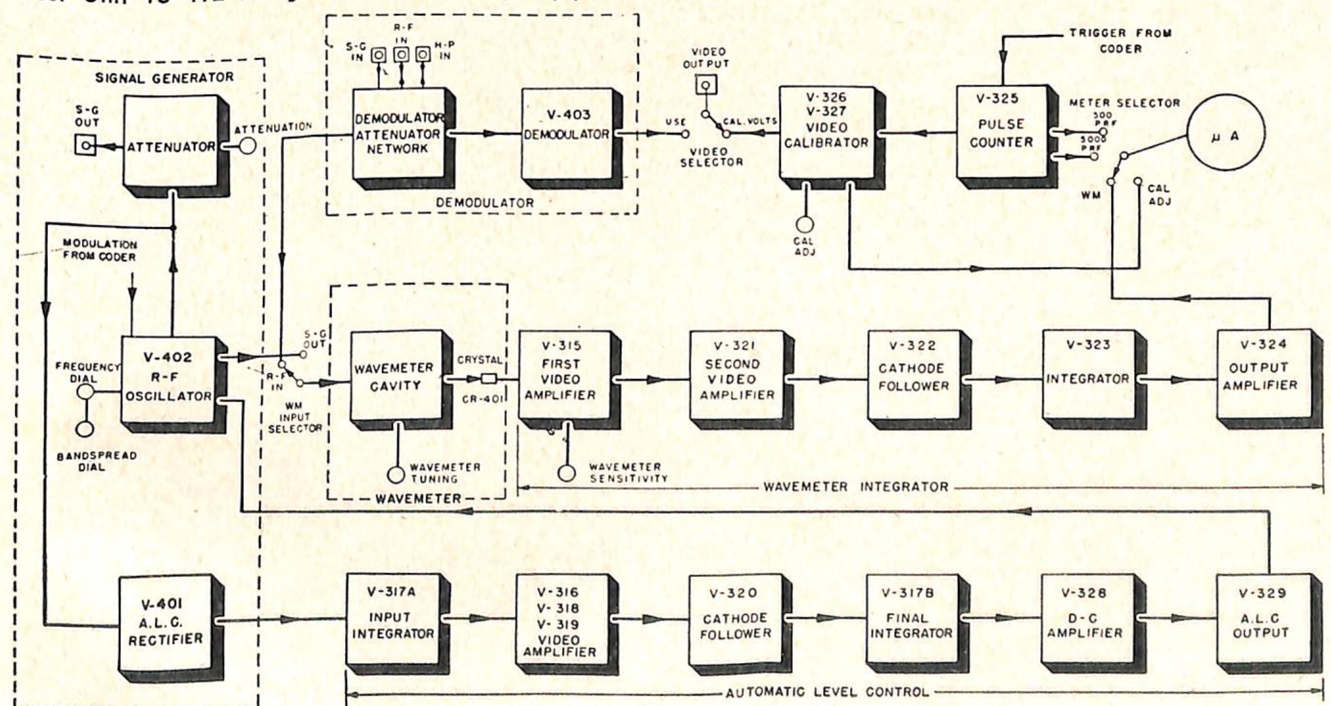


FIGURE 25. Functional block diagram of the R-F Test Unit TS–492 (less the Coder Section) showing basic signal paths and circuits.

variable capacitor. The plate of the oscillator is connected to a metal strip which is the center conductor of the tuned transmission line. The r-f pick-up for the wavemeter projects into the transmission line box and consists of a 47-ohm resistor, one end of which is connected to the center conductor of the coaxial cable leading to the WM INPUT selector, the other end bent into a pick-up loop. The r-f pick-up for the ALC (automatic level control) circuit and for the electrostatic coupling to the piston-type attenuator consists of a 56-ohm resistor and its leads. One end of the resistor is connected to the plate of the ALC rectifier (see Figure26) and the other end is by-passed to ground for r-f and connected through a coupling capacitor to the ALC input integrator. The output of the oscillator is picked up electrostatically by the attenuator and delivered to the SG OUT jack on the front panel. The attenuator piston is driven by a gear mechanism connected to the ATTENUATION dial on the front panel. The dial is carefully calibrated to read directly in decibels below a one-volt rms open-circuit reference level with a range from 15 to 115 db. The ALC circuit, composed of V–316, V–317, V–318, V–319, V–320, V–328, and V–329, is included to maintain the output of the r-f signal generator at substantially constant level with any given setting of the ATTENUATION DIAL over the entire frequency range. The action of the ALC system is such that an increase in r-f oscillator output causes a lowering of the oscillator plate voltage and similarly, a drop in the output of the r-f oscillator causes an increase in the oscillator plate voltage, resulting in the comparatively constant output level which is desired.

The wavemeter consists of a tunable cavity into which the r-f energy is coupled by an induction loop terminated in a 51-ohm resistor. Tuning is accomplished by means of a screw-driven plunger which is connected to the wavemeter tuning knob and a counter-type dial. When the cavity is tuned to one-quarter wavelength r-f energy is transferred to an output pick-up loop. This output is rectified by a crystal and applied through a filter to the output jack. The rectified output of the wavemeter is a negative waveform which approximates the envelope of the input signal. The rectified output is passed through two video amplifier stages, a cathode follower, an integrator circuit and applied to the front panel indicating meter through an output amplifier. Resonance in the wavemeter is indicated when the meter on the front panel reads minimum. A control is provided to vary the amount of signal applied to the integrator so that the operator may keep the meter needle operating at some level less than maximum but more than minimum scale reading, thus affording greater accuracy.

The demodulator consists of a lighthouse type diode detector, with associated attenuating and matching networks, operating over the frequency range employed by the Mark V IFF/UNB System to produce an output without appreciable distortion for waveshape measurements and of peak voltage for power measurements. A relatively small percent of the power applied to the demodulator from an external equipment is applied to the input of the wavemeter so that frequency measurements can be made.

The pulse counter is employed to count trigger pulses produced by the blocking oscillator (V–302) of the coder unit. This counter reads the pulse recurrence frequency at which the AN/UPM–4 is operating whether

