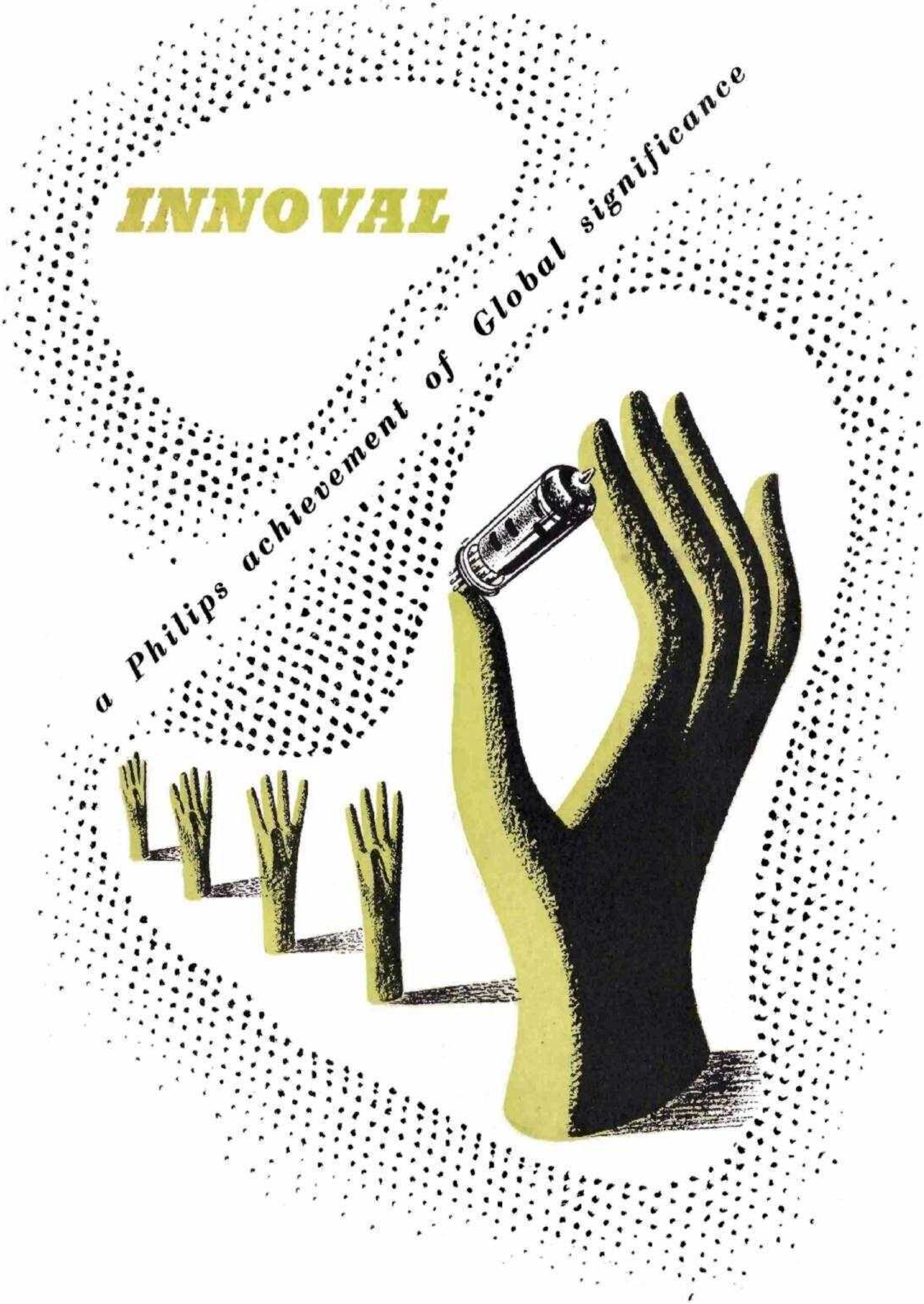
Radiomuseum.org, thanks to Martin Kent



"INNOVAL"

A Philips Development

The Australian release of a completely different and new Philips Miniwatt valve series is a contribution of vital importance to the radio, communications and general electronic fields. A new type of valve-construction has been evolved which offers more than has ever been possible in the world before.

The development of this new-type series, known as "Innoval," has resulted from the endeavours of the Australian Philips organisation to provide the complete answer to the very real need for a basic valve construction suitable for all electronic needs in Australia, and particularly with the applications of VHF, FM and Television in mind. Success has been achieved through the joint endeavours of the Australian and Eindhoven Philips valve laboratories.

"Innoval" offers much more than either the latest American valve development (now popularly known as the "Noval" series) or the widely accepted Philips European "Rimlock" series. It is because of this fact, and the fact that "Innoval" complies with the accepted British, European and American standardisation for combined services requirements, that this Australian-inspired series assumes such world-wide significance.

Why a New Valve Technique Was Necessary

The necessity for the development of a valve-manufacturing technique producing results achieved in the "Innoval" series was first perceived about 1936 when serious experiments with VHF communications and high-definition television commenced. Although several attempts were made to perfect such a valve-manufacturing technique, the problem remained unsolved when war broke out. The acceleration of development in UHF techniques and the requirements of tropical warfare only served to again highlight this real necessity.

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Shortcomings of "Pinch" Construction

The "pinch" type of valve construction, which was universal until 1937 and is still used to a large extent, has several basic shortcomings:—

1. With the "pinch" type construction, excessive heating of the assembly occurs during the sealing of the bulb to the electrode assembly. As this process takes place in a mixture of air and the products of combustion of the coal-gas flame, chemical reactions occur which adversely affect the emissive properties of the coated cathode or filament.
2. The single-plane support system of the "pinch" construction requires auxiliary supports pressing against the bulb wall to strengthen the assembly and reduce microphonic phenomena. These auxiliary supports often cause distortion of the electrode assembly during the valve sealing process and give rise to wide variations in valve characteristics.
3. Because the glass used in the "pinch" undergoes a change in its physical characteristics throughout the life of the valve (with the degree of change dependent upon the potential difference between the leads and the operating temperature of the glass) two major troubles develop. Firstly, leakage currents appear, and secondly, electrolysis of the glass takes place with resultant destruction of the vacuum seal.
4. At high frequencies, with the long, parallel, closely-spaced leads of the "pinch" construction there is a minimum, beyond which improvement cannot be affected, in the inter-electrode capacitances and self and mutual inductance of lead wires. In high-frequency applications, improved valve characteristics depend upon closer spacing and finer mechanical tolerances in the electrode assembly. Ruggedness of construction *beyond the limitations* of the "pinch" technique are necessary.
5. At high frequencies, normal phenolic bases give intolerable losses, and, under humid conditions, moisture absorption and loosening of the base occur. These two major troubles are inseparable from the "pinch" type construction.
6. At high frequencies the physical dimensions of the "pinch" type construction prohibit the short point-to-point wiring necessary to minimise inductive and capacitive effects. These problems can only be overcome effectively by a single-ended, miniaturised valve construction.

Pattern for the Ideal Valve

Once these limitations were realised and became a factor in restricting equipment development, it was apparent that a valve construction would eventually have to be evolved which would:—

a. Provide improvement in product quality with variations reduced to a minimum in the individual characteristics of valves of the same type.
b. Give improvement in dynamic characteristics for high-frequency operation.
c. Be single-ended in construction.
d. Eliminate the necessity for a moulded bakelite base.
e. Allow a reduction in the length of lead and support wires.
f. Increase the spacing between lead wires.
g. Have a multi-planar support system.
h. Permit low operating temperatures in the region of the lead-wire vacuum seals.
i. Permit reduced temperatures during bulb sealing.
j. Have small physical dimensions and a standard construction suited to all types of receiving valves.

Many Attempts were made to produce the "Ideal Valve"

Among the many attempts made to produce the "ideal valve" were the "Acorn", "Metal", "All-Glass", and "Miniature" valve construction techniques. Of these, the types most nearly achieving success were the "All-Glass" and "7-pin Miniature". Both of these, however, had bad faults.

The standard "All-Glass" construction had the advantage of solid base pins but required high bulb-sealing temperatures, a cement-affixed base-locating device, and was comparatively large. The "7-pin Miniature" construction overcame the problems of size and base location, but because of the smaller dimension, the glass base became plastic during bulb sealing and as a result distortion occurred. For this reason three-piece leads had to be used with the base-pin portion of soft metal to allow for correction of pin splaying. This, in turn, introduced the risk of the pins becoming bent in service so that the valve no longer correctly fitted the socket, possibly causing damage to the valve. Further, the three-piece lead did not give rigidity to the electrode assembly.

The dimensions of the "7-pin Miniature" restricted the maximum number of base pins to 7. This meant that the valve could not be used for popular types including the triode hexode or triode heptode frequency converters, or the duo diode R.F. pentode. Again the valve size was such that the anode dissipation of rectifier and power-output valves had either to be limited or the valves operated with greatly reduced factors of safety.

Philips engineers realised that the key to the problems, associated with the "All-Glass" and "7-pin Miniature" constructions lay in devising a new method of sealing the bulb to the base. For this purpose a special, non-porous glaze was developed and used as an intermediary sealing medium.

Using this technique, the temperature of the electrode assembly, during the sealing process, was about 300° Centigrade lower than in previous techniques. Under these conditions, cathode poisoning and distortion of the base and bulb are eliminated.

This technique was put into commercial practice in the "Rimlock" series of valves released in Europe nearly two years ago. This series made great strides towards the ideal valve construction. It was virtually a miniaturised version of the standard "8-pin All-Glass" series with a bulb diameter approximately ¼" greater than the "7-pin Miniature". However it fell short of the ideal because a cement-affixed base-locating device was necessary and the number of base contacts was still one short of the number available in a "pinch" type construction valve fitted with an octal base and top cap.

In America, contemporary development produced the "Noval" or "9-pin Miniature All-Glass" construction. This construction employed the same base-locating method and general technique as used in the "7-pin Miniature" but used the same bulb diameter as the "Rimock" series.

The Final Answer

..."INNOVAL"

...AN AUSTRALIAN ACHIEVEMENT

Obviously the final solution to the problem of the ideal valve was the combination of the "Rimlock" and "Noval" constructions and this has now been achieved in the Philips Miniwatt "Innoval" which retains the same physical dimensions as the "Rimlock" and "Noval" constructions, but combines the advantages, and eliminates the disadvantages of both.

The "Rimlock" type sealing process used for the new "Innoval" series is illustrated in figures 1, 2 and 3. First the "glaze" or sealing medium is firmly bonded to a flange on the glass base. The moulded-glass base with its completed assembly is then placed over the inverted bulb in a special sealing machine. Heat is applied and the glaze softens allowing the moulded-glass base to sink and the rim of the glass bulb to penetrate the glaze. On cooling, the glaze sets and adheres to the edge of the bulb to form a mechanical and vacuum-tight seal (see Fig. 2).

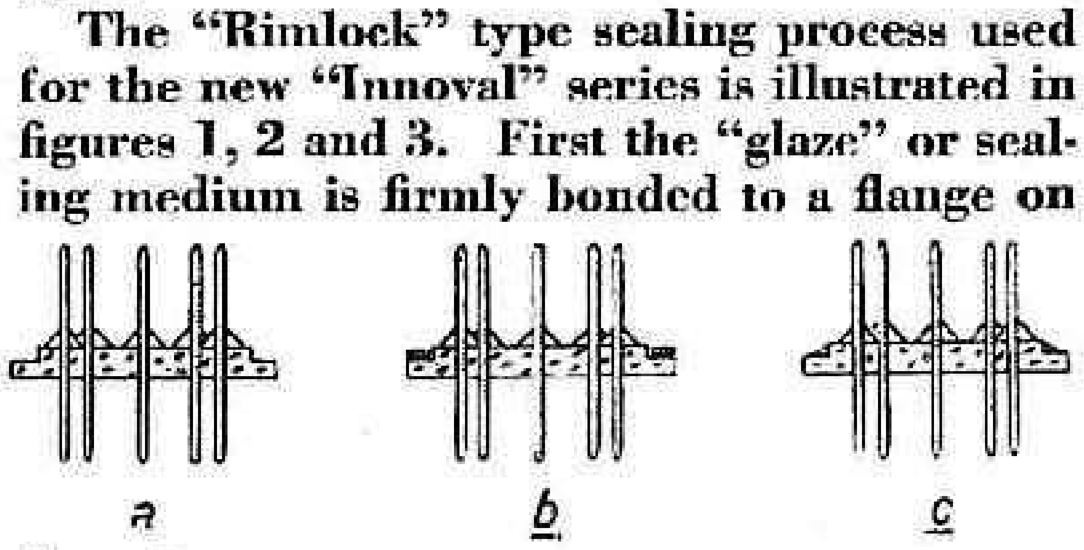


Figure 1.
(a) Moulded glass base for "Innoval" series valve. Actual size.
(b) Base with ring of glaze in position.
(c) Glaze fused to the glass.

To avoid the risk of dangerous mechanical stresses being set up in the valve while cooling, the glaze has a coefficient of thermal expansion practically equal to that of the glass used for the bulb and base. Moreover, the glaze has a suitable surface tension, so that the meniscus of the layer of glaze is slightly concave (see Fig. 1c). This prevents the base from becoming displaced to one side when placed on the bulb as shown in Fig. 2a.

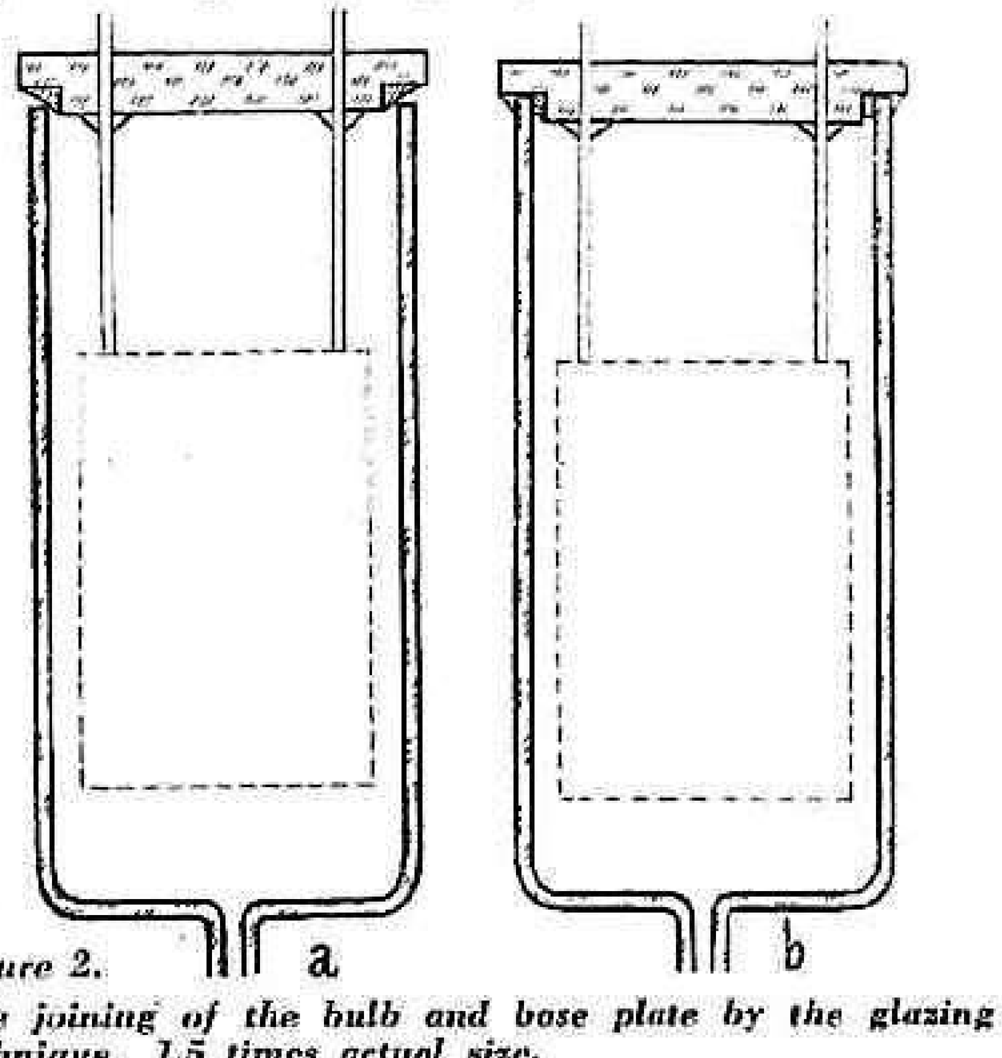


Figure 2.
The joining of the bulb and base plate by the glazing technique. 1.5 times actual size.
(a) The base plate with the fused ring of glaze laid loosely on the edge of the bulb.
(b) The edge of the bulb has penetrated the softened glaze and after the latter has solidified a strong mechanical and vacuum seal results.

Fig. 3 shows in detail the machine used in sealing the bulb to the base. A metal cap is placed over the upward-projecting contact pins of the base. The whole passes between two rows of flat flames directed towards the cap. The edge of the bulb and the base are thus heated uniformly, so that no mechanical stresses are set up in the glass. The weight of the cap assists the rim of the bulb to penetrate well into the glaze.

Sealing is thus completed without the glass of bulb or base becoming hot enough to reach the plastic stage as has been necessary in all other valve manufacturing techniques.

The Philips developed "Innoval" adds to the "Noval" series the characteristic of solid base-pin connections which, in turn, give rigidity to the internal valve-construction and provide much greater stability in normal handling for equipment, production and for servicing. It is impossible under normal conditions for any splaying of the pins to occur.

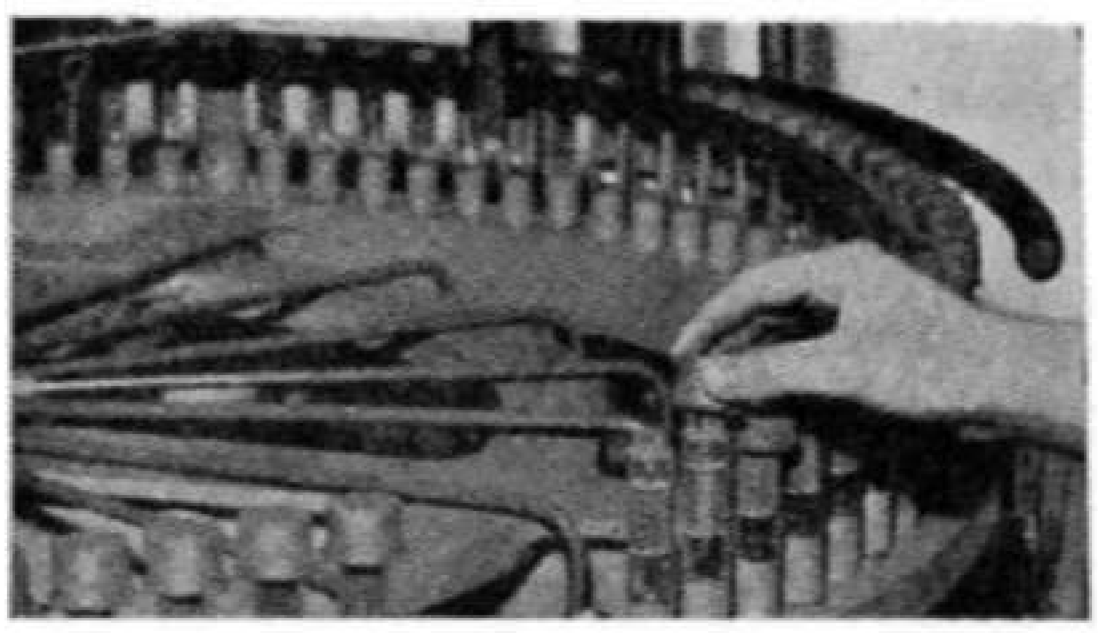


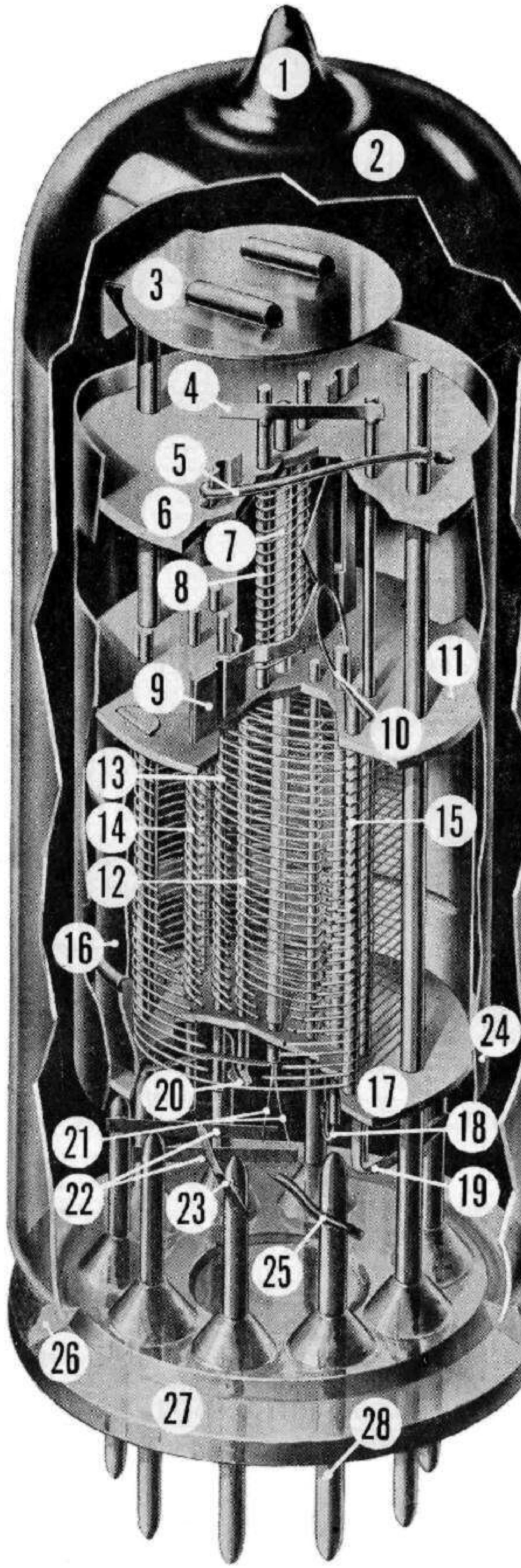
Figure 3.
Detail of sealing machines showing the metal caps used to ensure uniformity of heating of the glaze as the assembly passes through the gas flame.

With the use of the "Rimlock" type sealing-process the temperature at which sealing is completed in manufacture is greatly reduced, thereby eliminating cathode-poisoning and bulb-distortion. The result is that the "Innoval" series offers much greater product-uniformity.

Philips "Innoval" is indeed the most advanced valve technique yet evolved. It is an Australian achievement of global significance in the field of electronics. Not only does it provide the perfect answer for receiving valves, but is completely flexible and applicable to valves for all electronic purposes.

