The Scoon Machine Revisited

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<u>The “Scoon Machine” Revisited</u>

<u>Background</u>

In May 2001 the British Rife Research Group learned of a Rife machine being offered for sale. It resembled in many respects the machines known to have been made by Verne Thompson in the years during and after WW2. Stuart Andrews, having visited the vendor and inspected the machine, decided to purchase it and ship it to the U.K. There it was examined and tested mainly by Aubrey Scoon and Stuart, who presented Aubrey’s paper about the machine at the Las Vegas Rife conference in March 2002.

Soon after the arrival of the machine at Aubrey’s home I joined him there and we carried out some initial tests. I prepared frequency calibration charts for each position of the modulation oscillator’s four decade rotary switch. Copies of some old diary pages had been supplied with the machine, on which were written the names of various pathogens and diseases, along with associated dial settings and switch positions. The handwritten names and settings produced modulation frequencies corresponding to the familiar Crane MORs, such as 728, 880, 2008 and 2128 Hz*, but only if the decade range switch was set to the next position below that recorded on the diary page.*

There had been no reports of the use of a set of frequencies which were a decade higher than the familiar Crane MORs, the latter had been documented and used for many years. To an electronic engineer, a loose or wrongly positioned knob is just one of those things you expect to find from time to time on used equipment. Loose knobs on rotary switches are not unusual, and the knob on the range switch could easily have loosened and been re-tightened in a different position.

The diary settings could have been written down when the range selector knob was in a different position on its shaft. A frequency meter would not have been necessary to calibrate the machine. If another Rife machine with known pathogen settings had been available and set to each of the Crane frequencies in turn, our machine could have been tuned so that its audio output was in zero-beat with that of the other and its own dial and switch setting recorded. We knew it had been restored by the previous owner, and this would have entailed removal of the front panel and also the knob of the range switch in order to gain easy access to each chassis.

A phanotron tube fitted with a gas tap was supplied with the machine. The tube was unusable due to air ingress at the glass/electrode seals. A replacement phanotron made by Bill Cheb was connected to enable an initial test of the machine. It was not possible to measure precisely the frequency of the RF carrier because of the unstable waveform, but it appeared to be in the region of 4 to 5 MHz.

At the time it seemed to me that we had bought a machine which was intended to generate the well-known Crane frequencies which would modulate a fixed radio frequency carrier. We knew virtually nothing about its history, effectiveness, or what alterations might have been made during its restoration to a state of apparent functionality. I was disappointed to find that it was evidently not designed to produce radio frequency MORs as were the earlier No. 3 and No. 4 machines.

Stuart and Aubrey did not share my opinion. They believed the machine was an important new discovery providing evidence of the use of frequencies ten times higher than the Crane frequencies which had been used for many years in both pad and plasma tube machines. I had satisfied my curiosity and reached a different conclusion.

Following their deaths in 2009 and 2014 respectively, there remains a continuing interest in what has become known as the "Scoon Machine". Jeff Garff has described it as the "second most important machine to have been analyzed by his group". For a number of years Jason Ringas of the Canadian research group has encouraged me to re-examine it in greater depth and has kindly supplied type 812 triodes to enable further tests to be carried out. These notes document my findings.

A reader without prior knowledge will need to refer to Aubrey Scoon's and Jeff Garff's descriptions, schematics, opinions and speculation regarding this machine. These can be found on Peter Walker's website, www.rife.de. One version of Jeff's "History of Rife's Instruments and Frequencies" may be found in the Articles section. Aubrey's "1939 Beam Ray Machine" and "1939 Beam Ray Analysis" are in the Research section. The author acknowledges the valuable assistance in identifying components provided by Roger Blain's well-researched and informative report "The AZ58 Revisited".

Machine Construction

The large steel chassis of the modulation frequency generator occupies the upper part of a heavy grey steel cabinet and is screwed to brackets attached to the front of the cabinet. On it are assembled the components of an EICO 377 Wien bridge frequency generator which may have been supplied as a kit. Outline markings show that an EICO chassis, which was smaller, had been used to make a template for drilling the larger chassis upon which the components are now assembled.

The shafts of the three controls, the decade range switch, tuning capacitor and modulation amplitude control, protrude through holes drilled in the front panel of the cabinet. There is a large hinged access hatch in the top of the cabinet.

The RF oscillator and its power supply are assembled on an identical chassis screwed to the floor of the cabinet. In common with the upper chassis, the lower is stamped with the letter ”Z”. Both appear to be of the same age and were made by Bud Radio of Cleveland, Ohio, as were the mounting brackets and steel cabinet.

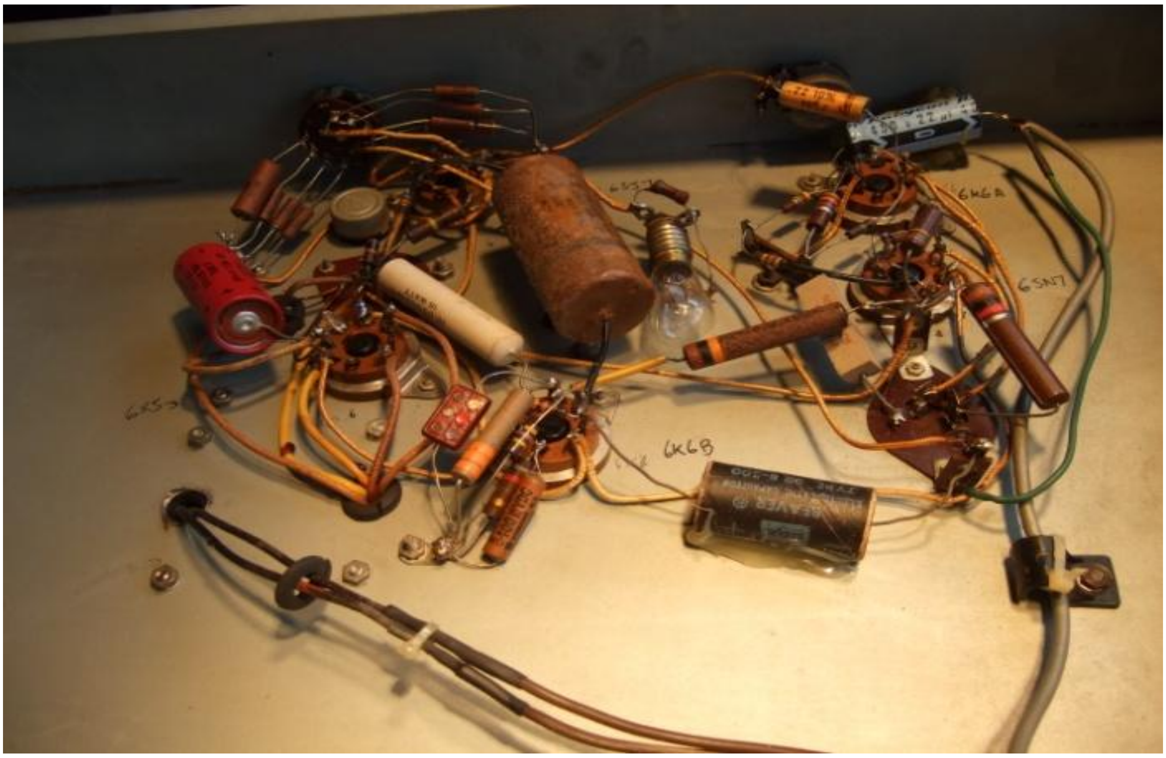
Modulation Frequency generator

Early EICO 377 frequency generators were supplied with a 4-gang variable capacitor, but at a later date EICO changed to the 2-gang type kit, suggesting that this machine was a made in the mid-1950s or later.

These sine-wave frequency generators incorporate a 6SN7 double triode and a switch to provide an optional square-wave output, but there is no provision to provide a signal path through the 6SN7 and related circuitry in this machine, even though the necessary components are present on the chassis and are powered.

The Wien bridge circuit generates a 50 - 60 V peak-to-peak sine wave which is coupled via the 50K amplitude control potentiometer to a 6K6A pentode, wired as a cathode follower. This provides a comparatively low output impedance, measured as 250 ohms, the output being AC coupled to the grid of the 812 RF oscillator via the original EICO output electrolytic of 22 microfarads and a 1mH RF choke in series. The low output impedance and the high capacitor value play a part in determining the response of the RF oscillator to a modulating signal, which will be described in a later section dealing with modulation tests.

