Marconi CM-11 Transmitter/Receiver Check-over, Testing and Refurbishment – Gerry O'Hara

Background

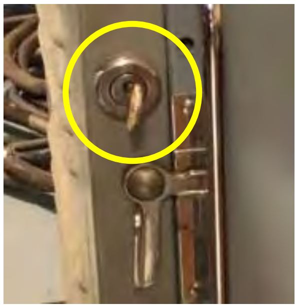
After restoring a Marconi CSR-5A receiver for a friend in 2020, I was asked by another friend if I could take a look at/check-over a Marconi CM-11 transmitter/receiver unit that he had bought and had someone work on previously (replacement of capacitors and other refurbishment work). Having enjoyed working on the CSR-5, and curious as to what its matching transmitter was like, I of course said I would take a look. The CM-11 was duly delivered to my garage late one very rainy afternoon in late-2020. I advised the owner that I had a line-up of several projects before I could work on the CM-11 and that as the assembled units were so large and heavy, some of the work would need to be undertaken in the garage – which I was not inclined to do in the Winter months. The owner said that this was ok, as the CM-11 had been a long-term project for him, but that it would be nice to have the rig operating by 'Marconi Day' in April, 2021. So the CM-11 was dried-off and reassembled in my garage, and it then sat there looking rather forlorn through to mid-March, 2021 (photo, above – the receiver is the lower unit,

the ATU the top unit and the transmitter is in the middle). The photo, left, shows the three power supply units (all upside down), and their cabinet can be seen to the right of the photo. The central plate in the photo, below, identifies the unit as a CM-11, S/N 161, Spec. 111-907, the left hand plate that the unit was reconditioned by RCA in February 1962, and the right hand plate that mods 1, 2 and 4 have been undertaken on this unit (assuming the various component units are all original).

The Marconi CM-11

The Canadian Marconi Company (CMC) designed and manufactured the CM-11 at their factory in Montreal, Canada, commencing in 1942. The CM-11 (and CM-11A from 1944) is the CMC designator for a radio system comprising a CSR-5 receiver (further information on the CSR-5 can be found here and here), a Type 112-912 transmitter unit, and its matching antenna tuning unit (ATU), Type 114-906, and its power supply, Type ZM-11. The ZM-11 comprises three chassis, these being housed in a separate cabinet to the receiver, transmitter and ATU. The power supply chassis comprised an 'LT' power unit (Type 102-902), supplying 24vDC to the CM-11 control relays and 400vDC to the transmitter exciter and modulator stages, an 'HT' power unit (Type 102-900), supplying 1300vDC to the transmitter power amplifier stage, and a 'Rec' power unit (Type 102-903-A), supplying 12vAC for the receiver heater circuits and 250vDC for the receiver HT supply. The 'Rec' power unit also included a small dynamotor unit capable of powering the receiver HT supply from 24vDC. Umbilical cables (photo, below) are used to connect the power supply and transmitter/receiver cabinets, and a telephone-style handset was hung on the left side of the cabinet for phone use. A Morse key and speaker were connected to a terminal strip located adjacent to the umbilical connectors on the transmitter/receiver cabinet. A remote control unit was also available for use with the CM-11.

The CM-11 was built for reliability and the degree of ruggedness needed for service aboard Royal Canadian Navy (RCN) vessels under wartime conditions, and, according to an article on a CM-11 installation in the 'Wireless Room' at the Nova Scotia Maritime Museum, was fitted on all RCN ships of Corvette size and larger[1]. The transmitter in the CM-11 was capable of operation in the 375 KHz to 13.5 MHz range, with two distinct bands of operation: 375 to 515 KHz on 'Low Frequency' (LF), and 1.5 to 13.5 MHz on 'High Frequency' (HF). In the HF band, the CM-11 could be used with crystal or master oscillator (VFO) frequency control. For LF operation, only the master oscillator could be used. The RCN labelled CM-11 crystals with two additional frequencies besides the fundamental, ie. the second harmonic and the third harmonic. On HF, the transmitter could be tuned to operate on any of the three frequencies. Modes and nominal power levels were: CW - 100 watts; MCW - 70 watts; AM - 30 watts. On MCW, the carrier was modulated with a nominal 1KHz tone. The ATU could match the transmitter to resistive loads between 5 and 15 ohms on LF and 15 to 759 ohms on HF. The CM-11 could operate on 115vAC, drawing 5.4 amps, or 24vDC, drawing a hefty 45amps, the latter requiring an external dynamotor.



CM-11's in service with the RCN were modified to operate with a "Man Aloft" key (circled in photo, left): this safety feature disables the final RF stage in the transmitter in case of someone climbing the ships mast to work on the antenna system. Generally, the lock was fitted to the cabinet of the CM-11 at the left side near the top (as is the case for the CM-11 unit described in this article). Inter-connection between the transmitter, receiver and ATU was provided by multi-pole 'snatch' plugs and an electrical bus contained within the cabinet. These connectors operate on the same principle as knife

[1] Comment by Tom Brent: "*Most of the Corvettes had the Marconi PV-500, not the CM-11. Like a lot of the allied forces, the RCN was scrambling for to find available radio gear, especially early in World War II. For that reason it is difficult to say one particular radio was allocated to a particular class of ship. Where the CM-11's were used I am not sure. I expect the Canadian-built Tribal class destroyers had them and possibly some of the frigates but there is scant photographic evidence available at this time to come to much of a conclusion.*"

switches, with a 'male' metal blade in the cabinet mating with its corresponding metal 'female' connector on the rear of the transmitter, receiver and ATU. CM-11's saw up to around 30 years of service life, with some units still being used well into the 1970's.

I would like to acknowledge and thank Tom Brent and Jerry Proc for their input in the troubleshooting phase, and the information provided on Jerry's website, here. Also, as noted above, an interesting article on Nova Scotia's Maritime Museum 'Wireless Room' and the restoration of a CM-11 and a CM-11A can be found here. The Appendix to this article includes the schematics as referenced in the text.

Check-out and Repairs/Preventative Maintenance

When the (slightly) warmer weather arrived in March, 2021, and having worked through my radio workshop backlog, it was time to take a look at the Marconi CM-11. As noted earlier, this CM-11 had been worked on by others, and, though claiming to be in working condition, the owner felt that it should be checked over before he used it and any remnant issues resolved. So, this was not to be a restoration project, or even a refurbishment project, rather more of a check out and test project, with troubleshooting/repair and preventative maintenance undertaken where considered appropriate.

Firstly, not being familiar with the CM-11, apart from the CSR-5 receiver component, I undertook some on-line background research and manual download/partial printing (mainly from Jerry Proc's website, here). Next, I lifted the CSR-5 receiver unit out of the cabinet, and lifted the three power supply chassis off the floor ready for inspection. The biggest issue for me to deal with was the sheer size and weight of the units (they total almost 500lbs). I decided that it would be best to work on the CSR-5 receiver, transmitter, ATU and the 'LT' and 'Rec' power supply units in my (upstairs) workshop, but the 'HT' power unit (very heavy!) and final assembly and testing of the complete CM-11 would have to be in my garage. Being familiar with the CSR-5, I decided to work on that unit first, and that I would use an external bench power supply for testing it rather than the 'Rec' power unit.

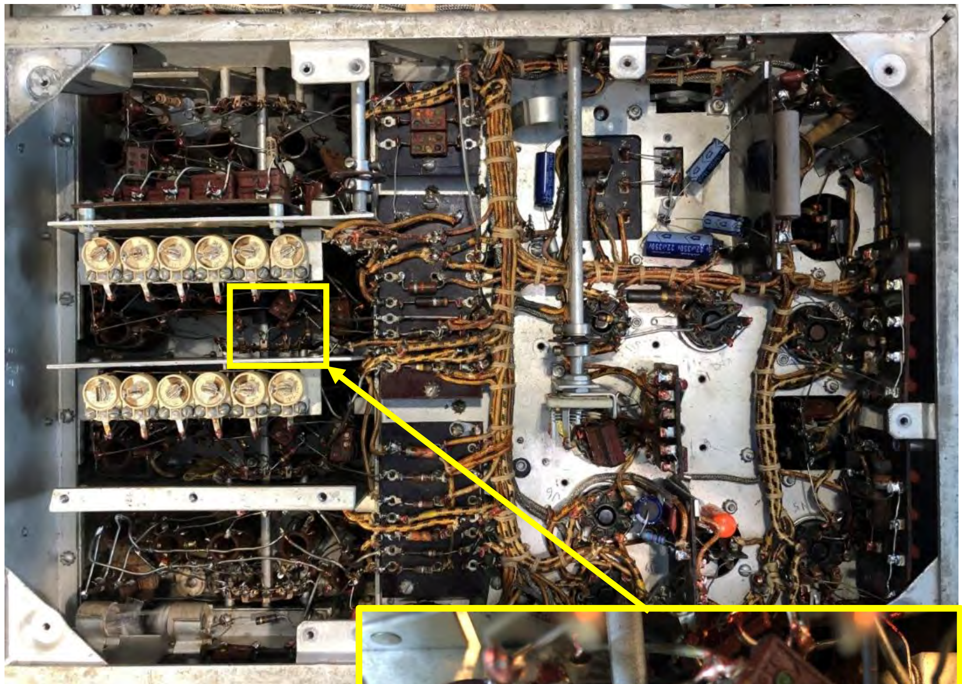
CSR-5 Receiver

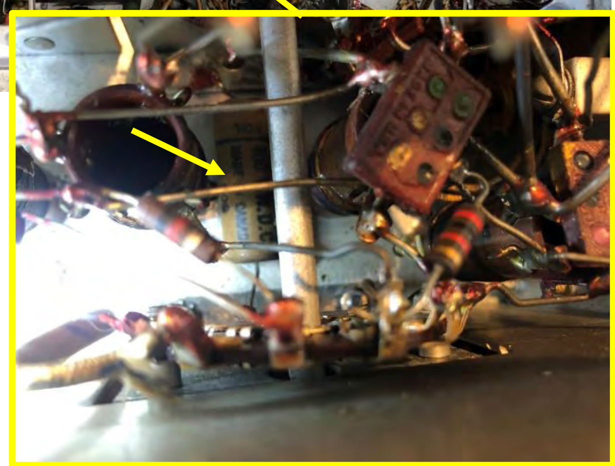
A description of the CSR5 (and CSR-5A) receiver can be found in an article here. The following provides only a description of the work undertaken to check out and refurbish the CSR-5 as included in this CM-11 unit (photo, right).

Observations/work during the initial check-over of the CSR-5:

- the receiver had been recapped (all but two tubular paper capacitors and all electrolytics replaced), plus a couple of resistors replaced;

- it appeared that high-quality replacement components had been used, eg. Nichicon electrolytics;





- two of the original tubular paper capacitors remained in place: these were the two 'primary shorting' capacitors in the RF amplifier stages (C19 and C32)[2] which short out the unused Band coil sections to ground. These two capacitors are very difficult to see, and even more difficult to replace, as they are buried deep in the RF amplifier compartments (photos, above/right – the arrow on the insert enlargement points to one of these capacitors). They did, however, replace all the tubular paper capacitors hidden under and behind the various tagstrips. I decided to test the two remaining paper capacitors and attempt replacement if needed;

- cleaned all rotary switch contacts, including in the crystal filter unit switch, with Deoxit;

- powered-up the receiver using a 12v transformer for the heater supply and a bench HT supply – it was working on all bands;

- the BFO was working;

- the dial was not too accurate, so I recommended to the owner that a full IF/RF alignment be undertaken;

- the audio was not as strong as it should be and was distorted at higher volumes. I thought that this could be a tube or maybe a resistor problem and needed investigating;

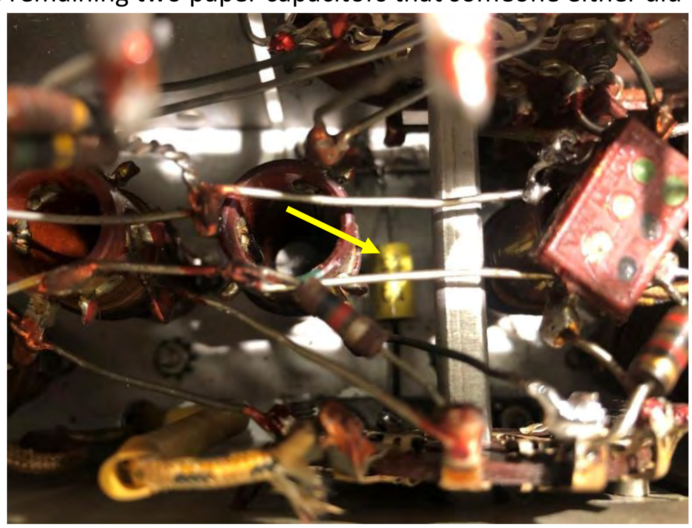
All the tubes except two tested ok. One of the 6SK7s (BFO) was noisy, but not really an issue in practice for this application, and the 6F6 (AF output) was weak, testing at 38% emission. However, subbing a higher emission 6F6 improved the distortion and output level only slightly... then I remembered that the output jack sockets on the rear panel of the CSR-5 are 10,000ohms 'loudspeaker' and 500 ohms 'line'.

