105.

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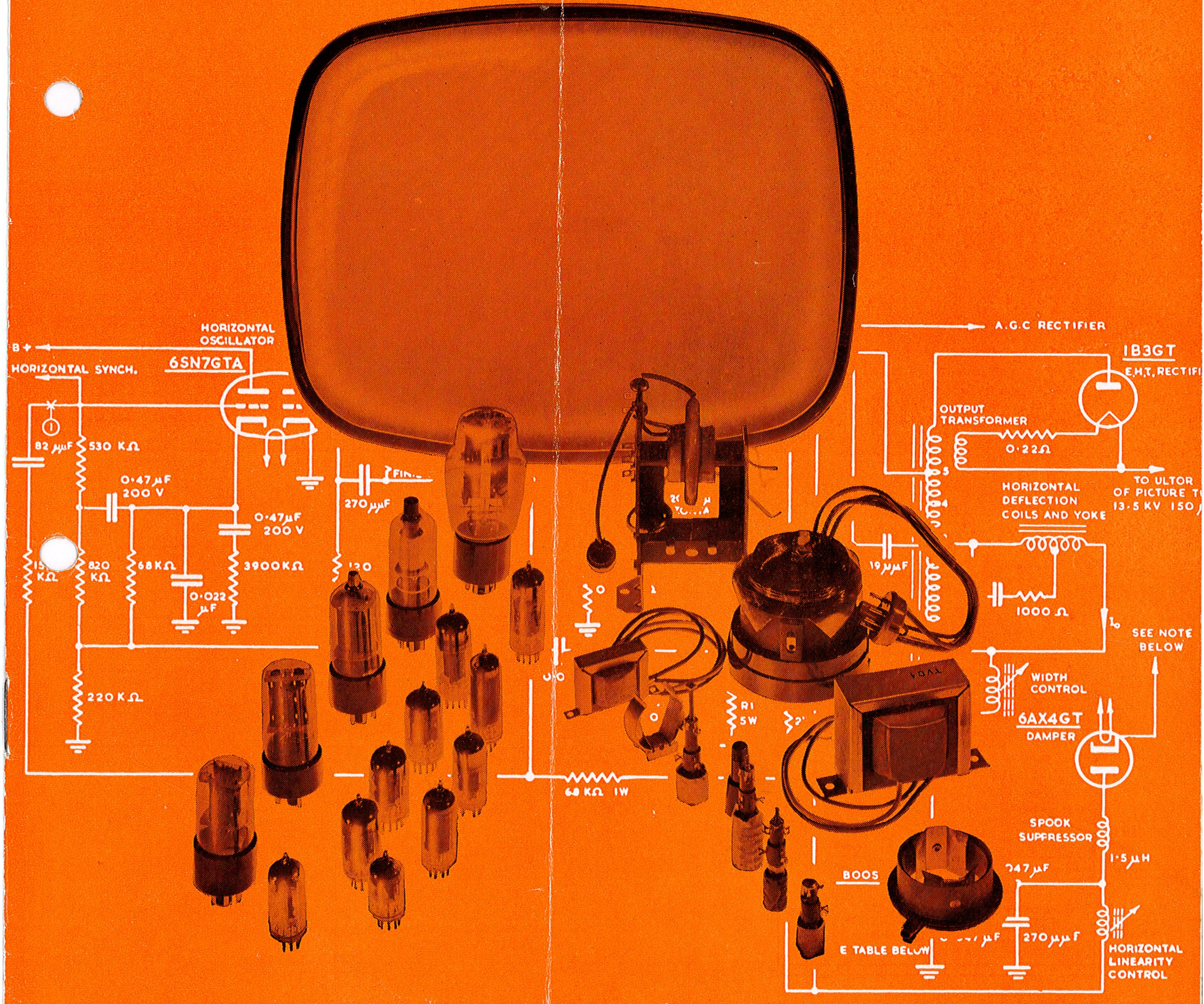

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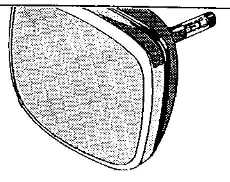

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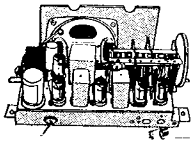

EDITOR .... **A. J. GABB,** B.Sc. (Syd.), A.M.I.R.E. (Aust.)

VALVE TYPES FOR AUDIO **107**

Not only does this article discuss why some valves are outstanding for audio amplifier service, but also includes a discussion of different types of interference due to valves in a-f circuits.

CONSTRUCTION OF INDUCTORS FOR TVI FILTERS **112**

This subject is one which will be of special interest to the hams around Sydney and Melbourne. At the same time the graphs for designing small inductors are of universal practical value.

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Our engineers review three new books:—

"Television Receiving Equipment"
"Television Explained"
"Electronic Components Handbook"

CATHODE RAY TUBES **116**

Descriptions, maximum ratings, operating conditions and basing arrangements are given for Radiotron C.R.O. tubes .

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VALVE TYPES FOR AUDIO USE

by M. B. Knight, Radio Corporation of America.

Of the many new valves available to circuit designers, some are better for audio applications than others. An expert explains the pertinent characteristics that make certain valves outstanding for high-fidelity equipment circuitry.

The flood of new valve types which has appeared in recent years has brought both blessings and headaches to designers of audio equipment. The blessings lie in variety and in the fact that some of the new types incorporate improvements making them superior to older types for audio service. The headaches lie in the number of valves which have similar characteristics, or which differ merely in heater ratings or basing, so that the choice of the most suitable type for a particular application is confusing.

The rapidity with which valve types continue to appear and disappear also poses a dilemma for the writer, because advice concerning a particular type may be worthless by the time it is published because the valve has already become obsolete.

The particular characteristics of a valve which most concern the designer of audio equipment depend on the relative position of the valve in the amplifier circuit. We shall begin with the characteristics most critical in low-level voltage-amplifier stages.

NOISE

The most important characteristic of low-level amplifier stages is noise. The useful sensitivity of an amplifier basically is limited by the "thermal" or "fluctuation" noise which appears at its input terminals. This noise (which is inescapable except at absolute zero temperature) is caused by the random motion of electrons in the conductors of the input circuit and signal source and appears across the input terminals of the amplifier as a noise voltage proportional to the square root of the total input-circuit resistance and directly proportional to the system bandwidth. (Noise **power**, however, is independent of resistance.) To this input-circuit noise must be added the fluctuation noise, microphonic noise, and hum generated in the valve, all of which can be expressed in terms of equivalent voltages at the grid.

