# MARINE AUTO ALARM SYSTEMS

53RC

finished Dec. 12, 1960

NATIONAL RADIO INSTITUTE

ESTABLISHED 1914

WASHINGTON, D. C.

PIONEER HOME STUDY RADIO-TV SCHOOL

NRI

of Life at Sea" in 1929 agreed to certain regulations regarding the reception of distress signals. It was stipulated that each cargo vessel of 5500 gross tonnage and over must keep a 24-hour radio watch unless fitted with an auto alarm, in which case the alarm must be in operation whenever the radio officer is not on watch.

The requirements that the auto alarm itself must satisfy are determined by the governments having jurisdictions on the vessels where such equipment is installed. For United States vessels, such requirements are specified by the Federal Communications Commission.

**FCC Requirements.** FCC requirements for auto alarm systems have to do with frequency response, timing, warning in case of failure or improper operation, and mechanical ruggedness.

The frequency response requirements are given in terms of the signal strength required to operate the receiver at various frequencies. At frequencies between 487.5 and 512.5 kc. (a band of ±12.5 kc. around the 500-kc. distress frequency), the receiver must operate on a minimum signal of 500 microvolts, and must be able to operate without overloading on signals up to 90,000 microvolts. At higher or lower frequencies, the response must drop off sharply: the receiver must not operate on a signal of less than 25,000 microvolts at 450 kc. and 550 kc., and must not operate on a signal of less than 100,000 microvolts at 375 kc. and 650 kc. In the FCC tests, these signals are applied to the receiver input through a dummy antenna consisting of a 500-mmf. condenser, a 20-microhenry coil, and a 5-ohm resistor connected in series.

The 25-kc. pass band around 500 kc., within which the receiver must have uniform sensitivity, takes care of slight deviations of the distress signal from the nominal frequency. The overload specification is made so that the receiver will be able to operate if the distress signal originates from a vessel close by. The response should fall off as specified, on both sides of the operating frequency range to avoid interference from broadcast stations on shore and from marine traffic.

With respect to timing, FCC regulations specify that the alarm shall give a warning signal after it has received 4 consecutive dashes, lasting between 3.5 and 4.5 seconds, separated by an interval between 0.1 and 1.5 seconds. The auto alarm distress signal, consisting of 12 4-second dashes separated by 1-second intervals, will therefore actuate the alarm even if there is considerable error in the timing of the signal. Such errors are, of course, to be expected when the signal is transmitted manually. The number of dashes (4) that must be received before the alarm operates was fixed with regard to the probability of chance disturbances (static or other interference) simulating the distress signal. It was felt that the likelihood of a disturbance simulating a 4-dash signal was small enough to be disregarded. This possibility of false actuation could be further reduced if the number were raised to 5 or more, but then a 12-dash distress signal might fail to operate the receiver if two of the spaces between dashes were "filled" by static, an occurrence that is not unlikely. Because of this possibility, European countries require alarm receivers to be responsive to 3 consecutive dashes rather than 4.

The FCC also requires that the ship's personnel must be automatically notified whenever, for any reason, the auto alarm becomes inoperative. The possible causes of failure of the alarm, and the indications the alarm gives if failure occurs, are:

1. Strong high-level static equivalent to a continuous signal of the "distress" frequency. Such a signal cannot operate the warning bells: only a series of correctly spaced dashes can do this. However, such prolonged static will effectively mask a distress signal and prevent proper operation of the alarm, and the ship's personnel should be cautioned accordingly. For this reason, regulations require that a warning light placed on the bridge be turned on by the receiver in the event of sustained noise sufficient to mask an incoming signal. When this light goes on, the operator knows that the alarm will not function properly unless the sensitivity control is adjusted.

2. Failure of a tube. A "no current" relay placed in the filament circuit of the tubes rings the warning bells and summons the radio operator to his station.

3. General power failure. This has the same effect as a tube failure. The warning bells are separately powered.

4. Failure of warning bell power. When this happens, the circuit is so arranged that the warning lights go on continuously.

The regulations for mechanical ruggedness are similar to those that apply to shipboard radio in general. All shipboard radio equipment must withstand vibration, salt air, humidity, and high temperature. Alarm equipment is particularly delicate because it includes several sensitive relays.

## AUTO ALARM EQUIPMENT

An auto alarm installation consists of two units, a receiver and a selector. The function of the receiver is to pick up all signals within the distress-frequency band (487.5 to 512.5 kc.), reject all other signals, and amplify the accepted signals to such an extent that they can operate a relay. This relay, which is the output device of the receiver, actuates the selector unit. The selector sorts out the distress signal from all other signals received and turns on the warning bell.

At the present time, four models of auto alarm equipment have been approved by the FCC for use on American ships. These are the Radiomarine models AR 8600 and AR 8601 and the Mackay Radio models 101A and 101B. Although both perform the same functions, the Radiomarine and Mackay units differ considerably in their operation. The Radiomarine equipment uses a superheterodyne receiver and an electronic selector; the Mackay equipment, on the other hand, uses a t.r.f. receiver and a mechanical selector.

We shall describe both types in detail in this Lesson. We shall take up the Radiomarine AR 8601 first, then the Mackay 101B; these are the later models now offered by these two companies.

# The RMCA Model AR-8601 Auto Alarm

A simplified schematic of the receiver used in the RMCA Model 8601 auto alarm equipment is shown in Fig. 1. Except for the fact that its output signal is used to operate a relay instead of a loudspeaker, this receiver is much like other superheterodynes you have already studied. This relay (SRL in Fig. 1) is called the "signal relay." It is normally closed; when a signal of sufficient strength comes through the receiver, the relay opens and starts selector action.

The design of the receiver is straightforward. The i.f. used is 1100 kc. To prevent external 1100-kc. signals from being picked up by the receiver and amplified in the i.f. section, an 1100-kc. wave trap, as you can see from Fig. 1, is included in the antenna circuit.

Let's run briefly through the operation of the receiver. The 500-kc. input signal is fed from the antenna into a mixer stage ($VT_1$). The oscillator section of the same tube produces a local 1600-kc. signal. The difference frequency, 1100 kc., is present in the mixer output. The 1100-kc. frequency is amplified selectively by two i.f. stages ($VT_2$ and $VT_3$). The i.f. transformers are slightly overcoupled to give practically uniform sensitivity over the required 25-kc. band, and strong attenuation outside this band. The potentiometer P controls the sensitivity of the receiver by varying the C bias of the two i.f. tubes, which are of the variable-mu or super-control types.

The detector stage ($VT_4$) operates as a linear detector in the conventional manner. The incoming signal causes a voltage to develop across the condenser C with a polarity that makes the ungrounded end of this condenser negative. C is connected to

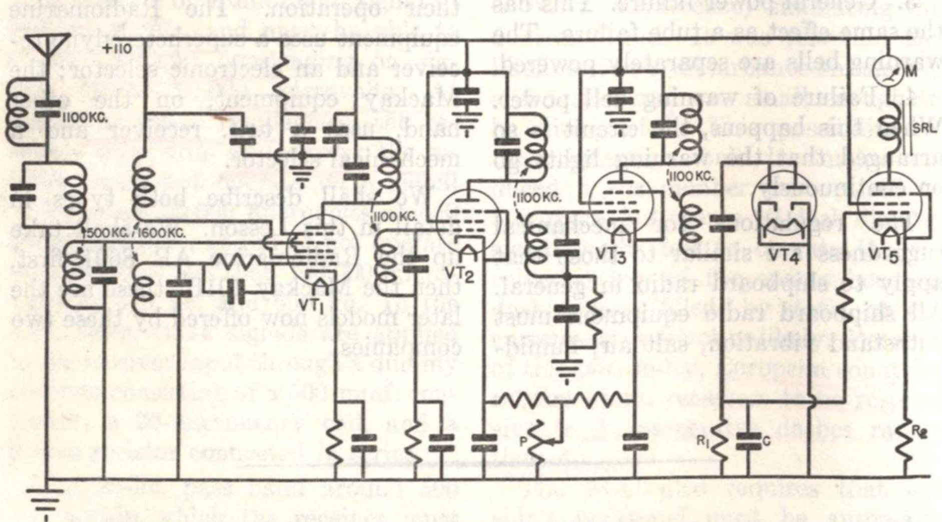


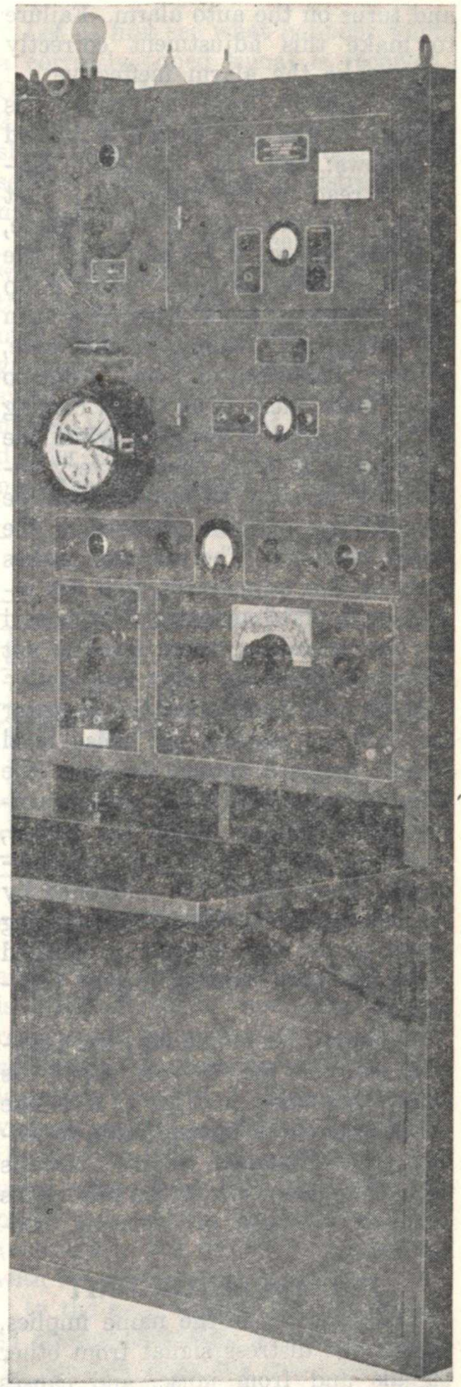

**FIG. 1. Simplified circuit diagram of RMCA auto alarm receiver.**



the grid of $VT_5$ in such a way that the voltage across C tends to drive the grid more negative. The resistor $R_2$ in the cathode circuit of $VT_5$ is of such value that the plate current of this tube is about 7 ma. when the grid is at ground potential. This condition corresponds to the absence of a signal (no voltage across C). This plate current flows through the operating coil of the signal relay SRL and through milliammeter M. The 7-ma. current is sufficient to operate the relay, closing its contacts.

