September, 1928

DUBILIER CONDENSERS & RADIO PRODUCTS

List No. 928

Dubilier Condenser Company (1925) Ltd.

DUCON WORKS, VICTORIA ROAD, NORTH ACTON,

LONDON, W.3

DUBILIER

DUBILIER CONDENSERS & RADIO PRODUCTS

List No. 928

SECTIONS

P—Condenser Equipment for Power Factor Improvement of A.C. Circuits

T—Condensers for Radio and Wired Wireless Transmission

L—Precision Condensers and Laboratory Apparatus

B—Condensers and other Components for Broadcast Reception

M—Mansbridge and other Paper Dielectric Condensers

R—Radio Receivers for Broadcast Reception

For easy reference the section letters are incorporated in the page numbering.

September, 1928

Dubilier Condenser Company (1925) Ltd.

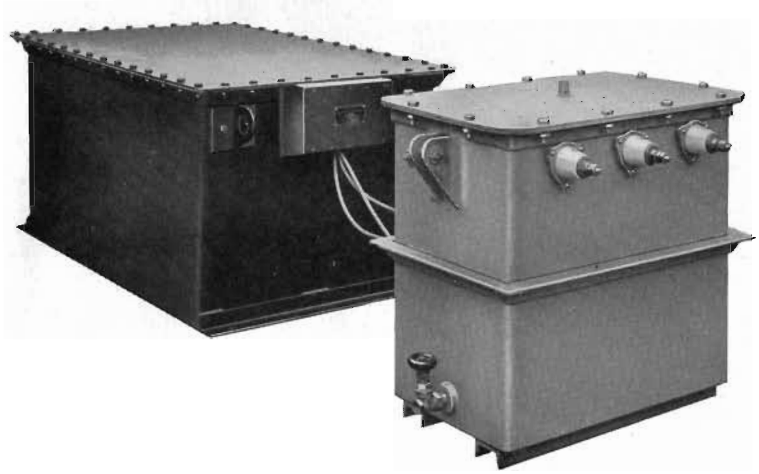
Ducon Works, Victoria Road, North Acton, London, W.3

Telephone: Chiswick 2241 *Telegrams:* Hivoltcon, Phone, London

Incoming Mains and Power Distribution Switch Boards
for Condenser manufacture and testing

Section P

Condenser Equipment for Power Factor Improvement of A.C. Circuits



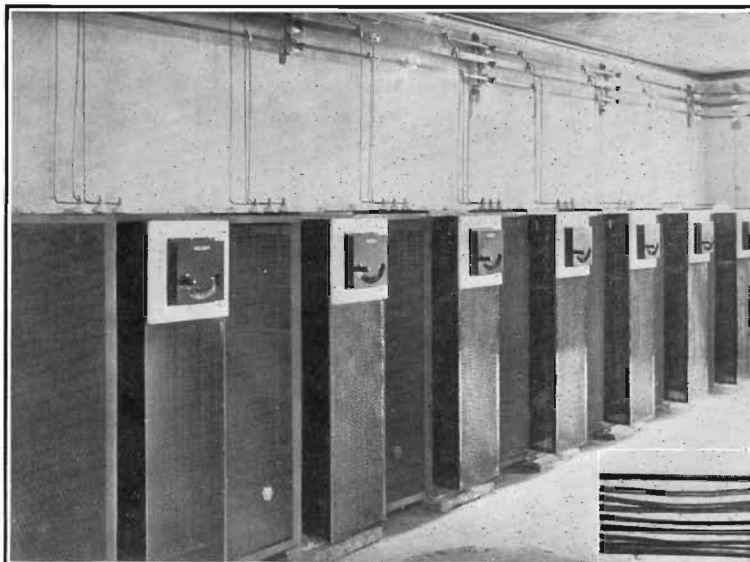
Dubilier Condenser Equipment for power factor improvement, with auto-transformer, 55 kVA, 500 Volts, 42 Cycles

Introduction

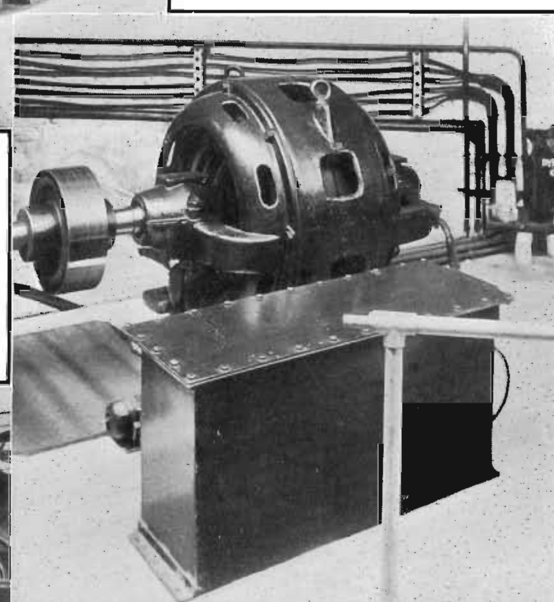
THE action of a condenser in an alternating current circuit and the effect of a condenser on what is known as the power factor of the circuit has been known for a great number of years, but it is only within recent years that condensers have found industrial applications in connection with alternating current power circuits and have been manufactured on a commercial scale for such uses. The advantages of high power factor in an alternating current circuit are now becoming appreciated, and the designs of condensers for use on these circuits have been brought to the requisite stage of perfection to enable them to be used on an extended scale. The growth in the demands for electric power made on the generating stations of the country are bringing about changes in the tariffs set up by the supply undertakings for charging for this electric power, and the introduction of systems of charging based on the maximum demand of power made on the supply system are encouraging the use of means to improve the power factor of the loads connected to such systems. Not only from the point of view of the generating stations and their cables supplying industrial works, but also from the point of view of the users of electric power is it advantageous to use condensers to keep a high power factor.

The Dubilier Condenser for Power Factor Improvement has been developed as a result of much research and careful design. The fact that it is a stationary piece of apparatus which requires no attention and has no maintenance cost is materially in its favour as a means of power factor improvement. Reliability, strength, and ruggedness, both of electrical and mechanical design, and flexibility of design and application, are leading characteristics of Dubilier Condensers. These condensers are constructed in a number of forms fitting them for different conditions of use, and Dubilier Condensers can be manufactured for the most exacting conditions of service either indoors or in the open air.

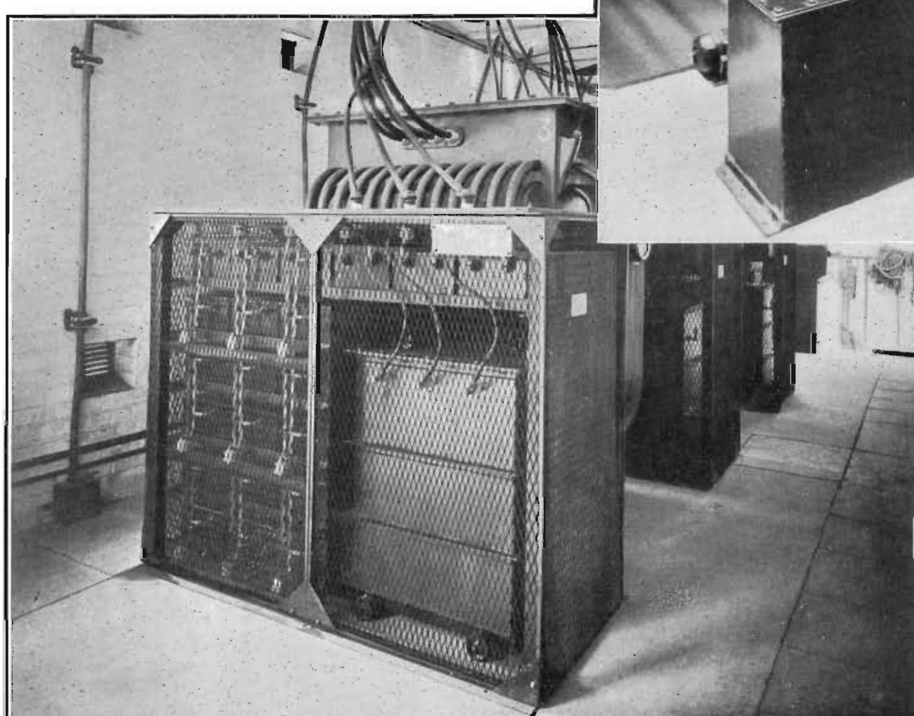
Dubilier Static Condenser Installations



SECTIONALISED CONDENSER BANK installed in large factory



INDOOR TANK TYPE CONDENSER installed adjacent to A.C. motor



CONDENSER BANKS installed in sub-station for power factor improvement

What is Power Factor?

In direct current and in some alternating current electric power circuits, the product of the pressure or voltage of supply with the current drawn from the supply mains is a true measure of the electric power which is being consumed. With most alternating current circuits, however, this product does not express the true power, and, in fact, the true power is, in such circuits, always less than this product. To obtain the true power this product of current and voltage must be multiplied by a factor which is less than unity. This quantity is called the power factor of the circuit.

In a single-phase alternating current circuit, 1/1000th of the product of the voltage of the supply with the current drawn from it is the kilo-voltamperes (kVA) of the load. The true power

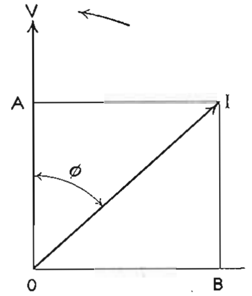


Fig. 1—Vector Diagram of A.C. Circuit

consumed is known as the kilowatts (kW), and hence, in accordance with the above definition, the power factor of the circuit is the quotient of $\frac{\text{kW}}{\text{kVA}}$. In two or three phase circuits the similar quotient of $\frac{\text{kW}}{\text{kVA}}$ is also known as the power factor of those circuits. The power factor of a circuit is accordingly usually expressed as a decimal number having a value between 0 and 1·0. In some cases, however, the same factor is expressed as a percentage, *i.e.,* a power factor of 0·75 is sometimes stated as 75%.

Causes of Low Power Factor.

A power factor of less than unity is found in all alternating current circuits except those which consist of a non-inductive load, such as purely electric lamps or electric heating apparatus. All ordinary forms of alternating current motors draw energy from the supply mains at a power factor which is less than unity, and the smaller the motor and the lighter the load upon it, the lower is the power factor at which it operates. It follows, therefore, that for all A.C. motor circuits Power Factor Correction Condensers should be used.

In the technical representation of the currents and voltages in an alternating current circuit, it is usual to express these currents and voltages by means of vectors drawn out on a diagram at angles relative to each other depending on what are known as the phase angles of the circuit. If in Fig. 1 the vector line OV is drawn to represent the voltage of the circuit, then in any A.C. circuit feeding motors or other inductive loads the current may be represented by a vector line such as OI on the diagram, this vector being drawn at an angle to the vector OV, the angle being designated by the Greek letter ϕ (phi). In considering vector diagrams it is usual to assume that the vectors are rotating in an anti-clockwise direction, as indicated by the arrow in the diagram in Fig. 1. This vector OI is therefore lagging behind the vector OV, and in all inductive A.C. circuits the current does lag behind the voltage by an angle which may have any value between zero and 90°. Obviously the vector OV may in effect be resolved into two components, one OA in phase with the voltage vector OV, and the second component OB at right angles to the voltage vector (or 90° out of phase with it). The component OA in phase with the voltage OV is the power component of the current. The product of the numerical value OA with the numerical value of the voltage OV is the true power consumed in the circuit, expressed in watts, and if this product is divided by 1000 the power is expressed in kilowatts (kW). It is obvious from the diagram that this product is numerically much less in many cases than the product of the current OI with the voltage OV. From a trigonometrical consideration of the diagram the vector OA may be expressed as equal to the vector OI multiplied by the cosine of the angle ϕ (that is, $OA = OI\cos\phi$). This angle ϕ is the phase angle of the current in the circuit, and hence the power factor of the circuit is numerically equal to the cosine of the phase angle. The vector OA is known as the energy or "watt" component of the current, while the second component OB is known as the "wattless" component of the current, since, vectorially speaking, the product of OB and OV is always zero, since they are electrically at right angles to each other. Numerically the wattless component OB is equal to the current OI multiplied by the sine of the angle ϕ (*i.e.,* $OB = OI\sin\phi$).

As a numerical example of what may be involved in an ordinary type of A.C. circuit with an inductive load taking current at a low power factor, the following may be considered. A 50-kW load drawn from a 500-volt single-phase alternating current circuit at unity power factor would draw a current from the mains of $\frac{50 \times 1000}{500} = 100$ amperes. If the load had a power factor of 0·8 this current would be increased to 125 amperes, the true power in such a circuit therefore being

$$\frac{\text{voltage} \times \text{current}}{1000} \times \text{power factor}$$

$$= \frac{500 \times 125}{1000} \times 0{\cdot}8 = 50 \text{ kW as before.}$$

If the power factor of the load were 0·7 the current would have increased to 143 amperes, at a power factor of 0·6 the current would be 167 amperes, and at a power factor of 0·5 the current would be 200 amperes.

From these figures it is obvious that a low power factor means in many cases a very considerable increase in the current flowing in the circuit to deliver the same actual energy to that circuit, and it is this increased current which is the objectionable factor connected with low power factor circuits which it is so necessary to overcome. The maximum output capacity of generators, transformers, cables, and switchgear is therefore very adversely affected by a low power factor load, and from these considerations it should be clear to all power users that a low power factor is disadvantageous, not only to the Supply Company, but to the user himself, since he must provide larger cables, transformers, switchgear, &c.

The Effect of a Condenser on the Power Factor of a Circuit.

The reason condensers can be used to improve the power factor of A.C. circuits is that condensers when connected to such circuits draw from the supply a current which is almost entirely a wattless one, but different from the wattless current taken by a motor or other inductive load in that it is, so to speak, in the opposite direction, or 180° out of phase with the inductive wattless current. The wattless current drawn by a condenser can therefore be used to cancel out or neutralise the wattless current drawn by a motor, and if the balance is a complete one the motor will then draw from the mains a resulting current which has a "watt" or energy component only, or, expressed in other words, the resultant power factor of the load will have been brought up to unity. On this view the condenser may be regarded simply as a means of cancelling or neutralising the unwanted wattless magnetising currents drawn by A.C. motors.

In the terms of the vector diagram in Fig. 1, the condenser has the effect of reducing or entirely cancelling out the wattless component OB of the load current, for the reason that the condenser takes a wattless current which leads the voltage by 90° (approximately). This is more completely expressed in the vector diagram in Fig. 2. A portion of this diagram is drawn in the same as Fig. 1, with the vector OV to represent the voltage of the supply circuit and the lagging vector OI to represent the lagging current drawn, for example, by a motor connected to the circuit, the angle of the lag being shown as ϕ on the diagram. The wattless component of the load current is, as before, represented by the vector OB. On the same diagram the vector OC_1 has been drawn in to represent the current taken by a condenser connected to the circuit in parallel with the motor, this vector being drawn to the left-hand side of the voltage vector OV, this direction representing a current leading the voltage by 90°. By a simple geometrical construction it is obvious that the resultant of the two current vectors OC_1 and OI is a new vector OI_1 which lags behind the supply voltage by a smaller angle ϕ_1 than did

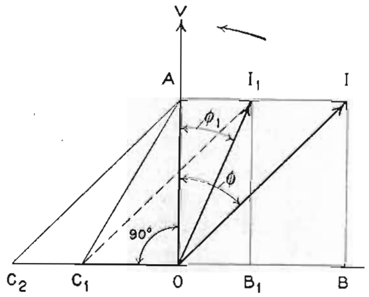


Fig. 2—Vector Diagram showing effect of Condensers

the original load current OI, and that this new current OI_1 has a much smaller wattless component OB_1 while maintaining the same energy component OA. The energy consumed in the load, therefore, remains unchanged, but the resultant current drawn from the mains has been reduced from OI to OI_1 and the wattless component of it from OB to OB_1. By using a larger condenser taking a heavier current OC_2, such that OC_2 is equal to OB, a complete neutralisation of the wattless component OB is obtained, and the vector OA then represents not only the energy component of the load current but the resultant load current itself, which is therefore under these conditions taken at unity power factor, and there is therefore no longer any wattless component to this current drawn from the supply mains. To obtain the result represented by Fig. 2 it is merely necessary to connect a condenser in parallel with the motor across the supply circuit as shown in Fig. 3, where the condenser is shown in a symbolical manner commonly adopted for representing condensers.

Rating of Condensers for Power Factor Improvement

The above consideration of the use of a condenser as indicated in Figs. 2 and 3, which are drawn for single-phase circuits, applies equally well to two and three phase circuits. With a two-phase circuit the total condenser is divided up into two parts, one of which is connected across each phase of the circuit, while with a three-phase circuit the condenser has three parts which are similarly connected, one part across each phase of the circuit.

Considering again the single-phase circuit forming the basis of Figs. 2 and 3 it is evident that the amount of improvement of power factor which is obtained by the use of a condenser depends upon the size of the condenser which is employed, and that if the maximum improvement is to be obtained a very definite size of condenser is necessary, depending upon the nature of the load and the voltage of the circuit. Since the condenser draws a current when connected to the circuit, although this current is a wattless one, the

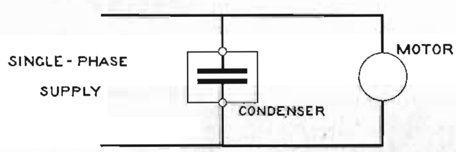


Fig. 3—Connection of Static Condenser to single-phase motor

condenser can be rated in terms of the product of this current with the supply voltage of the circuit, and on dividing this product by 1000 the rating is expressed in kilovolt-amperes (kVA) in a manner exactly analogous to the kVA of the inductive load connected to the circuit. To raise the power factor of a given load to unity or to any other predetermined value less than unity therefore requires the installation of a condenser of a certain kVA, and the magnitude of this kVA rating can be calculated from a knowledge of the circuit without reference to vector diagrams of the type referred to above. Obviously from Fig. 2 it may be seen that since vector OC_1 is equal to the vector BB_1 and the vector OC_2 is equal to the vector OB, the kVA rating of the condenser is numerically equal to the wattless kVA of the inductive load which it cancels out, and therefore for correction of the power factor of the circuit to unity the condenser kVA must equal the wattless kVA of the initial load; that is to say, the condenser kVA is under these conditions equal to voltage $\times$ load current $\times$ 1000 $\times$ $\sin\phi$.