6AN7

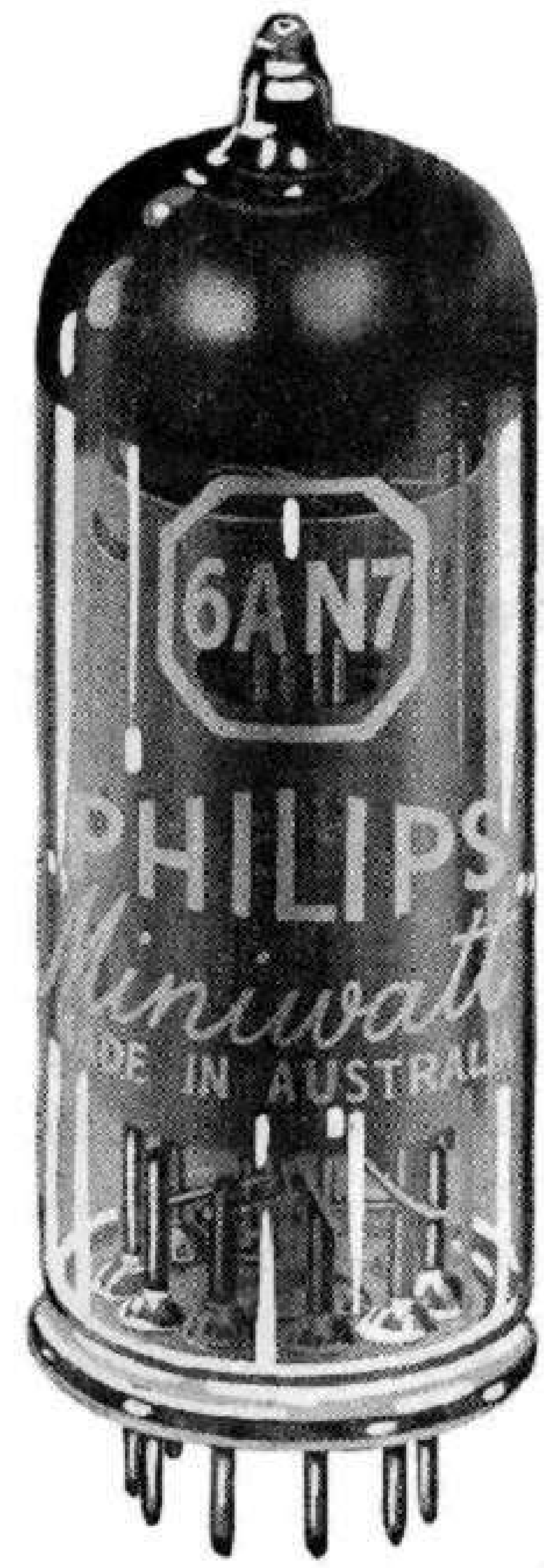
PHILIPS "INNOVAL" TRIODE HEXODE CONVERTER



1. *Sealed off exhaust tube*
2. *Glass bulb*
3. *Getter holder*
4. *Connection between triode grid and hexode grid No. 3 (Injection grid)*
5. *Connection between triode plate and base pin*
6. *Top mica*
7. *Common cathode for triode and hexode sections*
8. *Triode grid*
9. *Triode plate*
10. *Connection between hexode grids Nos. 2 and 4*
11. *Centre mica*
12. *Hexode grid No. 1 (Signal grid)*
13. *Hexode grid No. 2*
14. *Hexode grid No. 3*
15. *Hexode grid No. 4*
16. *Hexode plate*
17. *Bottom mica*
18. *Connection between hexode grids Nos. 2 and 4 and base pin*
19. *Connection between hexode grid No. 3 and base pin*
20. *Connection between hexode grid No. 1 and base pin*
21. *Heater*
22. *Connections between heater and base pin*
23. *Connection between hexode plate and base pin*
24. *Internal shield*
25. *Connection between internal shield and base pin*
26. *Glaze seal between bulb and pressed glass base*
27. *Pressed glass base*
28. *Silver plated chrome iron base pin*

TYPE 6AN7

Triode Hexode Converter



The 6AN7 is a remote, cut-off, indirectly-heated, frequency converter with a conversion conductance of 750 micromhos suitable for use at frequencies up to 100 Mc/s. In this valve an unusual structural layout has been adopted in that the triode section is mounted around the common cathode above the hexode section. In the past (due to the limitations imposed by the pinch type construction) this has not been practicable, with the result that the triode section has always been mounted below the hexode section, in that region of the cathode surface where the greatest temperature variations occur. With the new 6AN7 construction however, greater uniformity of triode characteristics is achieved and less variation in oscillator performance between individual valves results.

The hexode section follows conventional practice in that the grid closest to the cathode — Grid No. 1 — operates at signal frequency whilst Grid No. 3 is directly coupled to the grid of the triode section. Grids 2 and 4 act as the screening and accelerating electrodes. Hexode Grid No. 1 has a remote cut-off characteristic which gives a 100:1 reduction in the conversion conductance for a voltage of −29 volts.

The electrode structure of the valve is completely shielded internally, making the use of an external shield superfluous. The internal shield is connected to the cathode base pin.

Although the 6AN7 can be used in a multiplicity of circuits and will give excellent results, whilst operated within maximum ratings, the following points should be observed if optimum performance, particularly in high frequency applications is desired:

1. Frequency drift due to mains voltage variations will be reduced to a minimum if the oscillator tuned circuit is connected to the triode plate.
2. Reduction in conversion conductance due to the effect of capacitive coupling between the signal grid and the oscillator injection grid (grids Nos. 1 and 3 of the Hexode section) will be obviated if the oscillator is tuned to a higher frequency than the signal.
3. Reduction in selectivity of the hexode plate tuned circuits due to decrease in plate-cathode internal resistance will be prevented by the use of a voltage divider network to supply the voltage to the hexode Grid Nos. 2 and 4. If a series dropping resistor is used for this purpose the variation in Grid Nos. 2 and 4 current under cut-off conditions due to AVC action will cause the voltage applied to these grids to approach that of the plate. Secondary emission can then occur with resultant decrease in internal resistance.

The 6AN7 has a heater current of 0.23 amps and can therefore be used as the frequency converter in vibrator-operated receivers as well as for mains-operated and auto receivers. Its small physical dimensions and its excellent electrical characteristics make it the logical choice as the preferred type converter valve for all applications.

TYPE 6M5

High Sensitivity Output Pentode

The 6M5 is an indirectly heated power output pentode with a mutual conductance of 10,000 micromhos that lends itself readily to many applications. Besides its more conventional use in the output stage of all types of radio receivers in either single or multi-valve circuits, it can be used as a frame time base amplifier in television receivers or it can be connected as a triode by joining the plate and grid No. 2 together and used as a triode power amplifier.

As a single pentode an output of 3.9 watts at 10% total harmonic distortion is obtained for an input of only 3.8 volts r.m.s. whilst for an input of 5.1 volts r.m.s. the output is 4.8 watts, the distortion then being 14.5%.

Under push pull class AB_1 conditions the power output is 9.4 watts with a distortion of 4.6%. Connected as a triode an output of 1.55 watts at 8% distortion is available for an input of 6 volts r.m.s.

Because of the advantages of the "Innoval" construction there is little danger of parasitic oscillations, despite the high mutual conductance, provided that the connections to the valve electrodes are kept as short as possible. In those cases where chassis layout cannot be so arranged, the conventional method of parasitic suppression by the insertion of non-inductive resistors in the Grid No. 1 and/or Grid No. 2 circuits will be found effective.

The 6M5 is designed for use in cathode bias circuits and under this condition the maximum permissible external resistance in the No. 1 grid circuit is 1.0 megohm. "Back bias" operation is only permissible if the 6M5 contributes at least 50% of the current flowing in the bias resistor. Under these conditions however the grid No. 1 circuit external resistance must be reduced in the same ratio as the cathode current of the 6M5 bears to the total current flowing in the bias resistor.

The plate dissipation rating of 9 watts is for an average valve under "no signal" conditions. In the design of mains-fed receiving apparatus care should be taken to see that this figure is not exceeded by more than 15% due to variations in valve or component characteristics or to the action of the A.V.C. circuit under signal conditions. If it is anticipated that either the previous figure will be exceeded or that the nominal mains voltage will be exceeded by more than 10% of its value, the plate dissipation under "no signal" conditions should be reduced.

When the 6M5 is used in the output stage of an auto receiver the average plate dissipation should be adjusted to 9 watts for an accumulator voltage of 7 volts. Under these conditions the supply voltage to the receiver can vary within the range 5 to 8 volts without damage to the valve.

Because of its excellent electrical characteristics, its versatility, its small physical dimensions and robust construction, the 6M5 offers the ideal solution for the output stages of all types of receivers irrespective of size and price class.

TYPE 6BD7 Double Diode High μ Triode

The 6BD7 is a double diode triode with an amplification factor of 70 intended for use in combined detection A.V.C. and AF amplifier applications. In the construction of this valve special care has been exercised in the matter of internal shielding. The whole assembly is enclosed by a shield to obviate the need for an external valve shield and the diode section incorporates additional shielding to reduce electronic and capacitive coupling between the diode and triode sections to a minimum.

The effect of this shielding, and the advantages of the new valve construction, can be more readily appreciated if a comparison of inter-electrode capacitances is made between this type and type 6AV6—the miniature 7-pin double diode high μ triode.

The capacity between the two diodes in the type 6AV6 is approximately 3 times greater than the corresponding capacity in type 6BD7. Similarly the capacities between diodes and triode grid and between diodes and triode plate in the 6AV6 are of the order of 10 and 100 times greater respectively than those found in the 6BD7. In practice, the value of these capacities is of prime importance, as a low diode-to-diode capacity is essential in applications where the AVC diode is fed from the primary of the I.F. transformer, otherwise, an undesirable increase in coupling factor due to "top coupling" results. The effect of poor shielding between the diode and triode sections is to produce a high residual volume level when the volume control is turned to the "off" position.

The choice of the value 70 for the amplification factor for the 6BD7 was only made after most careful consideration had been given to all of the design problems arising from the use of double diode triodes in receiving apparatus.

Primarily the 6BD7 is intended for use in association with the high-sensitivity output pentode type 6M5 which only requires an input signal of 5.1 volts R.M.S. to deliver its maximum power output. In receivers using 5 or more valves, such as would require this valve combination, sufficient gain would be available to allow the use of adequate negative feedback and at the same time achieve maximum output. Secondly, consideration was given to the question of usable (as distinct from theoretical) stage gain with particular reference to the occurrence of microphonic phenomena. With the use today of more highly efficient loudspeakers, and the tendency to make smaller receivers, this phenomena becomes a greater source of trouble than it has in the past. However, with the advantages offered by the "Innoval" construction, not only is it possible to obtain greater uniformity of product quality in this regard, but it is also possible to lay down specifications for the guidance of the receiver design engineer.

When the 6BD7 is incorporated in a receiver using a 5% acoustically efficient speaker no special precautions are required in regard to microphonics, provided that the valve is not mounted closer than 4" to the loudspeaker and that the input to the grid of the 6BD7 exceeds 10 millivolts for an output of 50 milliwatts from the output valve.

These figures give limit conditions only and are not intended to restrict flexibility in receiver design. In the case of small receivers where less efficient speakers are used the distance between speaker and valve can be less than 4" for the stated input/output ratio whilst in larger receivers, where the distance between valve and speaker is greater, a higher stage gain is permissible. For all cases, if special precautions are taken to prevent microphonics, the usable stage gain is then limited only by the success of the method employed and the electrical characteristics of the valve.

The 6BD7 can be used in either cathode or grid leak biassed circuits. The former is recommended for general practice to lessen the influence of the variation in the voltage at which grid current commences to flow. This variation continues throughout the normal life of the valve.

Special precautions need not be taken with regard to hum, provided that the impedance for the hum frequency in the grid circuit does not exceed 1 megohm and the overall gain of the amplifier is such that an input signal in excess of 10 millivolts is required to produce an output of 50 milliwatts at the output valve.

The technical superiority of the 6BD7 over its contemporaries will recommend it to all quality conscious receiver design engineers as the valve essential for double diode triode applications in all types of equipment.

TYPE 6N8

Double Diode Pentode

The 6N8 is a double diode pentode, the diode section of which is intended for detection and AVC purposes whilst the pentode section can be used in R.F., IF or AF amplifier applications. In the mechanical construction of this valve use has been made of the same principle adopted in the type 6AN7, in that the diode section which in the past would have been located below the pentode section is mounted above it, thus ensuring uniformity of diode characteristics. Special care has also been exercised in the internal shielding employed to ensure low, direct inter-electrode capacitances and to minimise electronic and capacitive coupling effects between the diode and pentode sections. The internal shields are internally connected to the cathode base pin and the valve is intended to be used without an external shield can.

In RF and IF amplifier applications, when used under the so called "sliding screen" conditions (Grid No. 2 voltage supplied through a series voltage dropping resistor), the 6N8 has a remote cut off characteristic; a Grid No. 1 voltage of –41.5 volts being required to produce a 100:1 change in mutual conductance. The low grid to plate capacity (0.002 $\mu\mu$f Max.) the mutual conductance of 2,200 micromhos and the plate resistance of 1.6 megohms make this valve particularly suitable for use in 4-valve superheterodyne receivers, in either standard or reflexed circuits. In a 5-valve receiver, if used as an IF amplifier in association with type 6BD7 (double diode triode) as detector and AF amplifier, one of the diodes of the 6N8 can be used as a "sinking diode" to produce a delayed A.V.C. characteristic far superior to that achieved in any other manner.

As an AF amplifier the 6N8 can be used either as a resistance coupled pentode or with the plate and No. 2 grid tied together as a resistance coupled triode. When connected as a triode the valve has an amplification factor of 19, but due account should be taken of the comparatively higher percentage of total harmonic distortion introduced by the non-linear characteristic of the No. 1 grid. In those applications where low gain and low distortion are required consideration should be given to the use of the valve as a resistance-coupled pentode with a sufficient percentage of negative feed-back to give an equivalent stage gain to that of the triode connected condition.

As a resistance-coupled pentode the total harmonic distortion is low and even for normal applications, when used in conjunction with the output pentode 6M5, the stage gain is such that sufficient negative feed-back can be applied to reduce the overall distortion percentage to a low value.

As in the case of type 6BD7 special consideration has been given to the question of microphonic phenomena and a specification has been laid down for the guidance of receiver design engineers. When the 6N8 is incorporated as an A.F. amplifier in a receiver using a 5% acoustically efficient speaker no special precautions are required in regard to microphonics provided that the valve is not mounted closer than 4" to the loud speaker and that the input to the grid of the 6N8 exceeds 10 millivolts for an output of 50 milliwatts from the output valve. These figures give limit conditions only and are not intended to restrict flexibility in receiver design. In the case of small receivers where less efficient speakers are used the distance between speaker and valve can be less than 4" for the stated input/output ratio whilst in larger receivers, where the distance between valve and speaker is greater, a higher stage gain is permissible. For all cases, if special precautions are taken to prevent microphonics, the usable stage gain is then limited only by the success of the method employed and the electrical characteristics of the valve.

This valve can be used either in cathode or grid leak biassed circuits. The former is recommended for general practice to lessen the influence of the variation in the voltage at which grid current commences to flow. This variation continues throughout the normal life of the valve.

The 6N8 because of its extreme flexibility in application and its excellent electrical characteristics will find many applications in radio receivers apart from its fundamental purpose as a double diode super control reflexed RF pentode in 4-valve superheterodyne receivers.

What "I N N O V A L" means...

To the Equipment Design Engineer

- *Circuit flexibility.*
- *Valve and component standardisation.*
- *Improved performance.*
- *Simplified layouts.*

To the Equipment Manufacturer

- *Easier transition from design stage to production lines.*
- *Smoother production flow.*
- *Smaller parts stock lists.*
- *Greater product uniformity.*

To the Wholesaler and Retailer and Serviceman

- *Added selling features.*
- *Maintenance of factory "final test" condition.*
- *Easier restoration of receivers to factory test specifications after valve replacements.*
- *Less "within guarantee" service calls.*
- *Fewer replacement valve types for a greater number of receiver models.*
- *Greater customer goodwill.*

To the Customer

- *Better receivers incorporating the most modern features.*
- *More hours of trouble-free service.*
- *Greater value for money.*

"Innoval" gives all these advantages because . . .

- Innoval is a basic construction applicable to valves for all AM, FM, and television purposes.
- Innoval is small in size and of "All-Glass" construction.
- Innoval is single-ended and fitted with an internationally standardised 9-pin base.
- Innoval does not restrict the valve design engineer and force compromises between required valve characteristics and practical manufacturing possibilities.
- Innoval incorporates new and revolutionary manufacturing techniques.
- Valves made in Innoval construction are more efficient and more uniform valve to valve.
- Innoval will bring you entertainment or serve in essential services with equal efficiency.
- Innoval performance is not affected by extremes of atmospheric and physical conditions.

Only "Innoval" has everything to offer everybody

"Miniwatt" INNOVAL SERIES

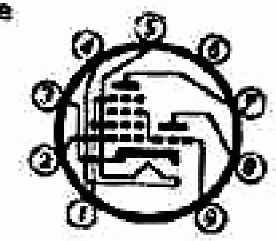
6AN7

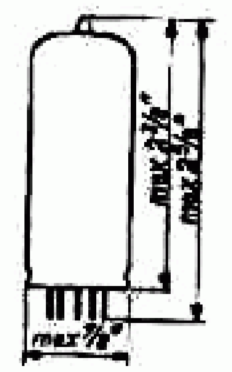
TRIODE-HEXODE for use as a Frequency Convertor.

Physical Specifications

Cathode	Coated unipotential
Base	Small button noval 9-pin
Bulb	T 6½
Mounting position	any
Basing connections - JETEC basing designation	9Q

Pin No. 1 - hexode grids No.2 and No.4
Pin No. 2 - hexode grid No. 1
Pin No. 3 - cathode and screen
Pin No. 4 - heater
Pin No. 5 - heater
Pin No. 6 - internal connection
Pin No. 7 - hexode plate
Pin No. 8 - triode plate
Pin No. 9 - triode grid and hexode grid No. 3





General Electrical Data

Heater voltage	6.3	volts
Heater current	0.25	amperes

Direct Interelectrode Capacitances

Grid No. 1 to all other electrodes		3.8 µµF
Hexode plate to all other electrodes		9.2 µµF
Between hexode grid No.1 and hexode plate	max.	0.1 µµF
Between hexode grid No.1 and heater	max.	0.15 µµF
Between cathode and triode grid + hexode grid No.3		5.6 µµF
Between cathode and triode plate		2.4 µµF
Between triode plate and triode grid + hexode grid No.3		1.4 µµF
Between hexode grid No.1 and triode grid + hexode grid No.3	max.	0.35 µµF
Between hexode plate and triode grid + hexode grid No.3	max.	0.2 µµF

Maximum Ratings of the Hexode Section

Plate voltage (without current)	550 volts
Plate voltage	250 volts
Plate dissipation	1.5 watts
Grid No.2 and 4 voltage (without current)	550 volts
Grid No.2 and 4 voltage (anode current less than 1 mA)	250 volts
Grid No.2 and 4 voltage (anode current =3 mA)	125 volts
Grid No.2 and 4 dissipation	0.3 watt
Grid No.1 voltage (grid No.1 current =+0.3 µA)	-1.3 volts
Cathode current	7 mA
External resistance between grid No.1 and cathode	3 megohms
External resistance between heater and cathode	20,000 ohms
Voltage between heater and cathode	50 volts

Maximum Ratings of the Triode Section

Plate voltage (without current)	550 volts
Plate voltage	175 volts
Plate dissipation	0.8 watt
Grid voltage (grid current=+ 0.3 µA)	-1.3 volts
Cathode current	6 mA
External resistance between grid and cathode	3 megohms

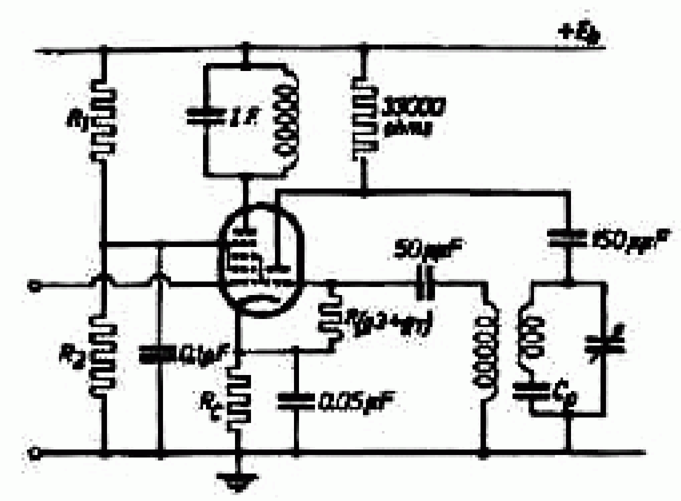
Operating Characteristics of the Triode Section as Oscillator

Supply voltage	250	250	volts
Plate resistor	33,000	33,000	ohms
Grid resistor	22,000	47,000	ohms
Grid current	350	200	µA
Plate current	5.1	4.8	mA
Oscillator voltage	8	8	volt rms
Effective transconductance	600	550	µ mhos

Typical Characteristics of the Triode Section

Plate voltage	100	volts
Grid voltage	0	volts
Plate current	10	mA
Mutual conductance	2800	µ mhos
Amplification factor	22	

Operating Characteristics of the Hexode Section



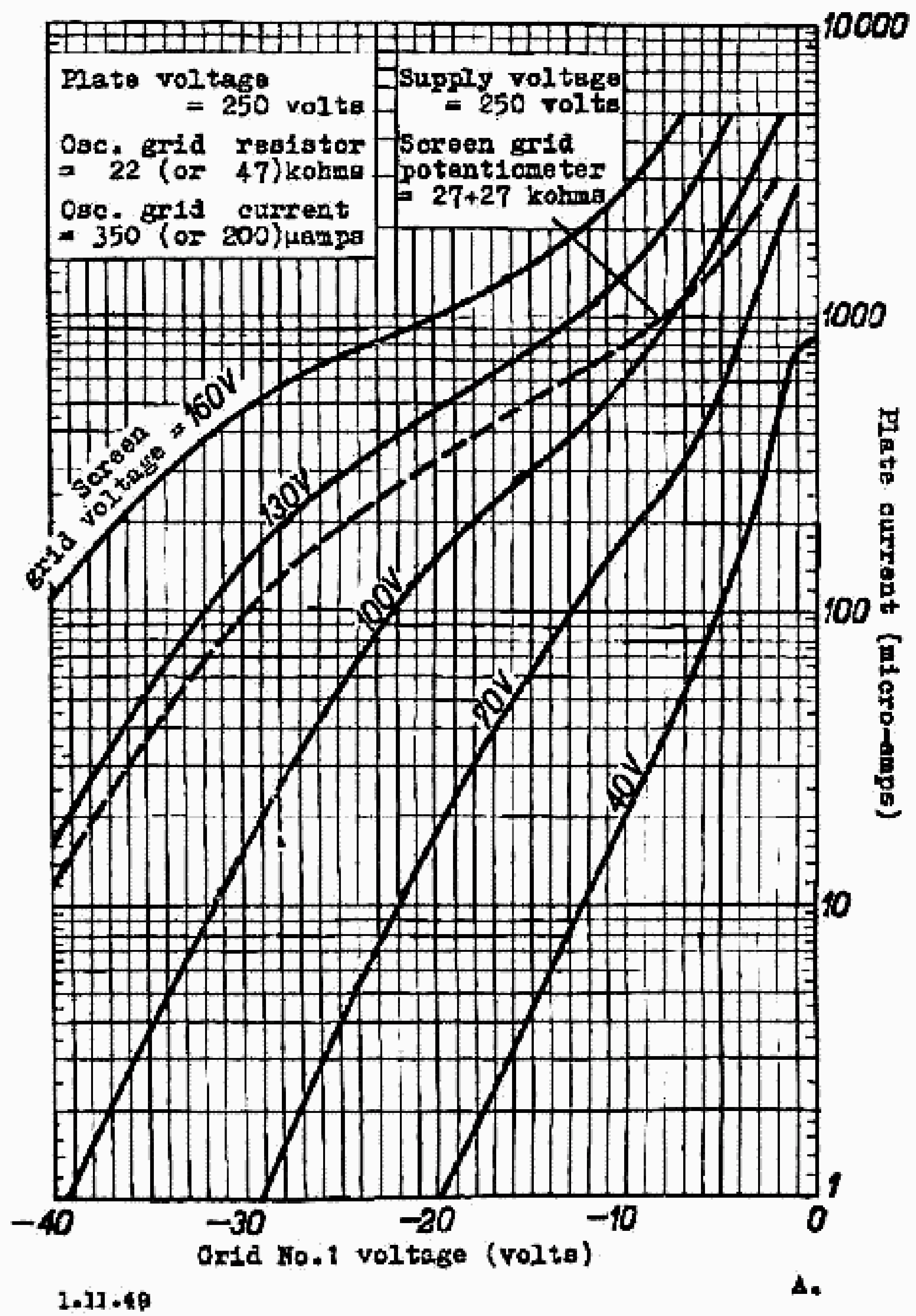
Hexode plate and supply voltage	250		volts
R_1 (see circuit diagram)	27,000		ohms
R_2 (see circuit diagram)	27,000		ohms
Cathode resistor	180		ohms
Grid No.3 and triode grid resistor	22,000		ohms
Grid No.3 and triode grid current (See Note 1)	350		µA
Grid No.1 voltage	-2	-29	volts
Grid No.2 and 4 voltage	85	124	volts
Plate current	3.0	-	mA
Grid No.2 and 4 current	3.0	-	mA
Conversion conductance	750	7.5	µ mhos
Plate resistance	1.5	>5	megohms
Equivalent noise resistance	75,000	-	ohms

