The Wireless World

THE PRACTICAL RADIO JOURNAL
29th Year of Publication

No. 1031. THURSDAY, JUNE 1ST, 1939. VOL. XLIV. No. 22.

Proprietors: ILIFFE & SONS LTD.

Editor:
HUGH S. POCOCK.

Editorial, Advertising and Publishing Offices:
DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.

Telephone: Waterloo 3333 (50 lines).
Telegrams: "Ethaworld, Sedist, London."

COVENTRY: 8-10, Corporation Street.
Telegrams: "Autocar, Coventry." Telephone: 5210 Coventry.

BIRMINGHAM:
Guildhall Buildings, Navigation Street, 2.
Telegrams: "Autopress, Birmingham." Telephone: 2971 Midland (5 lines).

MANCHESTER: 260, Deansgate, 3.
Telegrams: "Iliffe, Manchester." Telephone: Blackfriars 4412 (4 lines).

GLASGOW: 26B, Renfield Street, C.2.
Telegrams: "Iliffe, Glasgow." Telephone: Central 4857.

PUBLISHED WEEKLY. ENTERED AS SECOND CLASS MATTER AT NEW YORK, N.Y.

Subscription Rates:
Home and Canada, £1 10s. 4d.; other countries, £1 12s. 6d. per annum.

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.

CONTENTS

EDITORIAL COMMENT

Co-operative Service Guarantees

A Scheme from Denmark

ALTHOUGH we have not heard so much lately of the misdeeds of the unqualified (and often unscrupulous) service man who battens on the ignorance of the average broadcast set user, everyone knows that he still flourishes in our midst. As often as not his victims deserve little sympathy, as they are attracted into his clutches by specious promises of work to be done for nothing or else at an obviously uneconomic rate. We are more concerned here with the bad effects of his misdeeds on the reputations of the many genuine service men who are trying hard to perform what is admittedly a difficult task, and one requiring a high degree of intelligence and knowledge, with the utmost efficiency.

Guaranteed Repairs

A scheme that should do much to enhance the standing of the service man, and at the same time react to the benefit of the public, is reported on another page by our Scandinavian correspondent. It appears that the Danish association, Radioteknisk Forening, has instituted a plan whereby it becomes responsible as a body for the quality of service work done by its members as individuals, and also for the fairness of the charges made. A guarantee label, affixed to the set after the repair has been done, bears the name of the association, to which presumably the customer will address any complaints that may arise in the event of his being unable to obtain satisfaction from the service man who carried out the work.

It would appear that this guarantee label might well fulfil purposes other than that for which it was primarily devised. In the first place the scheme should help to inculcate what may be described as a pride of craftsmanship, as the service man who uses it automatically tends to identify himself with his work and so to accept a personal responsibility for its excellence. Further, the scheme should tend to foster an *esprit de corps* among service men; anyone affixing a label to defective work would know that he ran the risk, not only of damaging his own reputation, but of lowering the standing of all his confreres in the Association.

Weeding Out the Unfit

Perhaps most important of all, a scheme such as that under discussion would have the effect of helping a strong and well-organised service association to weed out the inefficient and slipshod workers from its ranks. Obviously, if the association is liable to incur a monetary liability in respect of any members whose work is consistently unsatisfactory, it is in its own interest to terminate their membership. This natural bar to inefficiency would operate even more powerfully—and perhaps more fairly—than a stiff qualifying examination for membership of an association.

The confidence of the public in wireless servicing is unfortunately not so high as it might be, and we stress this matter because we believe that it is highly desirable from every point of view that the fullest confidence should be established. We shall watch the working of the Danish innovation with the greatest interest, and suggest that the possibility of modifying it to suit the conditions prevailing in this country is worthy of consideration.

Voltage-current Relationships

POINTS IN AC THEORY CLARIFIED BY THE OSCILLOGRAPH

By N. PARTRIDGE, B.Sc., A.M.I.E.E.

IT is common knowledge that condensers and chokes give rise to phase shift when used in audio-frequency circuits. That a choke and a condenser, used in conjunction, can be tuned to resonate at any required frequency is also generally accepted. But to get right down to fundamentals, do we all honestly understand just what these casual observations really signify? Without worrying about the mathematical aspect, let us take an oscilloscope and try to collect some clear ideas about the matter.

As a preliminary step we must see how the peculiar patterns produced by the oscilloscope may be interpreted, and here the freehand curve of Fig. 1 will be useful. The wavy line may represent an alternating current or a voltage. The straight line through the centre is the zero and points above it indicate a current or voltage in one direction (say positive), while points below it denote a current or voltage in the reverse direction (say negative). Time is to be imagined as marching along this line from left to right. Starting from the point A, the current (or voltage) rises in a positive direction, then falls to point B. From here it rises in a negative direction, and then falls again to C. After this the process of alternate positive and negative pulses is repeated all over again. The complete story is told between A and C, the remainder of the curve being only a repetition of the same thing.

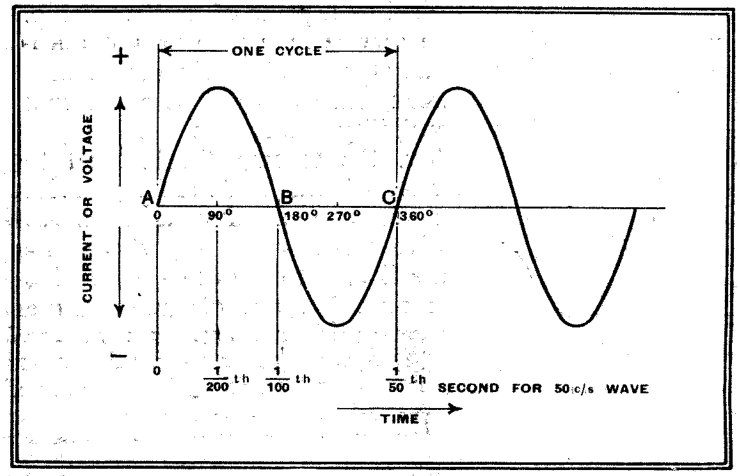


Fig. 1.—The nature of an alternating current or voltage.