Figs 1 and 2   Modulation frequency generator (EICO) chassis



The EICO frequency adjusting knob, cursor and scale supplied with the kit were not used. Instead a “Velvet Vernier” 5:1 slow-motion drive with a 180 degree, 0 to 100 scale, made by National Company Inc. of Malden, Mass., was mounted on the front panel of the cabinet. Two sets of four mounting holes for the drive had been drilled in the front panel, one set being an eighth of an inch too high (Fig. 3). This may be indicative of a failed initial attempt to achieve alignment between the axis of the drive and the capacitor shaft, rather than suggesting a change of audio oscillator, for which there is no evidence apart from four holes in the cabinet where the brackets had apparently been mounted two inches lower. If the machine had originally been fitted with an earlier type of modulating frequency generator then the complete chassis had been replaced and the same brackets re-used.

Fig, 3 Mounting holes for slow-motion drive

An insulating disc coupler acts as a universal joint between the slow motion drive and the variable capacitor shaft. Close examination revealed that the axes of the slow-motion drive and the variable capacitor had at some stage become misaligned, possibly by chassis movement due to impact in transit, and undue stress had been placed on the coupler. As a result, the bosses on either side of the insulating disc had loosened from their springy metal “spiders”, allowing the capacitor shaft to rotate with respect to the scale.

I soldered the bosses securely to the spiders to eliminate slippage and allow repeatable setting of the capacitor.

The discovery of movement between the rotating scale and capacitor shaft means that no reliance can be placed on the readings made by myself in May 2001 or those made by Aubrey and sent to me in November of that year, which differed slightly. It is not known when slippage first occurred between the capacitor shaft and the dial.

As the rotor of the variable capacitor is turned towards the position of minimum capacitance, the moving vanes approach within a tenth of an inch of the chassis (Fig. 4). The increasing capacitance between rotor vanes and chassis partially offsets the diminishing capacitance of the variable capacitor, causing a reduction in the slope of the frequency versus dial position curve over the last five degrees of rotation. EICO's design department was aware of this: one type of scale supplied with the frequency generator has greater spacing between frequency markers at the high-frequency end.

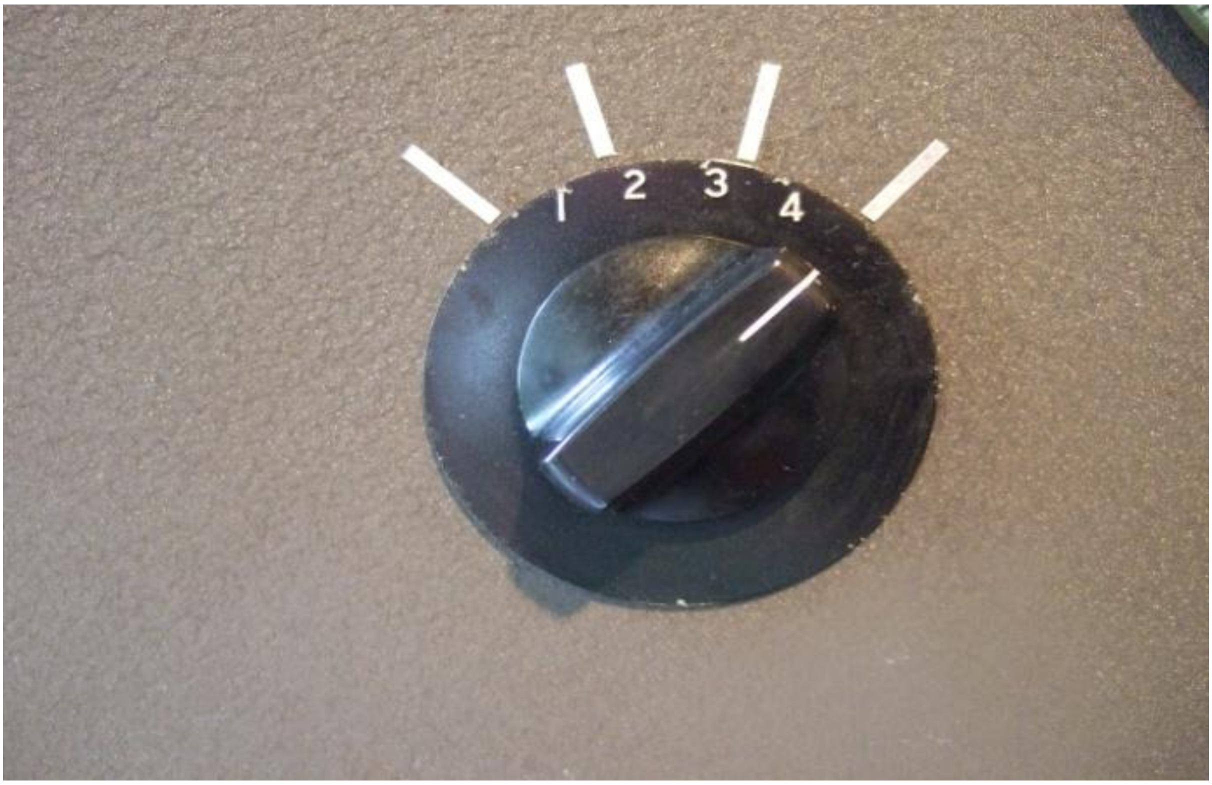
Fig. 4   Variable capacitor vanes

In testing the machine over a period it was found that the accuracy with which a frequency could be set was limited chiefly by the mechanical linkage between the adjusting knob and the variable capacitor shaft. The torsional compliance of the insulated coupling and friction in the capacitor bearings were the cause of imprecise movement and hysteresis. Using a digital frequency meter, and after repeated attempts, it was possible to set the frequency within +/- 0.2 %. Without a frequency meter, setting or returning to a frequency could easily result in an error of 0.5 % or more. After a 30 minute warm-up period the frequency drifted no more than 0.1 %.

Frequency Range Switch

A rotary switch selects the desired frequency decade. It has four positions at 30 degree intervals, so positions 1 and 4 are 90 degrees apart (Fig. 18). The switch positions are indicated by numbers from 1 to 4 on an anodised aluminium disc made by Mallory, *but the printed numbers are spaced at 20 degree intervals on this disc.* The disc is retained in place by the same hexagonal nut which secures the rotary switch to the chassis and front panel of the cabinet.

Fig. 5 Frequency range switch, white strips added to show the true positions



The numbered disc is free to rotate if the nut becomes loose, but eight resistors soldered to the switch tags prevent significant rotation of the switch itself. If the knob and the disc have been assembled with correct alignment for range 1, *then the knob must be set to number 4 to select the third highest range,* i.e. the frequency decade from 2,000 to 20,000 Hz.

An extended circumferential score mark made by the knob's grub screw on the shaft of the switch shows that sufficient torque has been applied to cause the knob to slip to and fro on the shaft by ninety degrees.

Figs 6,7 and 8   Score mark and hollow-point grub screw

The frequency accuracy of the oscillator was originally specified by EICO to be within +/- 3%. The accuracy relies on the values of the resistors selected by the range switch remaining constant. Although 1% tolerance carbon composition resistors were supplied with the kit for these critical positions, it was found that some had aged and increased in resistance, by as much as 8% in one case, thus causing the output frequency to be significantly lower than it would have been when the machine was new. These resistors were subjected to abnormally high temperatures because their location on the underside of the top chassis exposed them to heat due to the proximity of the 812 triode on the lower chassis. Resistor aging could be a potential problem with other EICO oscillators found in vintage Rife machines. Today the original dial settings may produce modulation frequencies significantly lower than when the machines were new.

Documentation

Photocopies of switch and dial settings, handwritten on three pages of a diary, accompanied the machine. However, there is nothing to link the diary pages with any particular machine. Alongside the settings are listed the names of diseases or pathogens, but *nowhere is there any record of an actual frequency.* A note written on one page suggests that the settings may have originated from two sources, a “card” and a “big book”.

On Stan Truman’s website (www.rife.org) the diary’s dial and switch settings for BX are shown handwritten in capitals at the bottom of a typed list of similar but not identical settings accompanying another machine, initially described by Dr. James Bare as a 1947 machine built in San Diego, later described by Jeff Garff as a 4.68 MHz, 1953 machine and subsequently described by Roger Blain as a 1954 AZ58 type machine, possibly using a 4.15 MHz carrier frequency. The typed settings produce the well-known Crane audio frequencies from an EICO signal generator which is set to the range indicated in the list. In terms of components and circuitry, photographs show this other machine to be virtually identical to the Scoon machine. Only the cabinet size and mechanical layout differ significantly. Twelve more diary settings are handwritten on a second similar typed list of another six settings which also relate to the “1947” machine. No frequencies are given on either of these lists.

