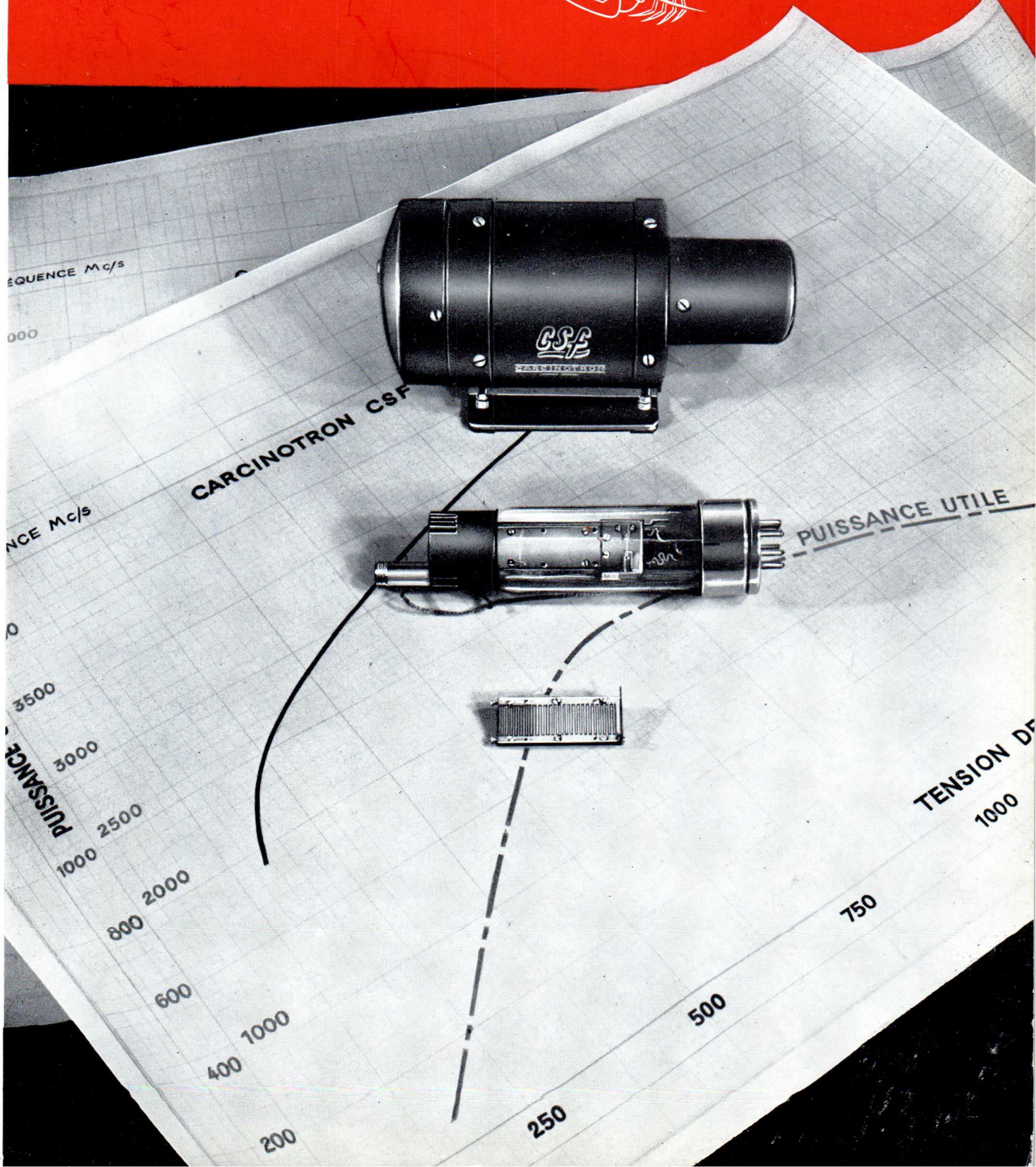
" CARCINOTRONS O "

χαρχινος



"CARCINOTRON O"

The " Carcinotron O " (★) represents the latest offspring of a long line of low power microwave tubes descended from the old special triode which was, not so long ago, terminated by the travelling wave amplifier tubes (TPO). The determining role played by the COMPAGNIE GÉNÉRALE DE T.S.F. laboratories in this evolution is well known; the " Carcinotron O " which after the magnetron type amplifier enlarged the family of travelling wave tubes is itself also a creation typical of our Company. Conceived, designed and developed by Dr. Warnecke and his team it is now in production in our factories.

I — BACKGROUND OF THE " CARCINOTRON O "

The " Carcinotron O ", the logical outcome of research carried out by electronic specialists on the exchange of energy between electronic beam and electromagnetic field, would probably have remained " a lab " curiosity if its appearance in viable form had not fulfilled the wishes of many electronic experts. These wishes were expressed by:

(*) " CARCINOTRON " is a registered trade mark.

- modern telecommunication technicians who above all sought to transmit simultaneously and without distortion the greatest possible number of high quality signals,
- Radar specialists striving to increase the accuracy of range measurements,
- and electronicmetrology technicians.

These requirements can be enunciated in their most elementary form in the following manner:

" We could simplify our equipment and increase performance quality if there were available in the field UHF a self-oscillator ,easily modulated by purely electrical means throughout a very large frequency range, and this, of course, without prejudice to the other qualities generally required for a microwave tube ".

From the outset, the " Carcinotron O " could be defined as **a microwave electronic self-oscillator capable of covering by simple electric adjustment a frequency range, considerably larger than that of tubes previously known:** special triodes, reflex klystrons, travelling-wave self oscillators using internal feedback (UHF field, UHF electron current...)

The " Carcinotron O " exactly replies to the wish formulated above : further, it has many advantages over its predecessors, which will be pointed out later, and in no case, is it inferior to them.

The ideal tube for the radio-technician has thus materialized in the form of the " Carcinotron " but the qualities of this newcomer greatly surpass the highest expectations. Development of the future " Carcinotron " by our Electronic tubes laboratories was so rapid that potentiel users, taken by surprise, have not even yet fully realised all the possibilities of the tube, outside conventional use.

II — *BEFORE THE " CARCINOTRON O "*

A simple example, backed up by a few comparisons will give a better appreciation of the superiority of the " Carcinotron " over older tubes. Examination of the characteristics of the CO 119 shows that around the 4,200 Mc/s frequency it is possible to obtain frequency deviations of 200 Mc/s by modulating the high voltage fed to the tube by means of a signal of which the frequency can attain a few Mc/s. The distortion of the modulation is small and the power delivered in a 400 Mc/s bandwidth remains practically constant and in the neighbourhood of 500 mW.

The tube could thus possibly be used with success as a transmitter in a very high capacity radio link.

The perplexity of the engineer faced in 1948 with the problem of designing a transmitter having the same overall characteristics as the " Carcinotron " just described can well be imagined.

Within the range of tubes available at the time the **magnetron** was quite obviously of no use. The **special triodes** (lighthouse tubes) which functioned precariously at around 4,200 Mc/s and which, if absolutely necessary, could be deeply modulated mechanically, could only provide, when used with reactance tubes, according to the conventional technique, electronic-tuning bandwidths of only a few Mc/s. The **reflex-klystrons** would have justified more hope : a CSF tube such as the KR 63 B operating at around 4,200 Mc/s has a tuning-band, defined conventionally, as being of the order of $\pm$ 15 Mc/s, the UHF power delivered attaining a maximum of 2 W ; but the mediocre bandwidth of 30 Mc/s of **the reflex klystron is far more affected by distortion than the band of the CO 119 " Carcinotron " which is 13 times larger.**