When a signal is received, a voltage develops across C and the grid of $VT_5$ becomes negative by an amount that depends on the signal strength. Consequently, the plate current drops from the "no-signal" value of about 7 ma. If it drops below 3 or 4 ma., depending on the relay adjustment, the relay drops out, opening its contacts. This action starts operation of the selector unit. (Operation of this unit will be described shortly.)

Too strong a signal cannot damage the relay or make it operate improperly, because such a signal will simply bias $VT_5$ beyond cut-off. There is the danger, however, that the prevailing noise level due to static or man-made interference may cause the relay to open intermittently or continuously, thus preventing proper operation in case a distress signal is received. This will happen if the gain control (P) is set too high. The receiver is designed to have a very high gain, so that a weak signal may be picked up *if the noise level permits.* If, however, the gain control were turned on full at all times, the chances are the noise would mask an incoming signal. It is therefore necessary for the operator to adjust the gain control according to the prevailing noise condition whenever he leaves his post



*Courtesy Mackay Radio and Tel. Co.*

**A view of the 101B auto alarm receiver used in the FT-106 Radio Unit.**

and turns on the auto alarm. Failure to make this adjustment correctly may make the alarm ineffective.

The correct gain adjustment is made with the gain control P turned as follows: first, the "no-signal" current is read on the meter (M). Let us say, for the sake of an example, that this current is 7.5 ma. Next, the operator turns the gain control P up until the meter reads 1 ma. less than the "no-signal" value; in this case, 6.5 ma. This drop of 1 ma. is due to noise, since there is no signal coming in (if a signal is received while the adjustment is being made, a very unlikely occurrence, its presence will be revealed by periodic changes in the meter reading). The operator makes sure, by this adjustment, that the reduction in plate current of $VT_5$ caused by the prevailing noise level is not enough to make the relay drop out.

If, at any time after the operator has left his station, the noise level should increase enough to open the relay for more than 3.5 seconds, warning lights will go on on the bridge, where an officer is on duty continuously. These lights are controlled by the selector unit. When the warning lights go on, the operator is notified that the gain control needs readjusting.

Although, for simplicity, the negative side of the 10-volt supply is shown grounded in Fig. 1, it is the usual practice in marine radio to isolate the electrical supply circuits from the framework of the ship. This requires the use of isolating condensers.

## THE SELECTOR UNIT

The selector, as the name implies, selects the distress signal from other signals and from noise, and causes warning bells to ring upon reception of the distress signal, in case of tube burnout, or if there is a general power failure.

The selection is made by *timing* the dashes and spaces that constitute the distress signal. This is done electrically by making use of the fact that it takes a definite time to charge a condenser through a resistor.

As you know, a series combination of a resistor and a condenser has a "time constant," which is the time required to charge the condenser to 63% (approximately) of the applied voltage. This time constant is equal to the product of the resistance and the capacity; when the resistance is expressed in megohms and the capacity in microfarads, the time constant is in seconds.

Fig. 2 is a simplified schematic diagram of the selector unit. Three R-C combinations, each with a different time constant, are used for timing in this unit. These are $R_1$-$C_1$, $R_2$-$C_2$, and $R_3$-$C_3$. Each can be connected by the operation of a relay to the voltage source E, which has a regulated value of about 57 volts.

Now let's see how the selector works. We'll discuss its operation in a general way first, then study the circuit action in detail.

The heart of the selector is the stepping switch SS. This switch contains a ratchet wheel to which a contact arm is fastened. Movement of the wheel moves the contact arm over a series of fixed contacts. As you can see from the diagram in Fig. 2, the switch can have any one of seven positions.

Two coils, NRL and RRL, control the operation of this switch. The passage of current through NRL moves a pawl that advances the ratchet wheel one step, or notch, against the force of a spring. NRL, therefore, is called a notching coil. Coil RRL, when it is actuated, moves another pawl that normally locks the stepping switch ratchet; movement of this pawl allows the spring to restore the ratchet to its initial, or home, position. Coil RRL is therefore called a restoring coil.



A relay coil, marked BRL in Fig. 2, is connected to the fixed contact at position 4 of the stepping switch. Operation of the relay of which the coil is a part rings the warning bell of the auto alarm. Thus, the purpose of the whole selector unit is to advance the stepping switch to its fourth position if the proper signals are received.

Tube $VT_1$ and its associated circuits have the function of advancing the stepping switch one notch each time a dash is received that is longer than 3.5 seconds in duration. Tube $VT_2$ and its circuits restore the stepping switch to its home position if any dash is received that is more than 4.5 seconds long. Tube $VT_3$ and its circuits do the same thing if the space between any two dashes is more than 1.5 seconds long.

Now, let's see how the various circuits of the selector perform their duties.

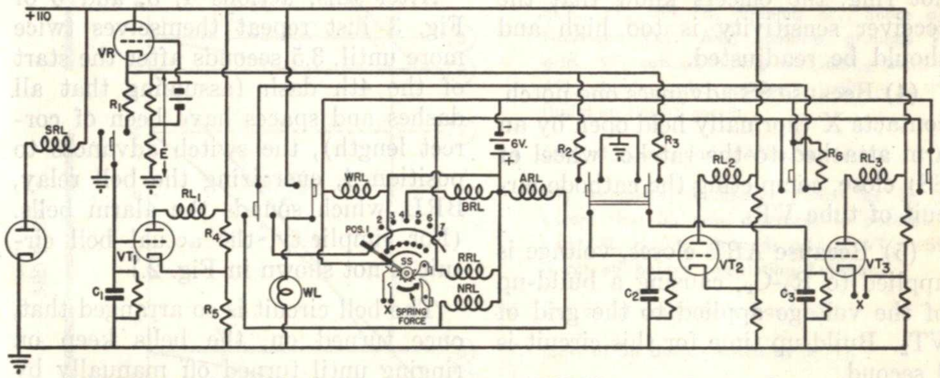



**FIG. 2. Simplified circuit diagram of RMCA auto alarm selector.**

Let us first see what happens when a correctly timed signal is received. Our explanation will be based on Figs. 2 and 3; the latter is a plot that shows how the various tubes in the selector operate when a distress signal is received.

Operation of the selector starts when relay SRL, the output device of the receiver, drops out. In its normal (operated) position, this relay grounds the grid of tube $VT_1$, and, since the cathode of this tube is connected to the midpoint of a voltage divider $R_4$-$R_5$, the grid is then highly negative with respect to the cathode, and $VT_1$ is cut off. When relay SRL is dropped out by operation of the receiver, $R_1$-$C_1$ is connected to E, and condenser $C_1$ starts to charge. This is action 1 in Fig. 3. Eventually the voltage across $C_1$, which is applied to the grid of $VT_1$, will increase to the point where tube $VT_1$ draws enough plate current to close relay $RL_1$ (action 2 in Fig. 3), which is in series with the plate circuit of $VT_1$.

In the case of $VT_1$, $R_1$ and $C_1$ are so chosen that $RL_1$ will close about 3.5 seconds from the time that SRL drops out. This time interval we will call the "build-up" time for the tube and its associated circuit.

Closure of relay $RL_1$ starts a chain of events:

(1) Relays NRL and ARL receive 6 volts (the battery voltage) across their windings, and close.

(2) Because NRL (the notching relay) closes, the wiping contacts of the stepping switch, SS, advance one notch to position 1.

(3) Because SS advances one notch, the coil of relay WRL (called the warning relay) is shorted, and the relay drops out. This causes the warning lights, WL, to light on the ship's bridge. If these lights go on repeatedly, but the alarm bell does not ring, the officers know that the receiver sensitivity is too high and should be readjusted.

(4) Because SS advances one notch, contacts X (normally held open by an arm attached to the ratchet wheel of SS) close, completing the cathode circuit of tube $VT_3$.

(5) Because ARL closes, voltage is applied to $R_2$-$C_2$, causing a build-up of the voltage applied to the grid of $VT_2$. Build-up time for this circuit is 1 second.

(6) Because ARL closes, the grid of $VT_3$ is grounded. Hence, this tube is cut off and unable to draw current, although it has just been inserted into the circuit by closure of contacts X.

The first dash of the distress signal, if correctly timed, will last between 3.5 and 4.5 seconds. Let's assume it has a duration of 4 seconds. When it ends (action 3, Fig. 3), SRL closes again, cutting off tube $VT_1$; in consequence, $RL_1$ opens, causing NRL and ARL to open. Nothing happens to SS, which can only be brought back to its initial position by the restoring coil RRL, but the closing of ARL cuts off tube $VT_2$ before it has had a chance to build up, and starts tube $VT_3$ building up instead. Build-up time for the $VT_3$ circuit is 5 seconds.

After the 1-second space, the second dash starts. The above cycle of events is repeated exactly except for two differences: switch SS is now in position 1 to begin with and at the end of 3.5 seconds goes to position 2 (action 5, Fig. 3); and tube $VT_3$, formerly inactive, is now building up (build-up time 5 seconds) until cut off by the closing of ARL (action 5, Fig. 3). As you can see from Fig. 3, $VT_3$ is cut off before its build-up is completed.