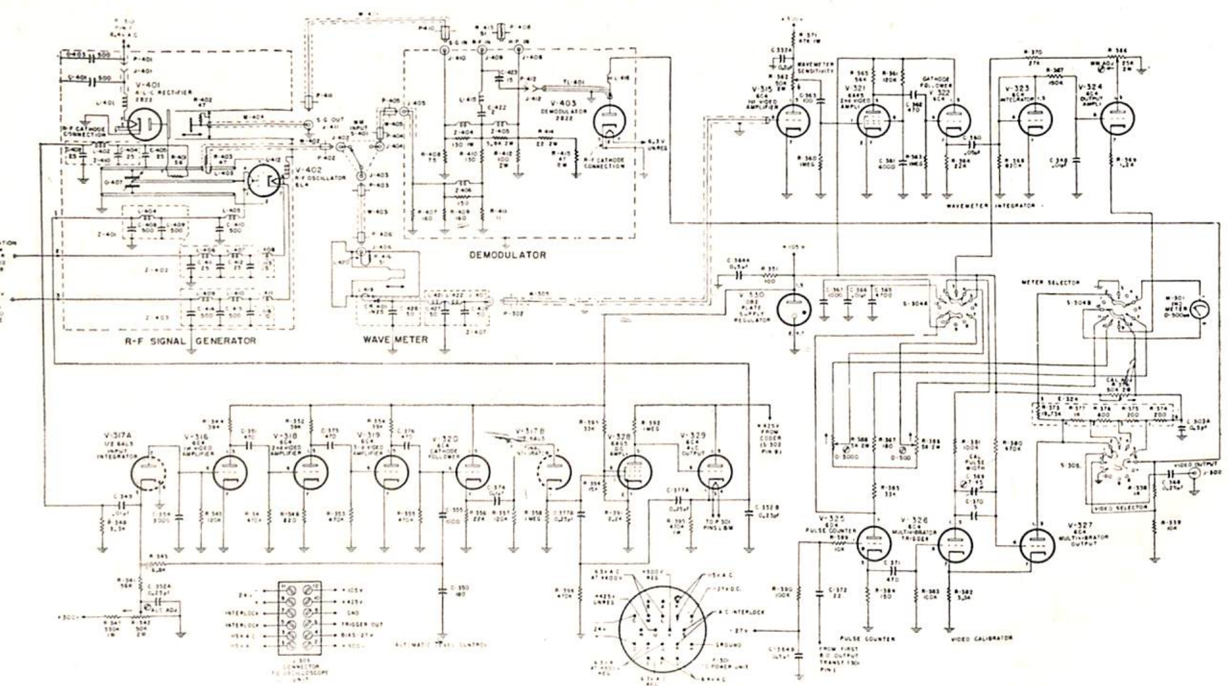


FIGURE 26. Schematic diagram of the R–F Test Unit TS–492 (less the Coder Section).

it is externally triggered or self-triggered. The indication is given on a front panel meter which has two scales provided—0 to 500 and 0 to 5000. This circuit employs a gas triode and associated components so that when a pulse is applied to the triode a current is passed through the pulse counter circuit and through the front panel meter. The average current through the meter is proportional to the pulse recurrence frequency with the meter being calibrated to read the exact repetition rate being applied.

Portable Test Equipment AN/UPM–6

The portable test equipment AN/UPM–6, which is primarily designed for "GO"—"NO GO" tests on units of the Mark V IFF/UNB, is similar in operation to the transportable test equipment AN/UPM–4 except for the following:

(1) No oscilloscope presentations are available on the AN/UPM–6.

(2) No time base measurements can be performed with the AN/UPM–6.

However, there are several circuits which are common in their purpose, although perhaps slightly different in circuity, such as the Coder-Decoder, R-F Signal Generator, Demodulator, Wavemeter, and front panel voltmeter. In the AN/UPM–4 slow code could be checked by the use

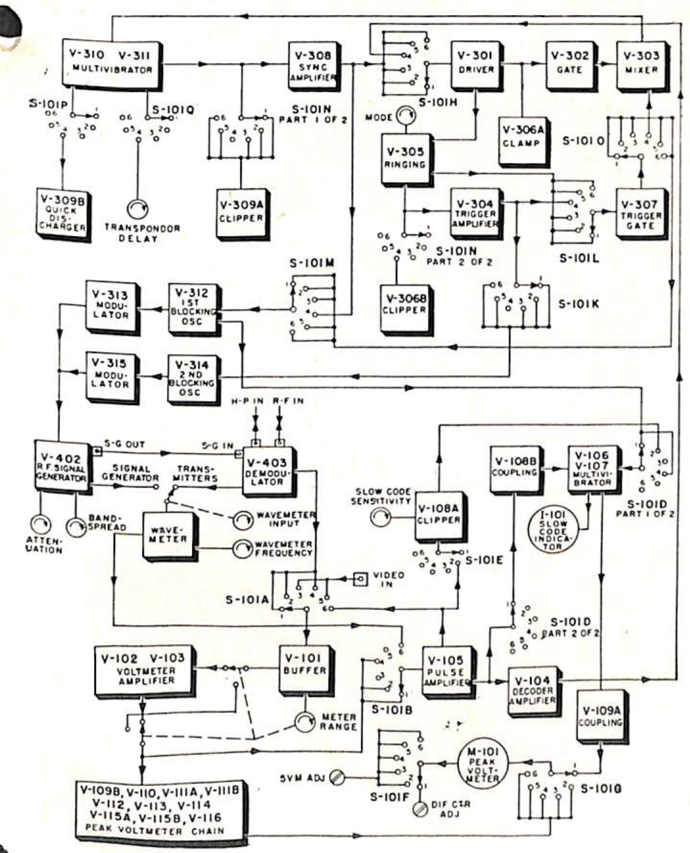


FIGURE 27. Functional block diagram of the portable test equipment AN/UPM–6(XN–21).

of the oscilloscope provided with the equipment, whereas in the AN/UPM–6 this operation is performed by a neon indicating lamp. The AN/UPM–6 is a self-contained instrument except for accessories case. The equipment will operate from an a-c supply of 115-volts, 47 to 2400 cycles, or from a d-c source of 20 to 30 volts. When operating from the d-c source, however, an Inverter, Type PU–120/U is necessary and is provided with the equipment.

This equipment is primarily designed for use in aircraft squadrons where a portable gear for checking airborne transponders and interrogator-responsors, without removal from the plane, is highly desirable. In this connection the AN/UPM–6 is made up as a single unit with a carrying strap, the weight being kept to a minimum. It has been used extensively throughout the period of the evaluation of the Mark V IFF/UNB System, both at aircraft shore bases and on board a light aircraft carrier which carried planes equipped with Mark V IFF/UNB components. The AN/UPM–6 can be employed to make transmitter and receiver frequency measurements, measure power output, check slow coding, check modes of operation, measure the firing rate of transpondors, etc.

Figure 27 is a functional block diagram of the AN/UPM–6 showing the various circuits, connections, inputs and outputs provided to accomplish the functions for which the equipment was designed. Note that Switch S–101 is a 6-position switch. This is the TEST SELECTOR switch and provides the necessary circuit changes to conduct each type of test available on the switch. The functions of each position of the TEST SELECTOR switch are described briefly as follows:

Position 1—The coder-modulated output of the r-f signal generator is supplied to external equipment connected at the RF IN or HP IN jacks on the demodulator. The type of r-f pulse depends on the position of the MODE selector.

The reply signal of the transpondor under test is received at the RF IN or HP IN jack on the demodulator, providing a check of its recurrence frequency. (See Figure 28.)

Position 2—The coder-modulated output of the r-f signal generator is supplied to external equipments in the same manner as in Position 1.

The reply signal of the transpondor is received at the RF IN or HP IN jack on the demodulator, providing a check of the peak amplitude of the r-f output of the reply signal. Slow code may be read in this position also. (See Figure 29.)

Position 3—The video signal under test is applied via VIDEO IN jack and video step attenuator to the peak voltmeter chain, providing a measurement of the amplitude of the positive polarity pulses. (See Figure 30.)

Position 4—Paired pulses from the equipment under test are applied to the demodulator at the RF IN or HP IN jacks. The rectified envelope of the signal is applied to the decoder circuit for check of decoding. The rectified envelope of the signal is applied to the peak voltmeter chain and the peak voltmeter reading is used in conjunction with calibration curves to determine r-f power output. (See Figure 31.)

Position 5—The coder-modulated output of the r-f signal generator is supplied to an interrogator-responsor connected at the RF IN or HP IN jacks on the demodulator. The type of r-f pulse depends on the position of the MODE selector. The level of the r-f pulses delivered at the jacks is known from ATTENUATION DIAL readings.

The video chain of the responsor is connected at VIDEO IN and applied to the peak reading voltmeter to check peak amplitude. (See Figure 32.)