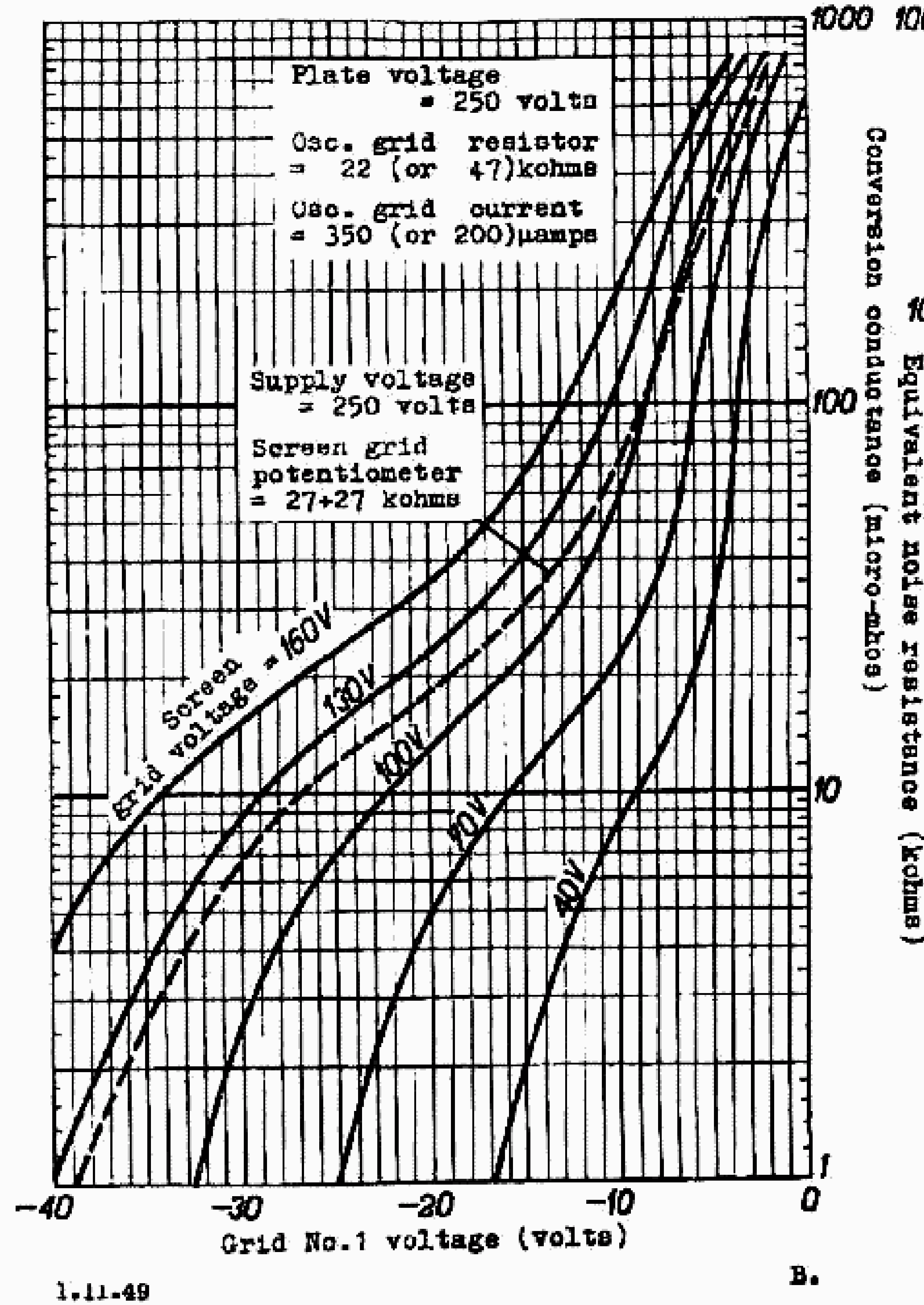
Note 1.

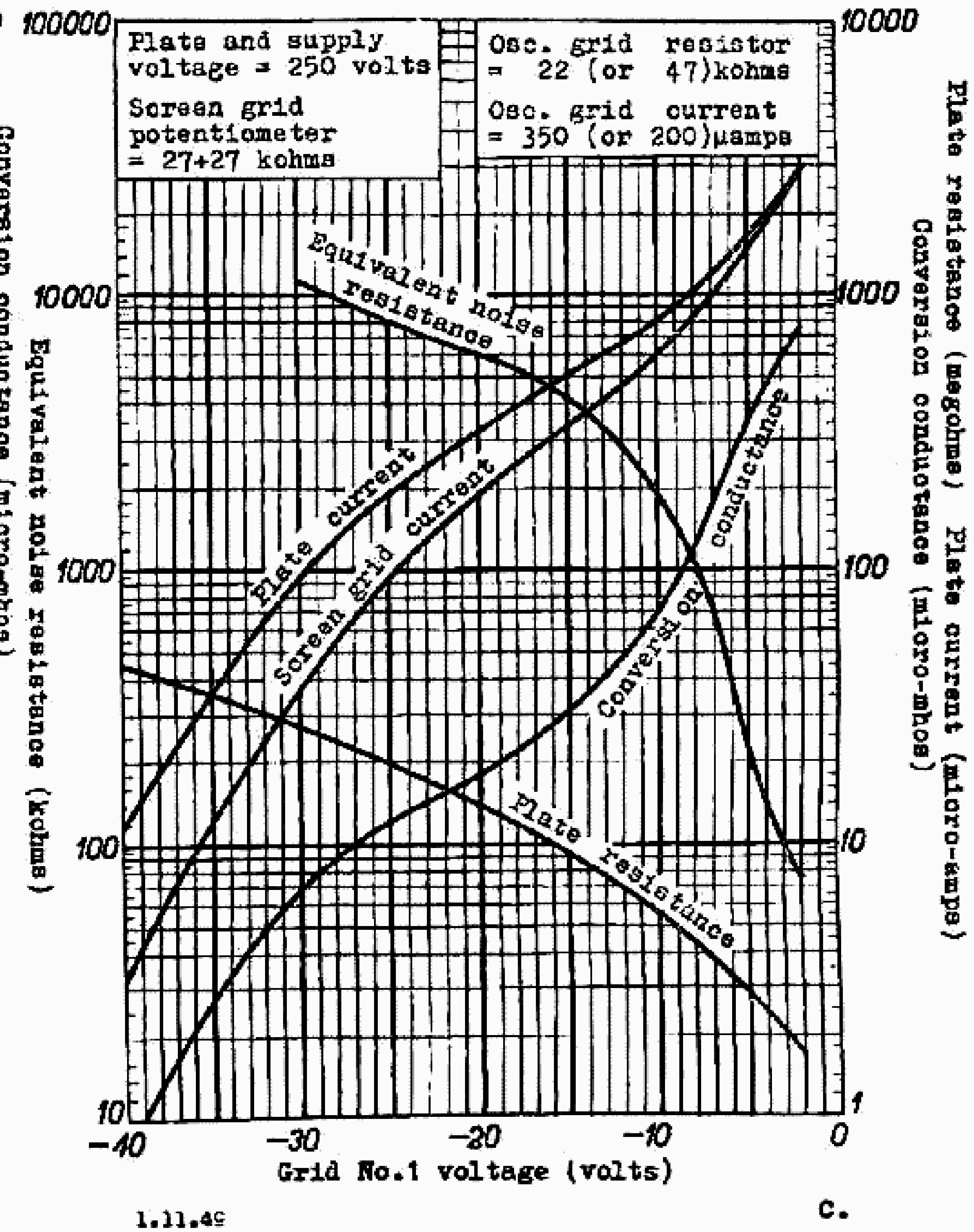
For the alternative value of Grid No. 3 resistor, viz. 47,000 ohms, the grid current should be adjusted to 200 µA.

"Miniwatt" INNOVAL SERIES

6AN7







"Miniwatt" INNOVAL SERIES

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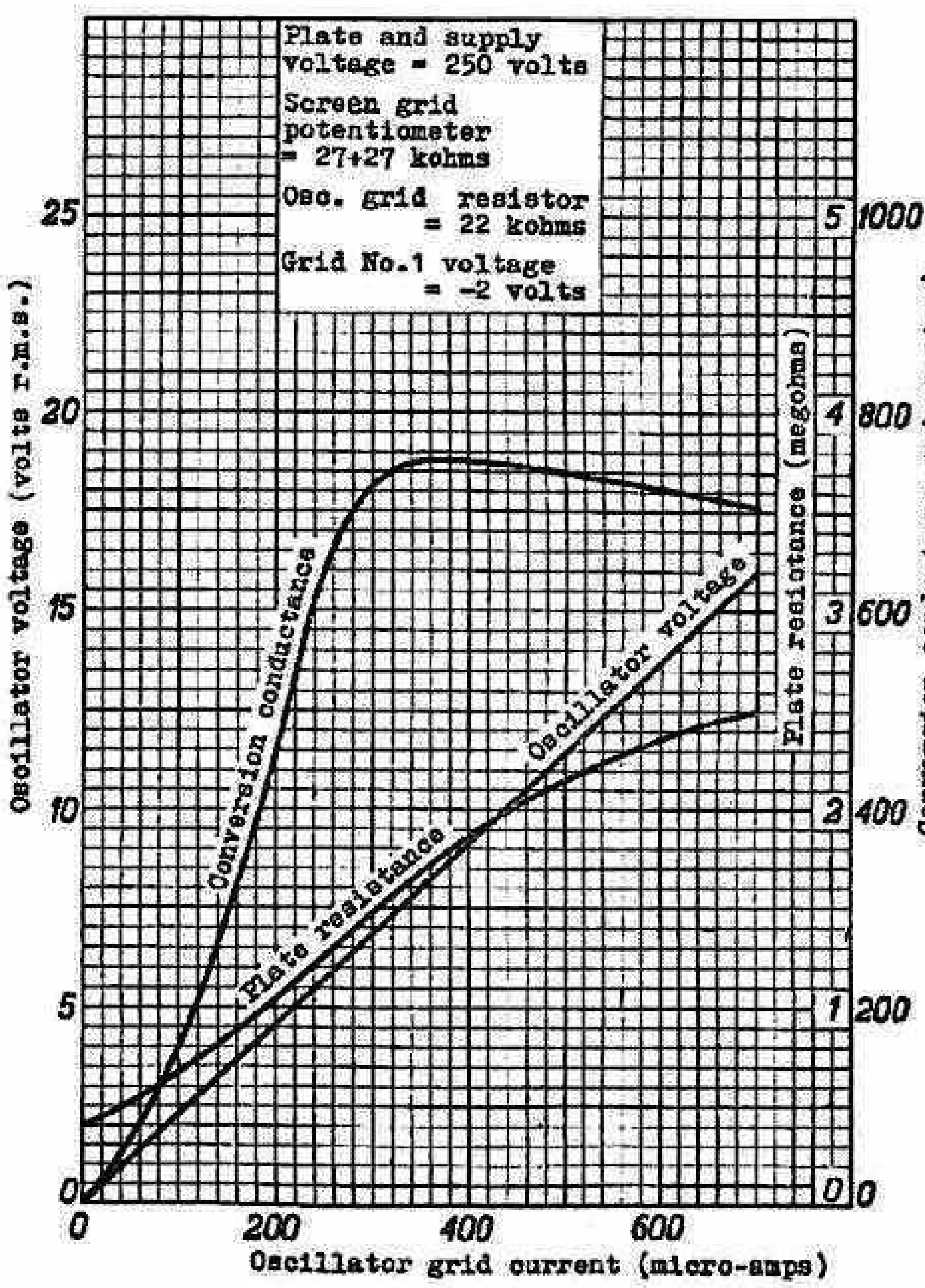

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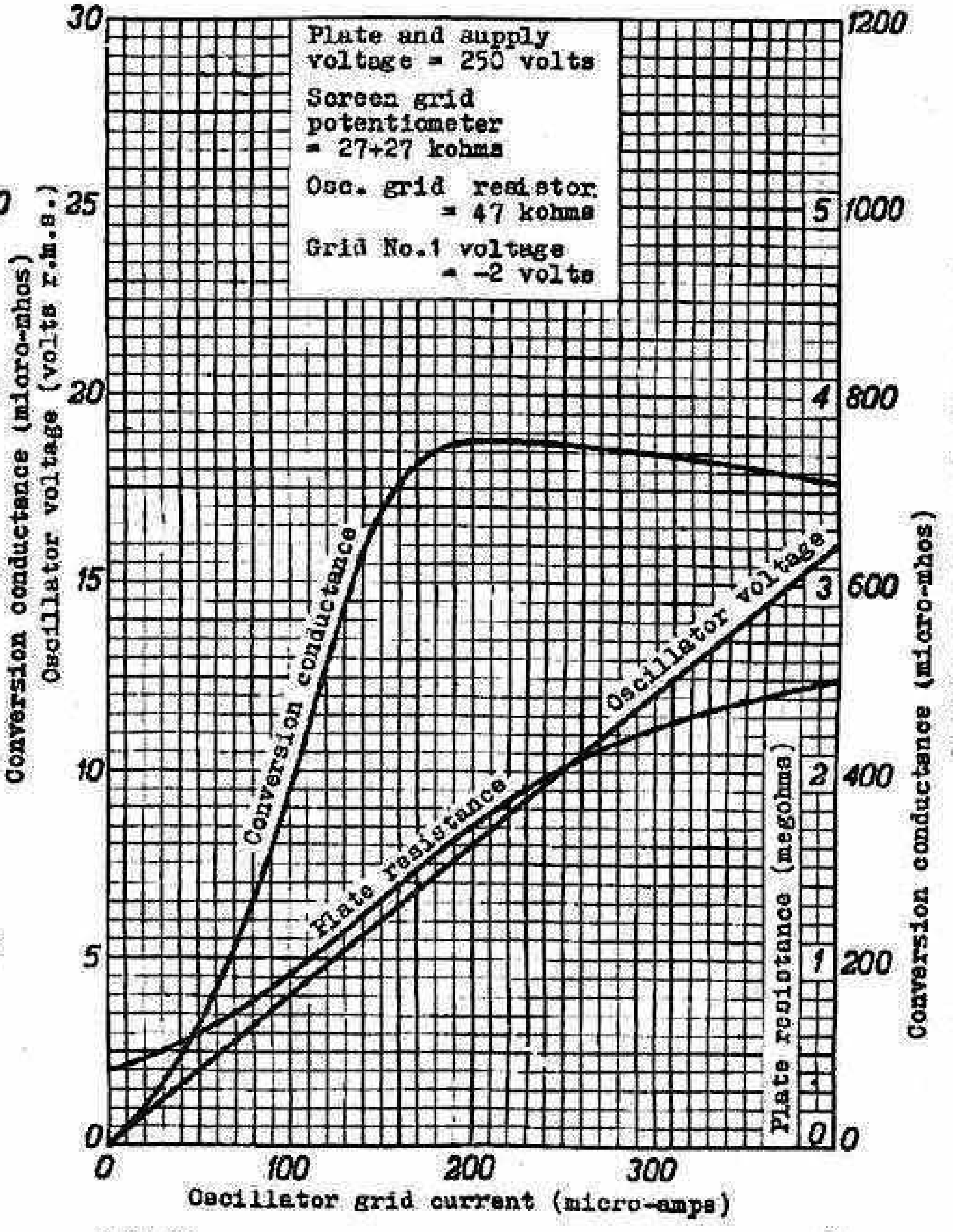

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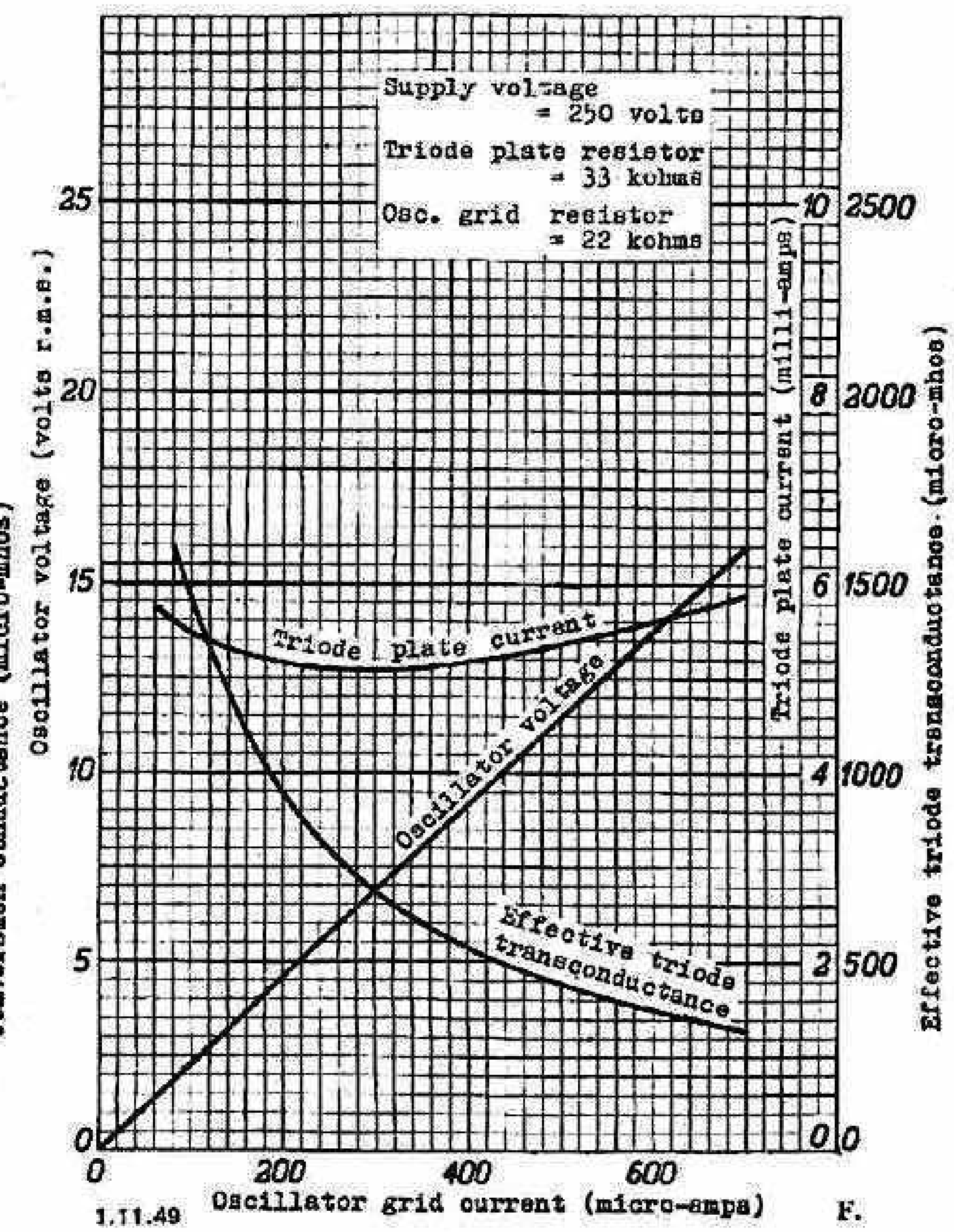