This "complete story" is known as a cycle. It is, as the name suggests, a complete cycle of events, and the frequency tells us how many times per second this cycle of events is repeated. If the frequency of the observed wave were, say, 50 cycles per second, the distance from A to C along the zero line would represent $\frac{1}{50}$th of a second. The time interval between A and B would be $\frac{1}{100}$th second, and the time taken for the current to rise from zero to maximum would be $\frac{1}{200}$th second. Sometimes the base line is divided into degrees instead of fractions of a second, this notation being more convenient for mathematical calculations. A cycle is divided into 360°, and, therefore, A to B would be 180°, and a quarter of a cycle becomes 90°. A phase difference of 90° does not mean that the current has gone round a corner, but simply that it is a quarter of a cycle behind or in front of the standard of comparison.

WITH the help of a series of oscillograms, several thorny points with regard to the relationships between voltage and current in various AC circuits are made clear.

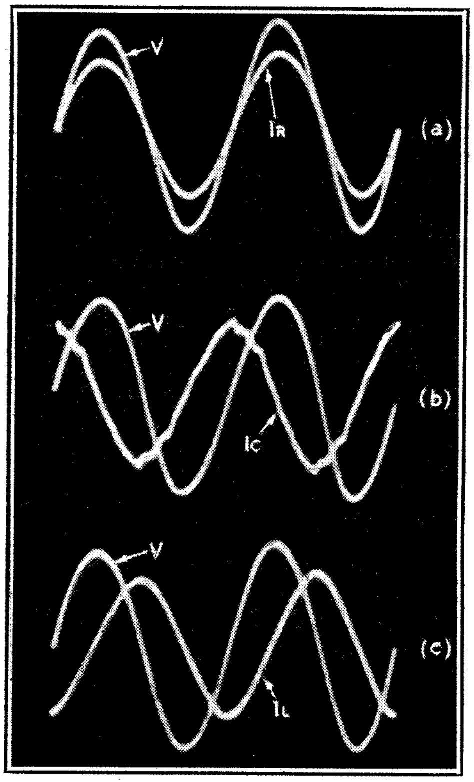


Fig. 2.—Relationships between current and voltage in simple circuits containing resistance, capacity or inductance.

We can now turn our attention to Exhibit No. 1, which is Fig. 2 (*a*). This shows the voltage (V) and current (I_R) relationship in a pure resistance. The circuit from which these curves were obtained is shown in Fig. 3 (*a*). The oscillogram confirms what one would expect from a knowledge of Ohms Law. The current is at all times proportional to the voltage. When there are no volts there is no current; when the voltage reaches a maximum so does the current. On the whole, it is a rather uninteresting demonstration.

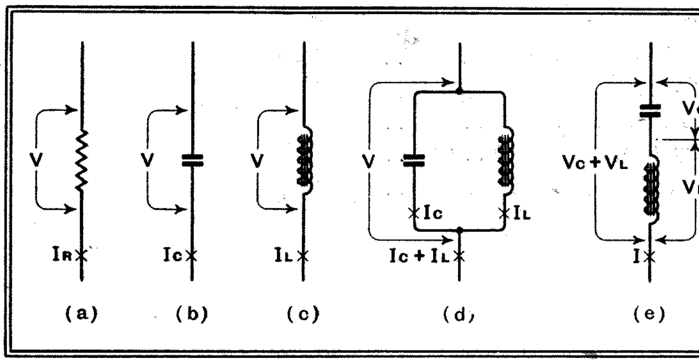


Fig. 3.—Circuit arrangements from which the various oscillograms were obtained.

The next photograph (Fig. 2 (*b*)) shows a similar pair of curves taken with a condenser instead of a resistance (see Fig. 3 (*b*)). The larger curve (V) represents the voltage as before, while the dented curve (I_C) is a trace of the current wave form. The rather second-hand appearance of the latter has been brought about by one of those unforeseen snags that go to make life more amusing. The supply voltage has a very small high-frequency harmonic content, probably due to tooth ripple in the alternator. The impedance of a condenser is inversely proportional to frequency, and, therefore, the harmonic will pass through more easily than the relatively low-frequency fundamental. The ripple in the current curve is only a magnified version of a corresponding ripple in the voltage curve too small to be noticeable. This minor imperfection must be overlooked for the purpose of the present discussion. The major difference between Fig. 2 (*a*) and Fig. 2 (*b*) is that the current curve (I_C) has shifted a quarter of a cycle to the left, and is, therefore, ahead of the voltage curve (V)

Voltage-current Relationships—

by 90°. Our next job is to elucidate the mystery of its having got there.

When a constant voltage (DC) is applied to a condenser, current flows into it until the condenser is fully charged, then current ceases to flow, although the voltage may be still applied. A short-circuit across the condenser terminals will reduce the volts to zero, and, at the same time, cause a discharge current to flow. Changing the voltage across the condenser produces a charging or discharging current, while a steady voltage results in no change of charge and, therefore, no current.

In Fig. 2 (*b*) we can observe this process of charging and discharging taking place in time with the alternations of the voltage. Consider the condition a quarter of a cycle from the left of the oscillogram, i.e., where the current is zero and the voltage is at a maximum. The voltage is changing from a rising to a falling state, and for an instant between the two conditions it is constant. The condenser at this instant maintains a steady charge, and, therefore, current flows neither in nor out. For the next half-cycle the voltage falls, first to zero, then to a negative maximum. The condenser is consequently first discharged and then charged up in the reverse direction, hence the negative loop of the current curve. The quicker the change of voltage the more rapid will be the change of charge held by the condenser. Where the voltage curve is steepest as it crosses the zero line we find the greatest discharge current; i.e., a negative maximum to the current curve.