[2] I tested C19 and C32 on the last CSR-5 I worked on and they were ok, so I left them in circuit as I felt accessing them could result in damage to other components. Moderate amounts of leakage within these capacitors will not impair receiver performance, however, If these capacitors leak heavily or short, it is likely they will burn out the corresponding plate load resistor (R10 or R21), silencing the receiver

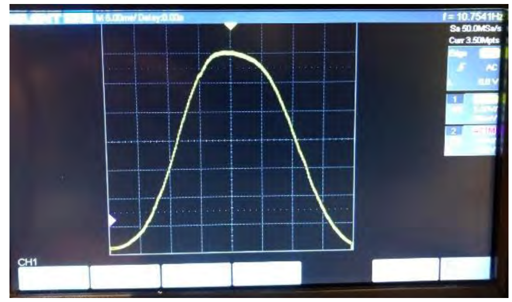
As I had connected the set to the speaker and power supplies through the rear 'snatch' connector (photo, left) I was driving an 8ohm speaker from one of these - that would explain the low output and distortion(!). Connecting the speaker to the low impedance 'phones socket on the front panel gave much better audio, even with the low-emission 6F6 output tube.

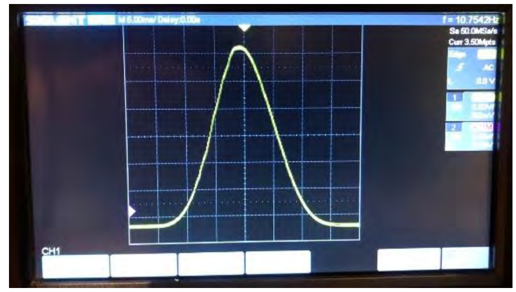
Next, I undertook tube socket voltage and critical resistor checks. I also noted that a mod that has been undertaken in the detector/1st audio stage that needed investigating, and one of the selectivity settings was 'dead' - I tried cleaning the selectivity switch again but this did not improve things, so further investigation of that was needed also.

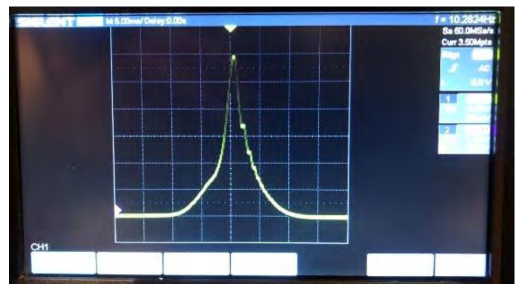
After testing the leakage on C19 and C32, (~10uA at 300v - not enough to cause problems, but probably better replaced), I decided to change-out these remaining two paper capacitors that someone either did not find when they did the re-cap, or gave up on replacing due to their inaccessibility. This was bit of a challenge – this job taking almost 2 hours as half of the band change switch shaft had to be withdrawn from the set (luckily there is a coupling on the shaft, other wise the front panel would have had to be removed), and several bus wires to the coils and band change switch wafers needed to be temporarily removed to gain limited access and then repaired afterwards (photo, right – arrow points to a replaced capacitor).



Next, I undertook IF alignment as described in the CSR-5 manual and found a fault that was traced to the 2nd IF transformer (T2). I suspected that the powdered iron slug on the middle coil in this transformer had detached from the adjustment screw (a fairly common issue with iron-cored IF transformers - I usually epoxy them back on without a problem). I removed T2 from the chassis, disassembled it and inspected all three slugs and adjustment screws – they were all in good condition and working ok (photo, left). I then disconnected

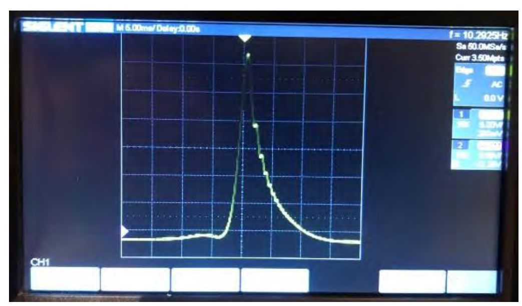






the silver mica (140pF) resonating capacitor on the middle coil - it also tested fine, so was re-installed. Also, all coils had continuity, so I re-installed T2 into the chassis and set up the IF again using the manual procedure and this time all three slugs on T2 adjusted perfectly. I can only conclude that there was a dry joint either on the middle coil, that was fixed by removing/replacing the resonating capacitor, or on the connections from T2 to the set, all of which were re-made during the removal/re-installation process (they did look a little suspect before removal). I then used a HP8600A/ HP8601A sweep generator and digital marker generator combo to optimize the IF responses with/without the crystal in circuit. The photos, right, show the response curves for each of the four selectivity positions from position 1 (broadest response, crystal not in circuit) at top, to 4 (sharpest), bottom. No provision is made for adjusting the crystal phasing from the front panel, rather this is adjusted using a pre-set trimmer on the side of the crystal filter unit. The response plots show the IF is probably functioning as good as it gets and meeting spec.

With the IF now working well, I moved on to realigning the RF section. This was straightforward, with all slugs and trimmers behaving as they should. All bands now had better dial accuracy, though not 'perfect' at some points on the bands (and it probably never was), but typical of other comms receivers of this era.

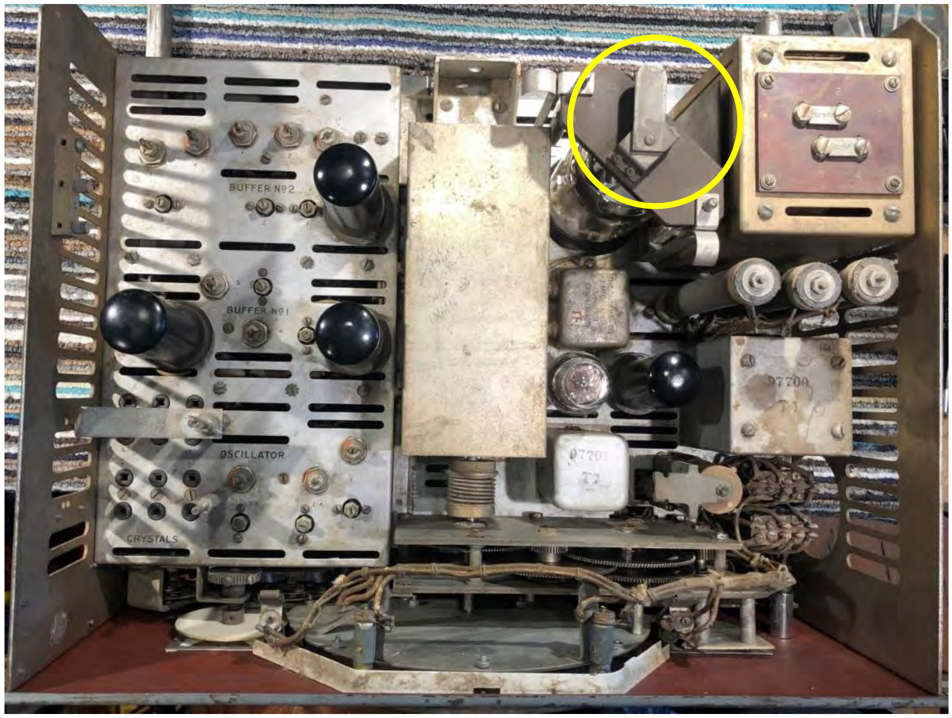


I left the receiver on 'soak test' on the bench for a few hours and all seemed ok – plenty of undistorted audio, and voltages at critical circuit nodes correct and steady.

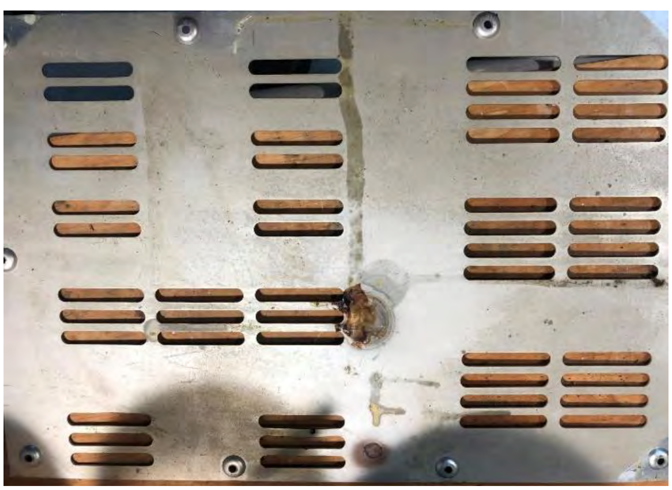
Type 112-912 Transmitter Unit

The transmitter unit (photo, below) comprises a switchable crystal/master (variable) oscillator (1 x 1619 tube), two

driver stages (2 x 1619 tubes), power output 'final' stage (813), and a single modulator tube (1 x 1619), plus a voltage stabilizer tube (VR150-30), providing 150vDC for the master oscillator plate and screen supplies to improve



frequency stability[3]. The plate of the 813 tube is connected by a 'special connector'[4] to the ATU (circled on photo, right), which includes the 813 tube's plate tuning circuit, variable coupling and antenna tuning circuits. The modulator tube can be switched to oscillate at 1KHz for modulated carrier wave AM Morse code operation (MCW), or used as an audio amplifier to modulate the grid of the 813 tube for 'phone' AM operation. A timing circuit is included that delays the application of the HT to the 813 tube until 15 seconds have elapsed after switch-on. This is to allow the heaters in the Type 816 mercury rectifier tubes in the 'HT' power unit to reach operating temperature and prevent premature failure. An 'Emergency' mode is provided that shortens the delay if the transmit function is needed in a hurry (and which also shortens the life expectancy of the rectifier tubes).



I hauled the transmitter unit onto the bench and undertook some preliminary observations/checks. As for the receiver, it has been largely recapped previously using what appeared to be reasonable quality parts, though the metal 'bathtub' (chassis-mounted paper in oil) capacitors had not been replaced and at least one appeared to have been oozing a little oil from its seals - this could be seen on the inside of the base cover beneath the weeping capacitor (C47) – photo, left. These bathtub capacitors are often ok, even if weeping oil slightly, but can be electrically leaky also. I decided that these would all be tested and replaced if needed.