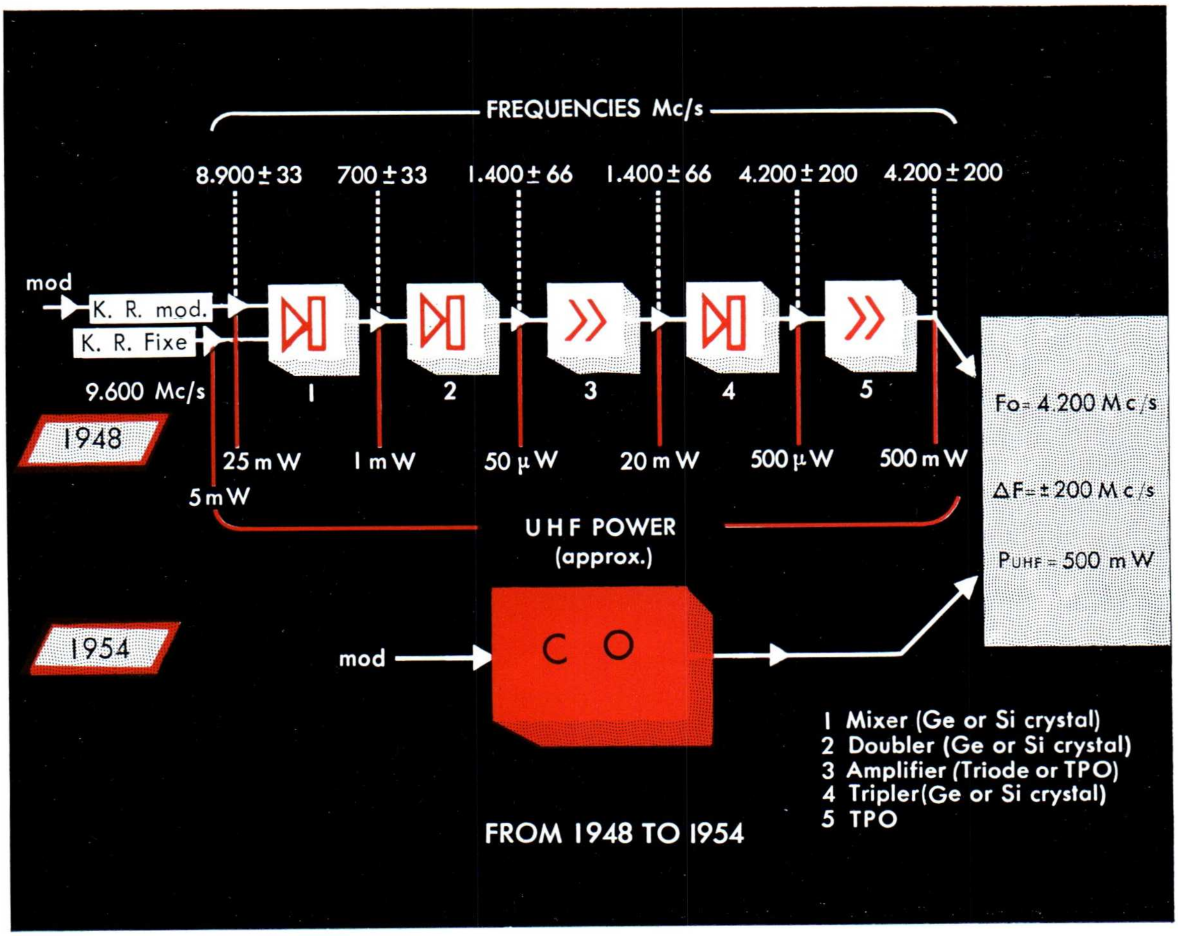
Confronted by the lack of straightforward solutions, what solution could the engineer adopt, to get out of difficulty, when bent upon solving this problem?

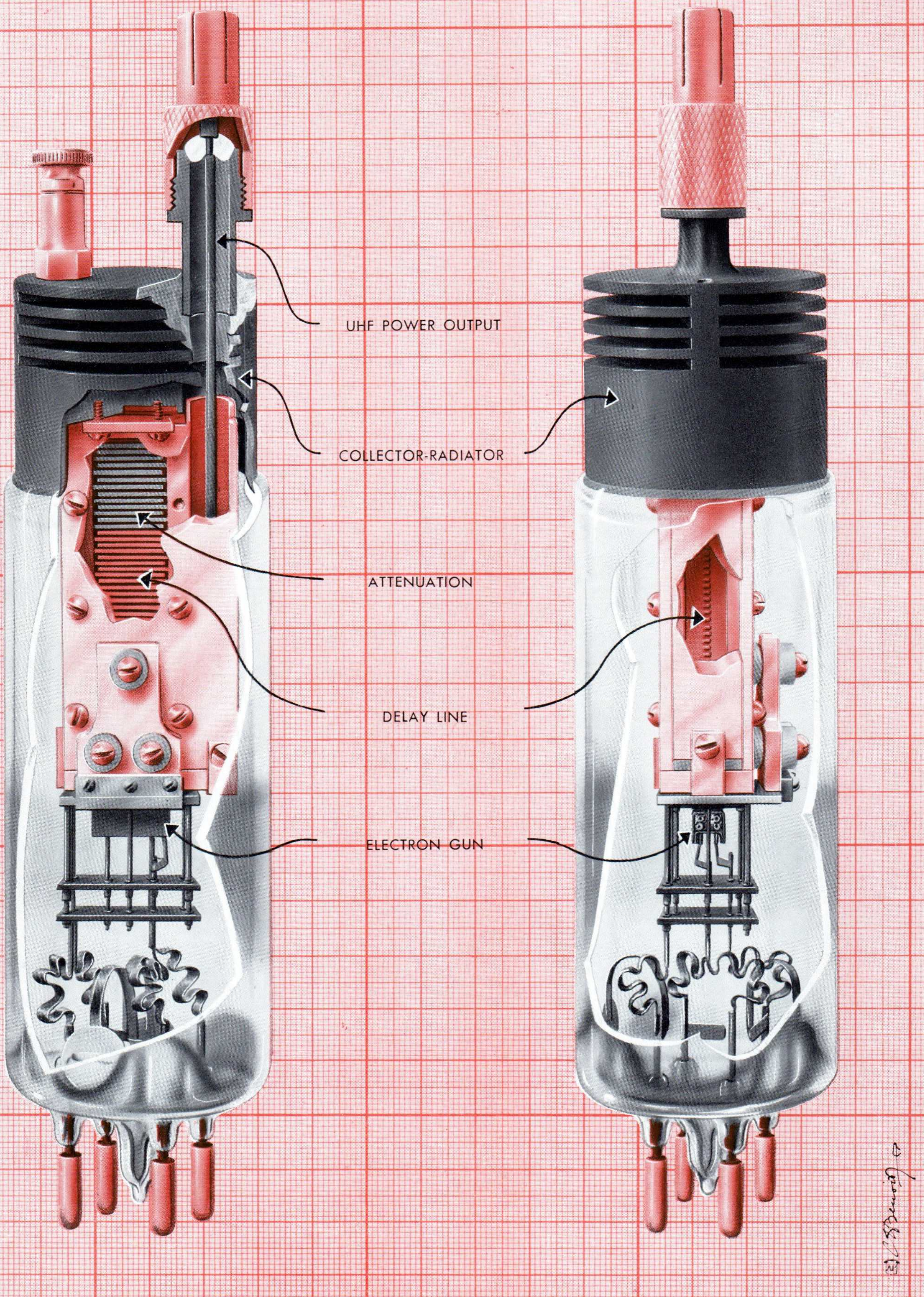
He would probably be lead to adopt the cumbersome methods used in the usual techniques of frequency modulation. It can be reasonably supposed that he would have perused the reflex-klystrons, catalogue searching for the tube characterized by the largest electronic-tuning bandwidth, quite apart from any consideration of the value of the carrier frequency. From the signal supplied by a tube with a 66 Mc/s bandwidth (a 2k25 reflex-klystron. working at 9,000 Mc/s, for exemple), the sequence of operations based on frequency changing and multiplication might have been that shown in the attached figure.

Is the " 1948 " signal, resulting from this long chain of operations (of which are quoted only the principal stages, for example the various band filters have been purposely omitted) qualitywise comparable to that produced in 1954 by the " Carcinotron O "?

Certainly not ; firstly, the noise level in the first case is much higher and further, the fairly high distortion which at the outset affects the modulation band of the reflex-klystron reappears in all the subsequent operations.

This example is obviously only of illustrative value and before continuing the praise of the " Carcinotron " this is the moment to describe it organically and to outline the theory of its operation ; this qualitative analysis will allow a better understanding of the technical reasons for the superiority of the new tube over its predecessors.




UHF POWER OUTPUT
COLLECTOR-RADIATOR
ATTENUATION
DELAY LINE
ELECTRON GUN

III — TPO (TRAVELLING WAVE AMPLIFIER) AND " CARCINOTRON O " TUBES

A — *Organic description.*

The " Carcinotron O " is related to the travelling wave tubes which, having made their " debut " in radio communications as amplifiers, to day exist in many forms, some corresponding to amplifiers and others to self-oscillators.

Under their various forms, is found the commun principle of a **prolonged** interaction between an **electronic beam** and an electro-magnetic wave guided by a **line** of periodic structure known as a **delay line** (helix, interdigital line, corrugated line...). The interaction is optimum when the velocity of the electrons is very close to that of the phase velocity of the wave **(condition of synchronism).** The " cumulative " mode of interaction explains the wide band and the high gain of the amplifiers. This processus of energy exchange is definitely different from that which takes place in triodes and klystrons : in the latter, on the contrary, the seat of an interaction between beam and electromagnetic field is only a very limited zone of the resonator.