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"Miniwatt" INNOVAL SERIES

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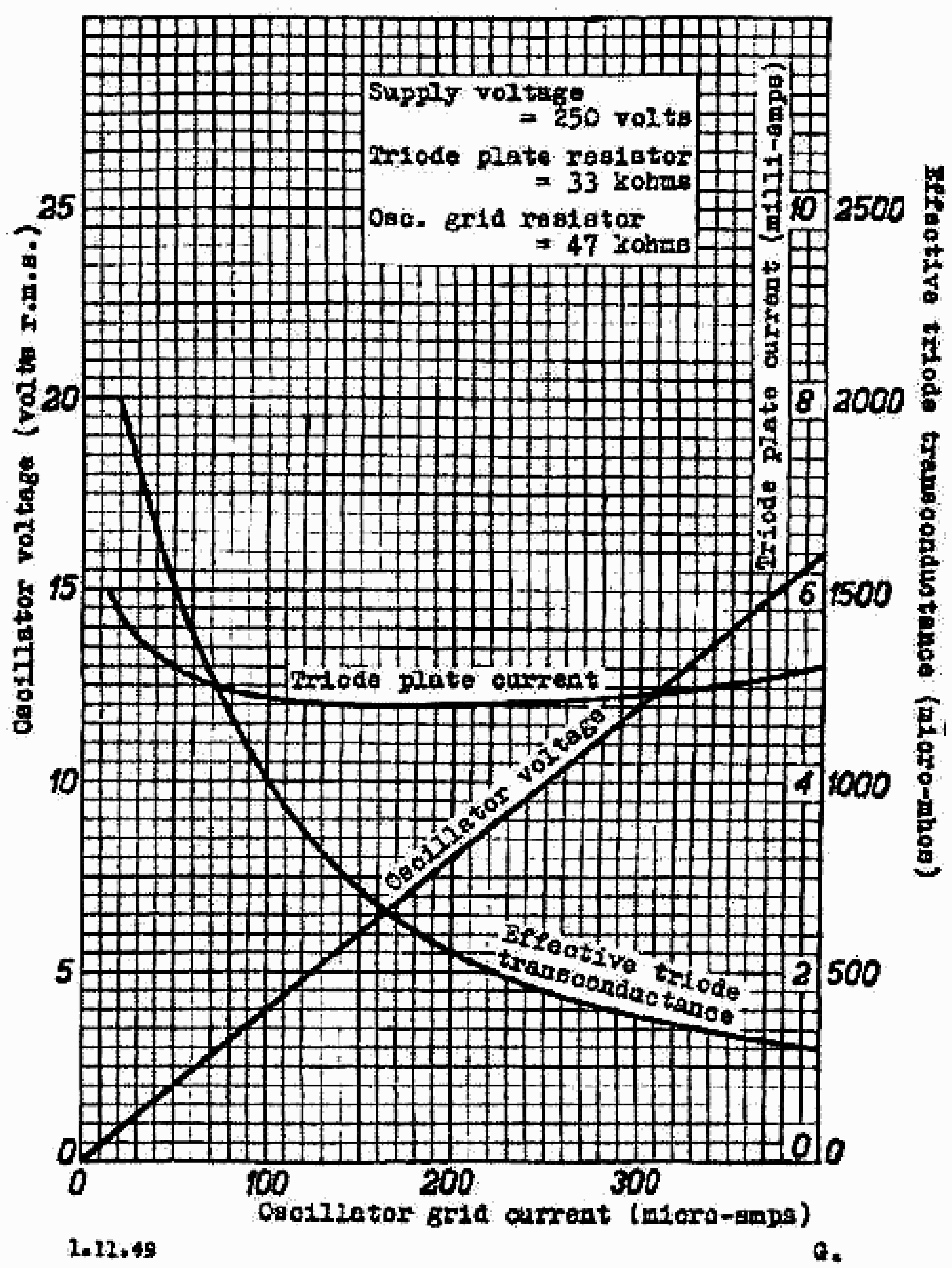
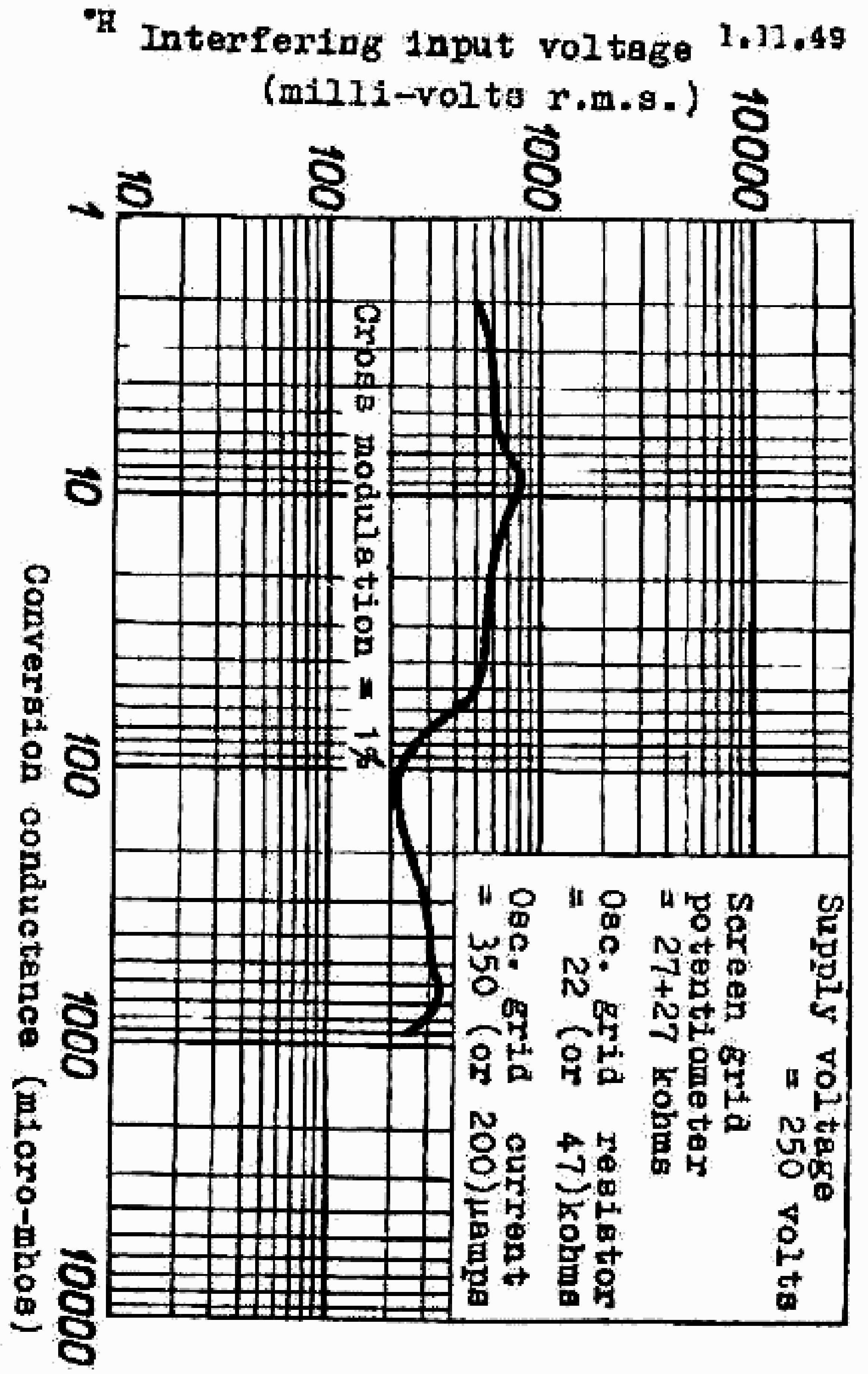
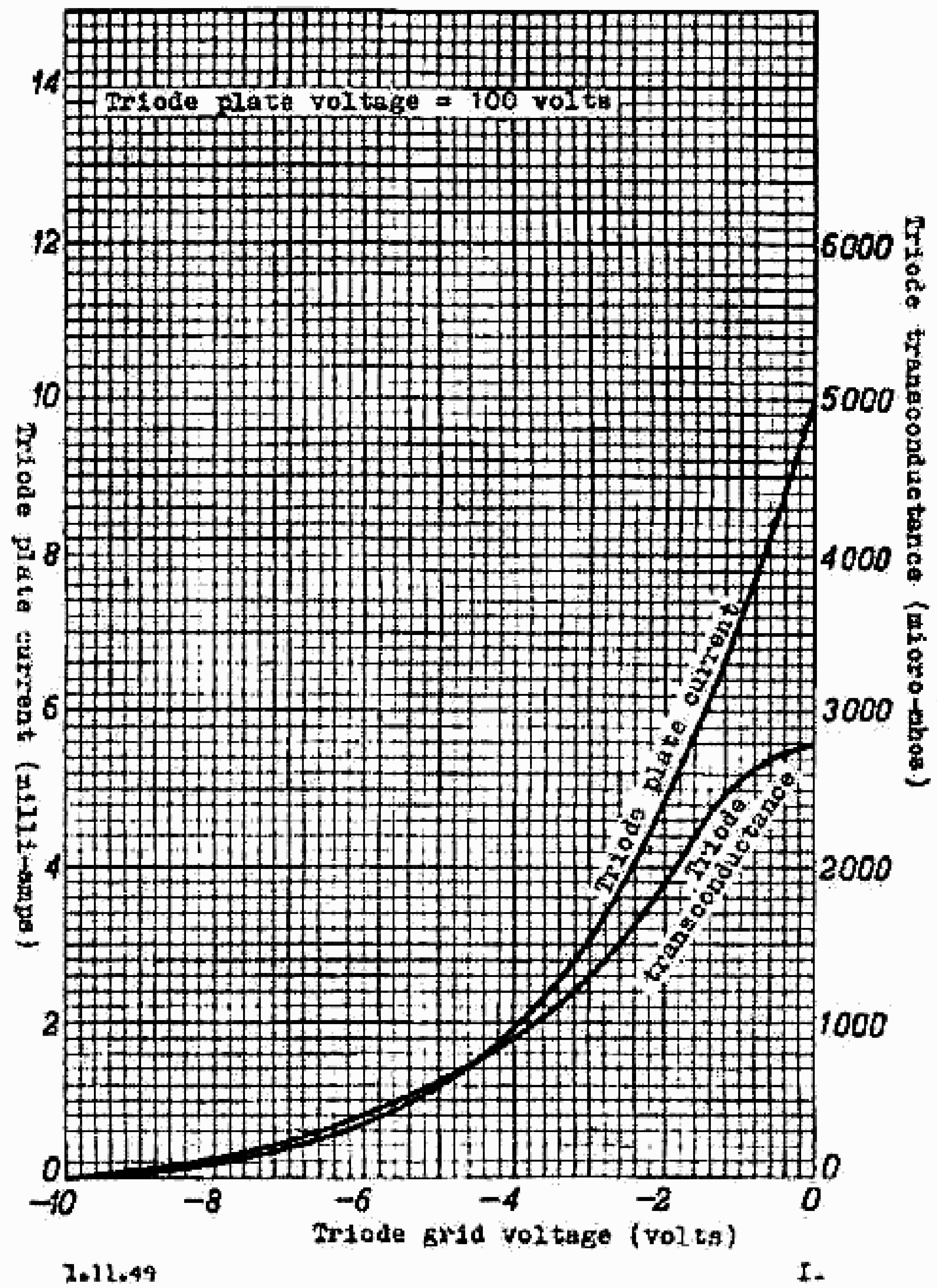






"Miniwatt"
INNOVAL SERIES

6BD7

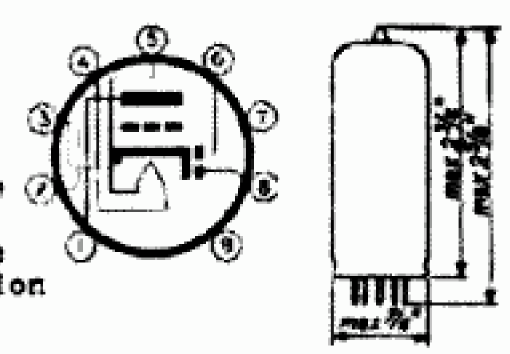
Double Diode Triode for use as Detector and AF Amplifier

Physical Specifications

Cathode	Coated unipotential
Base	Small button noval 9-pin
Bulb	T 6½
Mounting position	any

Basing connection - JETEC basing designation

Pin 1 - Triode plate
Pin 2 - Triode grid
Pin 3 - Cathode
Pin 4 - Heater
Pin 5 - Heater
Pin 6 - Diode No. 1 plate
Pin 7 - Internal shield
Pin 8 - Diode No. 2 plate
Pin 9 - Internal connection



General Electrical Data

Heater voltage	6.3 volts
Heater current	0.23 amperes

Direct Interelectrode Capacitances

Triode plate to cathode		1.3 μμF
Triode grid to cathode		2.4 μμF
Triode grid to triode plate		1.3 μμF
Triode grid to heater	max.	0.06 μμF
Diode No.1 plate to cathode		0.9 μμF
Diode No.2 plate to cathode		0.75 μμF
Diode No.1 plate to heater	max.	0.3 μμF
Diode No.2 plate to heater	max.	0.05 μμF
Diode No.1 plate to triode grid	max.	0.01 μμF
Diode No.2 plate to triode grid	max.	0.01 μμF
Diode No.1 plate to diode No.2 plate	max.	0.05 μμF
Diode No.1 plate to triode plate	max.	0.005 μμF
Diode No.2 plate to triode plate	max.	0.015 μμF

Maximum Ratings

Triode Section

Plate voltage (without current)	550 volts
Plate voltage	250 volts
Plate dissipation	0.5 watts
Cathode current	2 mA

Maximum Ratings (contd.)

Grid voltage at grid current =+0.3 μA	-1.3 volts
External resistance between grid and cathode (See Note 1)	3 megohms
External resistance between cathode and heater	20,000 ohms
Voltage between cathode and heater	50 volts

Diode Sections

Plate voltage (peak value)	200 volts
Plate current	0.9 mA
Plate voltage at plate current=+0.3μA	-1.3 volts
External resistance between cathode and heater	20,000 ohms
Voltage between cathode and heater	50 volts

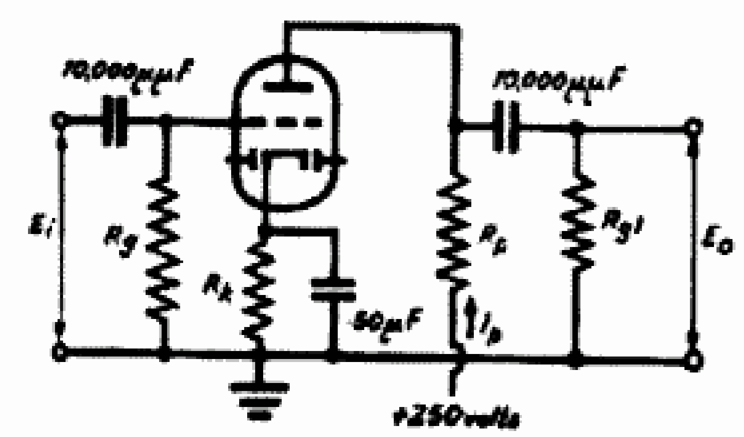
Note 1.
The maximum value of this resistor is 22 megohms if the grid bias is only obtained by the voltage drop across the grid resistor.

Typical Characteristics

Triode Section.

Plate voltage	250 volts
Grid voltage	-3 volts
Plate current	1.0 mA
Transconductance	1200 μ mhos
Amplification factor	70
Plate resistance	58,000 ohms

Operating Characteristics of the Triode Section as an AF Amplifier

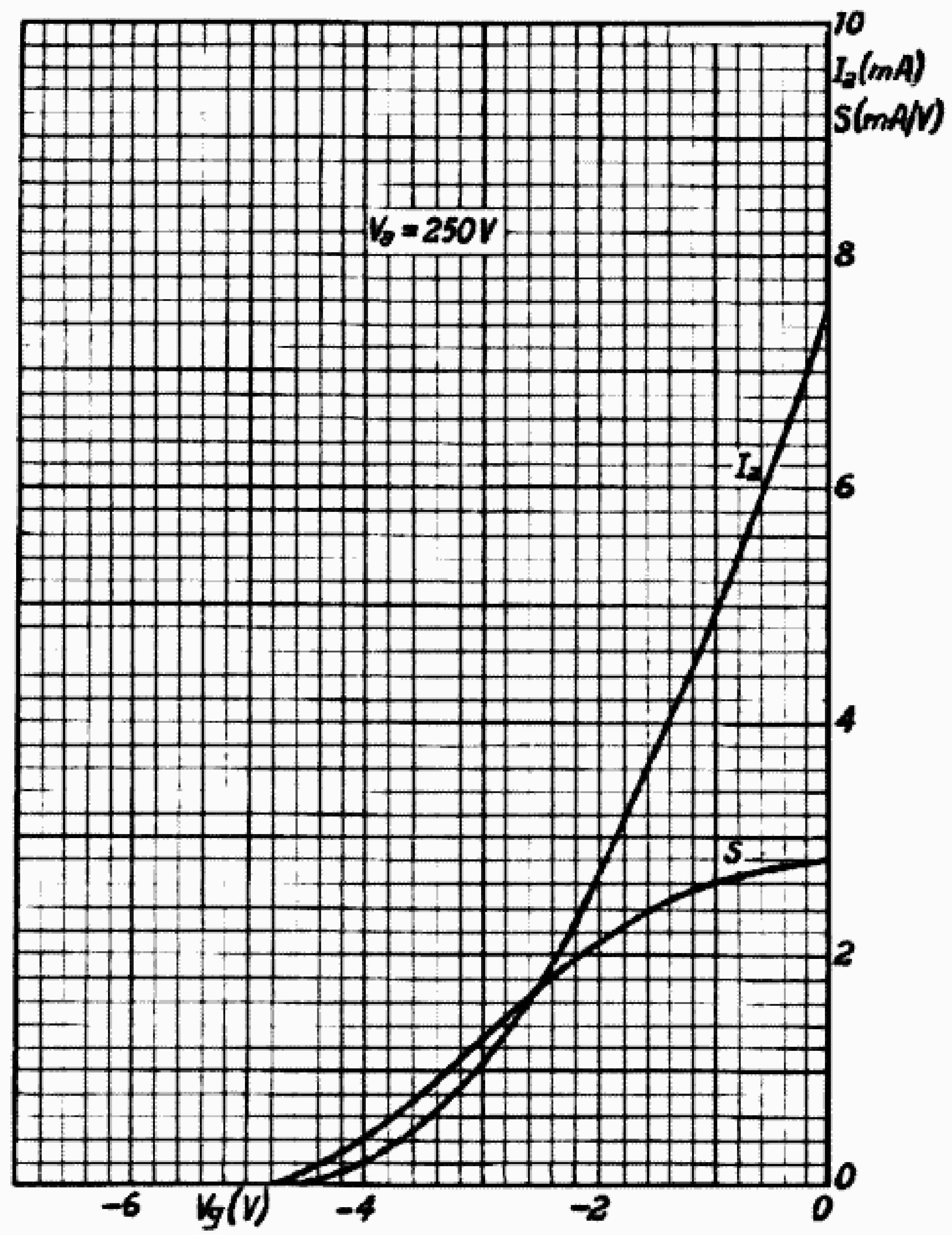


R_p (kΩ)	R_k (Ω)	R_g (MΩ)	R_{gl} (MΩ)	I_p (mA)	E_o/E_i	Distortion (%) at E_o (r.m.s.) 5 volts	10 volts
0.22	1800	1.0	0.68	0.70	51	0.55	0.9
0.1	1200	1.0	0.33	1.15	43	0.6	1.1
0.22	0	10.0	0.68	0.76	52	0.5	0.8
0.1	0	10.0	0.33	1.40	44	0.7	0.9

In circuits using a loudspeaker with an acoustical efficiency of 5% this valve can be used without special precautions against hum and microphonics if the grid circuit impedance for the hum frequency does not exceed 1 megohm and the input voltage for an output of 50 milliwatts is more than 10 millivolts.

"Miniwatt"
INNOVAL SERIES

6BD7



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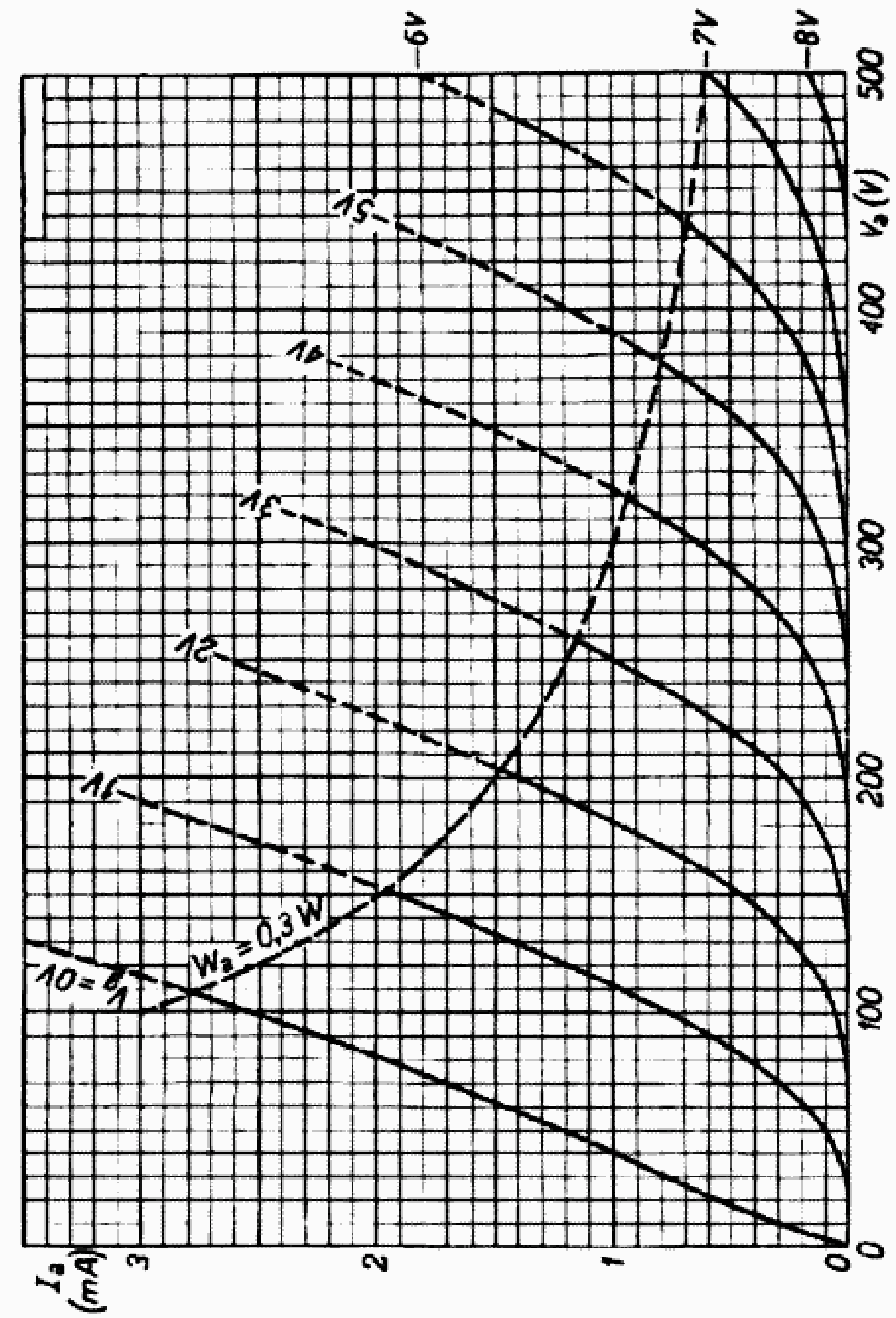

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B

"Miniwatt" INNOVAL SERIES

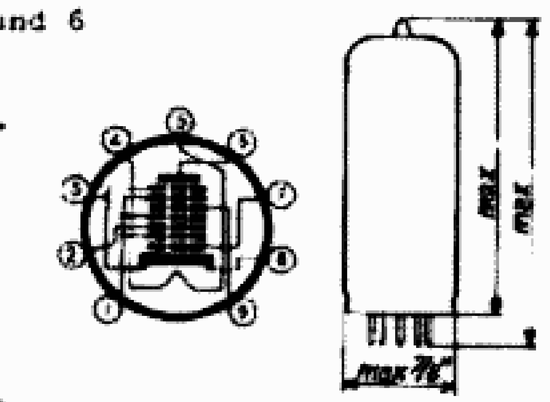
6BE7

ENNEODE for use as F.M. detector and limiter

Physical specifications

Cathode	Coated unipotential
Base	Small button noval 9-pin
Bulb	T 6½
Mounting position	any
Basing connections - JETEC basing designation	

Pin 1 - Grid No. 2, 4 and 6
Pin 2 - Grid No. 3.
Pin 3 - Cathode and grid No. 7.
Pin 4 - Heater
Pin 5 - Heater
Pin 6 - Plate
Pin 7 - Grid No. 1.
Pin 8 - Cathode and grid No. 7
Pin 9 - Grid No. 5



General Electrical Data.