The diary pages run from the 6th to 18th February with headings for Lincoln's birthday and the movable feast of Ash Wednesday, the latter falling on an unusually early date, February 8th. This requires the year of the diary to be 1967, 1978 or 1989.

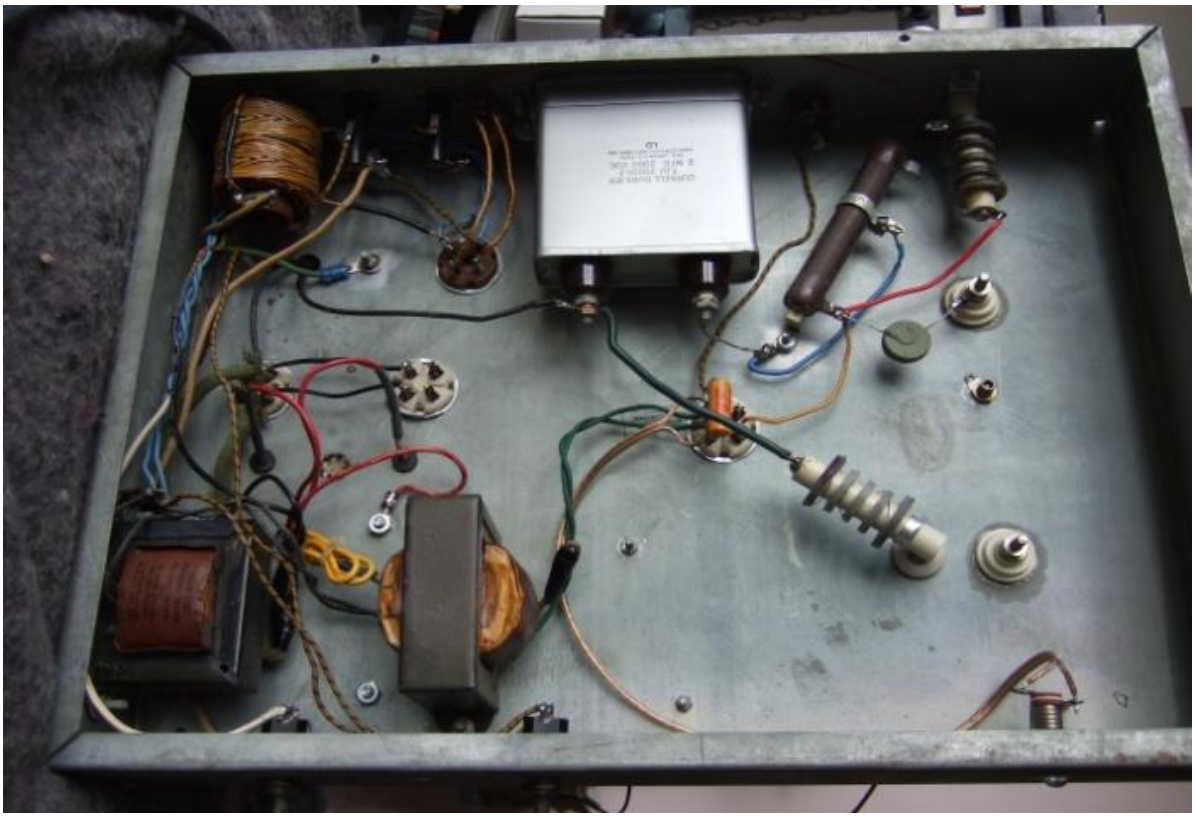
According to tape-recorded comments by Ben Cullen, Verne Thompson died several years before 1967, the earliest possible year of the diary. If so, the diary is not his. The names of some medicinal herbs can be read in reverse on the February 6th diary page, the mirror-image being produced by ink penetration from overleaf. All handwriting on the diary pages and on the typed lists for the "1947" machine strongly resembles that of Dr. Robert Stafford.

RF Oscillator Power Supply

A new HT supply transformer with a 1235 volt, 250 mA centre-tapped secondary has evidently been fitted to the RF chassis. This transformer (Triad type P7A) is slightly smaller than the original, it required two new mounting holes to be drilled in the chassis. It is rated at 250 mA rectified DC. Faint marks on the chassis show that the original transformer base was of the same size as the type P3158 used in the AZ58 (Fig. 9).

Fig. 9 RF oscillator and PSU (Faulty preset replaced by 1K2 and 1K0 in series)

Fig. 10   Underside of RF oscillator and power supply chassis



When I contacted the previous owner of the machine regarding the extent of the restoration which he had carried out, he spoke about the replacement of leaking electrolytics and wires with crumbling insulation, but did not mention the transformer. It may have been replaced relatively early in the life of the machine.

The 10 H smoothing choke, type SC3181 is rated at 3KV insulation and 200 mA rectified DC. It has a resistance of 140 ohms. The single 2 µF Cornell-Dubilier smoothing capacitor is type TJU 20020J and has a 2KV DC rating. The 866 heaters are wired in parallel to a Triad F-3X, 2.5 V, 10 A transformer.

The HT power supply for the RF oscillator is very basic. It is unstabilised and the output is smoothed by just two components, the 10 H choke and a reservoir capacitor of only 2 µF. As a result there is a residual 100 Hz sine wave ripple of typically 50 volts peak-to-peak on the HT supply when the oscillator is operating with a continuous carrier.

<u>RF Oscillator</u>

It has been suggested that originally the machine used an 812 triode. One of these was fitted for the following tests in place of the 809 previously used by Aubrey in some of his later tests.

A Triad F-18X 6.3 V, 6A transformer supplies the heater and an indicator lamp. Originally one end of the transformer's secondary was grounded via the rear panel ammeter jack socket used for cathode current measurement, and in his 2002 report, Aubrey noted that the resulting unbalanced supply-frequency voltage present along the filament would cause modulation of the anode current.

In order to make the measurements of RF carrier frequency (described in a later section) I transferred the jack socket wire to the centre tap of the secondary. This enabled the circuit to oscillate continuously at RF without the presence of 50 Hz cathode modulation, which I had previously found would cause the circuit to produce a train of RF pulses at about 7 Hz.

The leads to the plasma tube plug into green and blue sockets mounted on a clear 5/32 inch acrylic panel on the front of the cabinet (I believe Aubrey fitted these in place of the original red and black sockets). The blue socket was connected to the adjustable clamp of a 50 K vitreous enamelled wirewound preset resistor, both ends of the resistor winding being grounded to the chassis. This resistor was an Ohmite "Dividohm" resistor rated at 75 W, 25 mA and its value is wrongly shown as 10K on Aubrey's drawings. The resistance wire (which was only 1.6 thousandths of an inch diameter) was found to be severed at the point of wiper contact and when tested there was intermittent contact between the wiper and the shorter section of the resistor winding (Figs 11 and 12). When contact was made a resistance of 2K2 was measured. The series inductance of the short section of the winding was approximately 30 µH.

Initially I replaced the faulty preset resistor by 1K0 and 1K2 resistors in series to enable the RF circuitry to function, later replacing these with a 3K5 rheostat for further testing. In Aubrey's tests, arcing at the wiper contact could have contributed to the unstable operation of the oscillator which he reported.

Figs 11 and 12   50 K preset, clamp contact and severed winding

A light-brown, square Sangamo capacitor rated at 3 KV couples the oscillator output from one end of the tank coil to the green socket on the front of the cabinet. Its marked value is 150 pF, not 160 pF as shown on Aubrey's drawing. A 10K, 70 mA, 50 W Ohmite preset resistor set to 6K2 provides the grid leak for the 812 triode. Signal is coupled to the grid from the other end of the tank coil via a 250 pF green ceramic disc capacitor rated at 6kV.

Carrier Frequency Measurements

Unlike the Rife-Bare and some other modern machines, the radio frequency of the Scoon machine is not crystal controlled. It varies with the HT voltage, the grid leak resistance, the RF voltage at the grid, the instantaneous value of the modulating voltage at the grid, the impedance presented by the plasma tube, the length and electrical properties of the plasma tube's leads, the proximity of conducting objects to the tube and leads, and to a minor extent, the temperature of the machine.