In the TPO as in the " Carcinotron O " the same fundamental elements are found.

- The **electron gun** comprises : an emissive cathode, a control electrode (Wehnelt or grid), one or more anodes ; the electrons which have traversed the last anode penetrate into a space which is " statically " equi-potential and where they retain the same mean axial velocity.

- In the equipotential space is found the **delay line,** which the beam " licks " along all its length and the **collector,** an electrode placed at the extremity of the tube where the active life of the electrons terminates.

- Over a small part of its length the delay line always carries a **high attenuation ;** the attenuated zone is located towards the middle of the line in TPO's and at the extremity, collector end, in " Carcinotrons ".

- The UHF power is fed to the input of the tube and collected at its output, after amplification, by means of circuit elements coupled to the delay ilne ; the self-oscillators are only provided with a **device for picking up the energy,** in the case of the " Carcinotron " coupled to the **end of the line near the electron gun.**

- Finally, must be pointed out a disadvantage which affects all " O " travelling wave tubes : the **magnetic focaliser,** which in principle does not play a fundamental role in the interaction but which is rendered indispensable by the necessity of maintaining the beam in the neighbourhood of the delay line ; it is known that, in the absence of an axial magnetic field, the electrons under the action of the space charge have a great tendancy to disperse.

This is of minor importance in the " Carcinotron O ", the small length of the tube makes the use of small permanent magnets possible.

B — *Essential components.*

If it is sought to single out essential elements of this assembly, it will be found that in last analysis they are : the **electron beam and the delay line.**

The structure of the beam depends above all on the geometric and electric characteristics of the gun, ultimately the values which define it being :

- the intensity of the current,
- the section (shape and surface),
- the velocity v_e of the electrons.

It is convenient to measure v_e in relation to the velocity **c** of light and as a function of the voltage V_o applied between delay line and cathode ; **a rate of electronic delay m_e** can thus be defined :

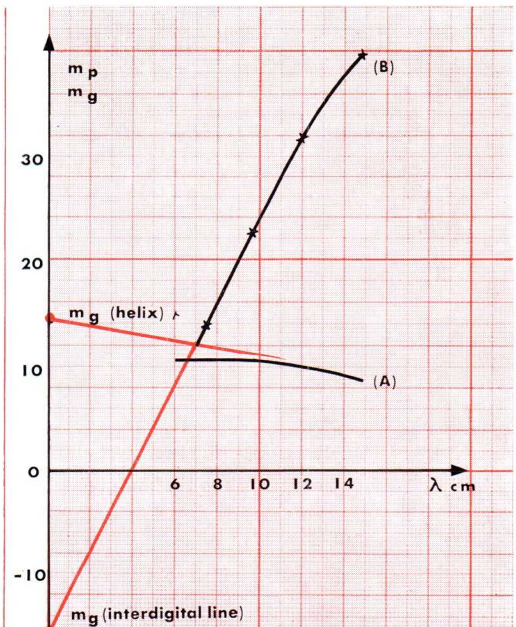
$$m_e = \frac{c}{v_e} = \frac{505}{\sqrt{V_o \text{ volts}}}$$

The delay line constitutes a new element still not very familiar to technicians : however, the helix which is found in most TPO's is becoming well known. The periodic structures used in the " Carcinotron " tubes are not so well known and so will be briefly described later.

The most important value to define, in order to characterize an electromagnetic wave travelling along a delay line, is **the rate of phase delay m_p** :

$$m_p = \frac{c}{v_p}$$

(v_p : phase velocity of the wave considered).



DISPERSION CURVES
A : of a TPO 851 helix
B : of a CO 127 interdigital line

The curve representing m_p as a function of the spatial wave length (dispersion curve) from which much information can be derived regarding the behaviour of the line in the presence of a beam, will most probably become just as useful to technicians as are, for example, the frequency-attenuation curves of lumped constants filters in conventional radio techniques.

Another value which is interesting to know is the **group velocity v_g** of the electromagnetic wave ; practically it is the same as the **propagation velocity of the energy** if the line is slightly attenuated. The group delay :

$$m_g = \frac{c}{v_g},$$

which is difficult to determine by direct experimental measurement can easily be deduced by a geometrical plot from the dispersion curve ; for a wave-length λ, m_g is measured by the ordinate of the point of intersection of the axis m_p and the tangent to the dispersion curve at the point (m_p, λ).

As an example, the curve A of the opposite figure represents the dispersion of the helix of a TPO 851. Between 6 and 9 cm wave-length, the phase velocity remains practically constant and equal to the velocity of the group. In this domain the TPO 851 can be used in a large band without modification of the line voltage since the interaction is optimum when the delay rates m_p and m_e are very close together.

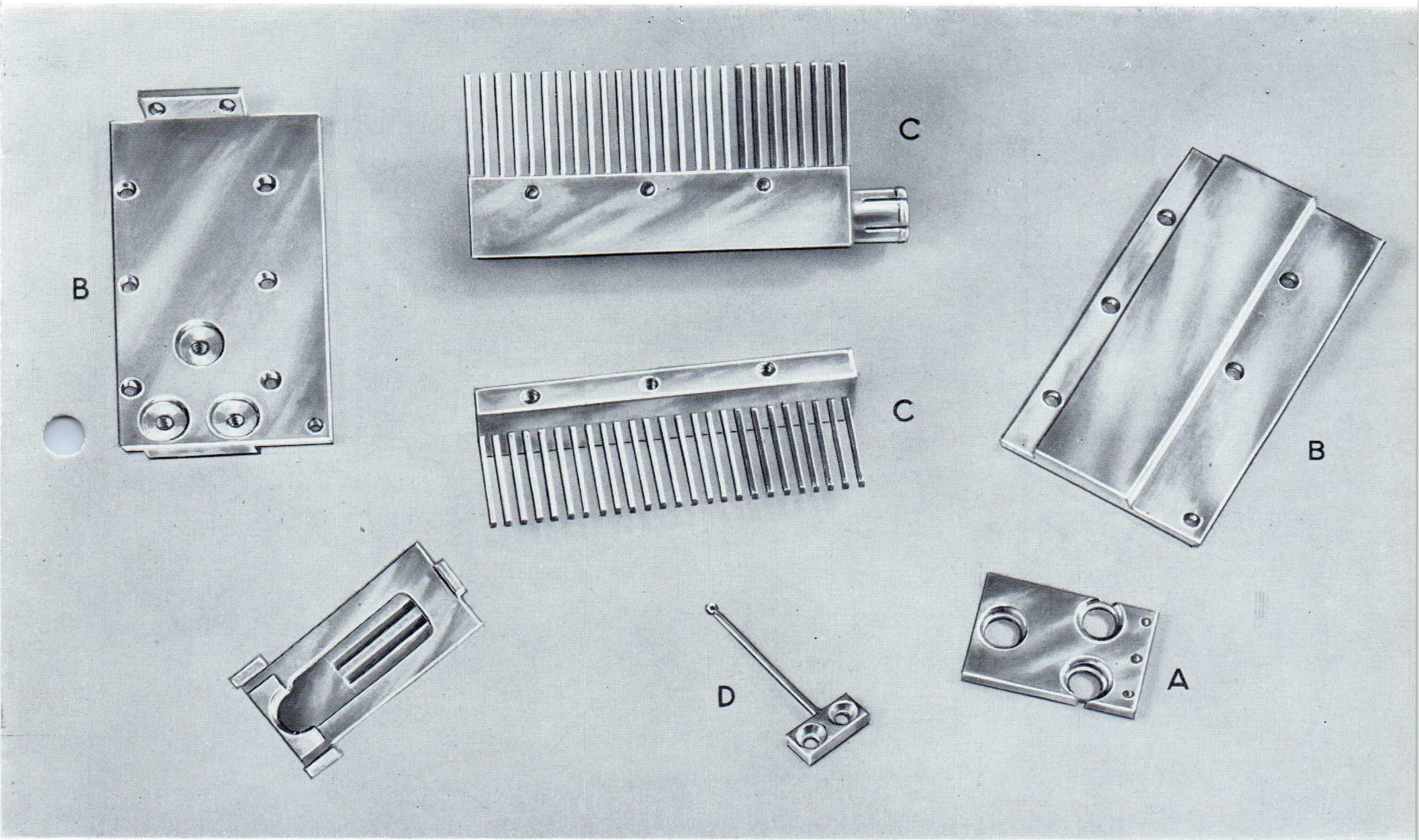
Above $\lambda = 10$ cm, the helix becomes dispersive, the rate of phase delay decreases linearly, which necessitates the use of higher and higher supply voltages ; the group velocity remains constant and inferior to the phase velocity.

