Coastal Telephone Transmitter unit

type A 218V

Frequency range:

11 crystal controlled frequencies in the 1600-5500 kc/s band. Crystals being supplied according to customer's specifications.

Output power:

100 watts carrier wave measured in an artificial aerial of 15 ohms resistance and a capacity of 250 pF.

Switch for reducing power to about 10 watts.

Modulation:

Modulation up to 95% when transmitting A3. (peak limiter).

Frequency tolerance:

The frequency tolerance is better than 0,02% thus fulfilling the A.C. Conference requirements.

Harmonics:

All harmonics radiated from the aerial will be attenuated at least 40 dbs in relation to the fundamental.

Aerial:

A very elaborate aerial matching network render correct loading of the R.F. power stage and correct tuning of the aerial circuit possible with any aerial more than 15 meters long (total length including down lead). Such matching takes place merely by turning knobs on the front of the transmitter - no internal adjustments or soldering during installation is needed.

Space for putting down figures, indicating the setting of the aerial tuning knobs and dial, is provided for each individual frequency.

Measuring instruments:

The transmitter is provided with a milliammeter and a switch by means of which the cathode current of each individual tube may be checked.

Likewise the grid current of the R.F. power tubes may be checked.

A thermocouple ammeter in the aerial circuit measures the aerial current.

Tubes:

12 tubes type 807 (or equivalent: Philips QE 06/50) are employed.
2 tubes type EF 41
1 tubes type EZ 40

A 218 V - Operation.

Set transmitter selector switch in switching panel to "coastal", set power switch to "1/1", set frequency switch in transmitter to the frequency in question, set "coupling" to "1", "aerial coarse" to "1". Turn operating switch in switching panel to "stand by". After 15 seconds turn lever to A1 and press key (or to A3 simplex and press push button of handset). Rotate tuning knob "aerial fine" and note aerial ammeter (below knob). Tune for maximum aerial current. Note cathode current of tubes nos. 5a, 5b, 5c and 5d. The cathode current should increase and decrease simultaneously with the aerial current and assume a value of 90-100 milliamps. when aerial is tuned to true resonance.

If no resonance is obtained at "aerial coarse""1" set "aerial coarse" to "2" and repeat tuning of "aerial fine". If no resonance at "aerial coarse" "2" proceed to 3 and so on until a true resonance point has been found.

If cathode current of tubes 5a, 5b, 5c, 5d does not come up to a value of at least 90 milliamps. turn "coupling" to "2" and repeat tuning procedure. Continue with coupling 3, 4 and so on until cathode current of each of the no. 5 tubes assumes a value of 90-100 milliamps.

A good check on the tuning being correct is to compare aerial current and cathode current (of the no. 5 tubes) at settings of "coupling" higher or lower than the correct setting: aerial current will decrease whether coupling is too "tight" (too high a coupling setting number - cathode current too high) or too "loose" (too low a coupling setting number - cathode current too low).

Yet it is a much better plan to use too loose a coupling than too tight coupling as tubes in the latter case will be ruined - and modulation bad.

When transmitter has been correctly tuned operating switch in switchboard may be turned to "A3 duplex" if wanted.

If the settings of the aerial levers and dials are known and the knobs set accordingly the operating switch may immediately be rotated to the mode of transmitting wanted, and after a warming-up period of 15-20 seconds the transmitter is ready for use.

For quick resetting of the aerial matching elements the settings of the levers "coupling" and "aerial tuning coarse" and the knob "aerial tuning fine", when once found, should be put down (by pencil or ink) in the lower part of the white space ("windows") containing the frequency labelling of the frequency switch.

Setting up of channels:

If a new channel, which has not been set up by the factory, is wanted, first procure a crystal for the desired frequency (same as the transmitting frequency). It is recommended to order a crystal with a frequency tolerance of not more than ±0,01%. Also when ordering the crystal draw the manufacturer's attention to the fact that the crystal should be calibrated with a capacity of 35 pF in parallel. Plug the crystal in an idle socket (note the manner of numbering: top line, from left: 1-2-3-4, no. 2 line from top, from left: 5-6-7-8 and so on).