Just as in the case of a two-phase motor the total kVA of the motor is divided on the two phases of the supply, so the condenser for

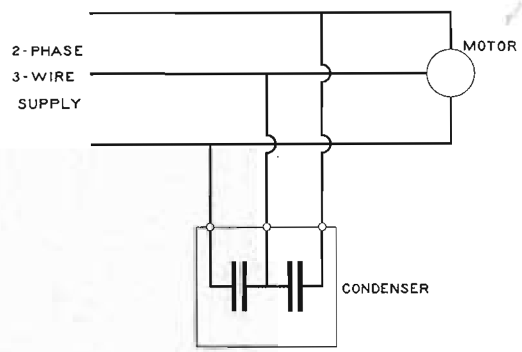


Fig. 4—Connection of Static Condenser to two-phase (three-wire) motor

raising the power factor of a two-phase circuit is similarly divided across the two phases of the supply while maintaining the same total kVA rating, likewise in a three-phase circuit similar conditions hold good: in all cases the rating of the condenser in kVA necessary to

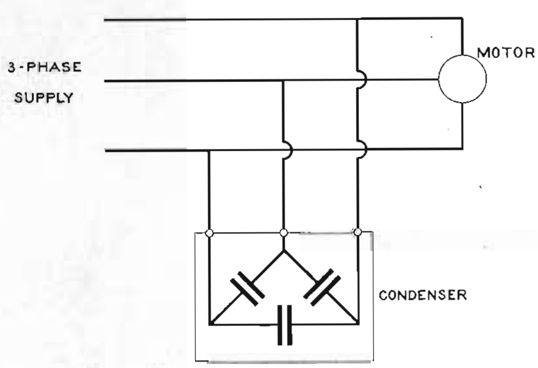
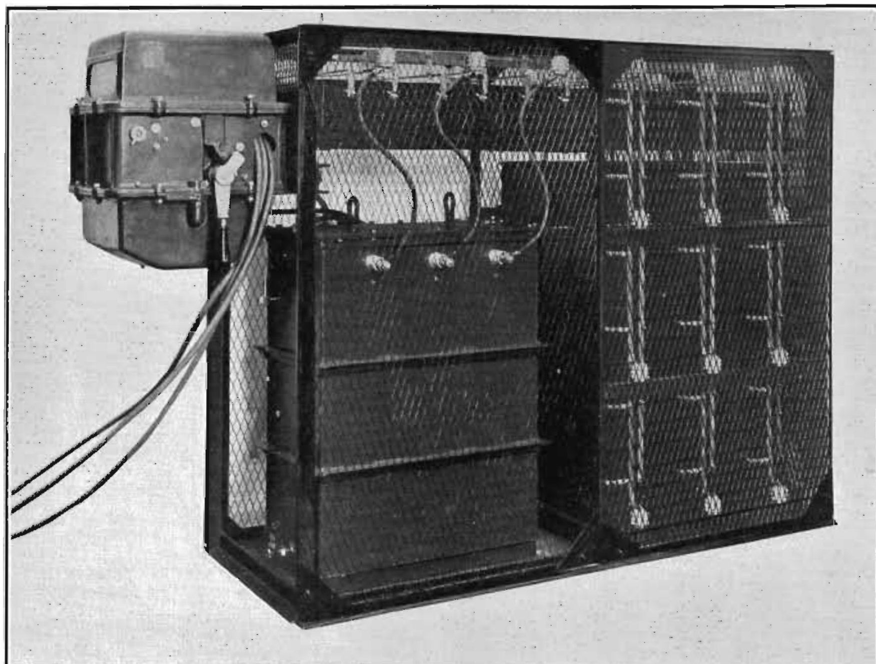


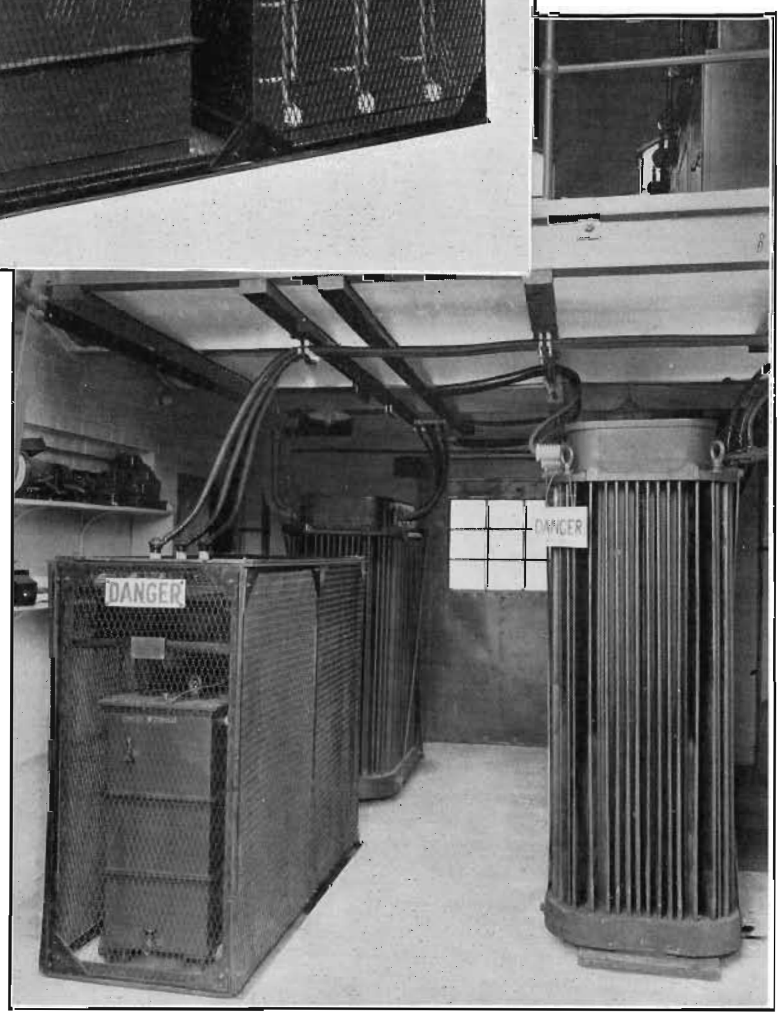
Fig. 5—Connection of Static Condenser to three-phase motor

raise the power factor a given amount must be equal to the total wattless kVA which it is desired to cancel. Figs. 4 and 5 show a similar arrangement of condensers with two-phase and three-phase motors respectively.

Indoor Condenser Installations for Power Factor Improvement



Dubilier Unit Type Static Condenser Installation, with oil-switch and auto-transformer. 100kVA



Dubilier 100 kVA Condenser Bank connected to sub-station transformers

Advantages resulting from Improvement of Power Factor

(a) To the Power User.

Since the improvement of the power factor of a circuit either to unity or to a figure in the neighbourhood of unity, brings about a not inconsiderable reduction in the current flowing in the circuit, it is evident that in designing a new power installation condensers should be allowed for in all motor circuits, as thereby the transformers, cables, and switchgear are all called upon to deal with much lower currents, with a result that the cost of such articles is necessarily reduced. Many A.C. motors take their current at a power factor of the order of 0·7, and therefore without condensers they require cables, transformers, switchgear, etc., capable of handling a current 43% greater than would be the case if they were operated at unity power factor by means of appropriate condensers. The increase of current brought about by low power factor is shown in the curve, Fig. 6, from which the above-mentioned figure of 43% at 0·7 power factor is obtained.

Existing installations may advantageously be fitted with condensers for raising the power factor, particularly when the energy drawn from the supply mains is charged for on a maximum demand kVA basis, and since the condenser brings about a reduction in this kVA value, it brings about a corresponding reduction in the fixed charge based on the maximum kVA demanded from the supply. A very considerable saving in the power bill may be effected in this manner, this saving sufficing as a rule to pay off the cost of the condenser in a very short period, and thereafter to result in a considerable annual saving.

When the Supply Company does not charge for its energy on a maximum demand kVA basis, but charges either according to a flat rate or a maximum demand kW basis, a rebate on the charges may often be obtained when the energy is drawn solely at a high power factor, and such rebate will usually rapidly pay off the initial cost of the condenser and thereafter bring about a considerable saving.

The installation of condensers for power factor improvement will usually also bring about an improvement in the voltage regulation of the circuit. Since the improvement in power factor reduces the load current drawn from the supply, the voltage drop in transformers, cables, etc., will likewise be reduced, and the voltage changes with varying load will be correspondingly reduced, making more efficient operation of motors, machinery, etc., and a more satisfactory lighting when the lighting supply is obtained from the same source.

(b) To the Power Supplier.

To the Power Supplier a load drawn at unity power factor also brings about saving in the cost of supplying power to the consumer, the transformers in sub-stations, etc., feeder and distribution cables, and switchgear may all be reduced in size when the load is maintained at a high power factor, or, conversely, a greater load may be delivered by existing installations if the power factor is improved. An existing power generating station may give a very considerably increased output with decreased heat losses in cable, etc., by maintaining the consumers' power factor at a high value. It is therefore entirely to the interest of Supply Companies to ensure that all consumers of energy from their mains take their current at a high power factor. The extra capital cost involved in providing larger apparatus is considerable if steps are not taken to improve the natural power factor of the circuits or of the system in general.

It has been felt in recent years that this extra capital charge should be borne by the consumers who contribute to a low power factor rather than be distributed over all consumers. This desire to split up power costs more fairly has led a large number of supply undertakings to revise their tariffs and to charge for power on a maximum demand kVA basis. As this maximum demand charge is directly proportional to the increase in current caused by low power factor, it will be realised—by reference, for example, to Fig. 6—that with a poor power factor the maximum demand charge might be several times that of one based on unity power factor. The extent of this increase in maximum demand charge is emphasised in Fig. 10 and in the examples relating thereto (page P.13).

(c) The Consumer who supplies his own Power.

The User of electric power with private generating plant, when this is of the alternating current type, derives benefit from both the sources mentioned above under (a) and (b), and a considerable reduction in the initial cost of the installation and in the running charges may be obtained by the installation of proper condensers.

The extent of these various savings which are set out above is illustrated below in numerical examples following the section dealing with determination of size of condensers for any given installation (page P.14).

Calculation of Size of Condenser required for any desired Power Factor Improvement

The size of the condenser required for any given installation in order to effect power factor improvement is determined by the load on the circuit, the existing power factor of that load, and the amount by which this power factor is to be raised. The condenser size is directly proportional to the load to be corrected, but is a more complex function of the power factors. It may be calculated by drawing out a vector diagram of the circuit on the lines of Fig. 2, by plotting out the vector representing the current OI at the known phase angle ϕ determined from the known power factor of the load. The requisite length of the vector OC_1 or OC_2 can then be determined by simple geometry to raise the power factor of the circuit either to unity or to some other value in the neighbourhood of unity.

In practice, however, it is not necessary to plot out a vector diagram in this manner, since a sufficiently accurate estimate of the size of the condenser can be obtained by means of curves plotted out from calculations made from diagrams of this type or by means of tables of factors prepared for various degrees of improvement of the power factor. A curve of this type is depicted in Fig. 7, the ordinates of this curve giving the ratio of required condenser kVA to the kW of the existing load for raising the power factor to unity from various initial power factor values. Thus, for example, by referring to the curve, it is seen that to raise the power factor of a circuit from 0·6 to unity requires a condenser kVA of 1·33 per kW of the load. If it is desired to raise the power factor to 0·95 only instead of to unity, the required size of the condenser may be obtained by subtracting from the figure of condenser size obtained as above, the size of condenser required to raise the power factor from 0·95 to unity. Thus, taking the above example, if the power factor is to be raised to 0·95 only, the following result is obtained :—

Condenser kVA to raise power factor of load from 0·6 to unity	1·33
Condenser kVA to raise power factor of load from 0·95 to unity	0·33
Resultant kVA of condenser required to raise the power factor of a load of 1 kW from 0·6 to 0·95	1·00

In most cases increase of the power factor of the circuit up to unity can easily and economically

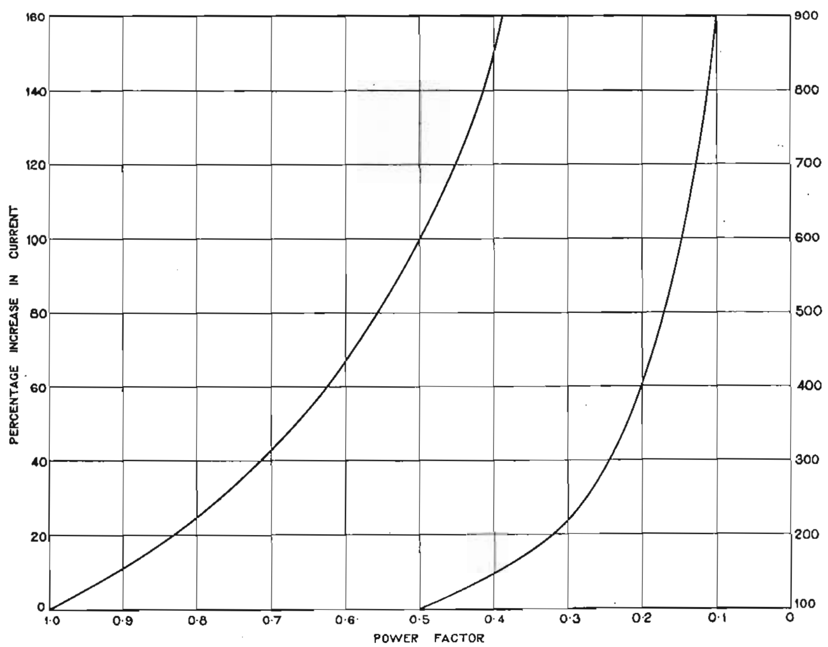


Fig. 6—Curves to demonstrate the increase of current (and of kVA) in an A.C. circuit caused by low power factor

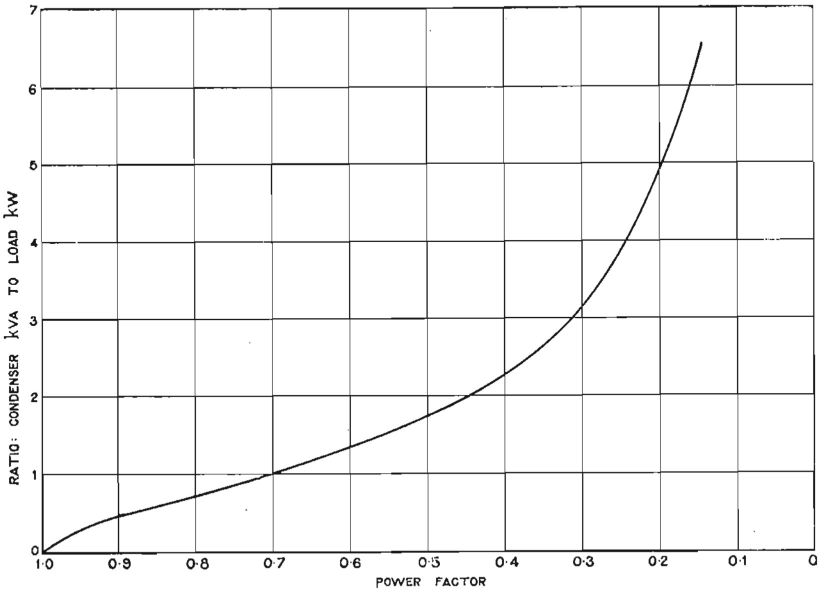
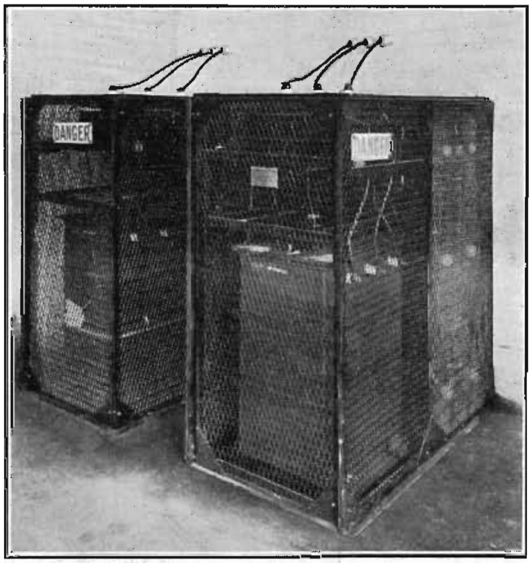


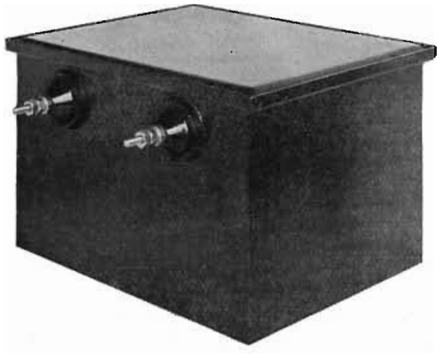
Fig. 7—Curve for estimating size of Condenser required for effecting power factor improvement. This curve gives total condenser kVA in terms of the load kW, and applies equally to single, two, and three phase circuits

be carried out by means of Dubilier Condensers for Power Factor Improvement, but the size of condenser required to raise the power factor to unity as compared with that required to raise it to 0·95 is rather larger than in proportion to the increase in power factor. This increase is shown by means of the curves in Fig. 8, which are plotted out to express the size of condenser required for power factor improvement for various initial and resultant power factors, the ordinates of the curve being expressed in the ratio of the condenser kVA to load kW as in the case of Fig. 7, while the abscissæ of the curves are the value of the final power factor, the initial power factor values being marked against each of the curves. Thus, reverting to the example referred to above, to raise the power factor of a load from 0·6 to 0·95 it is seen from this chart that the ratio of condenser kVA to load kW is 1·0 as was obtained before. From examination of these curves it will be noted that they have an upward tilt for resultant power factor values between 0·95 and unity, this upward slope of the curves being an expression of the above statement, that to raise the power factor to unity as compared to raising it to 0·95 requires a somewhat disproportionately large condenser size.

Both sets of curves, Figs. 7 and 8, apply to single, two, and three phase circuits. For a two-phase circuit the total condenser kVA is divided into two equal parts for connection across the phases, while for a three-phase circuit it is divided into three equal parts mesh connected to the supply circuit. The cost of a condenser for a given power factor improvement is, therefore, very little, if at



Dubilier Indoor Unit Type Condensers.
Two 75 kVA banks



Small Box-Type Condenser for direct connection to A.C. motors

all, affected by the number of phases in the circuit to which the condenser is applied.

While the curves in Figs. 7 and 8 serve to give a rough indication of the size of the condenser required for any given installation, a more accurate calculation of the condenser size may be obtained by means of the Table set out below. These tables give directly the size of condenser expressed in kVA required per kW of the load for various degrees of power factor improvement, the first column of the table being the initial power factor of the load before the condenser is applied.

Numerical Example.

As an example of the use of the accompanying Table the following may be considered :—

Required a condenser to raise the power factor of an A.C. circuit having a normal load of 50 kW at a power factor of 0·6. It is required that by the use of the condenser the power factor shall be raised to 0·95.

From the table opposite the figure of 0·6 in the left-hand column it is seen that the condenser kVA per kW of load to raise the power factor to 0·95 is 1·004. Therefore for the 50-kW load a condenser of 50·2 kVA will be required. In round figures, therefore, a 50-kVA condenser would be installed in such a case. This condenser must necessarily be rated to deliver 50 kVA at the operating voltage of the circuit.

To raise the power factor of the circuit to unity instead of to 0·95 it may be seen from the fourth column of the table that the condenser kVA per kW of load is 1·33. Therefore in this case a condenser of 66·6 kVA would be required, or, alternatively, should it be desired only to raise the power factor to 0·9, the 50-kVA condenser would be reduced to 42·45 kVA.

From these figures it is seen that to raise the improvement of power factor from 0·9 to 0·95 requires the addition of less than 8 kVA to the condenser, *viz.*, 42·45 to 50 kVA, whereas to raise the power factor from 0·95 to unity requires a further 16½ kVA. Raising the power factor to unity as compared with 0·95 therefore involves a larger additional condenser cost, which implies that the saving effected by the use of the condenser will take a longer period to pay off the cost of the condenser, but when this has once been effected the annual saving will necessarily be greater.