The curve B of the same diagram represents the dispersion of the fundamental wave of an **interdigital line** effectively used in the CO 127 " Carcinotron " tube. The accompanying photograph renders any comment on the geometrical structure of the circuit quite unnecessary.

Two remarkable facts become apparent on examination of curve B :

- **the line is highly dispersive,**
- **the group velocity and the phase velocity are of opposite direction.**

They characterize a backward wave ; the



A — supporting plate. B — ceilings. C — combs. D — matching probe.

interdigital or other line which serves as the physical support of such a wave is, as will be seen later, the **fundamental constituent element** of the " **Carcinotron** " tube.

Earlier reference was made to a " fundamental wave " that is, because in fact, for a given frequency, the delay line can guide several waves called " space harmonics " ; these waves, alternatively forward and backward, are all other things being equal, much less **coupled** to the beam than the fundamental wave and correspond to delay rates which increase with harmonic range.

To reduce the length of the line, it is necessary that the length of the backward wave used be equal to that of the **fundamental ;** such is the case in the " Carcinotron O ".

IV — AN OUTLINE OF THE THEORY OF OPERATION OF THE " CARCINOTRON O ".

How can the coupling of an electron beam and an electromagnetic wave produce a UHF oscillation?

In order to better understand the functioning of a " Carcinotron ", it is as well to examine the process of starting the oscillations.

Suppose that in the neighbourhood of a frequency **f**, an electromagnetic disturbance, in fact however always present in the form of noise, appears in the backward mode line at **a**, on the collector's side ; a portion of the energy associated with this disturbance moves **at the group velocity v_g in the direction of the gun, the phase propagating itself, in the opposite direction, at velocity v_p.**

If the velocity of the beam v_e is slightly above that of v_p a portion of the mean cinetic energy of the electrons is converted into electromagnetic energy and according to the usual mode of interaction between field and beam the electromagnetic disturbance coming from **a** arrives amplified at the origin of the line, the amplification for a given line depending on the intensity of the beam. The field thus produced on the gun side, causes a velocity modulation of the beam as soon as it enters the interaction space.

The synchronism on a backward wave thus causes an " internal reaction " to appear. The velocity modulation of the beam is transformed near the collector, at **a,** into intensity modulation which in its turn induces an electromagnetic field and the same phenomena are reproduced. It is thus that the oscillations are born. In effect, when the intensity modulation produced by a primary flux of energy E gives rise to a secondary flux at least equal to E (that is to say when the **mean intensity** of the beam is sufficiently high) the **internal reaction engenders the oscillations** of which the frequency is determined approximately by the **condition of " synchronism "** ($v_p = v_e$).

The flux of energy increases towards the source of electrons (*) while the intensity modulation of the beam increases in the opposite direction ; the distribution of the electric field in " Carcinotron O " explains the presence of the element collecting the UHF energy at the input extremity of the interaction space.

The attached figures well illustrate the difference of behaviour between the normal TPO and the " Carcinotron O ".

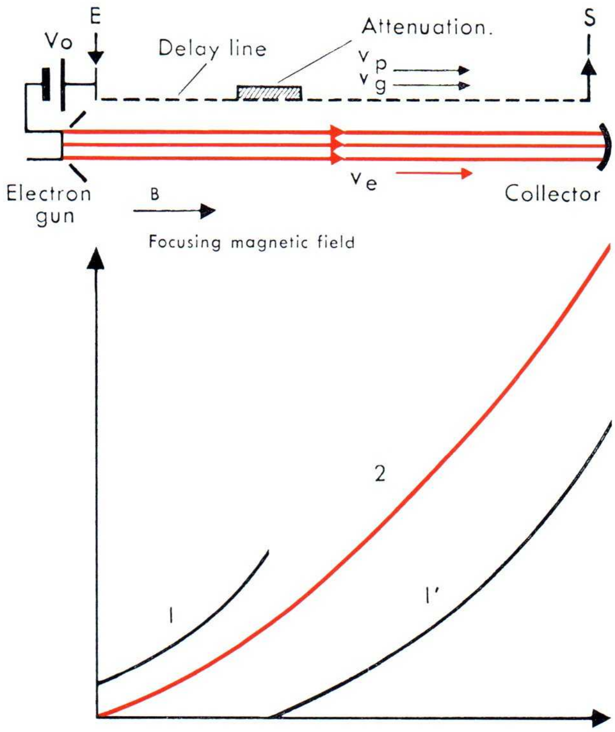
The functioning mechanism just outlined systematically distinguishes the " Carcinotron " from other travelling wave oscillators, the functioning which involves either an internal reflection and external feedback or an electronic reaction by reflection of the beam (TPO reflex).

To emphasize the really original characteristics of the new tube, it is worth while pointing out that paradoxically enough, the optimum operating conditions correspond to the **absence of reflections at the ends of the line.** Further to obtain a very satisfactory operation, good matching of only one of the extremities is sufficient : as it is extremely difficult to obtain an output load having but a slight reflection in a very wide band, this is effected on the free end of the line — collector side — by means of an **absorbant coating** which practically suppresses any deflection of energy in the electronic tuning range of the tube.

Under these conditions, a wave which is reflected on the mismatched load returns towards the

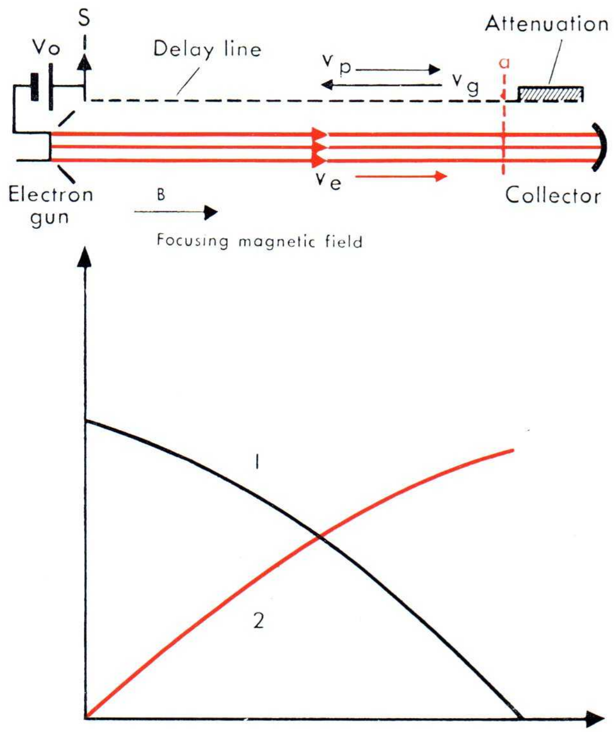
* The fact that in the new tube the electromagnetic energy moves backward like a crayfish (in Greek : KAPKINOS) is the origin of the name " CARCINOTRON ".

SCHEMATIC STRUCTURE OF A T P O



Distribution of U H F field and electron current along a T P O

SCHEMATIC STRUCTURE OF A "CARCINOTRON O"



Distribution of U H F field and electron current along a "Carcinotron O"

1 U H F longitudinal electric field
2 U H F electron current

(Supposing infinite, reflectionless and localized attenuation)

collector and is absorbed by the attenuating coating ; during its passage from gun to collector, it does not enter into interaction with the beam because **its phase velocity is in the opposite direction to the velocity of the electrons.** Therefore, as a first approximation, the characteristic frequency-line voltage **is not affected by the mismatching or modifications of the load.**

The only consequence of this mismatching is a slight drop in the UHF power delivered (for a standing wave ratio going from 1 to 2 : 0.4 dB, 1 to 3 : 1.25 dB).

SUMMARY OF THE ADVANTAGES

The following table summarizes features of the principal advantages of the " Carcinotron O " tube ; this summary constitutes a foreword to the exposition of its possible uses.