We are now at the negative peak of the voltage, and for an instant the voltage can again be regarded as constant. The current, therefore, falls to zero. For the following half-cycle the voltage returns to zero and then rises to a positive peak. During this time the condenser must be discharged and then charged in the original direction, a process resulting in the positive half-cycle of current which ends up at zero as the voltage reaches its maximum and instantaneously constant value.

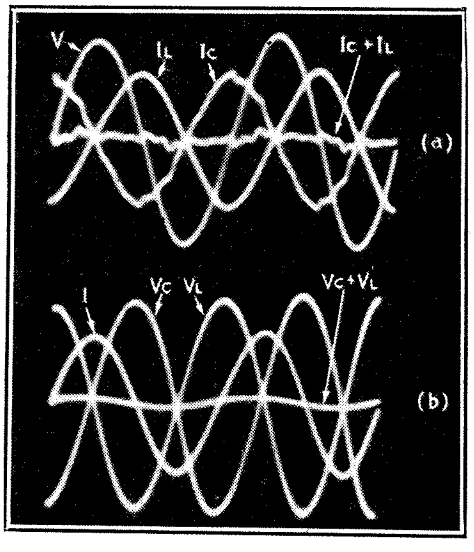


Fig. 4.—Oscillograms of voltage-current relationships in more complex circuits.

Since the process has been reduced to one of charging and discharging the condenser, it is reasonable to assume that no power is being used up. Energy is absorbed by the condenser when it is charged, but during the following discharge it gives the energy back again. The truth of this can be seen from the oscillogram. Starting from the extreme left, for the first quarter-cycle the current and voltage curves are both positive. This indicates that power is being supplied to the condenser from the mains. The subsequent quarter-cycle has a positive voltage, but a negative current; therefore, power is being returned to the mains from the condenser. The exchange of energy from mains to condenser and vice versa is repeated four times in every complete cycle.

Inductive Circuits

So much space has been given to chasing the condenser current up hill and down dale that the corresponding curves obtained by substituting an inductance (Fig. 2 (*c*)) can have but brief mention. The current (I_L) this time has shifted to the right of the voltage curve, i.e., it lags by 90°. Again, no power is dissipated because the same exchange of energy from mains to the inductance and back again occurs as with the condenser, but with one important difference. During the quarter-cycle that power is being absorbed by the condenser, power is being given out by the inductance. Where the condenser curves are both of the same sign, the inductance curves are of opposite sign. This follows, since the condenser current (I_C) is a complete half-cycle out of phase with the current through the inductance (I_L).

Looking at the two oscillograms of Fig. 2 (*b*) and (*c*), the current curves are the inverse of each other. Tip the condenser current curve upside down, and it gives the current curve obtained from the inductance. This is very interesting because it looks as though the two currents would cancel each other if drawn from the same source of supply.

It is quite a simple matter to examine this possibility experimentally. The circuit diagram is shown in Fig. 3 (*d*), and all we require of the two components is that they shall each pass the same current when separately connected across the supply. The oscillogram of the various currents is given in Fig. 4 (*a*). The condenser current (I_C) is substantially the same as the choke current (I_L), but always in the reverse direction. The sum of the two (I_C and I_L) would be zero were it not for the irrepressible harmonic, which we are justified in ignoring.

This idea of a substantial current passing through both components while none comes from the supply is suggestive of magic; nevertheless, it is amenable to reason. When the voltage is first switched on a little packet of energy is taken by the circuit. From then on the choke and condenser play shuttlecock with it. When the choke gives out energy the condenser takes it in; when the condenser gives up the energy a quarter of a cycle later, the choke receives it back again, and so on. It is not altogether correct to say that no power is drawn from the supply because a little energy is lost in the resistance of the choke winding and in the dielectric of the condenser. If these losses could be eliminated, literally no current or power would be dissipated. Then if the game were once started it would go on for ever, and the supply could be disconnected, since its only purpose was to provide the starting impulse.

In order to produce the above phenomenon the choke and the condenser must draw identical currents when individually connected to the AC source. This is the same thing as saying that they must have the same impedance at the frequency of the supply. And both these statements are equivalent to saying that the condenser and choke must be tuned to the frequency in question. A tuned circuit is nothing more or less than one in which the capacity takes in and gives out little parcels of energy of exactly the same magnitude as those needed by the inductance. The upshot of this is that the two partners (capacity and inductance) match each other perfectly and pass the energy back and forth without loss.

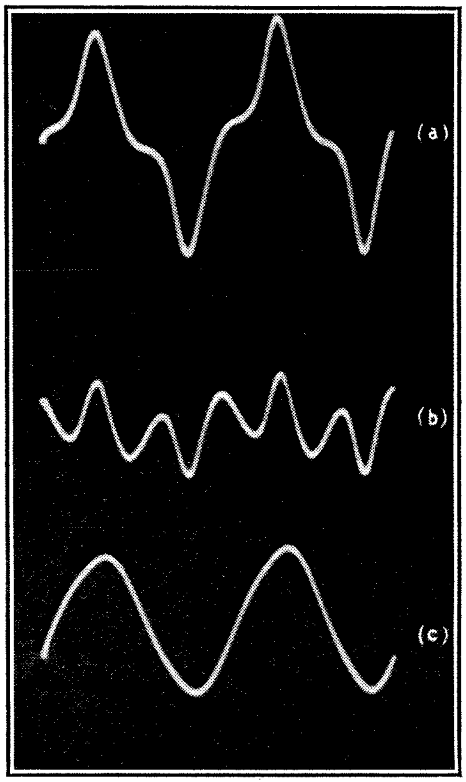


Fig. 5.—Waveforms with superimposed harmonics.