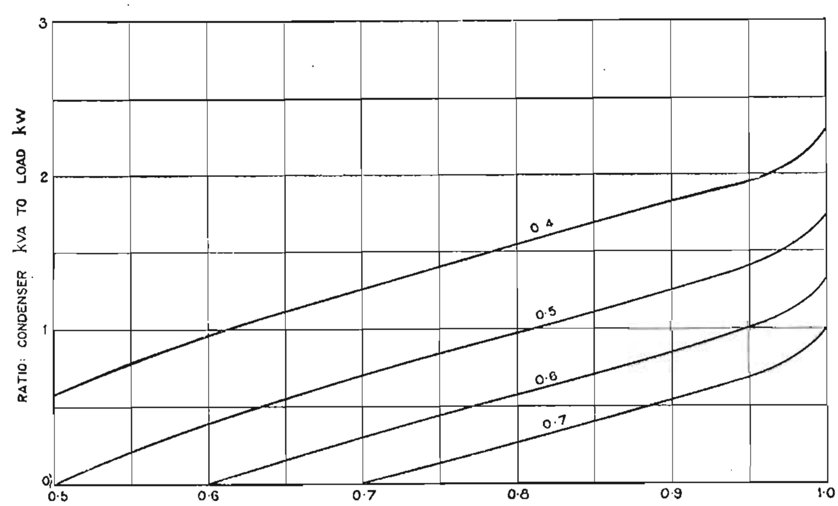


Fig. 8—Curves expressing size of Condenser required for power factor improvement for various initial and resultant power factors

Values of the initial power factor of the circuit are marked on the curves

Table for Calculating Size of Condenser for Power Factor Improvement

Power Factor of load before Condenser is applied	Size of Condenser in kVA per kW of Load: For raising the Power Factor to 0·9	For raising the Power Factor to 0·95	For raising the Power Factor to Unity
0·50	1·248	1·403	1·732
0·51	1·203	1·358	1·687
0·52	1·159	1·314	1·643
0·53	1·116	1·271	1·600
0·54	1·075	1·230	1·559
0·55	1·034	1·189	1·518
0·56	0·995	1·150	1·479
0·57	0·958	1·113	1·442
0·58	0·921	1·075	1·405
0·59	0·885	1·040	1·369
0·60	0·849	1·004	1·333
0·61	0·815	0·970	1·299
0·62	0·782	0·937	1·266
0·63	0·749	0·904	1·233
0·64	0·716	0·871	1·200
0·65	0·685	0·840	1·169
0·66	0·655	0·810	1·139
0·67	0·624	0·779	1·108
0·68	0·594	0·749	1·078
0·69	0·565	0·720	1·049
0·70	0·537	0·692	1·021
0·71	0·508	0·663	0·992
0·72	0·480	0·635	0·964
0·73	0·452	0·607	0·936
0·74	0·425	0·580	0·909
0·75	0·398	0·553	0·882
0·76	0·371	0·526	0·855
0·77	0·345	0·500	0·829
0·78	0·318	0·473	0·802
0·79	0·292	0·447	0·776
0·80	0·266	0·421	0·750
0·81	0·240	0·395	0·724
0·82	0·214	0·369	0·698
0·83	0·188	0·343	0·672
0·84	0·162	0·317	0·646
0·85	0·136	0·291	0·620
0·86	0·109	0·264	0·593
0·87	0·083	0·238	0·567
0·88	0·054	0·209	0·538
0·89	0·028	0·183	0·512
0·90	—	0·155	0·484
0·91	—	0·124	0·453
0·92	—	0·097	0·426
0·93	—	0·066	0·395
0·94	—	0·034	0·363
0·95	—	—	0·329
0·96	—	—	0·292
0·97	—	—	0·250
0·98	—	—	0·203
0·99	—	—	0·143
1·00	—	—	0·0000

Saving which may be effected by the Use of Condensers

When the energy drawn from electric supply mains is charged for on a two-part tariff based on a fixed charge per annum per kVA of maximum demand with the addition of a small fixed charge per unit, the installation of a DUBILIER CONDENSER for Power Factor Improvement will bring about a reduction in the fixed annual charge by reducing the maximum kVA demanded from the supply circuit. The actual cost of the electrical energy consumed which is paid for at a fixed charge per unit will necessarily remain to all intents and purposes the same, since the efficiency of the condenser is so high that the electrical losses in it involve no appreciable additional charge for energy. The reduction in the fixed charge per annum on this type of tariff will necessarily be directly proportional to the reduction in the kVA demanded from the supply circuit. This reduction of kVA will be numerically equal to the reduction in current brought about by the use of the condenser. The saving which can be effected in this manner can be obtained directly from the curves in Fig. 6, since these express the extent to which the current is increased beyond its value at unity power factor when the power factor has a low value. For example, at a power factor of 0·7 it is seen that the current drawn from the supply mains is 43% greater than it is at unity power factor. Hence by the installation of the condenser this 43% of excess current can be saved and the kVA demanded reduced by a like amount. These figures have been replotted in the curve of Fig. 9, which is expressed in terms of the saving or reduction of kVA which can be effected by the use of a condenser to raise the power factor to three alternative figures of 0·9, 0·95, and unity for various initial values of the power factor of the load itself. From this curve it is seen that the above example, which corresponds to a reduction of a maximum demand of say 143 kVA to 100 kVA, represents a saving of 30% of the original fixed annual charge based on the maximum kVA demanded from the supply circuit. A saving of this order of magnitude will as a general rule repay the whole cost of the condenser installation in a period generally of the order of 1 to 1½ years, and after this time the 30% saving in the fixed charge becomes entirely an annual saving of expenditure.

The extent of the saving obtained by the use of any particular condenser installation can also be visualised in another way by means of the curves plotted in Fig. 10. The curves in this diagram show the standing charge at £1 per kVA per annum for loads of various kW and at various power factors, so that the monetary saving obtained by any given improvement in power factor can be read off from this curve directly. For

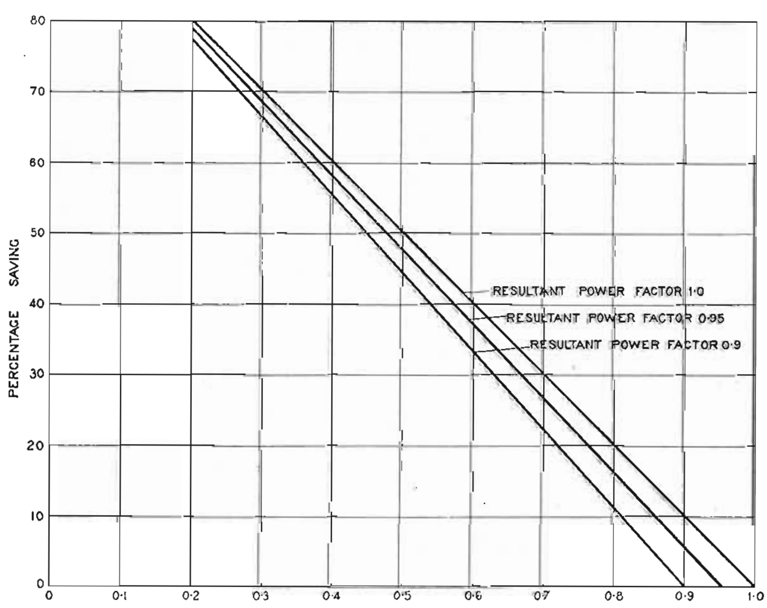
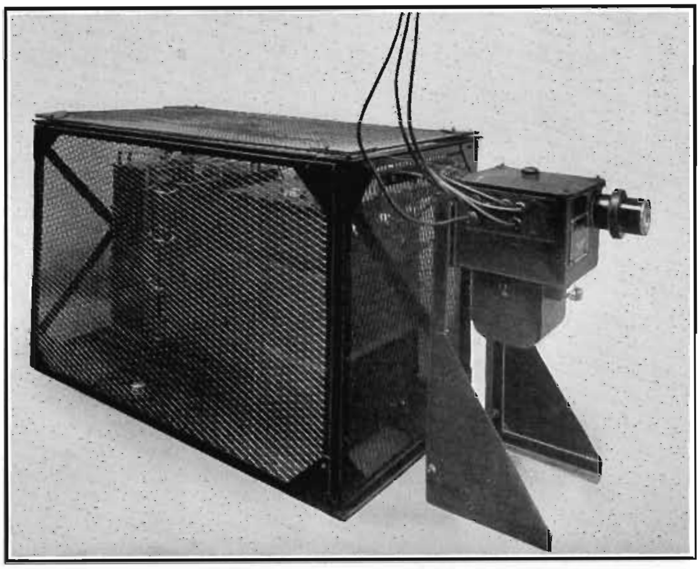


Fig. 9—Saving obtainable by use of Static Condensers—expressed as percentage of fixed annual kVA charge before installation of condensers



A 220V. Unit Type Condenser Bank with separate floor-mounting switchgear

example, with a load of 60 kW having a power factor of 0·75 it will be seen from the curve that the standing charge will be £80 per annum at £1 per kVA, or, in other words, if the tariff imposed by the Supply Company is on the basis of £5 per kVA per annum, the total standing charge which will be payable for this load at a power factor of 0·7 will be 80 × 5 = £400 per annum. By raising the power factor to 0·9 at the same kW loading the standing charge is reduced from £80 to £67 per £1 per kVA per annum; that is to say, for the same tariff as above the standing charge under these conditions would be 67 × 5 = £335, this representing a saving of £85 per annum. If, however, the power factor were further improved up to unity, the standing charge can be seen from the curve to be £60 per £1 per kVA per annum, equalling in this case 60 × 5, or £300, representing a saving of £100 per annum as compared with the initial cost without the installation of the condenser.

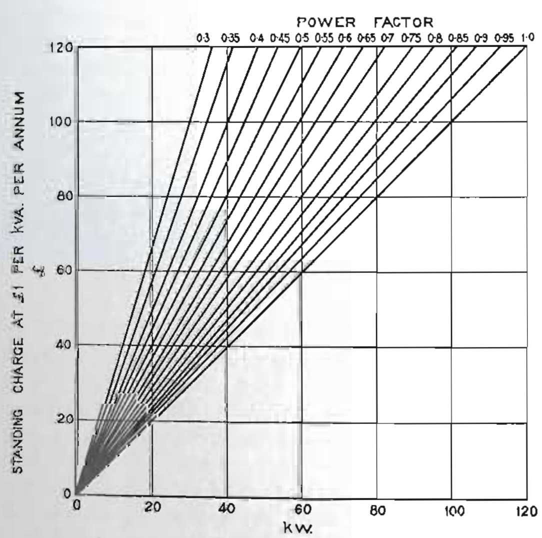


Fig. 10—Effect of low power factor on standing charges

Referring to the tables given above for the determination of condenser size, it may be seen that to obtain this saving of £100 per annum would require the use of a condenser of 0·882 kVA per kW of load; that is to say, the rating required for this condenser would be 0·882 × 60 = 52·92 kVA. Or, alternatively, to obtain a saving of £85 per annum for raising the power factor to 0·9 the requisite condenser size would be only 27¼ kVA.

As further examples of the saving effected by the use of condensers and the rapidity with which this saving will enable the entire cost of the condenser installation to be written off, the following cases represent small and large motor installations.

Example (a).

Assuming for a small motor installation that the charge is made on a maximum kVA basis and that a 3-h.p. motor is running at full load for a working year of 300 eight-hour days, the supply voltage being 500 at 50 cycles, the Power Company's charges will be as follows :—

(a) Fixed maximum demand charge per kVA p.a., £5.
(b) Energy charge per unit, 0·75d.

Then, with a power factor of 0·74 the fixed charge on the kVA demand will be	£18 19 0	
The energy charge will amount to	£21 0 0	
The total annual power bill is therefore ...		£39 19 0
By the installation of a condenser designed to bring the power factor up to 0·95 the sum payable on the basis of the fixed charge will be reduced to	£14 15 0	
The energy charge will remain at	£21 0 0	
The total power bill is now only		£35 15 0
Annual Saving ...		£4 4 0

The cost of the above condenser is £4 7s. 6d. so that the initial outlay would be covered in 12½ months ; considering it as an investment it yields a return of 96 per cent. per annum.

Example (b).

Taking now the case of a 50-h.p. motor running on a 500-volt circuit, on a varying load averaging approximately half-load over the same period, the power factor being 0·82 at half load, then :—

Fixed charge on kVA demand will be	£133 15 0	
Energy charge	£219 0 0	
Total Annual Power Bill ...		£352 15 0

After installation of a condenser to raise the power factor to 0·95 :—

Fixed charge on kVA demand will be	£115 10 0	
Energy charge	£219 0 0	
Total Annual Power Bill ...		£334 10 0
Annual Saving ...		£18 5 0

The cost of the condenser is £25 17s. 6d. and would be entirely written off in 17 months, equivalent to interest at the rate of 70 per cent. per annum on the capital outlay.

Example (c).

As an example of the rebate system of charging for electrical energy, the following is typical of a tariff which allows for a comparatively small rebate only. In this case the energy is charged for on the basis of a fixed charge of £4 per kW per annum, plus an energy charge of 0·5d. per unit with a rebate of 0·01d. per unit for each 1% improvement of power factor above 85%.

Normal load 100 kW with a peak load of 125 kW operating for 52 weeks per annum each of 48 working hours at a power factor of 0·8.

$$\text{Fixed charge} = 125\text{ kW} \times £4 = £600$$
$$\text{Energy charge} = \frac{52 \times 48 \times 100}{240 \times 2} = £520$$
$$£1120$$

Rebate if power factor is raised to 0·95 = 10 × 0·004 = 0·04d. per unit.
The reduction in cost of energy due to this rebate is therefore £41 12 0 per annum.

The cost of the condenser to raise the power factor of this load to 0·95 will be approximately £129, so that the capital expenditure on the installation of this condenser can be written off by the saving in 3·1 years, after which there is an annual saving of £41 12s.

Example (d).

A further example of the rebate system is that in which the energy charge is reduced in proportion to the power factor when this is above 0·85 with an initial price per unit of 1·125d.

Taking a load of 300 kW at a power factor of 0·7 and operating for 52 weeks per annum each of 45 working hours, the energy used per annum will be 45 × 52 × 300 = 702,000 B.O.T. Units.

The cost of this energy without the installation of the condenser would be—

$$\frac{702000}{240} \times 1125 = £3285$$

Allowing for the above rebate and raising the power factor to 0·95 the energy charge will become—

$$\frac{3285 \times 85}{95} = £2940$$

$$\text{Therefore the saving} = £345$$

The approximate cost of a condenser to provide for this improvement in power factor from 0·7 to 0·95 will be £591, which capital expenditure can be written off by the saving in 1·71 years, after which there is an annual saving of £345.

Example (e).

If in the case of Example (d) the power factor were raised to unity instead of to 0·95 the annual saving would become £395, and the condenser cost to effect this increased improvement of power factor would be approximately £830.

On this basis the cost of the condenser can be written off in 2·1 years, after which period there remains the annual saving of £395 due to the installation of the condenser.

Construction of Dubilier Condensers

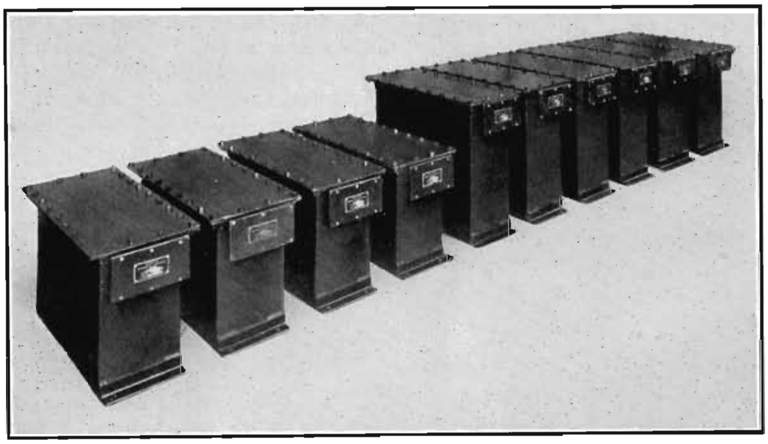


Fig. 11—A group of Dubilier Indoor Tank Type Condensers of various sizes (5 to 25 kVA) suitable for direct connection to A.C. motor circuits

DUBILIER CONDENSERS for Power Factor Improvement are constructed with a special paper dielectric which is enclosed in oil-filled sealed steel containers. The condenser elements themselves, inside the containing box or tank, are divided into a number of small parts so arranged and electrically connected together as to give the desired electrical capacity value to the complete condenser which is necessary to provide the required kVA loading, and arranged also to support the required operating voltage without undue electrical stresses in the dielectric material. The parts of the condenser are so arranged that under normal working conditions the electrical losses in the condenser are extremely small, so that the temperature rise of the material due to energy losses in it is also very small. By this means deterioration of the dielectric is avoided, thus securing the highest operating efficiency and reliability. The mechanical design of the interior of the condenser is such that the whole construction is a very robust one, all the individual parts of the condenser being held together by means of rigid metallic supports and electrically connected together by substantial busbars suitably proportioned to give the required current-carrying capacity. The condenser elements themselves are designed and constructed in such a way as to facilitate the circulation of oil around the parts, while the supports on which they are held are also liberally provided with oil ducts to facilitate the circulation of oil and to maintain the oil in intimate contact with all the parts of the condenser.

In the manufacture of the condenser the dielectric material is subjected to prolonged impregnating treatments so designed as to ensure the most perfect impregnation of the material and the most satisfactory and reliable electrical operation, while the oil in which the condensers are immersed is also carefully treated to ensure that it is free from moisture and has the highest possible electrical insulating properties.

In a condenser designed for connection to a single-phase circuit the whole of the condenser elements inside the containing tank are connected together so as to form a single condenser unit connected between two external terminals of the condenser, while in the two-phase unit they are divided into two equal groups, and similarly for a three-phase unit into three equal groups connected to the terminals. The internal construction is such that the individual condenser elements are readily accessible, both individually and in groups, as required both during the manufacture of the condenser and should any subsequent examination of it be necessary.

These condensers are constructed in a variety of forms suitable for mounting indoors and also for exterior uses. They are divided into three main types :—

1. The Indoor Tank Type.
2. The Indoor Unit Type.
3. The Outdoor Tank Type.
4. The Multiple Unit Outdoor Type.
5. Mining Type for use underground.

Examples of these five types are illustrated in the accompanying photographs.

TYPES OF DUBILIER STATIC CONDENSERS

1. The Indoor Tank Type.

In the first-mentioned of these three types the complete condenser is enclosed inside a single oil-filled steel tank provided with suitable terminals enclosed in a terminal box on the exterior of the tank for the external connections, Figs. 11 to 13.

Fig. 12—Indoor Tank Type Condenser, 3 kVA, 400 Volts

This type of construction is particularly useful where the condenser is installed in rather inaccessible positions and in damp situations, and where the condenser is required for direct connection to a motor and for mounting adjacent thereto. In the smaller sizes this type of condenser can be connected directly across the motor terminals without the interposition of any additional switchgear, so that the main switch and control gear for the motor circuit suffice both for the motor and for the condenser supply—Fig. 14. It should be noted with this arrangement that the connection of the condenser directly to the motor circuit in this manner does not produce any overloading of the switch and control gear for the motor, but in fact reduces the electrical loading of that gear since the effect of the condenser is to reduce the total current drawn from the line under

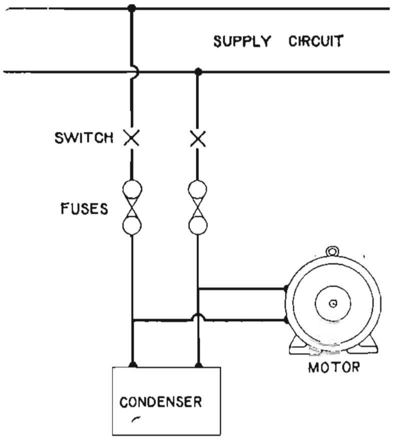


Fig. 14—Connection of Condenser to motor circuit

normal operating conditions. If the motor is normally operated at a low power factor this reduction in current may, as already seen in Fig. 6, be a very considerable one and thus lead to more reliable operation of the switch gear and prevention of damage to its contacts, etc., by prolonged usage. Condensers can be directly connected to motor circuits in this manner at any voltage up to 750 volts, the condenser necessarily being rated for the correct operating voltage of the motor. For other voltages it is desirable to insert an auto-transformer between the motor circuit and the condenser for changing the voltage at the condenser terminals as described below.

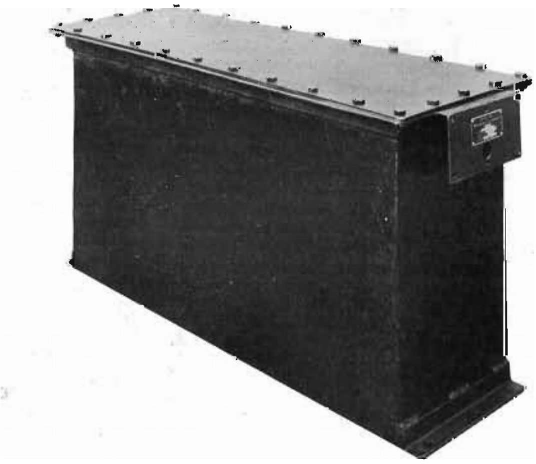


Fig. 13—Indoor Tank Type Condenser

25 kVA, 600 Volts, 3 phase

TYPES OF DUBILIER STATIC CONDENSERS

2. The Indoor Unit Type.

In the Unit type of condenser construction the arrangement takes the form of a number of small condenser units connected together in parallel and arranged in some form of framework or other suitable securing or mounting means. This type of construction lends itself to the mounting of the condenser in the form of a switchboard cubicle and for assembly of a number of units together in switchboard form, each with its individual control gear, ammeters, etc., with or without transformers, as may be required, depending upon the operating voltage of the circuit. A condenser of this type, complete with auto-transformer, circuit breaker and ammeter, is illustrated in Fig. 15. A similar installation, without switchgear, is illustrated in Fig. 16. In this construction each of the individual condenser units has a kVA rating of the order of 2 to 2½ kVA, and are connected together to paralleling busbars through a small fuse for each condenser unit. This individual fusing of the small condensers provides security against breakdown, and in the event of accident to any one unit the remainder of the condenser bank can remain in operation with only a comparatively small reduction in output.