Position 6—R-f output from external equipment under test is applied at the RF IN or HP IN jack. R-f energy is applied to the wavemeter via the WAVEMETER INPUT selector and the output of the wavemeter is applied to the peak voltmeter chain. When resonance is indicated on the peak voltmeter, frequency of the equipment under test can be measured. (See Figure 33.)

Thus we have a portable equipment, which for all practical purposes can be utilized for field service work without the attendant extra weight of the AN/UPM-4 and with only the loss of two functions as mentioned previously.

This concludes the series on the Mark V IFF/UNB System and it is hoped that electronics personnel of the Naval service who have read this, will have gained a better insight of the overall IFF program and be on familiar ground should they be assigned to maintenance of any of the units described in this series.

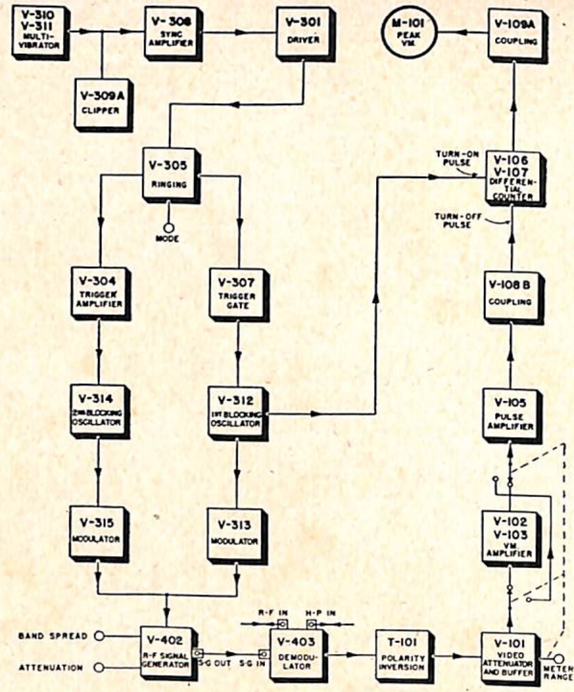


FIGURE 28. Block diagram of the AN/UPM-6 showing arrangement of circuits when checking pulse repetition rates of equipments under test.

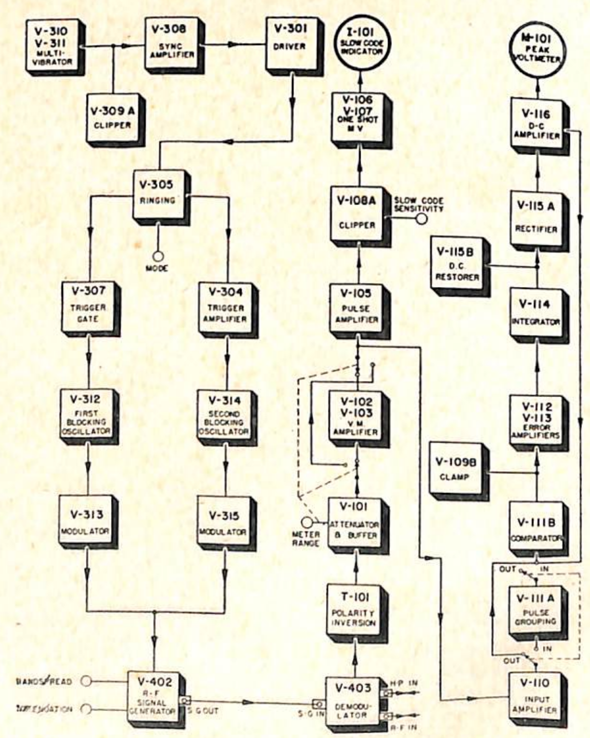


FIGURE 29. Block diagram of the AN/UPM-6 showing arrangement of circuits when checking slow code or peak power of equipment under test.

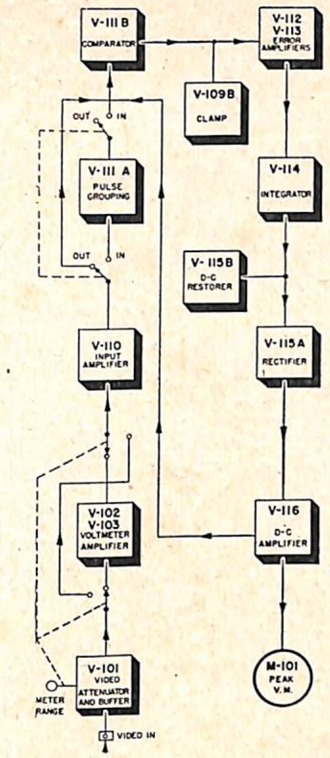


FIGURE 30. Block diagram of the AN/UPM-6 showing arrangement of circuits when checking peak amplitude of video signal from equipment under test.

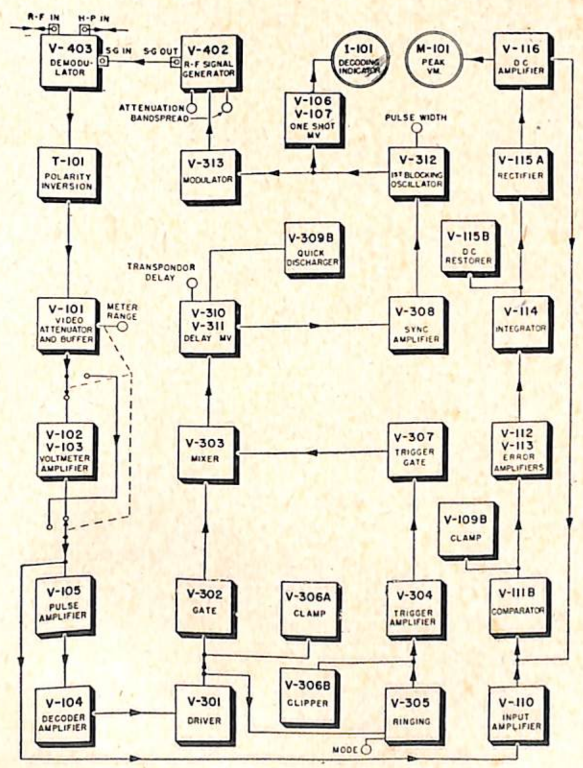


FIGURE 31. Block diagram of the AN/UPM-6 showing arrangement of circuits when checking r-f power output from equipment under test.

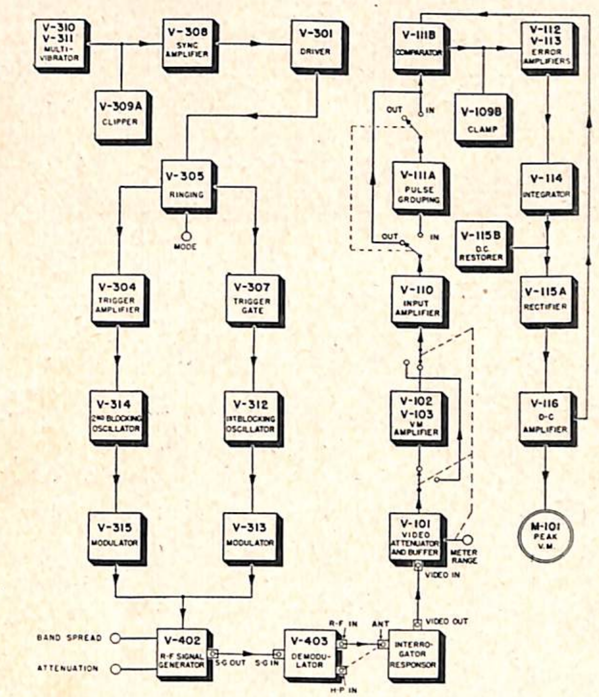


FIGURE 32. Block diagram of the AN/UPM-6 showing arrangement of circuits for checking peak amplitude of video signal from interrogator-responsor under test.