Heater voltage	6.3 volts
Heater current	0.2 amp

Direct interelectrode capacitances

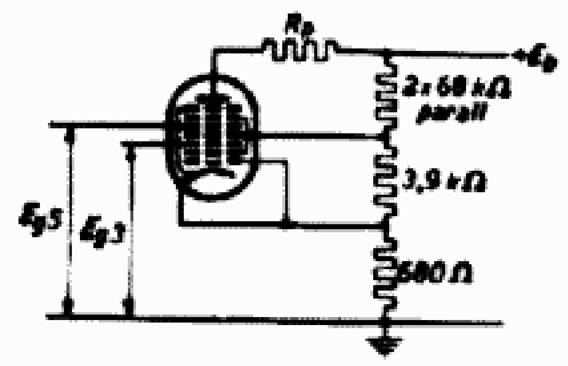
Plate to all other electrodes	8.9 µµF
Grid No. 3 to all other electrodes	7.4 µµF
Grid No. 5 to all other electrodes	12.1 µµF
Between grids No.3 and No.5	0.4 µµF

Maximum Ratings

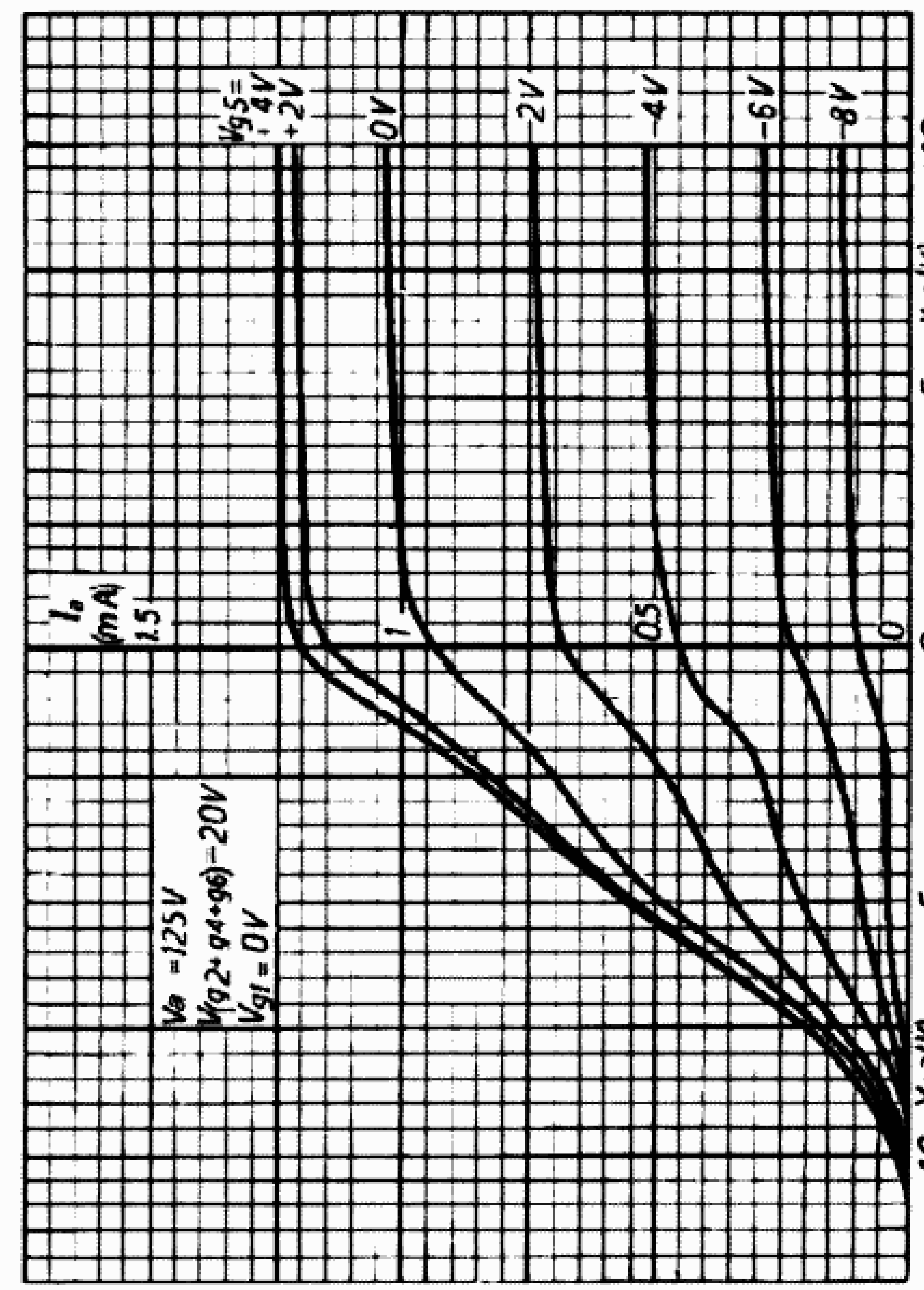
Plate voltage (without current)	550 volts
Plate voltage	250 volts
Plate dissipation	0.1 watts
Grid No. 2, 4 and 6 voltage (without current)	250 volts
Grid No. 2, 4 and 6 voltage	100 volts
Grid No. 2, 4 and 6 dissipation	0.1 watts
Cathode current	3 mA
Grid No. 3 voltage (grid No.3 current = +0.3 µamp)	-1.3 volts
Grid No. 5 voltage (grid No.5 current = +0.3 µamp)	-1.3 volts
External resistance between grid No.3 and cathode	3 megohms
External resistance between grid No.5 and cathode	3 megohms
External resistance between heater and cathode	20,000 ohms
Voltage between heater and cathode	50 volts

Operating characteristics

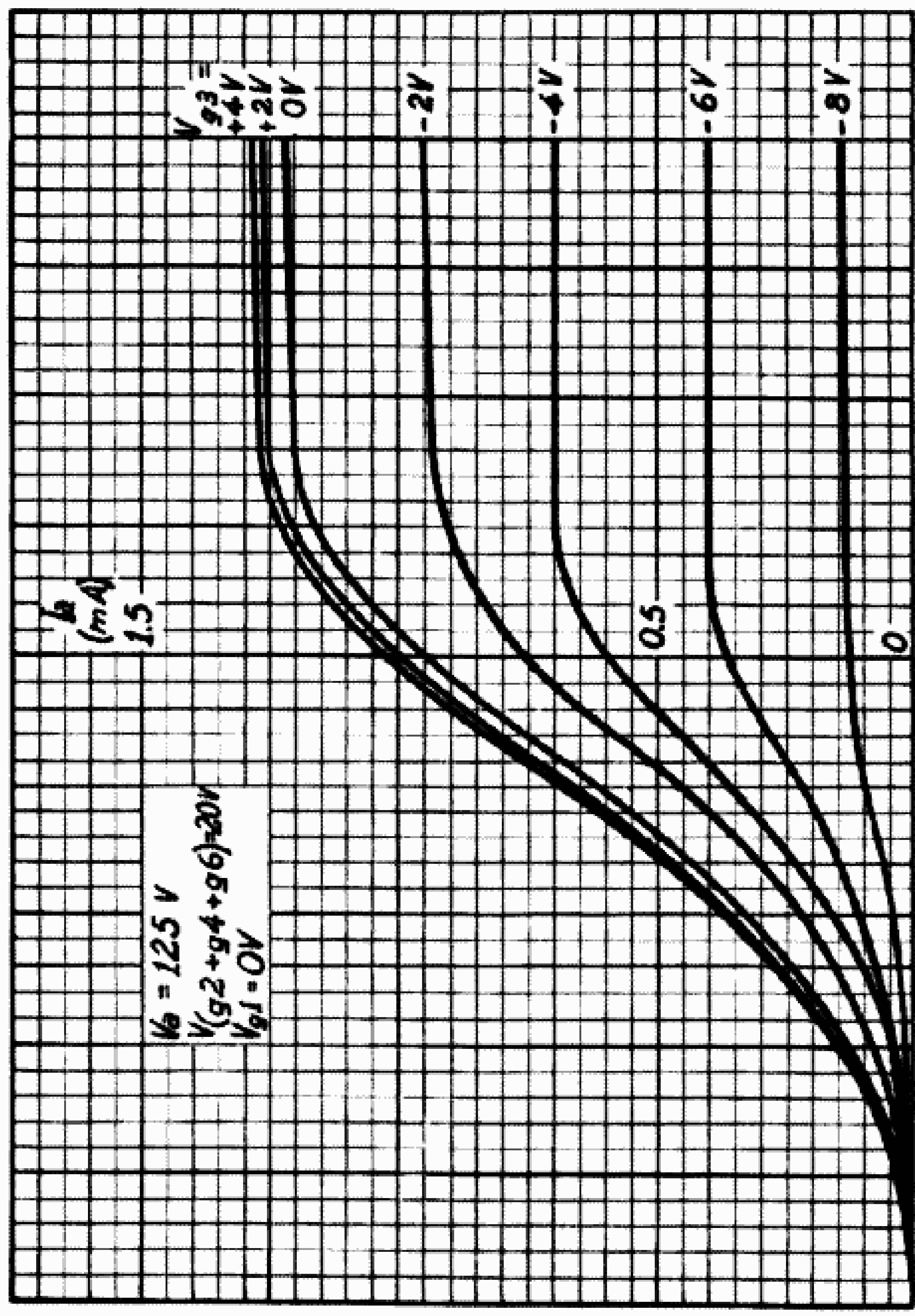
Supply voltage	250 volts
Grid No. 2, 4 and 6 voltage	20 volts
Grid No. 3 voltage	-4.5 volts
Grid No. 3 A.C. voltage	12 volt rms
Grid No. 5 voltage	-4.5 volts
Grid No. 5 A.C. voltage	12 volt rms
Phase angle between A.C. voltages of grid No. 3 and grid No. 5.	90 degrees
Plate resistor	0.5 megohms
Plate current	0.25 mA
Grid No. 2, 4 and 6 current	1.5 mA
Grid No. 3 current	0.1 mA
Grid No. 5 current	0.025 mA
Plate resistance	>5 megohms



This valve can be used without special precautions against microphonic effect in circuits with a 5% speaker if the input voltage of the next stage for obtaining an output of 50 milliwatts is more than 1.0 volt.



6BE7 "Miniwatt" INNOVAL SERIES



1.11.49   Provisional Data   B.

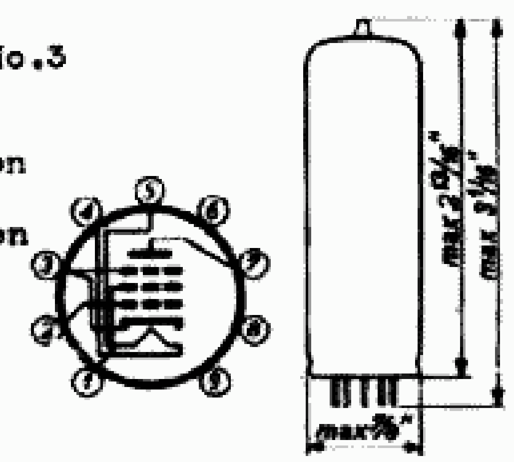
"Miniwatt" INNOVAL SERIES 6M5

OUTPUT PENTODE

Physical Specifications

Cathode   Coated unipotential
Base   Small button noval 9-pin
Bulb   T 6½
Mounting position   any
Basing connections - JETEC basing designation   9 N

Pin 1 - Grid No.2
Pin 2 - Grid No.1
Pin 3 - Cathode and grid No.3
Pin 4 - Heater
Pin 5 - Heater
Pin 6 - Internal connection
Pin 7 - Plate
Pin 8 - Internal connection
Pin 9 - No connection



General Electrical Data

Heater voltage   6.3 volts
Heater current   0.71 amperes

Direct Interelectrode Capacitances

Grid No.1 to all other electrodes   10 μμF
Plate to all other electrodes   6.2 μμF
Between grid No.1 and plate   max.   1 μμF
Between grid No.1 and heater   max.   0.15 μμF

Maximum ratings

Plate voltage (without current)   550 volts
Plate voltage   300 volts
Plate dissipation   9 watts
Screen-grid voltage (without current)   550 volts
Screen-grid voltage   300 volts
Screen-grid dissipation (without input signal)   1.4 watts
Screen-grid dissipation (at full power output)   3.3 watts
Cathode current   55 mA
Control grid voltage at control grid current = + 0.3 μ amp   -1.3 volts
Maximum control grid circuit resistance   1 megohm
External resistance between heater and cathode   20,000 ohms
Voltage between heater and cathode   50 volts

1.11.49.   1.

"Miniwatt" INNOVAL SERIES

6M5

<u>Operating characteristics in class A amplifier operation</u>

Plate voltage	250 volts
Screen grid voltage	250 volts
Cathode resistor	170 ohms
Plate current	35 mA
Screen-grid current	5.2 mA
Mutual conductance	10,000 micromhos
Amplification factor of screen grid with respect to control grid	22
Plate resistance	40,000 ohms
Load resistance	7,000 ohms
Power output at 10% distortion	3.9 watts
Required input voltage at 10% distortion	3.8 volts rms
Power output at grid current start (Ig1 = +0.3 μ amp)	4.8 watts
Required input voltage for 50 milliwatt output	0.32 volts rms

<u>Operating Characteristics in Triode Connection</u> (screen grid connected to plate)

Plate voltage	250 volts
Cathode resistor	250 ohms
Load resistance	3,500 ohms
Input A.C. voltage	6 volts rms
Plate current	33 mA
Output power	1.55 watts
Total distortion	8 percent

<u>Operating Characteristics in Class AB Amplifier Operation</u> (without grid current)

Plate voltage	250		volts
Screen-grid voltage	250		volts
Cathode resistor	85		ohms
Load resistance plate to plate	7000		ohms
Input A.C. voltage	0	5.6	volts rms
Plate current	2x36	2x39.5	mA
Screen-grid current	2x5.2	2x8.0	mA
Output power	0	9.4	watts
Total distortion	-	4.6	percent

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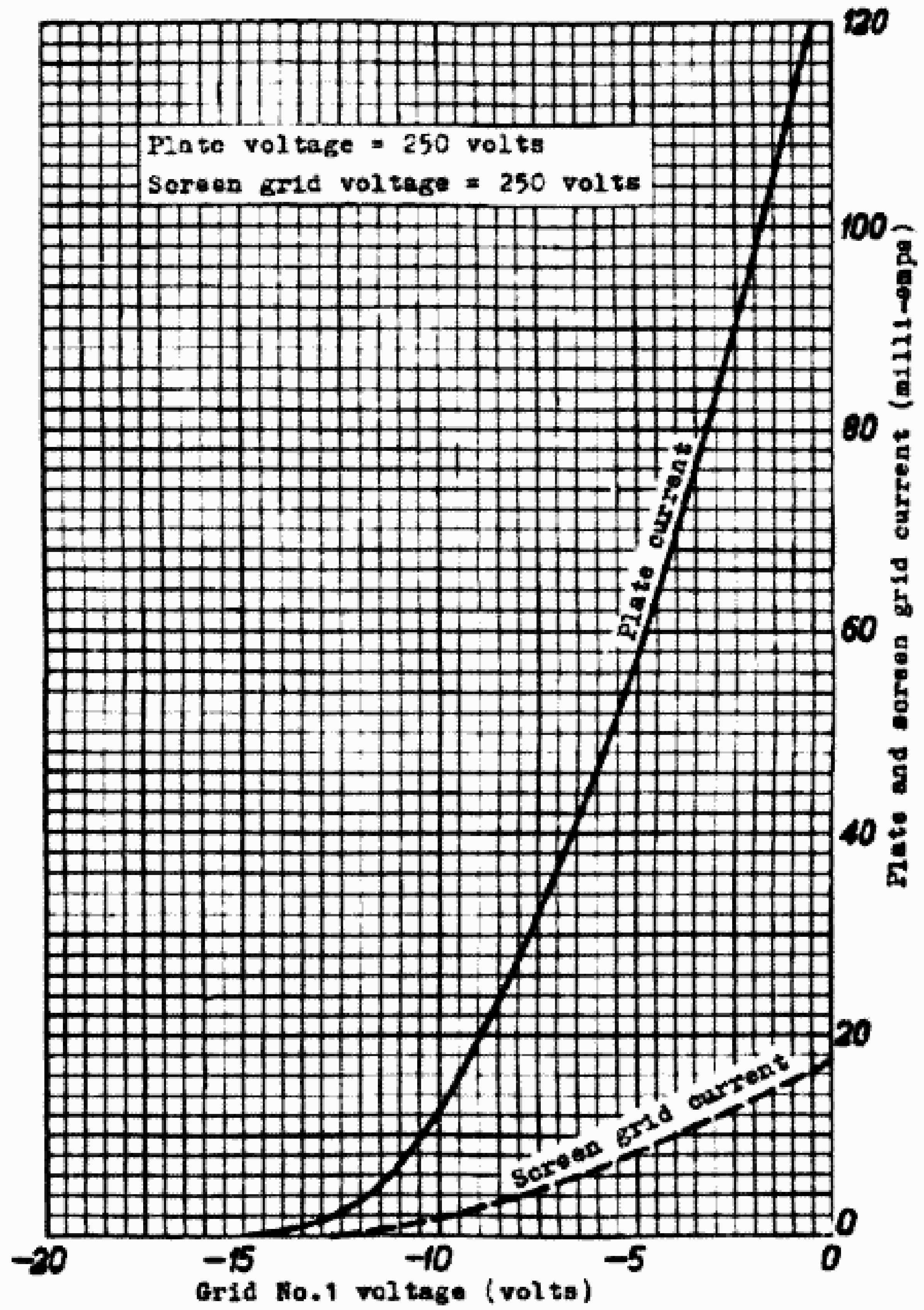

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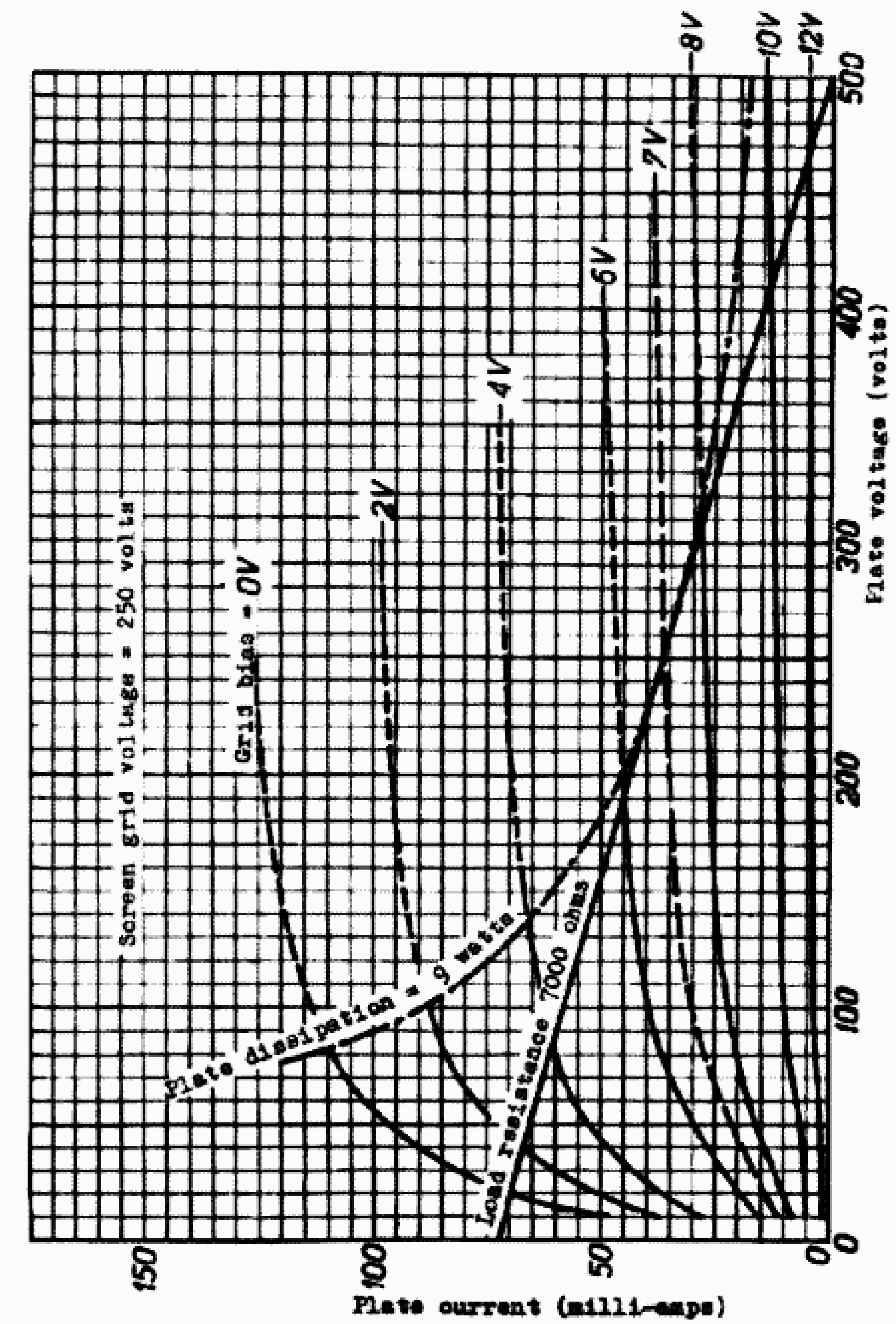

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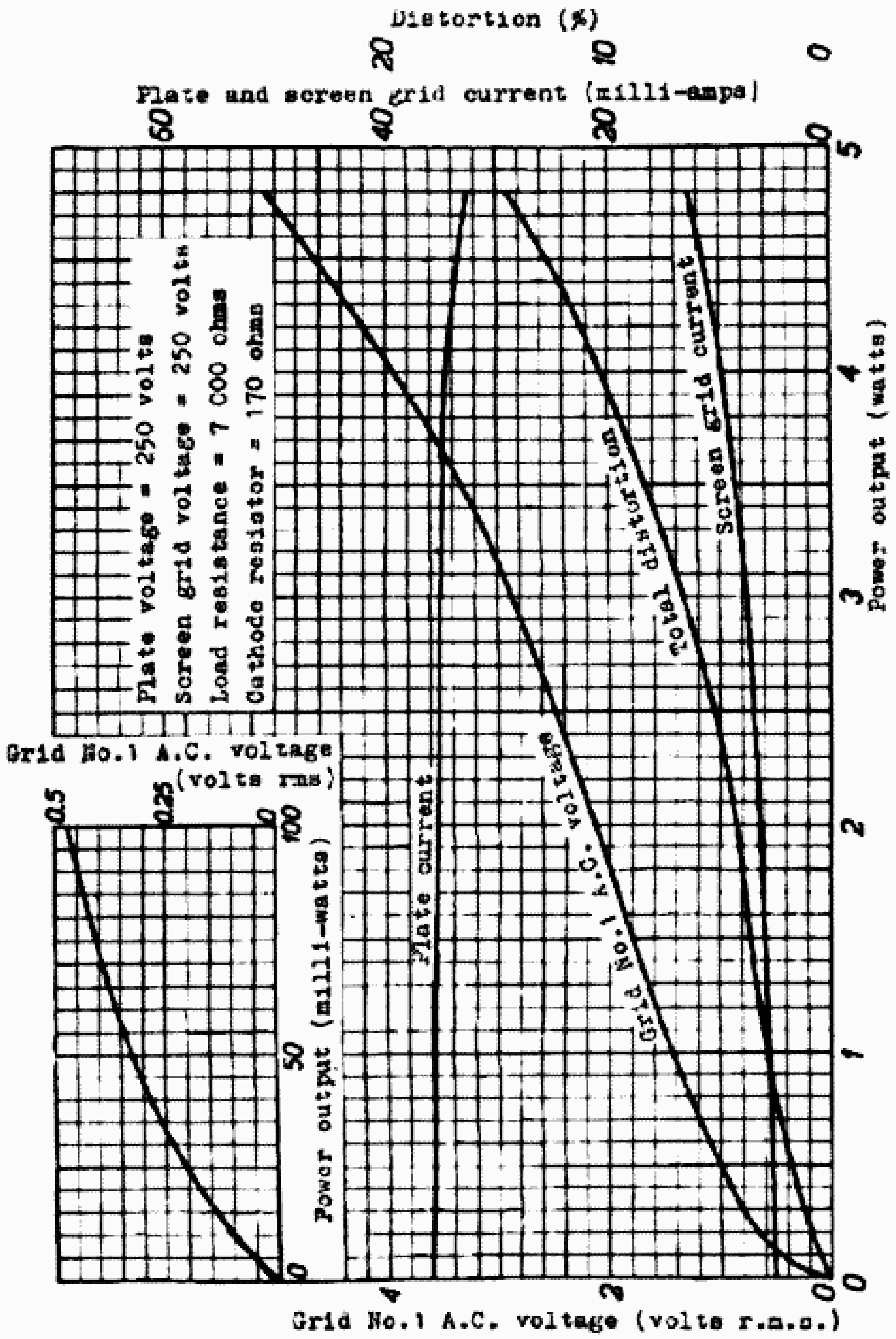
"Miniwatt"
INNOVAL SERIES