If the signal source is a high-impedance device such as a crystal microphone or pickup, the valve fluctuation noise is usually small compared with the noise generated by the source. On the other hand, if the signal source is a low-impedance device such as a tape head or magnetic pickup, the valve fluctuation noise will predominate unless the impedance level of the source is raised by means of a transformer. Because the cost of low-level input transformers having adequate magnetic shielding precludes their use in all but the most expensive equipment, the various types of valve noise must be considered in selecting types for use in many low-level input stages.

One of the sources of valve fluctuation noise is the random manner in which electrons are emitted by a thermionic cathode. The resulting noise, called "shot noise", appears in the plate current, and the equivalent noise voltage at the grid is inversely proportional to the square root of the effective transconductance. (Effective transconductance is the actual value obtained in the circuit and, in the case

tially less than the value shown in the published data for the valve.) In order to minimize shot noise it is necessary that the effective g_m be as high as possible, which means that the plate current of the valve must be as high as practical. In the case of a resistance-coupled amplifier these conditions are most easily achieved by the use of a relatively low value of plate-load resistance, usually between 50,000 and 100,000 ohms. The plate current under these conditions is usually about 1 milliampere. In such cases the grid-voltage equivalent of the shot noise, assuming a 20 Kc/s. bandwidth, is on the order of 1 microvolt, while the theoretical r.m.s. noise voltage developed across a 100,000-ohm resistance in a circuit having a 20 Kc/s. bandwidth is 5.75 microvolts. Because there is not likely to be a difference of more than 2 to 1 in effective g_m between different valve types, choice of valve type from this standpoint is not particularly critical.

These shot-noise considerations apply only for space-charge limited emission, i.e., when the valve is operated at rated filament or heater voltage. Because the shot noise produced under temperature-limited emission conditions is much higher, it is not advisable to operate low-level amplifier valves at less than normal filament or heater voltage.

An additional type of fluctuation noise associated with cathode emission, called "flicker noise", is often observed. In contrast to shot noise, which is uniformly distributed throughout the frequency spectrum, flicker noise is greatest at low frequencies and may be much larger than shot noise below a few hundred cycles. The causes of flicker noise are not well understood, and wide variations are observed even among valves of the same type. The only safe choice from this standpoint is one of the special audio types, such as the 1620, 5879, 12AD7, or 12AY7, since these are specifically tested in order to eliminate valves having excessive flicker noise.

Pentodes have an additional fluctuation noise component called "partition noise", caused by the random division of the cathode current between the plate and screen grid. As a result, the equivalent fluctuation noise voltage at the grid of a pentode is usually 2 to 3 times higher than that developed when the valve is operated as a triode. In critical applications, therefore, a triode is the better choice, particularly if the grid-circuit impedance is low.

Valve fluctuation noise can also be caused by defects, such as leakage or gas. Because these defects may occur in any valve type they need not be considered in the choice of a specific type.

HUM

One of the common causes of valve hum is leakage in heater-cathode insulation. Although the resulting hum, called "heater-cathode" hum, has a low fundamental frequency (the power-line frequency) it can be troublesome even in "low-fi" amplifiers because of its high harmonic content.

The materials used for heater-cathode insulation have non-linear and often unpredictable resistance characteristics. For low heater-cathode leakage the heater temperature should be as low as possible and the heater insulation as thick as possible. Both of these considerations require that there be plenty of room inside the cathode, which means (1) a relatively large cathode, (2) relatively high heater power. Consequently, one should avoid types designed for high-frequency service in which the necessity for small inter-electrode capacitances leads to the use of small cathodes. However, large variations are found between different valves of the same type, and it is good practice, therefore, to use every circuit means practicable to minimize heater-cathode hum. In low-level stages, cathodes should be grounded directly or through low-impedance bypass capacitors; cathode followers and phase splitters should be used only in stages operating at fairly high signal levels. The heater circuit should be provided with a centre tap at a.c. ground potential or, even better, should be shunted by a potentiometer of about 100 ohms resistance having its slider at a.c. ground potential so as to obtain an adjustable ground. It is also quite effective to bias the heater 20 or 30 volts d.c. positive with respect to the cathode.

Another common source of valve hum is heater-to-grid capacitance. However, it is difficult to devise general rules for choosing a type from this standpoint, since differences between types otherwise suitable for low-level service are not large. Hum from this source can be most effectively minimized by good circuit design. The use of a heater supply circuit having a grounded centre tap or adjustable ground tap, as described, is especially effective in reducing this type of hum. It is also advisable that the impedance of the grid-circuit at the power-line frequency be as low as possible. This consideration requires the use of a large coupling capacitance between the grid and the preceding stage or signal source. In cases where a reduction in low-frequency response is desirable to avoid motorboating, the large coupling capacitance should be retained and the change effected by a reduction in the value of the grid resistor.

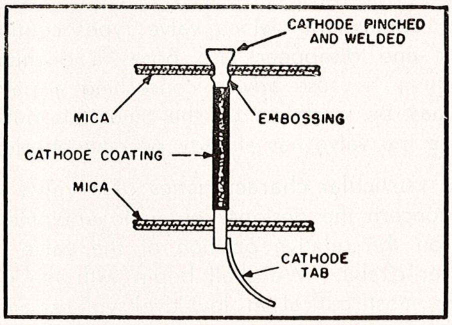


Fig. 1. Inverted-pinched-welded construction which insures a tight fit between a cathode and the supporting mica plates.

Valve hum may also be caused by the magnetic field of the heater or of an external device such as a transformer, choke, or motor.

Pentodes are more susceptible than triodes to magnetic hum. Even a relatively weak magnetic field may vary the division of current between plate and screen grid, and the resulting hum currents in the screen circuit will develop hum voltages which will be amplified. If external magnetic fields are a problem, screen grids should be bypassed with at least 0.5 microfarad of capacitance to minimize hum.

Operation of low-level amplifier valves at less-than-normal heater voltage is sometimes helpful for minimizing heater-cathode hum and magnetic hum, because it reduces both the temperature and the magnetic field of the heater. This expedient should be used with caution, however, because it usually causes a substantial increase in shot noise and may seriously impair valve life. Another method sometimes recommended is the use of d.c. heater supplies. However, with a proper choice of valves and careful circuit design, the hum level of a wide-band audio amplifier using a.c. heater supply should not be more than about 2 db greater than that obtainable with d.c. operation.

Occasionally a baffling hum problem turns out to be caused by the valve microphonics in conjunction with the vibration of a power transformer or choke. The choice of the valve types from this standpoint is considered in the next section.

MICROPHONIC NOISE

A valve will deliver electrical output if its interelectrode spacings are altered by shock or vibration. If mechanical resonances at audio frequencies exist in the valve, excitation from the loudspeaker may readily result in feedback or **sustained microphonics.** This problem is most serious in filament types, since a filament bears a dismaying resemblance to a guitar string. To minimize this type of microphonism, modern filament types employ "damper bars" which bear against the centre of the filament, raising its resonant frequency and reducing the amplitude of vibration in the same manner as a finger on a guitar string. Even so, as resulting mechanical resonance is usually well inside the audio range, it is usually necessary to limit high-frequency response in equipment using filament-type valves.