First the plate circuit of the oscillator has to be tuned. If the transmitting frequency is lying in the range 3800-5600 kc/s no extra tuning capacity is needed. If the frequency lies in the range 2500-3800 kc/s an additional 100 pF tuning capacitor (fixed) has to be connected in parallel with the coil and if it lies in the range 1600-2500 kc/s an additional 250 pF (no 100 pF capacitor connected on this range) should be connected in the same manner. The connecting wires of the additional capacitors have been taken to a small ceramic support placed horizontally above the frequency switch proper, the connection from the 100 pF capacitor in the right end and the 250 pF in the left end. In the same ceramic support 11 connecting wires from the contacts of wafer no. 3 (numbered from the front) of the frequency switch have been taken up through holes in the ceramic. The numbering of the 11 wire ends is as follows: count from left 1 to 6 in the line nearest the front plate and proceed 7 to 11 in the rear line from right. (The wire ends are numbered with figures and the size and number of the capacitors are printed on the ceramic.)

If prescribed one of the extra capacitors is connected to the wire end with the same number as the socket in which a crystal has been inserted, and the connecting is soldered.

The value of inductance of the oscillator plate circuit is selected by wafer no. 2 of the frequency switch. Connecting wires from this wafer are carried to a ceramic support mounted horizontally above the tuning coil. Clip a short piece of wire to the wire end with the number in question. Set transmitter to reduced power (1/10 power), set cathode/grid current switch to "grid 7" (gitter 7), set control switch to "Telegraphy CW" and press the key. Clip the other end of the short piece of wire to a tap on the coil which one finds reasonable for the frequency concerned and note the grid current on the milliammeter. Find the tap which will produce maximum grid current, about 20-25 milliamps. Practically it has shown desirable to tune the plate circuit of the oscillator to a frequency slightly higher than resonance; so a coil tap 1, 2 or 3 turns less than necessary for resonance is chosen (1 turn on the higher frequencies, 3 turns on the lower ones.)

A tap chosen along this line will produce a grid current of 14-16 milliamps. which is adequate for driving the r.f. power stage. (Moreover too high a value of grid current will lower the available output of the power stage). Both ends of the connecting wire are soldered. (Less turns means a coil tap nearer the front plate).

Next the tank circuit of the r.f. power stage has to be tuned. Switch "coupling" is set to 0 (Zero), and switch "aerial tuning, coarse" is also set to 0 (Zero). If the transmitting frequency is lying between 3800 and 5600 kc/s no additional capacitor should be connected across the tank circuit tuning capacitor (fixed). If the transmitting frequency lies between 2500 and 3800 kc/s an additional 350 pF capacitor has to be connected in parallel with the coupling capacitor and a 225 pF capacitor in parallel with the anode-cathode capacitor. If the frequency, lies between 1600 and 2600 kc/s an additional 915 pF capacitor has to be connected in parallel with the coupling capacitor (instead of the said 350 pF capacitor) and a 635 pF capacitor in parallel with the anode-cathode capacitor (instead of the above mentioned 225 pF capacitor).

The four extra capacitors have their connecting wires carried to two ceramic supports placed as nos. 2 and 3 (from the frontplate) right above the frequency switch. The connecting wires terminate as follows : 350 pF: second support, right end; 225 pF: third support, right end; 915 pF: second support, left end; 635 pF: third support, left end. If prescribed one of the extra coupling capacitors and the wire end of the contact of wafer no. 4 corresponding to the crystal socket concerned are connected by a small length of wire soldered to the appropriate wire ends.

Similarly one of the extra anode-cathode capacitors and wire end of the contact of wafer no. 5 corresponding to the crystal socket concerned should be connected by a short length of wire - if prescribed.