6M5



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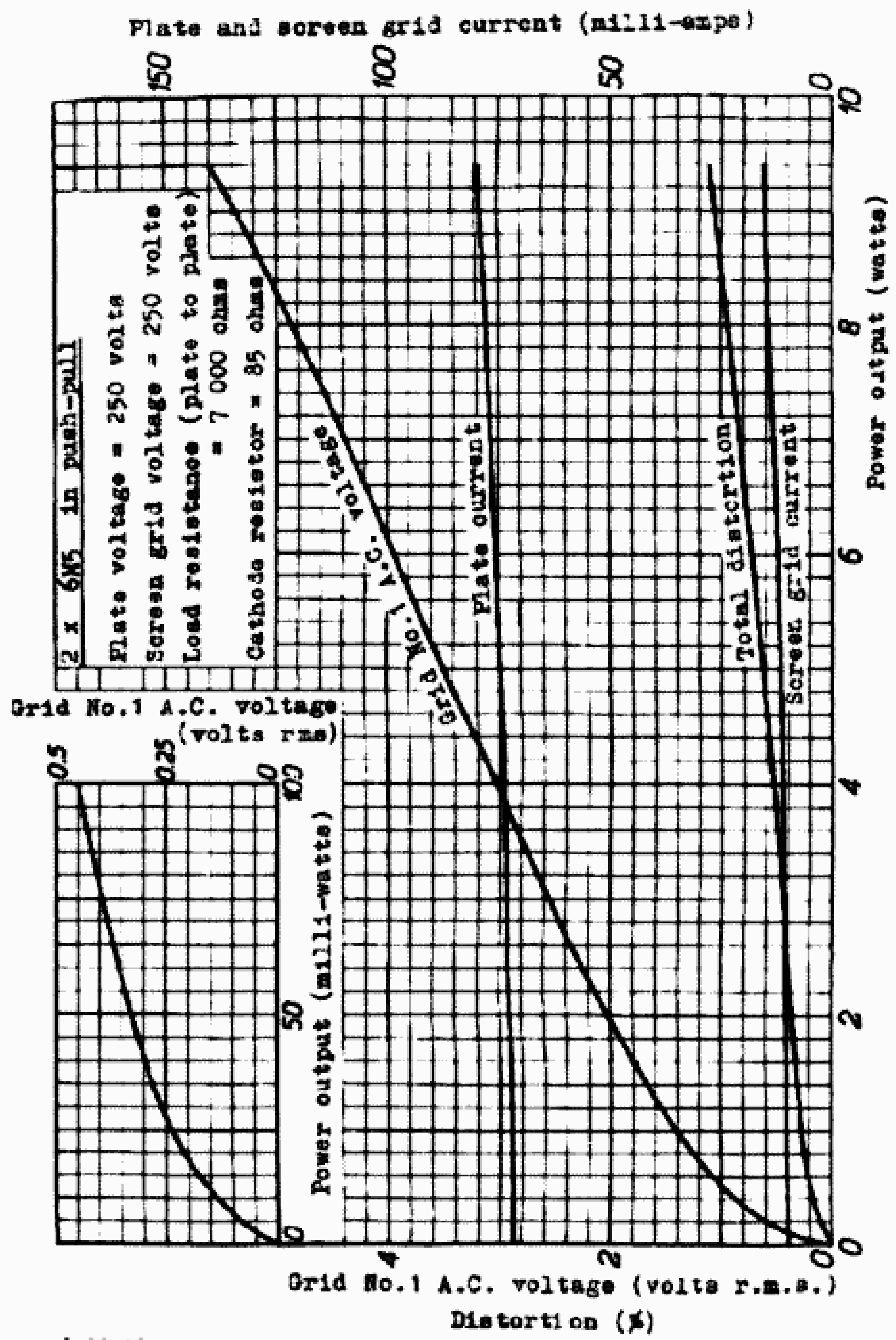

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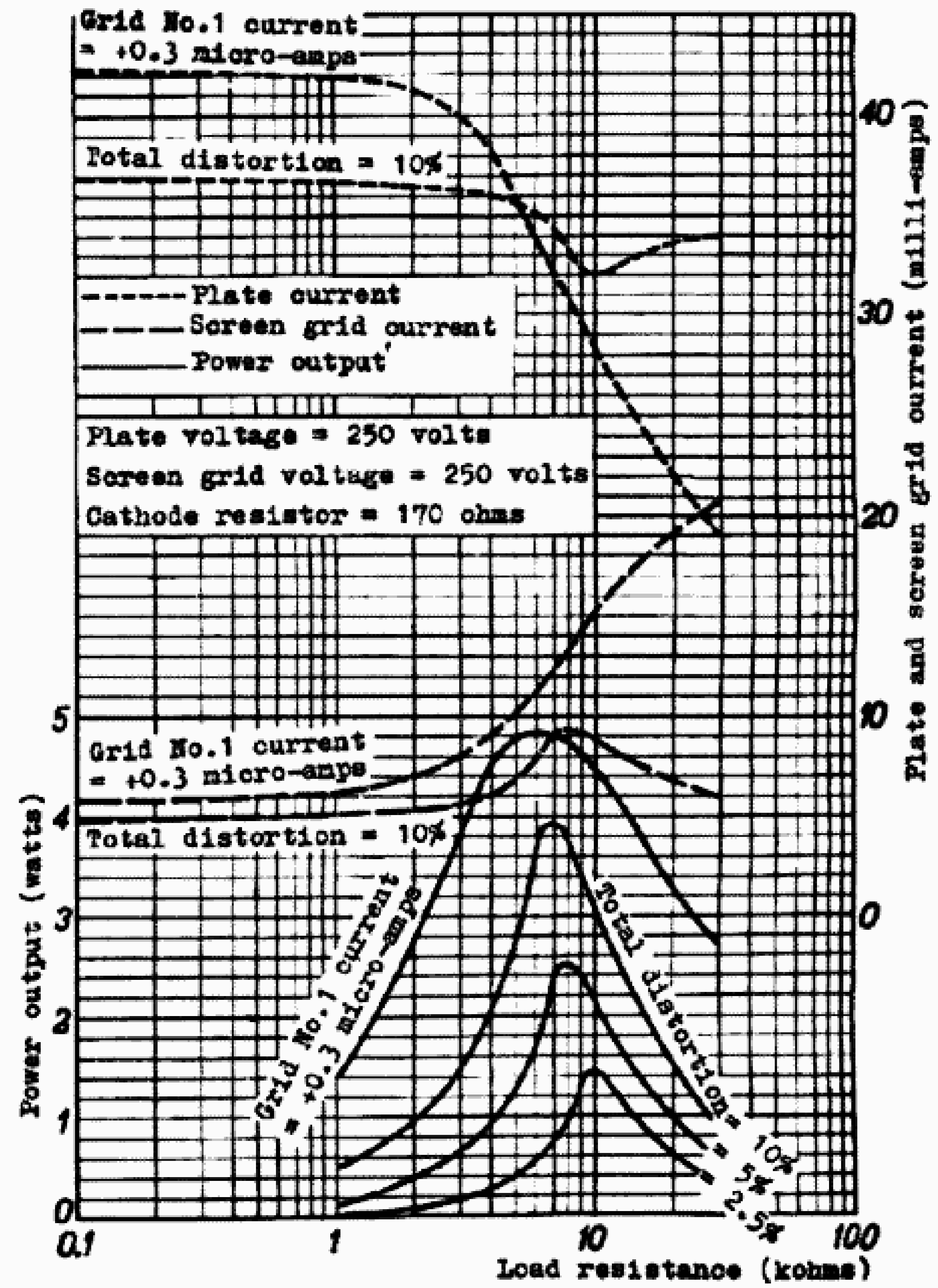

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"Miniwatt"
INNOVAL SERIES

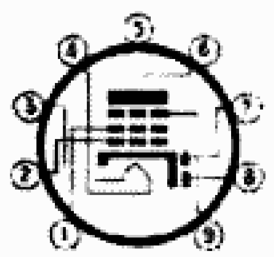
6N8

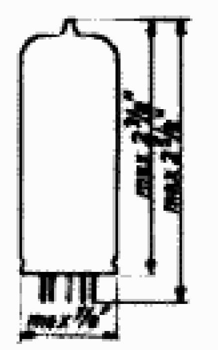
Double-Diode-Pentode for R.F., I.F. and A.F. Amplification

Physical Specifications.

Cathode	Coated unipotential
Base	Small button noval 9-pin
Bulb	T 6½
Mounting position	any
Basing connections - JETEC basing designation	9T-0-0

Pin 1 - Pentode screen grid
Pin 2 - Pentode control grid
Pin 3 - Cathode and internal shield
Pin 4 - Heater
Pin 5 - Heater
Pin 6 - Pentode plate
Pin 7 - Diode No.1 plate
Pin 8 - Diode No.2 plate
Pin 9 - Pentode grid No.3





General Electrical Data

Heater voltage	6.3 volts
Heater current	0.3 amperes

Direct Interelectrode Capacitances

Pentode grid No.1 to all other electrodes		4.0 µµF
Pentode plate to all other electrodes		4.6 µµF
Between pentode plate and pentode grid No.1	max.	0.002 µµF
Between pentode grid No.1 and heater	max.	0.06 µµF
Between diode No.1 plate and cathode		2.15 µµF
Between diode No.2 plate and cathode		2.35 µµF
Between diode plates	max.	0.3 µµF
Between diode No.1 plate and heater	max.	0.02 µµF
Between diode No.2 plate and heater	max.	0.01 µµF
Between diode No.1 plate and grid No.1	max.	0.0008 µµF
Between diode No.2 plate and grid No.1	max.	0.001 µµF
Between diode No.1 plate and pentode plate	max.	0.2 µµF
Between diode No.2 plate and pentode plate	max.	0.1 µµF

Maximum Ratings.

Pentode Section

Plate voltage (without current)	550 volts
Plate voltage	250 volts
Plate dissipation	2 watts
Screen grid voltage (without current)	550 volts
Screen grid voltage (plate current less than 2.5 mA)	250 volts
Screen grid voltage (plate current = 5 mA)	125 volts
Screen grid dissipation	0.3 watts
Cathode current	10 mA
Grid No.1 voltage at grid No.1 current = + 0.3 µa	-1.3 volts
External resistance between grid No.1 and cathode (See Note 1.)	3 megohms
External resistance between heater and cathode	20,000 ohms
Voltage between heater and cathode	50 volts

Diode Sections

Plate voltage (peak value)	200 volts
Plate current	0.8 mA
Plate voltage at plate current = + 0.3 µa	-1.3 volts
External resistance between heater and cathode	20,000 ohms
Voltage between heater and cathode	50 volts

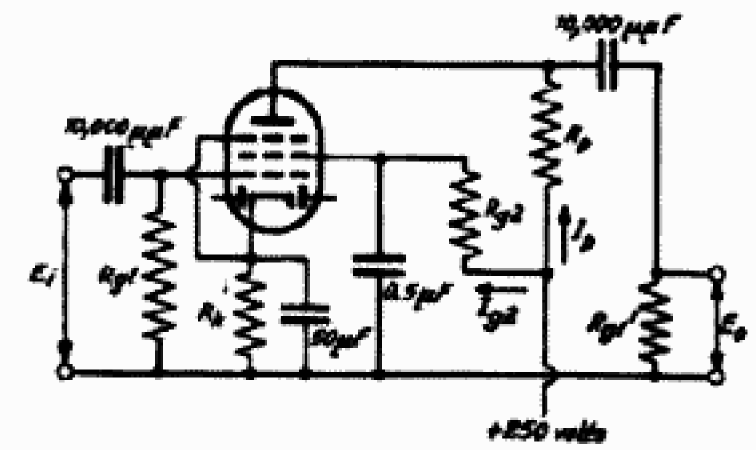
Note 1.
The maximum value of this resistor is 22 megohms if the grid bias is only obtained by the voltage drop across the grid resistor.

Operating Characteristics of the Pentode Section as R.F. or I.F. Amplifier.

Plate and supply voltage	250		volts
Grid No.3 voltage	0		volts
Screen grid series resistor	95,000		ohms
Cathode resistor	295		ohms
Grid No.1 voltage	-2	-41.5	volts
Screen grid voltage	85	250	volts
Plate current	5	-	mA
Screen grid current	1.75	-	mA

Mutual conductance	2200	22	micromhos
Plate resistance	1.6	>10	megohms
Amplification factor of grid No.2 with respect to grid No.1	19	19	
Equivalent noise resistance	6,200	-	ohms

Operating Characteristics of the Pentode Section as A.F. Amplifier.



In circuits using a loudspeaker with an accustical efficiency of 5% this valve can be used without special precautions against microphony if the input voltage for an output of 50 milliwatts is more than 10 millivolts.

R_p (MΩ)	R_{g2} (MΩ)	R_{g1} (KΩ)	R_k (Ω)	R'_{g1} (MΩ)	I_p (mA)	I_{g2} (mA)	$\frac{E_o}{E_i}$	Distortion (%) at E_o (r.m.s.) = 3 volts	5 volts	8 volts
0.22	0.68	1	1200	0.68	0.88	0.33	150	0.5	0.8	1.2
0.10	0.27	1	560	0.33	1.93	0.75	100	0.45	0.75	1.15
0.22	0.68	10	0	0.60	0.94	0.35	108	0.7	0.9	1.2
0.10	0.27	10	0	0.33	2.04	0.80	125	0.6	0.75	0.9

"Miniwatt" INNOVAL SERIES

6N8

Operating Characteristics of the Pentode Section as A.F. Amplifier in Triode Connection.

(screen grid connected to plate)

R_p (MΩ)	R_{g1} (MΩ)	R_k (Ω)	R'_{g1} (MΩ)	I_p (mA)	$\frac{E_o}{E_i}$	Distortion (%) at E_o (r.m.s.) = 3volts	5volts	8volts
0.1	1	820	0.33	2.08	14.5	1.6	2.5	4.3
0.047	1	560	0.15	4.1	13	1.3	2.0	2.9
0.1	10	0	0.33	2.16	15	2.0	3.1	4.8
0.047	10	0	0.15	4.5	15	1.7	2.7	4.1

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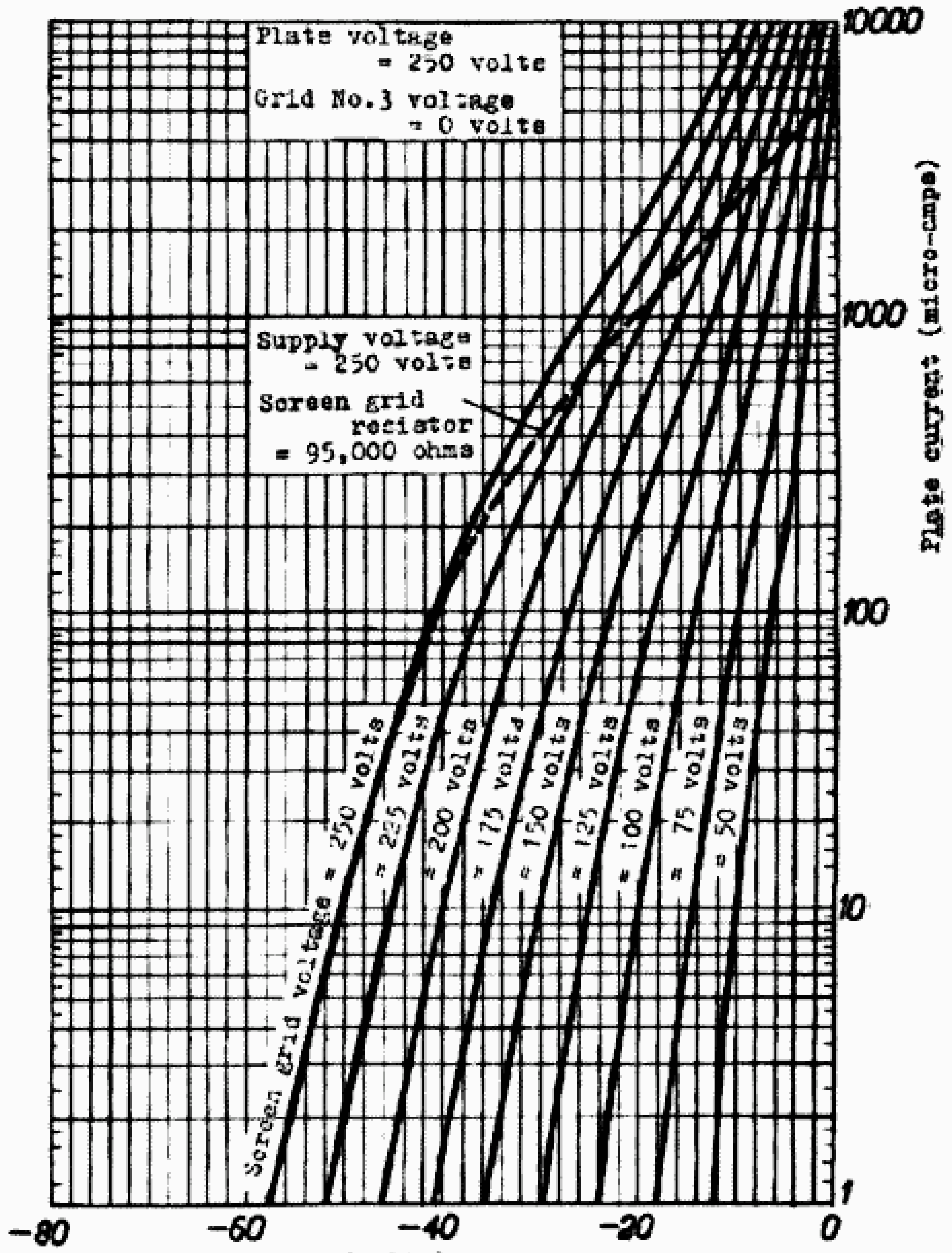

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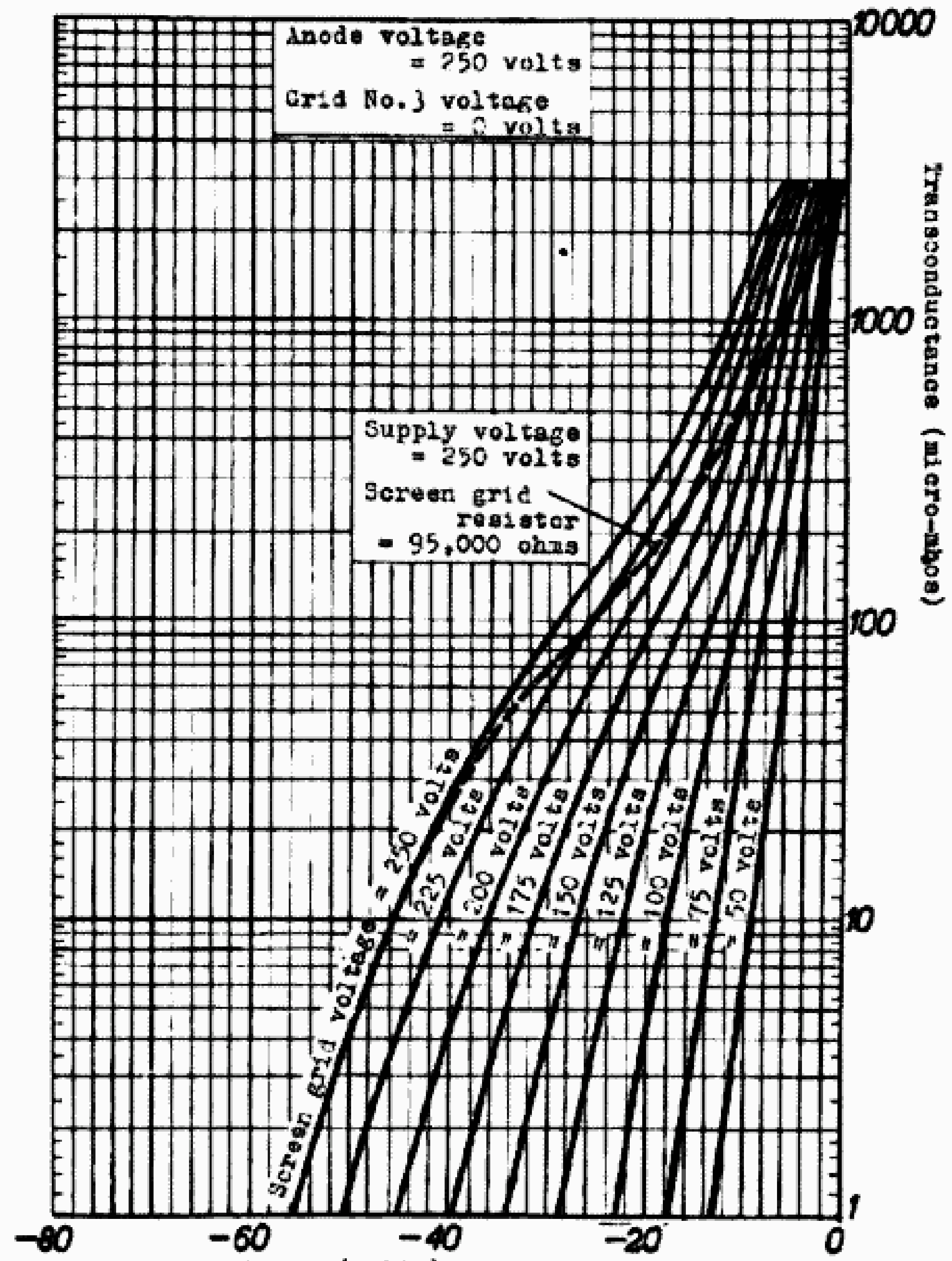

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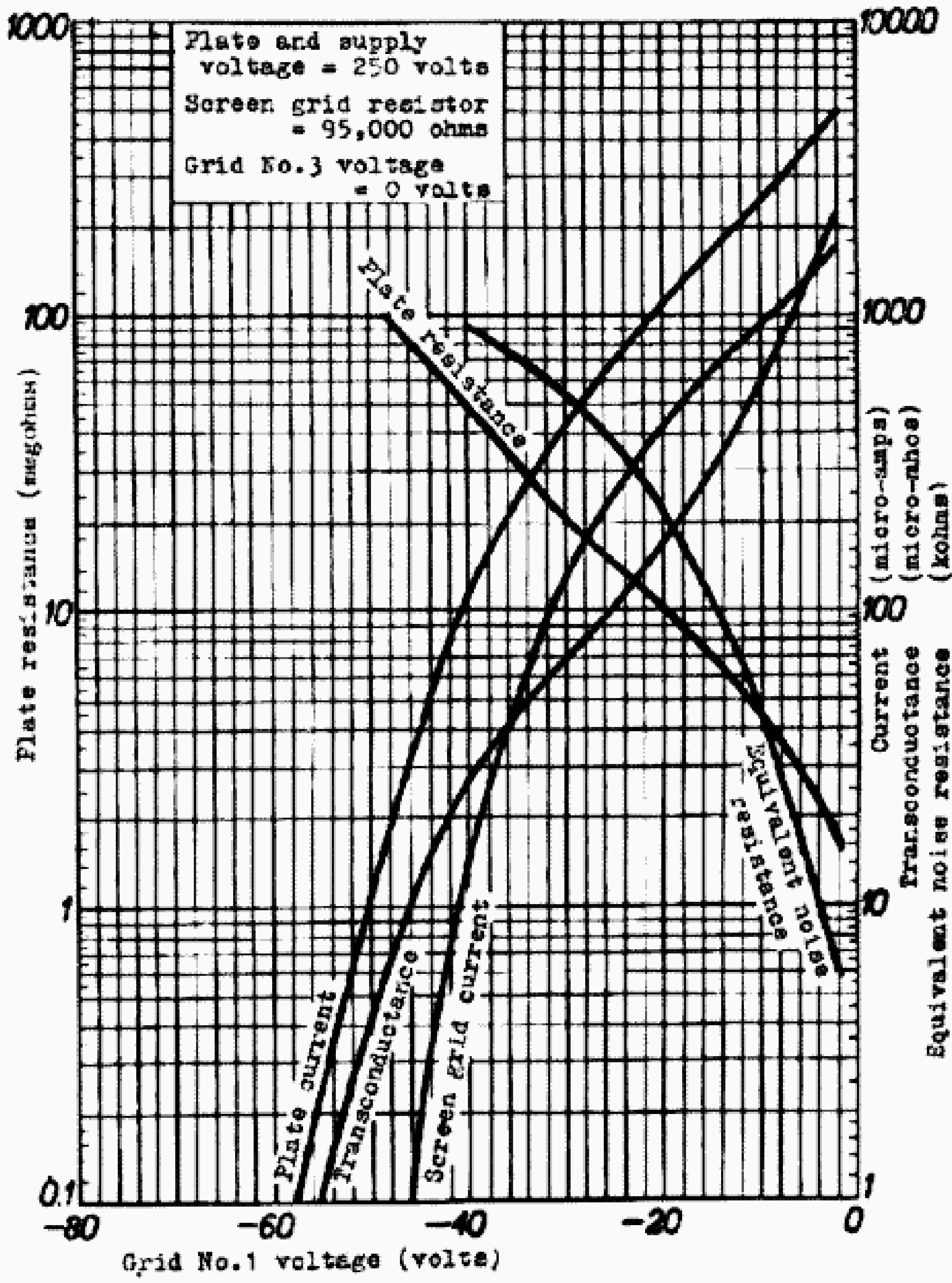
"Miniwatt"
INNOVAL SERIES