The most common microphonic difficulty with heater-cathode types is response to mechanical shock or **ballistic microphonics.** The sensitivity of a particular valve type to ballistic microphonics is largely determined by the interelectrode spacings employed and by the tightness of the electrodes in the mica, and is thus related to basic valve design as well as to economic factors related to the difficulty of assembly. Valves having smaller electrode spacings are more critical for microphonics. The principal variable determining the tightness of fit attainable is the mechanical strength of the cathode; it is easier to obtain tight fit with a round cathode of relatively large diameter than with a small flat cathode. The relatively large-diameter round cathodes also make it possible to obtain tight fit by the use of the "inverted-pinched-welded" construction shown in Fig I. These considerations indicate that types designed for high-frequency use should be avoided. Fortunately, most of the basic design factors which result in low hum are consistent with the requirements for low microphonics.

Economic considerations affect microphonics simply because it costs less to construct valves with loose-fitting elements. Thus the desires of both the valve manufacturer and the valve user are fulfilled if the internal fit of a valve is only as tight as it needs to be for its principal applications. The special audio types represent the extreme in this respect, because production speed is sacrificed in order to assure tight-fitting electrodes. In choosing from standard types, the user should seek those normally used in applications critical as to microphonics. Good examples of such types are the valves of the 6SN7GT family and the 6CG7, which are used extensively in the highly critical horizontal oscillator circuits of television receivers.

A few types which are not carefully controlled for microphonics in manufacture, have, nevertheless, been found to be quite good in this respect because of particular construction features. One example is the 6SC7. However, the construction features which make the 6SC7 good for microphonics also give it a tendency to develop leakage noise with life. Measurements made by the author a few years ago showed the 6BF6 to be quite good for microphonics, but a hum-balance adjustment was necessary to obtain an acceptably low hum level.

The whole amplifier design may be related to the choice of valve type for the lowest-level stages. Although the special audio types give the best performance for minimum noise, hum, and microphonics, the more common types are often used for economy. In such cases it is highly recommended that the amplifier design be arranged to use the same type in higher level stages. This practice permits the selection of the best of several valves for the first stage, while using the remainder in less-critical sockets. There is no economy in discarding several low-cost valves to get one good one.

DISTORTION

The distortion produced by valves is the result of the inherent nonlinearity of all grid voltage-plate current characteristics. At moderate signal levels, valve distortion is principally second harmonic and is approximately proportional to grid signal amplitude. At these levels valves having relatively low g_m and requiring relatively high heater power are usually preferable, because designs for high g_m with small start here

the 6CG7, which requires higher heater power than the 12AU7, is better than the latter at low signal levels, although both types have approximately the cathode area, such as employed for high-frequency types, lead to excessive nonlinearity. For example, same plate current, g_m, and μ. Sharp-cut-off pentodes, such as the 6SJ7 or 6AU6, are also better than variable-μ types at low signal levels.

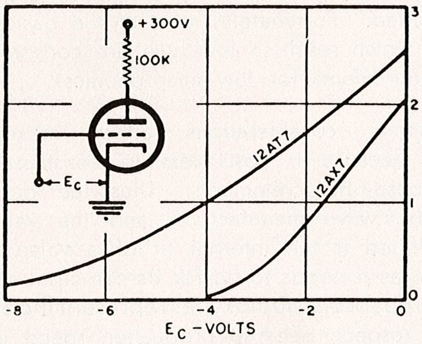


Fig. 2. Grid voltage vs. plate current characteristics of the 12AT7 and 12AX7

As signal amplitude is increased, a point is reached where valve distortion increases rapidly and contains substantial amounts of higher-order harmonics, the transition being caused by the signal swing reaching the cut-off or the grid-current regions. For this reason, the "maximum voltage output" values shown in the "Resistance-Coupled Amplifier Chart"[1] are usually determined by the points at which these higher-order harmonics appear. The fact that a particular valve type has higher maximum voltage output than another, however, is not necessarily an indication that it produces less distortion at moderate signal levels. For example, the 12AT7 has appreciably higher maximum voltage output than the 12AX7, but produces more distortion at moderate signal levels. Fig. 2 shows output versus input characteristics of the two types; the greater curvature of the 12AT7 characteristics throughout the operating range is apparent. The valve-design factors responsible for this difference are shown in Fig. 3. The cross-section views, which are drawn to scale, indicate the closer spacing used in the 12AT7 in order to obtain good performance in v.h.f. mixer service.

Pentodes usually are capable of higher maximum voltage output than triodes of equivalent rating, but also generate slightly higher distortion at moderate signal levels. As a general rule, medium-μ triodes are capable of more voltage output than high-μ triodes. The correct choice of operating conditions is very important in obtaining maximum voltage output, and is simplified by the "Resistance-Coupled Amplifier Charts" which are published by most valve manufacturers[1]. These charts are usually optimized for voltage output.

POWER AMPLIFIERS

Triodes: The science of designing power-amplifier triodes has been known for many years, and the older types, such as the 2A3, are still pretty good. Although several new triodes embodying improved construction techniques and having higher power sensitivity and power output than earlier types have appeared in recent years, most of these types have been designed for use as vertical-deflection amplifiers or voltage regulators. They are relatively poor audio amplifiers because the design factors which provide high output and high g_m usually result in highly nonlinear characteristics. In fact, the characteristics of practical vertical scanning circuits make it necessary to use nonlinear valves in order to obtain linear deflection.

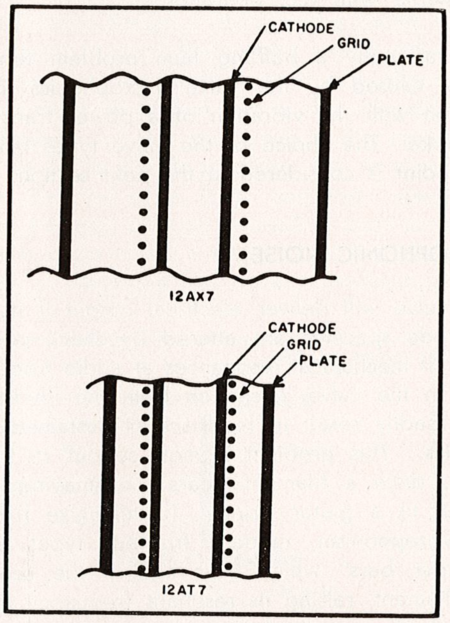


Fig. 3. Cross section showing, to scale, the differences in electrode geometries of the 12AT7 and 12AX7 valves. Refer to text.