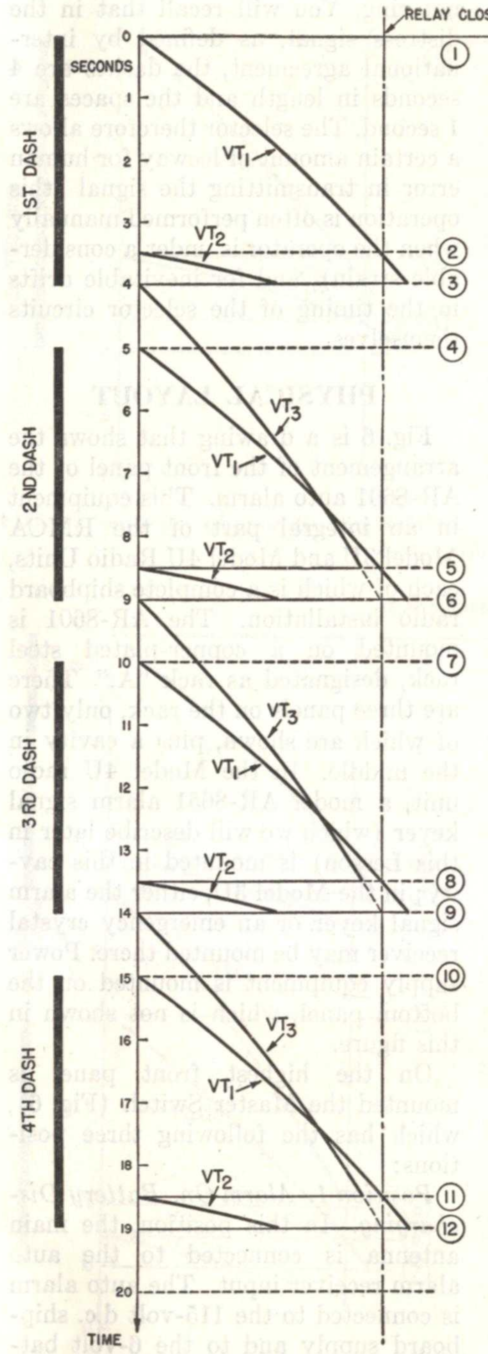
After this, actions 4, 5, and 6 of Fig. 3 just repeat themselves twice more until, 3.5 seconds after the start of the 4th dash (assuming that all dashes and spaces have been of correct length), the switch advances to position 4, energizing the bell relay, BRL, which sounds the alarm bells. (For simplicity, the actual bell circuit is not shown in Fig. 2.)

The bell circuit is so arranged that, once turned on, the bells keep on ringing until turned off manually by a switch placed at the radio operator's station. The same control restores SS to the initial position.

With the help of Figs. 4 and 5, we will now consider what happens if the incoming signal is incorrectly timed. There are four possible cases:

(1) A dash is received that is less than 3.5 seconds in length. In this case, $VT_1$ fails to build up, and SS does not advance. If SS has already advanced because of the reception of one or more correctly timed dashes and spaces, the fact that ARL does not close allows $VT_3$ to complete its build-up. $RL_3$ then operates, applying voltage to RRL, which restores SS to its home position.






1. Start of 1st dash. SRL opens and applies + voltage to grid of $VT_1$ (build-up time 3.5 secs.).

2. $VT_1$ builds up and $RL_1$ closes, applying 6 volts to NRL and ARL. NRL advances SS to position 1, energizing WRL, lighting WY and closing cathode circuit of $VT_3$. ARL, closing, applies + voltage to grid of $VT_2$ (build-up time 1 sec.) and grounds grid of $VT_3$, which is cut off.

3. End of 1st dash. SRL closes, grounding $VT_1$ grid. $VT_1$ cuts off, opening $RL_1$, hence also NRL and ARL. ARL, opening, grounds $VT_2$ grid. $VT_2$ cuts off before completing build-up. ARL, opening, also applies + voltage to $VT_3$ (build-up time 5 secs.).

4. Start of second dash. Action as in (1).

5. $VT_1$ completes build-up. Action as in (2), except that SS now advances to position 2, and ARL, closing, grounds grid of $VT_3$, which is cut off before completing build-up.

6. End of 2d dash. Action as in (3).

7. Start of 3d dash. Action as in (1).

8. Action as in (5). SS advances to position 3.

9. End of 3d dash. Action as in (3).

10. Start of 4th dash. Action as in (1).

11. Action as in (5). SS advances to position 4, completing BRL circuit except for $RL_1$ contacts.

12. End of 4th dash. Action as in (3). $RL_1$, opening, completes BRL circuit. Alarm bells ring until turned off by operator.

**FIG. 3. Sequence of operation in RMCA auto alarm selector when properly tuned distress signal is received.**

(2) A dash is received that is more than 4.5 seconds in length (Figure 4). In this case, $VT_1$ builds up and advances SS one position, but subsequently $VT_2$ also builds up, closing $RL_2$, which applies 6 volts to the restoring coil RRL. Operation of RRL brings SS back to its initial position. This wipes out the effect of any preceding dashes and puts the whole mechanism back where it started. Operation of $RL_2$ also inserts a resistor $R_6$ in the circuit of relays NRL and ARL, thereby decreasing the current through them to a value that will not cause overheating even if the current continues for some time.

(3) A space is completely "filled" by interference. This case is covered by the preceding one: as soon as the signal has continued for more than 4.5 seconds, the mechanism is restored to the original position.

(4) A space is more than 1.5 seconds in length (Fig. 5). If a space lasts just over 1.5 seconds, tube $VT_3$ will have had over 1.5 seconds of build-up time before the start of the subsequent dash. It will be cut off by the closing of ARL, 3.5 seconds *after* the start of this dash but, by this time, its build-up time of 5 seconds will have elapsed. Relay $RL_3$ will close, applying voltage to RRL and restoring SS to its initial position.

We can summarize operation of the auto alarm by saying that any group of 4 successive dashes of the correct frequency and sufficient strength, varying in length between 3.5 and 4.5 seconds, and separated by spaces of any length not exceeding 1.5 seconds, will cause the switch SS to advance to position 4 and set off the alarm bells. If any one of the dashes or intervening spaces does not meet the length requirement, the warning lights will light but the bells will not ring. You will recall that in the distress signal, as defined by international agreement, the dashes are 4 seconds in length and the spaces are 1 second. The selector therefore allows a certain amount of leeway for human error in transmitting the signal (this operation is often performed manually when the operator is under a considerable strain), and for inevitable drifts in the timing of the selector circuits themselves.

## PHYSICAL LAYOUT

Fig. 6 is a drawing that shows the arrangement of the front panel of the AR-8601 auto alarm. This equipment in an integral part of the RMCA Model 3U and Model 4U Radio Units, each of which is a complete shipboard radio installation. The AR-8601 is mounted on a copper-plated steel rack, designated as rack "A." There are three panels on the rack, only two of which are shown, plus a cavity in the middle. In the Model 4U radio unit, a model AR-8651 alarm signal keyer (which we will describe later in this Lesson) is mounted in this cavity; in the Model 3U, either the alarm signal keyer or an emergency crystal receiver may be mounted there. Power supply equipment is mounted on the bottom panel, which is not shown in this figure.

On the highest front panel is mounted the Master Switch (Fig. 6), which has the following three positions:

*Position 1. Alarm On. Battery Discharging.* In this position, the main antenna is connected to the auto alarm receiver input. The auto alarm is connected to the 115-volt d.c. shipboard supply and to the 6-volt batteries. The transmitter key interlock circuit is open, making it impossible to operate the main transmitter: this