So far we have applied the same *voltage* to the components, but, by connecting them in series, we can assure the same *current* passing through both. The circuit of Fig. 3 (*e*) illustrates how this is done. The current must be in phase with itself throughout the circuit, and, therefore, the current in the condenser will be in phase with the current through the choke. Instead of keeping the voltage as a standard of reference, as in Fig. 2(*b*) and (*c*), the condition now is that the current has become the standard. By moving Fig. 2 (*c*)

Voltage-current Relationships—
along until the current curve comes directly beneath that of Fig. 2 (*b*), it can be seen that the voltages are thereby pushed out of phase. They are equal and opposite.

The voltage oscillograms are illustrated in Fig. 4 (*b*). The large waves represent the voltages across the choke and condenser, while the almost straight line indicates the supply voltage. Being the sum of two equal and opposite voltages, the latter is practically zero. The analogy between the parellel and series circuits is very apparent. In the former the two *currents* add up to zero, while in the latter the two *voltages* combine to give the same answer.

The foregoing study is inclined to produce mental fatigue, and, in the manner of a not-too-serious schoolboy, one is tempted to end up by "larking about" with the apparatus available. Fig. 5 (*a*) shows a voltage waveform that is made up of a 50 c/s fundamental plus a considerable harmonic content. By juggling with the tuned circuit it should be possible to sort out the harmonics and separate them from the 50 c/s fundamental. This time deliberately instead of accidentally, as in the case of the intruding tooth ripple earlier on.

Filter Circuit

A parallel-tuned circuit draws no current from the supply, and, therefore, behaves like an open circuit at the particular frequency to which it is tuned. At higher frequencies the capacity passes more current and the choke less, so that the two no longer balance each other, and, therefore, the impedance falls below infinity. The arrangement of Fig. 6 gives hope of achieving our object. The circuit

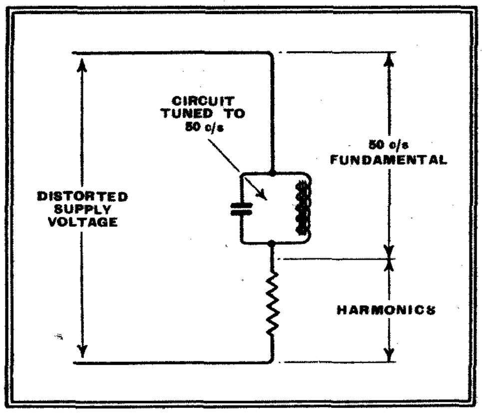


Fig. 6.—Circuit for separating harmonics from the fundamental frequency.

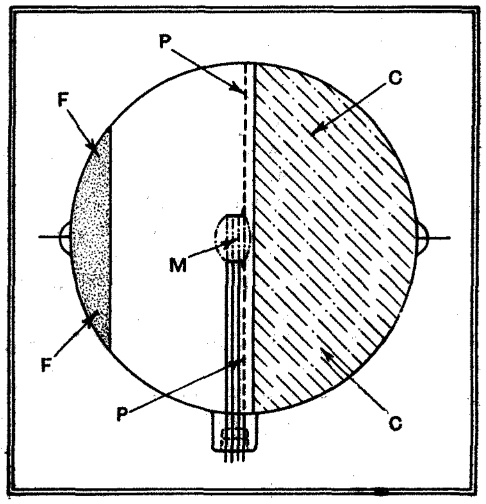
tuned to 50 c/s should prevent any current of this frequency from passing, but will allow the harmonics to go through. There is reason to anticipate that the voltage developed across the resistance will be almost entirely harmonics of 50 cycles. Fig. 5 (*b*) shows what was actually found. The third harmonic is the largest, but the fifth and seventh are also present, and are the cause of the irregular nature of the wave.

Fig. 5 (*c*) shows the voltage across the tuned circuit. It is practically a pure 50-cycle wave with only a suggestion of harmonic left. Since the three curves of Fig. 5 are all to the same scale, the two lower ones should add together to form the original wave. Some readers might like to try it for this week's homework, in which case the Editor will probably excuse them from attempting the "Problem Corner" question!

Light Amplifier

REGENERATIVE PHOTO-CELL

THE point at which incident light is first converted into signal current by photo-electric action is one of the weakest links in the chain of television. The Iconoscope tube, with its "storage" screen of mosaic cells, goes some way towards restoring the balance, whilst the electron-multiplier offers still



The principle of regeneration applied to a photo-electric cell in conjunction with an electron multiplier.

further possibilities. Another promising scheme is to apply the principle of reaction to "boost" the output from a photo-electric cell. For instance, the electrons liberated by the impact of light upon a photo-sensitive cathode can be focused upon a fluorescent screen, and the light from the latter "fed back" on to the sensitive cathode, where it serves to increase the strength of the orginal stream.

The accompanying drawing (from Patent 499661) shows a "back-coupled" photo-electric cell of this kind used in combination with an electron-multiplier, the latter serving to emphasise the regenerative effect. The cell contains a photo-electric cathode C which is arranged opposite to a fluorescent screen F, an electron-multiplier M being placed midway between the two and in line with a transparent screening partition P. Light falling on the cathode C liberates primary electrons, which are attracted by the positive voltage on the first electrode of the multiplier M and pass from it through a series of "permeable" target-electrodes, each biased more positively than the last.