6N8



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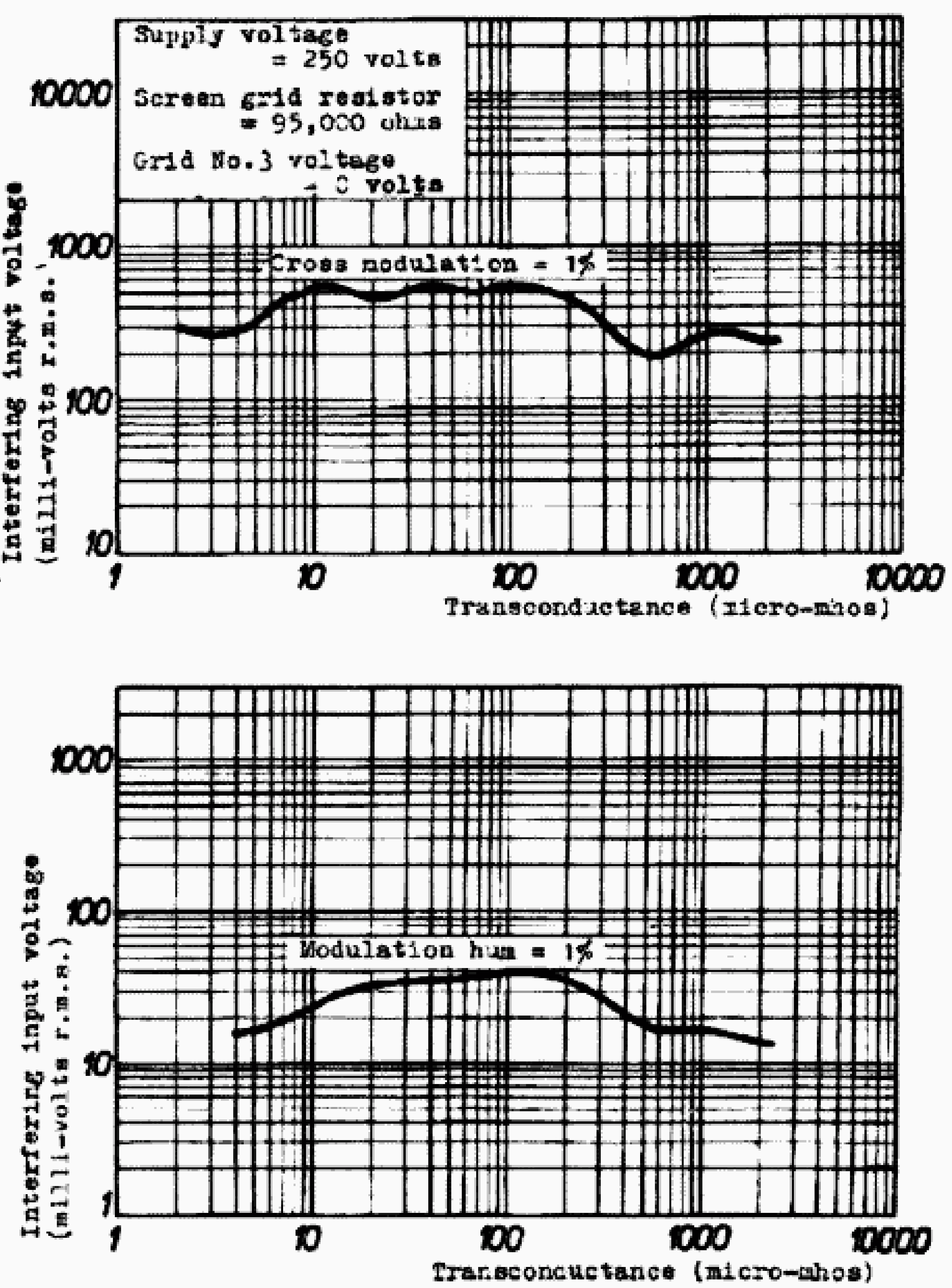

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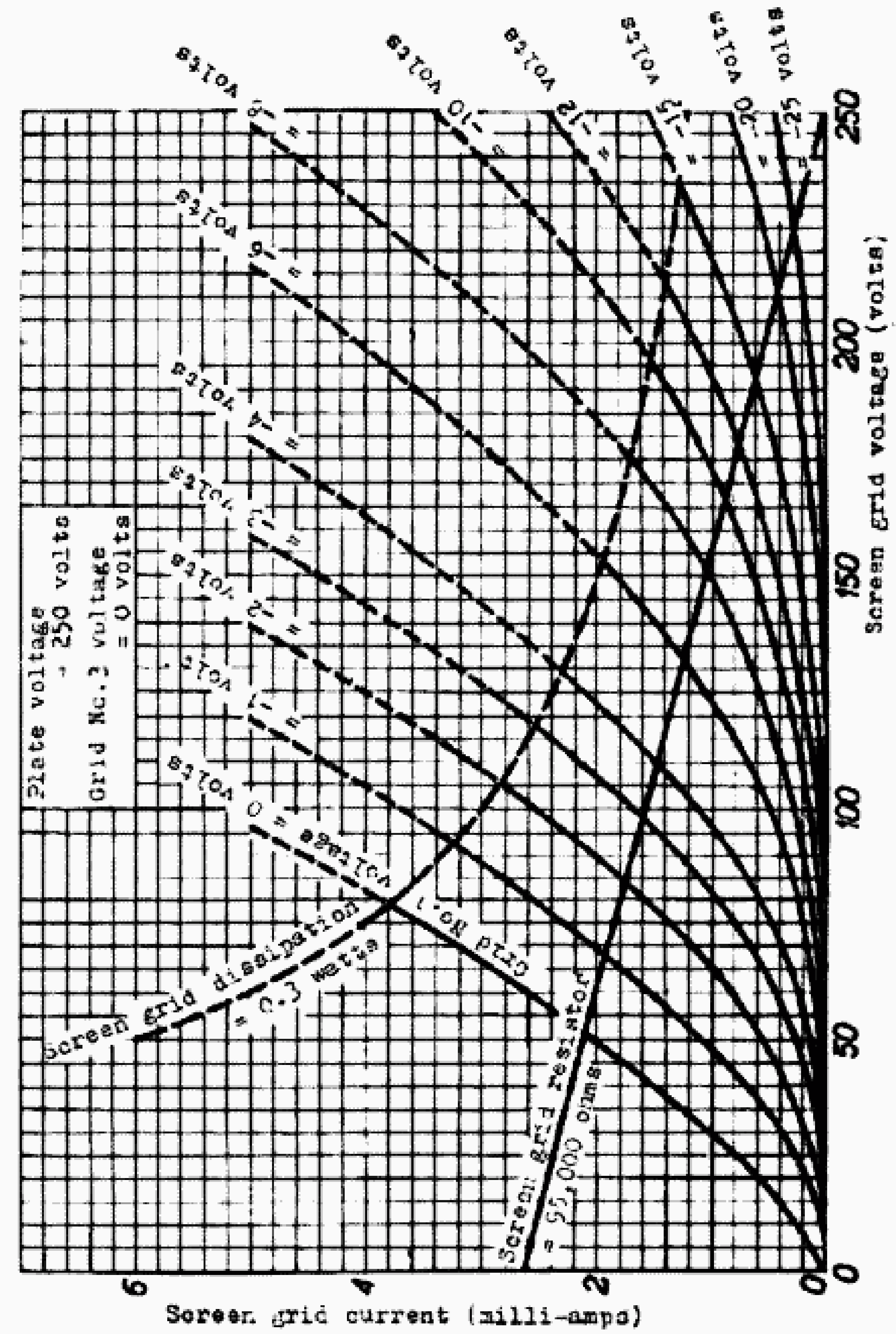

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"Miniwatt"
INNOVAL SERIES

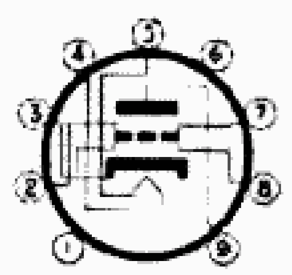
6Q4

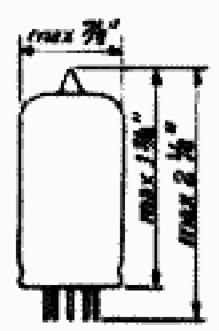
Grounded Grid Triode for VHF Applications

Physical Specifications

Cathode	Coated Unipotential
Base	Small button noval 9-pin
Bulb	T 6½
Mounting position	Any

Basing connections - JETEC basing designation
Pin 1 - Grid
Pin 2 - Grid
Pin 3 - Cathode
Pin 4 - Heater
Pin 5 - Heater
Pin 6 - No Connection
Pin 7 - Grid
Pin 8 - Grid
Pin 9 - Anode





General Electrical Data

Heater Voltage	6.3 volts
Heater Current	0.48 amps

Direct Interelectrode Capacitances

Plate to Cathode and Heater	<0.06 μμF
Grid to Cathode and Heater	5.4 μμF
Grid to Plate	3.4 μμF

Maximum Ratings

Plate voltage (without current)	550 volts
Plate voltage	300 volts
Plate dissipation	4 watts
Cathode Current	15 mA
Grid voltage at grid current = +0.3 μA	-1.3 volts
External resistance between heater and cathode	20,000 ohms
Voltage between heater and cathode	50 volts

Typical Characteristics

Plate Voltage	250 volts
Grid Voltage	-1.5 volts
Plate Current	15 mA
Mutual Conductance	12,000 μ mhos
Amplification Factor	80

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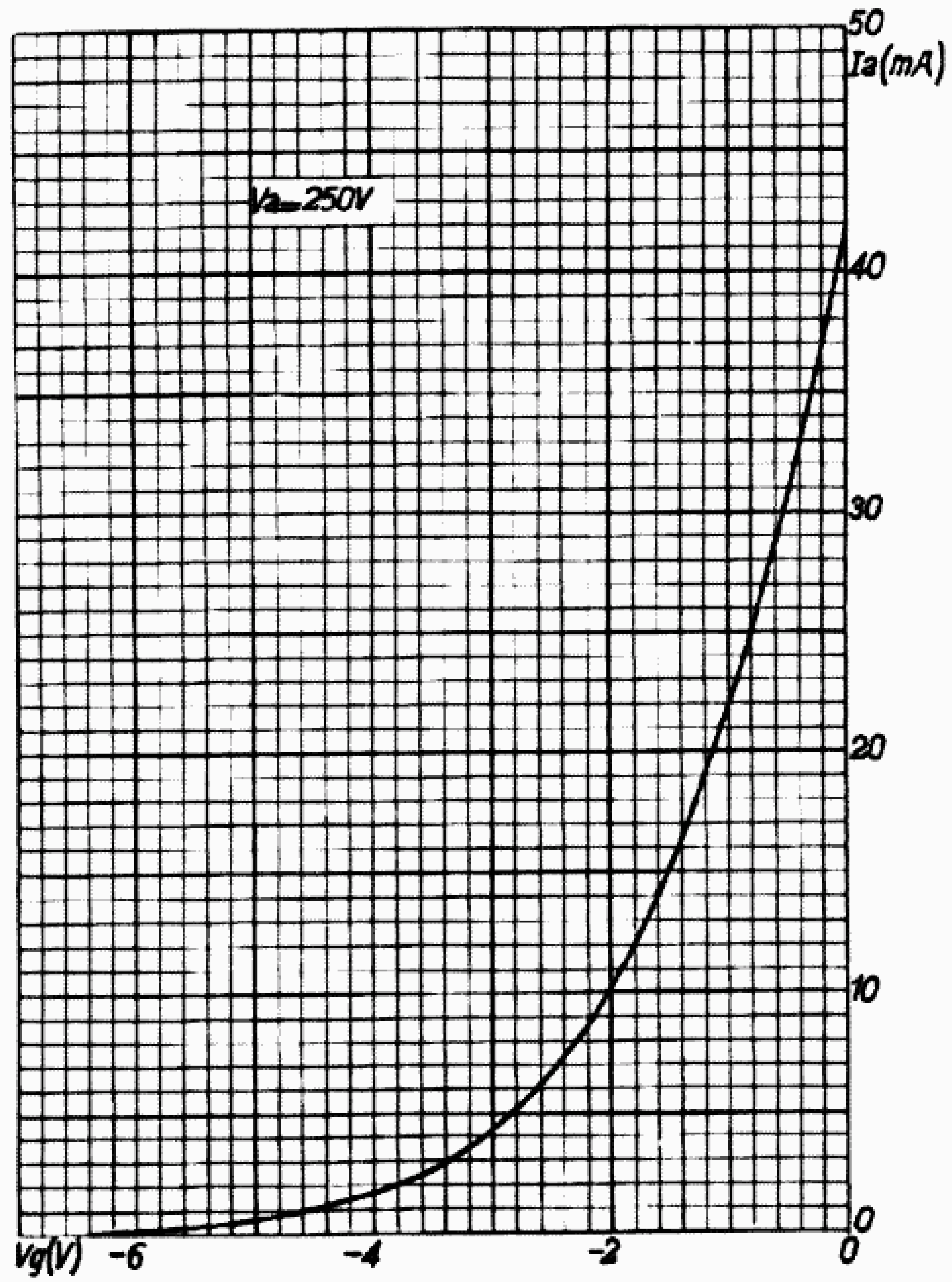

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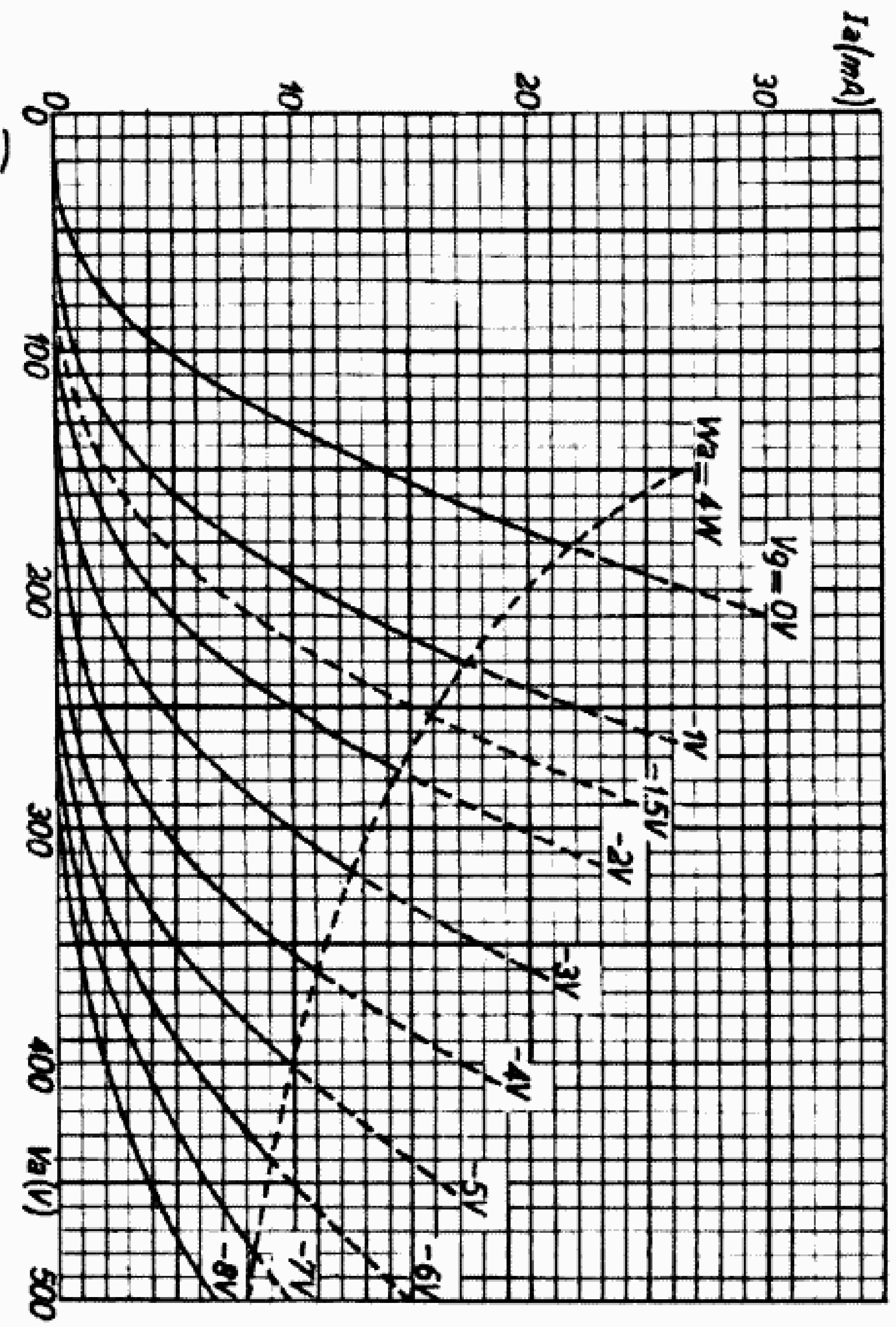

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"Miniwatt"

INNOVAL SERIES

6R4

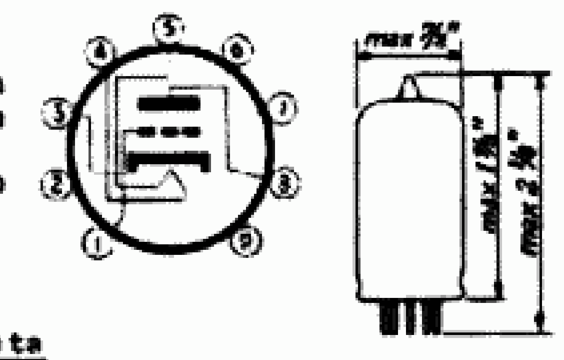
U.H.F. Triode for use as an oscillator for frequencies up to 1500 Mc/s.

Physical Specifications

Cathode	Coated unipotential
Base	Small button noval 9-pin
Bulb	T 6½
Mounting position	Any

Basing connections - JETEC Basing designation.

Pin 1 - Grid
Pin 2 - No Connection
Pin 3 - Cathode
Pin 4 - Heater
Pin 5 - Heater
Pin 6 - No Connection
Pin 7 - No Connection
Pin 8 - Plate
Pin 9 - No Connection



General Electrical Data

Heater supply voltage (See Note 1)	6.3 volts
Heater circuit current limiting resistor (See Note 1)	3 ohms
Heater current	0.2 amps

Direct Interelectrode Capacitances

Input	1.7 µµF
Output	0.5 µµF
Grid to Plate	1.5 µµF
Grid to Heater	<0.2 µµF
Heater to Cathode	2.3 µµF

Maximum Ratings

Plate voltage (without current)	550 volts
Plate voltage (without plate supply stabilisation)	275 volts
Plate voltage (with plate supply stabilisation ± 1%)	300 volts
Plate dissipation (without plate supply stabilisation)	3.5 watts
Plate dissipation (with plate supply stabilisation ± 1%)	5 watts
Grid Voltage	-100 volts
Grid Voltage at grid current+0.3 µA	-1.3 volts
Grid Current	7.5 mA
Cathode Current (without heater supply stabilisation)	20 mA

Cathode Current (with heater supply stabilisation ± 3%	30 mA
External resistance between grid and cathode	1 megohm
External resistance between heater and cathode	20,000 ohms
Voltage between heater and cathode	50 volts

Operating Characteristics as an Oscillator

A. Without Plate or Heater Voltage Supply Stabilisation

Heater voltage supply (See Note 1)		6.3 volts
Plate voltage	max.	275 volts
Plate dissipation	max.	3.5 watts
Cathode Current	max.	20 mA

Typical Applications

Operational Frequency	750 Mc/s	375 Mc/s
Plate Voltage	230	275 volts
Plate Current	16.2	17.0 mA
Grid Current	1.8	3.0 mA
Plate Input	4.2	4.7 watts
Power Output	0.7	1.8 watts

B. With Plate Supply Voltage Stabilisation

Heater voltage supply (See Note 1)		6.3 volts
Plate voltage	max.	300 ± 1% volts
Plate dissipation (See Notes 2 and 3)	max.	5 watts
Cathode Current		20 mA

Typical Applications

Operational Frequency	750 Mc/s	375 Mc/s
Plate Voltage	300	300 volts
Plate Current	18.4	17.0 mA
Grid Current	1.8	3.0 mA
Plate Input	5.5	5.1 watts
Power Output	1.0	2.0 watts

C. With Plate and Heater Voltage Supply Stabilisation

Heater Voltage	6.3 ± 3% volts
Plate Voltage	300 ± 1% volts

Plate Dissipation (See Notes 2 and 3)	max.	5 watts
Cathode Current (See Note 3)		30 mA

Typical Applications

Operational Frequency	750 Mc/s	375 Mc/s
Plate Voltage	230	300 volts
Plate Current	27.7	26.1 mA
Grid Current	2.3	3.9 mA
Plate Input	6.3	7.9 watts
Power Output	1.3	3.5 watts

Notes

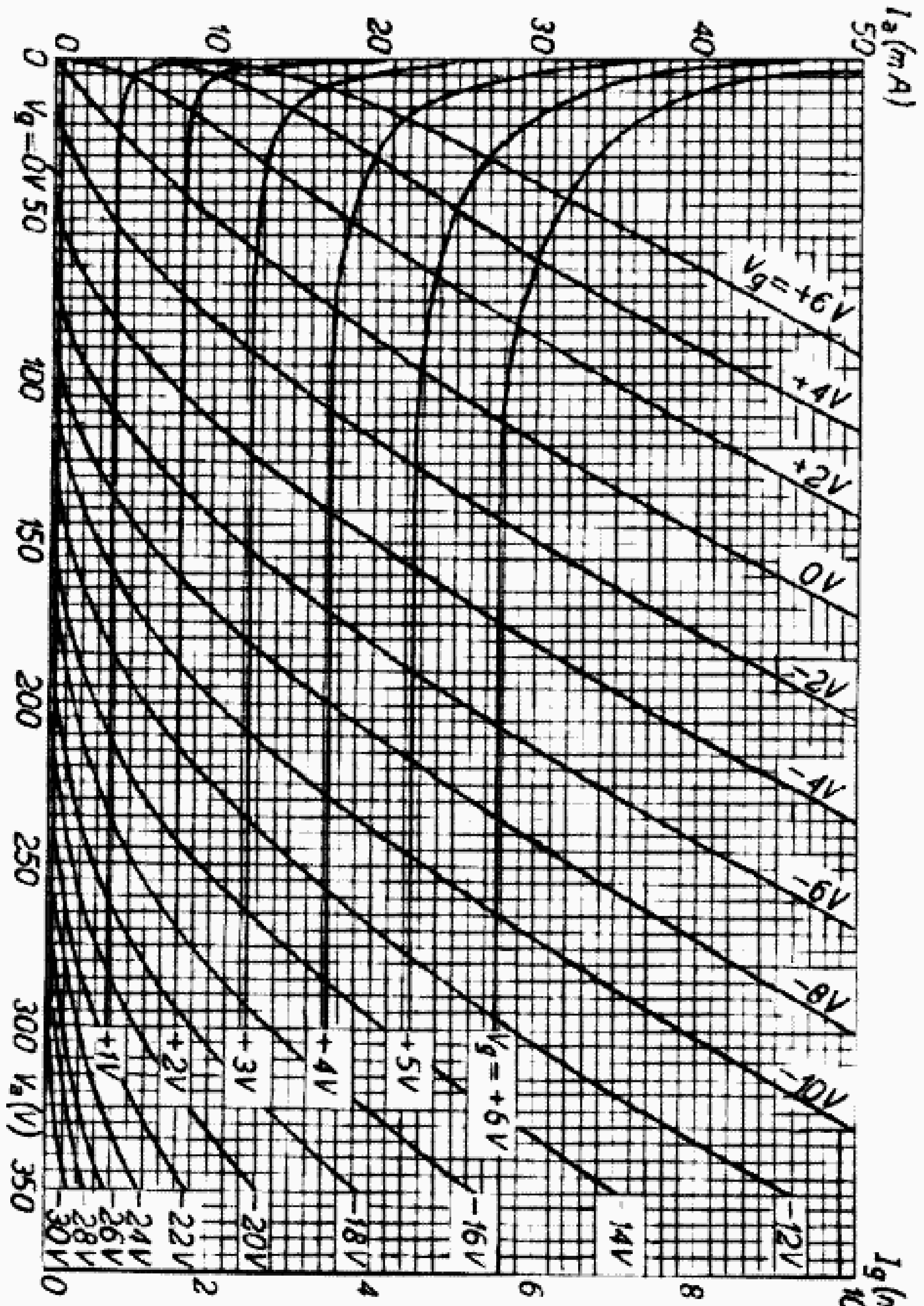
1. Unless a stabilised heater supply with a regulation of ± 3% is used an additional resistance of 3 ohms must be included in the heater circuit.