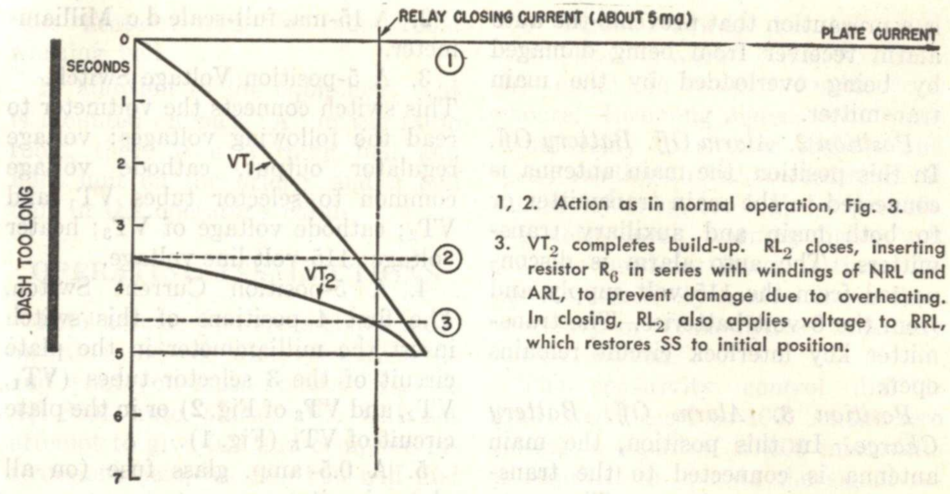



**FIG. 4. Sequence of operation in RMCA auto alarm selector when excessively long dash is received.**

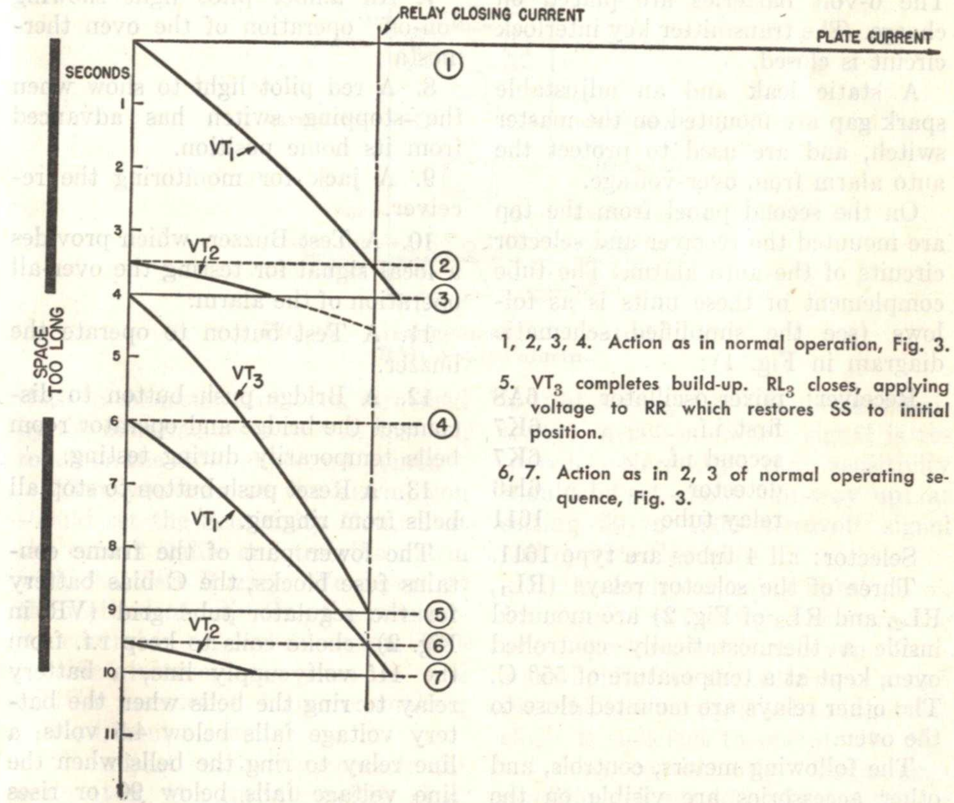



**FIG. 5. Sequence of operation in RMCA auto alarm selector when space between dashes is excessive.**

is a precaution that prevents the auto alarm receiver from being damaged by being overloaded by the main transmitter.

*Position 2. Alarm Off. Battery Off.* In this position, the main antenna is connected to the main transmitter or to both main and auxiliary transmitters. The auto alarm is disconnected from the 115-volt supply and from the 6-volt batteries. The transmitter key interlock circuit remains open.

*Position 3. Alarm Off. Battery Charge.* In this position, the main antenna is connected to the transmitter or transmitters. The auto alarm is disconnected from the 115-volt supply and the 6-volt batteries. The 6-volt batteries are placed on charge. The transmitter key interlock circuit is closed.

A static leak and an adjustable spark gap are mounted on the master switch, and are used to protect the auto alarm from over-voltage.

On the second panel from the top are mounted the receiver and selector circuits of the auto alarm. The tube complement of these units is as follows (see the simplified schematic diagram in Fig. 1):

| | | |
|---|---|---|
| Receiver: | mixer oscillator . . | 6A8 |
| | first i.f. . . . . . . . . | 6K7 |
| | second i.f. . . . . . . | 6K7 |
| | detector . . . . . . . . | 6H6 |
| | relay tube . . . . . . | 1611 |

Selector: all 4 tubes are type 1611.

Three of the selector relays ($RL_1$, $RL_2$, and $RL_3$ of Fig. 2) are mounted inside a thermostatically controlled oven, kept at a temperature of 55° C. The other relays are mounted close to the oven.

The following meters, controls, and other accessories are visible on the front of the middle panel:

1. A 150-volt d.c. Voltmeter.
2. A 15-ma. full-scale d.c. Milliammeter.
3. A 5-position Voltage Switch. This switch connects the voltmeter to read the following voltages: voltage regulator output, cathode voltage common to selector tubes $VT_1$ and $VT_2$; cathode voltage of $VT_3$; heater voltage: 115-volt line voltage.
4. A 5-position Current Switch. The first 4 positions of this switch insert the milliammeter in the plate circuit of the 3 selector tubes ($VT_1$, $VT_2$, and $VT_3$ of Fig. 2) or in the plate circuit of $VT_5$ (Fig. 1).
5. A 0.5 amp. glass fuse (on all plate circuits).
6. The Sensitivity Control (Part P in Fig. 1) for the receiver.
7. An amber pilot light showing "on-off" operation of the oven thermostat.
8. A red pilot light to show when the stopping switch has advanced from its home position.
9. A jack for monitoring the receiver.
10. A Test Buzzer, which provides a local signal for testing the over-all operation of the alarm.
11. A Test button to operate the buzzer.
12. A Bridge push button to disconnect the bridge and operator room bells temporarily during testing.
13. A Reset push button to stop all bells from ringing.

The lower part of the frame contains fuse blocks, the C bias battery for the regulator tube grid (VR in Fig. 2), choke coils to keep r.f. from the 115-volt supply line, a battery relay to ring the bells when the battery voltage falls below 4.5 volts, a line relay to ring the bells when the line voltage falls below 90 or rises above 130 volts; various resistors to supply the correct voltages to the tube heaters; and the radio room warning bell.

In addition to the equipment that is mounted on rack "A" in the radio room, there is a warning bell and light unit on the bridge, and a bell unit in the operator's cabin.

## OPERATING INSTRUCTIONS

Let's assume you are a ship's radio operator and see what you must do and what you must know to use the AR-8601 auto alarm. We will not attempt to give full and complete instructions here, because you will find

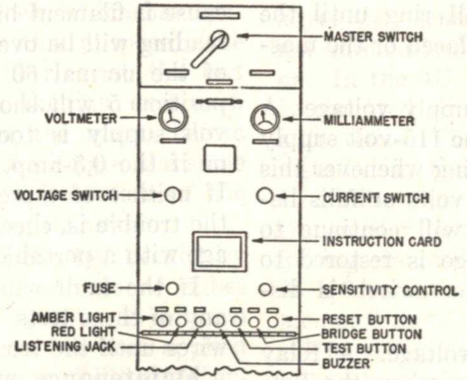



**FIG. 6. Arrangement of controls on RMCA auto alarm.**

these in the instruction book furnished by the manufacturer; we will, instead, touch on the more important points.

When you turn on the alarm, you should set the Sensitivity Control at the correct value and test the alarm with the Test Buzzer. We described the method of adjusting the sensitivity control in an earlier section. The specific instructions given in the RMCA instruction book for making this adjustment are:

"To adjust sensitivity control: Set scale at 0. Set current switch at 4. Meter will read about 9 ma. Turn sensitivity control to right until average meter reading, due to noise, static, etc., is about 1 ma. less than the maximum value. Listen with phones. Incoming signals will cause signal relay to chatter slightly and meter reading to fall toward zero. If sensitivity is set too high for prevailing noise level, warning lights will indicate need for lower setting. Do not set sensitivity control lower than necessary or weak distress calls may not be received."

The sensitivity control dial is graduated from 0 to 100. At the zero setting, a signal of 20,000 microvolts is required to operate the signal relay; at setting 100 (maximum sensitivity), a 200-microvolt signal is required. Normally the sensitivity should be set about half-way up: at setting 50, a 1000-microvolt signal will operate the relay.

If the bridge warning lights go on for a period of 5 minutes or more, the bridge personnel will call you. Constant lighting of these lights is a sign that the sensitivity is set so high that static is sufficient to operate the signal relay continuously. Under such conditions, it would be impossible for the selector to operate if a distress signal came through. You should decrease the sensitivity with the Sensitivity Control.

If the alarm bells ring on the bridge and in your cabin, this may be due either to the reception of a distress signal, or to one of the following causes:

1. False alarm. Static or interference may accidentally reproduce the sequence of dashes necessary to actuate the alarm. This is a rare occurrence.

2. Filament burnout. The operating coil of a relay is part of the filament circuits. If any filament fails or if the circuit is otherwise interrupted, this relay causes the bell circuit to close. The bells will ring until the defective tube is replaced or the master switch is opened.

3. Low or high supply voltage. A relay connected to the 115-volt supply causes the bells to ring whenever this voltage exceeds 130 volts or falls below 90. The bells will continue to ring until the voltage is restored to normal or the master switch is disconnected.

4. Low battery voltage. A relay sets the bells ringing when the battery voltage falls below 4.5 volts. The bells will continue to ring until the battery is replaced or the master switch is disconnected.

5. Blowing of the 0.5-amp. or the 6-amp. fuses. The 0.5-amp. fuses will blow if a short circuit occurs in the 115-volt circuit; the 6-amp. fuses, if one occurs in the 6-volt circuit. In either case, the bells will ring until the fault is corrected or the master switch is opened.

Intermittent ringing of the bells is a sign of fluctuating line voltage. You can check this by turning the Voltage Switch on the alarm panel to position 5; the voltmeter will then show the line voltage. The cause of the voltage fluctuations must be located and removed.

If the bells ring continuously, you should report immediately to the radio room and depress the Reset button. If the ringing is caused by incoming signals having advanced the stepping relay to position 4, it will stop when the Reset button is pressed. You should immediately plug the phones into the monitoring jack and listen for any incoming signal.

If pressing the Reset button does not stop the bells, their ringing must be due to causes 2 to 5, above. By turning the Voltage Switch to position 4, you can determine whether the cause is filament burnout; if it is, the reading will be over 100 volts instead of the normal 60 volts. Turning to position 5 will show you if the 115-volt supply is too high or too low or if the 0.5-amp. fuses have failed. If neither of these tests shows what the trouble is, check the battery voltage with a portable voltmeter.

If the fault cannot be located by any of these tests, disconnect the bell wires until the trouble is corrected.