Inspection and work undertaken on the transmitter unit was as follows:

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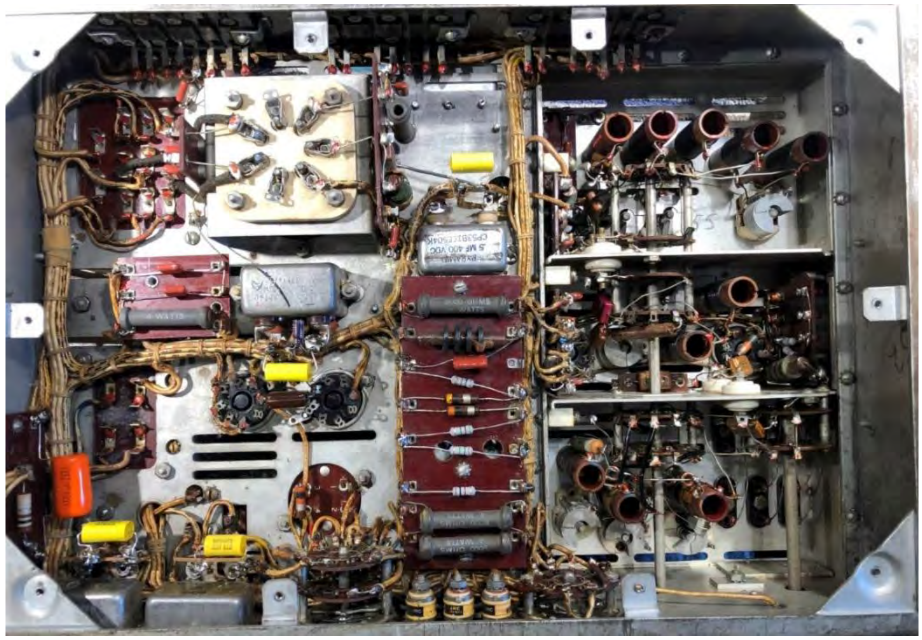
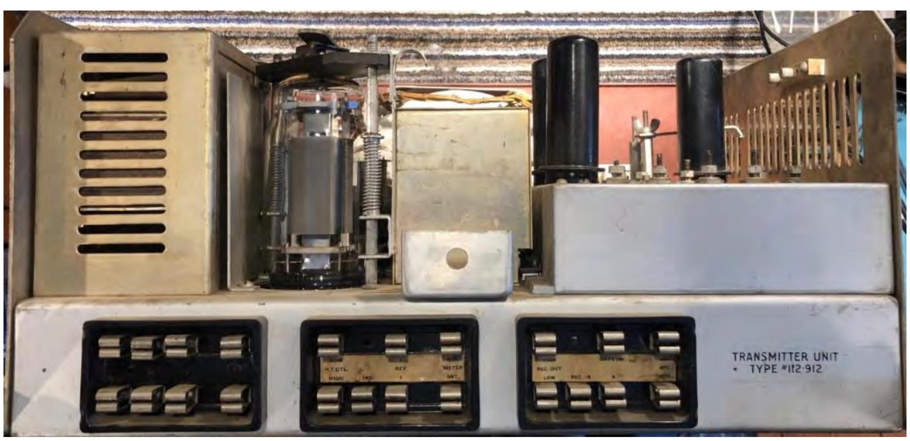
[3] In the CM-11A, the stabilized 150v from the VR150-30 also supplies the plate and screen of the 1st buffer stage and the screen supply of the 2nd buffer stage – likely a mod undertake to reduce 'chirp' when keying the transmitter (the CM-11 is noted as having this problem)

[4] An insulated contacting lug fitted to the plate top cap connector of the 813 tube, an insulated, springy metal strip mounted in the rear of the cabinet, and a metal contacting post on the rear of the ATU



- all but one of the bathtub capacitors had measurable leakage current – nothing too serious (several 10's of uA at their working voltages), but this would eventually become worse with time and use. Also, the small replacement electrolytic had been wired across the old capacitor – not good practice. So, I decided to replace them all, using tagstrips mounted on the old capacitor terminals to mount the replacement capacitors (all 630vw film types), and also re-wired the replacement electrolytic, a high quality 'Nichicon' part, to isolate it completely from the old capacitor (photo, above, which also shows several resistors that were eventually replaced – see 'Troubleshooting' below);

- checked all resistors – they were all within or marginally outside tolerance (non-critical), so I left them all in place;



- all rotary switches, the 813 tube plate connector and 'snatch' connectors were all cleaned with Deoxit (these can be seen on the photo of the transmitter rear apron, left);

- the relay contacts were cleaned with a burnishing tool and then wiped with Deoxit-soaked paper;

- chassis wiring was inspected and appeared to be in good condition; and

- the 1619 tubes were tested on an emission tester – all were over 70% emission.

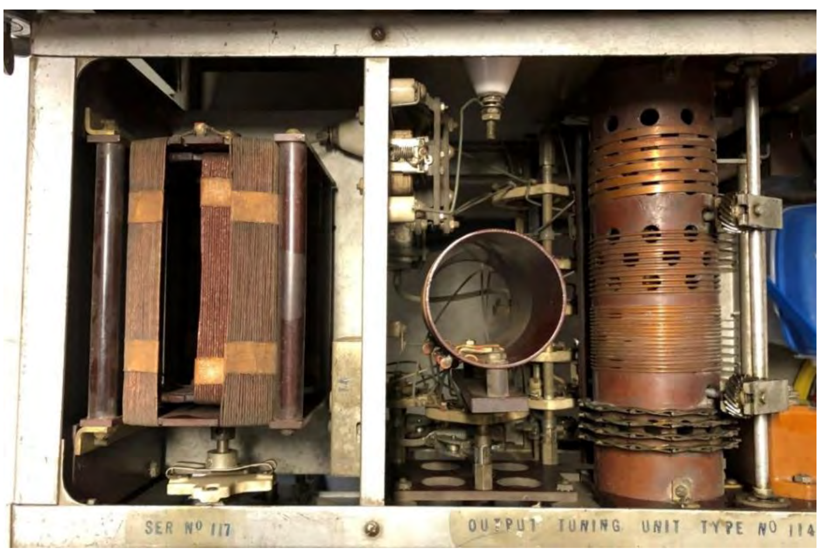
The transmitter cannot be tested on the bench as the correct power supplies and connection to the 813 tube plate circuit need the cabinet and the ATU. A 'patch cable'[5] can be used to link the transmitter into

[5] The owner has a box of parts to make up a set of patch cables, but these were not available when I was working on the transmitter. One was subsequently constructed for future use and this can be seen on Jerry Proc's website

the cabinet wiring to do this with the transmitter pulled part-way out of the cabinet (see 'TEST PLUG ONLY' stencilled above the socket used for this purpose on the photo, left, taken while cleaning the contacts on an adjacent socket with Deoxit), however, the 813 tube plate is still disconnected.

ATU

Next, the ATU was lifted onto the bench (photos, below). First, I cleaned a layer of grime off the coils/variable capacitor plates, cleaned all the rotary switch contacts with Deoxit, cleaned and lubricated the variable capacitors, and tightened an insulating coupler that was loose on one of the controls.



Observations/further work undertaken on the ATU was as follows:

- Some capacitors had been replaced, and, strangely, a new 0.22uF 4Kvw capacitor had been used to replace a 0.005uF 2.5Kvw part (C52) – photo, below. A dual 'bathtub' capacitor was still connected– although this is only in the antenna monitoring circuit, I decided to check its leakage and replace if needed;

- The dual bathtub capacitor was leaking around 80uA on one section and 55uA on the other with 200vDC applied, so I removed it completely and installed two new 0.1uF 630vw plastic film types in its place mounted on a new tagstrip (photo, left);

- All other caps and resistors checked ok; and

- I lightly burnished and then cleaned the antenna changeover relay contacts with Deoxit-soaked paper.

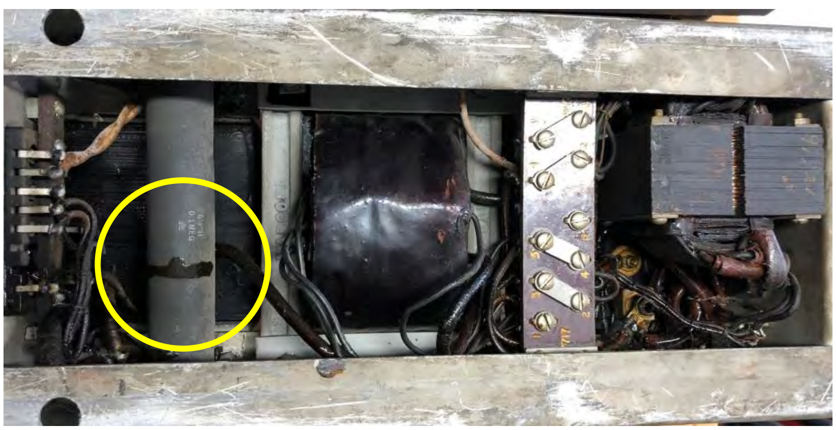
I also reached out to Jerry Proc and Tom Brent regarding the 0.22uF 4Kvw capacitor in place of the 0.005uF 2.5Kvw one, however, they had no idea why this would have been done. I concluded it would likely work ok with the larger capacitor so I left it in place for the initial CM-11 system operational test.

Power Supplies

Next on the bench were the three power supply chassis:

1) High Voltage Rectifier Unit (Type 102-900):

- I cleaned gobs of sticky insulation residue off the high wattage load resistor circled in the photo, below using acetone. This had been caused by poor lead dress that had draped wires around the resistor, which will get hot in use. I also tightened a loose (HT) connection to one end of this resistor. I then temporarily disconnected the opposite end of the resistor to check the 4uF 2Kv block paper capacitor: this measured 4.46uF with a leakage current of <8uA, but this was with only 600vDC applied using a Sencore LC53 capacitor tester (photo, above right) - the 'acid test' of this capacitor would be when it was powered up to >1300vDC.



2) LT Rectifier Unit (Type 102-902):

- The 8uF 600vw (block paper) filter capacitor (centre of photo, below) tested good (8.2uF, with <4uA leakage current at 500vDC using the Sencore LC-53);

- The 100uF 'hash filter' electrolytic capacitor had been replaced with a 1500uF 50vw part (rather a high value, but should be ok);

- The chokes tested ok for continuity;

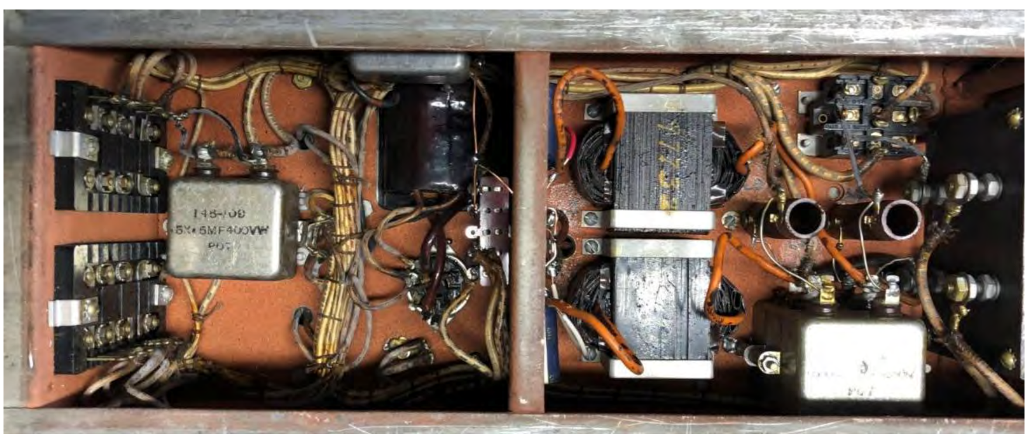
- All resistors tested within tolerance;

- The rectifier tube was tested: I noted that a 5Y3 had been fitted, whereas the schematic specifies a 5Y4. These rectifier tube types have the same electrical characteristics but a different pinout, however, the tube socket wiring had been modified such that it will take either tube type. The tube tested low emission (55%) so I replaced it with a NOS one; and

- I temporarily disconnected the selenium full-wave low voltage rectifier stack (top of photo, right), and tested each section with an ohmmeter. This testing was inconclusive, so I fed 120vAC into the primary of the transformer feeding the rectifier and it output around 28vDC, so appeared to be working ok. This supply provides the 24vDC needed for the various relays used to control the system when operating the CM-11 on an AC supply.

3) Receiver Power Unit (Type 102-903A):

- The bathtub capacitors in this unit (photo, below) had not been replaced, however, they are all on low voltage circuits (tube heaters and the receiver supply 24v dynamotor as hash filters). Any minor leakage will therefore not affect the operation of the unit, so I left them all in place. Also, I checked them in circuit and none appeared excessively leaky;



- The two receiver HT supply filter capacitors had been replaced with 10uF 450vw parts and high quality Nichicon parts had been used. Interestingly, the schematic specifies 100uF for the reservoir capacitor. This must be a typo, as in 1942, a 100uF 450vw cap would have been very large(!) and the illustrations in the manual show what would have been a typical dual 10uF 450vw part;

- The two 100uF 50vw electrolytic hash filter caps had been replaced with 1500uF 50vw parts. Again, a bit excessive, but should be ok;

- The chokes tested ok for continuity;

- The resistors tested within tolerance;

- I lightly burnished and then cleaned the relay contacts with Deoxit-soaked paper; and

- I tested the rectifier tube: again noting that a 5Y3 had been fitted (the schematic specifies a 5Y4). These have the same electrical characteristics but a different pinout, however, the tube socket wiring has been modified such that it will take either tube type. This 5Y3 tested strong emission (85%).