To carry out accurate RF carrier frequency measurements an uninterrupted carrier is needed. The original 6K2 setting of the preset grid leak resistor appears to have been chosen for optimal bias when there is a modulating signal from the EICO generator which results in a 50% RF duty ratio. An additional 6K8 resistor was needed in parallel with the existing 6K2 grid leak in order to ensure continuous RF oscillation for the following carrier frequency tests.

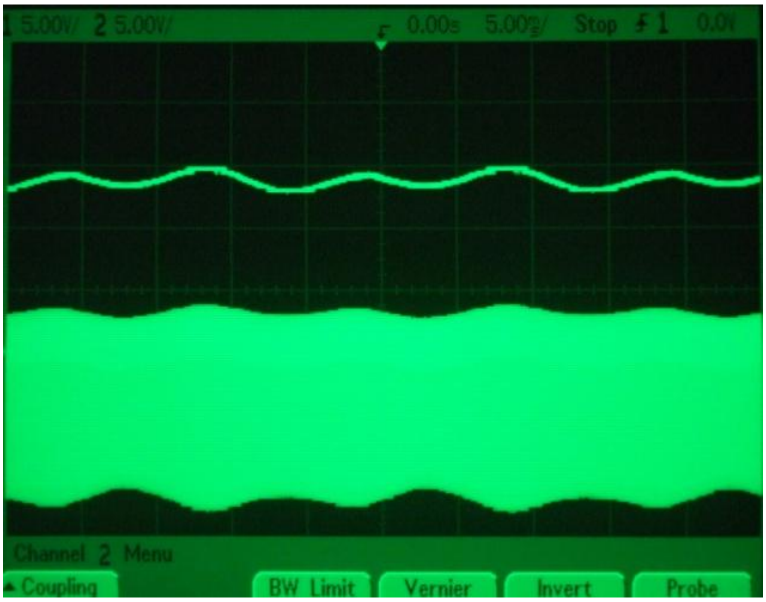
With an 812 triode installed and the modulation control set to zero, the RF oscillator frequency ranged from 4.78 MHz to 5.18 MHz, depending on which of seven different phanotron tubes was connected. Six tubes of 4 to 8 inches diameter made by Bill Cheb and one 4 inch Nazarov tube were available for these initial frequency measurements. The first tests were made using 36 inch connecting leads spaced 4 inches apart. The anode current varied from 110 to 144 mA depending on which phanotron was used and the mean HT supply voltage varied from 530 to 540 V, measured at the 2 µF capacitor.

Using some longer (60 inch) leads spaced 1 inch apart with each in its own length of flexible plastic tubing, the measured frequency with each phanotron fell by about 400 KHz to an average value of 4.7 MHz. Standing close to the tube, grasping the insulated leads or placing a conducting object nearby could cause a further reduction of 100 KHz or more.

The residual 100 Hz sine wave ripple of about 50 volts peak-to-peak on the HT supply caused amplitude modulation of about 10% and frequency modulation of typically 40 KHz peak-to-peak (Fig. 13).

Fig. 13   4.68 MHz carrier, no EICO modulation
Top trace: H T voltage with 100 Hz ripple, 200 V/div. and 5 ms/div.
Lower trace: Grid voltage, 100V/div

Note - RF envelope ripple due to 100 Hz ripple on HT supply



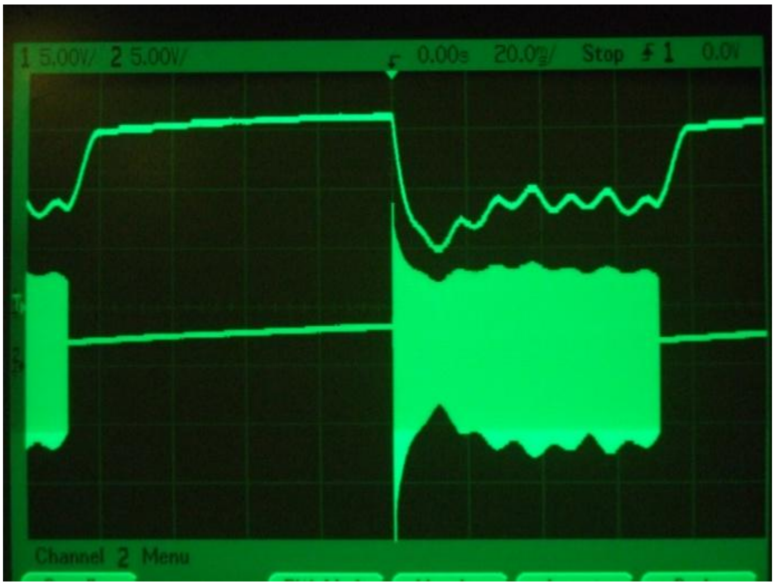
Further tests were carried out to investigate the effects of different settings of the two preset resistors, i.e. the grid leak resistance and phanotron return-lead-to-ground resistance. Lowering the value of grid leak resistance increased the cathode current and the power output, and lowered the frequency. Increasing the return-lead-to-ground resistance reduced the power delivered to the tube, varied the frequency and affected the stability of oscillation.

Regardless of the type of phanotron used, no combination of lead lengths and settings of the two adjustable resistors could be found which resulted in stable oscillation at a frequency below 4 MHz.

<u>Testing the original circuit with the EICO generator set to zero output</u>

For this test a 5 inch diameter Cheb phanotron was connected to the machine’s output sockets by 4 feet of 300 ohm twin (ribbon) feeder. The additional 6K8 grid leak resistor, fitted for the previous test, was removed and the cathode current monitoring jack was restored to its original connection point at one end of the heater transformer's secondary winding. The 6.3V 50Hz heater voltage was therefore present between the other end of the secondary and ground. In effect the 6.3V 50Hz heater voltage, averaged over the length of the cathode, produced an 8.9V peak to peak 50 Hz modulating signal between grid and cathode. This voltage alone was just sufficient to trigger the oscillator into periodic bursts of RF at a rate of about 7 Hz. (Fig 14)

Fig. 14 Relaxation oscillation at 7 Hz
Top trace: HT voltage, peak 840 V, 200 V/div. 20 ms/div.
Lower trace: Grid voltage, 100 V/div
Note - 100 Hz ripple on HT during RF oscillation



The grid coupling capacitor is not one which had been specially chosen to create oscillation at such a low frequency - it is the original 22 µF output coupling capacitor of the EICO generator, located on the upper chassis.

Understanding the operation of the circuit

At first sight the machine's schematic suggests that the EICO generator might provide a sine wave to grid-modulate the amplitude of the carrier. However, the original circuit of the Scoon machine cannot produce a depth of sine wave amplitude modulation which exceeds about 15%. If any modulating voltage results in AM which exceeds 15%, whether that voltage is applied to anode, cathode, grid or a combination of these, the anode current will reach a threshold where the RF loop gain momentarily exceeds unity. The circuit then switches regeneratively into full-power class C oscillation in 1 µs. Substantial grid current flows during positive peaks of RF grid voltage, until the accumulating negative charge on the grid reaches a second threshold at which RF oscillation can no longer be sustained, and the RF pulse ends almost as abruptly as it began.

Both thresholds are dependent on the instantaneous voltage of the anode power supply measured at the 2 microfarad capacitor, which has typically 50 V peak-to-peak 100 Hz ripple and poor regulation. Both thresholds are also dependent on the instantaneous value of the 50Hz cathode voltage which has a peak-to-peak value of 8.9V relative to ground, due to one end of the heater transformer secondary being connected to ground via the current measurement meter jack.

The 812 circuit functions simultaneously as both a Hartley RF oscillator and a low frequency relaxation oscillator, similar in some respects to the simplest type of self-quenching super-regenerative receiver circuit, but with a very much lower free-running “quench” frequency of about 7 Hz , determined by the 22 µF grid capacitor. Sometimes known as “motor-boating”, this low frequency oscillation only occurs in the absence of any grid modulation from the EICO generator.

The original output control of the EICO generator provides the means to set the level of modulating signal applied to the grid of the 812 up to a maximum of 50 - 60 V peak-to-peak. In effect it controls the extent to which the grid modulating signal from the EICO generator overrides the 50 Hz signal present on the cathode of the 812. The instantaneous grid-to-cathode voltage resulting from the combined sine waves is the dominant factor governing the initiation and termination of RF oscillation and hence the RF modulation frequency.

<u>Testing with grid modulation applied from the EICO generator.</u>

These tests were carried out with the same configuration as the previous test, i.e. with a 50 Hz voltage present on the cathode and the same Cheb phanotron connected.