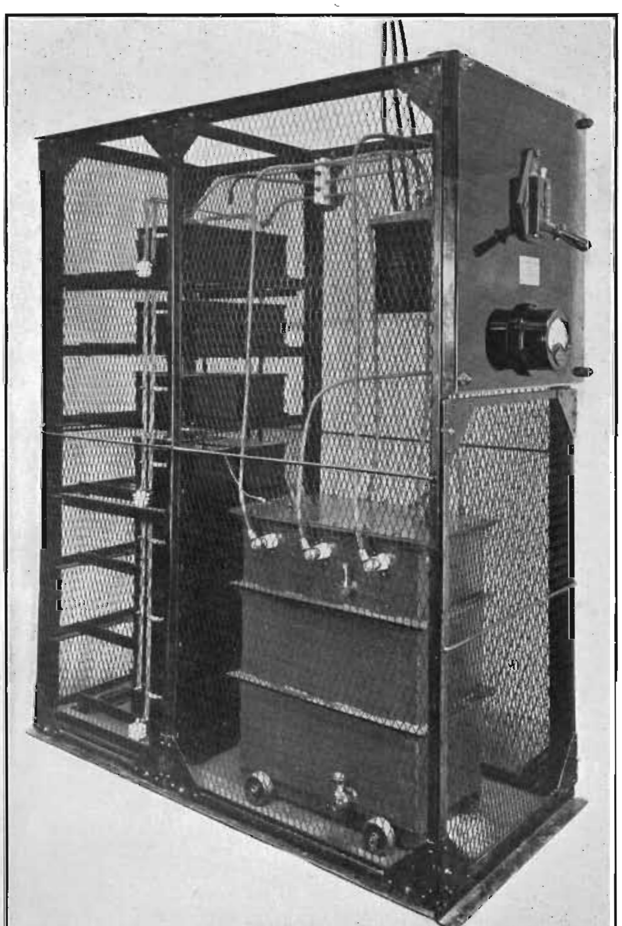


Fig. 15—Indoor Multiple Unit Type Condenser arranged in switchboard cubicle with transformer, oil-switch, and ammeter. 53·5 kVA at 400 volts, 3 phase

TYPES OF DUBILIER STATIC CONDENSERS

3. Outdoor Tank Types.

These are constructed of similar general form to the tank types mentioned above, the condenser tanks being fitted with rain shields and either with cable sealing boxes or with good protection for the terminal connections.

This type of condenser can in the small sizes be readily adapted for pole mounting for use on overhead lines.

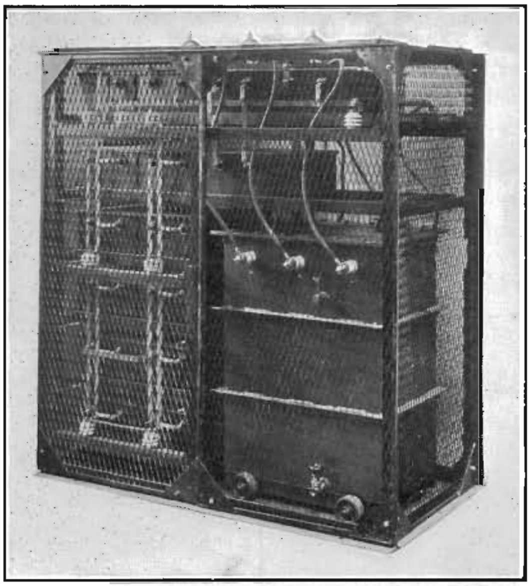


Fig. 16—Indoor Multiple Unit Type Condenser, 100 kVA, 440 Volts

4. Multiple Unit Outdoor Type.

In order to extend the flexibility and special reliability of the unit system of construction to outdoor use, designs have been developed and the units built in enclosed watertight tanks.

Large condenser banks with their appropriate switches and transformers can also be built up in kiosk form, thus economising indoor floor space (see Fig. 17).

5. Mining Type.

A special type of condenser is available for use underground in mines and/or in explosive atmospheres. This type is of very strong construction and will withstand much rougher handling than the other types. Here, too, the unit system of construction has been used. The great advantage of this construction will readily be appreciated when it is realised that in case of damage underground the condenser units can be replaced, and it is not necessary to remove the condenser above ground for repair.

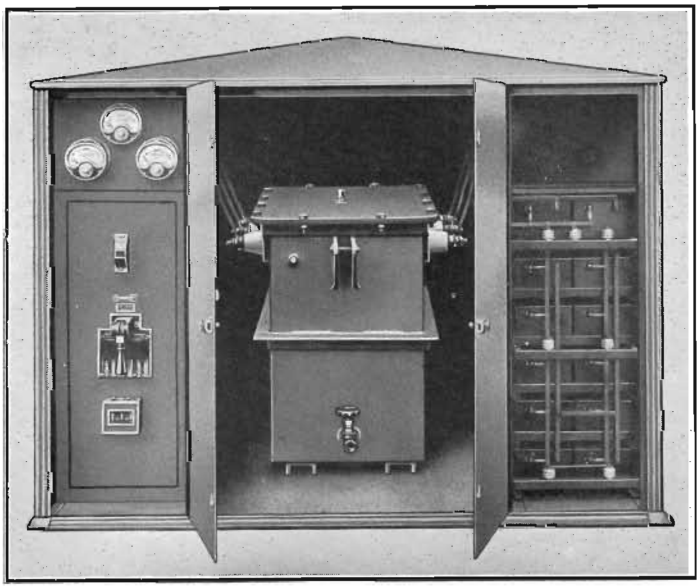


Fig. 17—Multiple Unit Outdoor Type Condenser Equipment mounted in street "kiosk" housing

Standard Sizes of Dubilier Condensers

Tank Type.

Single-Tank types mentioned above are standardised in sizes between 5 and 100 kVA in steps of 5 kVA.

Multiple Unit Type.

The Multiple-Unit Indoor Type Condensers are normally supplied for direct, auto-transformer, and double-wound transformer connection in single banks up to approximately 250 kVA.

For larger sizes it is recommended to use a number of smaller banks controlled by separate switches. This arrangement also allows the capacity to be varied.

Owing to the flexibility of this unit system the banks can be built up in steps of 1 to 7½ kVA depending on the voltage, number of phases, and the frequency of the supply.

For direct connection to motors, units can be supplied down to 0·25 kVA.

Mining Type.

These are available in the following sizes: 15, 30, 60, and 100 kVA.

Operating Voltage of Dubilier Condensers

The standard types of condensers mentioned above are available for *direct connection* on 300-volt, 500-volt, 600-volt, and 750-volt circuits. A special series of small box-type condensers, similar in form to the unit types of condensers mentioned above, can also be supplied in small sizes for use on 110-volt circuits, and in units of 0·5 and 1 kVA for use on 220-volt and on 250-volt circuits.

For higher voltages condensers can be supplied, within certain limitations, and quotations for condensers of this type can be given to meet special requirements.

For intervening voltages the nearest higher standard voltage condenser should be used. Under these circumstances it is often more economical to connect the condensers through an auto-transformer than direct.

The cost of these condensers per kVA output of the condenser necessarily varies with the operating voltage of the condenser, since the dielectric material in the condenser can be used more economically for certain voltages than for others. The rapid rise in the size of the condenser necessary to obtain a given kVA rating at the lower voltages also accounts in some measure for a less efficient use for the dielectric material at these lower voltages and brings a corresponding increase in the cost of the condenser per kVA.

The most economical voltages for condensers are the standard voltages for which they are designed, *viz.*, 300, 500, 600, and 750. The function of an auto-transformer is to transform the voltage supply to the condenser to the most convenient standard voltage.

For intermediate voltages between these values, the kVA rating of a given condenser varies proportionally to the square of the operating voltage. This point should be borne in mind when a condenser is connected to a circuit where the voltage is liable to considerable fluctuations. For example, if the voltage of a circuit falls from 600 to 550, the output of a 10 kVA condenser will be reduced to 8·4 kVA, while similarly if the voltage at the condenser terminals rises to 650 volts, the output of the 10 kVA condenser would increase to 11·7 kVA. From the point of view of avoiding undue stressing of the dielectric material it is desirable to ensure that the condenser shall not be operated at higher than its rated voltage. A fall in voltage will do no harm, other than reduce the kVA output, but a rise in the voltage might ultimately cause damage to the dielectric material due to the increased heating which may occur.

Advantages of Static Condensers over other forms of Corrective Apparatus

1. Higher Efficiency. (Condenser losses do not exceed about 0·3%).
2. No moving parts.
3. Requires no attention.
4. Negligible temperature rise.
5. Can be installed out of doors.
6. Requires no elaborate foundation.
7. Can be used in explosive atmospheres.

Summary of Common Causes of Low Power Factor

1. Induction Motors.
2. Transformers.
3. Electric Furnaces.
4. Electric Welding Equipment (A.C.).
5. Arc Lamps (due to choke coils).
6. Power-limiting Reactors and Choke Coils.
7. Long Transmission Circuit (other than overhead).
8. Faulty Conduit Installation.
9. Under-excited synchronous motors and rotary converters.
10. Inductive Apparatus of every kind.

The Correct Use of Condensers will achieve the following :

1. Improve the voltage regulation of the circuit.
2. Allow an increase of power output of generators operating at a low power factor.
3. Decrease the demand on exciters and the power required to drive them.
4. Increase the efficiency of generators by increasing their power output without increasing their copper losses.
5. Increase the efficiency of generators by decreasing the iron losses.
6. Increase the loading capacity of transformers, busbars, switchgear, and cables.
7. Reduce the capital expenditure on electrical generators, transformers, busbars, switchgear, and cables, thereby decreasing the capital charge per unit.
8. Reduce the operating cost per unit.
9. Economise the fuel or water consumption of prime movers.
10. *Where power is purchased on the kVA basis, save the consumer large sums of money.*
11. *When a rebate is given to the consumer for keeping a high power factor, considerably reduce the power bill.*
12. Most power companies insert a penalty clause against the consumer for a very low power factor. The use of condensers will stop the payment of penalty.

Location of Condensers

In a perfected power supply system every consumer would control his own magnetising current. In an ideal layout, each necessary induction motor, transformer, and inductive device of whatever kind would be compensated at its primary terminals for the wattless current required to magnetise it.

Of course, in practice, such refinement may not always be economical ; but it is desirable to approach it by distributing static condensers throughout the plant so far as the costs can be justified by the results. The wattless currents are by this means confined to short conductors between each inductive load and the condenser at the nearby load centre. The greatest gain in voltage regulation, greatest saving in conductors, and greatest saving in apparatus (other than the condensers) will be realised when the improvement of power factor is made at the source of the trouble, or as near to it as possible.

The static condenser is remarkably well suited for installation at sub-stations, since it is motionless and requires no attention.

When connected across individual motors, condensers maintain an almost even high power factor over a large range of load. This is illustrated in Fig. 18. The curves are made out for a 10-h.p. 750 r.p.m. motor.

The combination of condenser and induction motor provides a more economical arrangement than the use of special A.C. commutating motors.

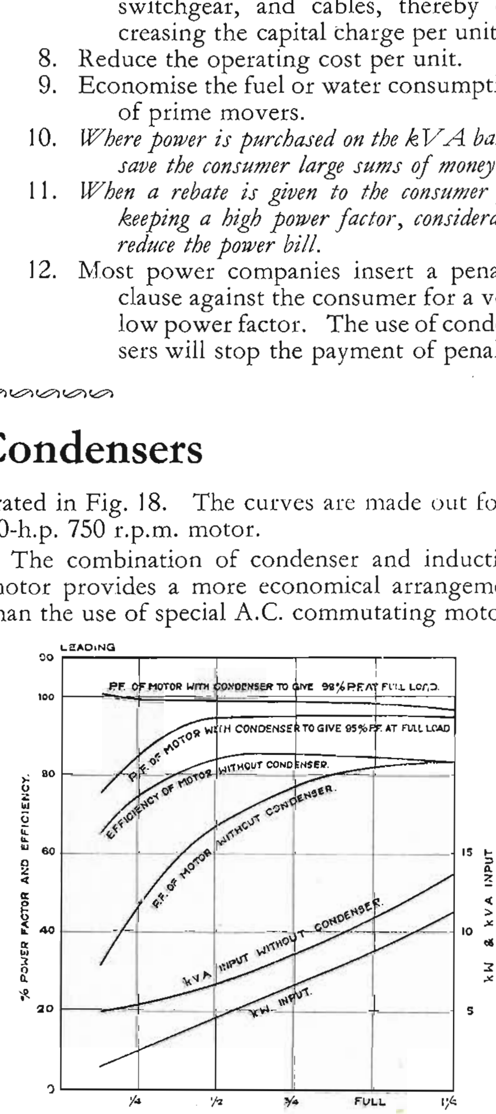
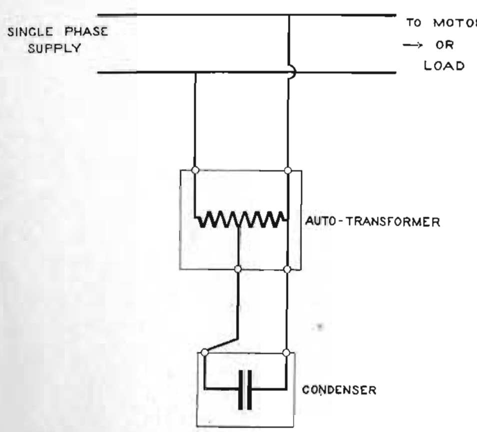


Fig. 18—Effect of Condenser on power factor of induction motor at various loads

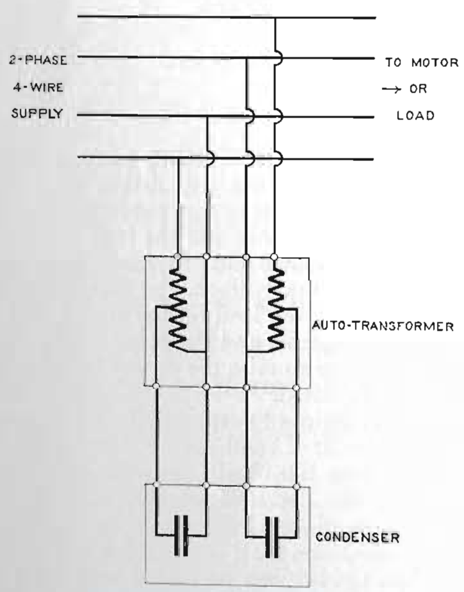
Use of Auto-Transformers and Switchgear

If the circuit on which a condenser is to be used is liable to large voltage fluctuations, it is desirable to design the condenser to give the desired kVA at the mean operating voltage and to arrange a suitable transformer between the supply circuit and the condenser to ensure that the condenser is not operated at higher than its safe working voltage. For certain intermediate voltages, for a similar reason, it is desirable to use an auto-transformer between the supply circuit and the condenser, connected as shown in Fig. 19. By this means the voltage at the condenser terminals can be raised from the circuit voltage – say, for example, with a 440-volt circuit—to a figure in the neighbourhood of 600 volts, which provides a more economical use of the dielectric material in the condenser. For small sizes direct connection of the condenser to the circuit, in spite of the loss in kVA resulting through operating the condenser at lower voltage, provides a more economical arrangement than by the use of an auto-transformer, but above a few kVA, the exact size depending upon the operating voltage, an auto-transformer is the more economical arrangement, and should always be adopted for intermediate voltage condensers.

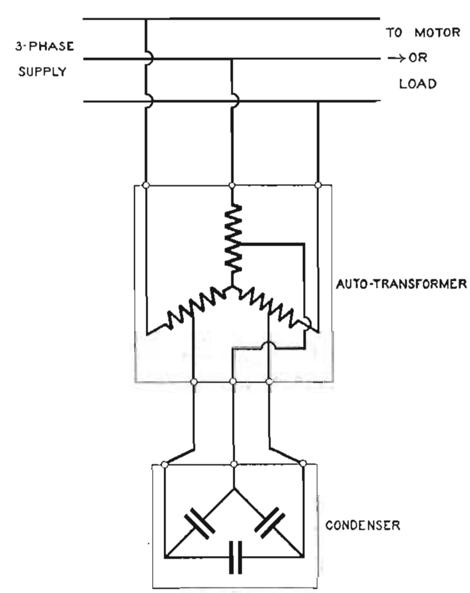
Where the condenser, with if necessary its auto-transformer, can be connected directly to the terminals of a motor circuit, no additional switchgear is as a general rule required. In cases where it is desired to be able to switch off the condenser independently of the remainder of the circuit, an oil switch should generally be fitted, this having the appropriate number of poles depending upon the number of phases of the circuit. Small con-



(a)



(b)



(c)

Fig. 19—Use of Auto-Transformer with Static Condenser on one, two, and three phase circuits

densers can be switched directly on to the circuit, but with larger condensers the use of an auto-transformer provides an additional means of lessening the shock of connecting the condenser to the circuit and removes to some extent the surges which may arise therefrom. With large condenser installations the switch connecting the condenser to the circuit should be arranged so that the circuit is closed initially through a charging resistance to limit the current rush due to charging the condenser. These additional contacts and resistances can be incorporated with the main circuit switch or can be arranged as separate charging resistances with short-circuiting switch as required. With some condenser installations graded charging resistances are fitted where it is particularly necessary to render the connection and disconnection of the condenser to the circuit as smooth as possible. In such cases a multiple contact charging switch is fitted in addition, so that the condenser can be connected through the various steps of resistances which are then gradually cut out of circuit. The two-phase condenser installation illustrated in Fig. 20 shows this feature.

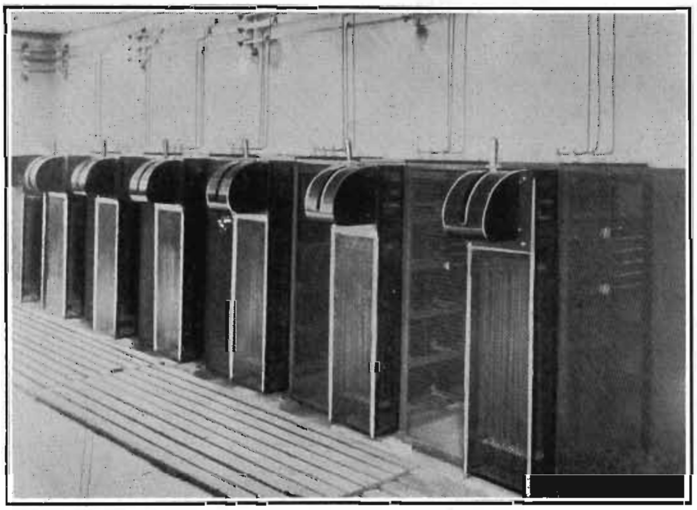


Fig. 20—An Installation of Condenser Banks, each fitted with charging resistances, 160 kVA, 550 Volts

Discharging Resistances.

When a condenser is connected to the circuit through an auto-transformer which is switched on and off with the condenser, no additional discharging resistances are required. When, however, the condenser is connected to a circuit directly through its own switchgear, discharge resistances are either incorporated in the condenser construction itself or are fitted to the switchgear, so that when in the "off" position the condenser is connected to a discharging resistance. The additional energy loss occasioned by permanently connected discharge resistances is quite small, and this method provides the safest arrangement, since the condenser can then always be handled with perfect safety as soon as it has been switched off the circuit.

Data required for Estimating Installations.

When considering the installation of a condenser for any particular circuit, the fullest possible data regarding the circuit and the load connected to it should be obtained and provided. It is essential at least that the voltage, the frequency, the number of phases, the load on the circuit and its existing power factor, and the required figure to which it is desired to raise the power factor of the circuit must be stated.

Where it is desired to estimate the most economical arrangement of condensers for any particular installation, then full details regarding the mode of charging for electrical energy, and the full operating conditions, load factor, etc., of the motors or other load must be provided in addition. Information should also be added regarding the locality of the proposed condenser installation, as to whether the condensers can be fitted adjacent to existing motors or can form part of a switchgear construction or need to be mounted outdoors.

Section T

Condensers for Radio and Wired Wireless Transmission

IN most modern radio transmitters a very wide variety of condensers is required. All of these must be of the highest quality to ensure reliability of the service given by the radio station; while, for some of them, efficiency also is of the highest importance. Dubilier Condensers of various types have long been recognised as standards for use in building radio transmitting stations of all sizes from the smallest short-wave station to the largest long-wave transmitters of world-wide range. Their electrical efficiency is always of the highest, and their design of the best, to secure the utmost reliability under the most exacting service conditions.

Examples of some of the more standardised types of these condensers are illustrated in this section, while special designs and arrangements of condensers are always being prepared to meet the requirements of any particular transmitting station or service conditions.

Condensers for Radio and Wired Wireless Transmission

SINCE the majority of radio transmitting condensers are now required for use in conjunction with thermionic valves it is convenient to subdivide the various types of these condensers into groups depending upon the main use to which they are to be applied. Many of the types of condensers illustrated, however, can be applied to various uses depending upon the particular power loading and the nature of the circuit.

A.—Smoothing condensers for smoothing out pulsations of anode voltage supply, whether derived from D.C. generators or from rectified A.C.

B.—Anode feed or anode blocking condensers and grid condensers.

C.—Aerial shortening condensers.

D.—Oscillation circuit condensers.

E.—Condensers for spark radio transmitters.

For other types of radio transmitting and wired wireless apparatus various condensers are required, for which uses generally one or other of the condenser types illustrated will prove suitable. These radio condensers are almost exclusively constructed with a mica dielectric, except for certain types of smoothing condensers and variable capacity condensers.