**Maintenance and Tests.** If the alarm does not operate normally, you should first check the voltage readings. Turning the Voltage Switch on the alarm panel from position 1 to position 5, you should get the following readings:

| | | |
|---|---|---|
| **Pos. 1** | **Volt, reg. tube output** | **57 v.** |
| **Pos. 2** | **Cathode voltage (bias) on tubes $VT_1$, $VT_2$ (Fig. 2)** | **34 v.** |
| **Pos. 3** | **Same on tube $VT_3$** | **34 v.** |
| **Pos. 4** | **Total heater voltage** | **60 v.** |
| **Pos. 5** | **Ship's line voltage** | **113 v. (normal value)** |

If the voltages are normal, next check the tubes. This is done by replacing each tube one at a time with fresh tubes until operation is normal. (We will describe how to test for normal operation in a moment.) The



1611 tubes can also be tested by placing each in turn in the socket of $VT_5$ (Fig. 1). You can then read its plate current on the meter M (Fig. 1) by turning the Current Switch to position 4. The normal value is 9 ma.

To check normal operation of the alarm, the Test Buzzer, already mentioned several times, is used. This buzzer, which is operated by depressing the test button on the panel of the auto alarm, sends a signal through the receiver strong enough to operate the signal relay. If 4 or more 4-second dashes, with 1-second intervals, are put through with the buzzer (time the dashes with the help of the radio room clock, which has special markings for this purpose), the alarm bells should ring at the end of the 4th dash. Make this check each time you turn on the alarm before going off duty. Also, follow the same procedure to check operation of the alarm after making repairs.

Selector circuits can be checked by reading the plate current of tubes $VT_1$, $VT_2$, and $VT_3$ (Fig. 2) in turn after a steady signal has been applied with the Test Buzzer. With the Current Switch in position 1, hold down the Test button; the current (plate current of $VT_1$) should immediately start to rise; then, after 4 or 5 seconds, it should level off at 8 to 10 ma. Make the same test at position 2 of the Current Switch; you will now be reading the plate current of $VT_2$, and should get the same result, except that the current will not start to build up until about 3.5 seconds after the Test button is depressed.

To test operation of $VT_3$, turn the Current Switch to position 3. The milliammeter now indicates the plate current of $VT_3$. Depress the Test button for 4 seconds, then release it. The plate current of $VT_3$ should start to rise when the Test button is released, should reach about 6 ma. after 5 seconds, and should then cut off.

If all the selector tubes check normally, the trouble may be in some of the relay contacts. Consult the RMCA instruction book for instructions on relay maintenance and for more detailed instructions on maintenance and test of the auto alarm.

## ALARM SIGNAL KEYER

In the past, auto alarm signals have been transmitted by an operator who timed the signals with a clock. The latest RMCA radio unit, the model 4U, contains an AR-8651 alarm signal keyer that sends the auto alarm signal automatically when it is switched on. In the 4U radio unit, this keyer is mounted directly under the 8601 auto alarm. The AR-8651 can also be installed in the older 3U radio unit. In addition, it can be used to key any transmitter in which the load on the keying circuit does not exceed 1 amp. at 110 volts d.c., 6 amps. at 115 volts a.c., or 3 amps. at 230 volts a.c.

The schematic diagram of the AR-8651 alarm signal keyer is shown in Fig. 7. It consists, as you can see, of a vibrator unit, powered by the 12-volt emergency battery that supplies 60-cycle a.c. to a synchronous motor. This motor drives a cam that operates a Microswitch. This Microswitch, in turn, controls operation of the keying relay that keys both the emergency transmitter and the main transmitter.

The vibrator unit furnishes approximately 22 volts at 60 cycles to the coil of the synchronous motor. Through a gear system, the motor drives the cam at a speed of 12 r.p.m. (one revolution in 5 seconds). The cam is shaped so that it does not move the operating arm of the Microswitch during four-fifths of a revolu-

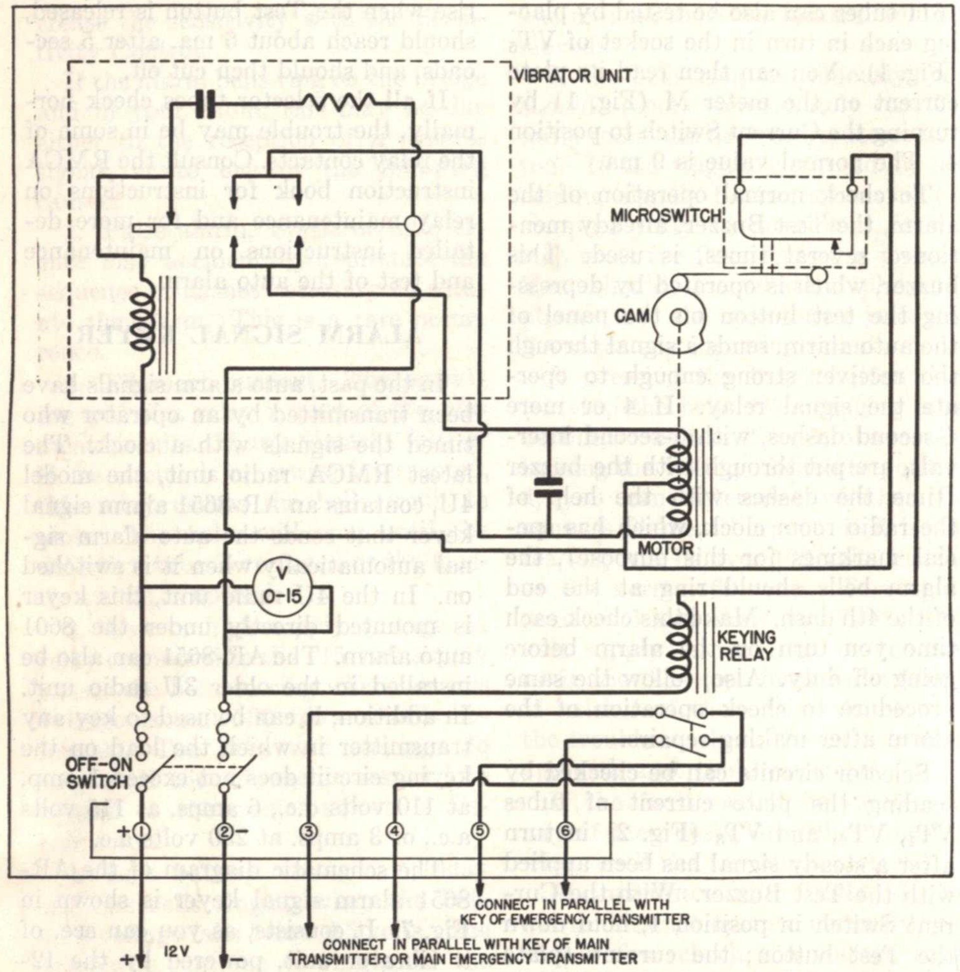



**FIG. 7. Simplified circuit diagram of RMCA AR-8651 auto alarm keyer.**

tion (4 seconds); during the other fifth of a revolution (one second), it lifts the operating arm and thus opens the contacts of the Microswitch. These are the nominal times of operation, which are adhered to rather closely in actual practice. The FCC regulations for automatic signal keyers require the dashes to have a duration of between 3.8 and 4.3 seconds, and the spaces between the dashes to have a duration between 0.8 and 1.2 seconds.

The timing of the device is relatively independent of the supply voltage; the keyer will operate satisfactorily at any voltage between 10 and 14.5 volts. These voltage limits are indicated by red marks on a battery voltmeter included with the AR-8651.

The alarm signal should be transmitted for a period of at least 60 seconds before distress messages are sent. If necessary, the signal may be transmitted for longer periods.

**Testing.** The alarm signal keyer should be tested each day. Be sure the transmitter is shut down during



tests. To test the keyer in the 4U radio unit, switch the 12-volt emergency battery to Discharge. This connects the battery to the keyer. Next, place the alarm signal keyer switch in the On position, and let the keyer run for about 90 seconds. While the keyer is on, look through the plastic window and panel and make sure that the keying relay is operating. Make sure, also, that the battery voltmeter reads between the red marks on the scale. If operation is satisfactory, shut the keyer off.

To operate the keyer in actual service, follow the same procedure, but make sure the transmitter is turned on. In this case, you can check operation of the keyer by watching the antenna meter; it should indicate that the carrier is being keyed. The keyer must be switched off before the distress message itself is sent. If the keyer does not operate properly, switch it off and send the distress auto alarm signal manually.

**Maintenance.** If the keyer does not operate properly during the test period, check the fuses inside the unit. If the vibrator is working properly, it should create a noticeable hum.

The contacts of the keying relay are made of silver, and therefore will seldom require cleaning. If they must be cleaned, never use sandpaper or steel files to do so; clean them with alcohol or carbon tetrachloride, or, if necessary, burnish them with a relay contact burnisher or a strip of clean steel.

No elements of the keyer require oiling or greasing.

Once every three months or so as a matter of routine, and at any time that faulty operation is suspected, check the timing of the keyer. The keyer is timed by counting the number of times it operates in 120 seconds. The best indication of operation of the keyer is the rather loud thump the keying relay makes each time it closes. Familiarize yourself with this sound; learn to distinguish between it and the much quieter click that is heard when the relay opens.

To time the keyer, first turn it on and make sure that the battery supply voltage is exactly 12 volts. Watch the radio room clock and listen to the keying relay. When you hear a thump from the relay, make a note of the time; then count 24 more thumps. Make a note also of the time when the 24th thump is heard. This time should be 120 seconds, plus or minus 2 seconds.

If the timing is not correct, and a spare vibrator is available, install it in place of the vibrator in the equipment. Repeat the test. If replacing the vibrator does not give correct timing, the keyer should be returned to a Radiomarine service station for repair.

The cam and Microswitch are carefully adjusted and locked at the factory. The adjustment should not be tampered with.

# The Mackay Auto Alarm Type 101B

The Mackay Radio and Telegraph Co. Auto Alarm type 101B, which is part of the Marine Radio Units FT-105 and FT-106, is manufactured by the Federal Telephone and Radio Corp. of Newark, N. J. Like the RMCA auto alarm, it consists of a receiver, a selector, and auxiliary equipment. Both the receiver and the selector differ very considerably from those used in the RMCA alarm, however.