The frequency of the EICO generator was set to 2128 Hz and the modulation level was slowly increased from zero. The repetition rate of the RF pulses increased irregularly from the initial 7 Hz, and by careful adjustment it was possible to obtain locking of the repetition rate, not to the small 2128 Hz signal, but first to alternate cycles (Fig. 15) and then to every cycle (Fig. 16) of the 50 Hz supply frequency signal present on the cathode. The repetition rate locked with some jitter, due to the 2128 Hz signal influencing the actual start and finish times of the 50 Hz RF pulses.

Fig 15 25 Hz pulses triggered by 50 Hz on cathode
Top trace: HT voltage, peak 810 V, 200 V/div. and 10 ms/div.
Lower trace: Grid voltage, 100 V/div.

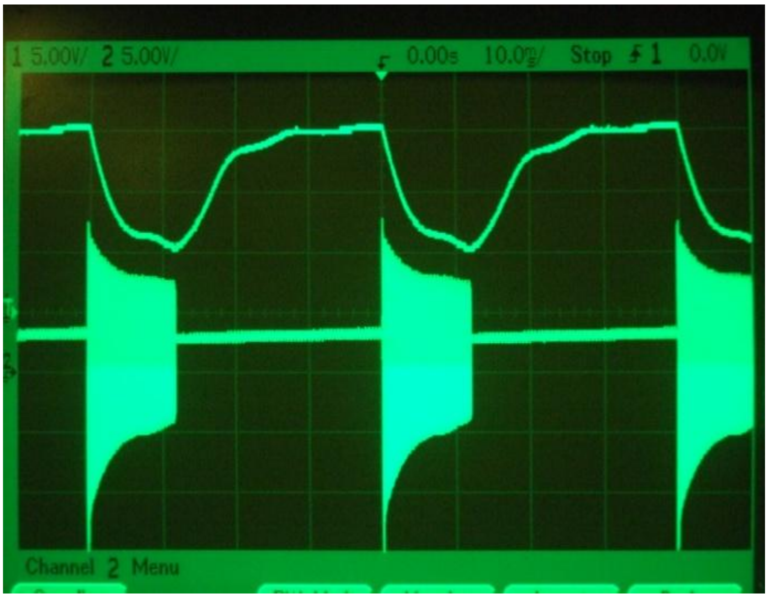
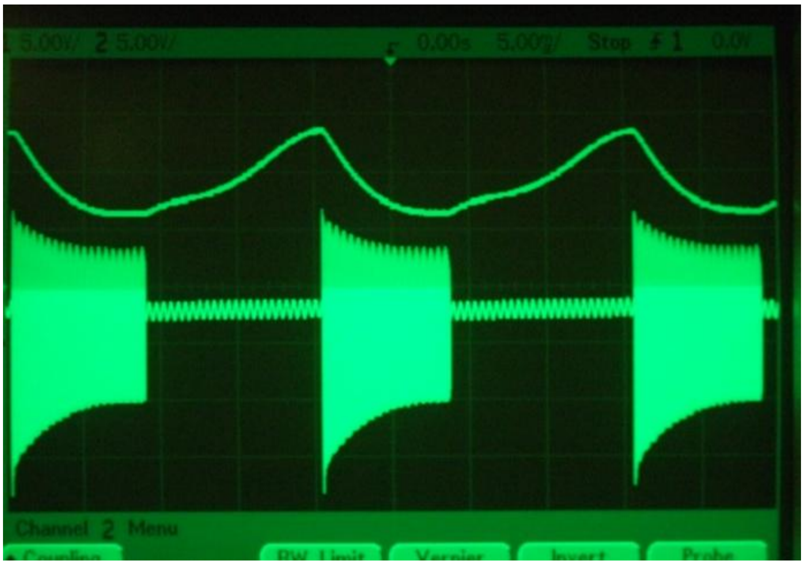


Fig.16. 50 Hz pulses triggered by 50Hz on cathode
Top trace: HT voltage, Peak 760 V, 200V/div. 5 ms/div.
Lower trace: Grid voltage, 100 V/div. 2128 Hz grid modulation visible

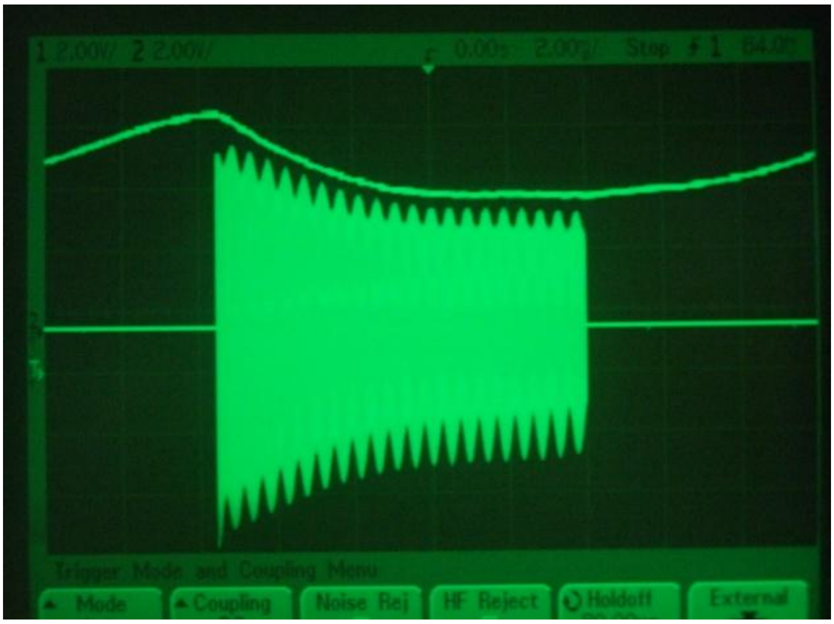


The duty ratio of the pulse stream was approximately 45%, and low-level amplitude modulation at 2128 Hz was visible on the RF envelope.

The amplitude of the RF envelope is dependent on the HT voltage. With 50 Hz amplitude modulation (caused by 50 Hz cathode modulation as in Fig. 16), the voltage of the 2 μF HT supply capacitor fell exponentially during each RF pulse, falling from an initial high of 760 V. This caused a similar exponential fall in the amplitude of the RF current envelope.

After about 9 ms when the supply voltage had fallen to 430 V, RF oscillation ceased. During oscillation the RF return current to ground (via the plasma tube lead) fell from a starting value of 880 mA to 440 mA p/p at the end of the RF pulse, measured at the point where the preset resistor in the tube's current return lead was connected to the chassis (Fig. 17).

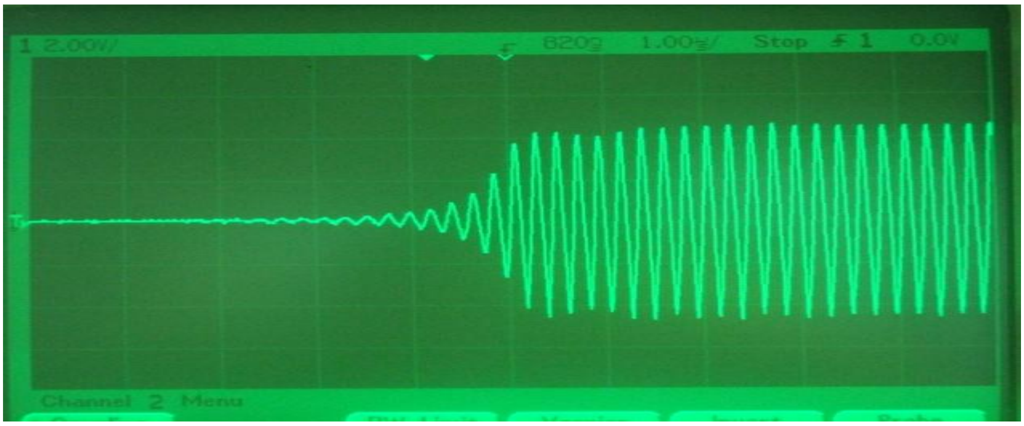
Fig. 17 HT voltage and RF tube current when triggered at 50Hz
Top trace: HT voltage, 200 V/div. and 2mS/div.
Lower trace: RF current measured at tube return lead to ground
Note – the RF pulse envelope shows slight modulation by the same low level 2128 Hz modulation signal which, in conjunction with the 50 Hz cathode voltage, is sufficient to trigger the circuit into RF oscillation at 50 Hz pulse repetition rate.