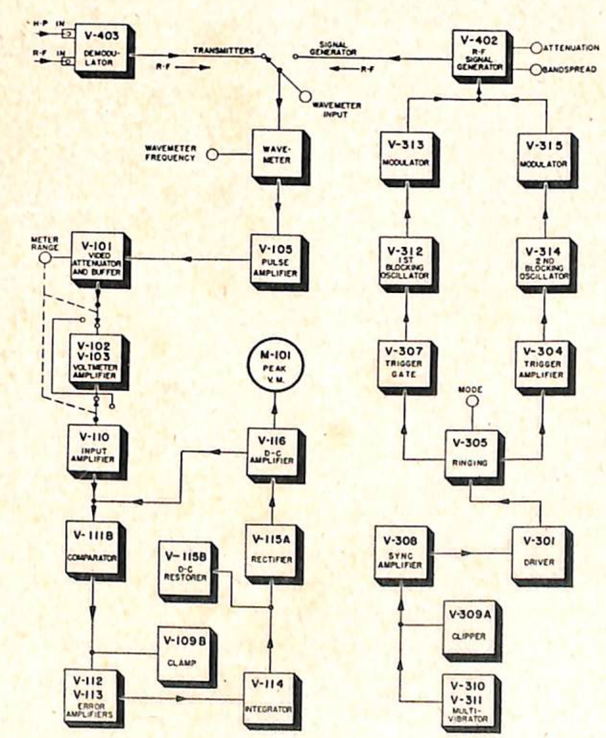
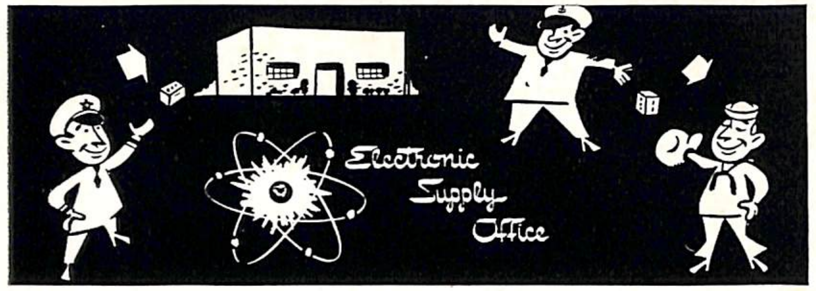


FIGURE 33. Block diagram of the AN/UPM-6 showing arrangement of circuits for checking frequency of equipment under test.



E.S.O. MONTHLY COLUMN

EQUIVALENTS AND SUBSTITUTES

In fulfilling its mission of providing electronic maintenance repair parts for the Navy, the Electronic Supply Office does not always provide the exact item requested on requisitions or as described on Stock Numbered Description Cards. When items are provided which are not identical to those requested on requisitions or as described on description cards, they are termed equivalent or substitute items.

An item provided as an equivalent can be issued and installed in all Navy equipment in lieu of the item it has superseded, but, when a substitute is provided, it can be installed only in the set or equipment in which the superseded item was used.

This office may provide equivalent and substitute items out of necessity or through planned programs to support Naval electronic equipment at a minimum cost. Many times the item described on a Stock Numbered Description Card or requested on a requisition is no longer available from suppliers; hence, this activity must accept slightly different items to maintain support of equipment. Also, equivalent items may be accepted to allow wider competition when purchasing the item, with resultant lower cost.

In other cases, ESO provides a better or "preferred" item that has not yet appeared on a preferred item list. The benefits of such an action are obvious, since a preferred item generally replaces two or more previously stocked items.

Before an equivalent or substitute item is provided to replenish stock or satisfy a particular requisition, a thorough technical review is made to determine whether the equivalent item can be issued and installed throughout the Navy or that the substitute item will satisfy a particular equipment application.

Activities receiving material procured as a substitute or an equivalent are so notified by annotations on the purchase documents. Two examples illustrating the manner in which these annotations are made follow:

1—To satisfy a recent requisition for a Connector, N17–C–70361–4343, ESO bought N17–C–70361–4337. The two connectors were essentially the same except for the insert material. In the first this was Bakelite; in the second phenolic. The following statement was inscribed upon the purchase document:

"The material described in item 1 is technically equivalent and is to be accepted as a replacement for stock number N17–C–70361–4343. This material should be carried under stock number N17–C–70361–4337."

2—If, on the other hand, the item bought by ESO is so similar to the requisitioned item that the two can be stocked together, the purchase document will bear a notation such as:

"The description of item 4 is the description of the material being purchased. It is equivalent to the basic description of the stock number of item 4 and will be carried under this stock number."

This method of annotating purchase documents eliminates difficulties which might otherwise arise at activities receiving substitute material.

SERAD PROGRAM

The BuShips Special Electronics Restoration and Distribution Program is bringing into the Electronic Supply System, at a relatively low cost, many parts-peculiar, high cost items and items in short supply.

To ascertain which items generated from the SERAD Program should be made available for stocking in the Electronic Supply System, a technical review is made of all Class III Material, that is, certain specified components and parts for those electronic equipments which, as a unit, are considered beyond repair. Spare Parts Breakdown Lists for such equipments are screened by ESO technicians, and annotations made to indicate those parts considered necessary to the system.

Whenever it is determined that there is less than two years' supply of these parts now in stock, ESO prepares a list of the desired items for each equipment, by stock number and circuit symbol number. This list is forwarded to the cognizant shipyards with the request that all quantities of such items generated from the SERAD Program at each activity be turned into the supply departments for stocking.

PROCUREMENT LEAD TIME

A major problem in maintaining the Electronic Supply System is that of procurement. ESO must meet requirements and must remain within the prescribed laws in doing so. Because of the complexity of electronic material, many difficulties are encountered in accomplishing this task. The time required to obtain delivery varies greatly due to problems arising within ESO and without.

In considering first those problems that cause delay within ESO, it must be borne in mind that the nature of the material itself is a very important factor. A large percentage of the Navy electronic maintenance repair parts do not have a commercial counterpart, having been manufactured especially for a certain Navy type equipment. As a result, if the original manufacturer does not have stock on hand, a special manufacturing run must be made which generally results in a unit price far above the estimated or war time price. This delays the award to the manufacturer, as a revaluation is made to determine if the need for the material warrants the expenditure of the funds. If, on the other hand, the manufacturer has the material in stock at a reasonable price, an award is made immediately, and delivery takes only a short time. Another cause of delay is the reluctance of manufacturers to bid on small quantities. Since the bulk of the purchase requests are for small quantities, this presents a definite problem.

In many instances, firms which manufactured material for the Navy during the past war are no longer in a position to bid on the item, having converted to the manufacture of peacetime products. This necessitates obtaining drawings and clearances from the manufacturer in order to have the material fabricated elsewhere. In other words, at least double the normally expected time must be taken to obtain bids. Lack of adequate descriptions has also caused considerable delay in obtaining material. This is being overcome, however, by the development of descriptions that will enable the item required to be readily identified by the commercial field and will result in much shorter delivery time.