At length a tap on the tank circuit tuning coil has to be selected. A flexible lead is clipped to the tag on the insulating strip (the one nearest the front plate) which has the same numbering (count from left) as the crystal socket concerned and which has a wire connection with a contact on wafer no. 6 of the frequency switch. The free end of the flexible lead is clipped to a tap on the tank coil, which one finds reasonable. A tap should be selected which will give a distinct fall of the cathode current of the no. 7 valves. If difficulty in finding the correct tap is encountered with the transmitter set to reduced power, full power may be employed, provided that the transmitter is keyed but for a very short time. When the current tap has been found a 2 mm tinned copper wire is drawn between the coil tap and the tag on the rear insulating strip with the same numbering as the crystal socket concerned. The wire is carefully soldered at both ends.

Finally the tank circuit is tuned fine by means of a trimmer coil, the number of turns being found by trial. The trimmer coil is placed between the soldering tags on the front and rear insulating strip.

When the tank circuit is correctly tuned the cathode current of the four no. 7 valves will amount to about 100 milliamps. with the transmitter on full power. The trimmer coil is carefully soldered after checking the cathode current of the no. 7 valves with the chassis pushed in. The iron cabinet may have a slight influence on the tuning of the tank coil, reducing the inductance a trifle, and a small readjustment of the trimmer coil may be necessary. Ordinarily pressing the turns of the trimmer coil slightly tigther will increase the inductance sufficiently for correct tuning of the tank circuit with the chassis pushed in.

If in special cases one "channel" has to be used with two crystals, differing no more than 0,5 per cent in frequency, the transmitter should preferably, be tuned with the crystal with the higher frequency inserted in the (common) socket. No difficulty whatever will then be encountered when the crystal with the lower frequency is inserted instead.

If a crystal which otherwise is assumed to be alright should refuse oscillating or start too slowly (dots too short when keying) the reason generally will be that the coil in the plate circuit of the oscillator valve is too large. A coil tap one or two turns farer-off the front plate is the remedy.

The degree of modulation can hardly be checked correctly without the use of an oscilloscope. The sensitivity of the modulator i.e. the maximum amplification of the modulation amplifier is set by the potentiometer labelled "A3", the slotted spindle of which projects above the chassis in the left end of the chassis. When the setting of the A3 potentiometer is fixed, next set the A2 potentiometer for about 80-90% modulation. The slotted spindel of the A2 potentiometer projects above the chassis in the right hand end of same.

Note: If the amplification is set too high by means of the A3 potentiometer, noise from the room will be heard at the receiving end when the handset push button is pressed and no speaking takes place. As soon as one begins speaking the sensitivity of the amplifier is automatically adjusted to a level corresponding with the strength of the speaking voice, the noise becoming weaker the louder one is speaking.

NB: When trimming the transmitter special caution to the high tension 550 volt has to be paid. The coils and connecting wires mentioned above are not themselves carrying the dangerous voltage, but all anodes (plates) which are brought out in top of the valves are "live" and dangerous.

A 218 V - Diagram.

Crystal control is employed throughout, 11 frequencies in the band 1600-5600 kc/s being available. An 807 tetrode is used as a crystal controlled oscillator, crystals in the grid circuit are switched in by a switch, which also engages coils and capacitors for the frequency in question. Crystals are connected between grid and chassis (Zero potentiale), the cathode being connected to a capacitive voltage divider between grid and chassis. The screen grid is decoupled to chassis by a large capacitor and the coupling to the anode circuit is electronic. The anode circuit consists of a coil (on a ceramic former) with taps and the interelectrode capacity of the valves plus stray capacities in the range 3800-5600 kc/s; in the range 2500-3800 kc/s an 100 pF capacitor (in fact two series connected 200 pF capacitors) is connected in parallel with the coil, and in the range 1600-2500 kc/s a 250 pF capacitor (in fact two series connected 500 pF capacitors) is connected in parallel with the coil (instead of the 100 pF).

