HEATH Company
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305 TERRITORIAL ROAD BENTON HARBOR, MICHIGAN

March 9, 1956

Mr. Vernon F. Clifford, W2FCQ
15 Carleton Avenue
Islip Terrace, L.I., New York

Dear Mr. Clifford:

Your recent letter concerning the Heathkit Amateur Transmitter, Model DX-100, is appreciated. It is regrettable that a few operating conditions have arisen to prevent you from obtaining the outstanding performance of which this fine transmitter is capable.

We feel that your questions and difficulties can best be discussed and answered through use of the enclosed Service Bulletin covering the DX-100. If necessary, parts will be included with this letter or if they are too large, sent under separate cover. Refer to the attached circuit diagrams and note the green pencil indications covering a circuit improvement that has been incorporated into the oscillator and buffer stages. Should we feel it necessary that other components be replaced, indications will be made on the diagram in red pencil. Any parts that are not included with this letter, but are called for replacement in red pencil, will be arriving soon under separate cover.

It was a pleasure hearing from you once again, and we do sincerely hope that this information will be of some help. If not, you may rest assured that a letter from you will facilitate a prompt answer.

Yours very truly,

HEATH COMPANY

G.R. McCotter

G.R. McCotter
Engineering Consultant

GRM/ed

SERVICE BULLETIN

In the interest of assisting our customers to maintain optimum performance from their Heathkits, this additional information is submitted to afford a better understanding of general operation.

HEATHKIT AMATEUR TRANSMITTER MODEL DX-100

(1) Arcing within the high voltage electrolytic condensers: In the field little or no trouble has been experienced through defective electrolytic condensers in the high voltage section; however they may be damaged if inadvertently they are incorrectly installed or if the 30K 50 watt bleeder resistor should be open or be otherwise defective. If an arcing indication is present in either of the two 125 MFD condensers, inspect first the bleeder resistor. Look for a loose or broken connection and check the high voltage potential by placing the meter selector switch in the "volts" position. Under normal operation the plate voltage will fall somewhere between 740 and 820 volts depending upon line supply voltage and individual transformer characteristics. If the voltage indication should be more than 820 volts, the condensers might then break down.

An open bleeder resistor or a defective high voltage filter capacitor may show up by other indications than an audible sound. Distorted audio, downward or inadequate modulation may result as well as extremely low plate voltage.

(2) When operating the DX-100 under full load there will be some sound in the high voltage transformer and choke. This, of course, is normal provided the sound remains at a low level and cannot be heard at distances greater than 8 or 10 feet from the transmitter. When operating phone, the modulation transformer will "talk back" at a low level. This should not be sufficiently high to cause feedback if the microphone is located near the transmitter.

(3) Downward modulation and splatter: Splatter that may be detected by extremely wide band width and/or distortion in the audio is generally caused by over modulation, that is, greater than 100%. If splatter should be detected and it can be determined that the transmitter is not being over modulated, the difficulty might then be traced to a defective condenser, and a check of the .02 MFD 1.6 KV disc ceramic capacitor directly across the secondary of the modulation transformer and also the .1 MFD capacitor from pin 3 of the first 1625 to ground should be made. It may also be well to reverse the plate caps on the two 1625 modulator tubes.

An indication of downward modulation that may be detected through use of a 100 watt lightbulb for a dummy antenna or "on the air" checks once again may be created by a defective .02 MFD 1.6KV capacitor or a defective (possibly gassy) 1625 tube. Once again, an open section in the bleeder resistor or a leaky 125 MFD high voltage condenser may result in an indication similar to downward modulation. Also a shorted turn in the modulation transformer or a 500 ohm tap accidentally shorted at the terminal strip.

The possibility of weak 5R4GY rectifier tubes must be taken into consideration if quality of modulation is not up to standard. For good audio quality the importance of a satisfactory microphone cannot be stressed too strongly. The DX-100 will operate satisfactorily with most all high output, high impedence microphones. These include ribbon, dynamic or crystal. Generally, a cardioid microphone is not satisfactory due to relatively low sensitivity and output.

(4) Insufficient excitation, gradual drop off of available grid drive during prolonged phone operation, spurious oscillation and minor key chirp: A simple circuit improvement has been discovered by our engineering department and it may be advisable to include this change if the conditions mentioned at the heading of this paragraph are present to a greater or lesser degree.

The circuit addition consists of bypassing the cathodes of the 12BY7 and the 5763 tubes to ground. The bypass condensers should be disc ceramic with a value of .005 MFD. Actual installation is as follows: At the 12BY7 socket between pin 1 and 3, on the 5763 socket between pins 7 and 3. The capacitors should be installed directly on the tube sockets for best results. The purpose of this ci cuit addition is to increase the overall available grid drive. This will be apparent particularly when operating the 15, 11 and/or 10 meter frequencies. Bypassing the cathodes in the above prescribed manner will also reduce a tendency towards a downward drift in excitation during prolonged phone transmissions. Thirdly, it is found that the keying characteristics of the oscillator stage are improved to some extent. It also may be wise to clean the key contacts.