ADVANTAGES	DATA, COMPARISONS, VALUES
● Electronic tuning over a very wide frequency band (approx. 1 octave). Band-width at 3 dB from max. UHF power : approx. 1/2 octave.	*Any variation of the voltage Vo, therefore of the electron velocity, determines a variation of the frequency, itself fixed by the dispersion characteristic of the delay circuit utilised.* $m_p(f) = \frac{505}{\sqrt{V_0 \text{ volts}}}$
● The band can be explored very rapidly, hence possibility of modulation at high frequencies (a few Mc/s) without interference of spurious phase modulation.	*There is not a single selective element in the " Carcinotron O; further, the transit time T of the electrons is relatively short (for Vo = 200 V in the CO 119, $T = 0.5 \times 10^{-8}$ s) and it suffices if the period of the modulating signal is sufficiently large before T.*
● Frequency modulation requiring low drive power.	*In this tube, thanks to the special structure of the gun, the electric current varies little with the drive voltage applied to the line. At high modulation frequencies, the internal capacities come into play, however, to increase the necessary power.* *In the case of the CO 119, at Fo = 3,300 Mc/s and for modulation frequencies less than 100 kc/s the powers required to obtain frequency deviations of ± 10 Mc/s and ± 200 Mc/s are in the order of 0.5 mW and 40 mW respectively.*
● Minimum influence of the load and of its variations on the value of the frequency (low " pulling figure ") and consequently absence of hysteresis of circuits or long line effects ; absence of oscillation " sinks " even with heavily mismatched loads.	*This advantage has been theoretically justified in the case of the ideal " Carcinotron " provided with a perfectly absorbent attenuation.* *In practice, with the attenuations which can be effectively realised, reflection is fairly weak and the effects of the load remain unnoticeable when the standing wave ratio remains less than 2.*

ADVANTAGES	DATA, COMPARISONS, VALUES
• Frequency defined in univocal fashion in terms of the voltage Vo. Absence of frequency " jumps ".	*This quality clearly distinguishes the " Carcinotron " from other self-oscillating TPO. In the " Carcinotron " the lenght of the line plays no part in the definition of the frequency, but merely assures the gain necessary to sustain the oscillations.* *In the field or current reflection self-oscillating TPO, in order to sustain the oscillations, it is essential that outward and return path of the wave corresponds to a whole number N of wavelenghts; the slightest variation of one of the parameters defining the beam or the load causes the oscillation of the order N to pass to a neighbouring order; a frequency " jump " takes place.*
• Electronic frequency adjustment without hysteresis or discontinuity	*The best reflex klystrons frequency modulated by the repeller voltage are subject to electronic hysteresis*
• The tetrode structure of the gun allows the power of the UHF signal to be submitted to an amplitude modulation or a pulse regime, or to be controlled by acting on the control grid voltage or on the anod screen voltage.	*The " Carcinotron O " tubes are supplied with an electrode controlling the intensity of the beam penetrating the interaction space, which allows modulation of the UHF energy without appreciable expenditure of energy; it is thus that as the tube does not include a single selective element, the envelope of the modulation of the microwave practically reproduces the form of a pulse applied to the grid even for very short pulse widths (0.5 μs for example).* *The oscillation frequency at the top of the pulse remains constant.*
• Very high signal-to-noise ratio.	*This ratio is roughly equal to that measured on the* ***best*** *reflex klystrons under the same conditions.*

A FEW POSSIBLE APPLICATIONS

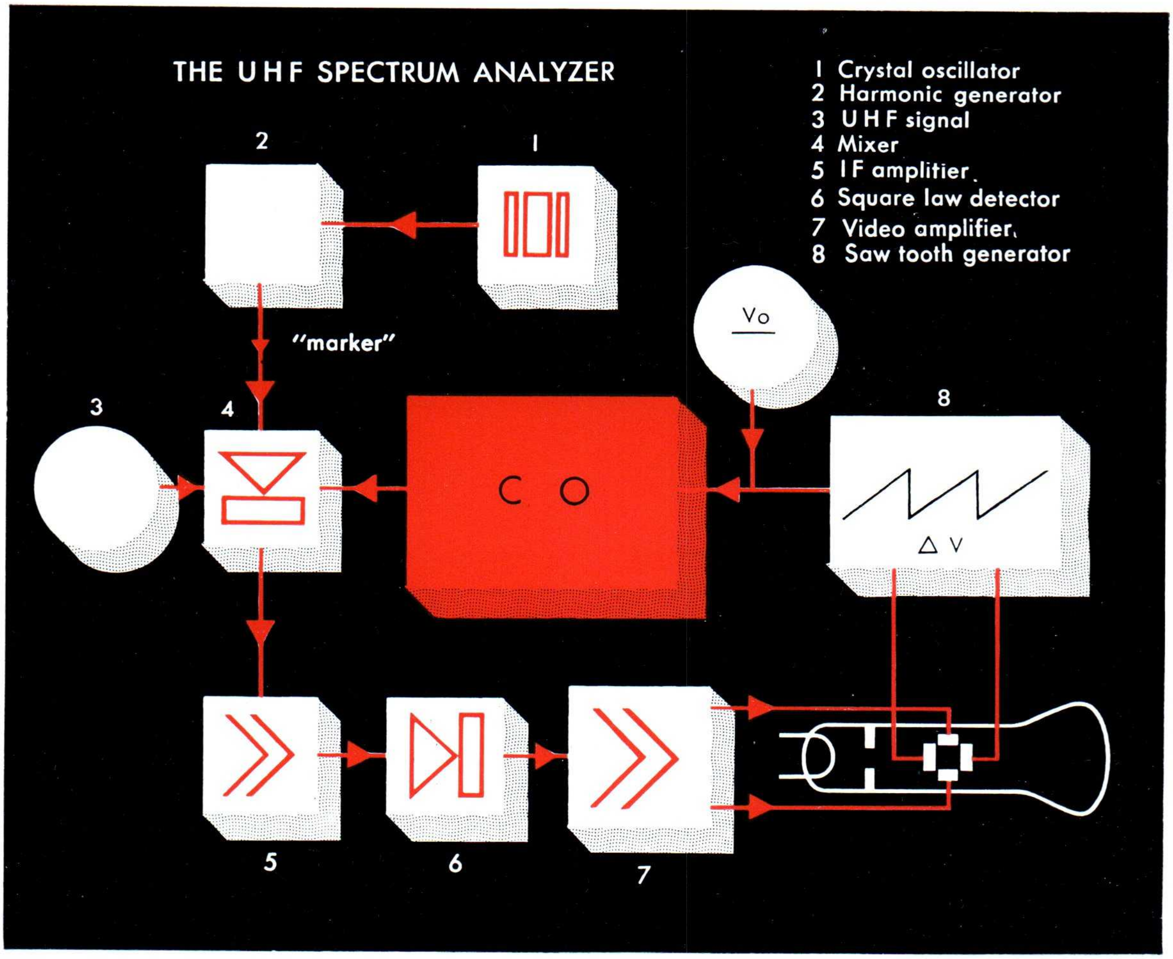
A glance at this table will prove that the " Carcinotron O " can with advantage replace the old type tubes in the greater part of usual UHF equipment (special triodes, reflex klystrons). Often, by making use of it in an equipment, it is possible to increase the quality and quantity of the services rendered (metrology, telemetry, altimetry, local oscillator in pulse radar units) ; again in certain cases thanks to the " Carcinotron ", certain interesting devices, rapidly abandoned during the experimental stage because of lack of tubes with appropriate performance, will again attract the attention of technicians (Frequency modulation anticolision Radar units). Finally, it is believed that the astonishing properties of this new tube, when better known by radiotechnicians, will induce them to use the " Carcinotron O " as the fundamental element of entirely new equipment.

I — APPLICATION TO MEASURING EQUIPMENT

1) UHF signal generators.

It is hardly necessary to underline the advantages offered by the use of the " Carcinotron " tube in this field.

- All the controls of the generator can be electronic ; thus the heavy mechanism associated with special triodes or reflex klystrons used to date is obviated.
- Variations of the power level with frequency are slight.
- Frequency is defined without ambiguity by the HT (Vo).



- The total deviation is approximately equal to 1 octave.
- The signal can be frequency modulated or chopped into square " pulses " without appreciable consumption of energy.

The fact that the frequency is not sensitive to the load is of great importance for rapid measurements ; in this case, it is possible to directly couple the output of the generator to the unit being monitored without altering the correct operation of the tube.

2) Wobbulator.

In this type of apparatus used for the synoptic oscillographic representation of the pass band of a circuit, it is advantageous to make use of the properties of the " Carcinotron O " (possibility of deep frequency modulation by sawtooth signal).

3) Panoramic receiver and spectrum analyzer.

These instruments are used to determine the spectral components (relative frequencies and amplitudes) of UHF sources. The panoramic receiver also has important military uses such as the search for and identification of Radar stations.

In this connection, it is worth noting that the practical advantage of using the " Carcinotron " resides :

- in the possibility of obtaining much longer frequency deviations than with current tubes,
- and that a single " Carcinotron " can replace several conventional oscillators with relatively narrow tuning bands.

II – *APPLICATION TO RADAR*

4) Pulse radar units (single control).

It is often found to be useful that the frequency of local oscillator instantaneously follows variations of the transmitted frequency.

The " Carcinotron " thanks to its very wide band and its flexibility of control which is implied by its purely electronic functioning and thanks also to its excellent signal-to-noise ratio, is well suited to replace the tubes currently used in this field : UHF triodes or reflex klystrons.

5) Linear FM range and height measuring equipment.