In the radio frequency amplifier 4 tetrodes 807 are connected in parallel, the grids being connected to the above mentioned buffer stage, while their anodes are connected to a pi-filter consisting of an anode-cathode capacitor, an inductance coil and a coupling capacitor. The anode-cathode capacitor consists of a 406 (in fact two series connected 812 pF capacitors) in the range 3800-5600 kc/s; in the range 2500-3800 kc/s an extra 225 pF capacitor (in fact two series connected 450 pF capacitors) is coupled in parallel with the latter capacitor and in the range 1600-2500 kc/s an extra 636 pF (in fact two series connected 1272 pF capacitors) is coupled in parallel with the 406 pF capacitor in-stead of the 255 capacitor. The coupling capacitor in the range 3800-5600 kc/s consists of a 670 pF capacitor, built in 11 sections of different size. Each section is connected to a contact in an 11 pole switch by means of which the coupling between the tank circuit and the aerial circuit may be varied in 11 steps without detuning the former. In order to keep the proportion between the anode-cathode capacity and the coupling capacity constant an extra 350 pF capacitor is coupled in parallel with the coupling capacitor in the range 2500-3800 kc/s and an 915 pF capacitor in parallel in the range 1600-2500 kc/s.

The aerial circuit consists of the antenna proper, a matching network comprising a variometer (continuously variable inductance) and a tapped capacitor, a switch giving 11 possible combinations of the latter components, the coupling capacitor (part of same) and the earth connection. A thermocouple ammeter reads the aerial current.

The stator and rotor of the variometer may (by the said switch) be coupled in series or in parallel producing an inductance of 15-60 microhenries and 4-16 microhenries respectively. The aerial capacitor consists of 12 series connected 800 pF mica capacitors, having taps for the following capacities: 67, 100, 200 and 400 pF.

For correct matching of the aerial circuit thus 3 knobs are available: coupling, aerial tuning coarse (11 steps) and aerial tuning fine (rotating the rotor of the variometer).

This very improved antenna matching network will match the transmitter to any aerial encountered onboard ships.

Modulation takes place as combined anode and screen grid modulation of the radio frequency power stage. The modulation power is produced by four 807 valves working as class A-B audio amplifiers in parallel - push pull with fixed grid bias (30 volts) derived from the bias rectifier. The modulator is matched to the r.f. power stage by a transformer through the secondary of which the anode and screen grid current of the r.f. power valves flows. An extra winding on the transformer with a nominal impedance of 5 ohms can produce 75 watts of audio frequency power to one or more loud speakers for hailing, when the control switch is set to position "Hailer".

The four modulating valves get their grid excitation from a push pull driver stage containing two type 807 valves working as class A amplifiers. The grids of the driver valves are via a normal resistance-capacity network excited by a push pull class A stage containing two small pentodes EF 41 with variable mutual conductance. The "cold" ends of the two grid leaks of the driver valves are connected to taps on a voltage divider, which is connected across the modulation transformer primary. In this way a negative feedback is applied to the amplifier, reducing distortion and making the modulation transformer secondary voltage fairly independent of the load, thus keeping modulation pretty constant when changing from full power to reduced power and preventing damage to the transformer if by accident it should run idle (no load connected).

24 volts of the 30 volts grid bias of the two driver valves, is derived from the voltage drop across a common 250 ohms resistor in the cathode circuit; the resistor is connected to the negative pole of the anode supply; the cathodes thus adopt a voltage about 24 volts more positive than this pole; the d.c. potential of the grids will be about 6 volts more negative than this pole, being composed of two voltages: a positive voltage of about 24 volts resulting from the d.c. drop across the above mentioned voltage divider across the modulation transformer and a negative voltage of 30 volt originating from the grid bias rectifier and supplied through the above mentioned midpoint.

The grids of the two variable-mu valves are connected to the outer ends of the symmetrical secondary of the input transformer. The midpoint of the transformer secondary is through a 2 MΩ resistor connected to the moving contact of a 500 ohms variable resistor in the common cathode lead of the variable-mu valves. The setting of the variable resistor determines the working point on the grid bias/anode current curve of the said valves and consequently the amplification of the stage when no other D.C. voltages are present in the grid circuit.

The midpoint of the input transformer secondary however, is also through a suitable filter connected to a balanced rectifier, containing an EZ 40 full wave rectifier valve, two 0,1 MΩ load resistors and two 0,01 mfd. capacitors coupled to the "hot" ends of the modulation transformer primary. The cathode of the rectifier is connected to a point about 350 volts positive relative to chassis, on a voltage divider.

Thus when the peak values of the voltage across each half of the modulation transformer primary exceeds 350 volts (corresponding with a modulation percentage of 85 - 90%) the rectifying valve begins rectifying and produces a negative D.C. voltage which is applied to the grids of the variable-mu valves reducing the amplification. The net result is, that within very wide limits of speech intensity the modulation percentage will be very high and yet no overmodulation will take place.

Suitable filters are inserted to make the amplifier reduce the amplification immediately a voltage higher than corresponding to 85-90% modulation appears in the modulation transformer and slowly increase the amplification when the speech intensity falls below the value corresponding to 85% modulation.

The total audio frequency distortion amounts to about 6 per cent measured at a modulation depth of 90 per cent and a test tone of 1000 c/s.

As the transmitter is constructed for as well A2 as A3 transmitting two primaries are supplied on the input transformer, one connected to the microphone through a low pass filter which cuts off at about 3000 c/s, the other via a potentiometer for adjusting the modulation depth, when transmitting A2, to an audio frequency oscillator, giving a pure note of frequency 1000 c/s.

The said low pass filter yields an attenuation of about 15 dbs at 3500 c/s and about 40 dbs at 5000 c/s. The microphone of the handset has a nominal resistance of 50 ohms and an A.F. charachteristic rising about 6 dbs per octav from 200 c/s to 2000 c/s, substantially flat from 2000-3500 c/s and about 10 dbs down at 5000 c/s.

Output of the microphone (at a D.C. current of 60 milliamps.): at 2000 c/s about 0,5 volts A.C. at a sound pressure of 10 dynes pr. square centimetre. The modulation amplifier requires at the input terminals about 100 millivolts for a 85% modulation depth with potentiometer for adjusting sensitivity of amplifier set to maximum amplification. Yet an input of 1 volt (from the microphone) will not modulate the transmitter more than 95%.

Suitable setting of the sensitivity control (potentiometer) is about three quarters up, which setting will give 85% modulation for an A.F. input of about 200 millivolts.

When transmitting A2 the vogad system is cut out by a contact in a relay operated by the main control switch in the switchboard. The aforementioned audio frequency oscillator (1000 c/s) besides working as a source of the A2-note also serves a quite different purpose: in the anode circuit of the oscillator a step-down transformer is inserted, a selenium rectifier connected across the low voltage secondary and the D.C. output of the rectifier filtered by a suitable low pass filter and fed to a voltage divider consisting of fixed resistors. From a tap on the voltage divider grid bias for the modulating valves and for the valves of the M.F. and M.H.F. transmitters A 217 and A 218 and from another tap grid bias for the valves of the H.F. transmitter A 219 is derived.

As mentioned above keying takes place by means of a keying relay which by key down condition shorts a resistor in a voltage divider across the high tension. All cathodes except for the one belonging to the MCW/bias generator are brought to the tap on the voltage divider which is grounded by key down. By key up the cathodes adopt a positive voltage of about 90 volts in proportion to chassis while the grids keep their voltages. In this way all plate and screen grid currents are cut completly off.

The MCW/bias generator is not keyed but oscillates continuously for, under all conditions, to provide negative voltages for biassing.