Following the above, the three power supply units were fitted into the ZM-11 power supply cabinet and the Amphenol plugs on the three system interconnect cables to the CM-11 transmitter/receiver /ATU cabinet installed.

Initial Testing and Troubleshooting

Following completion of work on the three power supply units, I replaced the antenna connector on the side of the CM-11 cabinet with a SO-239, photo, right, as requested by the owner to facilitate connection to his antenna. Next, I re-installed all the receiver, transmitter and ATU units into the CM-11 cabinet (photo, left), double-checking the 120vAC mains supply was connected to the correct input terminals on the power supply cabinet (it was), and jury-rigged a 'key' – a piece of flex as my Morse key was nowhere to be found…

Then the big switch-on! - The dial lights lit, and the receiver functioned ok, but nothing seemed to work on the transmitter. Then, after a tense moment or two thinking something serious was amiss, I realized the 'Man Aloft' key on the CM-11 cabinet was switched to 'off' (this is a safety feature installed by the RCN for when personnel were working on the ship's antennas that prevents the system from switching to transmit).

After the 'Man Aloft' key was switched to 'on', the transmitter powered up ok. The receiver was working ok, so its power supply was functioning correctly, was connecting to the antenna (receiving stations), and the antenna relay was switching correctly as far as I could tell. The transmitter also now appeared to be working as it should, but there was hardly any output to the antenna (dummy load) – photo, right: the power amplifier tube (813) was drawing grid and cathode current, and the cathode current could be dipped correctly using the plate tune control on the ATU, however, the coupling control did not seem to be working[6]. What little power was getting through the ATU to the 50ohm dummy load (estimated around 1W), could be tuned to the dummy load using the LF or HF tune controls. I surmised that the issue could be the coupling goniometer, the 0.22uF 4Kvw capacitor in the ATU, and/or insufficient drive from the transmitter unit (the cathode current draw was less than half what it should be) – see video [here](#) for a demo and explanation of what is happening. Although I had checked the four 1619 tubes and all were strong emission, I had no way of checking the 813 tube, and this could also be part of the low power output problem.

I subsequently removed the ATU from the CM-11 cabinet and changed out the 0.22uF 4Kvw capacitor for two 0.01uF 1600vw capacitors in series, photo, right, giving 0.005uF 3.2Kvw – the same capacitance value as shown in the schematic. I re-tried the CM-11 again, however, this time there was then another issue trying to power-up the transmitter (not the 'Man Aloft' key this time): I heard the HT delay relay click after around 15 seconds, but the remaining dial lights around the transmitter dial did not light up as they should, indicating the transmitter was ready for use. HT was not being fed to the transmitter - the mercury rectifiers were not illuminating, and no 813 tube plate voltage was indicated on the transmitter panel meter. I tried switching off/on several times with the same result, so I pulled the transmitter and pushed it back into the cabinet and tried again. This time it powered-up correctly (full HT on the meter), and, some good news, there was much more power being fed into the dummy load – this time the 813 tube was drawing around 120mA cathode current after tuning the 813 tube's plate circuit, and the SWR meter I was using indicated around 25W output on CW. Also, the coupling control on the ATU had some effect – the dummy load was even getting hot. So I concluded the capacitor change in the ATU had a positive effect.

I suspected that dirty relay contacts had caused the switch-on issue this time, even though they had been lightly burnished and wiped with Deoxit-soaked paper (photo, left). So, I decided the take the transmitter chassis back up to the workshop and work on/test the relay action, clean the snatch

[6] The owner later informed me that part of the 'Coupling' goniometer was repaired previously (one of the moving coils fully re-wound) as it had burned out and he was not sure if the unit had been tested after the repair

connectors and rotary switches (again), and re-check the resistors before I tried the unit in the CM-11 cabinet again.

With the CM-11 transmitter back on the bench and the relay contacts burnished, cleaned and tested, and the snatch connectors cleaned, I replaced all resistors that were out of tolerance (even if by only a small amount). I doubted this would make much difference but ended up replacing 7 resistors in total. I also tested the four 1619 tubes in my I-177 tester for mutual conductance (photo, left) and they ranged from 2200umohs to 2700umohs. The spec. for this tube type is 3400 umohs to 4500umohs depending on source of info, so they are 'under par' (assuming the I-177 is producing reasonable readings), however, I doubt not so much as to almost half the drive power to the 813 tube. I had no means of testing the 813 tube, but I removed it, cleaned its pins with Deoxit and examined the internal structure - the tube looked new – but looks can be deceiving. I also cleaned its ceramic socket with IPA before re-installing the tube.

With the second round of work on the transmitter completed, I took it back down to my garage workshop. Before I re-installed it in the CM-11 cabinet, I cleaned all the (male) snatch connectors in the cabinet that mate with the (female) ones on the transmitter chassis rear apron with Deoxit and Q-Tips.

With the transmitter re-installed, I applied power and, after the correct 15 second delay, the high voltage power supply cut in as it should. I

retried this several times and it worked correctly every time (nice blue glow in the 816 mercury rectifier tubes – photo, right), so, the intermittent switch-on problem was now resolved.

I connected the dummy load with a different SWR/power meter this time (a 'Vanco SWR-3'). Tuning the transmitter up on 7MHz on 'High Power', the transmitter was drawing around 140mA cathode current in the 813 tube (maximum cathode current should be around 200mA), and was initially outputting around 25W into the dummy load on 'CW', 12W on 'MCW' and 7W on 'Phone' according to this meter, as it had previously - only around a quarter of the specified power output on each of the modes). No amount of tweaking of the ATU could squeeze any more power into the dummy load. A short video of the CM-11 transmitter operating at this stage of the testing can be viewed here.

I then decided to try some other cables to the SWR/power meter and the dummy load. With these fitted and after some further tweaking of the ATU, the output power on CW now reached 75W, confirming a suspicion I had that one of the coax cables I was using was faulty[7].

Following the above tests, the CM-11's owner brought me a 'spare' transmitter and ATU unit plus some 'snatch' connector parts. With these to hand, some more progress was made as follows:

- First, I swapped the 813 tube from the 'spare' transmitter unit into the unit I had been working on. The transmitter now generated 100W on 'CW', but only around 35W on 'MCW" and 22W on 'Phone', as measured on the Vanco SWR/power meter into the 50ohm dummy load (note: the Yaesu Musen ATU/SWR/power meter was confirmed as not working correctly - it had developed a fault that I decided to investigate and repair later[8]);

- This indicates that the 813 tube in the transmitter I had been working on was not that good, even though it looked like new (photo, left);

[7] The cable was subsequently inspected and corrosion of the braid where it contacted the inside of the PL-259 connectors at either end was identified. The corroded sections were cut out and the connectors re-affixed to the cable. This remedied the problem

[8] There was actually two faults in the Yaesu Musen ATU: the first was that one of the ceramic switch wafers had cracked in half and the other was two faulty detector diodes in the meter circuit. The switch wafer was repaired with J-B Weld, and the diodes were replaced with new 1N4148 fast switching diodes. The unit then functioned correctly

- With the second 813 fitted, it seemed all was now ok with the transmitter in 'CW' mode, with the full 100W output being achieved;

- I then tried swapping in the 1619 tubes from the 'spare' transmitter, though this gave no further improvement in output power, so the original 1619 tubes were re-installed;

- Next, I tried out the 'spare' ATU (which, strangely, had the 0.005uF capacitor (C52) removed completely), and this worked exactly the same as the ATU I had been using with the homebrew goniometer coil fitted. I also inspected the 'spare' ATU's goniometer coils and the rewound one in the unit I had been using looked the same, so it appears that the home brew coil had been wound correctly. I concluded that any remnant problem(s) were not in the ATU;

- I then replaced the tubes back into the 'spare' transmitter unit to try it out 'as-is'. This had also been worked on by someone, who had added some disc ceramic bypass capacitors to the PA stage and replaced some resistors, but all the tubular paper capacitors, as well as the 'bathtubs' were still in place;

- The 'spare' transmitter took a bit of coaxing to get working (likely dirty switch/relay contacts), but when it did power up (photo, right), it pushed out around 85W on 'CW", but again on 'MCW' and 'Phone' the indicated output power was significantly lower than spec. (around the same as for the transmitter I had been working on).

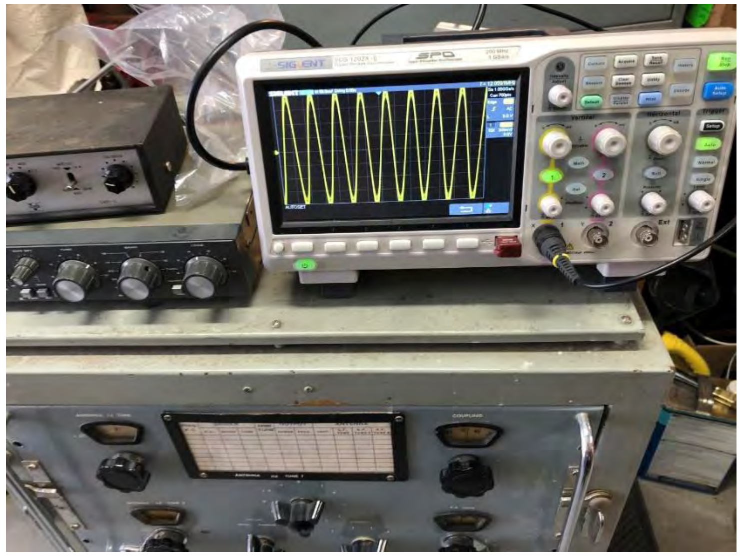
I therefore suspected either:

- A biasing issue on the 813 tube: its very strange it would be the same problem on the two transmitters though – see below;

- A (400v) power supply issue, causing lower drive level to the 813 tube, as the power supply is common to both transmitters (but, if so, why would full power be present on 'CW"?); or

- The SWR/power meter was reading incorrectly. Unfortunately I only had one working SWR/power meter to hand as the Yaesu Musen one was defective.

Regarding the 813 tube bias, from the schematic and circuit description of the transmitter, the lower power on 'MCW' results from the insertion of the modulation transformer secondary winding into the 813 tube's grid circuit, and the even lower power on 'Phone' results from a combination of the modulation transformer secondary winding in the grid circuit plus the shorting out of one of the 813 tube's cathode bias resistors (R18 and R19, with R19 being shorted out). The values of R18 and R19 measured correctly at 1.5Kohms each, and I doubted that the modulation transformer's secondary windings were faulty on both transmitters.



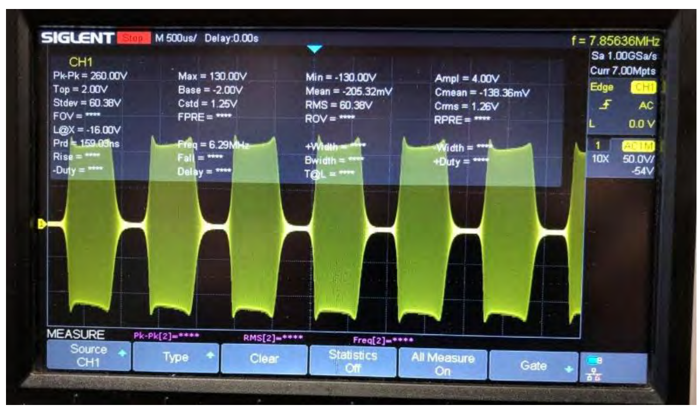
So, I decided to use a 'scope to measure the AC (RF) voltage across the 50ohm dummy load to confirm the output power as being measured on the Vanco SWR/power meter (photo, right). This is a simple technique and is described in a short article, here. There are also several videos on YouTube that describe this technique.

Results:

- CW: peak to peak 220v, RMS 76v = 115W (nice clean sine wave output signal as in photo, above)

- MCW: peak to peak 260, RMS 60v = 72W (see text below)

- Phone: peak to peak 120v, RMS 41v = 33W (nice clean output signal, similar to that on 'CW')



The 'scope trace on MCW showed the signal was over 100% modulated (photo, right), and there is no way of adjusting this in the transmitter. Over-modulation can cause harmonics, and I know the CM-11 has a reputation for generating these. Also, the complex waveform on MCW 'confused' the digital 'scope a bit – it was measuring the frequency as 7.8MHz and the peak to peak voltage measured by the 'scope's acquisition circuitry varied significantly, though the reported RMS voltage was steadier. This sort of waveform could certainly affect an analogue meter reading also (as in the Vanco unit). A video of some of the measurements being made using the 'scope can be viewed here.