2. Adjustment must be made for each individual valve.

3. This is an absolute maximum value which must not be exceeded under any circumstances including mains voltage fluctuations.

"Miniwatt"
INNOVAL SERIES

6R4



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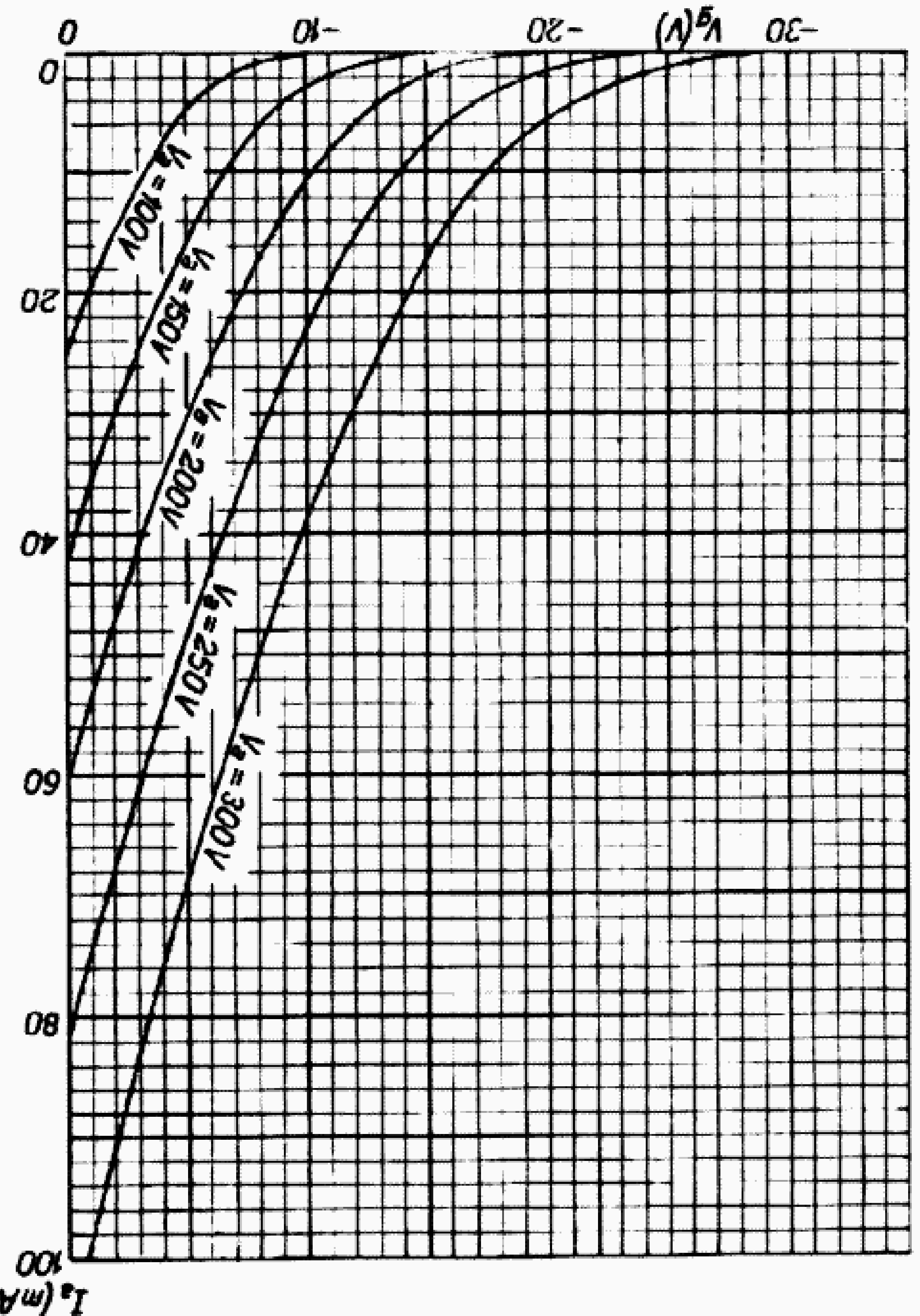

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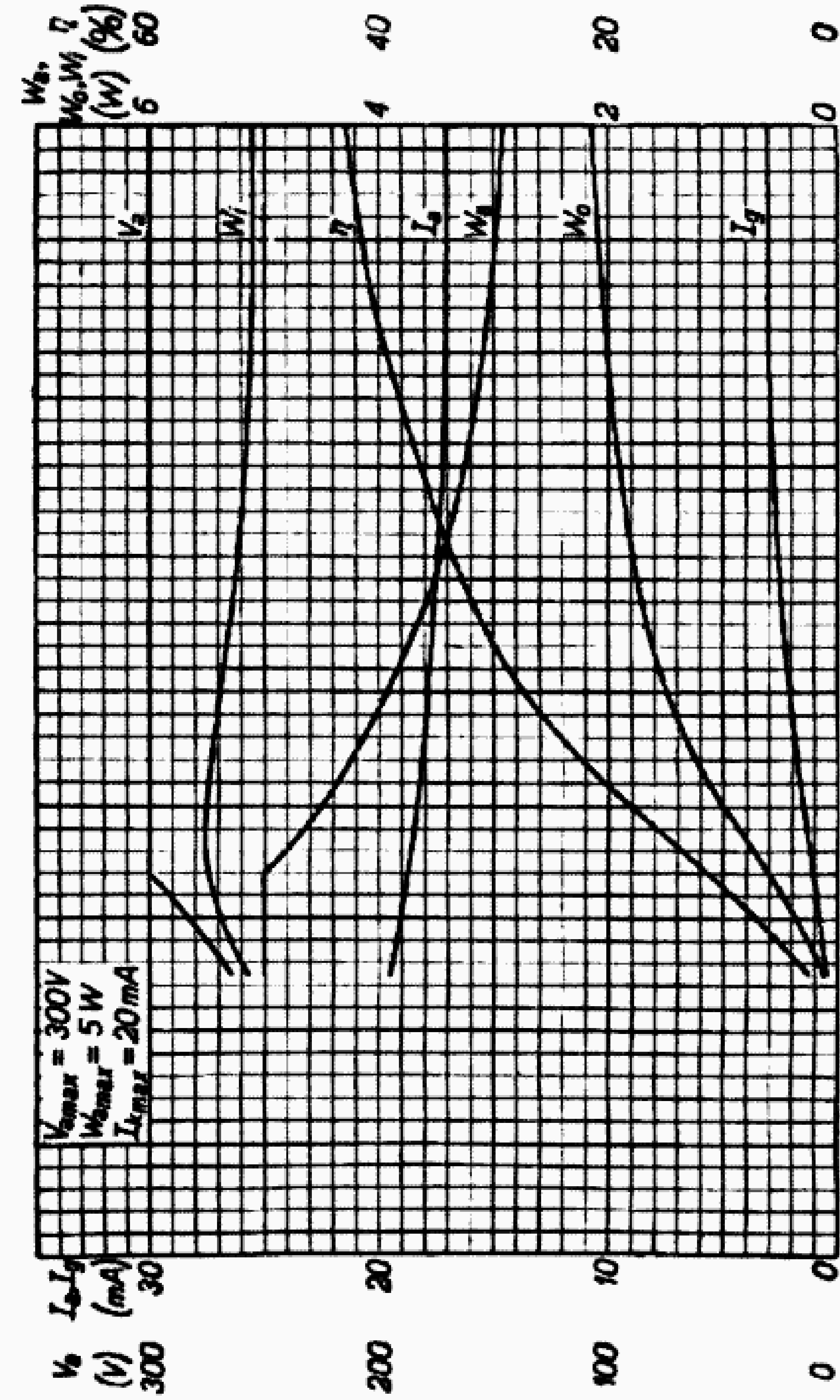

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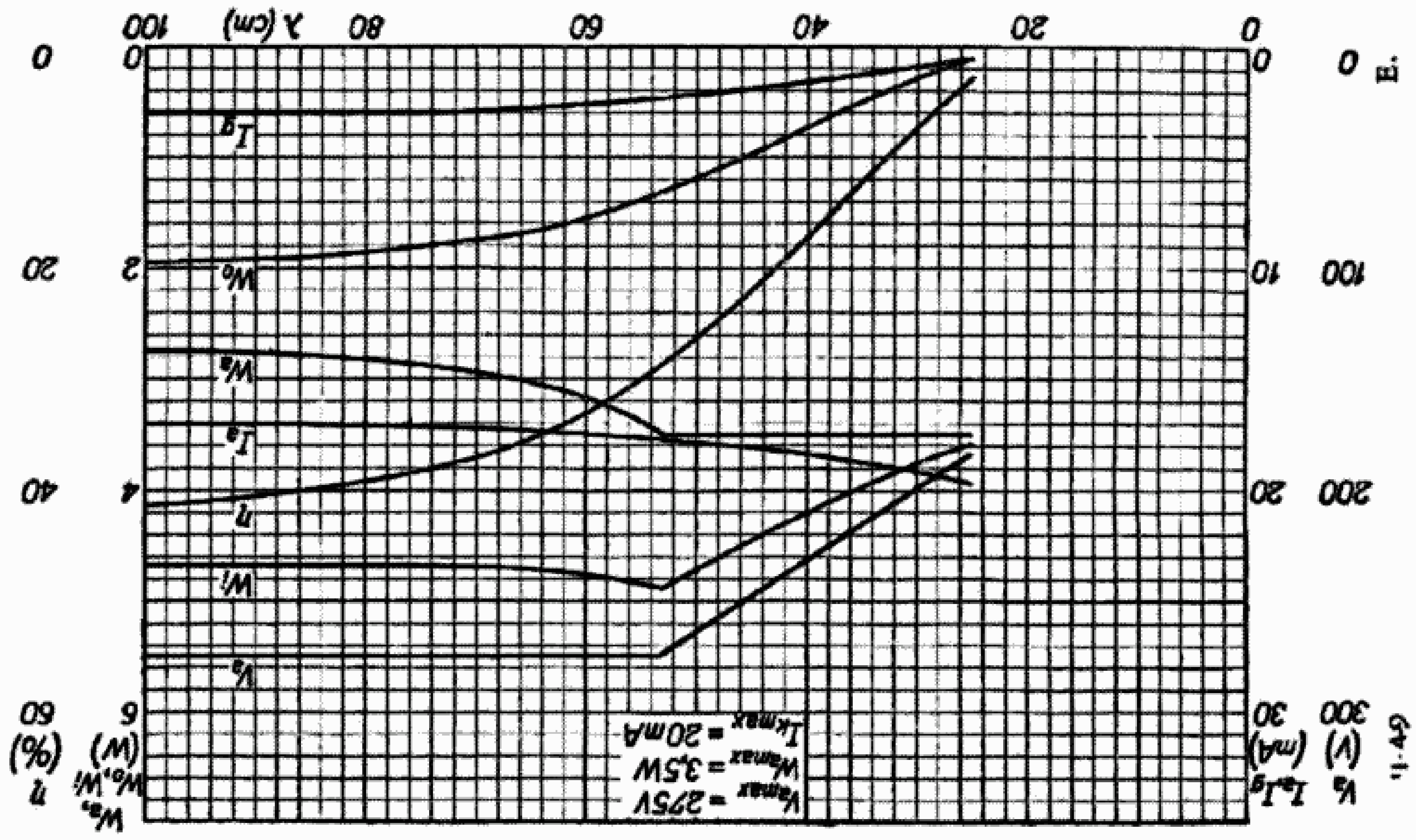
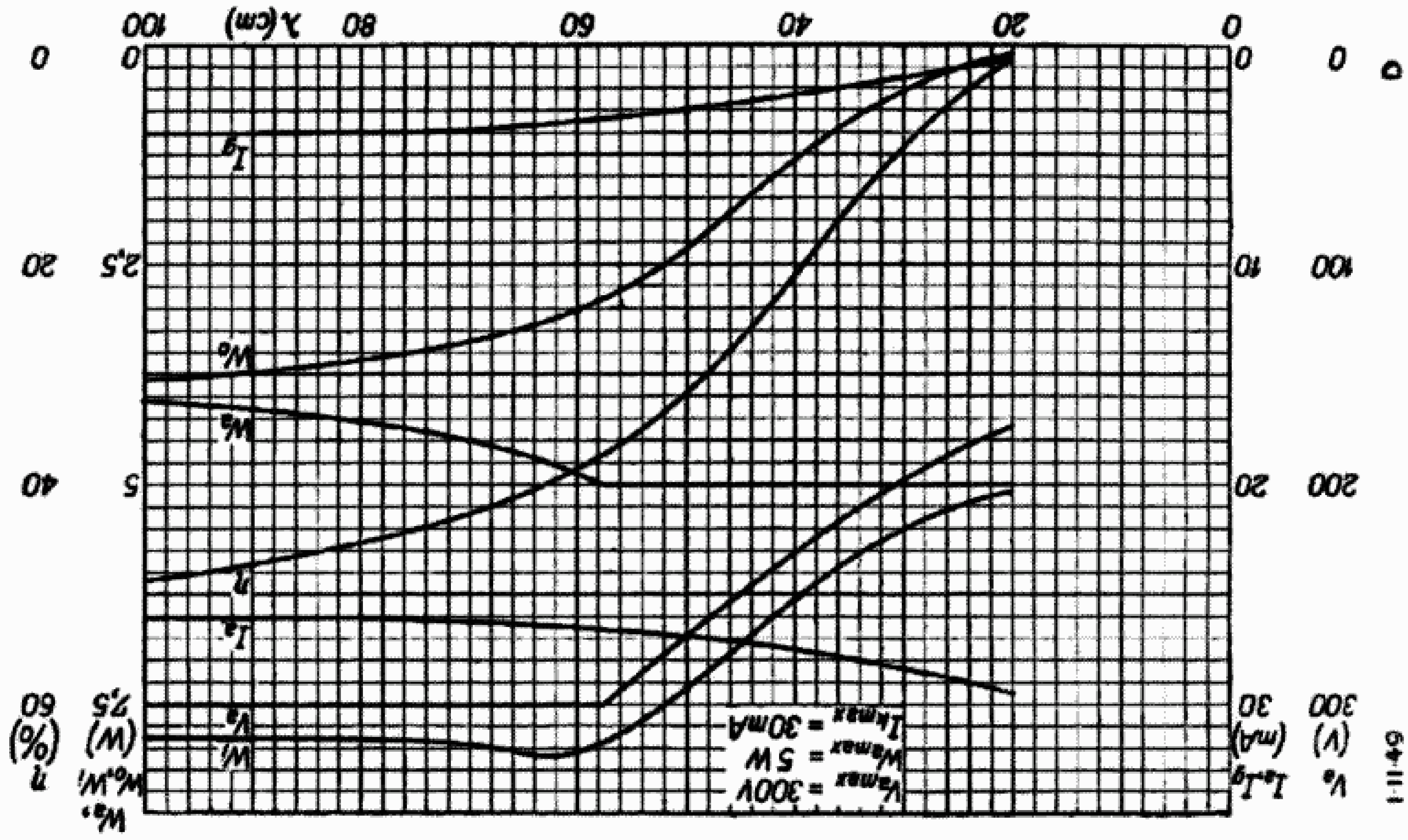
C

6R4





"Miniwatt"
INNOVAL SERIES

"Miniwatt" INNOVAL SERIES

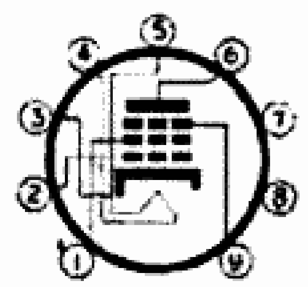
18042

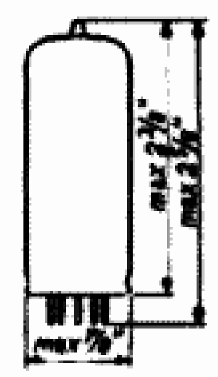
Amplifier Pentode for use in telephone repeater equipment.

Physical Specifications

Cathode	Coated unipotential
Base	Small button noval 9-pin
Bulb	T 6½
Mounting position	Any

Basing connections
Pin 1 - Grid No. 2
Pin 2 - Grid No. 1
Pin 3 - Cathode
Pin 4 - Heater
Pin 5 - Heater
Pin 6 - Anode
Pin 7 - Internal Connection
Pin 8 - Internal Connection
Pin 9 - Grid No. 3





General Electrical Data

Heater Voltage	18.0 volts
Heater Current	0.1 amps

Direct Interelectrode Capacitances

	Without External Shield Can	With close fitting External Shield Can
Output	3.4	3.8 μμF
Input	8.6	8.6 μμF
Grid No.1 to Plate	<0.05	<0.012 μμF
Grid No.1 to Heater	<0.07	<0.07 μμF

Maximum Ratings

Plate voltage (without current)	550 volts
Plate Voltage	210 volts
Plate Dissipation	2.1 watts
Grid No.2 Voltage (without current)	550 volts
Grid No.2 Voltage	210 volts
Grid No.2 Dissipation	0.35 watts
Cathode Current	16 mA

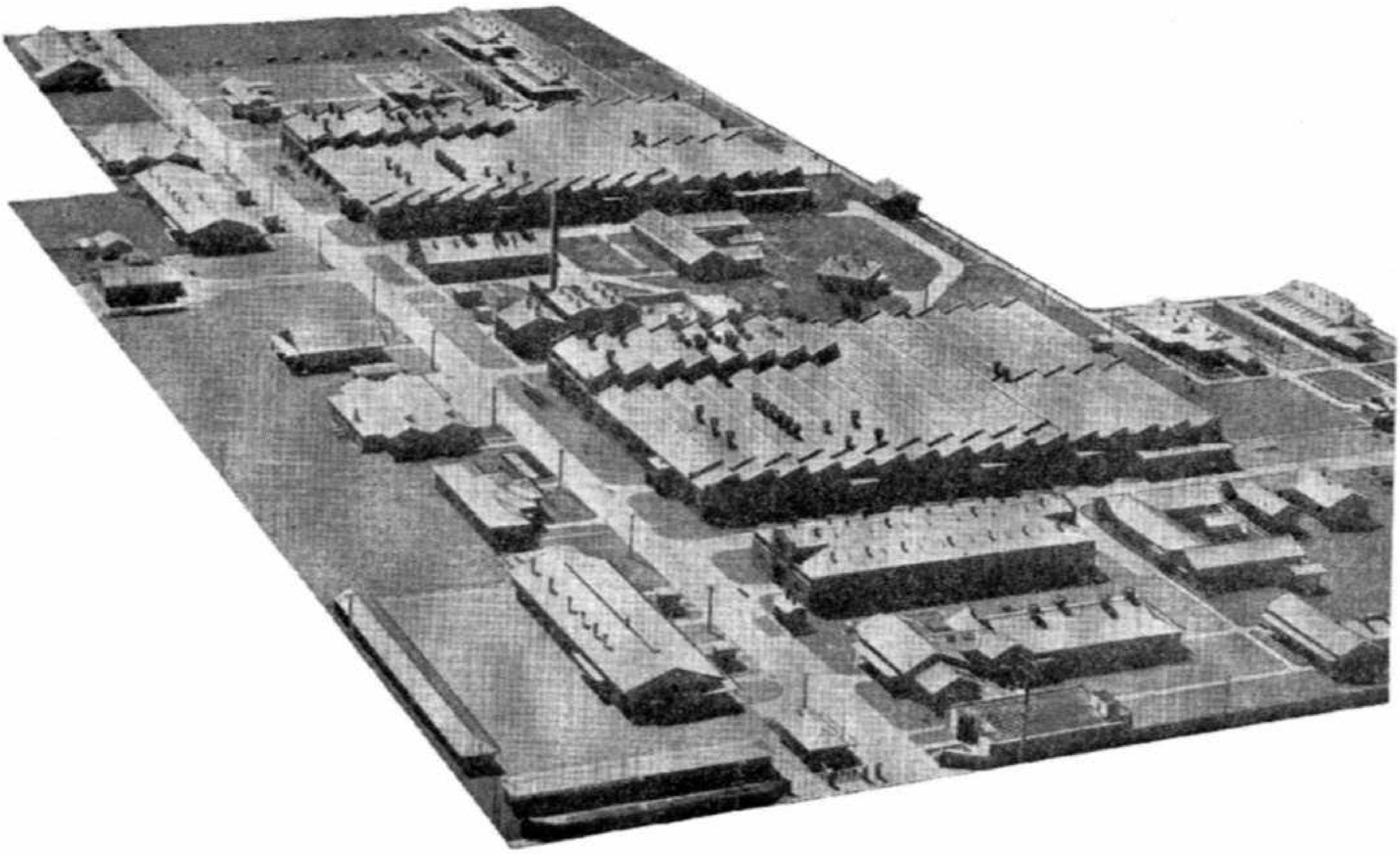
Maximum Ratings (contd.)

Grid No.1 Voltage at grid current = +0.3 μA	-1.3 volts
External Resistance between Grid No.1 and cathode (See Note 1)	1.0 megohm
External Resistance between heater and cathode	20,000 ohms
Voltage between heater and cathode	110 volts

Note 1.) With automatic grid bias.

Typical Characteristics.

Plate Voltage	120	210 volts
Grid No.2 Voltage	120	120 volts
Grid No.3 Voltage	0	0 volts
Cathode Resistor	120	155 ohms
Plate Current	12	10 mA
Grid No.2 Current	2.5	2.2 mA
Mutual Conductance	9,500	9,000 μ mhos
Plate Resistance	0.22	0.4 megohms
Amplification Factor Grid No.1 to Grid No.2	38	38
Equivalent Noise Resistance	700	700 ohms



Hendon . . .

where "*Innoval*" is made

The huge Philips plant at Hendon, South Australia, covers an area of 75 acres. It is to this vast plant, five miles from Adelaide, that Philips moved all their Australian factories in 1947 so that their multiple manufacturing activities could be co-ordinated and consolidated in the one factory area.

Separate production divisions are maintained at Hendon for the manufacture of radio receivers, transmitters and components, communication equipment, lighting and fluorescent equipment, sound reproduction apparatus, electro-medical apparatus, X-ray equipment for medical, dental and industrial apparatus, electric shavers and other general electronic instruments.

One of the most important units in the Hendon plant is the Tube Division, where a complete range of receiving valves is produced.

The Tube Division is spacious, modern and air-conditioned. It houses some of the most up-to-date precision machinery in the world . . . machinery that has been wholly designed and built by Philips engineers. Here, the "Innoval" series is now being mass-produced. This has meant the installation of additional equipment and the training of new staff so that the production of the "Innoval" series does not in any way affect the continuity of production of other Philips Miniwatt valve types which will, of course, continue to be made at Hendon as long as a demand for these types remains. Philips are confident that "Innoval" has a big future . . . a future in which all can share

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