Most of the newer power triodes can be used successfully in audio service, however, by operating them in push-pull so as to obtain cancellation of the even-harmonic distortion. For example, the 6AS7G, which was designed for television damper service, has highly nonlinear characteristics but is capable of excellent performance as a push-pull audio power amplifier.

Triode-connected pentodes and beam-power valves are generally not as linear as the best triodes, but are no worse in this respect than the vertical-deflection types and, consequently, can also be used successfully in push-pull circuits. Factors discussed in the next section which should be considered in the choice of a pentode or beam-power valve should also be considered when these valves are connected as triodes.

From the standpoint of maximum power output the choice of a triode will depend principally on the plate-supply voltage available. When the plate-supply voltage is low, the characteristic desired is low plate resistance, which usually means low μ. Maximum power output is usually reached while dissipation is still below ratings. When plate-supply voltage is high, the valve characteristics have less effect on maximum power output and valve dissipation ratings are usually the limiting factors. Power sensitivity is usually better with higher-μ valves. If both high power sensitivity and high power output are essential, the valve must have high g_m, which, in turn, means that it must have a large-area cathode and high heater power.

Power Pentodes and Beam-Power Valves: Quite a few new pentode and beam-power valve designs have been brought out specifically for audio applications and should be useful to builders of audio equipment. It is generally advisable to ignore the multitude of types developed for television deflection circuits. These valves are designed primarily to provide high peak currents at low plate voltage, and they develop considerable distortion when used in audio circuits. Another disadvantage of these types is the low screen voltages at which they are designed to operate. These voltages must generally be obtained from the plate supply through large series resistances or voltage-dividers making it difficult to obtain good screen-supply regulation.

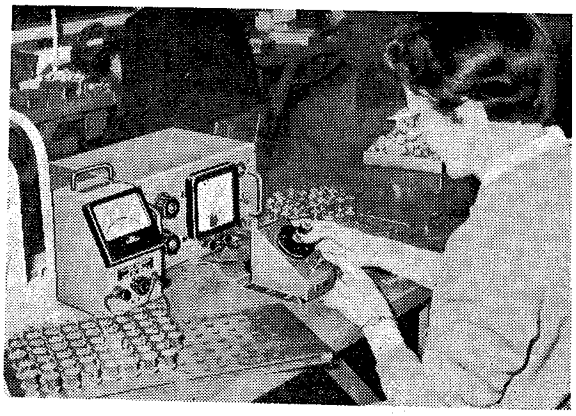
Most beam-power valves designed for audio use have comparable knee voltages and differ principally in power-output capabilities in accordance with their ratings. It is convenient to select a type which can be operated with screen-grid voltage approximately equal to the available plate-supply voltage. If the plate-supply voltage is relatively low, a suitable valve usually has low triode μ. The 6W6GT is one example. Power sensitivity is primarily a function of g_m. Some of the new types, such as the 6BK5, have exceptionally high power sensitivity, which is desirable for some receiver applications, but also produce relatively high distortion. The best all-around choice is usually a beam-power valve designed for audio use, such as the 6L6, 5881, 6V6GT, 6AQ5, and 6CM6.

REFERENCE

(1) "RCA Receiving Tube Manual," RC-18.

SEE PHILIPS EL33, EL34, EL84

MOUNTS TESTED BEFORE SEALING



One of the many steps taken to improve the quality of Radiotrons is the shorts testing of unsealed valves.

This operation is carried out on an extremely sensitive capacity bridge which checks all phases of the assembly operation. The bridge is an ingenious locked oscillator which reads unbalance on a meter. The operator plugs the assembly into a socket and the meter automatically reads assembly quality. The mounts are ejected from the socket and are ready for further operations. This device minimizes the possibilities of any human error.

Construction of Inductors for TVI Filters

By M. Seybold

Many of the published articles on the construction of low-pass filters include complete instructions for winding the inductors required for the filter sections. If the author's work is duplicated, and if the directions for winding the coils are followed implicitly, no difficulty will be encountered in building and adjusting the filter. However, the average amateur may experience considerable difficulty if he chooses to modify the original design to suit his particular needs; he may be handicapped by lack of references on the construction of coils which will fulfil the given requirements of inductance and Q.

This article supplies easy-to-follow instructions for winding inductors to given inductance specifications, and describes methods for checking inductance with an accuracy adequate to meet the requirements for practical TVI filters.

CONSTRUCTION.

A single-turn flat loop, as shown in Fig. 1, is satisfactory for an inductance of 0.03 to 0.1 µH. For inductances greater than 0.1 µH, the inductor may be wound as a conventional coil having several turns, as shown in Fig. 2, in order to conserve space and to maintain a reasonable Q.

EXAMPLE 1.

The dimensions of a 0.05-µH inductor can be found from Fig. 1. The dashed lines indicate how the wire length (2.7 inches) can be read from the curve opposite the inductance of 0.05 µH. This length of No. 12 wire, when formed into a single-turn flat loop having a ¾-inch gap between the ends of the wire as shown in Fig. 1, will have an inductance of 0.05 µH.

Reprinted from "Ham Tips" with acknowledgments to R.C.A.

EXAMPLE 2.

If a 0.25-µH inductor is required, the number of turns can be determined from Fig. 2 as shown by the dashed lines. If 3-4 turns of No. 12 wire are wound with a pitch of eight turns per inch and the diameter of the coil is ¾-inch (measured from the centre of the wire as shown in Fig. 2), the coil will have an inductance of approximately 0.25 µH (including the inductance of the one-inch leads).

Coils wound in accordance with Figures 1 and 2 are sufficiently accurate for most TVI applications; they may be soldered into a low-pass filter without further adjustment.

If desired, the coil may be wound to other dimensions. The nomograph shown in Fig 4 facilitates the selection of suitable values of inductance and capacitance for a circuit resonant at a given frequency. For example, the inductance necessary for resonance at 67.25 Mc/s with a 20-µµF capacitor can be determined by placing a straight-edge on