Awards must be made, in many instances, where the delivery cannot be effected until as far as six to twelve months from the date the manufacturer receives the order. This, as a rule, is the case where only one known source of supply for the item exists and the long delivery time must be accepted. The small percentage of government business today as compared to commercial business gives the Navy small preference for their requirements. The manufacturer is interested in large orders for production runs and the small orders must wait until later.

Additional sources of supply and adequate procurement history are being developed by this activity as rapidly as possible. Once this information is completed and maintained on a current basis, more intelligent buying can be accomplished, with a resultant shortening of procurement lead time. Until this goal is reached, however, delays in the receipt of purchased materials can be expected at a gradually diminishing rate.

INTER-DEPARTMENTAL PROCUREMENT

Increasing demand is being made upon electronic supply points for the logistic support of Army-type equipments used by the Marine Corps, U. S. Naval Air Missile Test Center, Point Mugu, California, and other Naval activities. ESO is responsible for complete supply support of the Marine Corps equipments and is maintaining close liaison with the Army Signal Corps to facilitate procurement of Army-type electronic repair parts.

The Army will act as a purchase agency for the Navy for materials not available within the Signal Corps stocks. It is expected that this interservice agreement will result in accelerated supply of requirements.

PREFERRED TYPES OF FIXED COMPOSITION RESISTORS

During a recent conference between representatives of the Bureau of Ships and the Electronic Supply Office it was agreed that the 10 per cent tolerance Fixed Composition Resistors would be used as the preferred types.

Resistors were one of the most critical items of manufacture and supply during World War II; therefore various studies have been undertaken to prevent a reoccurrence in the event of an emergency. The lower the tolerance rating the more critical the item becomes. The Armed Services Electro-Standards Agency (ASESA) recommends the use of the 10 per cent resistors in the design and maintenance of new equipments. When these recommendations and other standardization practices are incorporated in the production of new equipments, maintenance and supply problems will be materially reduced.

The 5 per cent tolerance resistors will be listed in the parts list and allowances to support the circuit applications requiring the use of this value. The 10 per cent tolerance resistors will meet all the requirements for Fixed Composition Resistors of 10 per cent and higher ratings and will appear as the preferred type in future parts lists and allowances.

BINDERS FOR ELECTRON MAGAZINES

At last your copies of ELECTRON Magazine, NavShips 900,100 no longer need lie around loose, without protection. The magazine can now be kept in neat strong binders, indexed, and grouped by volumes. Initial distribution of binders for the first four volumes is being made to all vessels of the active fleet and to all fleet commands. The binders for the fifth volume are under procurement and will be distributed shortly. A sufficient quantity of indices will be provided at the same time.

ELECTRON magazine was first published in July 1945 and Volume 1 includes the issues from that date through June 1946. The magazine is published on a fiscal-year basis rather than a calendar-year basis. This fact must be borne in mind when referring to a particular issue.

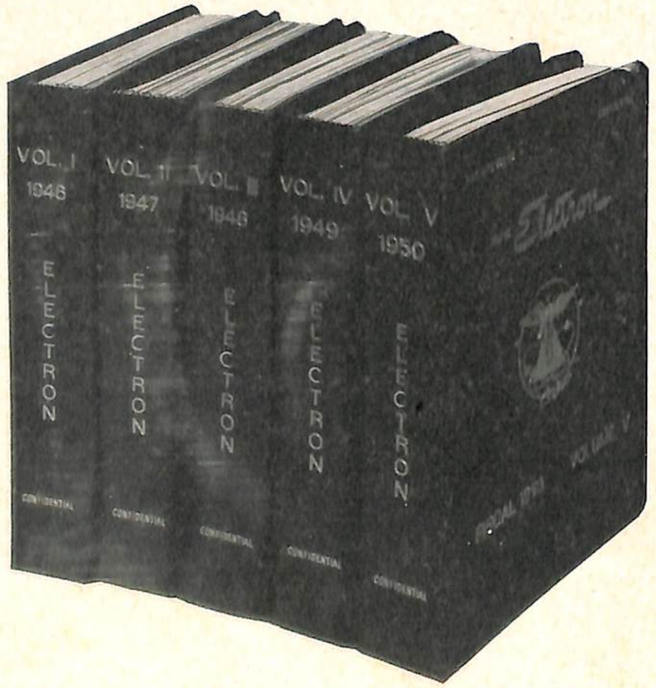


FIGURE 1. Set of binders for BuShips Electron. Binder for Volume V will be available shortly.

FIGURE 2. Magazines being inserted into binder.

The new binders are appropriately marked indicating volume number and year. Each binder will hold 12 monthly issues plus an index.

A set of five binders for the first five volumes is shown in Figure 1. These binders permit safe and convenient storage. An outstanding feature is the retention of all the copies of ELECTRON in one place. This is very important when reference must be made to articles published in the past. Examples of this are the frequent references an officer or technician may make to the article "Interchangeability of Synchros," February 1946 (Volume 1, Issue 8) or to the story "Electronic Equipment Records," February 1948 (Volume 3, Issue 8).

Insertion of individual copies is simple. First, the binder is placed on a desk or table with the front cover in almost a verticle position. The retaining wires should be loosened one at a time, facilitating the work. Next, the magazine should be opened to the center page and inserted carefully, so that it does not engage or tangle with the loops of the adjacent wires at the top of the binder. With the left hand guiding the magazine into position, the retaining wire should then be bowed slightly and brought down and re-inserted into the hole at the bottom of the binder as shown in Figure 2.

When assembled in this manner, the wires hold the magazines firmly, and the full contents of all pages is visible. With this type binder, the pages are not hidden by foldover or marred by holes as would be the case if ring binders or loose-leaf notebooks were used.

Additional copies of the magazine BUSHIPS ELECTRON may be ordered on Publication Requisition Navexos-158 from the nearest District Publications and Printing Office. The requisition should list NavShips 900,100 as the short title of the publication and should include the volumes and issue numbers desired.

Electron ORBIT

TEF MAINTENANCE KINK

SIRS:

It has been the experience of maintenance personnel at NSS that the average service life of the tuning inductors used in amplifier five of the Model TEF 2-kw Single-Sideband Transmitter (Western Electric Co. D156000) is excessively short. Failures in these tuning coils (Western Electric Co. Drawings ES–550309 and BR–463464) have been due in the main to arcing and burning between the coil conductors and the rolling contacts used to short turns in tuning. Investigation showed that when the coils are rotated to the ends of their range, the rolling contact strikes the silver-soldered end connection, burring the rolling contact. Then as the amplifier is tuned, the burred roller roughens the surface of the coil wire causing poor r-f contact with subsequent overheating and arcing between the roller and coil. Once overheating and arcing begin, the coil and contact surfaces progressively deteriorate resulting in complete failure with attendant circuit outage.

It was suggested by M. L. Baughn, RMC, USN, that if a "soft" stop could be made for these Amp-5 inductors, the rolling contact would not be damaged by operation into such a stop and the life of these expensive tuning coil assemblies would be considerably prolonged. This would result in increased circuit reliability as well as in considerably reduced maintenance cost for this type transmitter.

Accordingly a pair of Amp 5 coils were modified by building up soft-solder stops at each end of the coils. These stops were made the width of the coil wire and about 1/4 inch high with rounded edges. These experimental coils were then installed in TEF equipment Serial 67 which is used in the Washington-Honolulu Single Sideband Loop.