A simplified wiring diagram of the Mackay receiver is shown in Fig. 8. This receiver differs radically from that used in the RMCA equipment, since it is a tuned radio frequency receiver instead of a superheterodyne.

The antenna is transformer-coupled to the r.f. amplifier stage through a 500-kc. air-core r.f. transformer, tuned to 500 kc. on both sides, but over-coupled so as to admit the band between 487.5 and 512.5 kc. with substantially uniform gain.

The screen of $VT_1$, the r.f. amplifier tube, is connected to the moving contact of a potentiometer P, which acts as a volume control, since the gain of a pentode increases sharply with the screen voltage. This is the sensitivity control of the alarm.

Another air-core r.f. transformer with characteristics similar to those of the antenna-coupling transformer couples the r.f. amplifier tube to $VT_2$, which is a multiple tube, including a diode detector and a triode section. The detector section operates in the conventional manner, delivering to the grid of the triode section the audio component resulting from the rectification of the modulated r.f. carrier.

This audio component is subsequently amplified by two stages of audio amplification, $VT_3$ and $VT_4$. These stages are coupled together and to the adjacent stages by three iron-cored audio transformers. These transformers are designed to pass a wide band of audio frequencies. Condensers $C_1$, $C_2$, and $C_3$, across the output terminals of the transformers, are designed to enhance the response at the higher end of the band by forming a broadly resonant circuit with the leakage reactance of the transformers. Essentially the same function is performed by series circuit $L_1$-$R_1$-$C_4$ from the plate of $VT_3$ to ground. The third audio transformer has an additional winding connecting to a jack which enables the operator to listen to the audio signal during tests.

The final stage $VT_5$ is a pentode operating on the principle of plate rectification. The signal is fed to the grid and screen, which are tied together. Only a very small plate current flows when no signal is present. When a signal is applied to the tube, only its positive half-cycle is passed, the tube being cut off during the negative half-cycle; even so, the average plate current when a signal is applied is considerably greater than the no-signal current. This rise in average plate current, which may be read on the meter M, actuates the signal relay B. A condenser $C_5$ serves to bypass the alternating components of the plate current. Thus, only d.c. flows through the relay, which prevents relay chatter.

Notice that the suppressor grid of $VT_5$ is tied to the plate. This is done to increase the plate current. It is unnecessary to follow the usual practice of tying the suppressor to the cathode to prevent secondary emission, because no positive d.c. voltage is applied to the screen in this circuit; the screen therefore never becomes more positive than the plate, so secondary emission does not occur.

The operation of this rectifier stage is the reverse of that described earlier for the final stage of the RMCA auto alarm receiver. In that receiver, the presence of a signal reduced the plate current of the final stage, causing the signal relay to drop out. In the Mackay auto alarm receiver, the current in the final stage increases upon reception of the signal. The signal relay of this receiver is therefore normally *open*, and *closes* when a signal is received.

Remember that the schematic of Fig. 8, for simplicity's sake, differs somewhat from the actual circuit. The chief difference is that the cathodes are shown grounded. Actually, they go to the negative side of the 110-volt supply, which is not grounded but by-passed to ground through a number of high-capacity condensers. This practice, common in marine radio, reduces the danger of short-circuits. Also, the filament circuit is not shown, and a number of relays and other auxiliary apparatus mounted on the receiver chassis are omitted. This apparatus includes:

1. A test buzzer with a "buzzer antenna." This buzzer produces a signal (due to its sparking contacts) that is fed into the receiver for tests through a short wire close to the input terminals. Although this arrangement provides only a very slight amount of coupling, and only a small part of the buzzer output is of the right frequency to be passed by the receiver r.f. circuits, there is more than enough signal to operate the signal relay.

2. A switch to disconnect the alarm bells to keep them from ringing while the circuits are being tested.

3. A relay operating coil in series with the heater circuit. The circuit is so arranged that failure of any heater will cause a decrease in the current through the relay coil: the relay will operate when the current drops below a certain value, closing the alarm bell circuit.

### SELECTOR UNIT

The schematic diagram of the selector unit is shown in Fig. 9. The actual connections are shown except for some

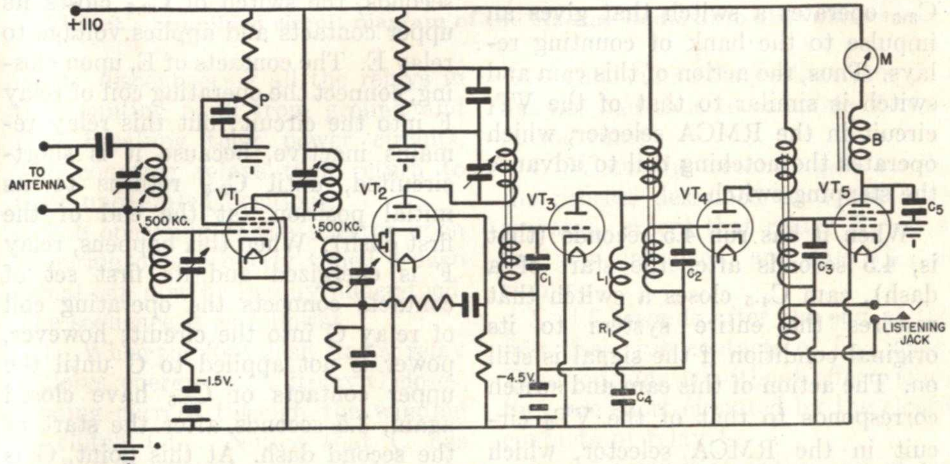



**FIG. 8. Simplified circuit diagram of the Mackay Radio auto alarm receiver.**

manual switches, omitted for simplicity.

Like its RMCA counterpart, this selector has three timing elements. However, in this circuit, the timing elements are motor-driven cams instead of tube circuits. Another fundamental difference is that the stepping switch of the RMCA selector is replaced here by a bank of counting relays.

The operation of the timing cams themselves (they are labelled $C_{1\cdot5}$, $C_{3\cdot5}$, $C_{4\cdot5}$ in Fig. 9, the subscript number giving the durations of their respective runs) is quite simple. Two of them, $C_{3\cdot5}$ and $C_{4\cdot5}$, are set in motion, at constant, uniform speed, by a clutch $CL_1$, which when electrically energized connects both cams to a shaft that revolves continuously at 6 r.p.m. This clutch is energized when relay B, the signal relay of the receiver, operates. Hence, at the start of each dash, cams $C_{3\cdot5}$ and $C_{4\cdot5}$ begin revolving at 6 r.p.m. They always start from the same position, to which they are restored by a spring as soon as the clutch is released. When it has run for 3.5 seconds (that is, 3.5 seconds after the start of a dash), cam $C_{3\cdot5}$ operates a switch that gives an impulse to the bank of counting relays. Thus, the action of this cam and switch is similar to that of the $VT_1$ circuit in the RMCA selector, which operates the notching coil to advance the stepping switch.

When it has run 4.5 seconds (that is, 4.5 seconds after the start of a dash), cam $C_{4\cdot5}$ closes a switch that restores the entire system to its original condition if the signal is still on. The action of this cam and switch corresponds to that of the $VT_2$ circuit in the RMCA selector, which operates the restoring coil of the stepping switch in that unit if the dash received is too long.

The third cam, $C_{1\cdot5}$, starts turning when clutch $CL_2$ is engaged, which happens at the start of a space. This cam runs 1.5 seconds, then opens a switch that restores the system to normal if the signal is absent. The action of this cam and switch corresponds to that of the $VT_3$ circuit in the RMCA selector, which operates the restoring coil of the stepping switch in that unit if the space between dashes is too long.

Thus, the cams and switches of the Mackay selector have functions that correspond to those of the electronic timing circuits in the RMCA selector, although, of course, these functions are performed in different ways.

Before going over the operation of the circuit as a whole when a series of dashes is received, let us see how the bank of the counting relays (E, F, G, H, J, K, L, M, of Fig. 9) works.

These relays count the number of runs completed by the cam $C_{3\cdot5}$. Suppose the system is in its normal condition and a signal causes $CL_1$ to engage and $C_{3\cdot5}$ to advance. After 3.5 seconds, the switch of $C_{3\cdot5}$ closes its upper contacts and applies voltage to relay E. The contacts of E, upon closing, connect the operating coil of relay F into the circuit; but this relay remains inactive, because it is short-circuited, until $C_{3\cdot5}$ returns to its initial position (at the end of the first dash). When this happens, relay F is energized and its first set of contacts connects the operating coil of relay G into the circuit; however, power is not applied to G until the upper contacts of $C_{3\cdot5}$ have closed again, 3.5 seconds after the start of the second dash. At this point, G is energized and performs a function



similar to that of relay E, connecting relay H into the circuit; then, at the end of the second dash, the short circuit across H is removed and H closes, connecting J; 3.5 seconds after the start of the third dash, J is energized and connects K; at the end of the third dash, K is energized and connects L; 3.5 seconds after the start of the fourth dash, L is energized and connects M. Finally, at the end of the fourth dash, M is energized; one of its sets of contacts closes, applying power to the alarm bells; the other

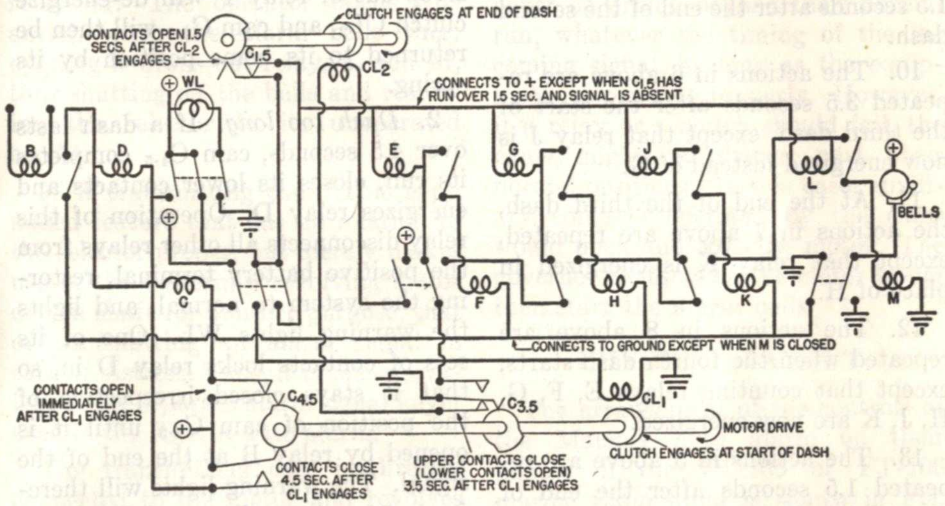



**FIG. 9. Simplified circuit diagram of the Mackay Radio auto alarm selector.**

opens, disconnecting all the relays in the counting bank from ground and thus breaking their power circuits. The counting relays then return to their unoperated positions.