The emerging stream, now considerably amplified by secondary emission, produces a more intense light than usual on the fluorescent screen F. This light "reacts" back on the sensitive cathode C to liberate more electrons, and so build up the current strength still further until it is taken off from the last or output electrode of the multiplier M. To prevent the current from building-up to saturation a "quenching" frequency is applied to the screen electrode P, together with an EMF of carrier frequency.

PROBLEM CORNER–22

An extract from Henry Farrad's correspondence, published to give readers an opportunity of testing their own powers of deduction :—

"Radiovilla,"
Hackbridge.

Dear Mr. Farrad,

Thank you for the tip about the dynatron oscillator ; it is working very nicely now with a tapped battery. Meanwhile, here is another little perplexity that I have come across in working on the 56 Mc/s amateur band. For adjusting the tuning of a certain circuit over a small band in the region of this frequency it was inconvenient to have the very small variable condenser close up against the coil ; I hadn't got a small enough condenser anyway. But I knew that when a certain capacity is tapped across part of a coil it is equivalent to a smaller capacity across the whole coil. I did this, using a condenser with a capacity of 0.000025 mfd. I reckoned this would be equivalent to about 5 micro-microfarads across the whole coil. But the funny thing is that when this condenser is connected, instead of the frequency going down, as it ought, it goes *up*!

The leads are nearly 6 inches long, unfortunately ; but I have spaced them well apart—about 3 inches actually. Can you tell me why the condenser acts apparently as a negative capacity ? And another thing —although the whole of this tuning arrangement is thoroughly "low loss," it makes it very difficult for the circuit to oscillate at all.

Yours sincerely,
Ray Lea.

Henry Farrad's solution is given on p. 514.

The Wireless Engineer

IN the June issue of our sister journal, *The Wireless Engineer*, which is on sale to-day, June 1st, price 2s. 6d., is the first part of an article which investigates the static and dynamic characteristics of pentode and tetrode output valves with a view to minimising in their design the distortion in the output stage of a receiver. Another article in the same issue gives some theoretical and experimental considerations of the requirements governing the production of power when using triode oscillators for ultra-short wavelengths.

A monthly feature of *The Wireless Engineer* is the Abstracts and References section, compiled by the Radio Research Board, in which is given abstracts of articles on wireless and allied subjects published in the World's technical press.

Winding Short-wave Coils

POINTS IN DESIGN AND CONSTRUCTION

By

DAVID R. PARSONS, Grad.I.E.E.

THIS article contains much useful information on such important factors in coil design as ratio between length and diameter, choice of former, wire gauge and covering and the effect of screening

FEW amateurs wind their own medium- and long-wave coils nowadays; with ganged circuits and the modern construction of coils the ability of the amateur to wind them himself is somewhat limited. With short-wave coils a different position arises as, even on the lower frequencies, coils consist of only a few turns of wire, and, although matching is still necessary, the coils can be cheaply and simply constructed at home.

Let us consider a short-wave resonant circuit as shown in Fig. 1 (a). This consists of a coil or inductance L and a condenser C. Actually, the circuit is not quite as simple as this, since the wire which forms the inductance L has a resistance R_L, and since a perfect condenser is never obtainable, except perhaps of the quartz-insulated type, the condenser has a certain resistance R_C. Also, the coil has a self-capacity C_O which resonates with the coil inductance L at the natural frequency of the coil itself. Thus the circuit becomes as Fig. 1 (b). Normally, the natural frequency of the coil is much higher than the operating frequency range of the complete LC circuit and so C_O, which normally consists of 3 to 5 mmfds. capacity, can be combined with C and forgotten except when the total minimum capacity in parallel with the inductance is considered.

The step-up or "goodness factor" of a coil or condenser is known as its Q value, which is always greater than unity. The Q value of a coil is equal to $\frac{\omega L}{r}$ or $\frac{1}{\omega Cr}$ for a condenser. When a condenser of Q_C is placed in parallel with an inductance of value Q_L, the effective total Q, that is Q_T, is equal to the inverse of the sum of the reciprocal values, or:—

$$Q_T = \frac{1}{\frac{1}{Q_C} + \frac{1}{Q_L}}$$

However, provided condensers of good insulation are used, with a minimum of insulating material, the factor R_C in Fig. 1 (b) may be neglected and considered as part of R_L, since it is very small with ceramic type condensers or air-dielectric condensers with ceramic insulation, at any rate at frequencies below 15 Mc/s. Thus, provided high quality condensers are used, we can say that the efficiency of a short-wave tuned circuit depends largely on having a "high Q" coil.

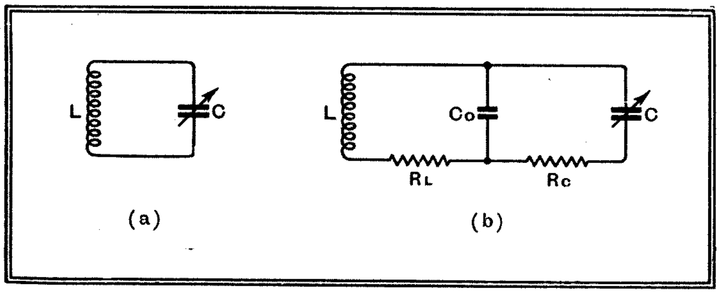


Fig. 1.—An oscillatory circuit and its equivalent in practice.

High Q coils are necessary in oscillators for efficiency and stability, and in RF amplifiers they are absolutely essential for gain and selectivity. Highly technical papers have appeared on the subject of coil design but very little advice has appeared in a form suitable for general readers. Thus, the following notes on short-wave coil design may be found very useful.

Provided reasonable care is taken in the selection of a former, no difference is noted between the Q of an air coil and a similar one wound on a smooth former, i.e., one with no grooves.

If grooves are required for mechanical reasons, ribbed formers should be used or the grooves should be of a depth not exceeding ⅓ to ½ the diameter of the wire. On no account should deeply grooved formers be used.