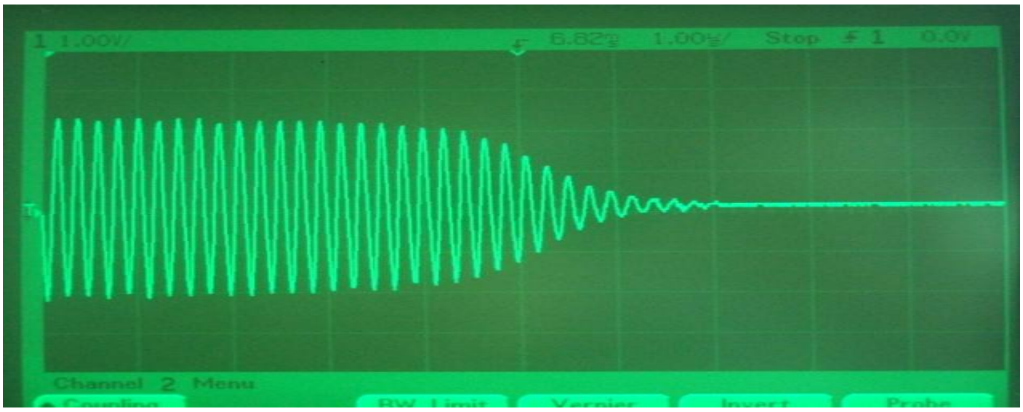


At the start of RF oscillation the supply voltage was higher because when the previous RF pulse ended, current continued to flow through the 10H choke, charging the 2 µF reservoir capacitor to a voltage substantially above the average value of 540 V (measured on a moving coil meter).

The measured 10% – 90% rise and fall times of the RF current envelope were very short, about one microsecond for the rise time, a little longer for the fall. The fast rise time was a result of the high RF loop gain of the oscillator when the 812 triode was driven hard into class C operation by positive peaks in grid-cathode voltage (Fig 18). The final rapid decay of the RF envelope was due to the sudden loss of RF drive to the grid, and also to the low effective Q of the tank coil when loaded by the impedance of the ionised plasma tube (Fig. 19).

Figs. 18 and 19   Rise time and fall times of RF envelope, 1 µs/division





Returning to the effect of further increasing the level of 2128 Hz modulation, fragmentation of the 50 Hz modulated RF envelope into shorter and shorter pulses was seen (Fig. 20) until finally, at maximum modulation level, there was a stream of RF pulses at 2128 Hz. This stream exhibited missing pulses or interruptions when the 50 Hz cathode voltage was close to its peak value, i.e. when the grid-to-cathode voltage failed to reach the threshold at which triggering into RF oscillation could occur (Fig.21). Similar results were obtained with other modulation frequencies up to 50 KHz. An increase of the initial HT voltage only occurred with lower modulation frequencies, and was caused by the L-C output of the power supply.

Fig. 20 Fragmented RF pulse train due to inadequate 2128 Hz modulation
Top trace: HT voltage, 200 V/div. and 5ms /div.
Lower trace: Grid voltage, 100V/div.
Note - the 2128 Hz modulation amplitude is insufficient to override the 50 Hz voltage on the cathode, but causes fragmentation of the 50 Hz envelope.

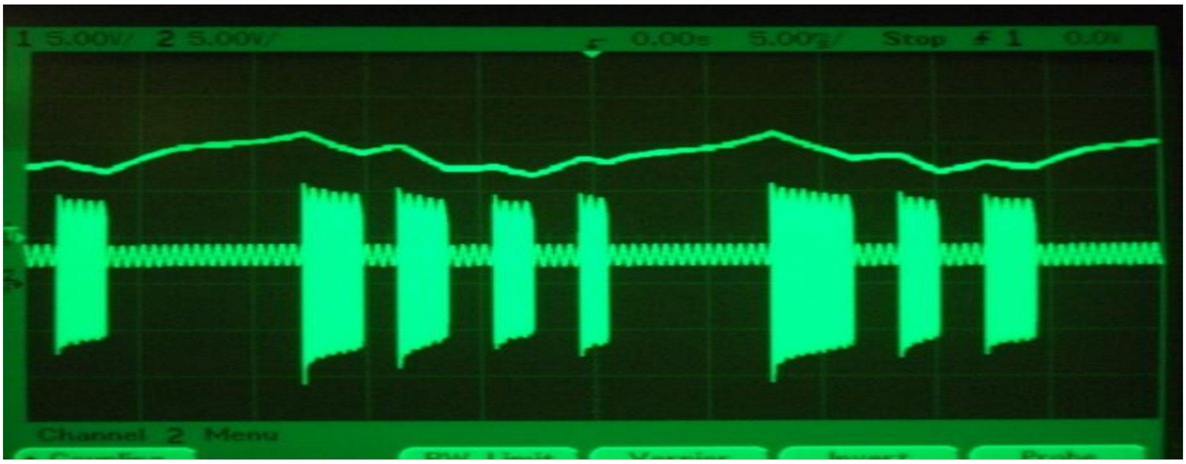
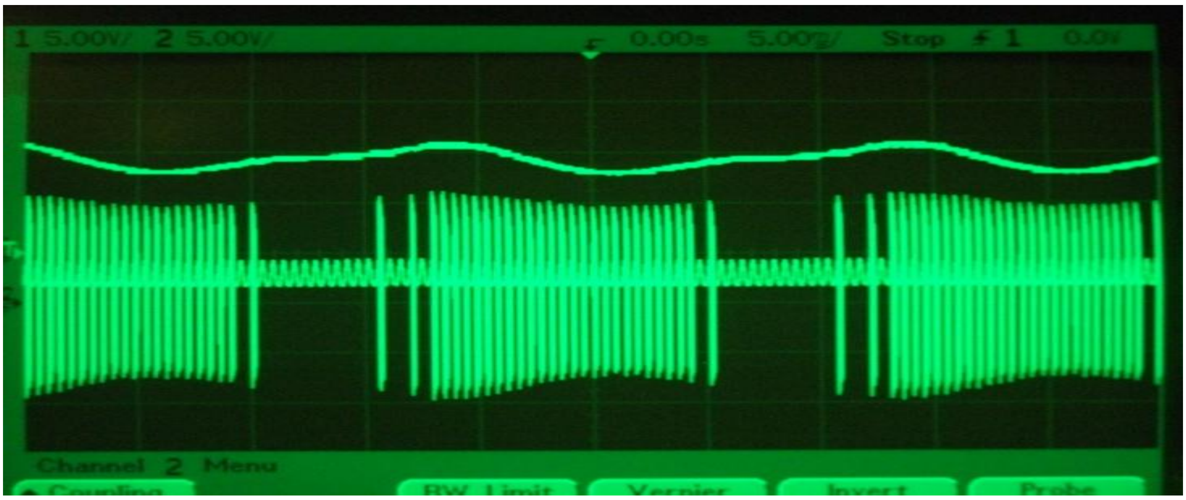


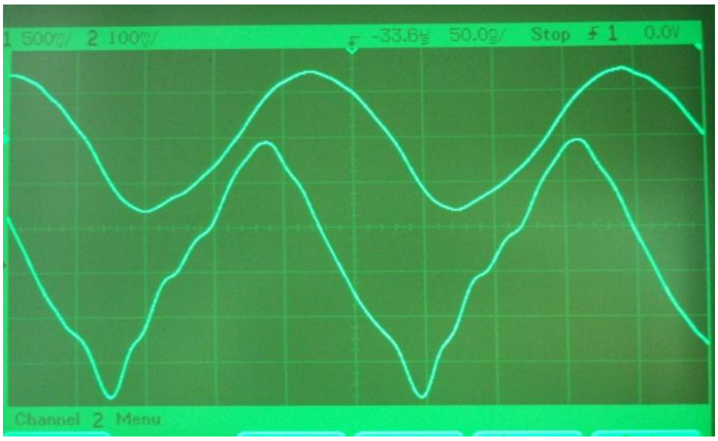
Fig. 21 Maximum setting of 2128 modulation, missing cycles of 2128 Hz
Top trace: HT voltage, 200 V/div, and 5 ms /div.
Lower trace: Grid voltage, 100 V/div.
Note - even with maximum 2128 Hz modulation, the 50 Hz cathode voltage inhibits triggering of 2128 Hz pulses during part of each 50 Hz cycle of cathode voltage.