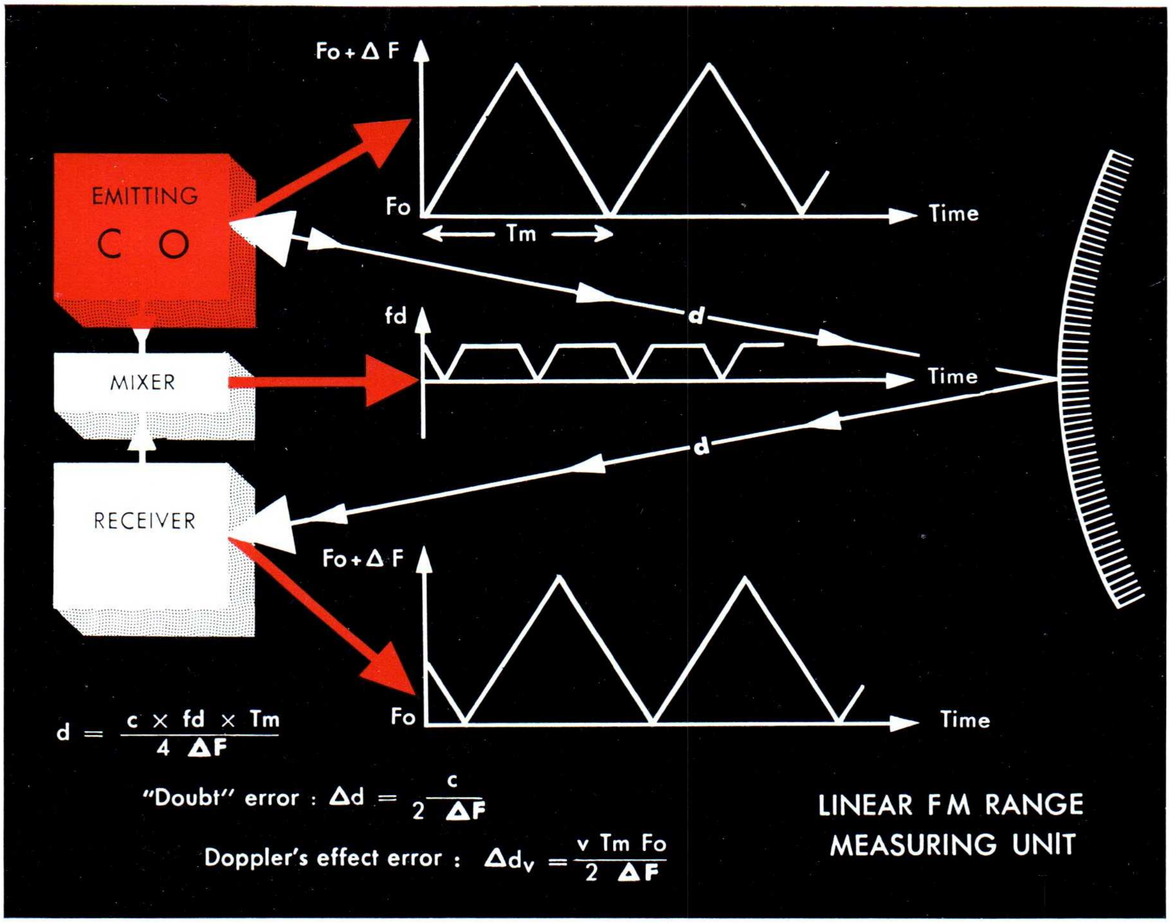
Let us recall the characteristics of the " Carcinotron " tube particularly interesting for this application.

- The very great width of the modulation band ΔF. It is known that in this process of range measuring " doubt error " exists which is inversely proportional to ΔF. Further, if the target is moving in relation to the transmitter at an unknown radial velocity v, the corresponding error, associated with the Döppler effect, is also inversely proportional to ΔF.
- The linearity of the frequency vs line voltage characteristics.
- The purely electronic modulation which avoids the introduction of complicated mechanical elements.
- The non-sensitivity of the frequency to variations of the load, which is of definitive advantage when measuring the range of nearby, highly reflective targets.

Very often, when tubes such as the reflex klystrons are used, it has been noticed that the important part of the field, associated with the echo, which returns towards the aerial of the transmitter, can cause the appearance of phenomena comparable to long line effects : the operation of the oscillator becomes unstable, a serious defect which can be avoided by the use of the " Carcinotron ".

6) Radar Navigation - Anti-collision devices.

In these devices, the frequency modulation in relation to time is generally of exponential form. The advantages quoted in the preceeding paragraph retain their full importance in this case ; in particular, the accuracy of distance measuring becomes greater as ΔF is higher.



III — *APPLICATION TO TELECOMMUNICATIONS.*

7) Microwave radio links - Mobile television relays.

It has already been pointed out in the introduction that the " Carcinotron " can play an important role in the field of high quality telecommunications (Carrier current telephony and television). particularly with reference to its use as the **modulator tube of terminal stations of microwave radio links.** In fact, a very wide band associated with low distortion of the modulation characteristic and the possibility of modulating at high frequencies are the features which will undoubtdly attract the attention of telecommunication specialists.

The non sensitivity of the frequency to changes of the load, added to the preceding properties allows the early use of this new tube in **mobile television relays to be predicted.**

NEW " CARCINOTRONS O " IN THE NEAR FUTURE

Certain " Carcinotron O " tubes, such as the CO 119 and CO 127, already form part of the current production of the CSF factories.

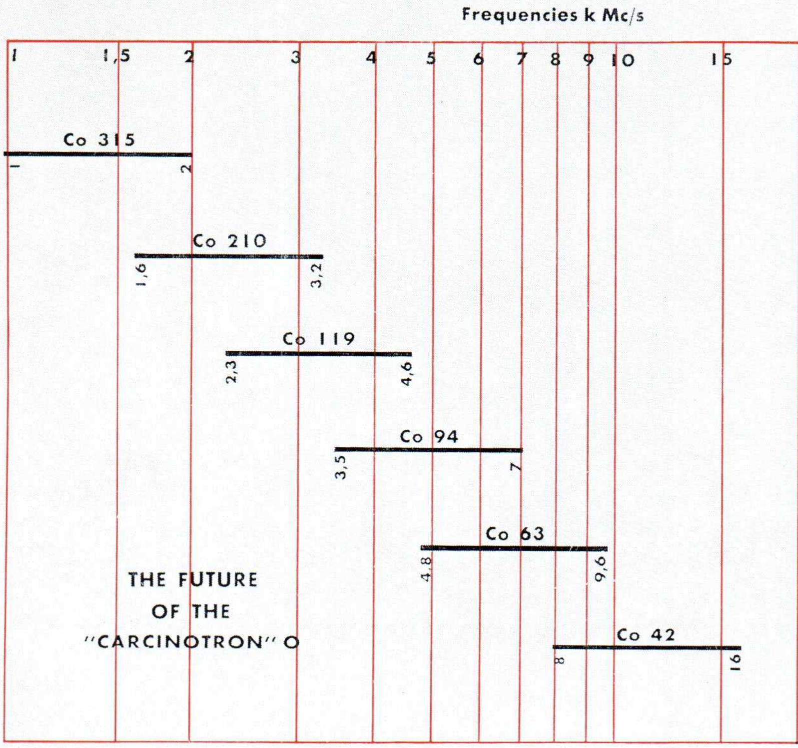
The electronic laboratories of our Company have continued their efforts in this field and have achieved the design of a coherent range of " Carcinotron O " tubes which, with large overlaps, permit the fruitful exploitation of four octaves in the microwave spectrum (1000-16,000 Mc/s).

The following table shows : the nomenclature of the six projected tubes, the band-widths and a few indications, which are, of course, subject to revision, of the applied voltages and UHF powers delivered (*).

The large frequency overlaps shown in this table gives the user a wide range of choice.

For **the same frequency and modulation depth** the following would be chosen for preference :

* No mention has been made of the CO 127 currently manufactured but in its place the CO 127 has been described. This tube has very similar characteristics and is more rationally integrated with those of the range described.



	UHF power (approx.) mW	Line voltage (approx.) V
Co 315	20-200	170-1400
Co 210	40-400	170-1400
Co 119	50-600	170-1400
Co 94	30-250	170-1400
Co 63	25-200	170-1500
Co 42	20-100	200-1600

in mobile equipment : a tube operating at low voltage, for example less than 700 volts, and not requiring forced air cooling, this at the expense of a slight lowering of UHF power and a slight increase in distortions ;

in permanent equipment : a tube operating at high voltage so as to make the best use of the qualities of the " Carcinotron ".

The CSF factories are beginning to produce some of the tubes figuring in the " Carcinotron " programme and in a few months the whole range will be commercialy available.