If shallow grooved formers are used, the Q reduction with bakelite is about 10 to 15 per cent., reaching nearly 30 per cent. with cardboard or wood.

The diameter of coils should be as great as possible, and the ratio $\frac{l}{D}$ (length/diameter) should preferably be less than unity, a ratio between 0.5 and unity being usually the best. Naturally, the length will be governed by the inductance required, but with large-diameter wire such as 16 or 18 SWG, the Q is practically independent of winding length.

Wire diameter should be as great as possible, though gauges below 16 SWG are not normally used, chiefly because of winding difficulties. Gauges between 16 to 22 SWG are generally preferred.

The spacing between turns may be equal to the diameter of the wire. Actually a small increase in Q is noticeable when the spacing is 25 per cent. greater than the wire diameter, but there is little practical advantage in exceeding this figure.

Bare copper wire is best, but after a time oxidisation occurs and, due to skin effect, the RF resistance of the coil increases considerably. Consequently, enamel wire is preferable in all cases as the surface cleanliness of the wire is maintained and the enamel has negligible effect on the Q of the coil.

With stranded wire, the losses in insulation become considerable, and thus the advantage of stranding the wire is lost. Iron-cored coils are also not advisable on short waves, since the reduction in copper made possible by their use is naturally small, and the iron loss is high.

If a coil has a diameter D, then any coil can placed over it should have a diameter at least equal to 2D. With such a screen, its Q will be reduced by about 5 to 10 per cent., while its inductance reduction will be 10 to 15 per cent. The latter can, of course, be allowed for when the coil is originally designed.

The ends of the coil should be at least a coil diameter away from the ends of the screen.

When coils are not screened but placed near a metal chassis as shown in Fig. 2, the dimension *d* should be at least equal to the diameter D of the coil. As *d* is decreased, the Q falls slowly at first and is not halved until *d* is about 1/10th of D, although the inductance change will be considerable.

Suppose, for example, we required to wind a short-wave coil having an inductance of 1 microhenry and a ½-inch diameter paxolin former is available. 20 SWG is probably the smallest gauge an amateur can handle unless a small winding mandril is available. 20-gauge enamelled wire has a diameter of 0.038 inch.

For maximum Q, spacing between turns

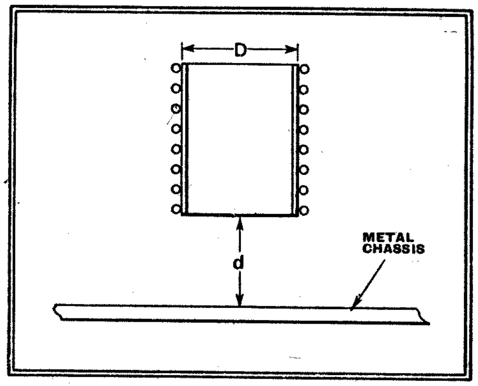


Fig. 2.—Spacing between coil and screen should be at least equal to coil diameter.

Winding Short-wave Coils—

is equal to 1.25 *d*, where *d* is the diameter of the wire used. Therefore spacing should be $\frac{0.038 \times 5}{4}$, or 0.0475in. The turns per inch will be $\frac{1.000}{0.0475}$, or 21.1. The effective diameter D of the coil is equal to the coil former diameter plus diameter of wire, or 0.500in. + 0.038in.; that is, 0.538in.

Using the *Wireless World* Abac No. 19 for coils of 0.2 to 20 microhenrys, we have $\frac{l}{D}$ ratios of 0.88, a satisfactory value, and the total turns will be 21.1 × 0.538 × 0.88, or 10 (approximately).

Since the spacing is 0.0475in. we can use another length of wire as a dummy winding for spacing purposes; 20 SWG is 0.046 inch diameter, so a length of this wire may be wound alongside the actual coil wire and removed afterwards.

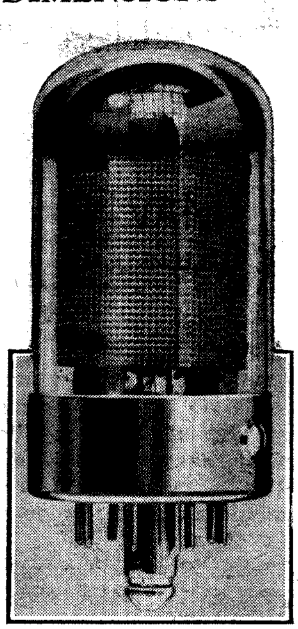
The smallest screening can in which the above coil should be mounted would have a diameter of 1in. and the ends of the coil should be at least 1 inch away from any steel chassis. Such a screen will reduce the inductance to about 0.85 to 0.9 microhenry, but if we had known a 1-inch screening can was to be used we could have based our calculation on a value of 1.15μH and the final inductance would be approximately 1μH.

American Loctal Valves

CHARACTERISTICS AND DIMENSIONS

THE "Loctal" valves recently introduced by Hygrade-Sylvania and Philco have a new base—of the octal variety—which differs from the ordinary octal base. Although the pins will fit present octal sockets, the pin connections are different, and although the centre locating pin has the usual key to ensure correct insertion, it is grooved near the tip to engage a spring catch or lock in its own special type of socket. The current-carrying base-pins are set in the thickened glass base of the valve and supported entirely by it. The metal shell, of which the locating peg is a portion, has clearance holes through which the contact pins pass. The glass shells of the Loctal type are rather small, and to agree with the present tendency all Loctals are single-ended.