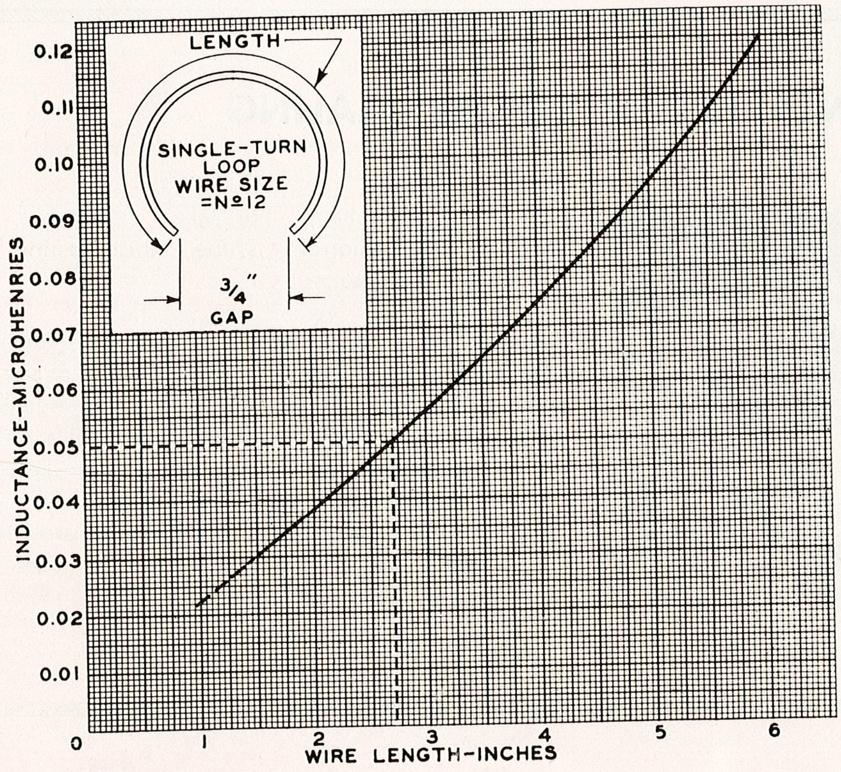


Fig. 1. Curve for determining the dimensions of a single-turn, flat loop (for inductance values of 0.03 to 0.1 µH).

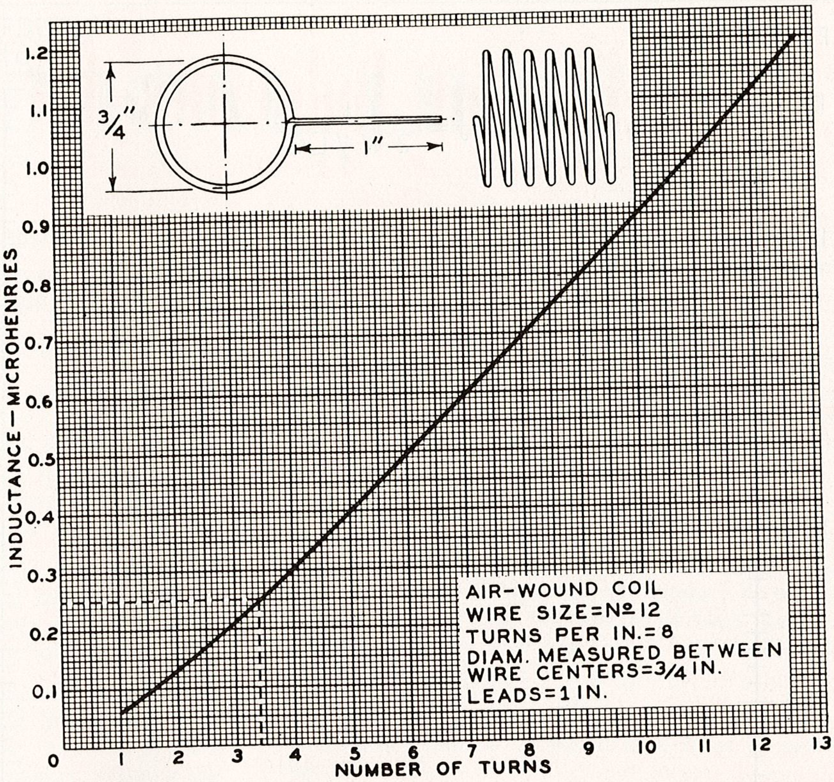


Fig. 2. Curve for determining the number of turns for inductance values greater than 0.1 μH.

the nomograph so that it connects the 67.25-Mc/s point on the frequency scale and the 20-μμF point on the capacitance scale. The intersection of the straight-edge with the inductance scale determines the required inductance value. The inductance, capacitance, and frequency ranges covered in this nomograph are applicable to most low-pass, TVI filter designs.

MEASUREMENTS.

The inductance of the coil may be measured with a Q-meter, or it may be checked in a resonant circuit with a grid-dip meter as shown in Fig. 3.

To facilitate measurement of inductance in a resonant circuit with a grid-dip meter, a calibrated variable capacitor should be included in the resonant circuit. Since such a capacitor cannot be found in the average ham shack, a reasonably accurate capacitance standard can be made from a set of six silver-mica capacitors — one each of 5, 10, 20, 40, 70 and 100 μμF (five per cent. tolerance). Combinations of these six capacitors will provide a capacitance range of 5 to 150 μμF in 5 μμF steps. Errors can be kept to a minimum by clipping the capacitor leads short and by soldering short connections to the coil being tested. Lumping of capacitance-tolerance error can be minimized by using a single capacitor whenever feasible rather than a combination of capacitors; the use of a single capacitor is practical when the frequency of the signal source can be varied.

The XYL's TV receiver can be used to calibrate the grid-dip oscillator. One or two wide, black, vertical bars will be visible on the picture tube when the grid-dip oscillator frequency is approximately the same as the picture-carrier frequency. When the oscillator frequency approaches the sound-carrier frequency, a T-6 c.w. signal will emanate from the speaker. The distance between the TV antenna transmission line and the grid-dip meter may be five feet or more during this calibration.

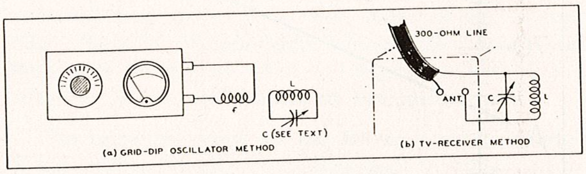


Fig 3. Two methods of checking inductance by the resonant-circuit method. Capacitor C is a silver-mica type of known capacitance, and L is the unknown inductance.

The TV receiver can also be used, alone, as a resonance indicator when a grid-dip meter is not available. When this method is employed, the parallel resonant circuit containing a known capacitance and an unknown inductance is connected between one side of the 300-ohm transmission line and the TV receiver antenna terminal as shown in Fig. 3b. When the inductor and the capacitor are resonant at a picture-carrier frequency, the picture brightness is reduced. When the inductor and capacitor are resonant at a sound-carrier frequency, the volume is reduced.