The operating of the selector upon reception of a properly timed 4-dash signal can now be readily understood. The sequence is as follows:

1. When the first dash starts, relay B closes, energizing C. Relay C closes, sending current through the winding of clutch $CL_1$. Notice that C has "locking" contacts so that, once closed, it will not reopen, whatever the position of $C_{4\cdot5}$, until B opens. Cams $C_{3\cdot5}$ and $C_{4\cdot5}$ start moving.

2. 3.5 seconds after the start of the first dash, cam $C_{3\cdot5}$ completes its run, closing the upper contacts of its switch and initiating the count (see above). Relay E closes.

3. When the first dash ends, relay B opens, and so does C; $CL_1$ is released, and cams $C_{3\cdot5}$ and $C_{4\cdot5}$ are returned to their home positions by a spring. The lower contacts of $C_{3\cdot5}$ close; relay F is energized; clutch $CL_2$ is engaged; and cam $C_{1\cdot5}$ starts on its 1.5-second run. (Notice that cam $C_{4\cdot5}$ has not had time to complete its 4.5-second run.)

4. When the second dash starts, the process described in 1 above is repeated, except that relays E and F are now energized, and cam $C_{1\cdot5}$ is running.

5. 1.5 seconds after the end of the first dash, the contacts of $C_{1\cdot5}$ open. Their opening is without effect, since they are short-circuited by the closed contacts of relay C.

6. 3.5 seconds after the start of the second dash, the upper contacts of

$C_{3\cdot5}$ close, energizing G. The lower contacts open, releasing $CL_2$. Cam $C_{1\cdot5}$ is returned to its home position, closing its contacts; again, this has no effect.

7. At the end of the second dash, the actions described in 3 above are repeated, except that relay H is now energized instead of F.

8. When the third dash starts, the actions described in 4 above are repeated, except that counting relays E, F, G, H are now energized.

9. The action in 5 above is repeated 1.5 seconds after the end of the second dash.

10. The actions in 6 above are repeated 3.5 seconds after the start of the third dash, except that relay J is now energized instead of G.

11. At the end of the third dash, the actions in 7 above are repeated, except that relay K is energized in place of H.

12. The actions in 8 above are repeated when the fourth dash starts, except that counting relays E, F, G, H, J, K are now energized.

13. The actions in 5 above are repeated 1.5 seconds after the end of the third dash.

14. The actions in 10 above are repeated 3.5 seconds after the fourth dash starts, except that relay L is now energized.

15. At the end of the fourth dash, the actions described in 11 above are repeated, except that relay M is now energized. Operation of M starts the alarm bells and breaks the ground connection of all relays, except L and M. These last two relays can be disconnected only by a manual switch (not shown on the diagram).

Now, let us see what happens when an improperly timed signal is received.

1. *Dash too short.* If a dash lasts less than 3.5 seconds, cam $C_{3\cdot5}$ will not complete its run before B and C open, and the dash will fail to register. If this occurs on the first dash, nothing else happens except that cam $C_{3\cdot5}$ is returned to its home position by its spring. If one or more dashes have already been recorded, the contacts of cam $C_{1\cdot5}$ will be open when C opens at the end of the dash; all relays in the counting bank will then be dropped out, erasing the effect of all dashes previously received. Drop-out of relay F will de-energize clutch $CL_2$, and cam $C_{1\cdot5}$ will then be returned to its home position by its spring.

2. *Dash too long.* If a dash lasts over 4.5 seconds, cam $C_{4\cdot5}$ completes its run, closes its lower contacts and energizes relay D. Operation of this relay disconnects all other relays from the positive battery terminal, restoring the system to normal, and lights the warning lights WL. One of its sets of contacts locks relay D in, so that it stays closed irrespective of the position of cam $C_{4\cdot5}$ until it is opened by relay B at the end of the signal. The warning lights will therefore stay on as long as the signal does. They do not light, however, for signals of less than 4.5 seconds duration (in this respect, the Mackay selector differs from the RMCA unit).

3. *Space too long.* If a space lasts over 1.5 seconds, cam $C_{1\cdot5}$ completes its run while no signal is on. When this happens, the connection from all counting relays to the positive side of the power supply is broken and the system is restored to normal.

The Mackay selector is capable of functioning through interference provided it does not effectively lengthen a dash beyond the 4.5 second limit. This can happen only if the static



lasts for half a second or longer and occurs immediately after or immediately before a dash. A short burst occurring during the space between dashes will operate relays B and C momentarily, but this will have no effect on the counting relays.

**Other Components.** There are several other components of the selector that are not shown in the simplified schematic. They are:

1. A manual "reset" switch, whose purpose has already been discussed. It is placed in the ground return of relay M. The operator opens this switch when the alarm bells ring; opening it drops out relays L and M, thus shutting off the bells and restoring the selector to its unoperated condition.

2. A transmitting cam. This is an added feature that has no relation to the selector proper, but merely makes use of the uniformly revolving motor driven shaft for another purpose, that of transmitting an alarm signal in case of distress. Thus, it is the equivalent of the separate alarm signal keyer used in the RMCA auto alarm.

The transmitting cam is directly connected to the motor and revolves whenever the motor is turned on. It operates a set of contacts in the prescribed sequence (4 seconds closed, 1 second open); leads connected to these contacts are brought out to separate terminals, which may be connected to a keying relay in the transmitter. (The keying relay is not a part of the selector unit.)

3. The "transmit" switch. This is a double-pole, double-throw switch used to operate the transmitting cam. In the "on" position, it connects the motor to the positive terminal of the batteries directly and completes the circuit leading from the transmitting cam contacts to the outside terminals; in the "off" position, it leaves the above circuit disconnected and puts the motor on the antenna switch, which in turn connects it to the positive of the batteries when the alarm is on.

4. A motor governor. A governor mounted on the motor shaft closes a set of contacts when the motor speed is too low. These contacts turn on the alarm bells.

5. Overrun contacts. The circuit is so arranged that the cams should never be driven beyond their normal run, whatever the timing of the incoming signal, as long as the equipment is operating properly. However, if a relay or a clutch should fail, the cams might be driven past their normal positions. In this case, auxiliary contacts operated by the cams would open and stop the motor. The governor contacts on the motor would then start the alarm bells.

## PHYSICAL LAYOUT

The arrangement of the controls of the Mackay auto alarm on their panels in the FT-105 or FT-106 marine radio units is shown in Fig. 10. The various buttons, switches, and meters shown have the same functions as the corresponding devices in the RMCA auto alarm. The Transmit Switch on the panel of the selector is the only feature of the Mackay unit not found in the RMCA equipment; closing this switch, as you just learned, starts the transmitting cam.

The Antenna Transfer Switch (upper left of diagram) is used to connect the auto alarm to the ship's antenna and, at the same time, to connect an auxiliary antenna to the ship's receiver. Throwing this switch to the auto alarm position (which is marked

AA on the equipment) also turns on the auto alarm equipment.

The horizontal row of switches and lights in the center of Fig. 10 is made up of the following components (from left to right):

1. A toggle switch labelled Charger Control Circuit. This switch controls operation of the battery charger used to charge all the storage batteries in the radio equipment power supply.

2. A red pilot light labelled Auto Alarm. This light is in parallel with the warning light on the bridge.

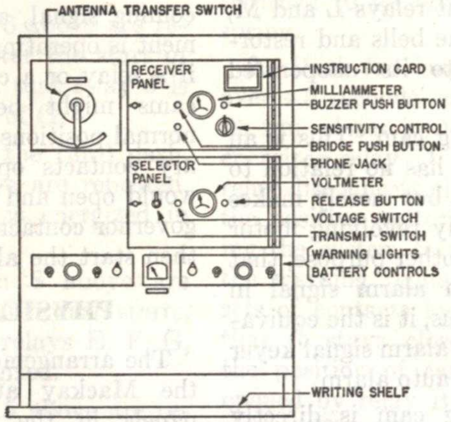



**FIG. 10. Arrangement of controls of Mackay Radio auto alarm.**

3. A toggle switch labelled Receiver Charger. This switch controls the charging circuit connected to the two storage batteries in the power supply of the ship's receiver.

4. A selector switch labelled Receiver Batteries. This switch has three positions: thrown to the left, it connects battery No. 1 of the ship's receiver power supply to the charging circuit, and battery No. 2 to the receiver; thrown to the right, it connects battery No. 1 to the receiver, and No. 2 to the charging circuit; in the center Off position it disconnects both batteries from both circuits.

5. A d.c. voltmeter marked Line Voltage. This instrument continuously indicates the voltage supplied by the ship's 115-volt line.

6. A selector switch labelled Auto Alarm Batteries. This switch is similar to the Receiver Batteries switch, except that it connects either of the two auto alarm batteries to the auto alarm receiver or to their charging circuit.

7. A toggle switch labelled Auto Alarm Charger. This switch controls the charging circuit for the auto alarm storage batteries. It must be thrown to its On position before either of the alarm batteries can be charged. Which battery is charged depends on the position to which the Auto Alarm Batteries switch is thrown.

