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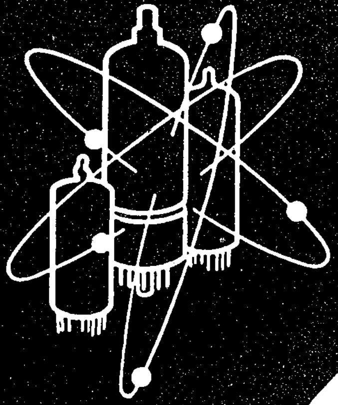

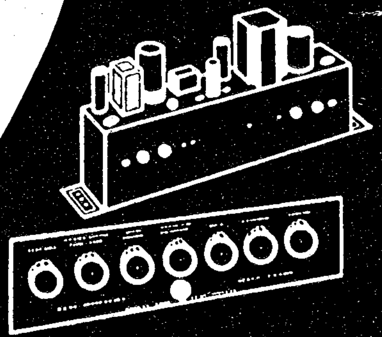

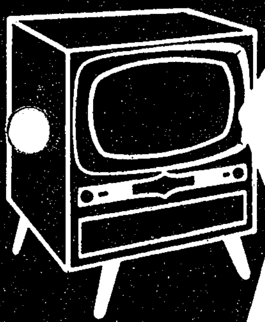

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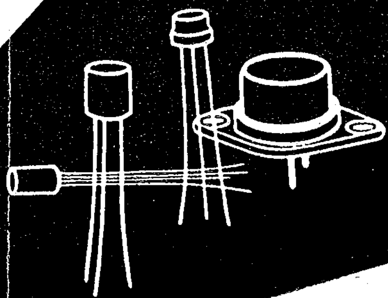

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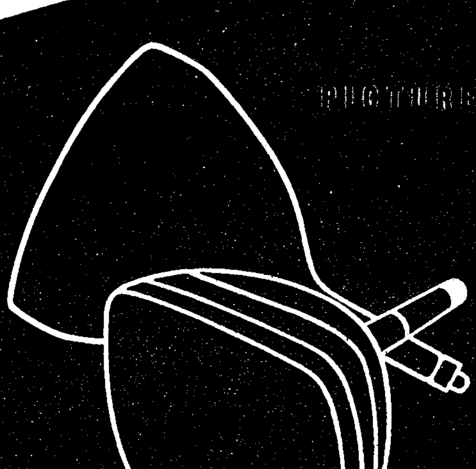

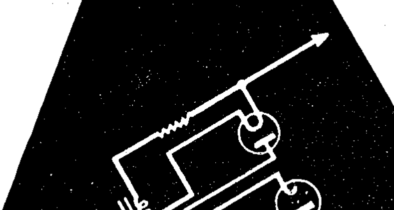

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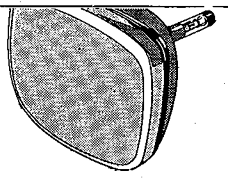

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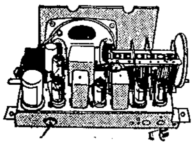

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THE POWER VALVE SECTION

A REVIEW OF ACTIVITIES

by
D. MILLER, A.S.T.C.
(Engineer in Charge, Power Valve Section, AWV)

Early Development

The Power Valve Section was established just before the start of the Second World War. The need arose at that time for a local source of large and medium-size transmitting valves, and also for smaller types in quantities not large enough to warrant quantity production by the Receiving Valve Section. As an initial measure, overseas investigations into power valve manufacture were made by the Company. Manufacturing methods were modelled on the RCA pattern, and small-scale production was achieved in a gratifyingly short time after the development of the new techniques and training of staff. The first of the new types produced were pure tungsten filament types such as the DER and DE7 series. These were followed by the 802 pentode, which has an oxide cathode, and the thoriated tungsten filament triode 809. It is interesting to note that both these types are still available, though no longer manufactured locally.

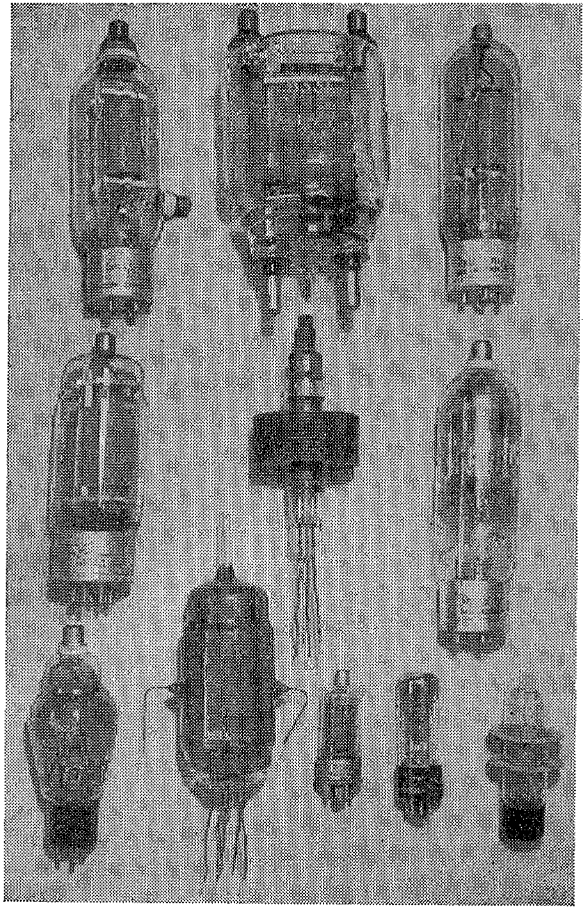


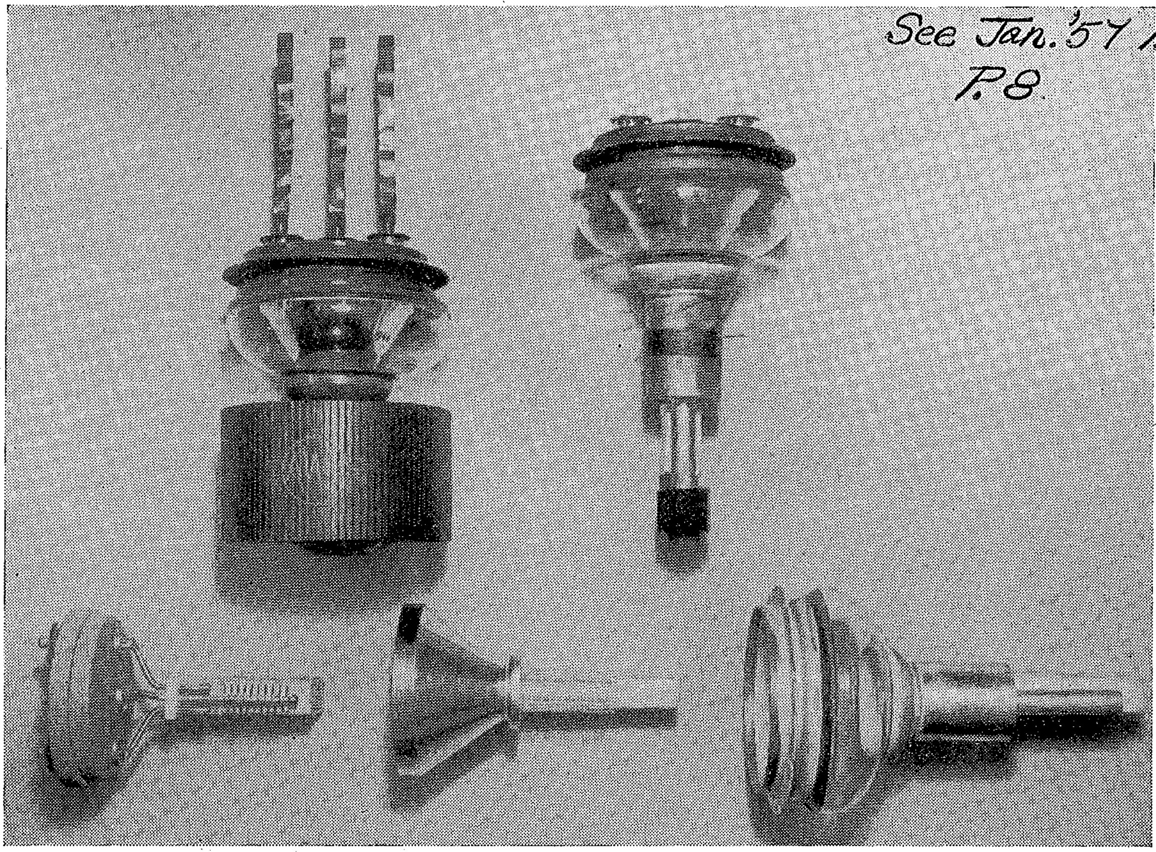
Fig. 1. Some AWV Radiotron Power Valves

Medium-size transmitting valves were brought into production as the section expanded, including the 805 and 810 triodes and the 804 pentode, which are still preferred types. Other early types were the 813 beam power amplifier and the 833A transmitting triode, both of which are still in current production. The later installation of a glass working lathe made it possible to undertake production of the larger types of transmitting valves. Furthermore, repairs could now be effected to water-cooled valves such as the CAT6 and CAT9, and to certain valves with silica envelopes. This extension naturally required additions to existing test equipment and other fixtures.

The exigencies of war demanded great reorganisation in industry, and the Power Valve Section was no exception. The demand for some types of power valves increased to such an extent that it became necessary to adopt quantity production methods to their manufacture. Sealex machines, which are normally used to seal and exhaust receiving type valves, were converted to produce for the Armed Services the VT25 triode, now obsolete, the 807 and the 813 beam power valves, and the 866A mercury rectifier. This vastly increased production was a considerable achievement, taking place as it did at a time when a large expansion was required in all sections.

The Picture Today

The function of the Power Valve Section, as its name implies, is mainly the production of valves for communication, broadcast and TV transmitters, FM communications, and industrial applications generally. The larger and more spectacular valves engage the imagination, but they are not, of course, the complete story. The largest triode transmitting valve made to date is the 892R, which has been mainly supplied to the PMG Department. This is a forced-air cooled valve designed for use as an RF amplifier and oscillator, and as a class B modulator; it has a useful RF output of 15kW. A more recent addition, which has been made in comparatively large quantities, is the 5762 forced-air cooled power triode. This valve is designed for grounded-grid operation, and is extensively used in modern broadcasting transmitters. The manufacture of this valve has been described in a previous article.[1]



See Jan. '57 issue, P.8.

Fig. 2. Stages in the Manufacture of the 5762.

It is natural that the larger types of valves mentioned generally form a small percentage of the total power valve production. The largest percentage is made up of small and medium-size power valves. In these categories, the valves produced in greatest quantities are thoriated tungsten filament types such as the 805, 810 and 833A power triodes, and the 813 beam power valve.

Two other types which are in quantity production are the 2E26 beam power valve and the 5786 forced-air cooled power triode. The well-known 2E26 is extensively used in the driver or output stage of modern FM communication equipment and in similar applications. It features a button-stem construction on an octal base, and incorporates a shielding screen around the base. The 2E26 can be operated at full input up to 125 Mc/s, and with reduced input up to 175 Mc/s. The 5786 power triode is used in the DME navigational beam equipment now installed throughout Australia by the Department of Civil Aviation. This valve is constructed with the filament, grid and anode coaxial. The anode is a cylinder with external cooling fins, and forms part of the valve envelope. The 5786 is rated for 825W output at 175 Mc/s.

In addition to normal production, the Power Valve Section is sometimes required to handle the development and initial production of new types, not necessarily power valves, which are being introduced to the range. After the process has been developed and proved, the responsibility for quantity production of the new type is then handed over to the appropriate section. A case in point was that of the 1B3GT half-wave vacuum rectifier, which is widely used as the EHT rectifier in TV equipment. This valve is now manufactured by the Receiving Valve Section.

No mention has been made so far of gas-filled valves currently manufactured. Foremost perhaps in this category are the half-wave mercury vapour rectifiers 866A and 872A. These valves are rated at a maximum peak inverse voltage of 10kV, maximum anode currents 0.25A and 1.25A respectively, and are widely used in transmitting and industrial equipment. Coming down the scale, there are the OC3 and OD3 cold-cathode glow discharge valves. These are used as voltage regulators where a steady voltage is required independent of moderate load current and supply voltage variations. The 884 grid-controlled gas discharge valve is designed for use in relaxation oscillator circuits, such as the sweep oscillator in CRT circuits, timing circuits and similar applications. Other gas-filled devices are radar TR switches, the AV15 for 10 cm operation, AV21 for 25 cm operation, and the AV35 for 200Mc/s.

Special Purpose Valves

Several special types of valve are produced in addition to the normal range of power valves for communication and industry. These special types include a range of three vacuum gauges. Two of these, the AV10A and AV26 are of the ionisation type, and are an Australian design. The AV26 possesses high sensitivity, and is widely used for reading very low pressures of the order of 10^{-6} mm Hg. A description of a suitable gauge control circuit for the AV26 has been published[2], and also an application note on this type.[3] For higher pressures of the order of 1 to 10^{-3} mm Hg., the miniature thermocouple type gauge AV34 is available with calibrated resistance. An application note on this type has also been published.[4]

An interesting special type is the AV25 demonstration triode, intended for educational use. The valve is a simple planar triode, so constructed that the side of the anode facing the grid and filament is visible to the audience through the grid and filament wires. This side of the anode is phosphor-coated, and glows under electron bombardment. The pattern of the electron stream striking the anode is thereby made visible, and can be demonstrated under various operating conditions.[5]

Voltage-regulating apparatus is a familiar item of equipment today. This type of equipment requires a sensing element which can detect unwanted voltage deviation from a fixed reference value, i.e., from the required regulated value. The most satisfactory sensing elements for such

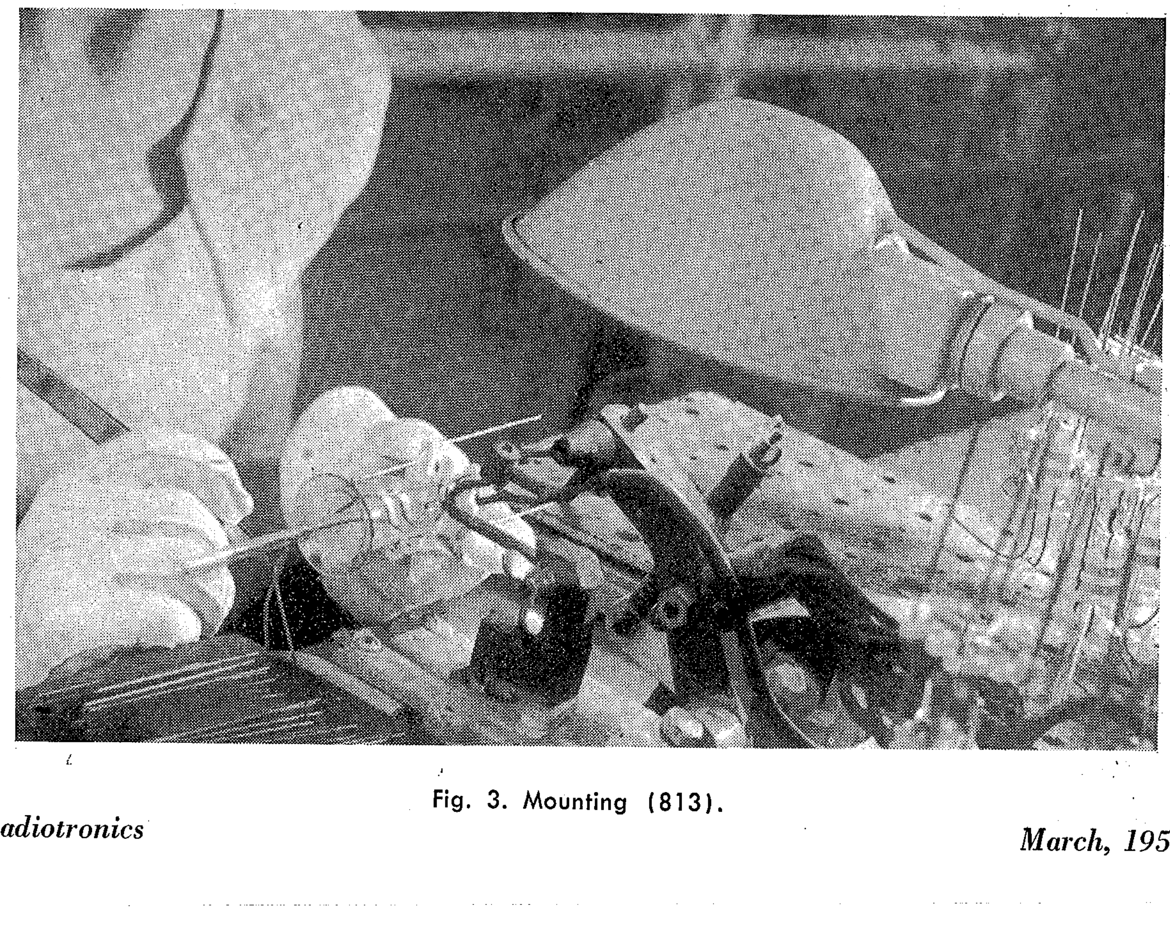


Fig. 3. Mounting (813).

applications are temperature-limited diodes having pure tungsten filaments. When this type of valve is operated in the temperature-limited or saturated anode current condition, the anode current does not vary appreciably with anode voltage, but does vary very rapidly with changes of filament voltage. The output of the diode or sensing element is amplified and applied to some point in the circuit to minimise the initial deviation, thus returning the output voltage to the correct value. The AV36 series of valves is produced for this type of application.[6]

Manufacture

The diversity of types and processes makes the work of the Power Valve Section both intricate and varied. The manufacture of power valves is a highly complex series of operations which cannot be fully described within the space of this article. Remarks here must necessarily be limited to giving a basic idea of some of the problems involved.

The first stage of manufacture is the issue of the necessary component parts from store. These parts are chemically cleaned, after which absorbed and occluded gases must be removed. The problem of these gases is dealt with by replacing them with hydrogen, which is easily removed during the final stages of valve manufacture. The process consists of passing the parts through a furnace, where, in a hydrogen-filled chamber, they are heated to temperatures in the range of 800° to 1200°C, depending on the material to be treated. After the heating process, the parts are cooled to room temperature in a second hydrogen-filled chamber, to prevent further oxidation of the treated parts. Some components are vacuum-furnaced by RF eddy currents as a preliminary de-gassing step before assembly.

Further processes are sometimes required on component parts before assembly can commence. The anodes and grids for certain types are sprayed with zirconium, which is then sintered by vacuum furnacing. Zirconium is used here to inhibit grid emission, improve the radiating characteristics, and serve as a gettering material.

After these initial processes, the component parts are assembled as "mounts" or electrode assemblies. Jigs are used during this process to ensure correct alignment, and the assemblies are completed by sealing, brazing or spot welding. The operatives wear gloves during this stage of manufacture to prevent contamination of the previously prepared parts. Welding is carried out in a jet of hydrogen to prevent the formation of oxides. Oxides must be avoided at all stages of manufacture as they can cause electrical leakage and other faults in the completed valves.

When the mounts have been assembled, they are closely inspected for shorts and open circuits, faulty welds and electrode misalignment before being sealed into glass bulbs on sealing-in machines. To prevent oxidation of metal parts during the sealing-in process, it is often necessary to flush the bulb interior with "forming gas", a mixture of hydrogen and nitrogen, during the sealing process.

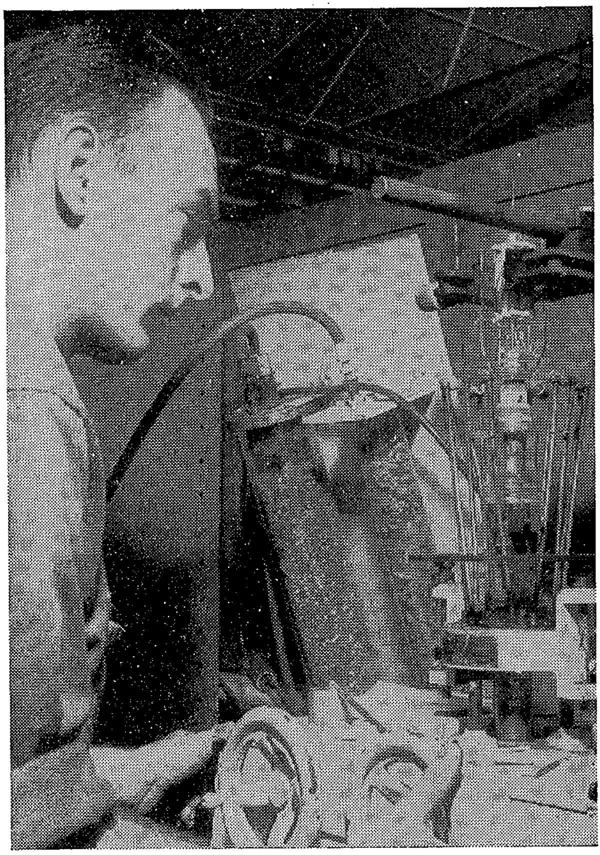


Fig. 4. Sealing (813).

The sealed valves are then connected to the pumping manifold of an exhaust bench for de-gassing treatment and evacuation. During this treatment the electrode assembly is heated to a temperature of between 900° and 1200°C by eddy currents from an RF induction heater. During this part of the process, the cathode or filament is activated by passing through the filament or heater a current which will heat the active material to a temperature at which gases are driven off, and an electron-emitting surface formed. When the valve has been thoroughly de-gassed and the cathode activated, the getter is fired as a final gas clean-up measure. The getter usually consists of barium, and is deposited by the firing process onto the inside surface of the envelope. As indicated previously, zirconium is also used in some types as a getter material. The final stage of manufacture is the application of base and cap where required, followed by an ageing process to stabilise the characteristics. The valves are

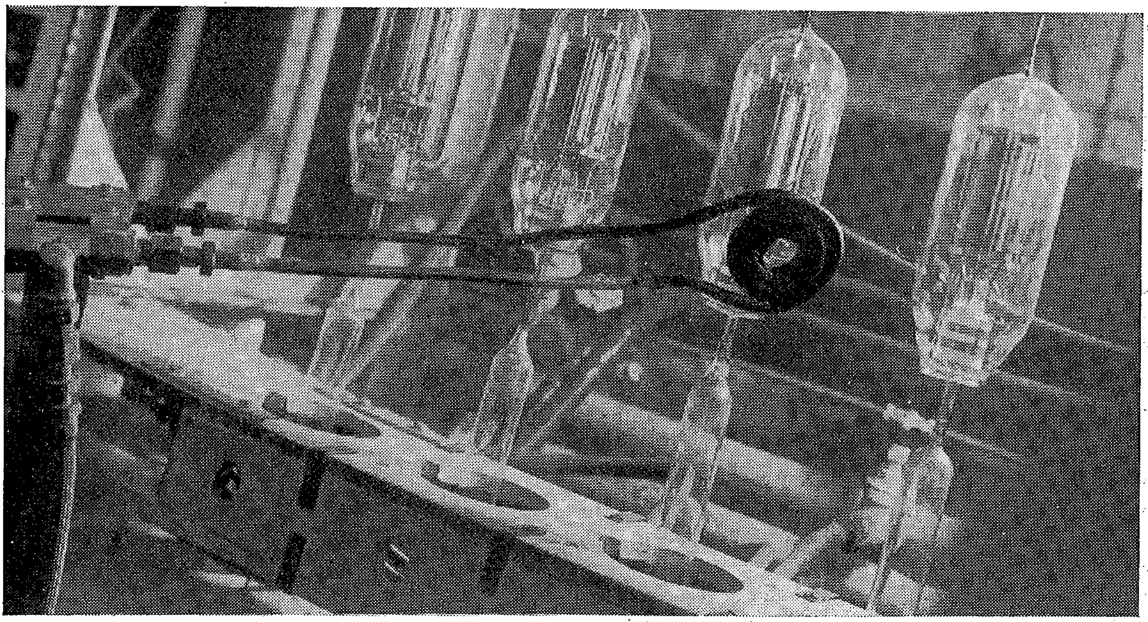


Fig. 5. Getter Flashing (813).

then tested and stored. The tests are repeated before consignment to the customer.

The larger transmitting valves such as the 5762 and the 892R require special techniques, and are built up using hydrogen brazing and welding methods. The major proportion of the glass sealing is carried out in a horizontal glass working lathe using sharp oxygen/coal gas or oxygen/hydrogen fires. RF heating is also extensively used in making glass-to-metal seals, and in making silver eutectic soldered joints between spun and drawn metal parts. Some of the parts used are nickel-plated before assembly to resist the penetration of silver solder during brazing, which could cause air leaks. Other parts have silver or copper deposited to improve the conductivity of glass-to-metal seal areas and avoid overheating.

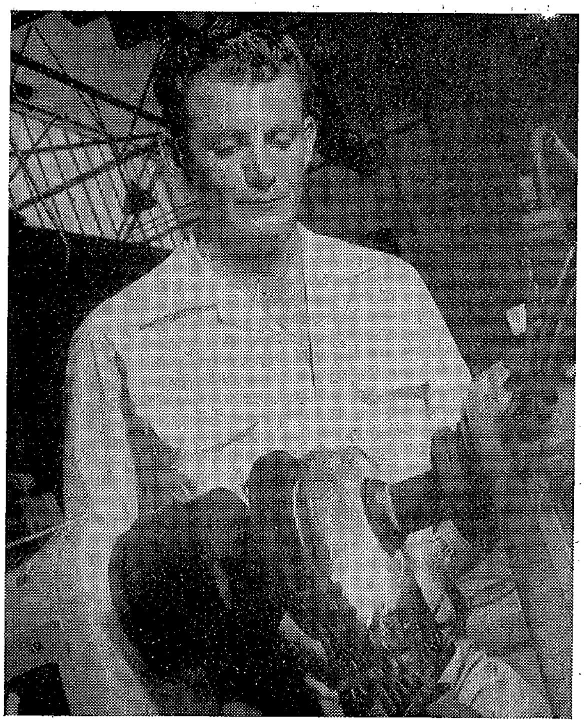


Fig. 6. Glass Sealing (5762).

Quality Control

The ultimate performance of radio valves depends on the use of good raw materials, and this is especially true in the case of power valves. All materials used must therefore conform to high standards of purity and possess specified physical properties. Sampling tests are made on materials before acceptance and use in manufacture, and rigorous inspection tests are applied to ensure that all parts and sub-assemblies meet the appropriate specification. Some examples of the routine tests applied are thermal shock and mechanical strength tests on glass-to-metal seals, pre-selection of thoriated tungsten filament wire, glass expansion tests and base torsion tests.

As a final check on valve performance, a batch sampling technique is used, in which samples from production are life tested under static and dynamic conditions. Information gained in this way, besides constituting a rigorous test on the valves, is also a useful indication of behaviour in service.

The manufacture of power valves brings into play a wide range of techniques in the fields of electronics and physics, and requires close control by a highly-trained technical staff. Vital assistance is rendered by the Chemical Laboratory, which forms an integral part of the Power Valve Section's activities. The engineers in the section have a constant task to maintain the high level of quality, and must be alert to detect and correct any process that may get out of control. In addition, they are, of course, responsible for all other engineering aspects in the section, such as solving the problems of faulty valves, the development of new types and the determination of tolerances and specifications. A very wide variety of manufacturing and test equipment is used by the section, including a large quantity of electronic control equipment. Most of this control equipment is designed, built and maintained by the technical staff of the section.

Future Development

The present standard type of transmitting valve of mainly glass construction will certainly be in demand for some time to come. Valves required for modern developments in communication and industrial equipment are becoming more varied, both in their application and the mode of construction. The trend is towards more rugged valves with higher ratings using thoriated tungsten filaments, with glass and metal construction. Valves of this type are now being produced without special gettering devices, designed for service under forced-air cooling conditions.

The most notable changes that can be foreseen are in valves designed for continuous and pulsed applications at ultra-high frequencies. Latest overseas developments in these types include high-power valves of metal and ceramic construction. A constant study is made of all such developments, supplemented by overseas visits by engineers where necessary to study the latest techniques at first hand.

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2. Idem.
3. Radiotronics, Vol. 21, No. 7, July, 1956.
4. Radiotronics, Vol. 19, No. 10, October, 1954.
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MEASURING THE SELF-CAPACITANCE OF COILS

Two methods of measuring the self-capacitance of coils are widely used, but both have the disadvantage that at least two accurately-determined frequencies are required. The accuracy of the measurement therefore depends on the accuracy with which the required frequencies can be set on the apparatus in use.

The first of the two methods mentioned is attributed to Howe. It consists of plotting against $1/f^2$ the values of external capacitance ($\mu\mu$F) required to bring the coil under measurement into resonance, where f is the resonant frequency in Mc/s. The self-capacitance of the coil, is then indicated by the interception of the resulting straight line with the capacitance axis. The second method is to determine the external capacitances required to tune the coil to frequencies of f and 2f. The self-capacitance of the coil is then given by the expression:

$$\text{Self-capacitance} = \frac{C_1 - 4C_2}{3}$$

where C_1 and C_2 are the two values of external capacitance.

A third method is now described in which the observation of frequency and its attendant errors is eliminated. In this method the self-capacitance of the coil is measured against a calibrated variable capacitor. The output of a generator having a fair proportion of second harmonic content is applied to the coil, which has the calibrated variable capacitor connected in parallel. The circuit is then adjusted for resonance at any convenient frequency, using a VTVM or other suitable instrument as an indicator. Let C_1 be the value of the external capacitance required to tune the circuit at the fundamental frequency f (ω).

Then adjust the variable capacitor to a second value C_2 at which the circuit is tuned to the second harmonic 2f (2ω). If we write Co for the self-capacitance of the coil, plus stray capacitance of the external wiring, etc., then

$$\omega^2 L\ (C_1 + Co) = 4\omega^2 L\ (C_2 + Co) = 1$$

$$\text{or} \qquad 4. \frac{(C_2 + Co)}{(C_1 + Co)} = 1$$

The self-capacitance Co of the coil is therefore determined by the expression:

$$Co = \frac{C_1 - 4C_2}{3}$$

The tuning of the generator is not disturbed during the measurement, and the measurement accuracy therefore depends only on the accuracy of the two capacitance observations. The value of Co found by this method includes wiring capacitance and the capacitance introduced by the generator and the VTVM. These capacitances must be accurately determined and subtracted to obtain the correct result. This is, of course, the case for any measurement of self-capacitance. No originality is claimed for this method, and it is published only for the interest it may have.

B.J.S.

TAPE RECORDERS

PART 1

INTRODUCTION

Magnetic recording is certainly not new, in fact, about the same time that Emile Berliner was producing his first commercial shellac records (the turn of the century) a young Danish engineer by the name of Valdemar Poulsen was experimenting with magnetic recording. Though a number of men had previously thought of the idea, none of them had done more than to write papers on it until Poulsen actually built one and obtained a patent on it. (U.S. Patent No. 661,619.)

Poulsen was definitely not a mathematical engineer (he was a service engineer with the Copenhagen Telephone Company) and how he came on the idea of recording sound on a magnetic medium is not known.

Undoubtedly it was his own idea, as it is believed that he had no way of knowing about the papers that had been previously written by other men who had thought of it. At least, he was the first to actually carry through his idea to a practical working model. He called it the "Telegraphone" and exhibited it at the Paris Exposition of 1900, where it won the Grand Prix award, and was a great sensation.

From that time until recently, many people have worked with the magnetic recording idea, but it never received the stimulus required to make it a practical, useable piece of everyday equipment until a few years ago.

USES AND ADVANTAGES OF TAPE RECORDERS

There are a number of types of magnetic recording possible and practical. However, this discussion concerns only the method which uses a plastic tape base coated with a magnetic medium. Because of certain advantages, tape recorders lend themselves to numerous purposes.

Tape recorders have a number of advantages over all other types of recording processes or machines. The major advantages are shown below.

1. An extremely wide frequency range is possible with tape. This is dependent upon the tape speed.
2. The recording process is very simple and immediate playback is possible.
3. The recordings are very rugged and can be played back indefinitely, without loss of quality, or an increase of the signal-to-noise ratio. Actually, recordings are degraded slightly in the very high frequencies by residual magnetism in the recording head.
4. The reproduced noise level is about the same as on a brand new gramophone record.
5. The tapes are very easy to splice and keep in good condition.

6 Last, but not least, the equipment is relatively light and portable, so can be used in many places with few transportation problems.

With tape recorders being used more and more, there will be new uses found each day to which they are particularly adapted. The more uses that are found, the more will be sold, and the more recorders service technicians will be called upon to service.

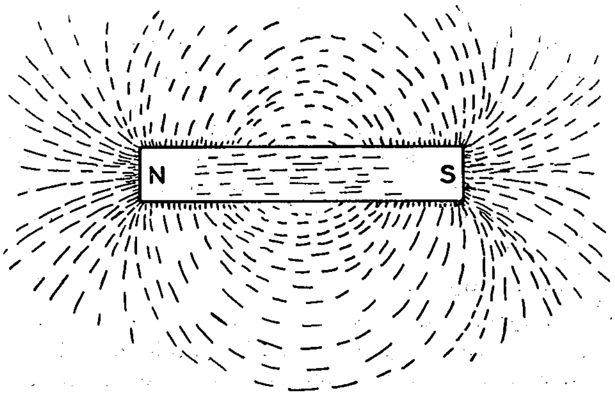


Fig. 1. The Bar Magnet.

MAGNETISM

The Bar Magnet

In order to understand the operaton of a tape recorder and the processes of recording, it will be useful to refer to basic Physics and review a few of the fundamentals of magnetism.

When a bar magnet is suspended in the air by a cord at its centre, it will seek a position where one end will point towards the north, and the other towards the south. To the end of the magnet that points towards the north has been assigned the name of "north pole" and to the other end, of course, "south pole". If another bar magnet is brought close to the first one in such a way that the two north poles are close together, they will tend to repel each other. The same thing happens if the two south poles are brought near to each other. If a north pole and a south pole are brought near to each other, they will attract. The force exerted on one pole by another is inversely proportional to the square of the distance separating them.

If we cover a simple bar magnet with a piece of paper, then sprinkle iron filings over the paper, the iron filings will take the form of the magnetic lines of force. These lines can be seen to link the two poles, north and south as shown in figure 1. The intensity of this magnetic field at any point can be measured by the number of lines of force per square centimeter.

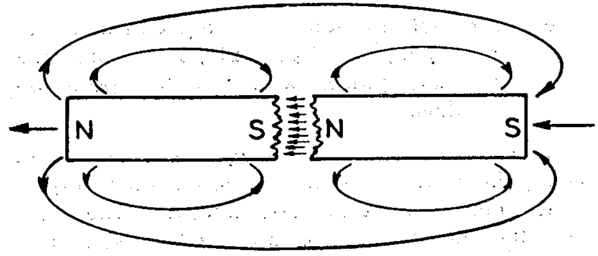


Fig. 2. Formation of New Poles When a Magnet is Broken.

If a bar magnet is broken at any point, two bar magnets result, with new poles being formed at the point of breakage. Each of the two new magnets will have both a "north" and a "south" pole, as shown in figure 2, and each magnet will have the characteristics of the original complete magnet except each of them will now be shorter.

Electro Magnets

Magnets can also be created artifically by placing any magnetic material inside a coil of wire and energizing that coil from a source of electromotive force. Normally, the material used is soft iron, as that will not hold its magnetism to any great extent after the source of EMF is removed.

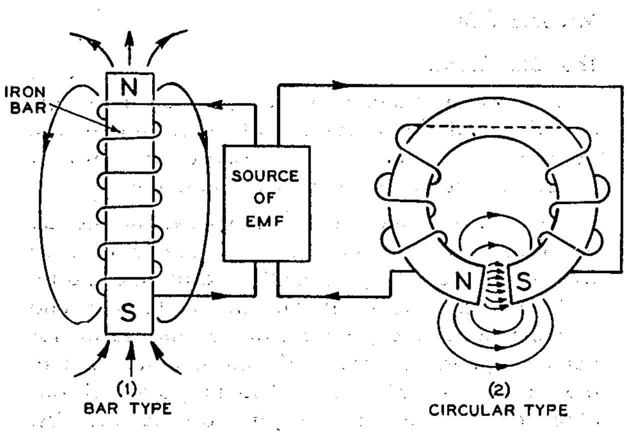


Fig. 3. Types of Electromagnets.

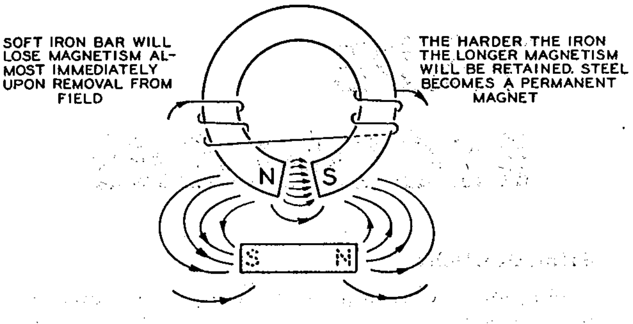


Fig. 4. Magnetization of an Iron Bar.

These magnets can be made in the form of a bar, a horse shoe, or a ring, and thus are capable of being used for many purposes.

Figure 3 shows both an electro bar magnet and an electro ring magnet and the magnetic field for each of them.

Magnetization of an Iron Bar.

A permanent bar magnet can be created by placing a hard iron or steel bar in the field of another magnet. Figure 4 shows how this is accomplished by the new bar to be magnetized completing the magnetic circuit of the system.

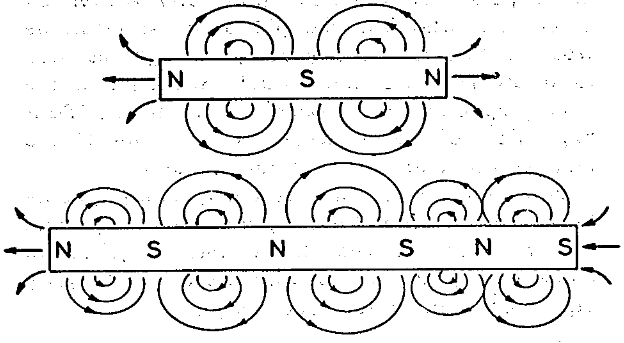


Fig. 5. Other Methods of Magnetizing a Bar.

A soft iron bar will lose its magnetism almost immediately upon removal from the field. A hard iron bar will retain its magnetism for a period depending upon the hardness of the iron. The harder the iron, the longer the retention of the magnetism. A steel bar will become a permanent magnet.

As shown in figure 5, a bar can be magnetised to have two north poles or two south poles by placing portions of the bar in the magnetic field of either a permanent or an electro magnet. This is actually what is done with a ferromagnetic tape or ferromagnetic wire during recording. As the tape moves through the head, the magnetic field from the head alternately increases and decreases by the audio signal energizing the recording system, and the tape is magnetized accordingly.

Permeability

A coil of wire which has an electric current passing through it will also generate lines of flux, but in quantities far less than that same coil with a bar of magnetic material placed in its centre. Therefore, the lines of flux, and thus the amount of magnetic induction, can be greatly increased by placing a magnetic material within a current carrying coil. When this characteristic exists, the material which has the greatest amount of induction has greater permeability. Permeability is the ratio of induction, divided by the magnetizing force for the material being measured, as related to the induction divided by the magnetizing force for that same coil in air. This is shown in figure 6.

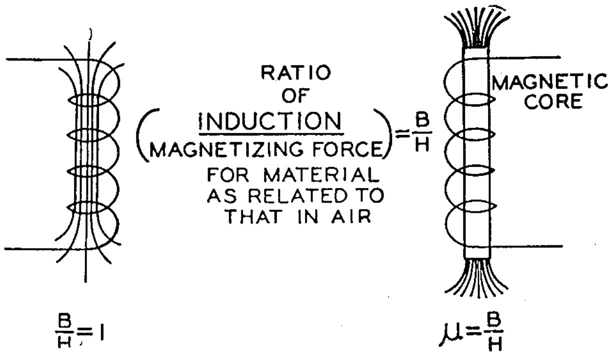


Fig. 6. Permeability of a Magnetic Core.

In air, the magnetic induction is arbitrarily chosen to be equal to 1, as is the magnetizing force, so the ratio of induction divided by the magnetizing force becomes numerically equal to 1. Therefore, permeability for any magnetic material becomes equal to the magnetic induction in that material divided by the magnetizing force. Permeability is represented by the Greek character μ, which then becomes equal to B/H where B represents the magnetic induction or flux and H the magnetizing force.

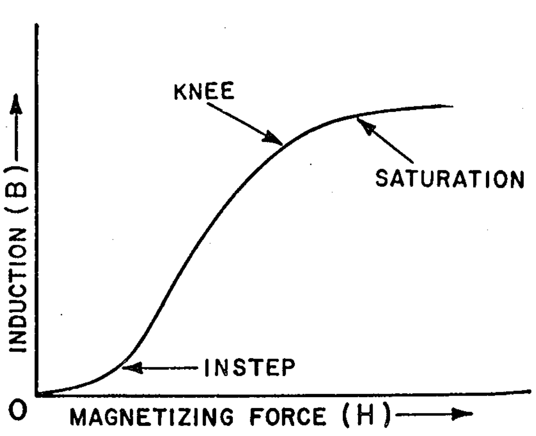


Fig. 7. The Normal Magnetization Curve.

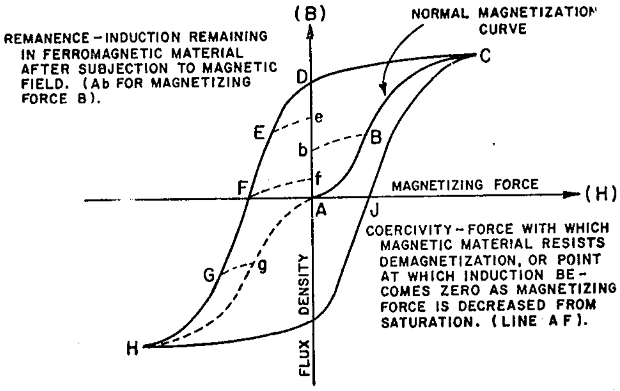


Fig. 8. The Hysteresis Curve.

Normal Magnetization Curve

When a material in its virgin state, in other words a material which has no previous magnetic history, or is totally unmagnetized, is placed in an electro magnetic circuit, a magnetization curve can be plotted for that material. To do this, a curve is drawn for the magnetic induction as compared to the magnetizing force. When a very small magnetizing force is applied, an extremely small amount of induction will exist. As the magnetizing force is gradually increased, the induction will increase only a slight amount up to a point where it suddenly begins to increase at a much greater rate as shown on the curve in figure 7. This occurs at the point marked "Instep". The relation will then increase in a straight-line characteristic to a point where the magnetic material in the coil becomes saturated, at which point the induction will flatten out and increase only a very slight amount from then on, for a very great increase in magnetizing force. This is shown on the curve at the point marked "Knee". Curves of this type are usually spoken of (when related to magnetic circuits) as BH curves. It can readily be seen from looking at the curve that the BH relationship of a magnetic material is non-linear and that because of this, many refinements must be used in order to obtain a tape recording which will give identical representation of the recording signal.

Hysteresis Curve

The normal magnetization curve shows the BH relationship in material which has been previously unmagnetized. If a material becomes magnetized and retains magnetization, a somewhat different relation exists since the BH characteristic shifts as shown by the hysteresis curve. The hysteresis curve shown in figure 8, takes a material which has been previously unmagnetized and follows it through its original magnetization and the conditions that exist after it has become magnetized.

Figure 8 showed what happened as we increased the magnetizing force through the material. Now, let's reduce the magnetizing force to zero at a point where the inductance is at point B on the normal magnetization curve. The magnetization of the material does not go back to 0, but drops only a slight amount as shown by the dotted line, so that as the magnetizing force returns to 0 the induction drops only to a point indicated by (b).

The amount of induction left in the material is called the **remanence,** and is defined as the amount of induction remaining in a ferromagnetic material after its subjection to a negative field, and in this case would be represented by the distance between A and (b). This will occur no matter where the magnetizing force is returned to 0 during the time that the material is following its original magnetization cycle, or is following the normal magnetization curve.

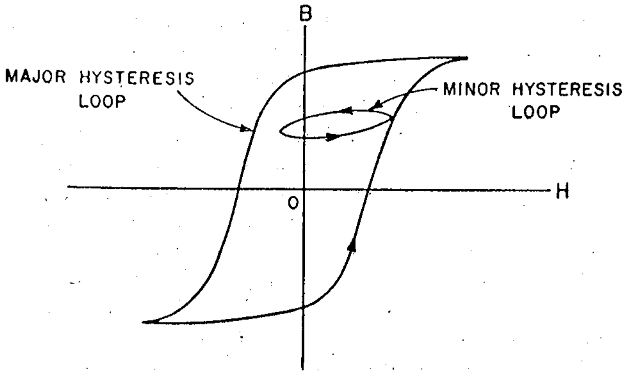


Fig. 9. The Minor Hysteresis Loop.

If, after the material has reached saturation the normal magnetizing force is returned to 0, the induction or flux density of the material will return to the point shown by D. When the magnetizing force is increased in the opposite (negative) direction the magnetism will be slowly removed from the material. If the magnetizing force reaches a point shown by E and is then returned to 0, the flux density will actually increase slightly to the point shown by (e). If the magnetizing force is still increased in a negative direction, a particular value will be found where the flux density will reach 0 as shown at point F. The distance between F and A represents the amount of magnetizing force required to do this and is equal to the force with which the magnetic material resists demagnetization. This characteristic is called **coercivity.**

Actually, a virgin material could be originally magnetized in a negative direction as well as in a positive direction. In this case, a normal magnetization curve would be that shown by the dotted line between points A and H. Should the magnetizing force continue to be increased in the negative direction, the material will eventually reach saturation in that direction, shown at point H, and if the magnetizing force is again returned to 0 and then on positive, the relationship between flux density and the magnetizing force will follow the other side of the hysteresis curve along the line and through the points shown by I and J, etc.

Reluctance

Reluctance in a magnetic circuit has the same effect as resistance in an electrical circuit. Resistance is dependent upon the length of the conductor, the cross-sectional area of the conductor, and the conductivity of the conductor. As magnetic permeability has the same effect in a magnetic circuit as conductivity in an electrical circuit, we see that the formula for reluctance will be, Reluctance equals L, divided by μ times A. Where L is equal to the length of the magnetic circuit, A is equal to the cross-sectional area, and μ is the permeability.

The effect of reluctance in series or in parallel is exactly the same as with resistance and can be calculated in the same manner.

Ohm's Law for Magnetic Circuits

As in electrical circuits, there is also an equivalent to Ohm's law for magnetic circuits. It can be stated: "Flux is equal to magneto-motive force divided by the reluctance." Do not confuse magnetomotive force with magnetizing force. They are not the same, though they are related. Magnetizing force is the magnetomotive force per unit length.

Minor Hysteresis Loop

Here again, please remember the major hysteresis loop already discussed. Let us assume that the magnetic circuit is such that it follows the major hysteresis loop shown in figure 9. If at any point in this hysteresis loop the magnetizing force is made to undergo a small cyclic reversal, a so-called minor hysteresis loop following the curve shown will result. Otherwise, the major hysteresis loop will be unaffected. Minor hysteresis

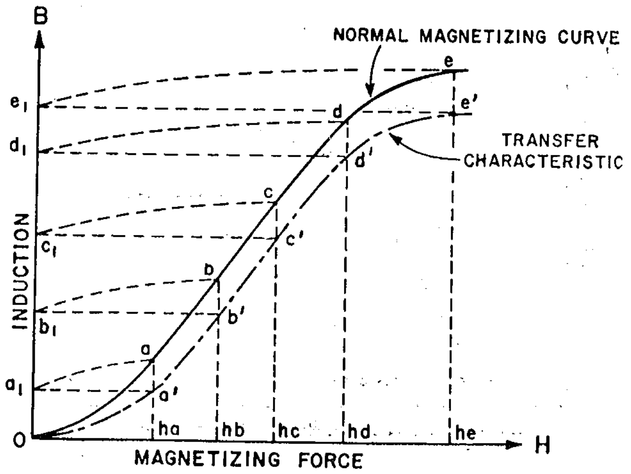


Fig. 10. The Transfer Characteristic.

loops occur during the making of a recording on tape or wire and are extremely important in many recording problems.

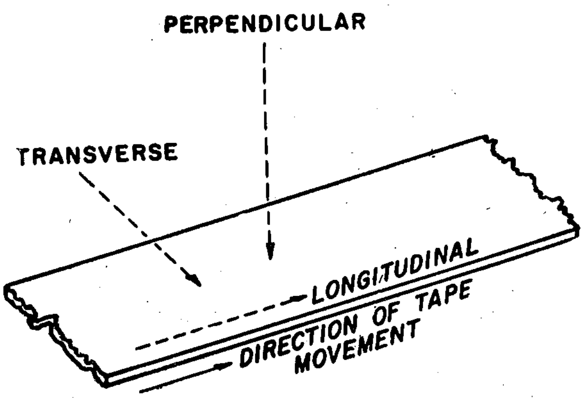


Fig. 11. Methods of Recording on Magnetic Tape.

Transfer Characteristic

Since tape and wire have the same general problems with regard to recording, this discussion will cover only tape in order to simplify the considerations.

When considering a tape recording, it should be remembered that as the tape passes from the field of the recording head and the magnetizing force is reduced to 0, the actual magnetic induction left in the tape will decrease slightly as shown in figure 8. Therefore, most of our consideration will not follow the normal magnetizing curve, but a curve called the "transfer characteristic" which is plotted against the **magnetic induction** left in the tape (the remanant induction) and the **magnetizing force** needed to create it. Figure 10 shows how this transfer characteristic is obtained.

As stated earlier, magnetizing force will cause a certain induction in the ferromagnetic material or the recording medium. Let's take a magnetizing force of value h_c causing an induction in the medium equal to a value shown by C. As the medium passes from the field of the recording head and the magnetizing force is reduced to 0, the induction drops to point C^1. This point is then projected back to the magnetizing force h_c and a point C^1 made. This is done for each of a number of magnetizing forces and the transfer characteristic drawn through the points given by a', b', c', d',etc.

RECORDING METHODS

There are three general methods of recording on tape. They are, as shown in figure 11, transverse, perpendicular, and longitudinal.

The transverse recording, of course, is crossways to the tape and the head is placed in such a position that the major field will record in that direction.

The perpendicular recording has the head placed so that the recording will be made perpendicularly to (through) the tape.

Longitudinal recording has the head placed so that the major field will run lengthwise to the tape and recording will be done in that direction.

Almost all present day magnetic recording is longitudinal recording. Transverse is almost never used. In the case of wire, transverse and perpendicular recording will be the same.

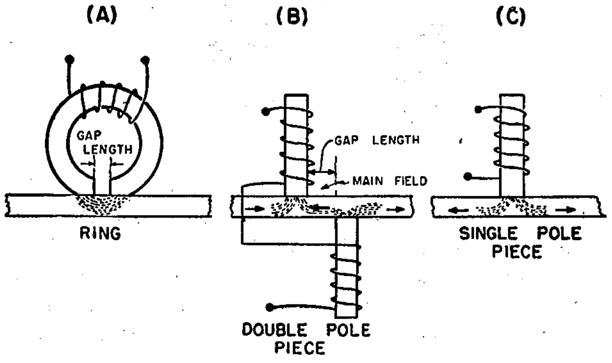


Fig. 12. Types of Magnetic Recording Heads.

Types of Recording Heads.

Several different placements of heads can be used. The three major types are shown in figure 12. Figure 12 (a) shows the ring head and indicates the general field pattern. It is in general usage at the present time. Figure 12 (b) shows the double pole-piece which has one pole of the recording head on each side of the tape. These poles can be either staggered or straight across from each other. Figure 12 (c) shows the single pole piece.

Any of these three heads can be used in any method of recording, in some cases the choice resulting in the way the head is mounted.

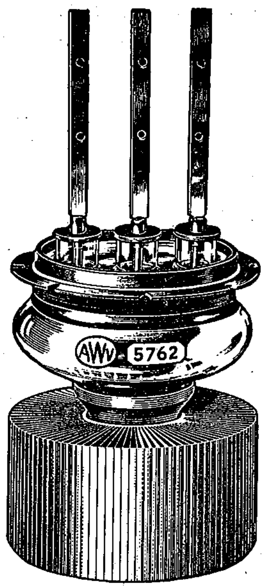
The heads themselves have pole pieces made of magnetically "soft" iron wound with coils of wire through which the recording signal is passed. There must be an air gap in the pole structure in order to have a strong magnetic field outside of the metal pole piece in which the recording medium can pass. The air gap will be discussed later.

The second part of this article, which is reprinted with acknowledgements to RCA, will appear next month.

Complete data & installation instructions are given in April '55 issue, P.45.

RADIOTRON 5762

A NOTE ON IMPROVING THE LIFE-EXPECTANCY OF THIS WIDELY-USED VALVE



The life of a Radiotron 5762 power triode can be increased if the eight simple recommendations given below are followed.

1 With forced-air cooling, keep the blower in proper working condition. The maximum temperature at the filament, anode and grid seals should not exceed 180°C.

2 At full anode load, hold the filament voltage at 12.6V. At reduced load, the filament voltage can be reduced as much as 5% for longer life. In intermittent service, where the standby periods are no longer than 15 minutes, reduce the filament voltage to 80% of the normal value for the duration of the standby period. For longer standby periods, the filament voltage should be turned off.

3 Watch line voltage fluctuations. Compensate for line voltage fluctuations where necessary to avoid exceeding the maximum valve ratings.

4 Operate new valves for 50 to 100 hours before storing. Operate spare valves periodically.

5 Allow the filament to reach the normal operating temperature before applying voltages to the other elements of the valve.

6 Make sure that the overload protection is operating properly in the anode circuit to prevent overheating due to improper circuit adjustment, overloading or loss of grid bias. Overheating may decrease filament emission, but filament activity can sometimes be restored by operating the filament at rated voltage for 10 minutes or more with no voltage on the anode or grid. This process may be accelerated by raising the filament voltage to 15V. (but not higher) for a few minutes. Full air flow must be maintained during this reactivation process.

7 Keep the valve clean. Remove dust or foreign material which may collect between the filament, anode and grid seal terminals.

8 Operate the Radiotron 5762 within the ratings as published by the manufacturer.

NEW RCA RELEASES

New Valves for Communication equipment

Eight new valves are announced, specifically designed for use in mobile communication equipment operating from 12V storage batteries. These valves are designed to operate over a heater voltage range of 12 to 15V, and are subjected to rigorous controls and tests during manufacture to ensure dependable performance. Brief details of the eight new types follow:

Radiotron 7054

A sharp cut-off pentode for use as a class C RF power amplifier, oscillator, and frequency multiplier at frequencies up to 40 Mc/s. It may also be used as a modulator and AF amplifier.

Radiotron 7055

Twin diode, intended for use as a low-current rectifier, detector and speech clipper.

Radiotron 7056

A sharp cut-off pentode, for use as an IF or RF amplifier at frequencies up to 45 Mc/s.

Radiotron 7057

This medium-mu twin triode may be used as an amplifier in cascode circuits at frequencies up to 200 Mc/s.

Radiotron 7058

A high-mu twin triode. This valve is useful as a phase inverter, RC-coupled amplifier, or low frequency oscillator.

Radiotron 7059

This valve consists of a medium-mu triode with a sharp cut-off pentode, and is intended for use as an oscillator and mixer at IF frequencies up to 40 Mc/s. The triode unit may also be used as an oscillator at frequencies up through the VHF region, or may be diode-connected to form a high perveance rectifier for noise squelch circuits.

Radiotron 7060

Medium-mu triode with sharp cut-off pentode. The triode section of this valve is particularly suitable as a reactance modulator, whilst the pentode unit may be used as a class C RF power amplifier and frequency multiplier at frequencies up to 40 Mc/s.

Radiotron 7061

This is a beam power valve, designed for use as an AF power amplifier.

Other Releases

Radiotron 5V4GA

This full-wave rectifier is like the 5V4G, but is constructed in a smaller bulb for more compact equipment design. The ratings are the same as those of the 5V4G.

Radiotron 7094

The Radiotron 7094 is a compact high perveance beam power valve with high power gain, designed for use as an RF power amplifier, oscillator, AF power amplifier or modulator in fixed and mobile equipment. In CW service, the 7094 can be operated with 500W input (ICAS) at frequencies up to 60 Mc/s, and with reduced input up to 175 Mc/s. It has a maximum anode dissipation of 125W (ICAS) in modulator and CW service.

Radiotron 12DL8

This twin diode/high perveance power tetrode is specifically designed for use in hybrid car radios in which electrode voltages are obtained directly from a 12V storage battery. The tetrode unit is of the space-charge-grid type, and is especially useful in the driver stage to supply a high power input at low distortion to the transistorized AF output stage. Space-charge-grid operation of the tetrode unit is accomplished by operating grid 1 at a positive potential and using grid 2 as the control electrode. This method of operation, together with the high perveance of the tetrode unit enables the Radiotron 12DL8 to supply high anode current with only 12.6V supply voltage. The diode units are used in AM detector and AVC circuits.

IN FUTURE ISSUES

THE RADIAL BEAM DUO-SPEAKER———— See P.51.

A RATIO DETECTOR FOR F-M BROADCAST RECEIVERS——— P.79.

A TRANSISTORIZED AMPLIFIER FOR RECORD PLAYERS——— P.100.

A NOVICE TRANSMITTER USING RADIOTRON 6146——— P.90.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