While on the subject of keying and varying grid drive, it may also be advisable to check three tubes in the transmitter, the 6AU6, 12BY7, and 5763. In the event of severe keying chirp, frequency shift and other detremental operating characteristics, and if bypassing the cathodes does not improve operation, no doubt substitution of one or all of the above mentioned tubes will be the only other change necessary to the VFO Oscillator and buffer stages.

On some very rare occasions, bypassing the cathodes of the oscillator and buffer tubes, as well as direct substitution, may not give sufficient drive on the 10, 11, or 15 meter bands. There is one other inspection that should be made and this is in reference to the 10-15 meter driver coil. It is the small center tapped air core coil located beneath the chassis at the rear of the front center compartment. Perhaps in the installation of this coil, the turns were compressed sufficiently so as to drastically change the inductance and over-all distributed capacity. Spread these turns beginning each side of center tap. The coil may be spread by merely pulling outward between each end and the center tap position.

In the event of severe keying chirp, frequency shift and other detrimental operating characteristics, and if bypassing the cathodes does not improve operation nor does tube substitution increase the over-all available excitation, then possibly the only other change necessary will be spreading the turns of the 10-15 meter driver coil.

(5) Ocassionally it may be noted that the final amplifier will tend to draw excessive current and no adjustment of the final amplifier tuning condenser will bring the dip indication down to a reasonable level. Should this condition be experienced, it can generally be traced namely to unsatisfactory antenna requirments, thereby constituting a high Standing Wave Ratio (SWR). If such should be the case and there is an intollerable SWR, the pi-network cannot effectively match the impedance of the transmitter to the impedance of the antenna. Bear in mind that a pi-network is not a true loading circuit but is a device to match impedance! If your antenna is not satisfactory for certain frequencies, then the impedance mismatch might rise to several thousand ohms. Should this happen, a high voltage will develop across one or several of the components in the pi-network. Subsequent failure of the capacitor may result, reflecting back to the final amplifier and plate tank coil. This condition also promotes excessive heating of the tank coil due to high circulating current. Therefore, should the final plate coil become sufficiently hot to melt the coil form and distort the physical appearance of the coil, it is then, of course, necessary to replace not only the coil 40-55 but possibly the loading capacitor as well, 20-45. In general poor loading characteristics may be attributed to (1) inadequate antenna facilities, (2) the possibility that a defective loading capacitor was included with the kit, or that it has been damaged while in operation and (3) parasitic oscillation within the final amplifier.

If severe heating of the 27K $\frac{1}{2}$ watt resistor located at the grid, Pin 8, of the 5763 tube should become extremely hot this then should be changed to a value of approximately 2 watts. This condition arises only when there is excessive excitation and the heating is due to an over amount of RF. Also reposition the resistor so that it may be kept as far as possible from the hole in the chassis plate located directly beneath the driver coil. The driver coil located directly over this hole does offer a chimney effect. Thus, extreme heating of the 27K resistor causes a convection through the center of the driver coil and therefore will change slightly the characteristics of this component.

(6) Parasitic or self oscillation: Assuming that all requirements so far discussed have been met, but the final amplifier will not dip or show resonance, it will then be necessary to look for parasitic oscillation. This condition might result if one or both of the 1300 MMF capacitors between pin 3 of each 6146 tube and ground were defective or incorrectly installed, i.e., loose connection. Gassy or "soft" tube or tubes in the final amplifier (6146), incorrect adjustment of the clamp circuit, a defective 6AQ5 clamp tube or a shorted as well as otherwise defective 1MH 500MA RF choke.

Generally, parasitic or self oscillation will show up in one of two common characteristics, either inability to obtain a satisfactory final amplifier dip indiation or strong harmonic output. Generally, however, harmonic output within the DX-100, (which is the exception rather than the rule) is through incorrect loading of the final amplifier, unsatisfactory adjustment of the oscillator stage, incorrect choice of crystal or improper calibration of the VFO. If the tank were tuned to a harmonic or should the antenna favor a harmonic frequency, the above conditions may show up.

(7) Operation of the DX-100 at reduced RF output: Many customers have asked us how they might reduce the RF output of the transmitter for novice operation as well as for using the transmitter as an exciter for a high power RF final. Power reduction can be accomplished by loading technique, that is, placing the pi-network in such a position that the transmitter loads somewhere below 150 ma. The RF output can also be controlled to some degree by varying the amount of available grid drive or in other words, excitation. One other very satisfactory method of reducing power output in a more or less permanent manner is through use of the clamp control adjustment, that is, the screw driver adjustment located on the chassis base directly behind the panel. Follow the manual instructions for initial setup and test of the transmitter. Then load to a satisfactory antenna as would be the case for normal operation, let us say for example, load the final amplifier to 250 ma. Then, using a screw driver turn the clamp control counterclockwise (this is done with the plate switch on) until the plate current indication on the DX-100 panel meter falls to the desired level, that is 100 ma or below. Through this method then, it will be impossible to exceed the FCC power input regulations for novice operation. The output of the transmitter cannot be increased then until the clamp control is reset.