8. A pilot light labelled Auto Alarm Power. This lights when the auto alarm power supply is turned on.

9. A toggle switch marked Auto Alarm Power Supply. This switch controls operation of the circuit that supplies power to the auto alarm from the ship's line. Normally, this supply is used to furnish the power for the auto alarm. There is also an emergency 90-volt dry-battery supply that is automatically switched in if the line voltage drops below about 70 volts; when this emergency supply is on, the bridge warning light and the Auto Alarm warning light (2, above) go on. This last feature is included so that the dry batteries will not be drained without the operator's being aware that they were used.

## OPERATION

To place the auto alarm equipment on watch, first throw the Auto Alarm Batteries switch to the side that will connect the fully charged battery to the alarm receiver and the discharged battery to the charging circuit. (This battery supply is so designed that one battery will operate the alarm for one watch of 16 hours. Therefore, a battery that is used for one watch should be charged during the next one.) Throw the Charger Control Circuit switch, the Auto Alarm Charger switch, and the Auto Alarm Power Supply switch to their On positions.

Next, throw the Antenna Switch to its AA position. The auto alarm is now in operation and is connected to the ship's main antenna.

Wait about 30 seconds for the tubes to warm up, then set the sensitivity control to about 6 and test the auto alarm by depressing the Test Buzzer button on the front panel to simulate the dashes of an alarm signal. Hold down the "Bridge Bell Off" push button while you send the signal, so the bridge bell will not ring when the alarm operates. (This test should be made once every 24 hours with the bridge bell in the circuit.) The alarm should operate, ringing the radio room bell, after you have sent four dashes with the test buzzer. More than four dashes may be necessary, however, if there is considerable interference.

If the alarm works properly, adjust the sensitivity control to the highest sensitivity usable for the local conditions. This is done in the same manner as for the RMCA alarm. Notify the Officer on watch on the bridge that the alarm has been tested, and make the proper entries in the radio room log.

To take the auto alarm off watch, turn the Antenna Switch to the radio operating position. This stops the auto alarm equipment. Throw the Receiver Power Supply unit switch to its Off position.

If the alarm bells ring when the auto alarm is on watch, go at once to the radio room and depress the Release button. If the bells do not stop, there is something wrong with the equipment; the driving motor of the timing cams may have stopped, for example. If the bells do stop, an alarm signal has been received. Take the alarm off watch at once and start a manual watch on the distress band.

**Maintenance and Tests.** Since the Mackay auto alarm is mechanically more complex than the RMCA unit, more detailed maintenance procedures are necessary for it. You will find complete maintenance and test instructions in the instruction book supplied with the Mackay alarm.

# FCC Auto Alarm Regulations

We mentioned the more important FCC regulations concerning auto alarms near the beginning of this Lesson. So you will know exactly what the FCC requires for this equipment, we will now give you the complete text of the auto alarm regulations:

8.161 Approval by Commission. An automatic alarm receiver approved by the Commission as complying with all provisions of its "Auto-Alarm Requirements and Type Tests" promulgated under date of October 1, 1935, is approved in accordance with section 3 (x) of the Communications Act, and when so approved shall be considered as complying with all relevant provisions of the International General Radio Regulations.

8.162 Type approval. Approval of an automatic alarm receiver under the provisions of section 8.161 is extended to all automatic alarm receivers of the same identical type, design, and construction, manufactured by the same person.

8.163 Auto-alarm installation. A vessel shall be considered as fitted with an auto-alarm in accordance with the requirements of title III, part II of the Communications Act and the radio provisions of the Safety Convention when the auto-alarm installation on board such vessel complies with the following conditions:

(a) The auto-alarm shall be located in the main radiotelegraph operating room and shall be installed in accordance with the Standards of Good Engineering Practice for Ship Stations promulgated by the Commission.

(b) Approved apparatus shall be provided for giving an audible warning in the main radiotelegraph operating room, in the radio operator's cabin, and on the navigating bridge. This apparatus shall operate continuously after the auto-alarm has been actuated by an alarm signal or by failure of the auto-alarm system, until manually stopped. Only one switch for stopping the audible warning apparatus from functioning is authorized and this shall be located in the main radiotelegraph operating room and shall be capable of manual operation only.

(c) Failure of the auto-alarm to function normally because of prolonged atmospherics (static) or other prolonged interference, or both, shall operate a visual indicator on the bridge. The type and method of installation of such visual indicator shall comply with requirements of the Bureau of Marine Inspection and Navigation of the United States Department of Commerce.

(d) There shall be furnished at least two sets of written instructions for the guidance of the ship station radio operator and ship's officers relative to the auto-alarm, which shall include:

(1) A general technical description of the auto-alarm, including a circuit diagram of the auto-alarm receiver and a wiring diagram of its complete installation on shipboard.

(2) A general explanation of its principles of operation.

(3) A list of faults which may be indicated by the sounding of the audible alarm.

(4) Explanation of how to correct faults, remove and replace defective parts, and perform limited repairs at sea.



(5) Explanation of how to test the alarm and adjust the sensitivity control to the "optimum" setting, which shall be summarized upon a card and permanently attached to the front of the alarm in a conspicuous position.

(6) Explanation of the effect of various sensitivity control settings upon the operation of the alarm, which shall be summarized upon a card and permanently attached to the front of the alarm in a conspicuous position.

(7) Description of procedure to be followed with respect to operator making adjustments when alarm bell sounds and also in making log entries.

(e) The testing device of the auto-alarm shall be adjusted to produce a test signal of the correct value. This adjustment shall be considered satisfactory when it becomes necessary to turn the sensitivity control from its position of the lowest sensitivity (zero dial position) to its position of approximately one-third maximum sensitivity before the alarm can be actuated.

8.164 Serial number. Each auto-alarm of a type approved by the Commission, when first installed on board a vessel of the United States, must bear an identifying serial number. Two or more principal components of one complete installation shall bear the same number. After the initial installation, if any principal component is entirely replaced, the substitute unit shall bear the serial number of the initial unit but must be identified in addition as a replacement. For this purpose the principal components of the following types of approved auto-alarms are designated as follows:

(a) Radiomarine Corporation of America Models AR-8600 and AR-8600-X auto-alarms. One combined receiver and selector unit, without regard to container; one control and terminal box.

(b) Radiomarine Corporation of America Model AR-8601 auto-alarm. One combined receiver and selector unit, without regard to container; one control and terminal unit.

(c) Mackay Radio and Telegraph Co. auto-alarm, Type 101-A and 101-B manufactured by Federal Telegraph Co. One selector unit without regard to container; one receiver unit, without regard to container.

8.165 Notification of installation. The Commission shall be informed in writing on the prescribed form immediately upon completion of each auto-alarm installation on board any vessel of the United States. Each report shall specify the type and serial number of the alarm, the name of the vessel, the date of completion of installation, the call letters and names of licensee of the ship radio station and the name of the owner and operating company of the vessel.

8.166 Daily tests. While the ship is being navigated outside a harbor or port, the auto-alarm shall be tested at least once every 24 hours by means of the testing device supplied as part of the alarm, the timing of the dashes to be made by reference to the second hand of the ship station clock. A test also shall be made to determine that the auto-alarm mechanism is operated in a normal manner by signals from other stations which are received on the frequency 500 kilocycles. A statement that the foregoing requirement has been fulfilled must be inserted in the radio station log daily.

8.167 Reports. Adequate records shall be maintained according to the prescribed forms covering operation of the auto-alarm. These forms shall be mailed to the Commission at

Washington, D. C., as soon as possible after the first day of each month, covering the month preceding.

8.168 Failure of power. An auto-alarm installed on board a cargo vessel of the United States for the purpose of compliance with title III, part II, of the Communications Act which is dependent for effective operation upon a power supply having a voltage within definite upper and lower limits shall be fitted with an auxiliary device which will energize the audible alarms if and when this power supply fails or its voltage exceeds the limits specified in Standards of Good Engineering Practice for Ship Stations for the particular type of alarm involved; or will automatically connect the auto-alarm to an auxiliary power supply, the voltage of which is within the specified limits.



# Lesson Questions

**Be sure to number your Answer Sheet 53RC.**

**Place your Student Number on *every* Answer Sheet.**

**Most students want to know their grade as soon as possible, so they mail their set of answers immediately. Others, knowing they will finish the next Lesson within a few days, send in two sets of answers at a time. Either practice is acceptable to us. However, don't hold your answers too long; you may lose them. Don't hold answers to send in more than two sets at a time or you may run out of Lessons before new ones can reach you.**

1. Upon what band of radio frequencies must an approved auto alarm receiver function?
2. What interval of time must elapse between the end of the auto alarm signal and an urgent cyclone warning?
3. Describe the international auto alarm signal.
4. What is the most probable cause of intermittent ringing of the bells in the RMCA auto alarm?
5. What factor or factors determine the setting of the sensitivity control of an auto alarm receiver approved for installation on a vessel of the United States?
6. What means are usually provided to prevent the operation of the ship's transmitter when the auto alarm receiver is in use?
7. Why does not a Mackay auto alarm respond to type A-1 emission?
8. When the auto alarm bell rings, what should the operator do?
9. If an auto alarm bell rings, and does not stop when the release button is depressed, any of 8 defects may exist. List them.
10. While a vessel is at sea, how frequently must the auto alarm be tested?

## YOU ARE HEADING TOWARD SUCCESS

**You have every reason to expect real success in your Radio and Television career. I base this statement on the following facts:**

**. . . you like Radio and TV and have much natural ability in this science.**

**. . . you are willing to work to increase your knowledge of Radio and TV, as proved by the progress you have made with your NRI course.**

**The above qualifications make for success, in the opinion of most experts. As Mark Sullivan once put it: "To find a career to which you are adapted by nature, and then to work hard at it, is about as near a formula for success and happiness as the world provides."**

**J. E. SMITH**