Phanotron non-linearity and emitted spectrum

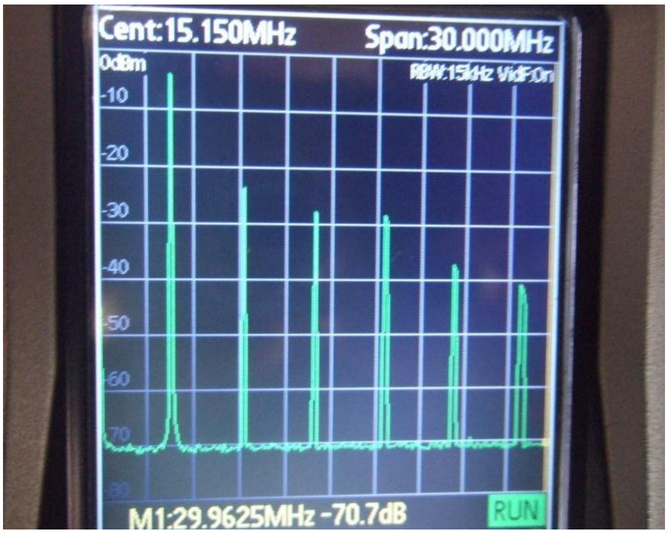
The output voltage to the tube is reasonably sinusoidal, but the tube current flowing to ground, measured where the return lead resistor is connected to ground, is far from sinusoidal as shown in Fig. 22.

Fig. 22 Output voltage to tube and tube current waveform
Top Trace: Output voltage to tube lead
Lower trace: Tube current to ground



The harmonics emitted by the tube are shown below (Fig. 23). The spectrum is rich in harmonic content, both even and odd harmonics are present. It was recorded using a four inch straight wire probe held two inches from the tube and connected by a 50 ohm cable to the 50 ohm input of TTI PSA 1301T spectrum analyser, which was set to 15 KHz bandwidth.

Fig. 23 Harmonics generated by phanotron



Frequency change during the RF pulse

Measurements made with a TTI spectrum analyser type PSA1301T (operating at 15 KHz bandwidth in peak-holding mode) suggested that the instantaneous oscillator frequency changed during each RF pulse. The measured spectrum width was far in excess of the broadening of the spectrum attributable to sidebands produced by square wave amplitude modulation alone. Fig 24 shows the spectrum occupied by the carrier due to 100 Hz HT ripple and 50 Hz cathode modulation alone. When there was also 2128 Hz modulation from the EICO generator the 3dB spectrum width increased to 300 KHz (Fig. 25).

Fig. 24   Carrier with no modulation voltage from EICO generator (50 KHz/div)

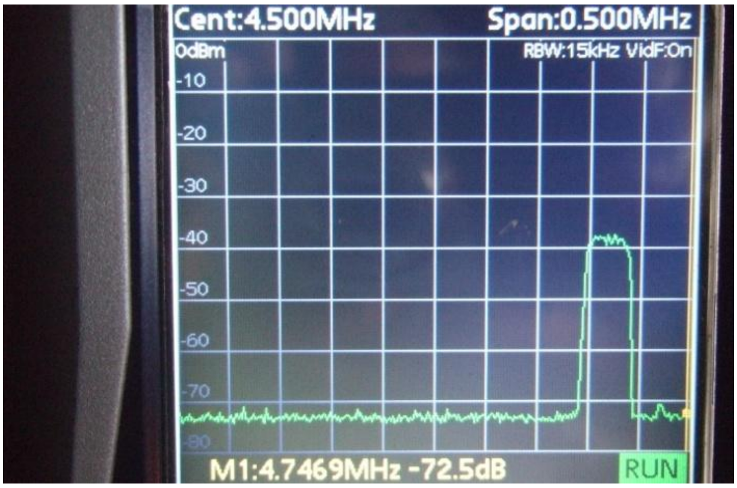
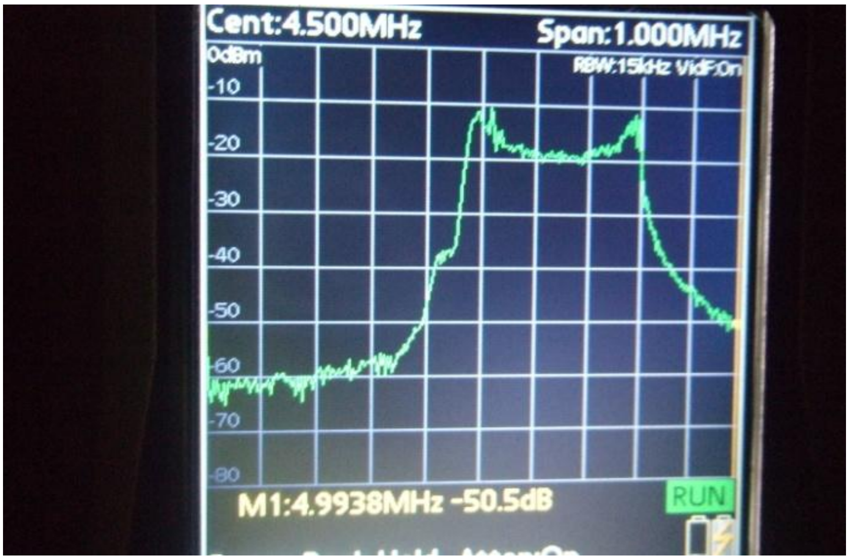


Fig. 25   Bandwidth occupied with 2128 Hz modulation applied (100 KHz/div)



A broadband discriminator circuit was made using a CA3189 integrated circuit in order to study the instantaneous frequency of the oscillator during each RF pulse, for a range of modulation frequencies (Fig. 29). The results are shown below in Figs. 26, 27 and 28.

In all photos the top trace is the grid voltage at a scale of 100 V per division. The lower trace is the output of the discriminator at a scale of -120 KHz per division, i.e. a higher voltage represents a lower frequency. In the absence of a signal the output of the discriminator is noise.

These tests confirmed that the instantaneous RF frequency increases by typically several hundred kilohertz between start and finish of each RF pulse.

Fig. 26 Modulation frequency, 2128 Hz. Horizontal scale 100 μs/div.

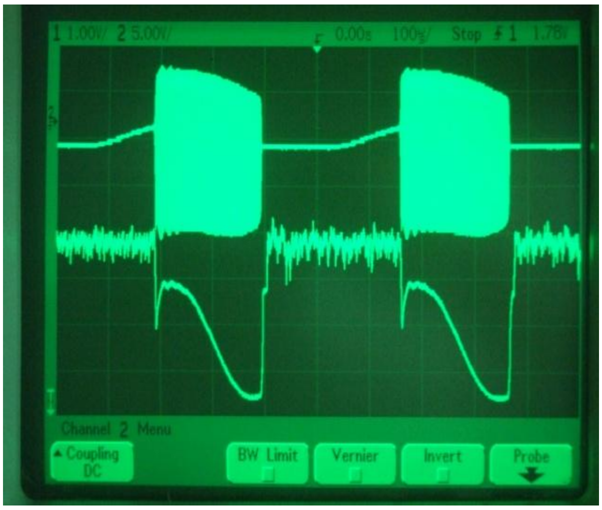


Fig. 27 Modulation frequency, 21.28 KHz. Horizontal scale 10 μs/div.

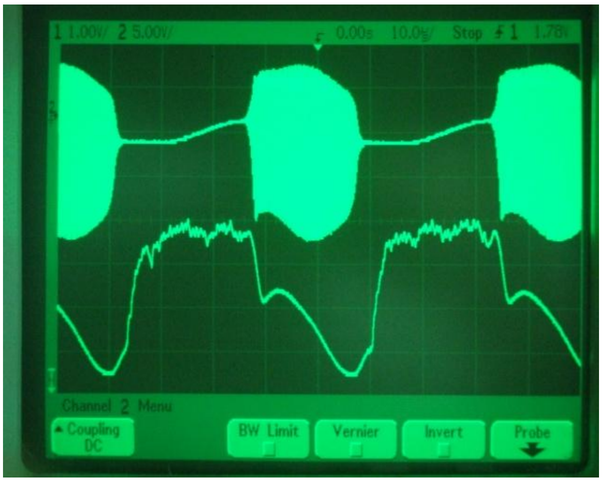
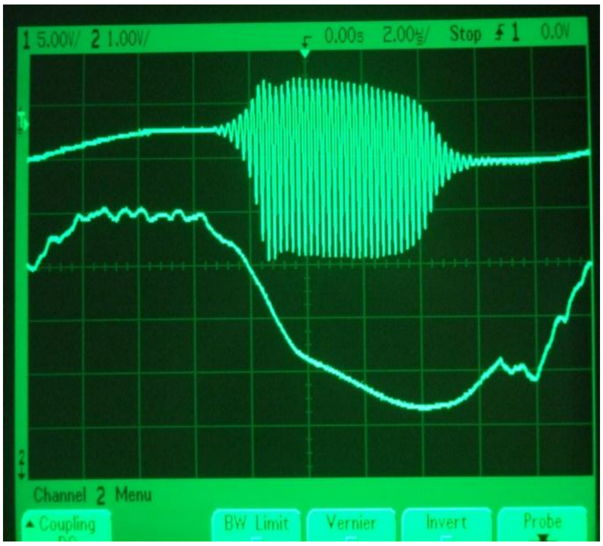


Fig. 28   Modulation frequency, 50 KHz. Horizontal scale 2 μs/div.