These modified coils have been inspected weekly since their installation five months ago and there has been no noticeable roughening or discoloration of either the rolling contacts or the coil wire. Further, there have been no cases of accidentally turning the rolling contact off the end of the coil, a failure which sometimes requires removal of the tuning assemblies for correction.

CAPT. R. E. ELLIOTT, USN
U.S. Navy Communication Station,
Annapolis, Maryland.

STRANGE RBB ACTION

SIRS:

In reference to E. M. Gilbert's letter which appeared in the December ELECTRON, I wish to describe another occurrence of the type reported.

We have quite a few Model RBB receivers which can be heard without earphones, due to the output transformers reproducing the signal. In checking the transformers, I have found that the resistance of the primary windings are lower than normal, while the secondary windings are normal.

I believe that one of two things could be causing the reproduction in the output transformer. Number one, the primary may be shorted and the signal comes from the arcing at the short. Number two, the windings may be loose and therefore free to vibrate, reproducing the signal.

It is my opinion that this is a common occurrence as I have also encountered it in the Fleet with different model receivers. I'm sure there are many other ET's who have also noticed it.

WALTER V. BEALL, ET1
Box 107, 5th Div.,
Electronics Material School,
Treasure Island, Cal.

STRANGE RCH ACTION

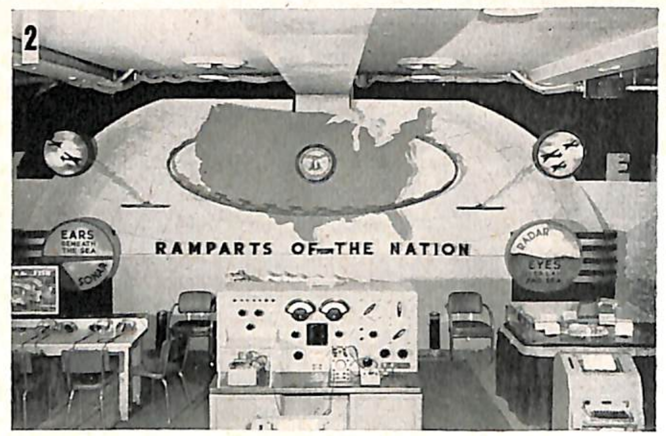
SIRS:

Concerning the December 1949 ELECTRON Orbit, "The Strange Action of RCH Serial No. 205." If I understand the problem correctly the answer will be found by a review of L-F oscillators, H-F oscillators I-F amplifiers, and heterodyne action. Put them all in a box like an RCH and most anything will come out.

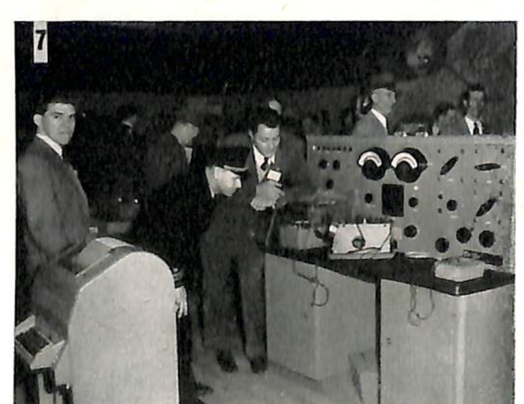
There is no reason why an R-F oscillator coil can not have an iron core. Think that is the "Q."

COMMANDER W. B. MARTIN,
D.R.E.W.P.O.
Fourth Naval District,
Philadelphia, Pa.

Navy Scores Again!



The March 1950 BuShips Electron featured the U. S. Navy Electronics Exhibit at the I. R. E. Convention, and contained artist's conceptions of the various parts of the exhibit. On this page are a few photographs of actual scenes from the exhibit. 1) Balance-Strain Gauge submitted by N.O.L.; 2) View of center of exhibit; 3) Right-hand section of exhibit; 4) Throng viewing left-hand section of exhibit; 5) V-H-F Communication Equipment; 6) Sonar Trainer; and 7) Calibration Standard and modern test equipment.



1950 ELECTRONICS CONFERENCE at Bureau of Ships

As this issue of BuShips Electron goes to press, the 1950 Electronics Conference is about to start at the Bureau of Ships. The conference will run from May 1st to May 5th, inclusive.

Representatives of the fleet, field activities, and the Bureau of Ships will meet to discuss common problems, such as new technical advances in the electronics art, improved service to the fleet and shore establishments, maintenance and installation problems under stress of strict economy and conservation of critical materials, and the most effective methods by which electronics may better contribute to national defense.

This conference, held annually, affords an opportunity for the Bureau to obtain the individual and collective opinions of field representatives concerning the many problems which arise in the field of Naval electronics. In addition it provides a close contact between field and Bureau personnel, facilitating the optimum utilization of electronics material and manpower. From this conference, there will emerge, as in years past, plans for progress in research and development, and advancements in Naval electronics that will further strengthen our national defense. The major problems to be considered at this year's conference are outlined below in the tentative agenda:

1—Problems of General Interest.
2—Problems of Maintenance Yards.
3—Electronics Supply Problems.
4—Fleet Installation and Maintenance Problems.
5—Shore Installation and Maintenance Problems.

Each of these general topics has been subdivided and each of these subdivisions has been assigned to one of the activities concerned, for preparation and presentation at the conference. The Bureau greatly appreciates the interest taken by the field in the submission of numerous excellent suggestions for the agenda and in the preparation of articles for the conference. Obviously the five-day period will be far too short to discuss all items of interest. Many will be covered during the conference discussions, and the Bureau hopes to provide supplementary information or comment regarding as many other points as possible prior to the end of the conference.

QHB SERIES TUNING

It has recently been brought to the attention of the Bureau of Ships that the Model QHB series equipment is being tuned at 25.5 kc, the resonant frequency of the transducer, as shown in the QHB series instruction books.

The Bureau of Ships is extremely concerned regarding these reports, because, if true, the operating efficiency of the equipment is seriously impaired.

Sonar transducers are constructed as near to a given frequency as possible, but due to the variables of mass of the physical elements in a transducer, each transducer has its own individual frequency, which may vary from 24.6 kc to 26.7 kc, or greater. Therefore, when tuning or taking a beam pattern, each equipment must be tuned to the resonant frequency of the transducer installed. The resonant frequency is to be determined by using a Model OCP–1 Sonar Portable Testing Equipment, and the QHB equipment is to be operated at this frequency.

In order to supply the proper information to all shore activities and units of the Fleet, the Bureau has published complete information in the Electronics Installation Bulletin #240 dated 17 November 1949; in the Sonar Bulletin (NavShips 900,025A) Supplement #16, Page 12:2 dated 1 January 1949; and in the March 1949 BuShips Electron on Page 22.

All personnel, civilian, officers and enlisted men, who take beam patterns, tune, operate or otherwise have anything to do with frequency setting of the QHB series sonar equipment are instructed to read Paragraph eight of the article in either of the foregoing publications which contain special instructions concerning correct alignment and frequency setting.

Attention is also invited to the fact that some installations have dome-mounted monitors that indicate maximum output in the water; where installed, these monitors should be used when tuning.

DANGER!

MODEL BC–610 TRANSMITTING EQUIPMENT

No inside service work should be performed on the Model BC–610 Radio Transmitter with the filaments lighted.

LCdr. L. C. Harlow, Asst. E.O., Norfolk Naval Shipyard reports that a high-voltage hazard exists in this equipment when the filament circuit is energized. Although the interlocks may function correctly, the design of this transmitter is such that 400 volts appear on the grids of the 100 TH modulator tubes and the outside cans of filter capacitors C–20 and C–21 whenever the filament power switch S–11 is ON. This switch also turns on the modulator bias power supply. Personnel servicing the BC–610 should remember that whenever the tubes are lighted there is danger present from this 400-volt potential.