For some uses, such for example as anode-feed condensers, the entire condenser must be insulated from earth, either by supporting the condenser upon suitably designed insulators, or by so constructing the condenser inside its containing case that two adequately insulated terminals are provided. In many cases, however, it is possible so to arrange the condenser in the circuit that the case of the condenser can be of metal and can be connected to earth (or to an earth point of the circuit) and that one terminal of the condenser itself can be connected to the containing case.

For all condensers which need to handle any considerable amount of radio frequency energy, and in all cases where the voltage is high, this type of construction should be adopted whenever possible. A more robust and reliable condenser can be constructed in this manner.

In cataloguing high power transmitting condensers it is obviously impossible to illustrate more than a small percentage of the large number of different types which we construct owing to the variation of customers' requirements. From this it can be seen that it is impossible to stock such condensers as standard products, and they are, therefore, manufactured to the customer's requirements.

In preparing the following pages, a few selected types are illustrated in order to give some idea of the enormous range which we construct, both in physical dimensions and capacity, and also to show the wide range of working conditions.

In view of the wide diversity of uses to which these condensers can be applied and of the large number of types which we manufacture, it is essential that when sending enquiries for condensers, the fullest possible information should be given with regard to the manner and type of circuit in which the condenser is to be used. Wherever possible, the type of condenser required, in accordance with the above classification, should be specified and in such cases as this is not possible, the exact nature of the use must be given. In addition, numerical specification should be given for the following quantities :

1.—Capacity in microfarads or centimetres.

2.—Maximum permissible capacity tolerance expressed either in microfarads or as a percentage of the nominal capacity.

3.—Voltage or voltages applied to condenser:
- (*a*) D.C.
- (*b*) A.C. Low frequency.
- (*c*) Radio frequency.

4.—Frequency (or Wavelength) of voltage applied to condenser.

5.—Current flowing through the condenser.

Answers should also be given to the following questions :

6.—Nature of the voltage applied to the condenser:
- (*a*) Steady D.C.
- (*b*) D.C. with superimposed audio frequency.
- (*c*) D.C. with superimposed radio frequency.
- (*d*) A.C. (low, or audio frequency).
- (*e*) A.C. (low, or audio frequency) with superimposed radio frequency.
- (*f*) Radio frequency, continuous wave (C.W.).
- (*g*) Radio frequency, interrupted continuous wave (I.C.W.) or tonic train.
- (*h*) Radio frequency, telephone modulated.

7.—Whether metal or porcelain container is preferred.

8.—Whether one terminal of condenser may be connected to the metal container or metal base, or whether both terminals are to be insulated for full working voltage. The position of the condenser or condensers in the circuit, together with circuit diagram should also be given if possible.

9.—Climatic conditions under which the condenser is to operate.

10.—Nature of service—continuous or intermittent.

In the following pages, typical specimens from our different types are illustrated from the smallest low power transmitting condensers, weighing a few ounces, up to large banks of condensers weighing many tons, such as those installed by us at the Rugby Radio Station, England.

(A) Smoothing Condensers

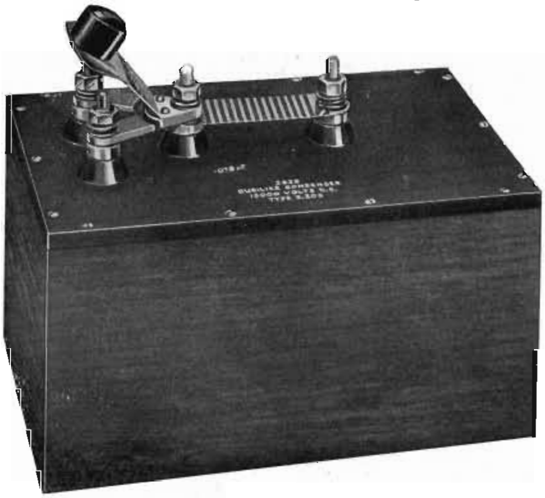
Smoothing condensers are required in conjunction with D.C. generators providing the anode supply to valve transmitting apparatus, for removing the commutator ripple from the voltage waveform, and also in conjunction with rectified A.C. circuits—as, for example, those supplied by valve rectifiers—for smoothing out and storing the rectified impulses. These condensers need, therefore, usually to have as large a capacity as possible and frequently also must operate continuously at high voltages. They are usually used in connection with choke coils for forming a filter circuit to assist the smoothing action. For the greatest reliability mica dielectric condensers should be used for smoothing purposes; but in certain cases paper dielectric condensers are permissible for this purpose. When the arrangement of the smoothing circuit is such that there is any radio frequency current flowing through the condenser in addition to the D.C. voltage to which it is subjected, mica dielectric condensers should always be chosen, since such condensers are better able to carry the radio frequency currents without excessive losses.

In many cases, condensers of this type are useful also as by-pass condensers for shunting various pieces of apparatus in the radio installation.

Mica Dielectric Smoothing Condensers

These condensers are commonly fitted into wax-filled wooden boxes, provided with insulated terminals for the condenser connections, these insulators carrying also the electrodes of a safety spark gap and discharger. In order to prevent damage to the condenser when discharging, a special resistance is fitted to all these condensers to limit the discharge current. When required, two condenser units are mounted in a single case with one common terminal to enable them to be used more conveniently with a choke coil forming part of the smoothing filter circuit.

Mica Dielectric Smoothing Condenser complete with discharge spark gap and discharging resistance, single unit type



Mica Dielectric Smoothing Condenser, double unit type, with double discharge gap and single discharging resistance

This type of condenser, as illustrations, can be supplied for various working voltages up to 20,000 volts D.C. (40,000 volts D.C. test), the maximum capacity in a single unit at this voltage being 0·1 microfarad. These condensers should not be operated at more than one-half of the test voltage for which they are rated. Some commonly used sizes for this type of condenser are as follows:

Capacity (microfarads)	D.C. Test Voltage	Type No.	Nett Price £	s.	d.
0·25	10,000	S0305	4	5	0
0·25	10,000	S0325	17	0	0
0·125+0·125	10,000	SS0325	17	0	0
0·075+0·075	15,000	SS0540	26	0	0
0·125+0·125	15,000	SS0565	42	0	0
0·07	20,000	S0625	17	0	0
0·12	20,000	S0645	30	0	0
0·25	20,000	S0690	55	0	0
0·125+0·125	20,000	SS0690	55	0	0
0·1	30,000	S10100	60	0	0
0·1	36,000	S12145	84	0	0

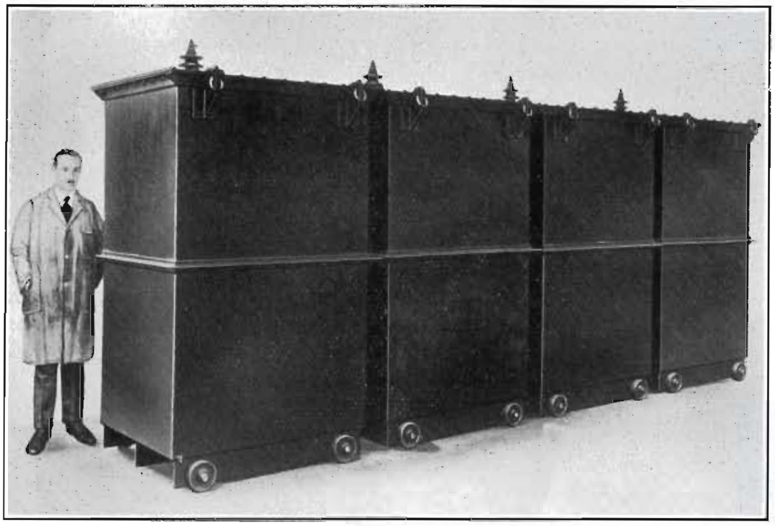
For use in warm situations, these condensers are fitted into oil-filled metal boxes, as shown, and are available in a similar range of sizes to those tabulated above. For larger capacities these condensers are all supplied in oil-filled steel tanks, of similar general form to those illustrated under group (D) below

Oil-immersed Mica Dielectric Smoothing Condenser, double unit type, in metal container, suitable for tropical uses

Paper Dielectric Smoothing Condensers

The smaller types of paper dielectric smoothing condensers are described in Section M of this catalogue (Dubilier Type T Condensers). Large capacity and high voltage condensers can be built up of a plurality of such condenser units. The illustration shows such a high voltage large capacity condenser using a wax impregnated paper dielectric. This type employs our patented unit construction, and consists of a bank of low voltage units connected in series-parallel. An equi-potential resistance device, which also acts as a discharge resistance, is connected across the bank and avoids unequal subdivision of the total voltage between the parts of the condenser. The condenser illustrated has a capacity of 5·0 microfarads and is designed for a working voltage of 10,000 volts D.C. The complete condenser is insulated for the full working voltage to earth. These condenser banks are also built up in sections of 1·0 microfarad each for a working voltage of 10,000 volts D.C., a number of such sections being used for larger banks. Full particulars of other sizes will be given on receipt of details of requirements.

Paper Dielectric Smoothing Condenser Bank, built up with Type T Paper Dielectric Condenser Units. Capacity, 5 microfarads: working voltage, 10,000 volts D.C.



Paper Dielectric Oil-immersed Smoothing Condenser Bank for Trans-Atlantic telephone

Large Capacity Paper Dielectric Smoothing Condensers for Radio Telephone Transmitters

The illustration shows an exterior view of the bank of high-voltage oil-immersed paper dielectric smoothing condensers constructed by us for the Rugby Trans-Atlantic Telephone Service. The complete bank has a capacity of 40 microfarads and a working voltage of 10,000 volts D.C. The total weight of the condenser bank is approximately 16 tons.

An idea of the size of this equipment can be gained from the man shown in the photograph. This particular condenser is constructed in four units each of 10 microfarads capacity, and each enclosed in an oil-filled steel tank.

An interior view of one of these smoothing condensers is also reproduced, giving a good idea of the general construction of this type of condenser. The whole construction of this condenser is a very rigid mechanical and electrical one, so as to ensure the utmost reliability of operating service. These condensers incorporate a patented arrangement for ensuring equality of voltage distribution between the parts of the condenser.

Interior arrangement of one unit of oil-immersed Paper Dielectric Smoothing Condenser

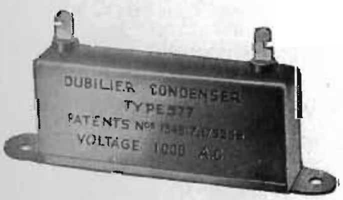
(B) Anode Stopping and Grid Condensers for Valve Transmitters

As a general rule it is necessary that both poles of condensers required for these uses must be insulated from earth. This insulation must be able to withstand the full anode voltage applied to the valves. For the smaller sizes of these condensers it is convenient to provide sufficient internal insulation in the condenser case to enable two insulated terminals to be fitted, either to a metal or to an insulating container; with larger sizes, however, for high-power transmitters, such an arrangement adds materially to the cost of the condenser, and the more economical arrangement is to provide porcelain or similar insulation external to the (metal) condenser case to give the required isolation from earth. In special cases, however, when the size is of lesser importance, and it is necessary that the whole condenser should be enclosed in and insulated from a metal tank which is connected to earth, we can provide such arrangements with special internal insulation of low capacity which is able to stand up to high radio-frequency voltages as well as to steady D.C. potentials.

Some typical forms of anode stopping condensers are illustrated, showing a range of sizes suitable for various powers of transmitters from the smallest upwards. These condensers can be used for grid circuit condensers also.

In specifying these condensers the normal steady D.C. anode voltage should be stated and in addition the frequency and magnitude of the *radio frequency* feed current which flows through the condenser superimposed upon the D.C. potential. It should be noted that this superimposed current is a radio frequency one, and is quite distinct from and often much larger than the D.C. feed current to the valve anode. For transmitters operating directly upon an A.C. supply without rectifying valves, this radio frequency feed current is superimposed upon the A.C. transformer voltage, and the R.M.S. value of this A.C. voltage should be quoted.

The Type 577 condenser of mica dielectric is contained in a hermetically sealed case, the plates of the condenser being brought out to insulated lugs suitable for soldered connections. This is particularly suitable for use as a grid condenser, or anode stopping condenser in a small transmitter. It may also be used in an oscillatory circuit, and



Type 577 Mica Dielectric Condenser for Small Radio Transmitters

the maximum rating should not exceed 1 ampere at any wavelength between 50 to 2,000 metres provided that the maximum working voltage does not exceed 500 continuous wave. Maximum working conditions should not exceed 1,000 volts low frequency A.C. Capacity range, 50 micro-microfarads to 0·015 microfarads.

The B775 Condenser shown is similar in general construction, but the container is of high insulating quality bakelite and terminals as well as soldering lugs are provided.

This condenser is suitable for similar circuit positions to Type 577, but the working voltage is higher in the case of the smaller capacities. This condenser is also particularly suitable for use as a coupling condenser in high voltage power amplifiers. Capacity range 0·05–0·5 microfarads. Maximum working voltage 2,000 volts direct current.

Type B775 Mica Dielectric Condenser for smoothing circuits of Small Radio Transmitters

The Type AF77 condenser which is illustrated has been specially designed for low-power transmitters operating on ultra short wavelengths. Capacity range 50 micro-microfarads to 15,000 micro-microfarads; but the maximum

Type AF77 Anode Feed Condenser in porcelain container

continuous wave current capacity is 5 amperes. When used as an anode stopping condenser, the maximum working voltage is 2,000 D.C. This condenser is entirely enclosed in a porcelain container.

The condensers Types AF650, 700, 750, and 800 are suitable for use in the grid, anode, and oscillatory circuits of valve oscillators; capacity range of the series 50 micro-microfarads to 0·3 microfarad. Voltage rating up to 5,000 volts direct current for the smaller capacity values only. Continuous wave rating up to 25 kilovoltamperes approximately, depending on type and the working frequency. Like the Type AF77, these condensers are enclosed in porcelain containers. They are also fitted with a metal fixing base, and are provided with two screw terminals mounted in the porcelain lid of the condenser case.

Anode Feed and Grid Condenser, Mica Dielectric, Type AF750

Merely as examples, the following are typical ratings for two of these condensers :—

Type AF650.

Capacity 0·002 μF.
Working voltage 2,000 V. D.C.
Superimposed radio frequency current 2 amperes at 300 metres wavelength.

Type AF800.

Capacity 0·05 μF.
Working voltage 4,000 V. D.C.
Superimposed radio frequency current 5 amperes (telephone modulated) at 100 metres wavelength.

Condensers of Types AF77, AF650, AF700, AF750, and AF800 are also well suited for use in wired wireless apparatus, as filter circuit condensers and for other similar purposes.

Mica Dielectric Anode Feed Condenser, Type P800AF

The condensers shown on this page are specially constructed for use as anode stopping condensers in medium size radio transmitters operating at anode voltages of between 5,000 and 15,000 volts D.C. A typical example of the smallest type (Type P800AF) suitable for a maximum working voltage of 5,000 volts D.C. is illustrated. The second illustration is of a condenser of similar construction, but consisting of two of the above type units connected in series. This arrangement is suitable for a maximum working voltage of 10,000 volts D.C. (Condenser Type P2S800AF.) The next illustration is similar and shows a condenser consisting of three such units mounted in series. This type is suitable for a maximum working voltage of 15,000 volts D.C. (Type P3S800AF.) All these condensers are insulated from earth by means of porcelain insulators, which are suitable for a working voltage of 20,000 D.C. to earth.

Examples :

Type P800AF.

1.—Capacity 0·05 μF.
Working voltage 5,000 V. D.C.
Superimposed radio frequency current 7 amperes (telephone modulated) at 1,000 metres wavelength.

2.—Capacity 0·002 μF.
Working voltage 1,000 V. D.C.
Superimposed radio frequency current 5 amperes (telephone modulated, at 1,500 kc

Mica Dielectric Anode Feed Condenser, Type P2S800AF

Mica Dielectric Anode Feed Condenser, Type P3S800AF

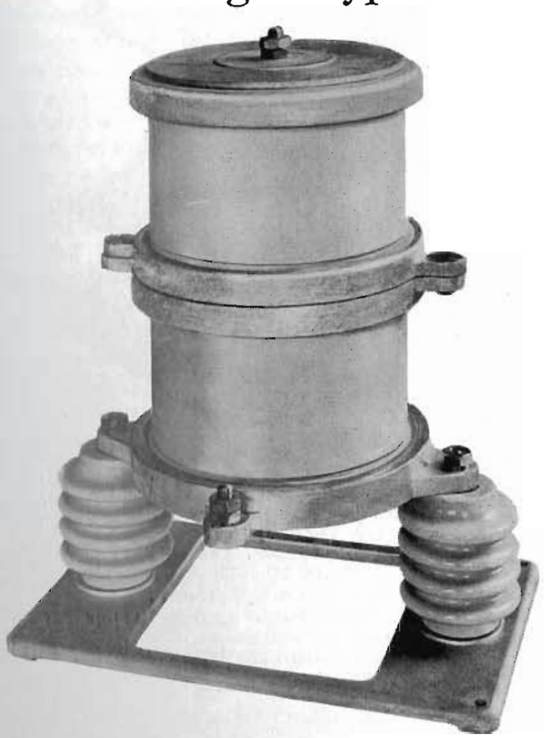
SMALL ANODE-BLOCKING AND GRID CONDENSERS

Type	Nett Price £	s.	d.
577	0	7	6
AF77	0	17	6
AF650	1	15	0
AF700	2	5	0
AF750	2	15	0
AF800	3	10	0

Type	Nett Price £	s.	d.
P800AF	4	0	0
P2S800AF...	7	10	0
P3S800AF...	12	0	0

The prices quoted apply to normal condensers of the types stated. In special cases they are subject to modifications.

Larger Types of Anode-Feed Condensers



Porcelain-cased Mica Dielectric Condenser for use as Anode-Blocking or Aerial Shortening Condenser, Type P2S150AF

For the larger anode-stopping condensers larger individual units, either wax or oil-filled are used, mounted on appropriate porcelain insulation. In the larger sizes this insulation is of a special type particularly suited to prolonged usage and having a very high flash-over voltage.

The condenser Type P2S150AF, which is illustrated, is a typical example of the medium-sized wax-filled anode stopping condenser, suitable for a maximum working voltage of 20,000 volts D.C. for the smaller capacities. The maximum permissible working voltage is lower when the capacity is increased.

The condenser Type CW1126AF is an example of a larger sized anode stopping condenser. This is mounted in an oil-filled container and is suitable

Oil-immersed Mica Dielectric Condenser, Type CW1126AF. Suitable for Anode-feed or Aerial Shortening Condenser

for high working voltage on the condenser and between the case of condenser and earth.

Examples :

1.—Condenser Type P2S150AF.
- Capacity 0·002 μF.
- Working voltage 17,500 D.C.
- Superimposed current 1 ampere at 75 kc.

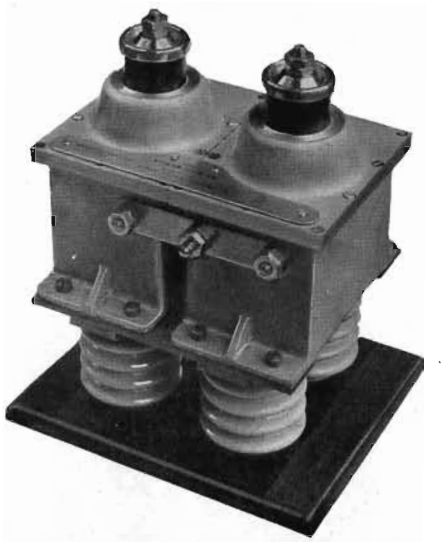
2.—Condenser Type CW1126AF.
- Capacity 0·00045 μF.
- Maximum current 25 amperes at any wavelength between 400 and 600 metres.
- Insulation from earth tested at 30,000 volts D.C.

(C) Aerial Shortening Condensers

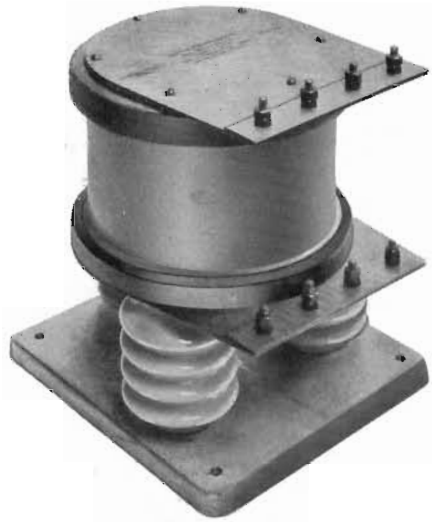
When these condensers are connected in the earth lead of the radio transmitter, one terminal of the condenser can be joined to earth, and an earthed metal container (with one terminal mounted on it) is convenient for the condenser. Any of the types of condensers illustrated under group (D) below may be used in this way. In most cases, however, the condenser must be connected in the aerial circuit of the transmitter and have both poles well insulated from earth in a manner able to support a radio frequency voltage as distinct from a steady D.C. voltage. Any of the types of Anode-Stopping Condensers [group (B)] already illustrated can be used in this way, provided that the insulation from earth is suitable for the working *radio frequency* voltage.