Could we but undo the past here in America, we should certainly have fewer valves with octal bases, and certainly not two sorts of octal base. Perhaps then we should not so soon have come to the end of our alleged system of valve designations, which appears to have been abandoned in the Loctal series. Previously an initial "6" has meant "operating filament voltage between 6 and 7," but in the Loctal series such valves have type designations beginning with a "7" instead of a "6," presumably because the system is at best



This view of the 7A7 clearly shows the locking groove on the centre pin.

vague, and the "6" combinations are so nearly used up that we are encountering such type numbers as "6AC5-G," "6J7-GT." The old system of arbitrary numbering was no worse.

The Loctal valves, however, are good. Their advantage lies in a desirable physical form, for their electrical properties are identical with, or very similar to, other valve types.

Some of the Loctal valves have 0.15A filaments. The variety is sufficient to permit their exclusive use in a midget receiver with series-connected heaters and no transformer. The smaller current and the higher voltage drops in the heaters of the rectifier and output valves of this series make it unnecessary to drop voltage in a resistance external to the receiver. Thus the usual flexible cord resistor can be dispensed with. This resistor may not have caused any fires, but it certainly looks dangerous and has never been approved by the insurance underwriters who are the final authorities in America on the safety of household electrical appliances.

In addition to the Loctal valves a new series of valves has appeared with the subscript GT. These are merely glass valves in a straight-sided tubular form. There are thus the following electrical equivalents: 6K7 (metal), 6K7G (glass), 6K7GT (tubular glass), and the near equivalents 6SK7 (single-ended metal) and 7A7 (single-ended glass Loctal).

CHARACTERISTICS OF THE LOCTAL VALVES.

Type No. Valve.	1231 R.F. Pentode	7A6 Duo-diode	7A7 R.F. Pentode	7A8 Octode	7B5 Output Pentode	7B6 Duo-diode-triode	7B7 R.F. Pentode	7B8 Heptode	7C5 Output Tetrode	7C6 Duo-diode-triode	7Y4 Rectifier	35A5 Output Tetrode	35Z3 Rectifier
Heater volts	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	35.0	32.0
Heater amps.	0.45	0.15	0.3	0.15	0.4	0.3	0.15	0.3	0.45	0.15	0.5	0.15	0.15
Anode volts...	300	—	250	250	250	250	250	250	250	250	350	110	250
Screen volts	150	—	100	100	250	—	100	100	250	—	—	110	—
Grid bias	—	—	−3	—	−18	−2	−3	—	−12.5	0	—	−7.6	—
Anode current (mA) ...	10.0	—	8.6	3.0	32.0	1.0	8.5	3.5	45.0	1.3	60.0	35	100.0
Screen current (mA) ...	2.5	—	2.0	2.8	5.5	—	2.0	2.7	4.5	—	—	2.8	—
Mutual conductance (mA/V)	5.5	—	2.0	0.6	2.2	1.1	1.7	0.55	4.1	1.0	—	5.5	—
AC resistance (Ω)	700,000	—	800,000	—	—	90,000	700,000	—	—	100,000	—	—	—
Input capacity (μμF) ...	8.5	—	6.0	7.5	—	3.0	5.0	10.7	—	2.4	—	—	—
Output capacity (μμF) ...	6.5	—	7.0	9.0	—	3.0	7.0	7.5	—	3.0	—	—	—
Grid-anode capacity (μμF)...	0.015	—	0.005	0.15	—	1.5	0.005	0.15	—	1.4	—	—	—
Load resistance (Ω) ...	—	—	—	—	7,600	—	—	—	5,000	—	—	2,500	—
Power output (watts) ...	—	—	—	—	3.4	—	—	—	4.25	—	—	1.4	—

The Elements of Radio Communication. By O. F. Brown, M.A., B.Sc., and E. L. Gardiner, B.Sc. 2nd edition. Pp. 551 + vii. Published by Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 16s.

THIS book is an elementary text-book and it opens with an introductory and historical chapter. High-frequency alternating currents are then dealt with, after which oscillations and radiation are treated.

Valves are discussed in some detail, and such modern forms of electronic apparatus as the electron multipier, the gas-triode, and the cathode-ray tube are included. Chapters on transmission, detection and amplification follow, and there are long chapters dealing with receiving circuits and selectivity. Propagation and directional reception are not omitted, and the book concludes with a chapter on television.

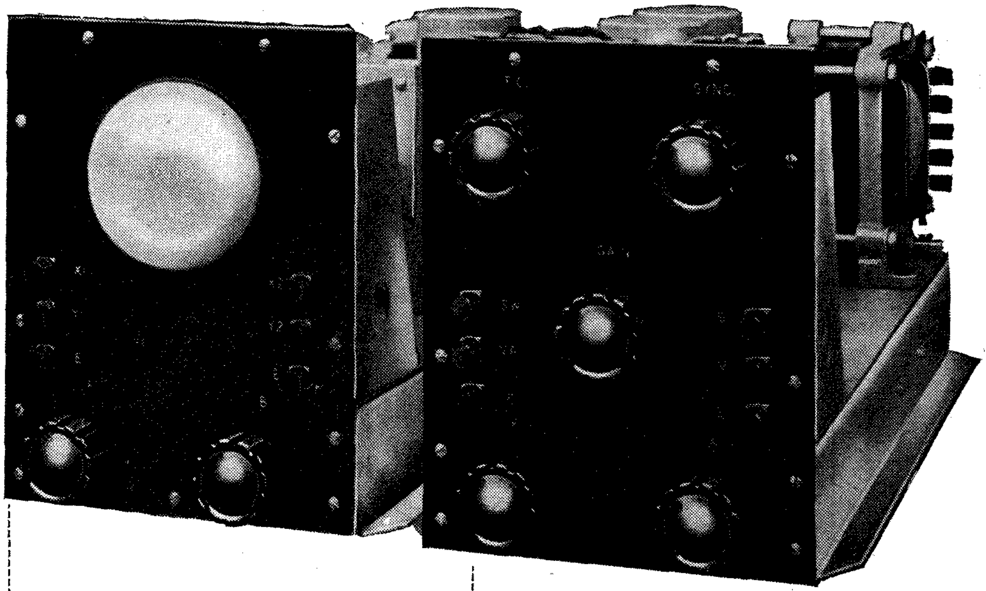
Although formulæ are occasionally introduced, the book is largely non-mathematical. The operation of wireless apparatus is well explained and the book is unusually free from errors. The authors intend it to cover the syllabus of the City and Guilds Grade 1 examination, and to assist the student have provided a set of examination questions at the end of each chapter. Answers are not provided, however.