Model BC–610 transmitters are being installed at Naval Reserve Training Centers, Warfare Stations and Companies.

GCA SCORES AGAIN

An outstanding instance of the valuable and lifesaving contribution of GCA to aviation was brought out in the March Operations Report of GCA Unit #31 located at Naval Air Station, Willow Grove, Pennsylvania.

At about 1700 on 10 February 1950, this GCA Unit was alerted for possible assistance to a JRB, which was en route to Quantico, Virginia on an IFR flight plan from Glenview, Illinois. The pilot was unable to land at Quantico and could not get clearance for his alternate field, Patuxent River Naval Air Station, so he proceeded to Willow Grove reporting that he was low on fuel. The aircraft was reported over the Willow Grove Range Station at 5,000 feet at 1742. Communication was established immediately with the plane as it started to descend and at 1745 radar contact was made about nine miles northeast of the field. The plane was landed on the first approach at 1759 with the wind velocity 8-10 knots from the northeast. The ceiling was 1,200 feet, overcast, with scattered clouds at 500 feet. Visibility was restricted to 1½ miles by light rain, fog and darkness. A check on the plane's fuel immediately after landing revealed only four gallons of gasoline remained. The occupants of the plane, two pilots and two passengers, were, of course, very much impressed by GCA.

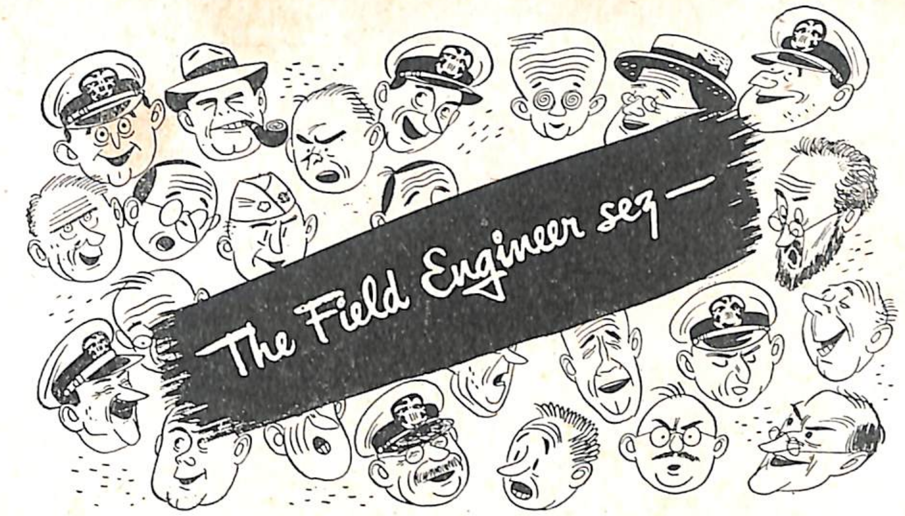
MARK 25 MOD 2 AFC DIFFICULTIES

One of the most frequent causes of trouble in the Mark 25 Mod 2 equipment has been the failure of the automatic frequency control (AFC) to lock in while operating. This condition has been caused by maladjustment of the repeller voltage on the local oscillator, nonalignment of the magnetron tuning drive with the magnetron, or, in a few cases, by bad tubes in the AFC unit. The most serious cases have been caused by the 2K45 oscillator tube and the 2J51 magnetron.

Failure of the 2K45, in most cases, has been due to the breakage of the polystyrene insulation in the output coaxial transmission line of the tube at the point where the outer conductor is crimped to hold the insulation in place. When this dielectric in the output probe is broken, the r-f output from the tube arcs across the coaxial line, and as a consequence, the output is zero or very erratic.

On several installations replacement of the 2J51 magnetron has corrected the failure of the AFC unit to lock in normally. In one case, replacement of the 2J51 did not correct the trouble, but in desperation another new 2J51 was installed, and the trouble cleared up. The indication of trouble where replacement of the magnetron restored normal operation, was that the unit usually locked in, but its flip-flop frequency was approximately only 2 to 3 cycles per second, which appeared as amplitude modulation on echoes. The flip-flop frequency was noted to vary with different magnetron frequencies, and usually an r-f frequency could be found where the unit would not lock in under any circumstances. All of these equipments appeared to work normally in manual tuning before replacing the magnetron.—*W. E. Newsletter*

Type of Approach	Through February	To Date
Practice Landings	10,586	323,073
Landings Under Instrument Conditions	659	13,043



MARK 39 MOD 3

U.S.S. Floyd Bay (AVP–40) Field Engineer R. D. Schroeder, San Francisco Naval Shipyard, reports:

Preliminary voltage checks showed lack of a-c excitation to the main terminal panel of the Mark 39 Radar. The initial fuse at the Mark 3 fuse box was blown and the replacement blew immediately. An ohmmeter check of the line at the Mark 3 fuse box indicated a direct short. Further tracing revealed the trouble to be in the OFF-ON switch in the primary of the 3-kva regulating transformer. As wired, a direct short was thrown across the line when the switch was in the ON position. The trouble was cleared by rewiring the switch.

Both the main and precision sweeps had what appeared to be a 60-cycle modulation. Although meter M–702 indicated that the output of the regulated rectifier in the power supply was set at 300 volts, a check with an external meter indicated the level was actually 360 volts. When this level was lowered to 300 volts, as read on the external meter, the sweeps returned to normal. M–702 was corrected by resetting the zero point to its correct position.

A complete lack of grass and/or signals was observed on the indicator scope. Checking the external video cable showed it to be good and installed in the correct jacks. A check of the internal video cable indicated an open in the section connecting the radar indicator to the console (P and J 408 to P and J 408A). Checking the remainder of the cables in the same "tree" revealed that the cable connecting to P and J 403 was also open. The entire group of cables in this "tree" was replaced from a spare Mark 39 Radar being rebuilt by the shipyard. After all cables had been replaced, video signals appeared on the indicator scope.

The operation of V–316 (local oscillator) was very unstable while tuning. A spare local oscillator was installed and tuning became stable and normal.

After the receiver was tuned, it was found that throwing the AFC switch to the ON position detuned the receiver to the point where the echoes on the indicator were only about half the amplitude for peaked manual tuning. A check of the tuning control (manual) of the local oscillator indicated that it was operating in the proper mode. Further checks indicated that the secondary of L–314 was not properly balanced. This condition was overcome by readjusting C–341–B and the circuit operated normally except for a chattering of the AEC relay (K–302) which was cleared by tightening the relay.

When the FTC relay (K–301) was energized, the traces on the indicator became very unstable. This action indicated a faulty relay or dirty contacts. Removal of the relay and burnishing of the contacts corrected the trouble.

With the receiver gain in manual control, the sweeps and echoes on the indicator inverted when the gain control was placed in its upper limit. A check of the voltages and resistances in the gain control circuits revealed all to be within tolerances. An improperly operating i-f stage was then suspected as the cause. Tube-by-tube substitution check of the receiver i-f strip disclosed Tube V–304 to be defective. Replacement of this tube cleared the trouble.

The aided tracking motor of the radar range unit would not drive the range counter without hanging at approximately every 2000 yards. A complete clearing of all the gearing in the range unit did not correct the trouble. Further check showed the trouble to be that shaft clamp C–920 was hitting a loose mounting screw. This screw was tightened and the motor operation was normal.