In specifying these condensers it is therefore essential to quote full details regarding the radio frequency voltage above earth at which the whole condenser will be operating, stating also whether this voltage is pure C.W., Interrupted C.W. (I.C.W.), or telephone modulated, since this also affects the design of the insulation. In addition, the required capacity of the condenser, the normal current flowing through it, and the frequency and character of this current must of course be quoted.

As examples, two types of condenser are illustrated, Types CW2SS158AF and P150AF; but many other sizes and types can be supplied to meet special requirements.



Mica Dielectric Aerial Shortening Condenser, Type CW2SS158AF



Mica Dielectric Aerial Shortening Condenser, particularly for use in short wave circuits, Type P150AF

Examples :

1.—Condenser Type P150AF.
Capacity 0·0005 μF. Current 25 amperes C.W.
Frequency 500 kilocycles.

2.—Condenser Type CW2SS158AF.
Capacity 0·001 μF. Current 10 amperes C.W.
Wavelength 2,400 metres.
Insulated from earth for 3,000 volts C.W.

When a transmitter is used over a range of wavelengths, it is often convenient to have a range of condenser capacities for use in series with the aerial circuit. In many cases these can all be combined into a single condenser case, with several terminals brought out to enable connections to be made to the various capacity tappings. An example of a small size tapped capacity condenser of this type is illustrated, and two typical ratings for these condensers are as follows, one of these ratings being for the condenser type which is illustrated, and the other being for another condenser of similar size but having different terminal and capacity arrangements.

Examples :

1.—Condenser Type CW1582D4/6.

Capacity Tappings	Current
0·001 μF.	1 ampere.
0·002 μF.	2 amperes.
0·004 μF.	4 amperes.
0·004 μF.	4 amperes.
Total capacity 0·011 μF.	11 amperes.

Frequency 110 kilocycles.

2.—Condenser Type CW1581D3/4.

Capacity Tappings	Current
0·005 μF.	4 amperes.
0·01 μF.	8 amperes.
0·01 μF.	8 amperes.
Total capacity 0·025 μF.	20 amperes.

Frequency 75–100 kilocycles.

Tapped Capacity Aerial Shortening Condenser, Mica Dielectric, Type CW1581D3/4

(D) Oscillation Circuit Condensers

A wide variety of condensers are manufactured for use in main circuits of radio transmitting apparatus, the smallest ones usually being wax-filled and enclosed in either metal or porcelain containers, and the larger ones oil-filled and enclosed in aluminium or steel tanks. These condensers, when of the fixed capacity type, are all manufactured with a mica dielectric, and are constructed in accordance with our patented processes, in such a way as to ensure extremely low radio frequency losses even when carrying very large radio frequency currents. The rating of any given condenser of this type depends considerably upon the waveform of the current which is to be passed through the condenser. In general, three main types of waveform are recognised in this connection :

1.—Pure Continuous Wave (C.W.), *i.e.,* sine waveform.
2.—Interrupted Continuous Wave (I.C.W.) in which the continuous wave is interrupted into audio frequency groups (known also as "Tonic Train").
3.—Telephone Modulated Wave.

Either of the first two types may be continuous or cut up into signals for telegraphic transmission.

The type of current waveform, as above, should always be specified when ordering condensers of this class. In addition, too, the capacity, the normal current (r.m.s.) and the frequency or wavelength must be stated.

Of the many types of these condensers which we manufacture, only a few examples are here illustrated to show the range of our products.

Small Mica Dielectric Condensers for Radio Transmitters

Condensers, Types P800, P150, and P350, are small types of these continuous wave condensers. These are enclosed in porcelain containers with

Porcelain-cased Condenser for main closed circuit of Small Radio Transmitters, Type P800

Porcelain-cased Condenser for main closed circuit of Small Radio Transmitters, Type P150

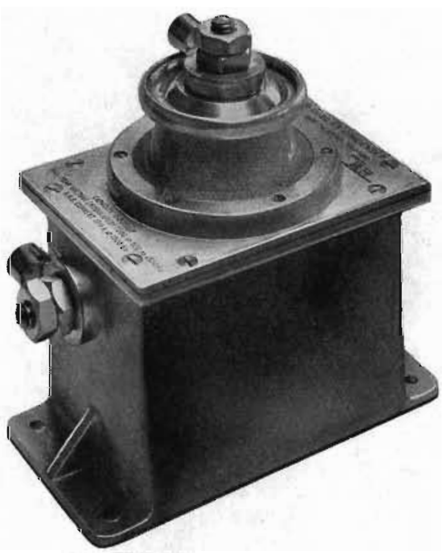
metal ends and bases, on which the terminals are mounted, this arrangement permitting a greater current-carrying capacity than does that adopted in the other porcelain cased types (Types AF650, AF700, AF750, and AF800) already illustrated. Capacity range 50 micro-microfarads to 1·5 microfarad. Maximum working voltage up to 20,000 direct current for the smaller capacities. Under continuous wave conditions the maximum loading is between 20 and 200 kilovoltamperes dependent upon type and frequency. These condensers are particularly suitable for use in the oscillation circuit of short-wave transmitters.

The porcelain-cased type Condensers, Types AF650-AF800, referred to above, are also suitable for use in the closed circuit of valve oscillators, and for master oscillators, drive and amplifier circuits.

Condensers Types CW158P and CW4583PD are examples of small metal-cased condensers of this class. These are mounted in wax-filled aluminium boxes with porcelain insulated terminals, and are constructed either with one terminal connected to the case as, for example, Type CW158P or with both terminals insulated as, for example, Type CW4583PD. These may be used in the oscillation circuit either with one side of the condenser connected to earth, or with both sides insulated from earth, and the case earthed and acting as an electrostatic screen. Working voltages up to 10,000 volts direct current, or 6,000 volts C.W. at the

Porcelain-cased Condenser for main closed circuit of Small Radio Transmitters, Type P350

lower frequencies. Maximum current 50 amperes. Maximum loading 50 kilovoltamperes dependent on frequency and type.



Metal-cased Mica Dielectric Condenser for closed circuits of Radio Transmitters, with single porcelain terminal insulator and live metal case, Type CW158P

Examples :

1.—Type CW158P.
Capacity 0·0025 μF.
Maximum current 17·5 amperes (telephone modulated) at a frequency of 500 kilocycles.

2.—Type CW4583PD.
Capacity 0·003 μF.
Maximum current 12·5 amperes (telephone modulated) at a frequency of 100 kilocycles.

Condensers of this class and in the smaller sizes are also supplied with patent mica insulated terminals for certain ranges of frequency and currents.

Other very commonly used condensers of this class are known as Types CW175, CW158, CW1582, CW3583, CW4583.

Metal-cased Mica Dielectric Condenser, fitted with two insulated terminals, Type CW4583PD

Each of these can be supplied in a variety of patterns having different arrangements of terminals, and terminal insulators, &c., depending upon requirements, as to the electrical loading of the condensers.

Prices of Types Illustrated

Type	Nett Price
P800	**£3 10 0**
P150	**£7 0 0**
P350	**£18 0 0**
CW158P	**£7 0 0**
CW4583PD	**£18 10 0**

The prices quoted apply to normal condensers of the types stated. Special arrangements entail modifications to these prices. Particulars and prices of other sizes and types on application on receipt of details of special requirements.

Condensers for Medium-size Transmitters

All the larger condensers belonging to this class are fitted into oil-filled tanks, the smaller tanks being constructed of cast aluminium and the larger of welded steel. Condensers Types CW174L and CW1126L are examples of small oil-filled tank condensers, these being fitted into cast aluminium tanks. These condensers are suitable, as a general rule, for oscillation circuits of higher loading than the wax-filled condensers illustrated above. The smaller of these two is suitable for currents up to 50 amperes and the larger for currents up to 70 amperes. These currents, however, are only permissible for the largest capacity values which can be fitted into these containers, so that the corresponding radio frequency voltages are small. With smaller capacities for higher voltages, the maximum permissible currents are smaller also.

The terminal insulators fitted to these condensers are special porcelain ones, constructed in accordance with our patented designs. They are

Small Oil-immersed Mica Dielectric Condenser for closed circuits of medium-sized Radio Transmitters, Type CW174L

so designed that the losses in the terminals are very low due to the radio frequency potentials to which they are subjected, with the result that the heating of the terminals is negligible. They are protected from the harmful action of corona discharges by appropriately shaped electrostatic shields, the design of which is such that in the event of a flash-over taking place due to excessive voltage, the discharge will take place entirely through an air path and not along the surface of the insulator. Damage to the porcelain is thereby avoided.

Oil-immersed Mica Dielectric Condenser for closed circuits of Radio Transmitters, Type CW1126L

These oil-filled radio frequency condensers are constructed in accordance with our patented ring condenser principle, whereby not only are all the internal parts of the condenser made self-supporting without additional insulating material, but the current distribution through all the parts of the condenser is made as uniform as possible, resulting in the most efficient operation. This construction is best suited to the construction of condensers with one pole connected to the containing tank, since all the heavy parts of the condenser can then be supported directly from the tank without any additional insulation material. Where necessary, however, these condensers can be provided with two or more insulated terminals.

Examples :

CONDENSER TYPE CW174L.
Capacity 0·01 μF.
Current 50 amperes at 300 metres wave-length.

CONDENSER TYPE CW1126L.
Capacity 0·003 μF.
Current 36 amperes at 2,000 metres wave-length.

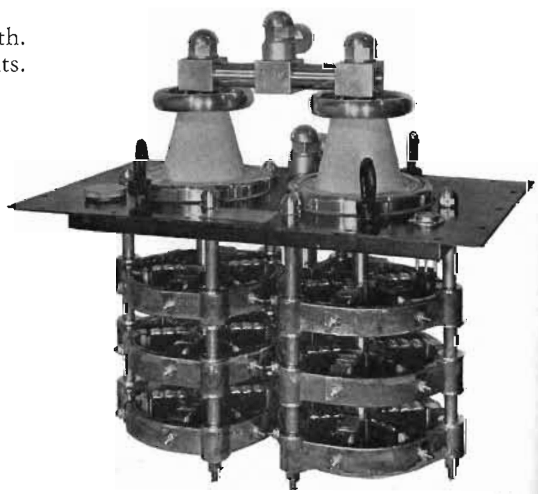
Condensers for Large Radio Frequency Currents

With many condensers of this class the currents to be carried by the condenser are large and the radio frequency voltages low. In such condensers special terminals are provided to enable the large external conductors to be connected conveniently, and the current is distributed into the condenser through a number of terminal conductors so as to subdivide the current and avoid over-heating of the terminal connections. These terminal conductors are made tubular further to reduce the heating losses. The condenser Type CW192L1/3 is an example of such terminal arrangements, this particular condenser being rated for a current of 100 amps. at a wavelength of 100 metres, the capacity being 0·01 microfarad.

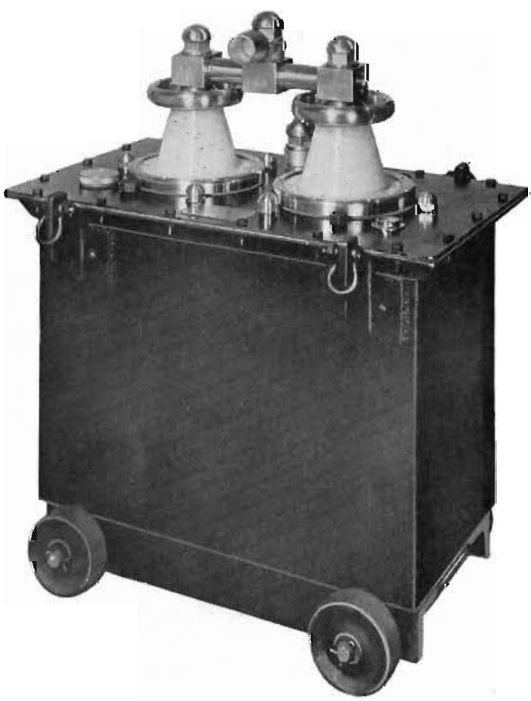
Heavy Current Mica Dielectric Condenser for medium wavelength circuits. Type CW192L1/3

A larger condenser of this class for a heavy current circuit is illustrated in the condenser Type CW6126L2. From the photograph of the inside of this condenser it is easy to see that the total current is subdivided into a large number of parallel paths, so that all parts of the condenser dielectric operate without overloading. The large terminals provided for the heavy currents are also noticeable. The particular condenser illustrated is rated as follows:—

Type CW6126L2. Capacity 1·0 μF.
Current 140 amperes CW at 3,000 metres wavelength.
D.C. voltage superimposed on r.f. current, 1,200 volts.



Interior arrangement of Condenser Type CW6126L2 showing ring condenser construction



Heavy Current Tank Type Condenser for Radio Frequency Circuits. Oil-immersed Mica Dielectric, Type CW6126L2

A still larger condenser of this class, Type CW101714D2/3, which is illustrated, is one of the condensers constructed for the Rugby Trans-Atlantic Telephone Station. An idea of the dimensions of this condenser may be obtained from the girl standing beside it.

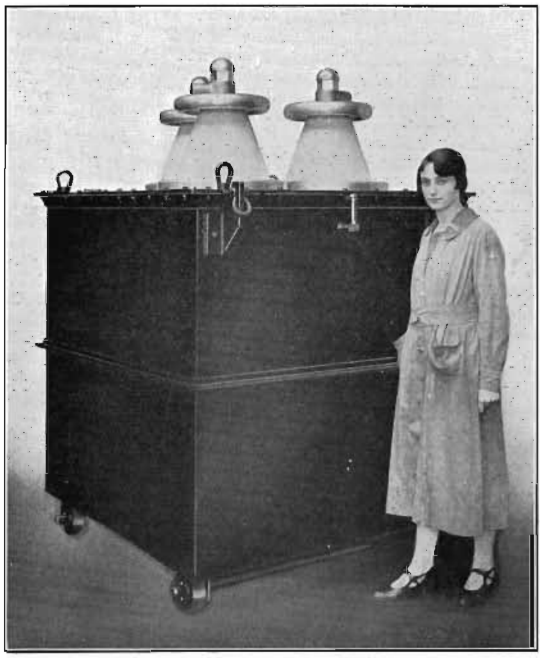
The rating of this condenser is as follows :—
Type CW101714D2/3.
Capacity 0·07 μF.
Current 250 amperes at 45 kilocycles.
Weight of condenser in tank, approx. 6,000 lbs.

Condensers for High Power Radio Stations

Condenser Type CW20179L4 is one unit of the "A" bank of condensers which was constructed for the telegraph transmitter of the Rugby Radio Station of the British Post Office. Ten of these condensers are used in the condenser bank, the rating of each unit being as follows :—

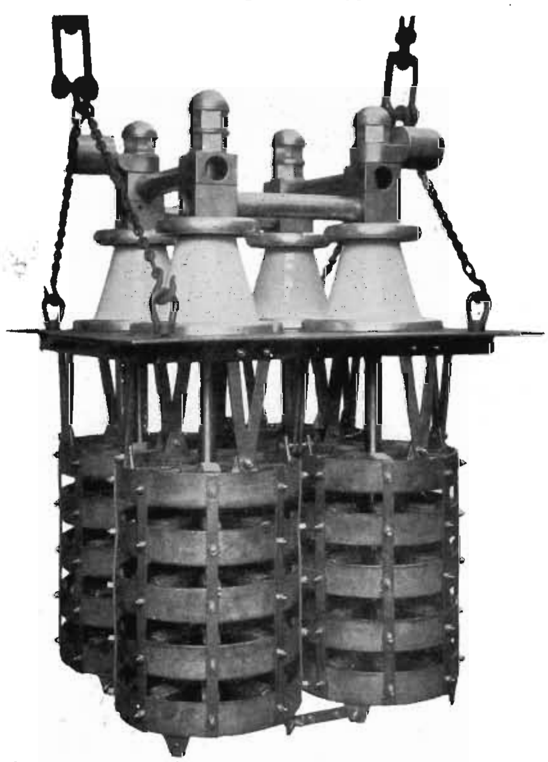
Type CW20179L4.
Capacity 0·025 μF.
Radio frequency voltage 34,000 V.
Current 82 amperes at 18,000 metres wave-length.

The photographs show also the internal construction of one of these condenser units. The ring construction used in these high power mica dielectric transmitting condensers can be noted from the illustration.



Large Tank Type Mica Dielectric, oil-immersed, Condenser for heavy current radio frequency circuits with condenser entirely insulated from containing tank. Type CW101714D2/3

One of the Condenser Units of the Rugby Radio Telegraph Transmitting Station. Type CW20179L4

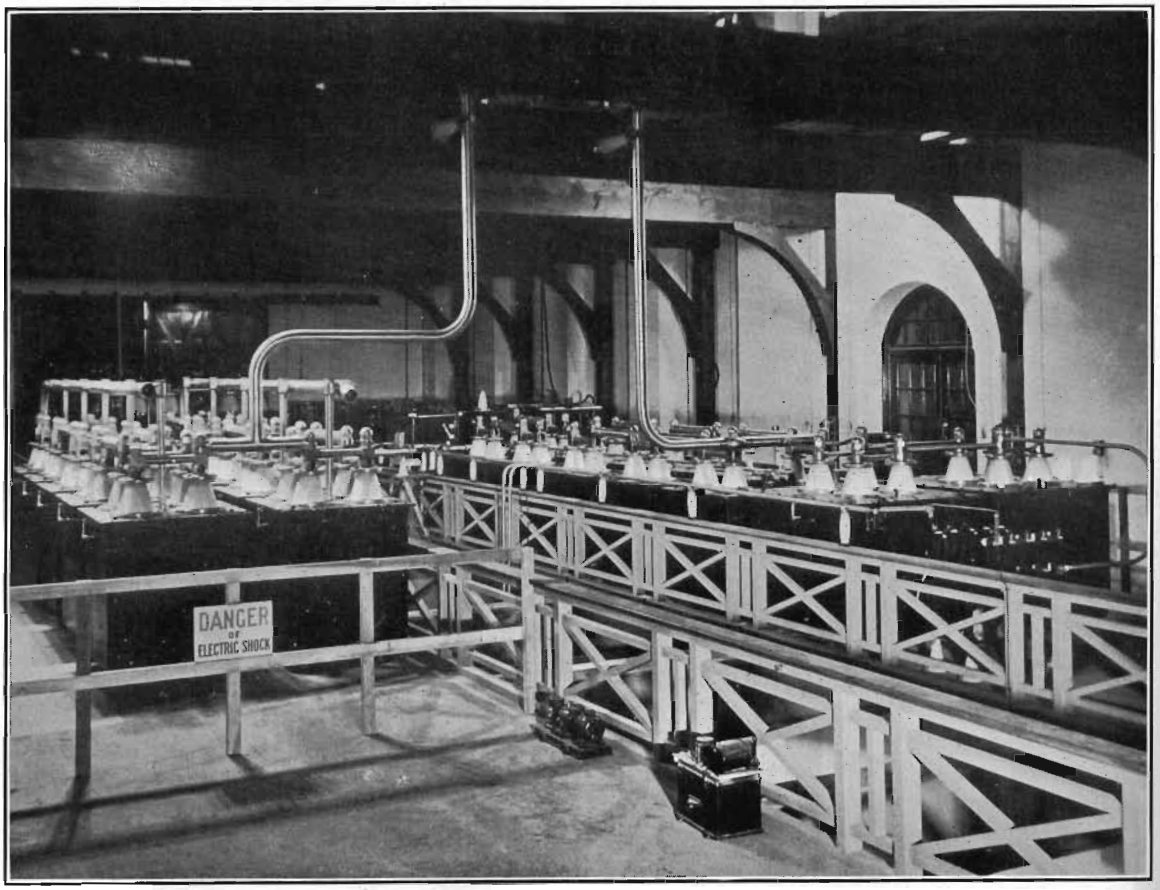


Interior arrangement of Condenser Type CW20179L4, showing multiple ring construction and subdivision of the terminal connections

The photograph of the condenser gallery of the Rugby Radio Station shows this condenser bank and also a number of other large condensers of similar types.

Radio frequency tank type condensers of this class can also be constructed so as to have a number of different capacity values in a single tank. The condenser Type CW4129/4126D4/5 illustrates one of this type, wherein four capacity values can be obtained, by using either part alone or by joining them in series or in parallel by means of the links provided. (See page T.15.)