Power consumption

With the modulation frequency set at 2128 Hz the machine's power consumption from a 115 V, 50 Hz supply was 170 W.

Power delivered to the plasma tube and power consumption

The highest peak voltage to the plasma tube occurs at the start of each RF pulse when the HT voltage is highest. For this particular power measurement a low modulation frequency of 50 Hz was chosen because that would cause the anode supply voltage to reach a peak value of 760 V at the start of each RF pulse. The RF current measured from the phanotron's return lead resistor to ground at the start of the RF pulse was 300 mA rms. At that moment the RF voltage applied between the phanotron's connecting cables was 400 V rms. Taking into account the phase difference between current and voltage, the peak instantaneous power being delivered to the tube leads at the start of each RF pulse was 60 W.

Under normal running conditions, i.e. a modulation frequency of several hundred Hz or more, duty ratio of 50% and HT supply of 540 V, the long-term mean power delivered to the phanotron connecting leads was no more than 20 W and the temperature rise of the phanotron was barely detectable.

Discussion

The “Scoon Machine” is one of a number of machines made by Verne Thompson which employ a plasma tube, an amplitude modulated RF carrier and an off-the-shelf modulation frequency generator capable of generating the well-known Crane audio frequencies such as 728, 880, 2009 and 2128 Hz. It is a forerunner of the AZ58 machine and no particular RF carrier frequency is required to ensure the effectiveness of this type of machine. Complying with licensing restrictions and avoiding radio interference became important issues, but the primary purpose of the RF carrier was to ionise the gas in the tube, rather than providing a stable frequency which played a part in creating the MOR. As might be expected, there is no provision for adjustment of the carrier frequency in the Scoon machine.

Until now the non-use of the 6SN7 square wave producing circuit in the EICO generator has been puzzling, particularly because Dr. James Bare emphasised in his early publication “Resonant Frequency Therapy” that a square wave RF envelope with fast rise and fall times is essential in order to obtain therapeutic results using the Crane frequencies. He described how to extend the modulation bandwidth of a CB transceiver to achieve this end.

This puzzle has now been solved. Although the EICO oscillator in the Scoon machine generates only a sine wave output, the 812 RF oscillator nevertheless produces the required square wave RF envelope, with a fast rise-time of 1 µS by virtue of its high loop gain when triggered into oscillation by the modulation oscillator’s sine wave. (This information is important because it also throws light on the mode of operation of the Gruner machine’s circuit).

To dispel some confusion which has arisen regarding terminology, it should be noted that the RF oscillator in this machine is a single 812 triode which delivers RF power to the phanotron tube. A MOPA, i.e. a Master Oscillator *and* Power Amplifier, is a combination of an oscillator and one or more amplifier stages. It is designed to overcome the problem of changes in oscillation frequency which occur when a single power triode oscillator is connected to a load of varying impedance, such as an ionised plasma tube.

The plasma tube, itself a radiating element, forms part of the tuned circuit of the oscillator in the Scoon machine. Any changes in the degree of ionisation of the tube or the movement of conducting objects in its vicinity can produce significant changes in the frequency of oscillation.

A MOPA is designed to provide high isolation between the master oscillator and whatever load is connected to the power amplifier (in its original role, the intended load was a transmitting antenna). A MOPA made by the Radio Marine Corporation of America has been identified in a photograph of equipment in Rife's laboratory. It could have been used to help him obtain the very high frequency stability essential in his early machines which generated radio frequency MORs. In the days before the introduction of crystal control, the MOPA was needed to ensure a stable transmission frequency in tuneable marine transceivers which were subjected to variations in antenna VSWR during severe motion at sea. Such frequency stability was not needed in the Scoon machine.

No review of the Scoon machine could be complete without a thorough examination of the anomaly of the "10X frequencies", which was described in the 2002 report by Aubrey Scoon in association with Stuart Andrews.

The tests carried out in May 2001 led me to believe that the knob on the range switch and/or the numbered disc had slipped or been replaced in a different position since the switch position numbers in the diary were first recorded. It is now clear that there was a high probability of that happening because the decade switch positions are 30 degrees apart whereas the numerals on the indicator disc are only 20 degrees apart. There is no "right" position of the knob on the switch shaft. There is bound to be ambiguity in one or more switch positions and/or a clear-cut but false indication in another.

The knob is known to have been removed and replaced when a new transformer was fitted and when the machine was restored. A circumferential score mark caused by movement of the knob's single grub screw on the switch shaft showed that the knob had been forcibly rotated on the shaft at some time, this constituting another potential source of error.

A link has been established between the Scoon machine and the 1947 machine by the discovery of identical hand-written switch and dial settings on the diary pages supplied with the Scoon machine and on two typed lists of settings for the 1947 machine. Both machines used EICO modulation frequency generators. The typed list of switch and dial settings accompanying the 1947 machine is consistent with its use of the Crane frequencies.
Prior to 1959 Crane and Thompson kept the frequencies secret, even from Dr. Stafford. If Dr. Stafford had access to the 1947 machine he could have used it

independently to find operating settings for the Scoon machine by the zero-beat method. This would provide a plausible explanation, both for his writing on the two 1947 machine lists and the absence of any recorded frequencies. Taking into account all the evidence that has been presented, there is no reason to suppose that the Scoon machine used other than the same modulation frequencies as the other Verne Thompson machines of that era.

Conclusions

The Scoon machine employed the well known Crane frequencies to modulate the carrier, as did other machines of that era built by Verne Thompson. The so-called 10X modulation frequencies are the result of confusion in setting or reading the position of a frequency decade switch with an insecure knob and an inappropriate scale. The operating and position-indicating knob for the switch has at some time slipped or been forcibly rotated on the switch shaft and has been removed and refitted at least twice since the switch and dial settings were recorded.

It appears that the machine was built for operation with an intended carrier frequency of 4.68 MHz in common with the “1947” machine. The two machines are very similar. Tests were made with various phanotron tubes using 48 inch leads, a length appropriate to the machine’s tube supporting rod and clamp. It was not possible to obtain stable operation at a carrier frequency below 4 MHz

During normal modulated operation a reduction in centre frequency occurs, accompanied by frequency modulation with a deviation exceeding $\pm$100 KHz. Even when the EICO modulation generator is set for zero modulation, a high level of frequency modulation is constantly present due to the unbalanced heater voltage applied to the 812 triode’s cathode and also to the high level of ripple on the HT supply.

The HT voltage is unregulated and varies with fluctuations in the mains supply and changes in the current drawn by the RF oscillator. The frequency of the carrier is greatly affected by changes in HT voltage and by the proximity to the plasma tube of anything that reflects or absorbs radio waves. The machine is not provided with any means for setting the carrier frequency.

For the reasons given above, the Scoon machine does not generate a fixed frequency carrier. Instead, its power output to the plasma tube occupies a broad RF spectrum with an unstable centre frequency and a bandwidth determined by the overall frequency deviation of the carrier, i.e. 30 – 300 KHz or more.

Without a carrier of exact frequency and free of modulation, no calculations can be made to support a widely promulgated hypothesis that a machine of this type can generate the same precise output frequencies as Rife's #3 machine and Hoyland's #4 machine, by means of harmonics, sidebands or otherwise.

Consideration as to whether there is any validity whatsoever in the above-mentioned hypothesis is beyond the scope of this document.

Appendix

Fig. 29 Discriminator schematic