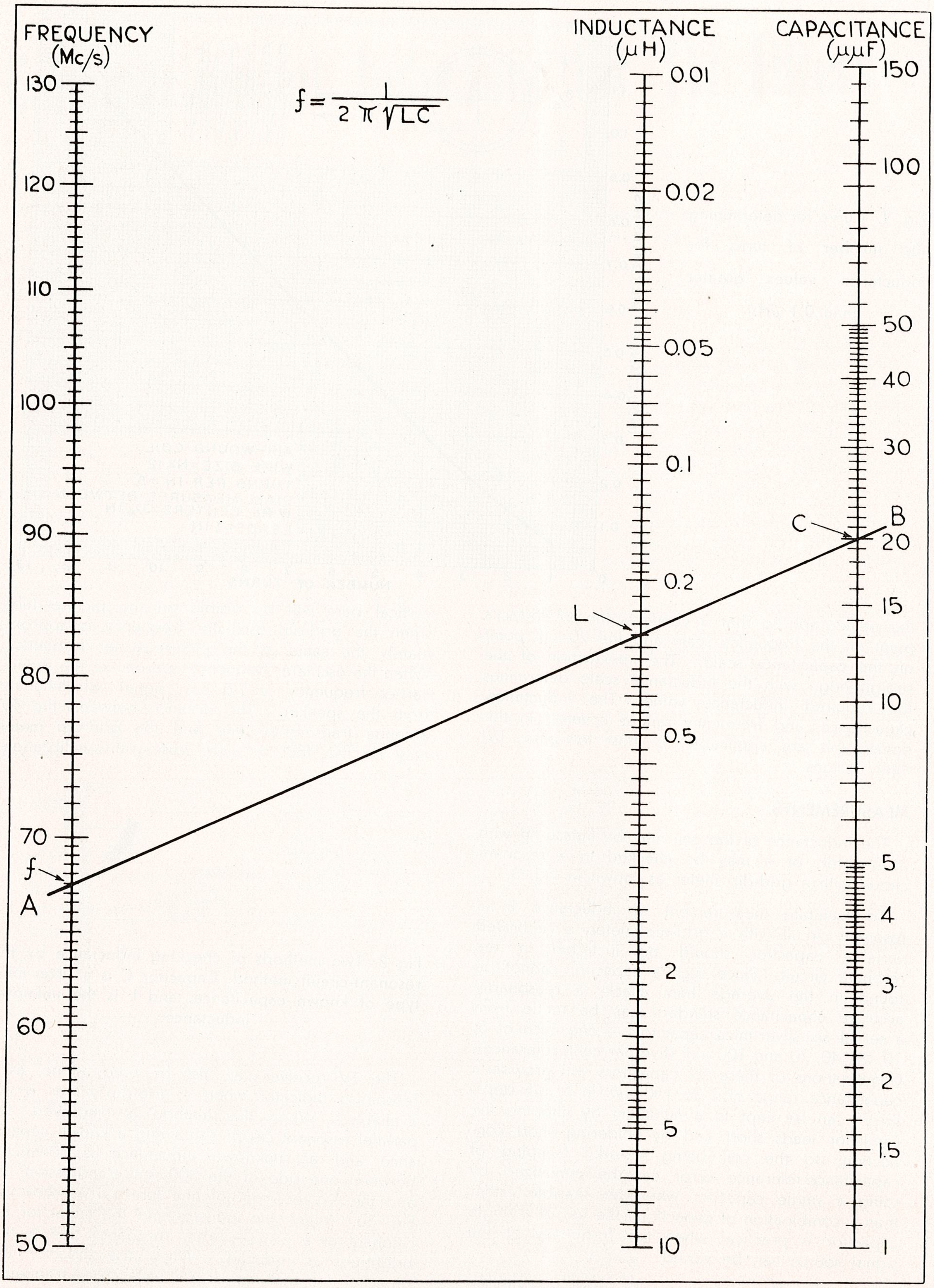


Fig. 4. Nomograph for determining any one of the three parameters, inductance, capacitance or resonant frequency of a parallel resonant circuit when the other two are known. For a given frequency, f, and the desired inductance, L, the value of capacitance for the parallel circuit shown in Fig. 3 is determined by the intersection, C, of line AB and the capacitance scale.

TECHNICAL LIBRARY

TELEVISION EXPLAINED

By W. E. MILLER, M.A. (Cantab.), M.Brit.I.R.E. revised by E. A. W. SPREADBURY, M.Brit.I.R.E.

(Associate Editor of "Wireless & Electrical Trader")

This 6th Edition is a completely revised edition of the popular text originally written by W. E. Miller and first published in 1947. It has been written for those who are about to embark on television service work and who wish to understand the complete operation of the television receiver.

The book is written in quite an interesting manner and has been made exceptionally easy to read for beginners by an entirely descriptive approach which completely neglects any mathematical aspects.

Unfortunately for the Australian reader the authors have only considered the British 405 lines system, failing to mention either the 525 or 625 line system. Thus, as far as Australian readers are concerned, the book partially defeats its own purpose, for a fair amount of knowledge is needed to convert for the 405 to the 625 line system. This is particularly so in the chapters dealing on "Synchronisation", "Video and Sound Circuits" and "The Vision I.F. Amplifier". The chapters on "Aerials" and "Automatic Gain Control" are just what the beginner wanted and would also be quite useful to qualified engineers. A series of photographs showing picture faults and these corrections and an appendix on the B.B.C. Test Card "C", with explanations and benefits obtainable also enhance the books usefulness.

If one could overlook the shortcomings in only dealing with the British System then this book could well be the ideal for the beginners, for it is a book which a beginner can read and find extremely useful.

D. A. Latter

ELECTRONIC COMPONENTS HANDBOOK

Published by McGraw-Hill Book Coy. Inc., New York, produced by the Electronic Components Laboratory of the Wright Air Development Centre and edited by Keith Henney and Craig Walsh.

This book deals in a most comprehensive manner with four essential electronic components, viz.: Resistors, Capacitors, Switches and Relays.

The first Chapter examines reliability and its assessment with special application to military equipment and the responsibility of engineers in selection and use of components, and the second amplifies this subject and discusses the use of specifications.

Each of the other four chapters deals with one of the above components, covering all types for which a MIL specification has been written. These MIL specifications in use by the services in U.S.A. are generally similar to the RCS 1000 series in current use in Australia. (These will be replaced by DEF specifications.)

A general description of the components and their application is given, assessing the faults and virtues, and drawing conclusions as to when and where to use, or not to use, specific types. A comprehensive treatment of the effects of heat, humidity, altitude, pressure, vibration, shock, etc., is illustrated with numerous graphs and diagrams.

A very useful reference book for the engineer, as all relevant data is arranged in a form convenient for reference.