The particular condenser illustrated gives capacities of 0·002, 0·0035, 0·0045, and 0·008 microfarad, the rating at the smallest capacity being 65 amperes CW at 3,000 metres. These condensers are suitable for use in the closed circuits of radio transmitters which are required to be operated at three or four different wavelengths.



Condenser Gallery of the Rugby Radio Station of the British Post Office, showing heavy current condenser banks

Variable Capacity Transmitting Condensers

Variable Capacity Condensers are constructed either to be variable in fixed steps or by continuous adjustment. In the former case, the condensers are usually of the mica dielectric type, provided with tappings, as illustrated on page T.8 and also on this page. The continuously adjustable condensers are constructed with either an air or an oil dielectric, depending upon the size of the condenser and the electrical loading to be applied to it. The illustrations show a condenser of each of these types.

The smaller condenser has a capacity of 0·0005

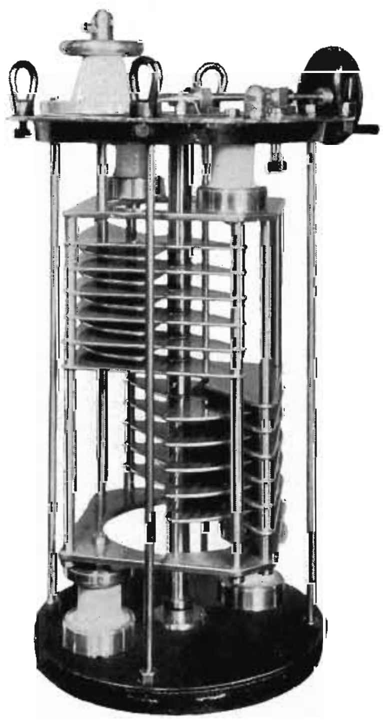
Multiple Capacity, mica dielectric, Condenser for use in Multi-wavelength Circuits, Type CW4129/4126D4/5

Variable Capacity Condenser for Radio Transmitting Circuits, air dielectric

Large Variable Capacity Condenser, oil dielectric, for Radio Transmitting Circuits

microfarad and is suitable for a maximum working voltage of 2,000 volts D.C., and will carry a current of 15 amperes at 30 metres at the maximum setting of the condenser. At longer wavelengths, the permissible current through the condenser is less ; for example, at 200 metres the current must be limited to approximately 2 amperes.

The second example illustrated shows a larger variable condenser capable of carrying 5 amperes at 100 kilocycles when set at the maximum capacity of 0·001 microfarad, the condenser at this rating is working at 8,000 volts C.W. This condenser is oil immersed.



Interior of Large Variable Capacity Condenser, oil dielectric, for Radio Transmitting Circuits

Short-Wave Condensers

For short-wave radio transmitters the condensers required are generally much smaller in bulk than those used for longer wavelength sets of corresponding power. Many of the types of condensers illustrated above can be supplied in a form suitable for short-wavelength circuits, the design of the condenser in this case being different, and following a special patented method which maintains high operating efficiency even at these very high frequencies. Special constructions of condenser and condenser insulators have, however, also been developed particularly for these conditions of use.

Special Porcelain-cased Mica Dielectric Condenser for short-wave circuits, Type P2(2S150)

An example of a special construction for short wave radio circuits is illustrated in condenser Type P2(2S150). This condenser is constructed from four smaller porcelain-cased condenser units arranged in series—parallel with special terminal connections designed for wide flat-strip conductors.

Full particulars and prices will be given on receipt of detailed requirements.

(E) Condensers for Spark Radio Transmitters

For use in the closed circuit of spark radio Transmitters, condenser units similar to the type illustrated are commonly employed, using two or more condenser units connected together in parallel as may be required for the particular installation.

Example:

Condenser Type QS1582.
Capacity 0·012 μF.
Working voltage 12,500 volts (spark).
Tested at 15,000 volts (r.m.s.) at 50 cycles.

Mica Dielectric Condenser for Spark Radio Circuits, Type QS175

Mica Dielectric Condenser for Spark Radio Circuits, Type QS1582

Section L

Precision Condensers and Laboratory Apparatus

Introduction

A LARGE range of Condensers has been designed for use as laboratory standards of capacity, and the following pages give some idea of the various types we manufacture. Great care has been taken in the design of these so that there shall be no variation of capacity under widely differing climatic conditions, or variation of capacity due to change of operating temperature and working frequencies under normal conditions. From experiments we have made, the temperature coefficient has been found to be negligible over the normal working temperature range. Where condensers are used in the laboratory it is not usual for them to operate at high voltages, but special condensers can be made suitable for use at high voltages if required. Specially selected materials are used in these condensers in order to ensure an extremely low value of power factor, and a high value of insulation resistance. In the case of sub-divided standards the switches have been specially designed to reduce the self-capacity of these to an absolute minimum and to ensure that an extremely good contact is at all times maintained. It is also usual to incorporate in these condensers metal cases for the purpose of electrostatic shielding. The normal accuracy of calibration of these condensers is $\pm$ 1%, so that they are suitable in this form for factory sub-standards, but increased accuracy of calibration for precision work can be provided at a slight extra charge. In the case of variable air condensers these are provided with a calibration chart, and in all cases a National Physical Laboratory certificate will be supplied on payment of the necessary fee.

Variable Air Condensers

The illustration shows an example of a special air dielectric variable condenser constructed for use as a precision laboratory standard. The complete unit is contained in a polished brass case which provides electrostatic shielding. Mica insulation is used throughout permitting of a high insulation resistance, with extremely low dielectric losses. The condenser is of the straight line capacity type and has a maximum capacity of 1,000 micro-microfarads. A slow motion drive is provided and a vernier is engraved on the pointer, so that one-tenth of a division of the main scale, which is divided into 100 parts, may be accurately observed.

Dubilier Precision Variable Condenser, air dielectric

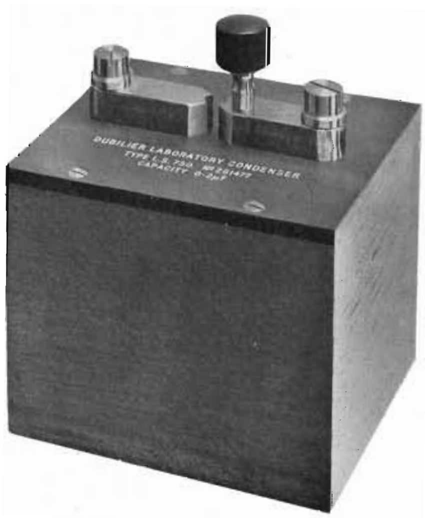
Fixed Mica Dielectric Standard Condensers

Condenser Type LS1/0·5D/P1 is illustrated as a typical example of a fixed-capacity mica dielectric laboratory standard condenser. This condenser is mounted in an electrostatic screening case and a short-circuiting plug is provided. This type of standard condenser can be supplied in any capacity value between 0·01 and 1·0 microfarad and can be guaranteed accurate to $\pm$ 0·1%.

A smaller condenser, Type LS750, is also illustrated. This type is constructed for the smaller capacity values only, and is enclosed in a wooden box fitted with substantial terminals mounted on an ebonite lid. These terminals are provided with brass sockets for a short-circuiting plug.

These condensers are constructed of the best possible materials, and are so designed as to maintain extreme constancy of capacity value.

Laboratory Fixed-Capacity Standard Condenser
in polished brass case



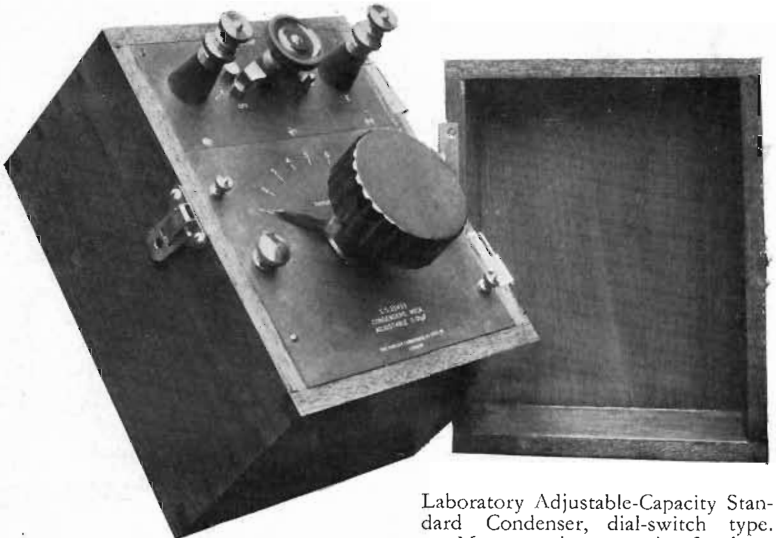
Laboratory Fixed-Capacity Standard Condenser
in polished wood case

Adjustable Mica Dielectric Standard Condensers

These are constructed in a variety of patterns to meet special requirements. Three main types are illustrated in which the capacity adjustment is effected :

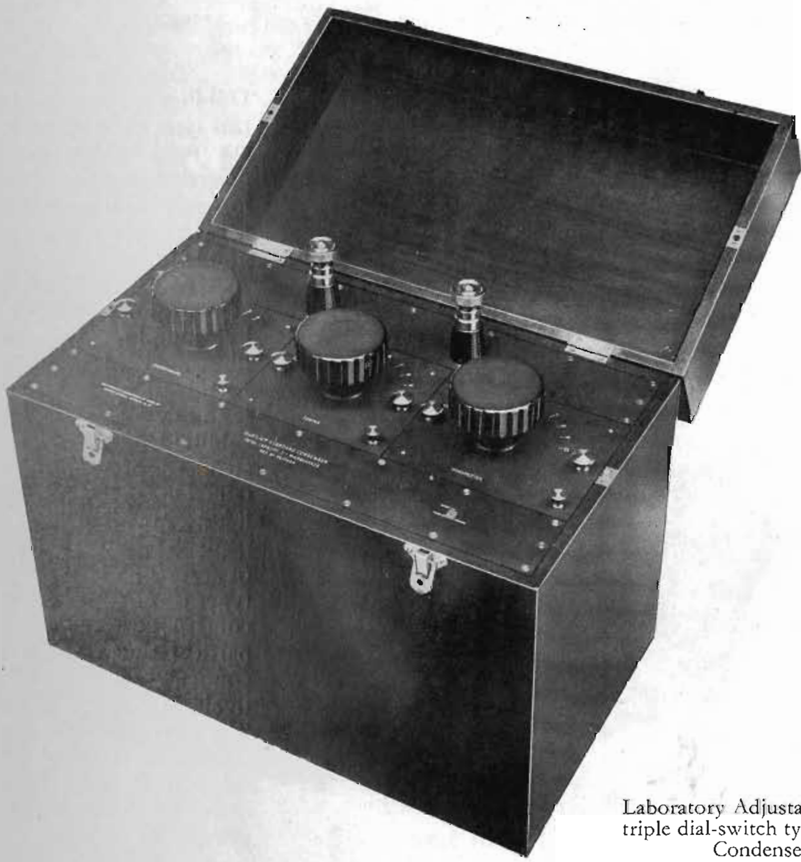
1.—By Dial Switches.
2.—By Knife Switches.
3.—By Plug Switches.

Two examples of the first type are illustrated, the smallest one having a maximum capacity of 0·01 microfarad and being adjustable in steps of 0·0005 microfarad. This condenser is of the usual Dubilier Laboratory standard construction, and is completely shielded in a metal container mounted in a polished mahogany case.



Laboratory Adjustable-Capacity Standard Condenser, dial-switch type. Max. capacity 0·01 microfarad.

The larger condenser, Type LS24/5·1D/DS3, represents a very useful type of adjustable standard condenser having a maximum capacity of 5·1 microfarads, which is adjustable in steps of 0·01 microfarad. The usual electrostatic screen is provided, and the capacity can be adjusted to any reasonable degree of tolerance in accordance with customers' requirements. The switching employed is on the decade system, with 10-point and 5-point dial switches.



Laboratory Adjustable-Capacity Standard Condenser, triple dial-switch type. Max. capacity 5·1 microfarads. Condenser Type LS24/5·1D/DS3

ADJUSTABLE MICA DIELECTRIC STANDARD CONDENSERS—*continued*

Laboratory Adjustable-Capacity Standard Condenser, knife-switch type.
Max. capacity 1·11 microfarads. Condenser Type LS12/1·11L/KS12

Another laboratory standard condenser, particularly suited also as a factory substandard, is illustrated in the condenser Type LS12/1·11L/KS12. This type, which has a maximum capacity of 1·11 microfarads is adjustable in steps of 0·001 microfarad by means of knife switches. The usual Dubilier construction and quality are ensured throughout, the condenser being enclosed in an electrostatic screening box, and the whole condenser unit contained in a polished teak case with hinged lid. One terminal of this condenser is usually connected to the electrostatic screen. The usual guarantee of accuracy holds with this type as with all Dubilier condensers. In this type knife switches are used which have been designed to ensure low self-capacity, while retaining extremely good contact.

Laboratory Adjustable-Capacity Standard Condenser, plug type.
Condenser Type LS4/0·0075L/P4

A condenser having adjustment provided by plug switches is illustrated in Type LS4/0·0075L/P4, which is an example of a small subdivided laboratory standard condenser contained in a teak box with lid. This type can be made to the same degree of accuracy as the other types described, but the construction used is particularly suitable for condensers of comparatively small capacity. The cover protects the condenser terminal insulation if used in a damp or dusty atmosphere.

Dubilier Wavemeters

(a) Buzzer Type

This instrument is of the standard type employing a special high-grade high-note buzzer operated by a small dry cell, enclosed in the case. The instrument uses standard type plug-in coils, and a number of these can be supplied with each instrument to cover any desired wave range. The apparatus is supplied complete with calibration charts. Accuracy of calibration is sufficient to permit of the calibration of an ordinary radio receiving set.

The illustration shows a simple form of this wavemeter, which can, however, also be supplied in a case designed to house a set of coils and calibration charts, to cover a wavelength range of 25 to 2,000 metres.

Buzzer Wavemeter

(b) Neon-Lamp Type

This instrument works on the resonance principle, and is usually used in connection with a transmitting apparatus. Resonance is indicated by a glow discharge in the Neon lamp due to the voltage induced in the tuned circuit of the wavemeter. It may be used in connection with receivers when the receiver is oscillating, resonance being indicated in this case by a click heard in the head-phones of the receiver. This instrument can be supplied with a number of different coils to cover any desired wavelength range, and complete calibration charts are included.

Neon-Lamp Wavemeter, with coils and case

The instrument illustrated is a simple form of this wavemeter arranged so as to be convenient for application to radio transmitting circuits. The single box contains the tuning condenser, sockets for plug-in inductance, and the Neon indicator lamp. The complete instrument is usually supplied in a case having compartments for containing the plug-in inductances and the calibration charts of the wavemeter, the meter itself fitting into a section of the containing case, as shown in the illustration.

(c) Combined Neon-Lamp and Buzzer Type

The instrument illustrated combines the two previously described types of wavemeter into a single containing case, the buzzer enabling the tuned circuit of the wavemeter to be excited for the emission of feeble oscillations for tuning the receiver; by throwing over a change-over switch the Neon lamp

DUBILIER WAVEMETERS—*continued*

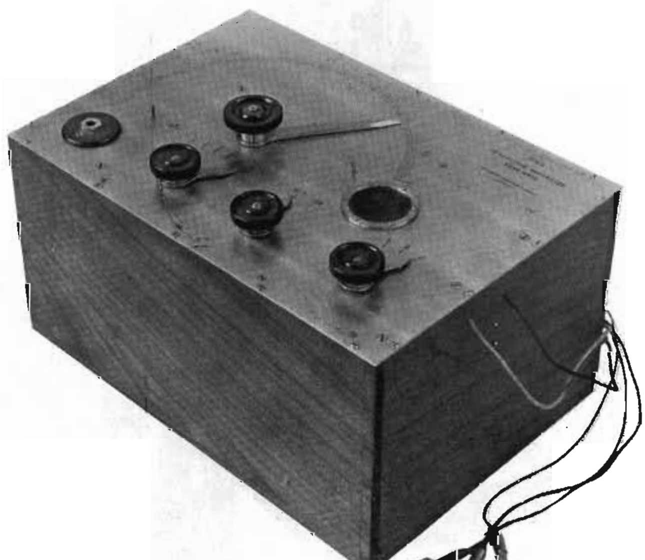
Combined Neon-Lamp and Buzzer Wavemeter

is put into circuit so as to enable the meter to be used in conjuction with transmitting circuits so that the Neon lamp provides an indicator of resonance.

Prices on application

Dubilier Heterodyne Wavemeters

These instruments make use of an oscillating thermionic valve for the generation of feeble undamped C.W. currents. They have many uses for laboratory and other experimental measurement purposes, as they provide a very accurate means of measuring frequencies within the range for which each instrument is calibrated, and also outside that range by the formation of heterodyne beats between the circuit which is to be measured and harmonics of the oscillating wavemeter. In all these instruments a very rigidly constructed variable condenser is employed, with wide spacing of the plates, to ensure the maintenance of accuracy of calibration. This condenser is used in association with other fixed condensers so as to increase the wavelength range, and to increase the accuracy of reading and setting of the scale of the variable condenser.



Long-wave Heterodyne Wavemeter, 200-20,000 metres

DUBILIER HETERODYNE WAVEMETERS—*continued*

In the first two types of instrument illustrated, a pointer indicating on an engraved metal scale is fitted to the condenser, while in the other instruments the condenser is fitted with an enclosed scale provided with very fine divisions which may be observed through the window fitted in the metal panel of the meter.

The inductances used with these instruments are so constructed as to ensure rigidity of calibration, and the circuit of the instrument is so arranged that hand-capacity effects are reduced to a minimum. The metal screen used for the instrument also assists in this direction, and the circuit is so arranged that this screen can, if desired, be connected to earth.

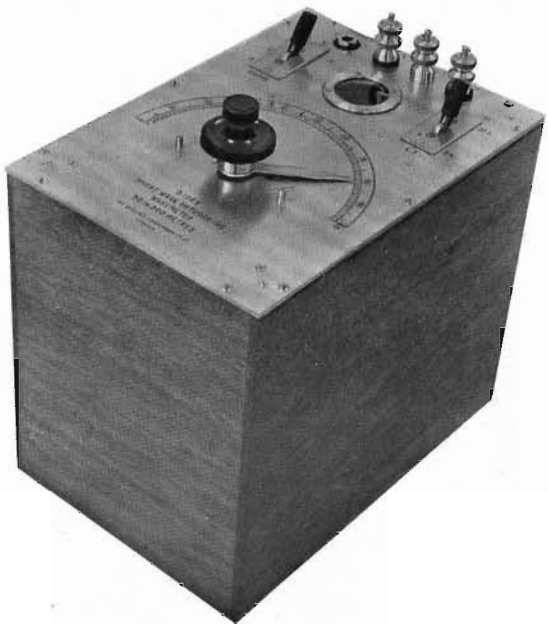
Separate L.T. and H.T. batteries must be used with these instruments.

These instruments are built to order, and can be supplied for all wavelengths, and to cover any desired wave range.

Five examples are illustrated :

(1) Long-Wave Type

This instrument is built to cover a wavelength range of 200-20,000 metres, and can be calibrated to a very high degree of accuracy.



Broadcast-range Heterodyne Wavemeter, 50-500 metres

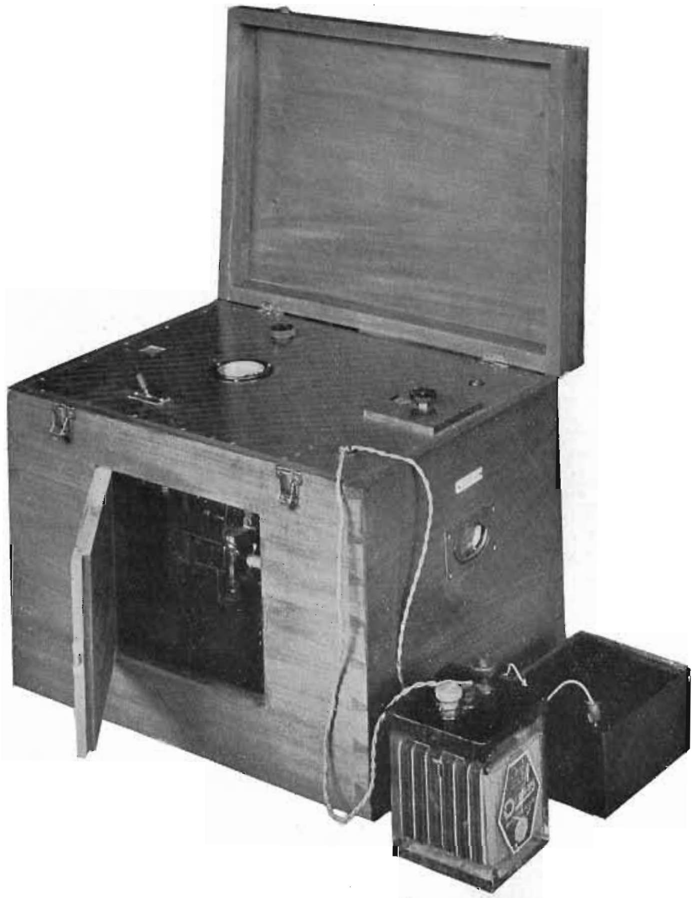
Long-range Heterodyne Wavemeter, with plug-in inductances (50-20,000 metres)

(2) Broadcast-Range Wavemeter

This instrument is constructed for a wavelength range of 50-500 metres, with a similar accuracy of calibration to the long-wave instrument above.