(8) Variations in driver plate current: The driver plate current may not necessarily remain at a constant or specified level in direct proportion to frequency of transmission. The driver plate current will vary from frequency to frequency and from kit to kit. It is not at all critical and therefore we do not state in the manual any specified driver current reading. When operating the higher frequencies such as 10, 11 or 15 meters, you will notice a slight drop off in available grid drive. The circuit improvement mentioned in a previous paragraph will, to some extent, offset this characteristic. However, it is normal to expect a lower excitation current on the higher bands and if somewhere between 3 and 4 ma. can be maintained with the plate switch "on", this is sufficient to drive the DX-100 to its maximum rated RF power output at these frequencies.

At this point it should be mentioned that the grid drive may not necessarily be reduced to zero when operating the 40 meter band using VFO excitation. Note that the VFO operates on a fundamental of 160 meters and doubles to 80. On 40 meters once again it becomes fundamental then doubles to 20 and triples to 15 meters. The fact that the oscillator circuit becomes "straight through" at a frequency of 40 meters, and at this point generally available excitation is extremely high, there may be some residual indication with the panel meter selector switch in the grid position even with the drive control at zero. This we mention as it does not in any way indicate an abnormal operation or an error in wiring. It will not prove detremental to the normal operation of the transmitter.

The plastic dial included with the DX-100 VFO unit is identically the same dial as is used in our VF-1 Variable Frequency Oscillator. Note that the dial includes two 40 meter calibrations as is necessary in the VF-1. However, the VFO unit in the DX-100 requires use of only one scale for 40 meters and this is the scale marked in megacycles, not the scale marked in KC. Completely disregard this particular 40 meter calibration.

(9) Voltages: There is no voltage chart included with the DX-100 construction manual. Due to the fact that most voltages within the circuitry of this transmitter are lethel, we feel it advisable not to include any check points. Of course, the plate voltage may be checked on the DX-100 panel meter and should fall somewhere within the specifications mentioned in an earlier paragraph. The low voltage B supply will deliver somewhere between 350 and 410 volts. The actual voltage will vary depending upon power line supply voltage and individual power transformer characteristics. Therefore, it should be necessary only to check the B potential in the low voltage power supply at the 40 MFD condenser, Reference to the circuit diagram will show the correct point to make a check as it is designated as "M". Generally, it will be noted that the plate voltage on the 6AU6 VFO tube will run 375 volts or slightly higher. This is not harmful to the tube itself nor will it appreciably shorten its life.

(10) General: If at any operating frequency the chassis, cabinet or panel of the DX-100 should become "hot" with RF, this is an indication that grounding facilities are not adequate. In some locations, that is if the transmitter is located on the second story or quite some distance to a good earth ground, it will be found necessary to run two or possibly three separate ground wires from the transmitter itself to earth ground. Each ground wire should be sufficiently heavy as is recommended in the manual and of a different engtth to prevent the possibility of anyone or all of the leads becoming resonant at any specified frequency. Do not rely entirely on a waterpipe for a satisfactory ground connection. Copper ground stakes at least six feet long should be used. If the ground is damp most of the time, generally one is sufficient. If in doubt, use two or three stakes, placed about three feet apart and each one tied together by heavy copper wire. To be doubly safe throughout the summer months keep the ground around the stakes wet.

When operating phone it may occasionally be noticed that the idling current of the modulator stage is appreciably higher or, in some cases, lower than the specified 50 ma in the construction manual. An idling current of 50 ma is by all means only an average. If, due to individual tube characteristics, an idling current of up to 75 ma is experienced, this would then possibly point to a "soft" tube. An unusually low idling current of, say, 25 ma indicates a "hard" tube, these limits are not seriously out of line; and no further consideration for the time being should be given this circuit. On the other hand, if an idling current upwards of 100 ma is noted then one or both of the 1625s should be replaced. If replacement at this time does not help, check all components within the circuitry of the modulator tubes.

Parts placement and lead dress throughout the DX-100 is of the utmost importance. We strongly urge the kit builder to follow exactly the step by step instructions and pictorial diagrams included in the manual. Above all, if difficulty is experienced a visual check should be made. Resolder any connections that look doubtful, that is, loose or "cold".

Antenna requirements and facilities for the DX-100 is of prime importance. This is true not only for the Heathkit transmitter but is the case with any RF transmitter. Give your antenna considerations some thought. Do not under any circumstances exceed the matching limitations afforded by the pi-network. If at some frequencies certain specific antennas require more than 600 ohms matching between the radiator and the transmitter, it will then be necessary to choose a separate antenna coupling device to fit your own specific requirements.