Soon then, CSF will be able to place at the disposal of radiotechnicians an incomparable tool : simple in operation, of small size, of very robust construction, the " Carcinotron O " is ready to replace, in all domains, the greater part of the low power UHF tubes currently used.

Often, too, it will also constitute the heart of new equipment of completely original design.

THE " CARCINOTRON CO 119 "

The utilization range of this tube extends from 2,400 - to 4,700 Mc/s and the output power is between 50 and 600 mW approximately.

I — *DESCRIPTION*

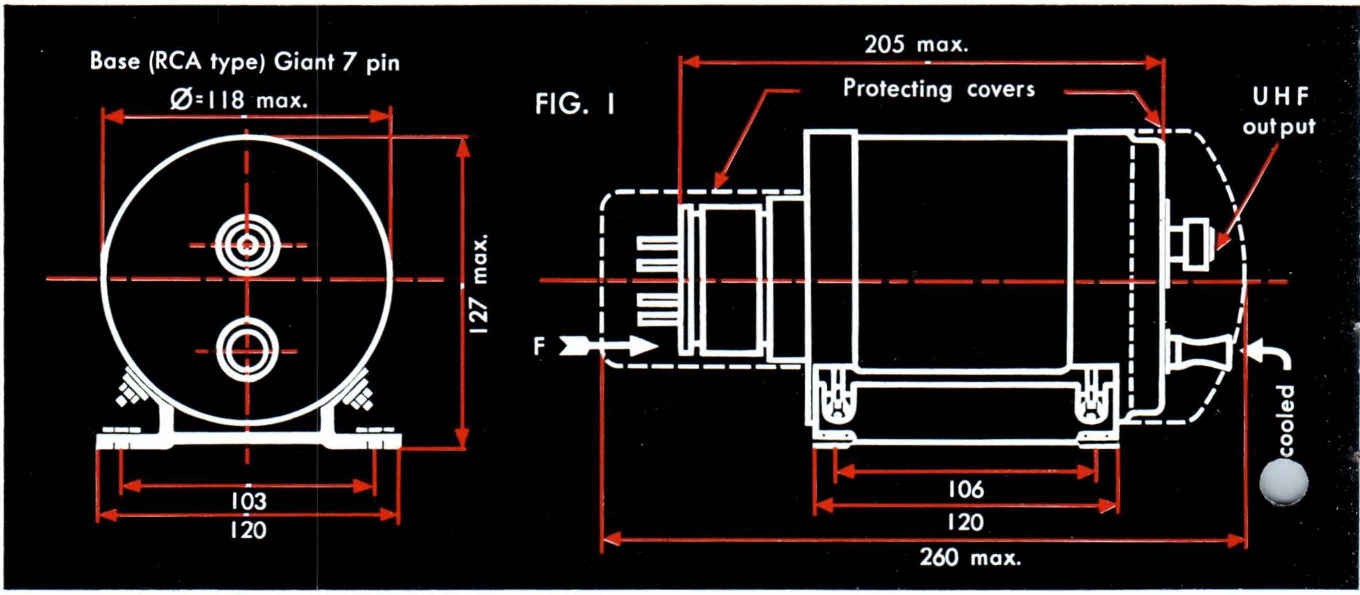
The CO 119 is delivered mounted in a permanent magnet under a protective cover. The tube comprises a " Giant 7 pin " base for the following connexions : filament (F), cathode (K), control grid (G), screen anode (A), line and collector (L, C).

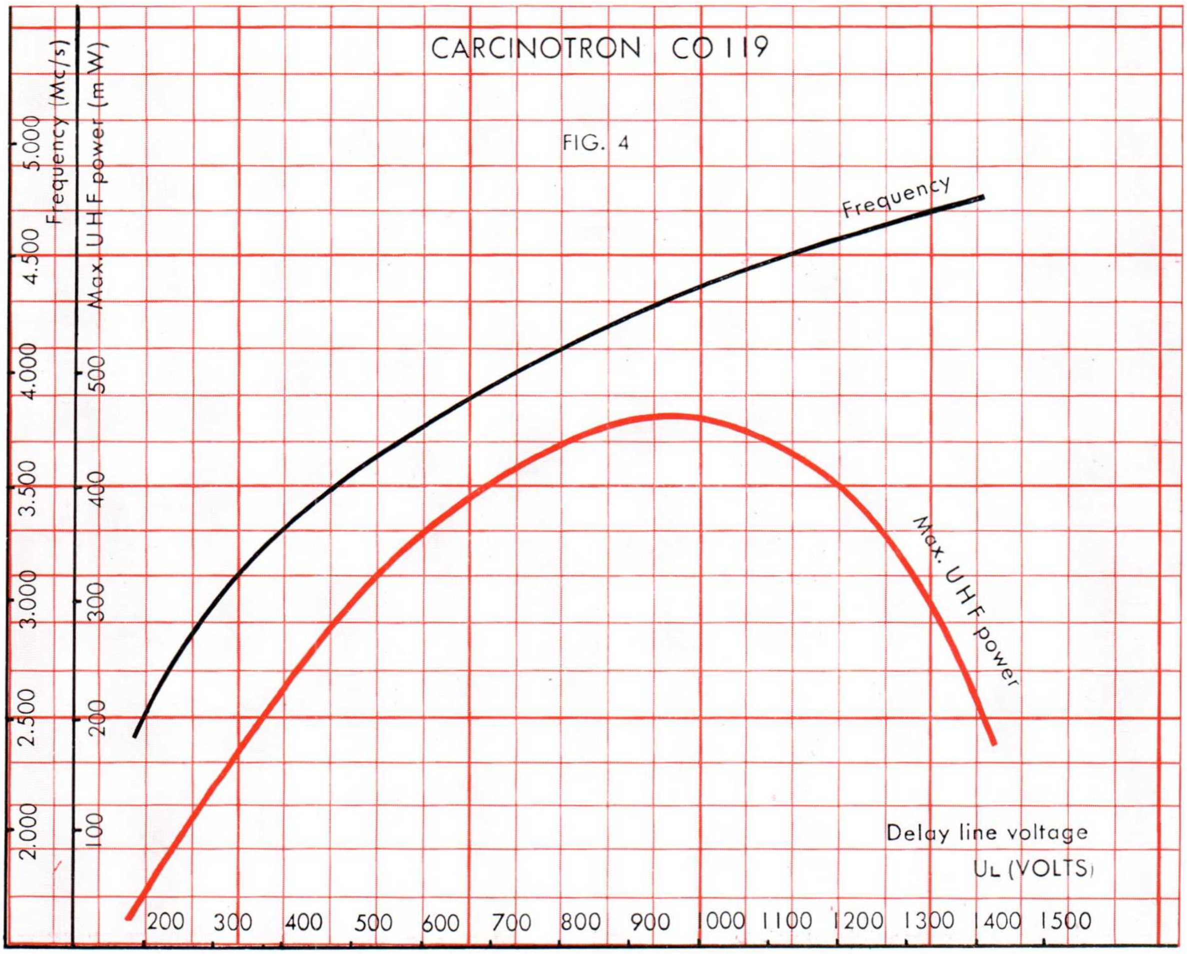
At the other extremity is the N type coaxial output of characteristic impedance : 50 ohms.

The magnet is formed of bars assembled on two polar pieces which also assure fixing of the tube on the gun side by a rubber joint and on the collector side by locking pieces. The cover assures protection and fixing of the system to the equipment in which it is used. It is equipped with a duct for ventilation.

Dimensions : Figures 1, 2 and 3 represent respectively the size of the tube, its pin-connections and the dimensions of the coaxial output.

Net weight : 5 kg.


Base (RCA type) Giant 7 pin
Ø=118 max.
127 max.
103
120
FIG. 1
205 max.
Protecting covers
UHF
output
F
cooled
106
120
260 max.