When the SEARCH-TRACK switch on the TACU was on

SEARCH, very little movement of the spot by the spot deflection controls was possible. The trouble was found to be a high resistance in relay K–2 of the TACU. This trouble was cleared by burnishing the contacts of K–2. It was also noted that when operating in SEARCH, the movement of the spot by the elevation spot control was reversed. The trouble was found to be that the leads on R–1–R–2 on B–2 were reversed. The following changes were made on the equipment: 1) A 51-mmfd capacitor was added from pin 4 of V–404 to ground, which completely eliminated the shortening of the precision sweep at short ranges. 2) The value of R–481 was changed from 0.82 megohms to 0.62 megohms which gave a better control over the amplitude of the main sweep. 3) The value of R–516 was changed from 0.2 megohms to 0.39 megohms which stabilized the operation of the modulation blocking oscillator, thereby eliminating the tendency of this particular radar to double trigger at some repetition rates.

MARK 25 MOD 2

U.S.S. Macon

The *U.S.S. Macon* reports the following operational difficulties and corrective remedies on the Mark 25/2:

1—Radar out of commission—no transmitter pulse—no magnetron current—no high voltage. A check of the power supply revealed an open filament in the high voltage rectifiers. Replacement of the tube and energizing of equipment resulted in a blown fuse (F–15). Replaced fuse and again energized with same result—blown F–15. Further checking and testing revealed Modulator Tube (4C35) was shorting. After replacing this tube and putting in a new fuse, operation of the equipment returned to normal.

2—Slow slew not operating—fast slew and handwheel control operating satisfactorily — slew satisfactory when operating in AUTOMATIC—slew switch checked satisfactory. Megging of cables from slew switch to range unit revealed a short between Junction Box #5 and radar unit assembly. Disconnected the grounded lead and replaced with a spare wire in the same cable. After obtaining slew operation, next adjusted slew potentiometer to provide a 0 to 500-yards-per-second rate of slew.

3—Radar out of commission—no sweeps, main or precision, on all scopes. Checked range sweep chassis—found no output, but input satisfactory. Tubes all tested good. Checked cable from range sweep chassis to indicators, found it shorted. Replaced shorted lead with a spare in same cable. Sweeps returned to normal in all indicators but the "A" scope. Found lead to aquadag coating in tube broken. Replaced lead and operation returned to normal in all respects.

4—The Delta E sweep would not follow director dials—would follow only up to 45°. Tried a different computer with no improvement. Checked angle sweep chassis and found R–51 and R–52 had changed value. Replaced these components and adjusted Delta E sweep and operation returned to normal.

5—Targets would appear and disappear at intervals, ringtime unstable—AFC would not lock in. All tubes checked good. Voltage checks revealed that line voltage was not constant. Inspection of regulating transformers disclosed an open filter capacitor and arcing between output leads and ground. Replaced the capacitor and insulated the output leads, after which operation was normal.

INDEX TO *Electron* VOLUME 5

PART I • ALPHABETICAL

PART 2 • CLASSIFIED

COMMUNICATIONS EQUIPMENT

Model Letters:

Teletypewriter:

General:

RADAR

Model Letters:

General:

SONAR

Model Letters:

General:

MISCELLANEOUS

Charleston Naval Shipyard

Countermeasures:

Electron Tubes:

Electronic Supply Office:

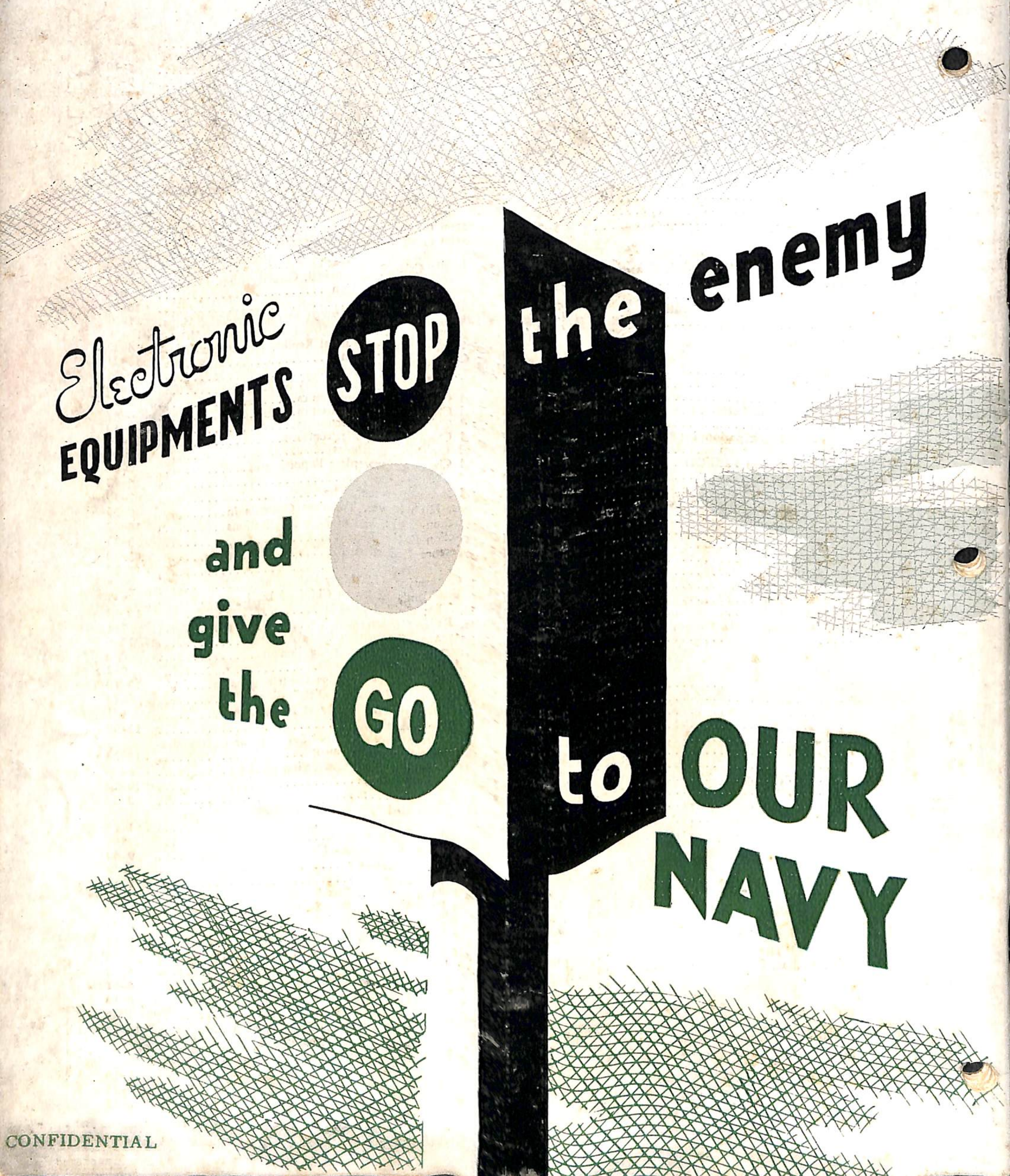
GCA:

Navigational Aids:

Radiac:

Test Equipment:

General:


Electronic
EQUIPMENTS
STOP
the enemy
and
give
the
GO
to
OUR
NAVY