A. F. Bell

TELEVISION RECEIVING EQUIPMENT

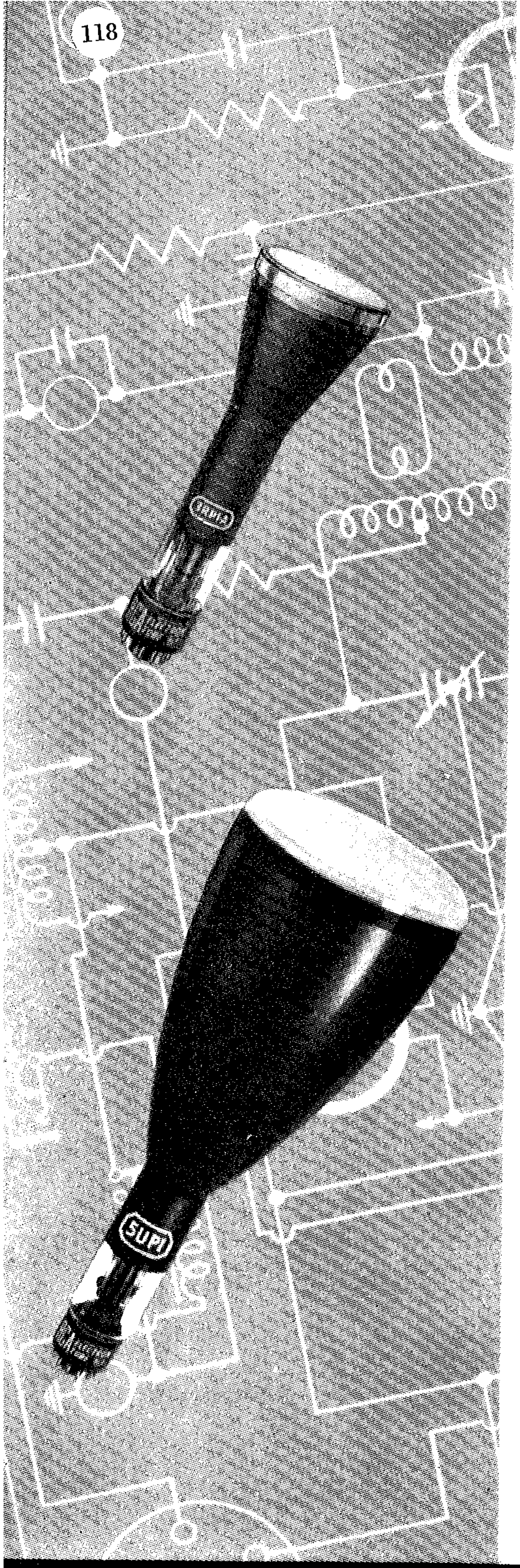
by W. T. Cocking, M.I.E.E.

In his book "Television Receiving Equipment", Cocking achieves a "high standard of simplicity". He describes and explains in an efficient, but relatively non-technical manner, many of the "everyday" features of television which often elude the television technician who is forced to confine his attention to certain aspects of the system only.

This book is based on the British system of television and although it is extended to cover other systems, including the 625-line one adopted in Australia, intercarrier receivers are not covered and there is no information about frequency modulated sound amplification and detection.

The main text is almost free of mathematical treatment but an appendix section explains several relationships and provides some very good design data. All sections of the television receiver are covered, their requirements and difficulties discussed and methods of solution outlined. A chapter on aerials and feeders is included which presents in a quite informal manner the most important requirements of the aerial and explains the various elements which comprise the more common types, and some of the problems associated with the feeder and the need for proper matching.

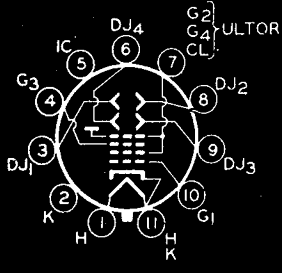
R. A. Darnell



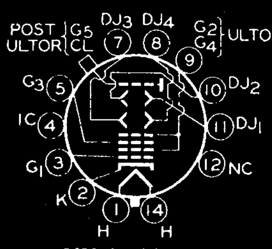
Type	Description△
OSCILLOGRAPH TYPES—Cont'd	
5BP1-A	For renewal use. For new equipment design, use the 5UP1.
5CP1-A **5CP7-A** **5CP11-A** **5CP12**	5″ types featuring post-deflection acceleration for high brightness. The 5CP1-A is for general oscillographic use; the 5CP7-A is for long-persistence images and for pulse-modulated applications such as radar indicator service; the 5CP11-A is for photographic use; the 5CP12 has similar application as 5CP7-A except for having medium-long persistence. Recessed small ball cap. Medium-shell diheptal 12-pin base.
5FP7-A **5FP14**	5″ magnetic-focus-and-deflection types. The 5FP7-A is for low-frequency pulse-modulated applications; the 5FP14 is for high-frequency pulse-modulated applications. Recessed small ball cap. Long medium-shell octal 8-pin base.
5UP1	5″ type having high deflection sensitivity and resolution. For general oscillographic applications. Small-shell duodecal 10-pin base.
5UP7 **5UP11**	5″ types same as 5UP1 except: the 5UP7 is for long-persistence images; the 5UP11 is for photographic applications.
7BP7-A	For renewal use. For new equipment design, use the 7MP7.
7CP1	7″ electrostatic-focus-and-magnetic deflection type. For general oscillographic use. Recessed small ball cap. Long medium-shell octal 8-pin base.
7MP7 **7MP14**	7″ magnetic-focus-and-deflection types. The 7MP7 and 7MP14 are for low- and high-frequency pulse-modulated service, respectively. Recessed small cavity cap. Small-shell duodecal 5-pin base.
7VP1	7″ type having short overall length and good deflection sensitivity. For general oscillographic applications. Medium-shell diheptal 12-pin base.
10KP7	10″ magnetic-focus-and-deflection type for use in pulse-modulated applications such as radar indicator service. Filterglass faceplate. Recessed small cavity cap. Small-shell duodecal 5-pin base.
12DP7-A **12DP7-B**	12″ magnetic-focus-and-deflection types for pulse-modulated applications. 12DP7-B same as 12DP7-A except has Filterglass faceplate. Medium cap. Long medium-shell octal 8-pin base.
16ADP7	16″ metal-shell type having magnetic focus and deflection. For use in pulse-modulated applications such as radar indicator service. Features high resolution at high beam currents and a Filterglass faceplate. Small-shell duodecal 7-pin base.
902-A	For renewal use. For new equipment design, use the 2BP1.
908-A	3″ type with P5 phosphor. For photographic applications involving film moving at high speeds. Medium-shell medium 7-pin base.#

△ Unless otherwise specified, all of these types have electrostatic focus and deflection and a heater rating of 6.3 volts and 0.6 amp.

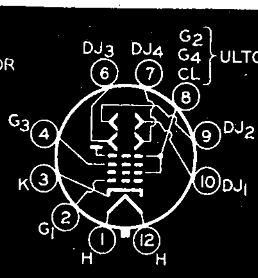
Heater rating: 2.5 volts, 2.1 amp.



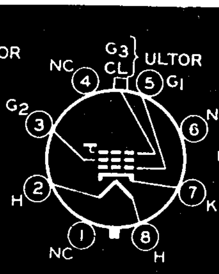
5BP1-A



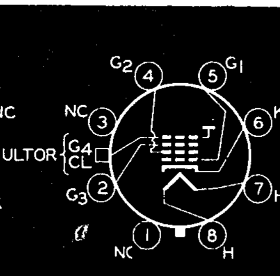
5CP1-A 5CP7-A
5CP11-A 5CP12



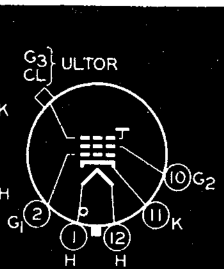
5UP1
5UP7 5UP11



5FP7-A 5FP14
7BP7-A



7CP1



7MP7 7MP14
10KP7

Maximum Dimensions		Min. Useful Screen Diam. Inches	Maximum Ratings♦♦					Operating Conditions						Type
Overall Length inches	Envelope Diam. inches		Final High-Voltage Electrode		Grid-No. 3 Volts	Grid-No. 2 Volts	Grid-No. 1 Bias Volts†	Final High-Voltage Electrode Volts♦	Grid-No. 3 Voltage for Focus approx.	Grid-No. 2 Volts	Maximum Grid-No. 1 Volts for Visual Cutoff¢	Deflection Factors volts dc/in.		
			Post-Ultor● Volts	Ultor■ Volts								DJ1 & DJ2♉	DJ3 & DJ4	
OSCILLOGRAPH TYPES—Cont'd														
17 1/8	5 5/16	4 1/2	—	2000	1000	2000	−125	2000 1500	340 to 560 255 to 420	2000 1500	−60 −45	70 to 96 53 to 72	64 to 88 48 to 66	**5BP1-A**
17 1/8	5 11/32	4 1/2	4000	2000	1000	2000	−200	4000 3000 2000π	375 to 690 280 to 515 375 to 690	2000* 1500* 2000*	−90 −67.5 −90	78 to 106 59 to 80 62 to 84	66 to 90 50 to 68 54 to 74	**5CP1-A** **5CP7-A** **5CP11-A** **5CP12**
11 1/2	5 1/32	4 1/4	—	8000	—	700	−180	7000 4000ø	— —	250 250	−70 −70	Deflection Angle, 53° approx.		**5FP7-A** **5FP14**
15 1/8	5 11/32	4 1/2	—	2500	1000	2500	−200	2000 1000	340 to 640 170 to 320	2000 1000	−90 −45	56 to 77 28 to 39	46 to 62 23 to 31	**5UP1**
15 1/8	5 11/32	4 1/2	—	2500	1000	2500	−200	2000 1500ø	340 to 640 255 to 480	2000 1500	−90 −67.5	56 to 77 42 to 58	46 to 62 35 to 47	**5UP7** **5UP11**
13 5/8	7 1/8	6	—	8000	—	700	−180	7000 4000ø	— —	250 250	−70 −70	Deflection Angle, 53° approx.		**7BP7-A**
13 13/16	7 1/8	6 1/2	—	8000	2400	300	−125	7000 4000	955 to 1705 545 to 975	250 250	−67.5 −67.5	Deflection Angle, 57° approx.		**7CP1**
13 1/8	7 5/16	6	—	8000	—	+700 −180	−180	7000 4000ø	— —	250 250	−63 −63	Deflection Angle, 50° approx.		**7MP7** **7MP14**
14 7/8	7 1/8	6	—	4000	2000	4000	−200	3000 1500	800 to 1200 400 to 600	3000 1500	−84 −42	93 to 123 47 to 62	75 to 102 38 to 51	**7VP1**
18	10 5/8	9	—	10000	—	+700 −180	−180	9000 7000	— —	250 250	−63 −63	Deflection Angle, 50° approx.		**10KP7**
20 1/8	12 3/16	10	—	10000	—	+700 −180	−180	7000 4000ø	— —	250 250	−70 −70	Deflection Angle, 50° approx.		**12DP7-A** **12DP7-B**
22	16	14 3/8	—	14000	—	+410 −180	−180	12000	—	250	−63	Deflection Angle, 53° approx.		**16ADP7**
7 5/8	2 1/16	1 3/4	—	600	300	600	−125	600 400	85 to 180 57 to 120	600 400	−90 −60	110 to 166 73 to 111	96 to 141 64 to 94	**902-A**
11 7/8	3 1/16	2 1/2	—	1500	1000	1500	−125	1500	300 to 515	1500	−75	91 to 137	87 to 131	**908-A**

● The "post-ultor" is the electrode to which is applied a dc voltage higher than the ultor voltage for accelerating the electrons in the beam after its deflection.

■ The "ultor" is the electrode to which is applied the highest dc voltage for accelerating the electrons in the beam prior to its deflection.

♦♦ Design-center values.

♦ Post-ultor voltage for types having a post-ultor electrode; otherwise, ultor volts.

¢ For visual cutoff of undeflected focused spot except as noted.

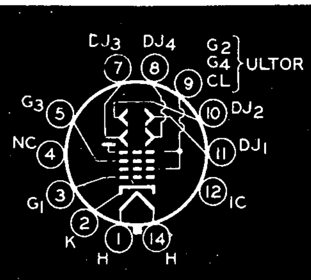
† Positive bias value = 0 volts, positive peak value = 2 volts.

* And grid-No. 4 volts.

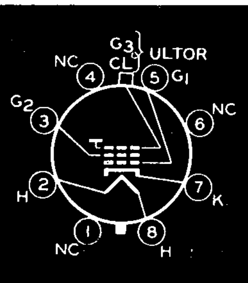
π It is recommended that the post-ultor voltage be not less than 3000 volts for high-speed scanning.

♉ DJ1 and DJ2 are deflecting electrodes nearer screen.

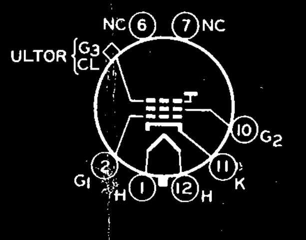
ø Recommended minimum voltage.



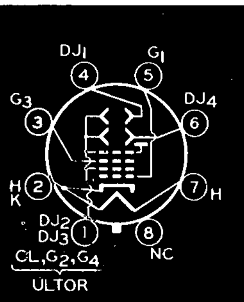
7VP1



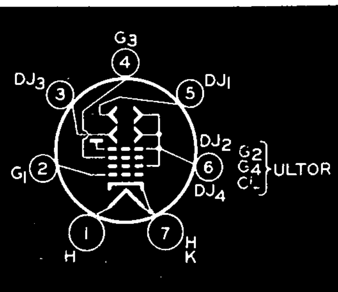
12DP7-A 12DP7-B



16ADP7



902-A



908-A


AWV