CARCINOTRON CO 119
FIG. 4
Frequency (Mc/s)
Max. UHF power (mW)
2.000
2.500
3.000
3.500
4.000
4.500
5.000
100
200
300
400
500
Frequency
Max. UHF power
Delay line voltage
UL (VOLTS)
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500

1 Heater

2 Cathode

3 Anode

4 Grid

5 ⎤ Line Collector

6 ⎦ and external schell

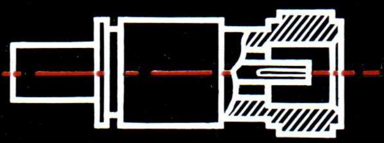
7 Heater

All dimensions are in millimetres

FIG. 2

Base (RCA type) Giant 7 pin
(through F)

FIG. 3



U H F output
50 Ω N type Connector
(UG/160)

II — *OPERATING CONDITIONS :*

Indirect heating

Oxide coated cathode

filament heating V_F = 6,3 V ; I_F = 2,4 A

Limitations : Under permanent operation the following limitations must be observed :

Maximum line voltage	V_L =	1,450 V
Maximum line current	I_L =	50 mA
Maximum continuous power	W_L =	60 W

Normal conditions of operation are as follows :

grid voltage V_G = 0

line voltage V_L = 150—1,400 V

line current I_L = 20—45 mA

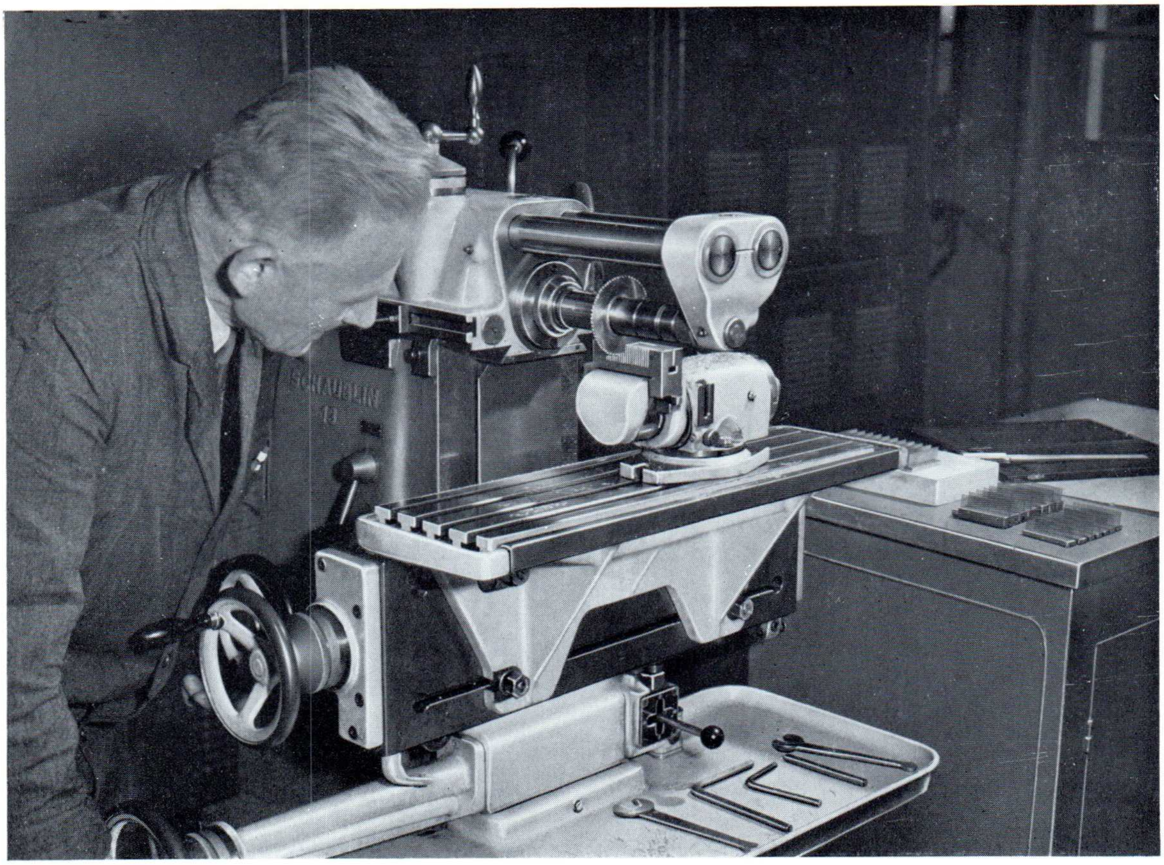
anode voltage V_A = 150—200 V

anode current I_A = 3—25 mA.

Cooling :

Cooling by forced air : for an applied power of 60 watts : 10 cubic meters per hour.

Figure 4 shows the curves of frequency and power characteristics under these operating conditions for an average tube from a production series.



Milling of the combs

III — *PRECAUTIONS - RECOMMENDATIONS*

Starting up operations must be carried out in the following sequence:

cooling - filament heating - grid voltage - line voltage - anode voltage.

The reverse order must be followed for switching off.

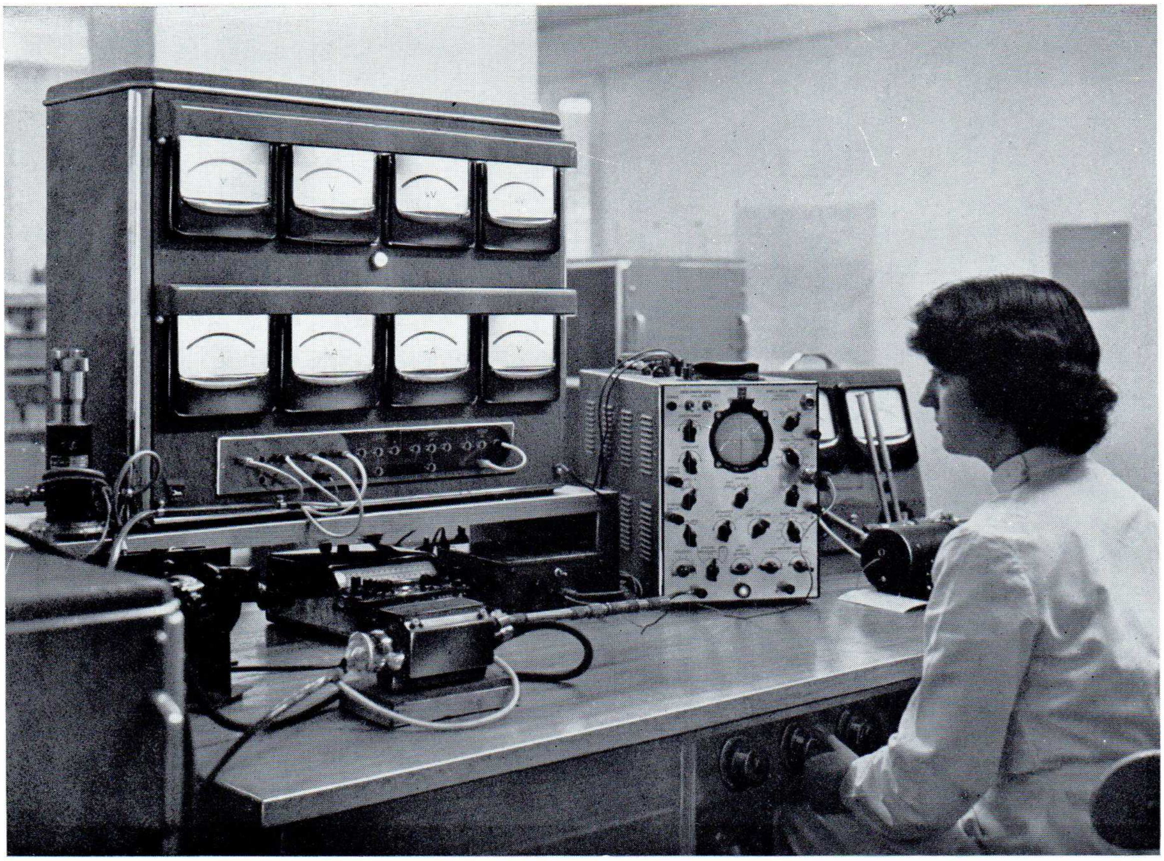
During the initial adjustment or when starting up for the first time, moderate voltages should be applied (for example, $V_L = 400$ volts, $V_A = 150$ volts) and correct operation must be verified before applying normal currents.

Insulation

The body of the tube being connected to earth the cathode and the filament are taken to a negative voltage which can be as high as 1,400 volts.

Filament heating

It is often advantageous to heat the filament by d.c. (rectified supply or even from batteries) in order to reduce hum and spurious frequency modulations.



A CO 119 tube with housing removed during tests

Load

Although the oscillating frequency is normally independent of the load (no pulling) and in order **to take full advantage of the " Carcinotron "** when used as frequency modulated oscillator, the load must fulfil certain conditions among which are:

a) standing wave ratio (measured at the coaxial output) less than 2 in the modulation band ;

b) tube-to-load connecting line as short as possible in order to obviate phase modulation distortions, which are proportional to the product : **electric length of the line x modulation frequency** and which can become appreciable when the latter has a high value.

Precautions

- When in store or during operation avoid placing the tube nearer than 30 cm to any other magnet and orientate the neighbouring magnet in such a way as to produce an effect of attraction.

- Do not place the tubes on ferro-magnetic base plates.

- Avoid all dismantling operations which are liable to modify the mechanical adjustment of the system and hence the performance of the tube.

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