(3) Combined Long and Broadcast Range Wavemeter

This instrument is a combination of Nos. 1 and 2 above, covering a similar range of wavelengths. For this purpose it is provided with plug-in inductances, rigidly constructed and enclosed in ebonite cases, the spare inductances being housed in a compartment at the end of the meter, the coil in use being plugged into sockets provided inside the instrument. The whole instrument is mounted beneath a metal panel, which provides electrostatic screening, and the two flexible leads attached to the instrument are for connection to L.T. and H.T. batteries operating the thermionic valve. A telephone jack is provided to enable telephones to be inserted in the valve circuit when required.



Short-wave Heterodyne Wavemeter, 5-70 metres

(4) Short - Wave Type Wavemeter

In this instrument a specially constructed variable condenser is used, and the inductances used are so made as to ensure minimum self-capacity and maximum permanency of calibration. The instrument is made to cover a waveband of 5-70 metres. Adequate electrostatic screening is provided.

(5) Double - Heterodyne Wavemeter

The instrument illustrated is a special type of oscillating wavemeter constructed for use in conjunction with special experimental work where it is desired to obtain beats of known frequency between two oscillator valves. The instrument contains two separate oscillating valves which are fed from common H.T. and L.T. supply voltages. Each oscillator is provided with an accurately constructed variable condenser and with rigid inductance coils, the scale of each condenser being of large diameter and finely divided to enable accurate readings to be obtained. Voltmeters for filament and anode voltage are provided with a changeover switch, to enable the filament voltage of either of the oscillator valves to be read at will.

Wavemeters 1, 2, 4, and 5, above, are provided with self-contained inductances, the connections to which are changed by the range-switch fitted to the instrument.

All types of Heterodyne Wavemeters are supplied complete with calibration charts, such calibrations being carried out against accurately standardised wavemeters.

National Physical Laboratory Certificates can be supplied, when required, at appropriate extra charges.

Prices on application

Double-Heterodyne Wavemeter

PRECISION ABSORPTION WAVEMETER WITH TRIODE INDICATOR

This instrument is of the absorption type, but is specially constructed for precision work. A special precision variable condenser is used and resonance is indicated by means of a triode voltmeter with a milliammeter in the anode circuit of the triode. Batteries, special calibrated valve and charts are included. With this instrument very high radio frequencies can be read to a very high degree of accuracy, the reasonance setting being extremely sharp, since the valve voltmeter adds very small damping to the wavemeter circuit.

Precision Absorption Wavemeter, fitted with valve voltmeter

Dubilier Radio Frequency Ammeter and Special Voltmeters

Dubilier Condenser-Shunt Radio Frequency Ammeter, self-contained pattern

CONDENSER-SHUNT R.F. AMMETER

This ammeter makes use of condensers as a means of shunting radio frequency currents in known proportion, so as to enable accurate low-reading thermo-junction ammeters to be used for the measurement of large currents (British Patent 259533). The instrument illustrated is rated at 50 amperes at a wavelength not exceeding 500 metres, and the type of instrument is particularly suitable for use in short wavelength circuits.

The same type of instrument can be supplied for larger currents and can be constructed also, if desired, to give indication at a point distant from the location of the main part of the instrument. With this arrangement the indicating ammeter can be mounted upon the control switchboard or switch panel of a radio transmitting station or on the control switchboard of any other apparatus applying radio frequency currents, while the essential part of the instrument itself can be located directly in the oscillating circuit, the current in which it is intended to measure. Standard lengths of leads are provided for use with these instruments, and the instrument is calibrated with these leads in circuit, allowance being made for the resistance of the lead. When long leads are used, the calibration of the instrument is slightly affected by the operating frequency, but in the type illustrated, and in similar types in which the indicating instrument is mounted directly upon the case containing the condenser shunts, the readings of the instrument are independent of the frequency of the currents. The normal type of these instruments must not be used at long wavelengths, or their impedance would cause excessive voltage drop in the circuit. For long wavelength circuits special types are constructed with special condenser shunts of larger capacity. Special devices are incorporated to prevent inaccurate readings arising from harmonics in the currents to be measured.

High-Resistance Voltmeter, low-range D.C. pattern.
Three ranges: 0-12, 0-120, and 0-360 volts

HIGH-RESISTANCE VOLTMETERS

Low-Range Patterns

Two special instruments are manufactured of the high-resistance type for D.C. and A.C. circuits respectively. Both instruments are provided with multiple ranges and are designed to draw very small currents from the circuit to which they are applied, the resistance being approximately 10,000 ohms per volt on all voltage ranges.

The A.C. instrument is of the diode rectifier type, utilising a small rectifying valve, and the filament heating battery for the valve can, if required, be incorporated in the case. Accurate calibration charts are provided for the A.C. instrument and the D.C. instrument is direct-reading.

A special combined instrument can also be supplied, available for use on either D.C. or A.C. circuits, by means of a changeover switch mounted in the instrument. Indications are given on the same movement for both A.C. and D.C. voltages, and the changeover switch automatically puts the diode rectifier into operation in the A.C. position.

The D.C. instrument can be supplied in various ranges up to 1,000 volts; and the A.C. up to 250 volts (r.m.s.).

Prices on application

High-Resistance Voltmeter, low-range, combined D.C. and A.C. pattern.
Ranges: 0-1, 0-10, 0-100, 0-1,000 volts D.C.; and 0-2·5, 0-25, and 0-250 volts A.C.

HIGH-RESISTANCE VOLTMETERS

High-Voltage Patterns

High-resistance voltmeters are manufactured in two patterns for use on A.C. and D.C. high-voltage circuits. The instruments contain oil-immersed high resistances connected in series with sensitive indicating instruments which are graduated to read the voltage directly. Either pattern instrument can be supplied for use on circuits up to a maximum of 50,000 volts.

Owing to the use of very high resistances, which are oil immersed to ensure reliability and freedom from breakdown, the power consumption in the instrument is kept down to as small a figure as possible.

For A.C. circuits, these instruments can also be supplied with a high voltage condenser in lieu of the high resistance.

HIGH-VOLTAGE POTENTIAL DIVIDERS

Potential dividers for use on high-voltage circuits can be supplied in either the high-resistance type or the electrostatic-capacity type. The former are available up to a maximum of 50,000 volts, while the latter can be supplied up to 100,000 volts. The latter can, of course, only be used on A.C. circuits.

Full particulars and prices on receipt of details of requirements

Section B

Dubilier Components for Broadcast Reception

IT is scarcely possible to over-estimate the importance of using only components of the highest class in a radio receiver; or, for that matter, in any apparatus of a like nature.

When one is dealing with currents of such small intensity as those circulating in, for example, the aerial circuit of a wireless set it is essential that every possible loss should be reduced to a minimum.

Dubilier Components have long held pride of place in the radio world, and their acknowledged superiority is largely due to the care which is devoted to their design and manufacture. Both electrically and mechanically they are as perfect as long experience, intensive research, expert craftsmanship and thorough testing can make them.

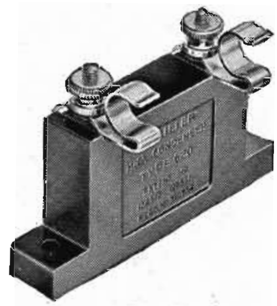
Behind every Dubilier product, however small, however large, stands the assurance of satisfactory performance. We invite criticism — in fact, we welcome it—and that in itself is proof of our confidence in our products. That adverse criticism is almost unknown, and praise frequent, is one of the reasons which justifies us in using the slogan

DUBILIER BUILT IS *BETTER* BUILT.

Type 610 and Type 620 Mica Condensers

Type 610 Mica Condenser

Series Clip



Type 620 Mica Condenser

Type 610 and 620 Condensers are known the world over, They are primarily intended for use in radio receivers and in similar apparatus where mica condensers of comparatively small capacity are required. The Type 610 Condenser is intended for horizontal mounting; the Type 620 is of vertical design and is particularly suitable for use when mounting space is limited.

Both types are hermetically sealed and are unaffected by adverse climatic conditions. The condenser element is tightly clamped, ensuring constant capacity, and only the finest Indian Ruby Mica is employed for the dielectric.

Type 610 and 620 Condensers are tested at 500 volts A.C. Condensers of capacities between ·00005 and ·0005 microfarad are supplied with a pair of detachable Dumetohm clips, and also with a special series clip as illustrated above. This series clip enables a connection to be made to one end of the resistance independently of the connection to the condenser.

Distance between fixing hole centres, 2 in.; overall length, $2\frac{3}{8}$ in.
Width of moulding, Type 610, 1 in.; overall width, $1\frac{1}{8}$ in.
Width of moulding, Type 620, $\frac{1}{2}$ in.; overall width, $\frac{13}{16}$ in.

PRICES

Microfarad		s.	d.
·00005 to ·0009	... ...	2	6
·001 to ·006	... ...	3	0
·007 to ·009	... ...	3	6

Type B775 Mica Condensers

Although designed primarily for use in resistance-capacity coupled amplifiers, the Type B775 Condenser is also suitable for use in other circuits where a condenser having a comparatively large capacity and capable of withstanding potentials of several hundred volts is required.

Type B775
Mica Condensers

For Resistance Capacity
Coupled-Amplifiers

In appearance, the Type B775 Condenser is particularly attractive, and its design is such that the space occupied on the baseboard of a radio set is small. This condenser can be supplied for any working voltage up to 2,000 D.C., but the normal stock is tested at 500 volts D.C., is suitable for a maximum working voltage of 250 D.C., the capacities and prices for these being given below.

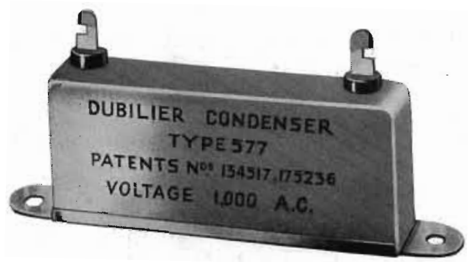
Distance between fixing hole centres, $2\frac{3}{8}$ in.
Overall width, $2\frac{3}{4}$ in.; overall thickness, $\frac{11}{16}$ in.; overall height, 3 in.

PRICES

For Condensers tested at 500 Volts D.C.

Capacity	s.	d.	Capacity	s.	d.
·01	4	0	·125	10	0
·015	4	6	·15	12	0
·02 to ·05	5	6	·2	15	6
·06	6	6	·25	19	0
·07	7	0	·3	22	6
·08	7	6	·4	30	0
·09	8	0	·5	37	6
·1	8	6			

The Universal Condenser, Type 577



Type 577
Mica Condenser

The Dubilier Type 577 Condenser is well described as "Universal," for its uses are legion. While it is largely employed for transmitting purposes, it has an equally wide field of use in radio receiving sets and similar apparatus, particularly where a condenser capable of withstanding a comparatively high voltage is required.

The dielectric is of the best Indian Ruby Mica, which is standard in all Dubilier fixed condensers using mica as the dielectric material. The case, which acts as an electrostatic screen, is of brass, finished in polished nickel, and carries two tag terminals.

Type 577 Condensers are standardised in capacities from ·0001 up to ·01 microfarad, and the accuracy of the rated capacity is guaranteed to within $\pm$ 10%. Condensers of this type are tested at 2,000 D.C. and 1,000 A.C. voltages.

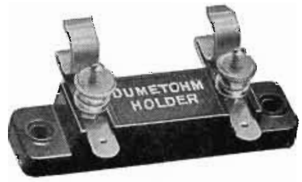
Distance between fixing hole centres, $2\frac{5}{8}$ in.

Overall width, 3 in. ; overall thickness, $\frac{1}{2}$ in ; overall height, $1\frac{1}{2}$ in.

PRICE - **7s. 6d.**

Add 10% to price for capacity tolerance closer than 10% and up to 5%.
Add 15% to price for capacity tolerance closer than 5% and up to 1%.

The Dumetohm



The Dumetohm is a high resistance of special construction which may be utilised in a number of ways, particularly as a grid leak or high-value anode resistance in a radio receiver. It consists of a resistance element of metallised glass rod, enclosed in a glass tube fitted with metal end-caps with which the element makes connection.

Dumetohms are supplied in nine resistance values, the approximate maximum rating of each in watts being as follows :

Resistance of Dumetohm (Megohms)	Max. Rating (Watts)
·25	·05
·5	·025
1·0	·015
1·5	·01
2·0	·005
3·0	·004
4·0	·003
5·0	·002
10·0	·001

Dumetohms will withstand a maximum voltage of 100 D.C., and are carefully checked after manufacture for accuracy and freedom from noise when under load.

Many other types of resistances vary considerably in value with changes in the voltage applied to them and with variations of temperature. Dumetohms, provided that they are not subjected to wattages greater than those given above nor a voltage greater than 100 D.C., are unaffected by such conditions. Moreover, it should not be forgotten that in a resistance-capacity coupled amplifier the anode resistance is never subjected to the full voltage of the high-tension supply, as part of this voltage is dropped across the valve. In such cases, therefore, a considerable voltage may often be employed in the circuit without injuring the Dumetohm. It is not, however, advisable to use high voltages if a valve of low impedance (of less, say, than 70,000 ohms) is employed, as under these conditions the Dumetohm would be overloaded.

The soldering of connections to the Dumetohm is a delicate operation, and we recommend the use of either of the Holders illustrated above. In addition, Types 610 and 620 Condensers, of all capacities between ·00005 and ·0005, are supplied complete with detachable clips designed to take the Dumetohm, and also with a special Series Clip, to make one insulated terminal connection to the resistance.

DIMENSIONS

Dumetohm : $1\frac{3}{4}$ in. long × $\frac{3}{8}$ in. diameter.

Dumetohm Holder (Horizontal Type) :
Plan $2\frac{3}{8}$ in. long × $\frac{5}{8}$ in. wide.
Overall width, including resistance, $1\frac{1}{8}$ in.
Overall height, $\frac{7}{8}$ in.
Distance between fixing hole centres, 2 in.

Dumetohm Holder (Vertical Type) :
Plan $1\frac{11}{16}$ in. long × $1\frac{1}{4}$ in. wide.
Distance between fixing hole centres $1\frac{11}{32}$ in.
Overall height, including Dumetohm resistance, $2\frac{1}{4}$ in.

PRICES

	s.	d.
Dumetohms, all values	2	6
Horizontal type Holder	1	0
Vertical type Holder	1	0

The Duwirohm

The Duwirohm is a wirewound resistance of low self-capacity, so constructed as to be non-inductive. It may be utilised in a number of ways, particularly as an anode resistance, or in a high tension supply unit to reduce the output voltage to a given value. A holder, as illustrated, can be supplied if desired.

The Duwirohm is accurate, noiseless, constant, and robust, and is supplied in 14 standard resistance values ranging from 10,000 up to 300,000 ohms. Other values can be supplied specially to order.

The following table shows the maximum safe currents for standard Duwirohms. If these are exceeded the insulation of the wire winding may be damaged.

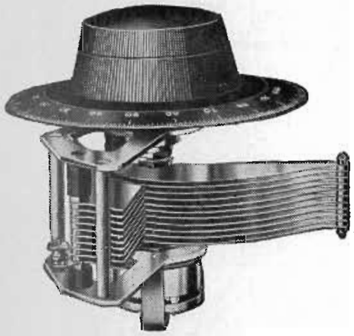
Resistance of Duwirohms (ohms)	Maximum Rating (watts)	Maximum Current (milliamperes)
10,000	·5	7·0
20,000	1·0	7·0
30,000	1·5	7·0
40,000	2·0	7·0
50,000	2·5	7·0
60,000	3·0	7·0
70,000	3·5	7·0
80,000	3·0	6·0
90,000	2·75	5·5
100,000	2·5	5·0
150,000	1·5	3·0
200,000	1·25	2·5
250,000	1·0	2·0
300,000	·5	1·5

Distance between fixing hole centres of Holder, $3\frac{1}{8}$ in.
Overall length, $3\frac{7}{8}$ in.; overall width, $\frac{3}{4}$ in.
Overall height of resistance in Holder, $1\frac{1}{2}$ in.

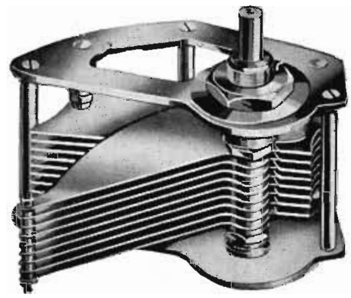
PRICES

		s.	d.
Duwirohms,	10,000 to 100,000 ohms	**5**	**0**
	150,000 and 200,000 ohms	**8**	**0**
	250,000 ohms	**9**	**9**
	300,000 ohms	**11**	**6**
Holder		**1**	**6**

The K.C. Condensers



K.C. Condenser, with dial and slow-motion drive



K.C. Condenser, without dial and slow-motion drive

The modern practice of spacing Radio Transmitting Stations according to their frequencies necessitates the use in receivers of variable condensers designed according to the Kilocycle law.

Numerous condensers claiming to follow this law have been marketed, but it will be obvious upon reflection that such a claim can only be justified provided that the constants of the circuits to be associated with the condenser are stated.

The Dubilier "K.C." Condensers have been designed to give true kilocycle (or S.L.F.) tuning when used in conjunction with the Dubilier Toroids; or with other coils the self-capacity of which is of the same order. The rotary vanes are connected to the end-plates, which are normally connected to earth or to a low potential point in the circuit. The fixed vanes are held insulated by pillars of moulded material of the highest quality; these are under compression, and the result is that dielectric losses are particularly low.

Dubilier "K.C." Condensers are made in two capacities, ·0003 (max.) and ·0005 (max.), and can be obtained either with or without knob, dial, and slow-motion drive.

Though highly efficient both electrically and mechanically, these condensers are exceptionally low-priced. The slow-motion drive is entirely free from backlash and gives an approximate reduction ratio of 200 to 1. One fixing hole only is required, which should be $\frac{1}{2}$ in. clearance size.

Diameter of dial, 4 in. sweep of rotary plates, $2\frac{5}{8}$ in. from centre.

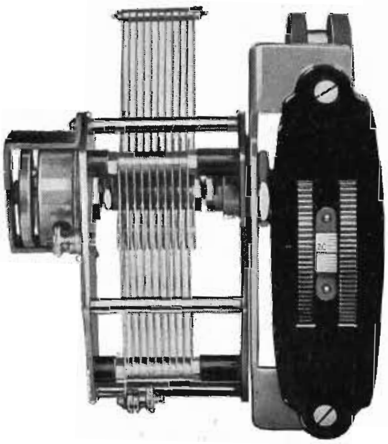
Projection behind panel: with dial and slow-motion drive, $2\frac{13}{16}$ in.; without slow-motion drive, 2 in.

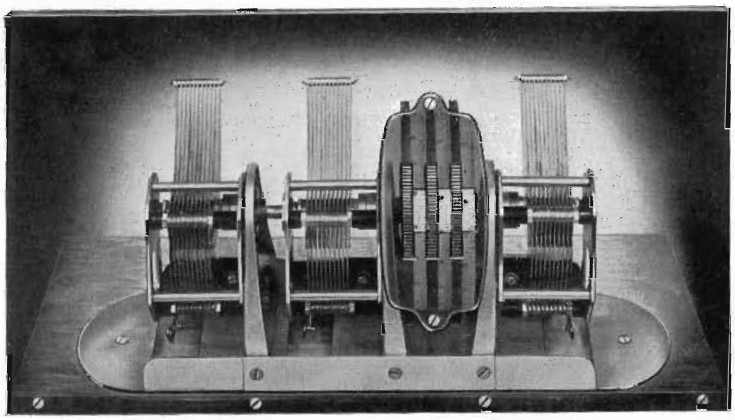
PRICES

	s.	d.
With Knob, