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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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EDITORIAL COMMENT

Television Distribution

A Plan After All ?

IN our issue of November 17th we commented on this page on the difficulties which stand in the way of the development of television on a national scale with a number of stations, so that the whole country may be served. We referred to a recent lecture by Sir Noel Ashbridge, Chief Engineer of the B.B.C., in which these problems were discussed, alternative methods of distribution described and where it was pointed out that the greatest obstacle in the way of the expansion of the service at present was the costly nature of the technical means available for national distribution.

New Hope

Following close upon this rather pessimistic disclosure by Sir Noel Ashbridge comes a much more optimistic outlook from Mr. Alfred Clark, Chairman of Electrical and Musical Industries Ltd., in his speech at the general meeting of that concern. Mr. Clark, too, referred to the problem of the extension of television and said that there were two methods of accomplishing distribution ; one by means of special cables and the other by radio links working on wavelengths much shorter than those allotted for television broadcasting, and he continued :

" In an attempt to arrive at a decision the technical aspect of the problem will have to be faced, inasmuch as, besides the present state of the technique, the trend of future development will also have to be taken into account. We believe that our work has resulted

in a solution which, while permitting an immediate start for relaying television to the provinces, is, at the same time, economical and will not stand in the way of future progress. It can be incorporated and may become part of any relay system embodying future developments.

" A scheme embodying the results of our work has been submitted to the Television Advisory Committee and the Post Office, and we have every reason to believe it is being sympathetically considered by them at the present moment.

Importance of Research

" This work, as is, in fact, all television research work, is under the able guidance of Mr. Shoenberg, the head of our research laboratories. The importance of this department can better be understood if I add that the uses of television are expected eventually to go beyond entertainment for the public."

The fact that this scheme is now before the Television Advisory Committee and the Post Office precludes the publishing of any details of it at present, but it is extremely encouraging to learn that a scheme has been worked out and that it is possible to describe it as economical and of such a character that it will not stand in the way of future progress.

In our leader in the issue of September 29th, we asked whether there was yet a B.B.C. plan for television distribution. It would seem that the E.M.I. proposals may eventually prove to be this plan for which all of us are waiting before we can feel justified in looking upon television as having a national future of service to the whole community.

Equity on the Long Waves

The Brussels Suggestions

AT the time of going to press/official confirmation is lacking of the project for a new European wavelength plan, as published in our last week's issue. But, so far as the long broadcast band is concerned, the proposal that certain countries should relinquish their long-wave channels seems so eminently fair and equitable that we can only hope, not only that the project was correctly reported, but that it will receive sympathetic consideration at the Swiss Conference in the spring. Small and compact countries like Holland, Luxembourg and Lithuania, which can be easily and adequately served by medium-wave stations, can hardly establish a moral claim to monopolising a long-wave channel.

Valve Standardisation

Series-Parallel Heaters

IN our Correspondence columns a reader draws attention to the present lack of standardisation in valve heater ratings and suggests that a uniform rating of 13 volts be adopted for all types. We have ourselves often expressed the desire to see a greater degree of standardisation in the valve industry, and there are signs that the valve makers are endeavouring to improve matters in this respect.

We do not feel, however, that our corre-

spondent's suggestion of a 13-volt heater is likely to be adopted, and we ourselves favour the 6.3-volt rating. The advantage of this voltage over the 4-volt is that the heater current is lower, and there is consequently a lower voltage drop in connecting leads in AC sets, while the current is also low enough for economical operation of series-connected heaters in AC/DC sets. The rating suits car radio sets for cars with 6-volt batteries, and it is also suitable for 12-volt batteries, since the heaters can be series-connected in pairs. Moreover, the rating is in line with standard American and Continental practice.

In comparison, a 13-volt rating has the disadvantage of making car radio impossible for cars with 6-volt batteries and of leading to the possibility of rather more hum pick-up from the heater wiring in AC sets. Moreover, the heater power is greater, for up to the present 13-volt valves take as much current as 6.3-volt types. This means a more expensive mains transformer.

Whatever voltage is decided upon, complete standardisation can hardly be effected if general economy in consumption is to be retained. The present average 6.3-volt valve consumes 0.3 ampere, but certain valves, notably frequency-changers and output pentodes, require more heater power. This will necessitate the duplication of such valves. A valve taking 1.2 ampere at 6.3 volts is suitable for AC operation and car radio, but must have a heater rated for 0.3 ampere at

25 volts for AC/DC operation. It should be noted that this duplication would still be necessary if a 13-volt rating were adopted.

It should be noted, however, that much, if not all, of this duplication could be avoided by fitting certain valves with centre-tapped heaters and bringing out three heater leads to the base. The two halves of the heater could then be connected in series or parallel as required. With the two halves in parallel a valve might consume 0.6 ampere at 6.3 volts and be suitable for AC sets and 6-volt car radio. With the two halves in series it would take 0.3 ampere at 12.6 volts, and be suitable for AC/DC sets and 12-volt car radio.

There are at present one or two valves on the market in which this scheme is adopted, and if it were extended it would seem that a much greater degree of standardisation could be effected.

Post Office and Relays

Finding a New Excuse

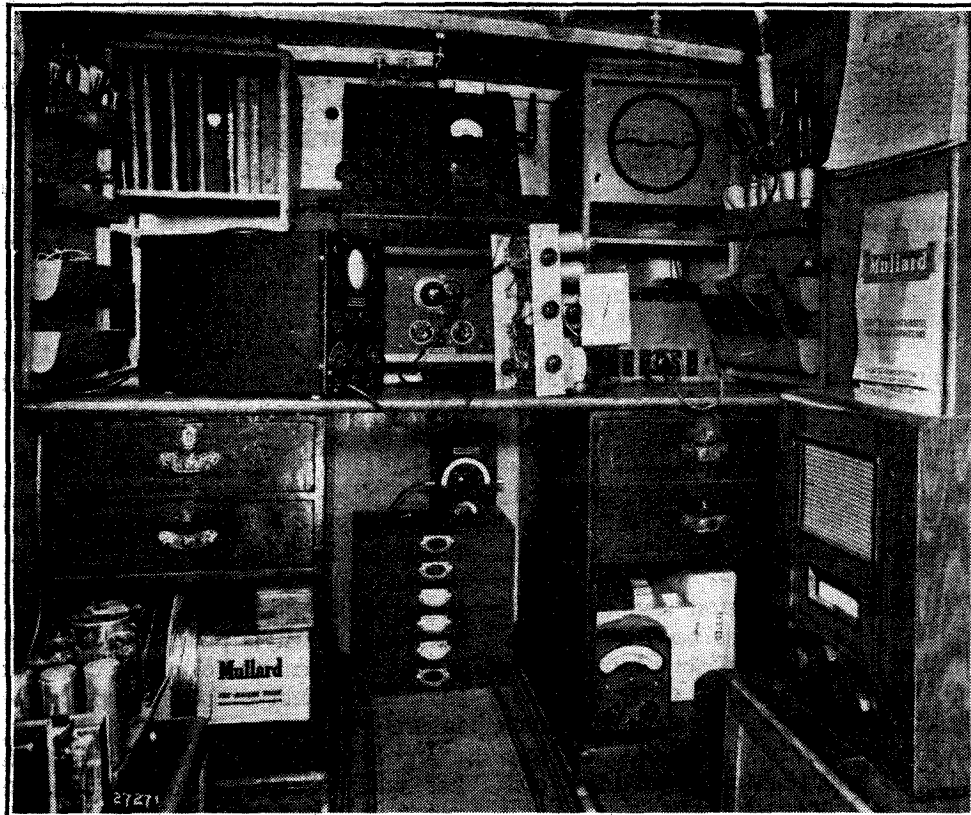
THE Post Office appears to hold on to the idea of taking over the wireless relay services with a distressing tenacity. The latest argument we have heard put forward is that they ought to undertake the service in the national interest and see that every home is wired so as to be ready to replace the broadcasting system in case of emergency. Which, we would ask, in time of air raids, is likely to suffer first: a network of telephone wires to individual houses and distributed from central buildings, or a system such as broadcasting, where there are no destructible links between transmitter and individual receivers? If the Post Office has money to spend on relays let them rather devote it to a network of ultra-short wave stations coupled to the B.B.C. system which in time of emergency could be used for national purposes without much fear of eavesdropping beyond their service areas.

Amateur Transmitters

Room for More

IN recent issues we have pleaded for some relaxation (but always with proper safeguards) of the official attitude towards the granting of amateur transmitting licences. In making friendly reference to our proposals the *T. and R. Bulletin*, official organ of the Radio Society of Great Britain, suggests that there is not room in the ether for an appreciable number of newcomers.

While hesitating to express disagreement with a society that has rendered such valuable services to the British amateur, we feel that this is a statement that can hardly be allowed to stand unquestioned. In the U.S.A. over 40,000 amateurs manage to find elbow-room in a waveband allocation very little more generous than that at present occupied by a mere 2,600 stations in this country, or under 7,000 in the whole of Europe.



DOOR-TO-DOOR SERVICE. Universal Services, of "The Radiolab," Lyndhurst Avenue, North Finchley, London, N.12, have equipped a small motor van as a travelling service shop. The interior is shown in this photograph and is fully equipped, the apparatus including cathode-ray gear and all-wave test oscillator with "wobbling" facilities. A valve tester is provided and there are loud speaker, gramophone pick-up and turntable built in. An AC supply for the operation of receivers and test gear is obtained from a 12-volt accumulator and vibrator, this portion of the equipment being duplicated. A stock of spare valves and components is carried.

How the Valve Works

ADDING ELECTRODES ONE BY ONE

Part 1.—The Diode

MANY of the valves in common use to-day are highly complicated both in their structure and in their mode of operation. Ten years ago most valves were triodes, whereas now the electrodes range up to eight in number. It is consequently quite difficult to understand how some of these complex types function unless one is thoroughly acquainted with the simpler specimens.

In this series of articles, therefore, we shall start with simple types and work up gradually to the more complicated ones. In this way we shall not only trace the history of valve development, but by adding electrodes one at a time we shall clearly see their effect and how they alter the characteristics of a valve.

Now, the simplest valve of all and the first to be produced is the diode. As its name implies, it has only two electrodes—an anode and a cathode. It does not amplify, and is used mainly as a rectifier. Briefly, the cathode acts as a source of electrons which are attracted to the anode when this electrode is positive and repelled from it when it is negative.

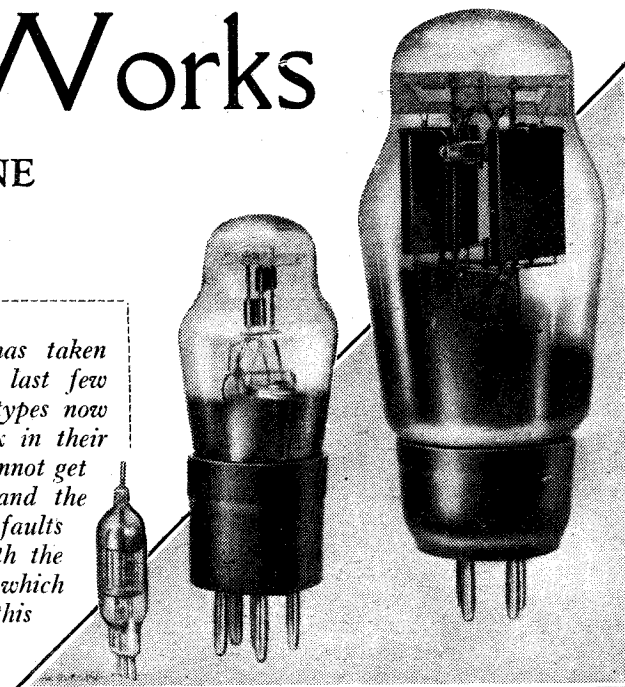
The cathode is thus quite important, for it acts as the source of electrons; in modern valves it is one of two types—directly or indirectly heated. The directly heated cathode, and this applies to all valves, not merely to diodes, consists of a filament which is heated by the passage of current through it. At a certain temperature electrons are emitted in great quantity, and this is the normal operating condition. This normal temperature depends on the filament material and upon the emission required.

In the early days filaments were usually made of tungsten, and were operated at temperatures of the order of 2,000-2,500° K. Quite a large amount of power was necessary to raise the filament to this temperature, and a typical valve would consume about 0.8 ampere at 4.5 volts.

Thoriated tungsten filaments followed and gave much more emission for the same operating temperature. Usually, however, they were worked at a lower temperature, and the filament of a normal valve consumed about 0.25 ampere at 5 volts.

Coated filaments were also used. With

VALVE development has taken place rapidly in the last few years and many of the types now available are quite complex in their action. The set designer cannot get the best out of a valve and the service man cannot remedy faults unless they are familiar with the fundamental principles upon which the valve operates. In this series of articles the mode of operation of modern valves will be explained, starting with the diode and going on by easy stages to the complicated structures such as the octode and triode hexode.



Types compared. A single diode detector for television, a duo-diode type, and right, a full-wave HT rectifier.

these the filament proper acts as a core, and there is deposited on its surface a coating which is often a mixture of barium and strontium. Such a filament can be operated at only 850° K., and needs only one-tenth the power of the tungsten type.

Directly heated cathodes of the filament type are still very widely used, being fitted to nearly all battery valves. They are also adopted for large-power triodes and for many diode rectifiers.

The indirectly heated cathode, as its name implies, is not raised to its working temperature by passing a current through it, but is heated by the conduction of heat from a nearby body at a higher temperature. In practice, the cathode consists of a tube which is coated on the outside by an emitting substance. Inside, but insulated from it, is a heater which often consists of a filament of tungsten or nickel. The passage of a current through the heater raises it to a high temperature, and it consequently brings the cathode to a suitable temperature for the emission of electrons.

The indirectly heated cathode has two advantages over the directly heated; there is no voltage drop along the cathode due to the heating current and its temperature can change only relatively slowly. The second advantage is the main reason for the use of indirectly heated cathodes, for

it permits the cathode to be heated from an AC supply without hum being introduced. Only in a few cases, such as an output valve or a rectifier, is it possible to run a directly heated valve from AC without serious hum.

The chief disadvantage of the indirectly heated valve is that the heater consumes more power than the filament of a directly heated valve. This is of little importance in mains-driven apparatus, but explains the retention of directly heated valves for battery-operated equipment. The separation of heater and cathode in the indirectly heated valve is, however, a great practical convenience, for it greatly simplifies automatic grid bias, and is often advantageous in other directions.

After this preliminary discussion of the cathode, it will be clear that this term applies to both the filament of a directly heated valve and to the heated element of an indirectly heated type. It is the electron-emitting electrode of a valve.

Let us now consider a heated cathode, naturally in vacuo, and suppose that there are no other electrodes. The cathode emits electrons which leave its surface with a certain initial velocity; their number depends on the cathode temperature and the material of which it is made. After traveling a short distance the electrons lose their velocity and fall back into the cathode. This electrode can thus be regarded as surrounded by a cloud of electrons.

The Anode-Cathode Space

Now, electrons have a negative charge, and tend to repel each other. The cloud of electrons surrounding the cathode thus tends to prevent further electrons being emitted by the cathode, and a state of equilibrium is reached at which the number of emitted electrons is equal to the number falling back on to the cathode.

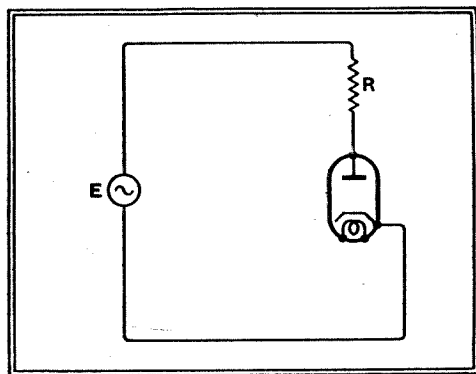


Fig. 1.—The basic circuit of a diode rectifier is shown here.

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This cloud of electrons is often referred to as the cathode space-charge.

Let us now consider a diode. The cathode is surrounded by an anode, which often consists of a metal cylinder. Suppose the anode is joined externally to the cathode, what happens? A few of the electrons emitted from the cathode will have sufficient velocity to reach the anode, and they will not fall back to the cathode but return through the external path and form a current.

If we now connect a battery between anode and cathode to make the anode potential negative with respect to cathode and gradually increase the voltage, we shall find that the number of electrons reaching the anode gets fewer and fewer, and eventually none do so. The negative anode repels the electrons, and only those of very high velocity can reach it; when the anode is sufficiently negative all electrons are turned back and the current ceases. The anode also exercises an elec-

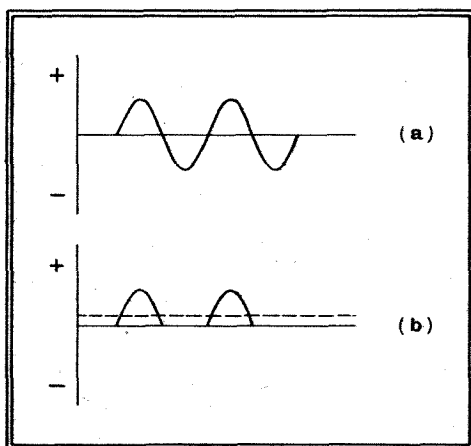


Fig. 2.—The waveform of the input voltage to the diode is shown at (a) and the rectified current at (b).

trostatic force on the space-charge and tends to move it nearer the cathode.

Now, if we reverse the polarity of the battery to make the anode positive with respect to the cathode, the anode will no longer repel electrons but will attract them. These electrons will at first be supplied by the cathode space-charge, for, instead of electrons falling back into the cathode, many of them will travel to the anode. If the potential is high enough all will go to the anode, and the normal space-charge will largely disappear, electrons emitted by the cathode passing straight to the anode.

Saturation

When this happens a further increase in anode voltage will not increase the anode current. All electrons emitted by the cathode are reaching the anode, and an increase in its voltage can attract no more. This is the saturation condition, and the anode current can be increased only by increasing the cathode temperature so that it emits more electrons. In practice, the saturation is not complete, or, rather, an increase of anode voltage above the saturation point does cause an increase in anode current, although only a small one.

This is because of a secondary effect. The anode gets hot through the work done by the electrons hitting it; the velocity of the

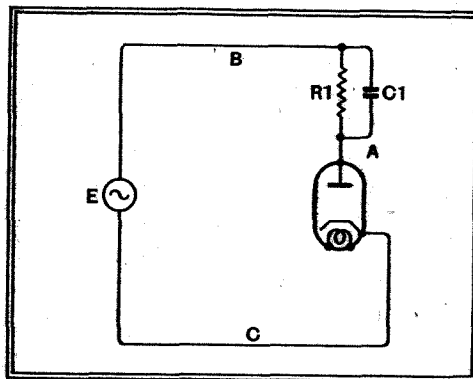


Fig. 3.—In practice, the load circuit R_1 usually has a condenser C_1 across it. The operation of the rectifier is then profoundly modified.

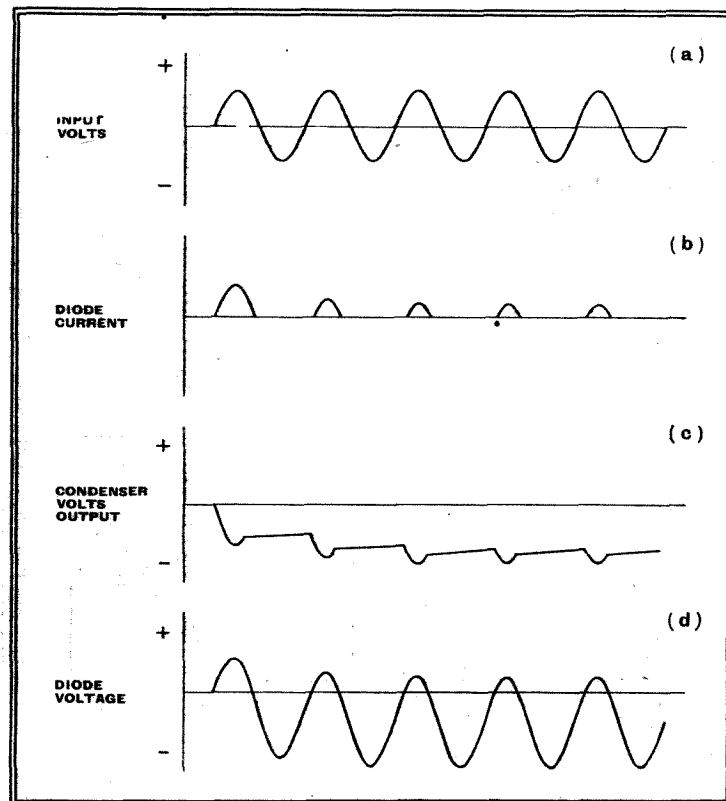
electrons, and hence the work done, increase with the anode voltage, and the anode temperature rises. By radiation the increase in anode temperature raises the cathode temperature and hence the emission.

With most modern diodes the saturation condition cannot be reached, because the cathode emission is so great that the cathode surface would be destroyed before saturation began.

The primary purpose of a diode is rectification. The valve is connected in series with a source of alternating voltage E and a load circuit R , as shown in Fig. 1. The applied voltage has a waveform such as that shown in Fig. 2 (a) and it swings the diode anode alternately positive and negative with respect to the cathode.

When the anode is positive the electrons are attracted to the anode and the current flows, but when the anode is negative electrons do not reach the anode and there is consequently no

Fig. 4.—When a reservoir condenser is used the action is as depicted in these diagrams, where (a) represents the input voltage waveform. The current through the diode is depicted at (b) and the voltage across the condenser at (c). The voltage between anode and cathode of the diode is shown at (d).



current. The current flow in the circuit is, therefore, as depicted in Fig. 2 (b); it flows in pulses on every positive half-cycle of the input voltage.

The current is pulsating and unidirectional, and it has a mean value, illustrated

by the dotted line, which will operate a direct current ammeter. The pulsating current can be regarded as a direct current with a superimposed alternating current of complex waveform. By means of smoothing circuits the latter can be removed and an output of nearly pure direct current can be secured.

In practice, the action of the rectifier is rather more complicated than this because the load resistance R_1 is shunted by a condenser C_1 , as in Fig. 3. The diode then conducts for a much shorter period than the whole of every positive half-cycle.

Consider what happens when the alternating voltage E is applied with the condenser C_1 uncharged. As soon as the anode becomes positive with respect to the cathode the valve is conducting and the electrons reaching the anode flow out into the external circuit. Very few flow through R_1 , for the majority flow into the condenser to charge it. The accumulation of electrons on the lower plate (in the diagram) of the condenser means that this plate is acquiring a negative potential with respect to the other plate.

Rectification

The voltage acting on the diode anode is thus reduced, for at the moment taken the point B is positive with respect to C by the input voltage and the point A is negative with respect to B. Consequently A is less positive than B with respect to C.

Current flows through the diode into C_1 and increases the potential across it as long as the positive input voltage is greater than the voltage across C_1 . When the peak of the positive half-cycle of input voltage is passed the voltage falls, and as

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soon as it equals the voltage on the condenser, there is no voltage applied between the diode anode and cathode and the anode current ceases.

The condenser then commences to discharge through R_1 and the voltage across it falls. The discharge is not completed by the time the next positive half-cycle of input comes along, and the diode again passes current when the positive input voltage exceeds the negative voltage on the condenser. After a few cycles a steady state is reached when the electrons leaving the condenser through R_1 during the non-conductive time of the diode are

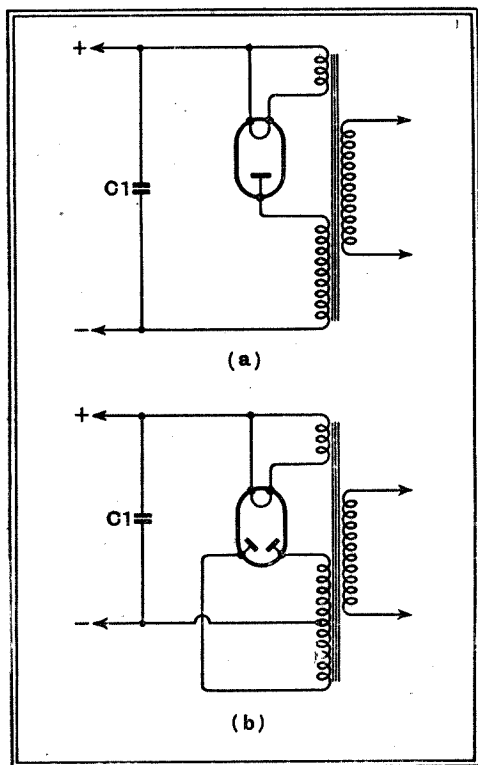
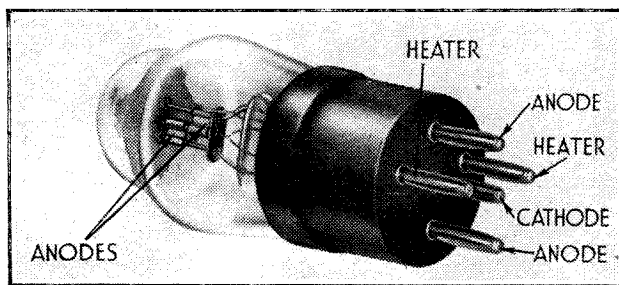


Fig. 5.—A typical half-wave rectifier suitable for a small HT supply unit takes the form shown at (a), while a full-wave rectifier is illustrated at (b).

equal to those entering it through the valve when the diode is conductive.

This state of affairs is sketched in Fig. 4, where (a) shows the input voltage E and (b) depicts the diode current. The condenser voltage is sketched at (c) and the voltage between the diode anode and cathode at (a). It will thus be clear that the ordinary rectifier conducts current for only a small portion of the

A typical duo-diode for use as a detector. Two diodes with a common indirectly heated cathode are fitted.



cycle of input voltage, and that this time decreases as the values of C_1 and R_1 increase. This is clear when it is remembered that the loss of voltage across C_1 during the non-conductive period of the valve increases as the product $C_1 R_1$ is reduced. In the limit, with $C_1 R_1$ equal to infinity, the voltage across C_1 would

not fall, and this condenser would charge up until the voltage across it equalled the peak input voltage. The condenser voltage would then always offset the input voltage, and the diode anode would never become positive with respect to its cathode, and so would not conduct.

This condition is never reached, of course, for we must have a current through R_1 , as it is to obtain this current that we use the rectifier. Nevertheless, for a given value of R_1 , the larger we make C_1 the more nearly will the mean voltage across it equal the peak input voltage, and the shorter will be the conductive time of the valve.

To come to practical values, a valve might be rated for 250 volts RMS input with a mean output current of 75 mA. The peak input is $250 \times 1.414 = 354$ volts, and on no load, that is, with R_1 removed, the output voltage across C_1 will rise to this value. With the full output current of 75 mA. flowing through R_1 the condenser voltage will fall to perhaps 265 volts when C_1 is some $8 \mu F$. Reducing the current to half this value by doubling R_1 will cause the voltage to rise to perhaps 300 volts. If the condenser capacity is doubled, the voltage will also rise.

The Peak Current

Now as the output current is continuous and nearly uniform, and the valve conducts for only a small portion of the total time, it is clear that when the valve does conduct the current through it must be very much greater than the output current. This peak current increases with the capacity of the condenser C_1 and, of course, with the load current, and forms the limit to the safe rectifier output. Users of small rectifiers rarely take much account of the peak current, for it is normal to use a condenser, and valve makers usually take a $4 \mu F$. condenser into account when specifying the load current. With very large rectifiers, however, it is usual for the maximum safe peak current to be specified rather than the output current to the load. In order to make the load current more nearly equal to the peak current, a condenser C_1 is not used

with such valves, and the operation follows more nearly the simple lines discussed earlier.

It should be noted that when a condenser is used, the maximum voltage across the valve on the negative half-cycles is equal to the peak input plus the condenser voltage. This is called the

peak inverse voltage, and can reach on open circuit 2.828 times the RMS input voltage. With high-voltage rectifiers, the maximum voltage input is usually specified in terms of the peak inverse. It should also be noted that with most of the usual circuits the peak inverse voltage

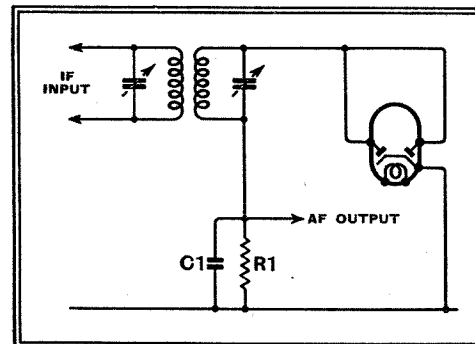


Fig. 6.—The half-wave rectifier is commonly used as a detector and the circuit often takes the form shown here.

appears between two windings on the input transformer.

A practical half-wave rectifier circuit is shown in Fig. 5 (a) using a directly heated type of diode rectifier. Such circuits are usually only used when low output current is required, as in small HT supply units and for high-voltage low-current supplies in television equipment. The resistance R_1 has disappeared, being, of course, replaced by the apparatus which is using the output of the rectifier. Smoothing equipment is interposed between the output shown and the load circuit to remove the ripple.

In order to avoid the considerable discharge of C_1 during the non-conductive time of the diode, it is common to use full-wave rectification. Two diodes are used to conduct on the opposite half-cycles of the input, and their outputs are taken in the same sense to the condenser C_1 , so that it is now charged twice as often. The arrangement is shown in Fig. 5 (b). The two diodes are usually separate electrode assemblies with separate filaments, but mounted in the same glass bulb.

Diodes of much smaller type but functioning in essentially the same way are often used as detectors. The most widely used circuit is fundamentally the same as that of Fig. 5 (a), and is shown in Fig. 6, where the similarity is readily apparent. The values of components are, of course, widely different. Instead of C_1 being $4-8 \mu F$. it is $0.0001-0.0005 \mu F$., and R_1 is of the order of $0.25 M\Omega$. The input is derived from an IF transformer.

In general, detector diodes are available as a pair in one glass envelope with a common cathode. Such a valve is shown in Fig. 6, and the two anodes are strapped together so that the two are used in parallel to form one diode of greater current handling capacity. In some applications they are used separately, and some of the latest duo-diodes have separate cathodes for the two sections, giving greater flexibility of use.

When used as a detector the rectified current rarely exceeds 1 mA., and is

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usually much less. Quite small cathode emission is needed, therefore, and the heater need consume only a small power. The whole electrode assembly can be quite small, and diodes are consequently often built into the same glass bulb as the electrode assemblies of other types of valve. The lower heater power also makes the diode one of the few valves which is available with an indirectly heated cathode in the types intended for

operation from a 2-volt accumulator.

Diodes are not only used for detection and rectification, they are also widely employed to simulate the action of a single-pole make-and-break switch! By changing the anode-cathode potential the valve can be arranged to short-circuit or open-circuit some connection as required. Used in this way a diode can give a delay on AVC action, can effect sync. separation in television, and can reduce certain types of ignition interference.

spectrum is like that sketched in the diagram.

The detector output of the sound receiver then contains the usual audio-frequencies and the 15 kc/s and 25 kc/s sub-carriers which are easily filtered out from the sound channel. The two sub-carriers are then separated by band-pass filters and applied to detectors, in the output of one of which appears the frame scan voltage and in the output of the other the line scan voltage. Amplifiers follow to bring the scanning signals to the correct level for applying to the deflecting plates or coils of the CR tube.

It will be seen that saw-tooth oscillators are not required in the receiver, for the actual saw-tooth voltages are present in the transmission and need only to be selected and amplified. There is consequently no possibility of a lack of synchronism between transmitter and receiver.

Another advantage of the scheme is that it is possible to change the scanning system at the transmitter without affecting the receiver. The number of lines or frames or method of interlacing can be changed as desired without necessitating any alteration to the receiver, since the whole process of synchronising is entirely automatic and does not depend on receiver characteristics.

It remains to be seen whether the system will be generally adopted or not. The use of separate carriers for vision and scanning raises the possibility of greater difficulty of good reception in districts where fading is severe, for the fading is unlikely to be the same on the two carriers. It is clear, too, that variations in signal strength would cause variations in the height and width of the picture. A good AVC system operating on the sound carrier will naturally help greatly.

Television Topics

"FOUR-WAY INTERLACING"

AMERICAN television methods are in general similar to the British, the chief differences in the proposed standards being the adoption of 441 lines and 60 frames. Negative modulation is also used. The 60 frames are interlaced to give 30 complete pictures a second.

A new method of considerable interest has been developed by the Du Mont Laboratories, however, in which interlacing is carried much farther. No fewer than four frames are needed for each picture. It is well known that with normal interlacing alternate lines are scanned in the first frame and in the next those missed in the first scan are covered. That is, if the lines are numbered downwards, lines 1, 3, 5, 7, etc., are scanned in frames 1, 3, 5, 7, etc., and lines 2, 4, 6, 8, etc., in frames 2, 4, 6, 8, etc.

The object of this interlacing is to reduce the frequency response range occupied by the transmission. A frame frequency of some 50 c/s is necessary to prevent flicker, but from the point of view of obtaining continuity of motion in the picture a much lower frequency would suffice.

The maximum modulation frequency is proportional to the number of lines and to the picture frequency. With the ordinary 2-1 interlacing there are two frames to every picture and the maximum frequency is consequently only one-half of what it would be if interlacing were not used, for without interlacing the picture frequency would have to be as high as the frame frequency to prevent flicker.

In the Du Mont system four-fold interlacing is used, so that the picture frequency is only one-quarter the frame frequency

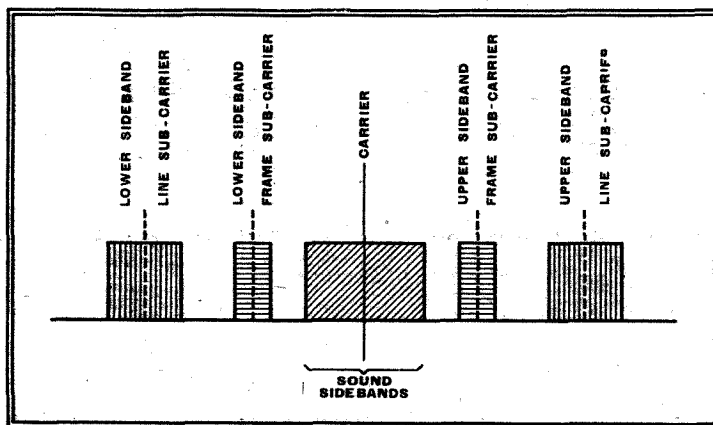
and the maximum modulation frequency is only one-half of that with ordinary interlaced scanning. There are four frames to each picture. Lines 1, 5, 9, 13, etc., are scanned in frames 1, 5, 9, etc., lines 2, 6, 10, 14, etc., in frames 2, 6, 10, etc., lines 3, 7, 11, etc., in frames 3, 7, 11, etc., and lines 4, 8, 12, etc., in frames 4, 8, 12, etc.

The major difficulty in putting this quadruple interlaced system into operation lies in synchronising, for it has been found that ordinary methods are not accurate enough for such complex interlacing. The difficulty has been overcome by abandoning the use of synchronising pulses altogether. Instead the actual saw-tooth scanning waveforms are transmitted.

The Scanning Signals

The vision transmitter deals only with the picture signals and not with a mixture of picture signals and sync pulses as in other systems. The scanning signals are transmitted with the sound on another carrier.

The frame scanning voltages modulate



In this diagram the arrangement of sidebands on the sound carrier is illustrated. The scanning waveforms are carried by two sub-carriers which modulate the sound carrier.

a sub-carrier of 15 kc/s and the line scanning voltages another sub-carrier of 25 kc/s. The carrier of the sound transmitter is modulated by the sound and by the two sub-carriers, so that its frequency

SPRAYED SCREENING

New Process for Non-metallic Materials

CONSIDERABLE savings in manufacturing costs can be effected in components and complete receivers if the necessary metallic screening can be sprayed directly on to non-metallic materials such as bakelite, wood, etc. The difficulty is to find a composition which will not flake off under continual changes of temperature, but which at the same time will have a sufficiently high conductivity.

We learn that the problem has been solved and a method patented in Germany, where the process in question has been adopted by the A.E.G. company for use in their receivers. The mixture is sprayed on in the usual way and subsequently stoved at 150 deg. C. The cost of materials for completely treating an average broadcast receiver would be about eightpence.

The British Empire rights are for disposal, and those interested should apply to the agents, F. Arnold Best and Co., 21, Old Queen Street, London, S.W.1.