W. T. C.

Cathode-ray Oscilloscope

SIMPLE UNITS EMPLOYING A $2\frac{1}{2}$ in. TUBE

(Concluded from page 486 of last week's issue)



IN concluding the description of this cathode-ray oscilloscope notes on the construction are given as well as an account of the method of operation with the time-base.

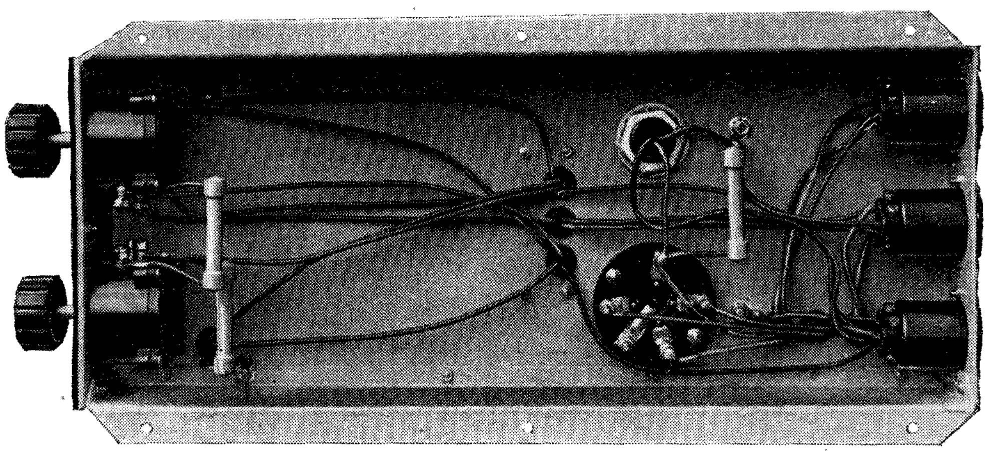
IN many applications of the CR tube a linear time-base is needed, but as it is not always required it is included in a separate unit from the tube. When using the units together they are connected by plugs and sockets, as shown in the drawings. In most cases X1, Y1, and E on the tube unit will be joined, and X2, Y2, and E joined respectively to SW, VA, and E on the time-base unit, while the signal to be examined is applied between V and E. If the amplifier is not required Y2 and VA are disconnected and the signal applied between Y2 and E; in general, it will be necessary to insert a condenser in series with the lead to Y2 in order to prevent any steady potential in the signal circuit from giving a steady deflection.

When first setting up the gear, set the gain control R5 at minimum and the amplitude and frequency controls R11 and R13 about half-way. In the tube unit, set R5 for maximum bias, that is, for minimum brilliance. Switch on and allow time for the valves to warm up. Then advance the brilliance control. If all is in order a horizontal line should appear, and the focus control can then be adjusted for maximum sharpness. No greater brilliance than is necessary should be used.

Adjust the amplitude until the line extends nearly across the tube. Apply a signal, and with the sync control at minimum turn up the gain control until the pattern on the tube reaches a convenient height. The pattern will be complex and unsteady. Now turn the frequency control *slowly*. The pattern will change and certain settings will be found at which it is nearly steady. These are when the time-base and signal frequencies bear definite relationships to one another. With the usual sine-wave input, there will be one setting giving a half-sine curve for the pattern, another giving one sine curve, another giving two, and so on.

It is usually best to pick the setting which gives three complete sine curves, because one is then certain of obtaining an undistorted picture of the centre one. The two end ones may be slightly curtailed by the fly-back.

Having obtained as steady a picture as possible, advance the sync control while readjusting the frequency slightly. The picture should lock in and be quite steady. The sync control should be advanced no more than is necessary, otherwise some distortion of the ends of the trace may occur.



An underview of the tube unit showing the wiring.

Little need be said about the construction of the apparatus, for the drawings are self-explanatory. It must be pointed out, however, that the CR tube is very susceptible to the stray field of the mains transformer. The optimum position for the transformer specified is shown on the drawings, but if a component of different design is employed a new position for it may have to be determined experimentally.

Constructional Hints

The components should be completely assembled on the base-plates before wiring is started. The earthing points are particularly important, and it is necessary to see that the metal is bright, so that the screws are not held back by cellulose paint. See that the heads of the screws on all valve holders are well recessed and, if sparking across to the base is feared, cut out and insert waxed paper or bakelite rings between the valve holders and chassis. Avoid subjecting the heavy transformer leads to excessive twisting, and do not pull on the finer wires, since they may break off short at the bobbin. Before fitting the valve holders it is advisable to solder the blades to their screws rather than rely entirely upon the tightness of the nuts; a really hot iron is needed for this purpose.

Make sure of the identity of the centre-taps on the transformer HT windings. An error in this respect will lead to the destruction of an electrolytic condenser immediately the unit is switched on. Avoid nicking the wire when cutting back sleeving—it is better to slide the sleeving off when cutting to length. Use 22 SWG tinned wire for connecting up and 1 mm. (size of hole) silk sleeving. It is, of course, easier to wire from the circuit