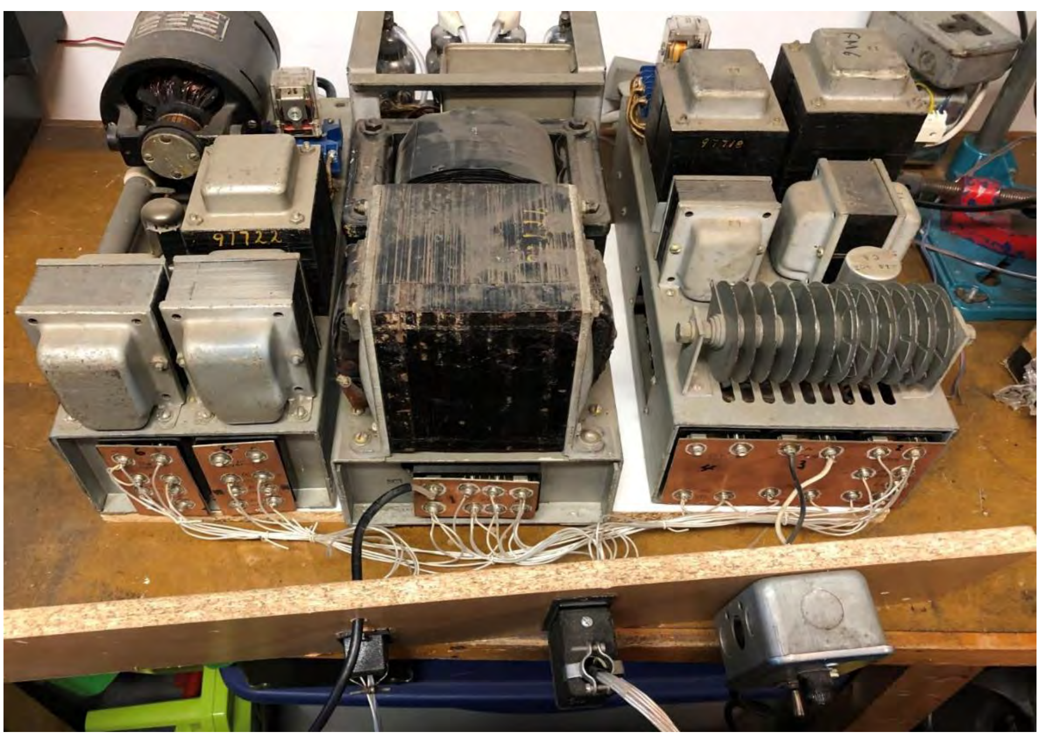
My conclusion was that the transmitter was most likely functioning properly on all modes (if the over-modulation is normal for this transmitter design on 'MCW'), and it was generating the specified power outputs on all modes, ie. the Vanco SWR/power meter was the problem, not the transmitter - I certainly believe a new 'scope and Ohm's law over that old, low-cost SWR/power meter.

Next, I tried the 'spare' transmitter out on 'MCW' mode and the output waveform was identical to that from the transmitter I had been working on, so I concluded that the overmodulation in this mode was normal for this transmitter design. I also obtained another new-looking 813 tube from a friend and I tried that in both the original transmitter and the 'spare' - it worked, but did not produce as much power as the used-looking one (strange - two brand-new looking 813 tubes that only output around 75% of the output of an old, used one).

Closure

The owner collected the complete CM-11 a couple of days later (CSR-5 receiver, transmitter, ATU, the CM-11 cabinet, the 3 power supply chassis and their cabinet, plus the set of interconnect cables). He now has the CM-11 set up on his WWII tugboat and noted it was pushing out over 120W CW on the 20m ham band! (that is actually slightly above the claimed maximum frequency coverage of the CM-11).

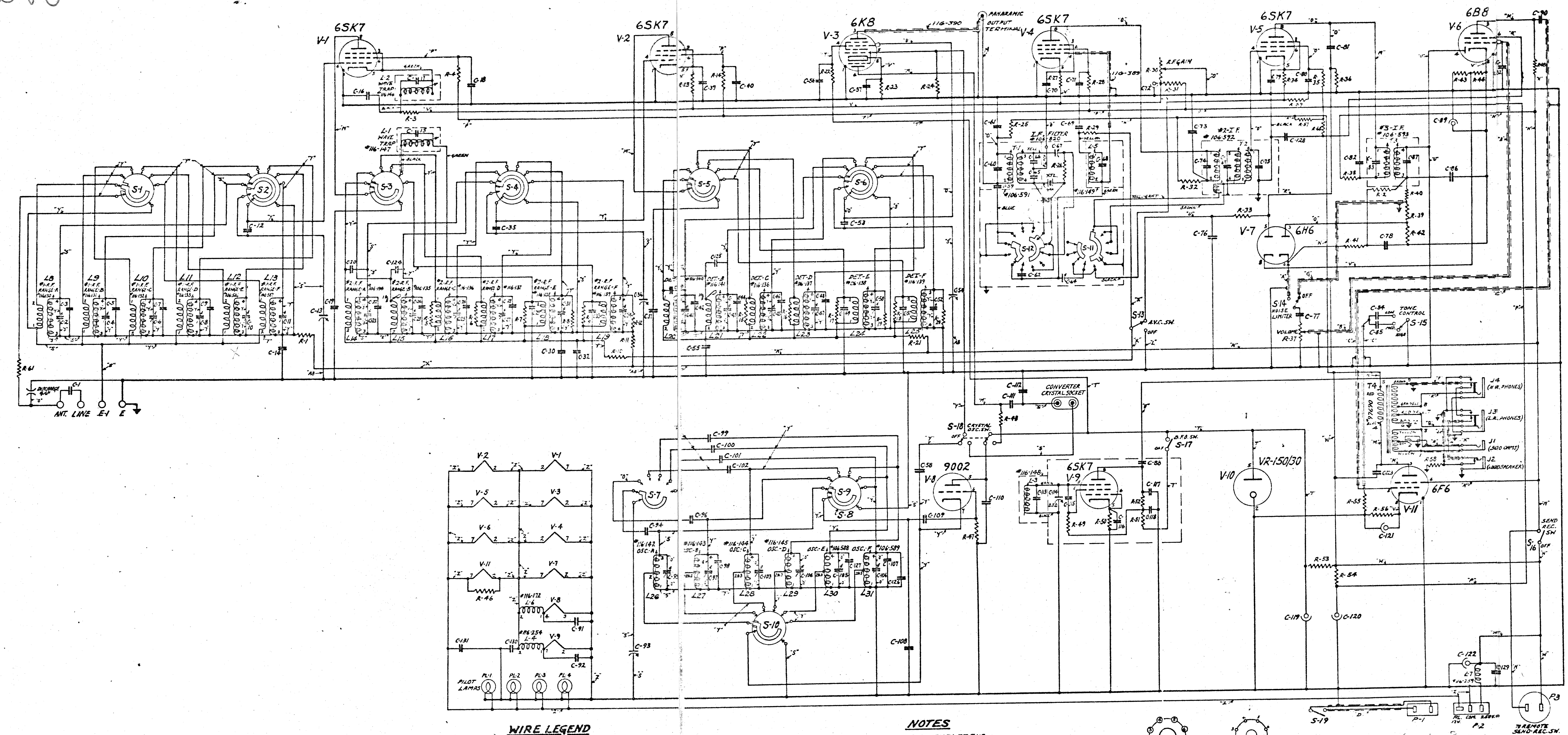
The owner also brought me the remaining parts of his 'spare' CM-11 to work on - I already had the transmitter and ATU from this, and so he brought me a CSR-5 receiver, a second 'spare' transmitter, and the three power supply chassis. The power supply cabinet was not included, and the power supply chassis connect to the CM-11 cabinet via a home-made arrangement built on a piece of chipboard (photo, below). Also, this CM-11 cabinet has been completely butchered, with the phone and remote sockets replaced by jack sockets, all the internal wiring replaced by a festoon of Teflon-coated wiring (photo, above), as well as including some additional miniature relay boards with transistors and IC switching arrangements (why on earth would someone do that?). The power supply chassis have also been modified, with new relays installed, and both transmitters and the CSR-5 receiver have had a few parts replaced, but are in need of a thorough going-over. I intend to take a bit of a 'breather' before I tackle any of these 'spare' units though... so look out for an addendum.



APPENDIX

Schematics:

- Receiver (CSR-5)
- Transmitter (112-912) and ATU (114-906) – both CM-11 and CM-11A
- Power Supplies (102-902, 102-900 and 102-903-A)
- CM-11 Cabling Diagram



OCTAL BASE 7-PRONG (V-8)

BOTTOM VIEW OF VALVE SOCKETS

WIRE LEGEND

"A" = CABLE #111-250
"B" = " #111-251
"C" = " #111-252
"D" = " #111-253
"E"
"F" = " #111-255
"G" = " #111-256
"H" = " #111-257
"J" = " #111-258
"K" = " #111-259
"L" = #108-528, WIRE SPEC. #240 (BLACK)
"M" = " " " #246 (BLUE)
"N" = " " " #242 (RED)
"O" = Nº 20 BARE, TINNED, SOLID CU. WIRE SOFT
"P" = # 108-528, WIRE SPEC. #244 (YELLOW)
"Q" = " " " #256 (RED-YELL.)
"R" = " " " #268 (GREEN-YELL.)
"S" = Nº 14 BARE, TINNED, SOLID, CU. WIRE SOFT
"T" = #108-528, WIRE SPEC. # 254 (RED-WHITE)
"U" = #108-528, WIRE SPEC #245 (GREEN)
"V" = " " " #248 (GRAY)
"W" = " " " #251 (BLACK-RED)
"X" = " " " #241 (BROWN)
"Y" = Nº 22 BARE, TINNED, SOLID, CU. WIRE, SOFT.
"Z" = #108-528 WIRE SPEC. #120-B (BLACK)
"AB" = Nº 10 B&S GA. FLEX. COTTON WRAP, SING. BRAID, NO RUBBER.

NOTES

(1) INTERMEDIATE FREQUENCY 575KC.
(2) RANGE SWITCH (S-1 TO S-10) SHOWN IN COUNTER-CLOCKWISE POSITION (RANGE "A") LOOKING FROM KNOB END.
(3) SELECTIVITY SWITCH (S-11 & S-12) SHOWN IN COUNTER-CLOCKWISE POSITION (MIN. SEL.) LOOKING FROM KNOB END.
(4) ⏚ DENOTES CHASSIS.

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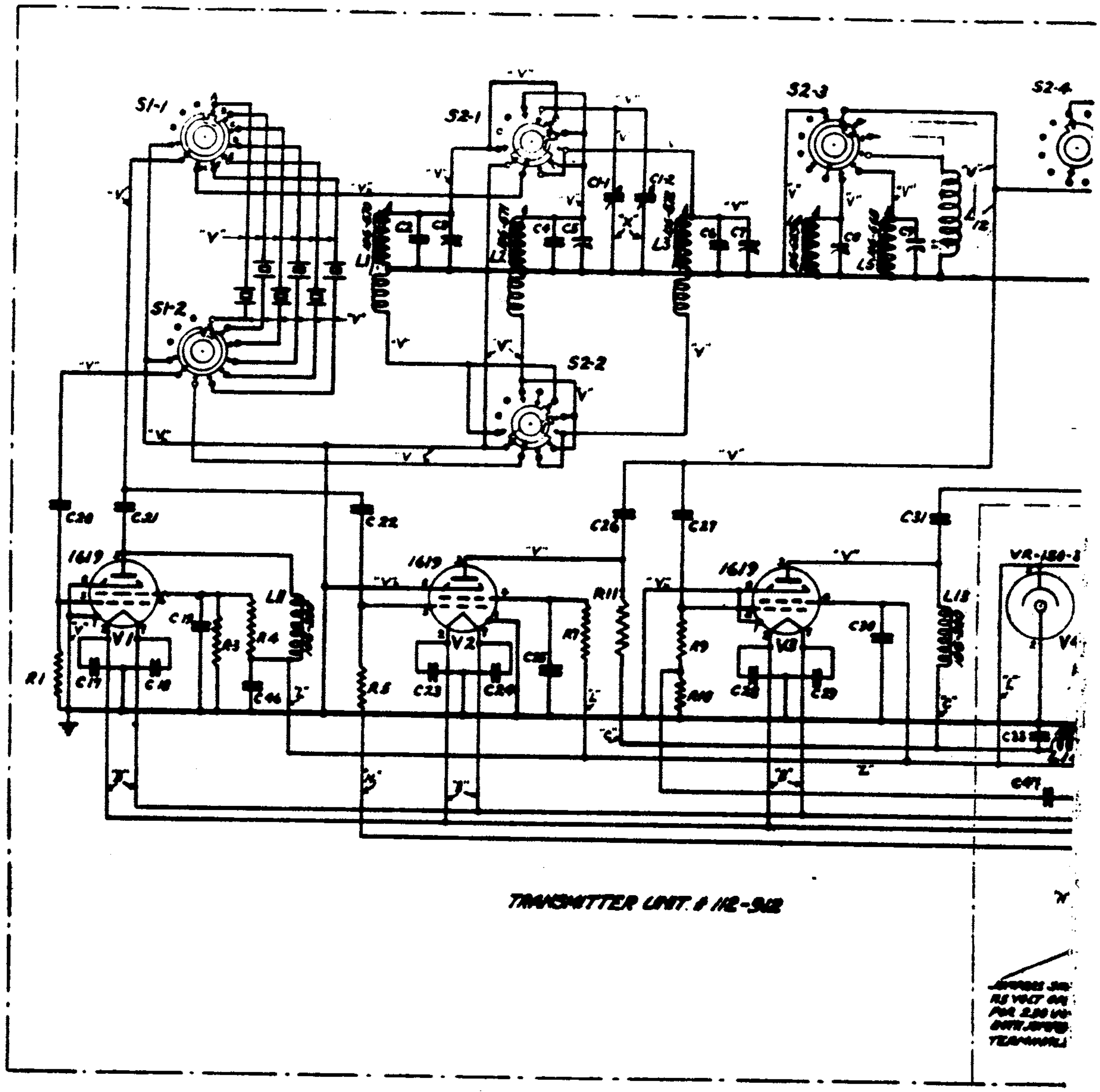
Per ....

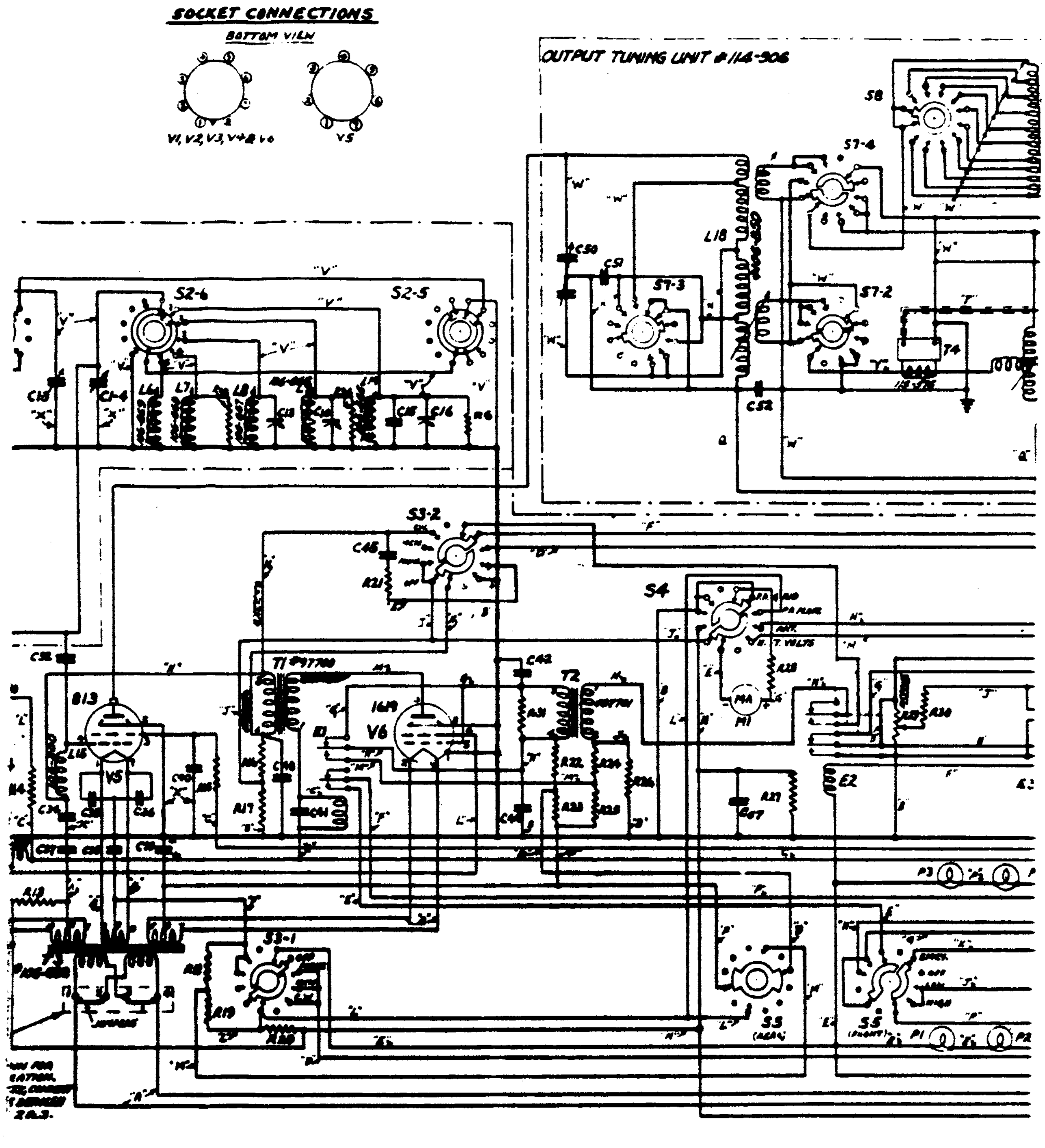
DIAGRAM OF CONNECTIONS CSR-5 RECEIVER

FIG. 41



CANADIAN Marconi COMPANY

MARCONI TM-11



WIRE LEGEND

ALL WIRING TO BE AS PER SPEC. #100-528, UNLESS OTHERWISE SPECIFIED.

"A"	CODE #	189-B (WHITE)
"B"	"	100-A (BLACK)
"C"	"	242-B (RED)
"D"	"	244-A (YELLOW)
"E"	"	273-A (YELLOW/BROWN)
"F"	"	274-A (YELLOW/GREEN)
"G"	"	266-A (GREEN/RED)
"H"	"	268-A (GREEN/YELLOW)
"J"	"	248-A (GREEN)
"K"	"	241-A (BROWN)
"L"	"	246-A (BLUE)
"M"	"	270-A (BLUE/RED)
"N"	"	276-A (BLUE/BROWN)
"P"	"	288-A (SLATE)
"R"	"	280-F (RED/WHITE)

NOTES

(1) ALL ROTARY TAP SWITCHES SHOWN IN EXTREME ANTI-CLOCKWISE POSITION, LOOKING FROM KNOB END OF SHAFT.

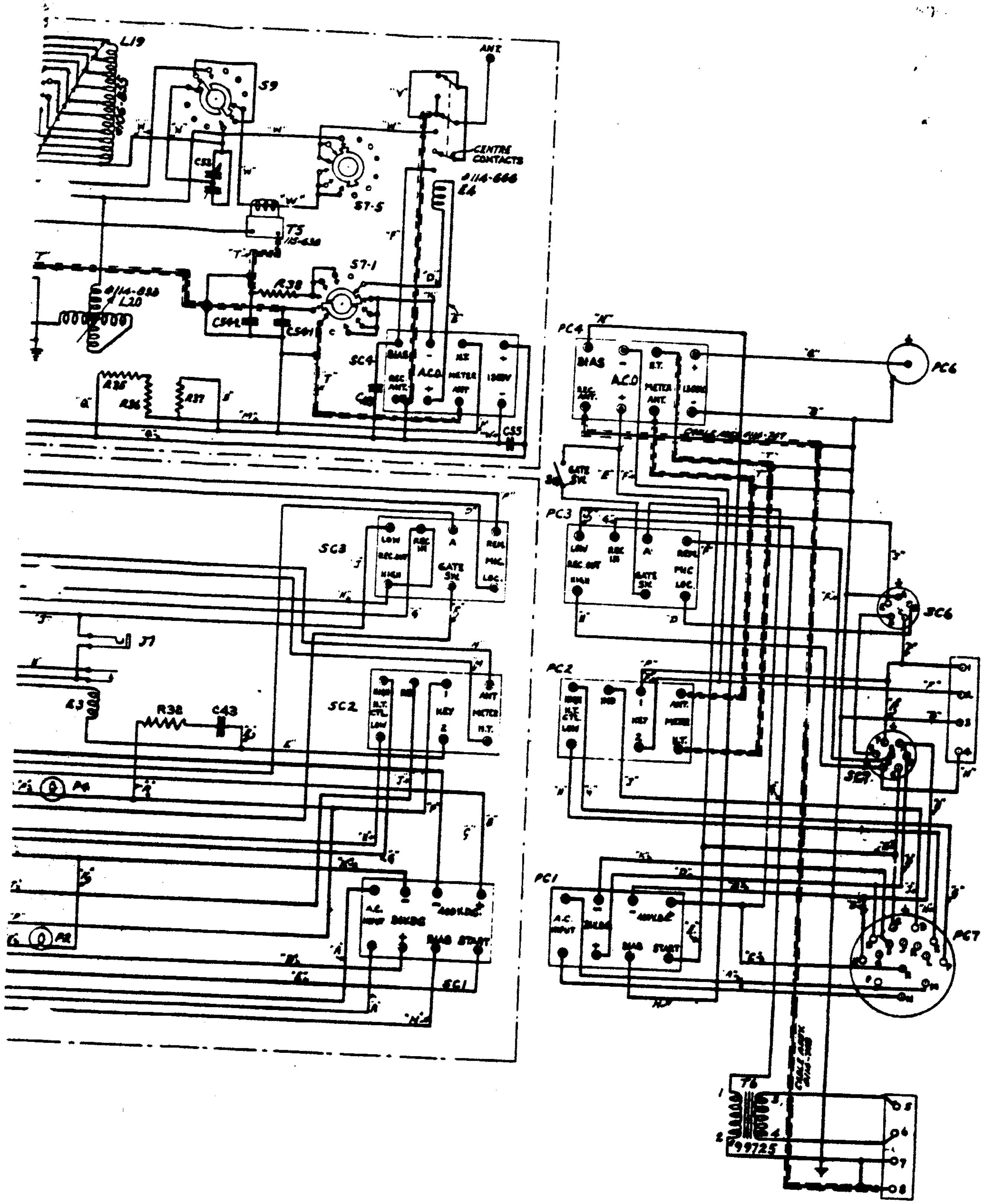
(2) ALL CONNECTORS TO BE WIRED ACCORDING TO DESIGNATIONS AS INDICATED.

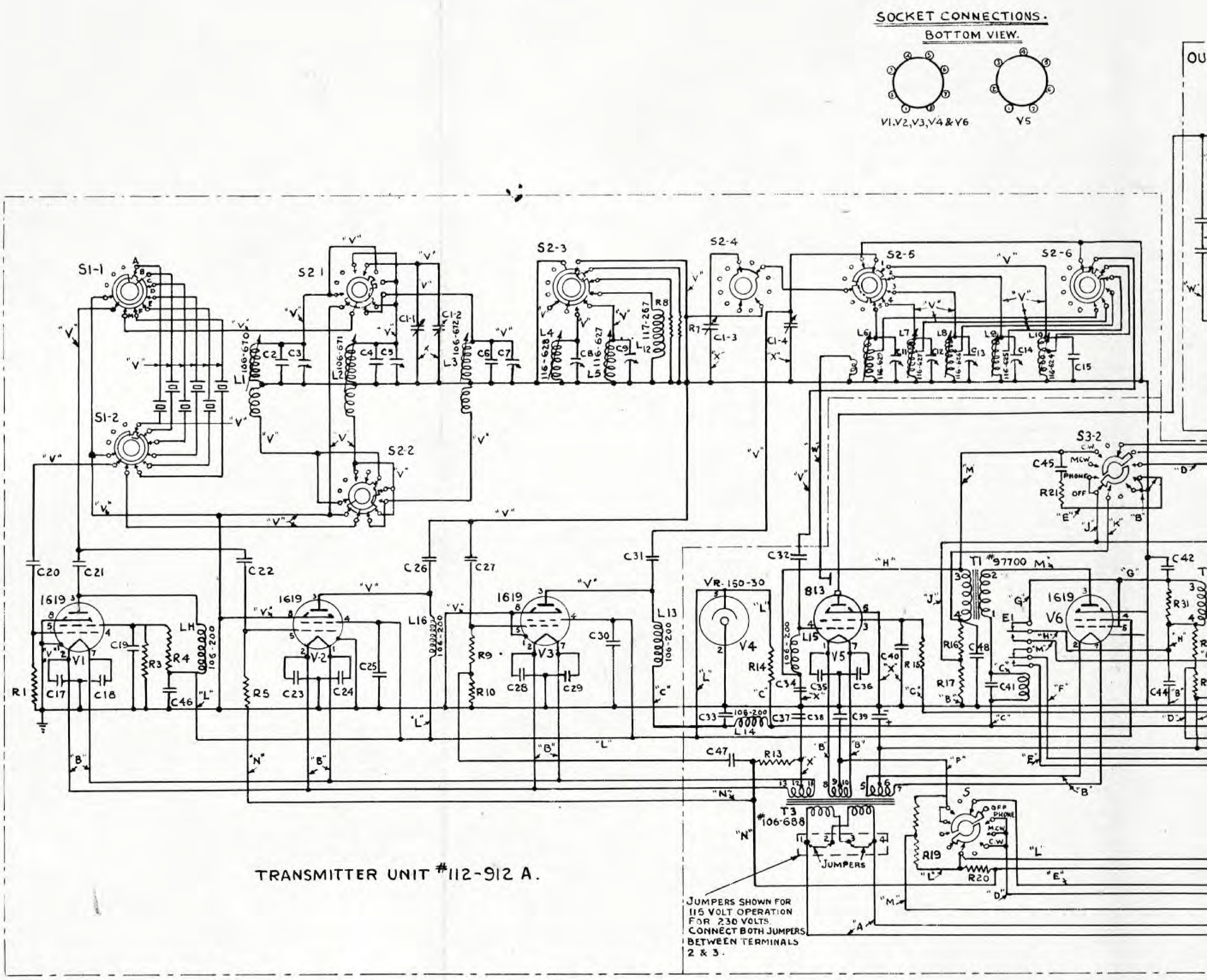
(3) ALL INSULATED WIRES TO BE CABLED TOGETHER WHERE POSSIBLE, UNLESS OTHERWISE NOTED. ALL BARE WIRES TO BE AS SHORT AND STRAIGHT AS POSSIBLE.

(4) SC1 TO SC6 ARE SHOWN TERMINAL VIEW. PC1 TO PC6 ARE SHOWN PRONG VIEW

(5) CONNECTIONS MARKED "X" TO BE GROUNDED TO A COMMON POINT ON THE CHASSIS.

MARCONI TM-11





WIRE LEGEND.

ALL WIRING TO BE AS PER SPECIFICATION #108-528 UNLESS OTHERWISE SPECIFIED.

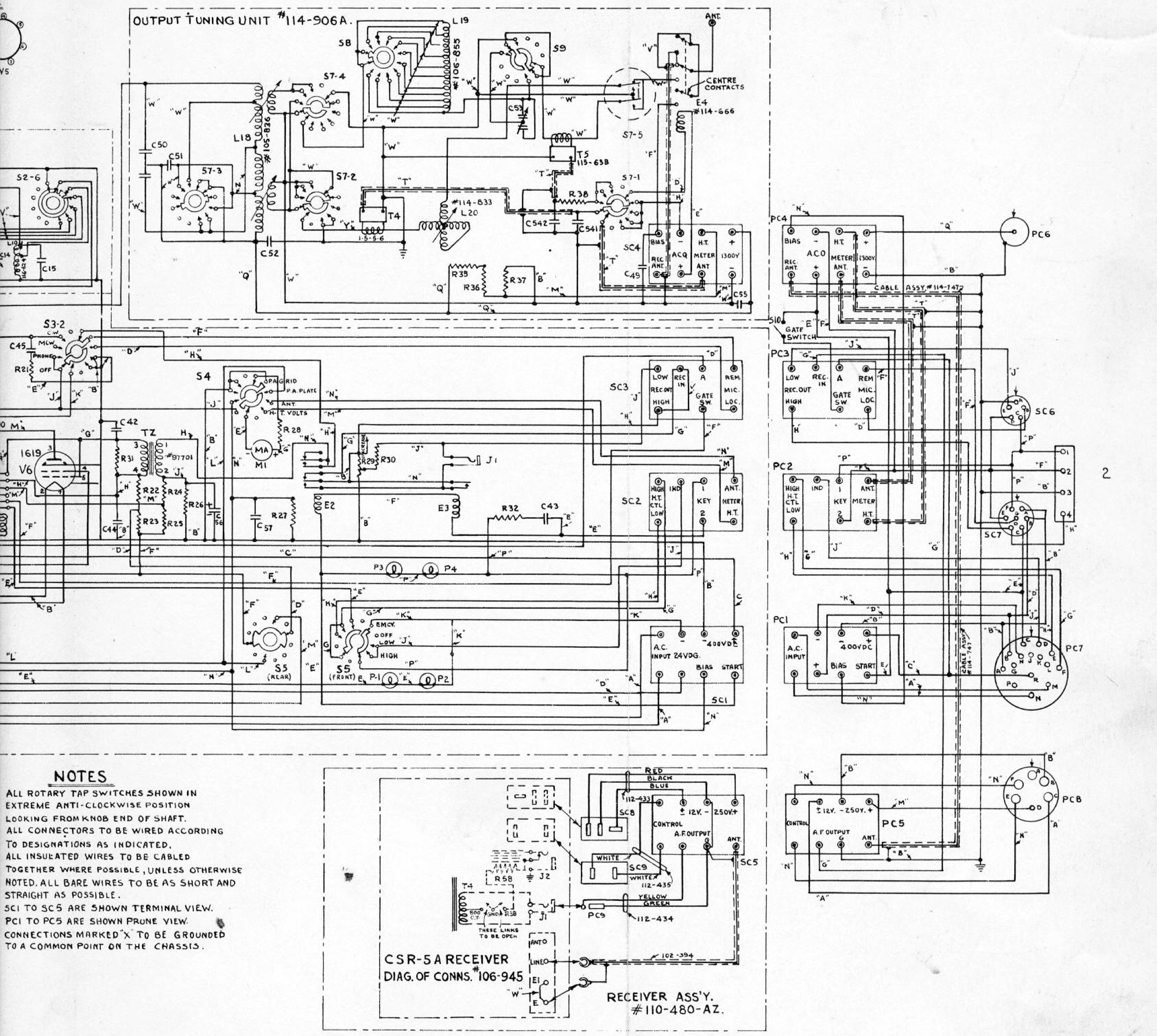
"A"	CODE #	189 B (WHITE.)
"B"	"	180 A (BLACK.)
"C"	"	242 B (RED)
"D"	"	244-A (YELLOW)
"E"	"	273-A (YELLOW/BROWN)
"F"	"	274-A (YELLOW/GREEN)
"G"	"	266-A (GREEN/RED)
"H"	"	268-A (GREEN/YELLOW)
"J"	"	245-A (GREEN)
"K"	"	241-A (BROWN)
"L"	"	246-A (BLUE)
"M"	"	276-A (BLUE/RED)
"N"	"	278-A (BLUE/BROWN)
"P"	"	288-A (SLATE)
"Q"	"	254-F (RED/WHITE)
"R"	"	
"S"	"	
"T"	"	SHIELDED CABLE # 35897
"V"	"	#20 B & SGB. BARE, TINNED, SOLID, CU. WIRE
"W"	"	#14 " " " " " " "
"Y"	"	#16 " " " " " " "

IF NOT OTHERWISE SPECIFIED, WIRING TO BE "B" "P" "V" OR "W" AS.

NOTES

(1) ALL ROTARY TAP SWITCHES EXTREME ANTI-CLOCKWISE LOOKING FROM KNOB END O
(2) ALL CONNECTORS TO BE WI TO DESIGNATIONS AS INDICA
(3) ALL INSULATED WIRES TO BE TOGETHER WHERE POSSIBLE, NOTED. ALL BARE WIRES TO STRAIGHT AS POSSIBLE.
(4) SC1 TO SC5 ARE SHOWN TE PC1 TO PC5 ARE SHOWN PRO
(5) CONNECTIONS MARKED "X" TO TO A COMMON POINT ON THE

Figure 22 CM-11A Tran
110-981A - Diagra



NOTES

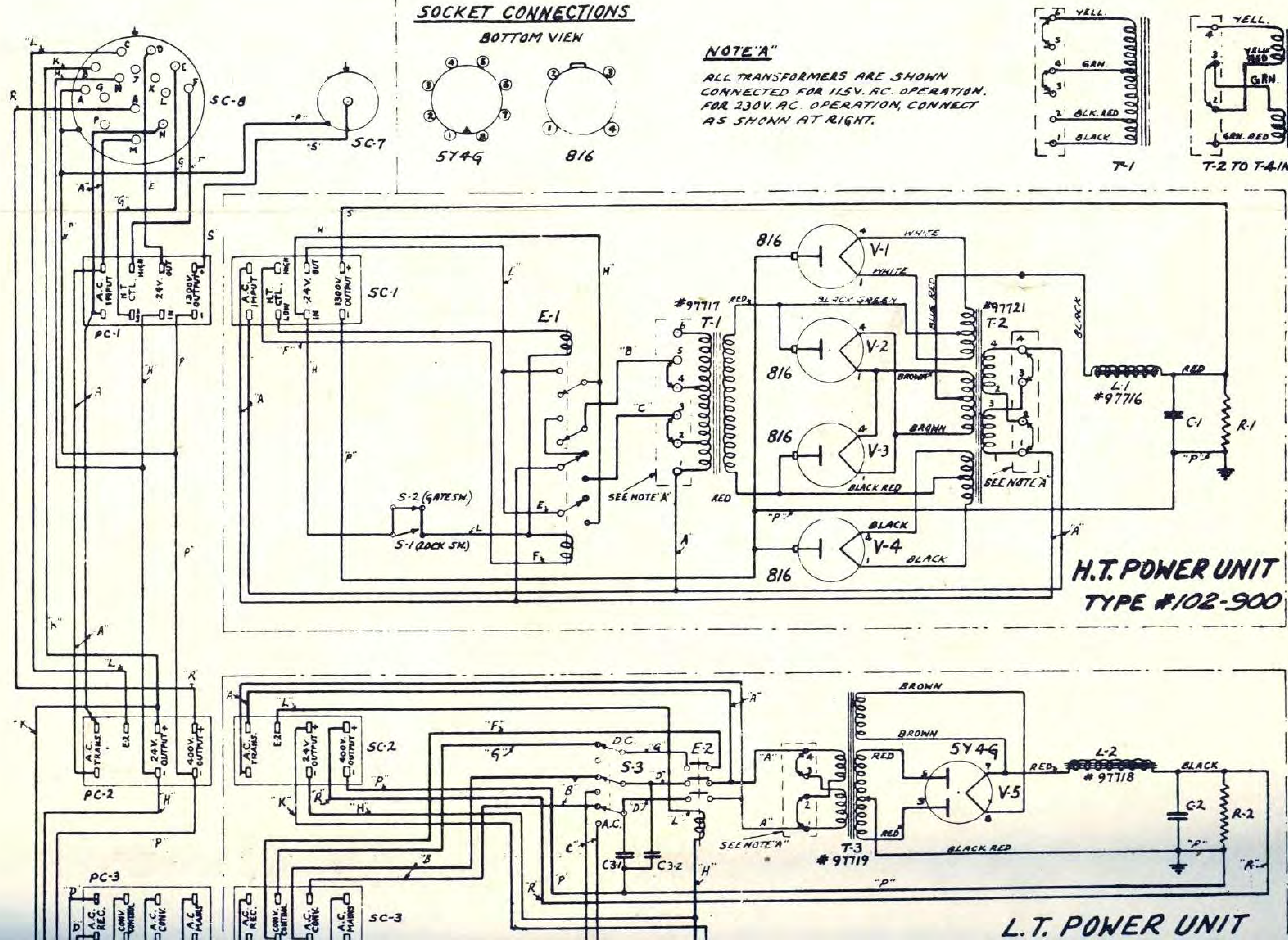
ALL ROTARY TAP SWITCHES SHOWN IN EXTREME ANTI-CLOCKWISE POSITION LOOKING FROM KNOB END OF SHAFT.
ALL CONNECTORS TO BE WIRED ACCORDING TO DESIGNATIONS AS INDICATED.
ALL INSULATED WIRES TO BE CABLED TOGETHER WHERE POSSIBLE, UNLESS OTHERWISE NOTED. ALL BARE WIRES TO BE AS SHORT AND STRAIGHT AS POSSIBLE.
SC1 TO SC5 ARE SHOWN TERMINAL VIEW.
PC1 TO PC5 ARE SHOWN PRONE VIEW.
CONNECTIONS MARKED "X" TO BE GROUNDED TO A COMMON POINT ON THE CHASSIS.

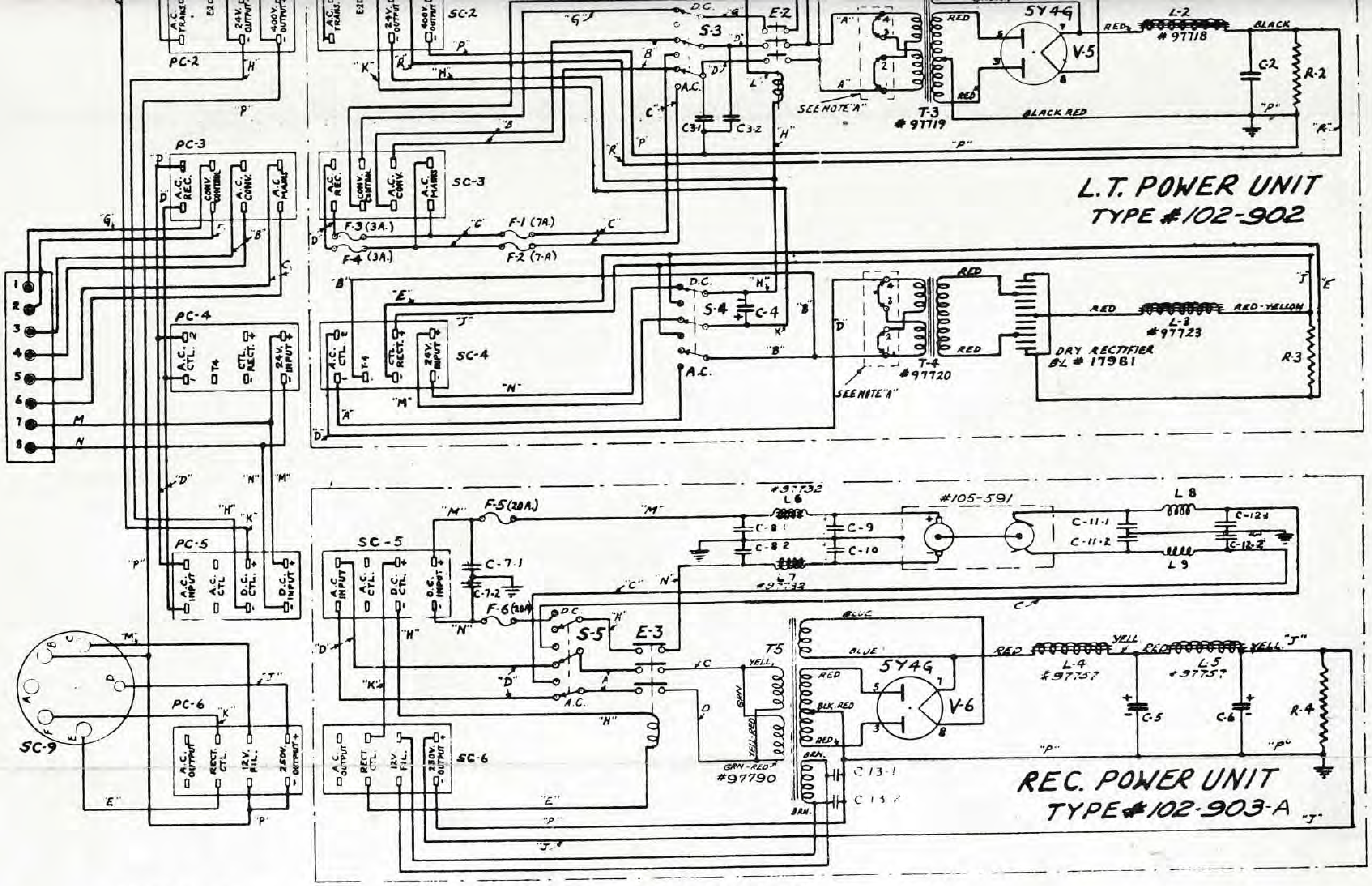
M-11A Transmitter-Receiver Type
1A - Diagram of Connections

FIGURE 22

ORIGINAL

BRCN 2769





WIRING

ALL WIRING TO BE AS PER SPECIFICATION #108-528 UNLESS OTHERWISE SPECIFIED.

"A"	CODE	211-B (YELLOW-RED)	"M"	CODE	96-B (BLUE-RED)
"B"	"	213-B (YELLOW-BRN.)	"N"	"	100-B (BLUE-GREY)
"C"	"	214-B (YELLOW-GRN.)	"P"	"	180-B (BLACK)
"D"	"	212-B (YELLOW-WHITE)	"R"	"	242-B (RED)
"E"	"	245-A (GREEN)	"S"	"	126-F (BLUE)
"F"	"	266-A (GREEN-RED)			
"G"	"	268-A (GREEN-YELL.)			
"H"	"	241-A (BROWN)			
"J"	"	242-A (RED)			
"K"	"	243-A (ORANGE)			
"L"	"	273-A (YELLOW-BRN.)			

NOTES

(1) ALL CONNECTORS WIRED ACCORDING TO DESIGNATIONS AS INDICATED

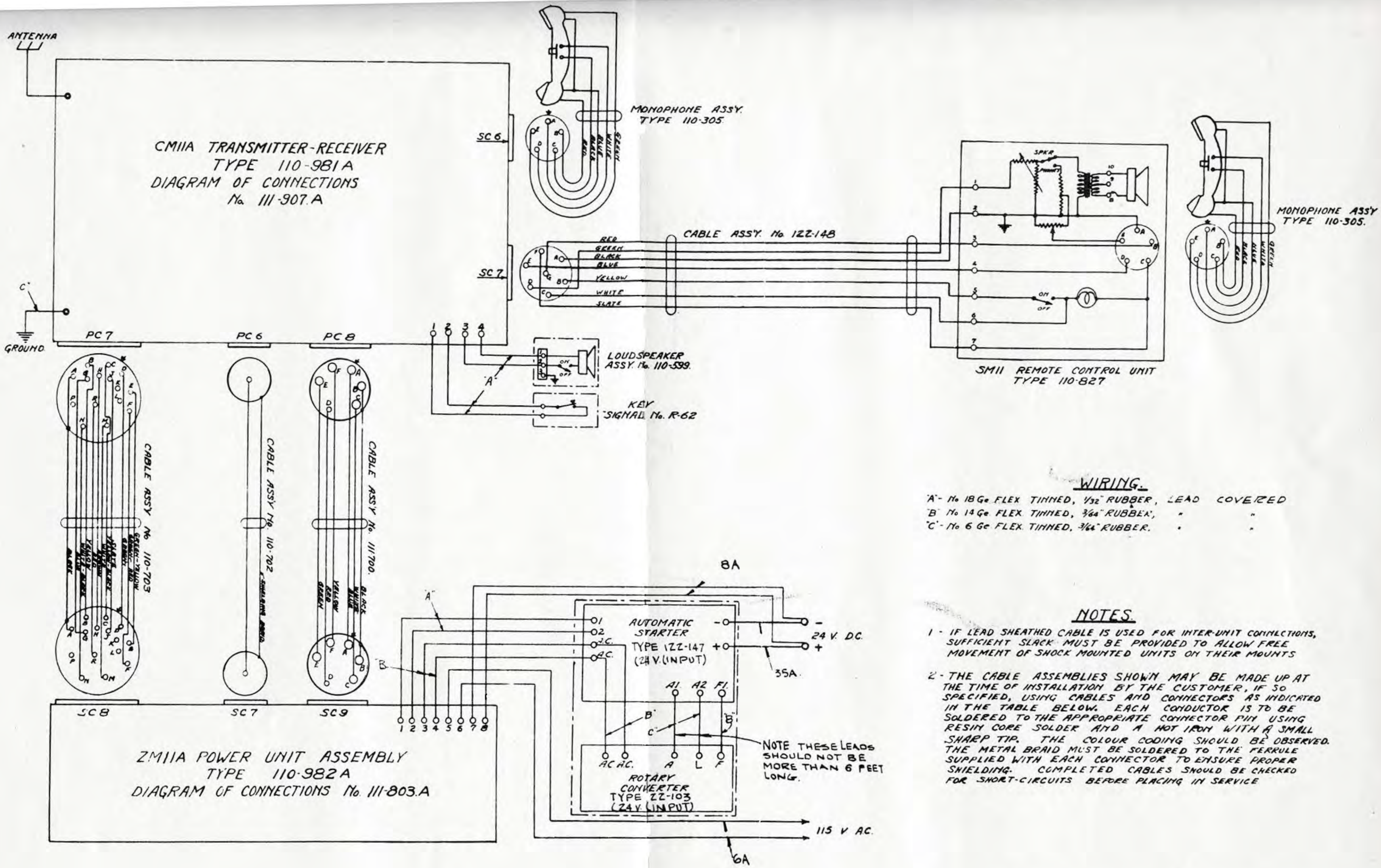
(2) SC-1 TO SC-6 ARE SHOWN REAR OR TERMINAL VIEW.
PC-1 TO PC-6 ARE SHOWN FRONT OR PRONG VIEW.

(3) ALL WIRING TO BE CABLED WHERE POSSIBLE.

(4) TRANSFORMER & CHOKE LEADS TO BE USED WHERE POSSIBLE.

Figure 23 ZM-11A Power Unit
Diagram of Connections

FIGURE 23



WIRING.

'A' - No 18 Ge. FLEX. TINNED, 1/32" RUBBER, LEAD COVERED
'B' - No 14 Ge. FLEX. TINNED, 3/64" RUBBER, " "
'C' - No 6 Ge. FLEX. TINNED, 3/64" RUBBER. " "

NOTES.

1 - IF LEAD SHEATHED CABLE IS USED FOR INTER-UNIT CONNECTIONS, SUFFICIENT SLACK MUST BE PROVIDED TO ALLOW FREE MOVEMENT OF SHOCK MOUNTED UNITS ON THEIR MOUNTS

2 - THE CABLE ASSEMBLIES SHOWN MAY BE MADE UP AT THE TIME OF INSTALLATION BY THE CUSTOMER, IF SO SPECIFIED, USING CABLES AND CONNECTORS AS INDICATED IN THE TABLE BELOW. EACH CONDUCTOR IS TO BE SOLDERED TO THE APPROPRIATE CONNECTOR PIN USING RESIN CORE SOLDER AND A HOT IRON WITH A SMALL SHARP TIP. THE COLOUR CODING SHOULD BE OBSERVED. THE METAL BRAID MUST BE SOLDERED TO THE FERRULE SUPPLIED WITH EACH CONNECTOR TO ENSURE PROPER SHIELDING. COMPLETED CABLES SHOULD BE CHECKED FOR SHORT-CIRCUITS BEFORE PLACING IN SERVICE

CABLE ASSEMBLY DATA

CABLE ASS'Y TYPE	CABLE TYPE	CABLE CONNECTOR TYPE 111-291		MAX RECOMMENDED LENGTH.
		SOCKET	PLUG	
110-702	111-283	MODEL - D	MODEL - C	25 FEET
110-703	111-286	MODEL - H	MODEL G	25 FEET ·
111-700	111-285	MODEL - F	MODEL E	25 FEET
122-106	111-284	— — —	MODEL - B	100 FEET

Figure 24 CM-11A Equipment
Station Wiring Diagram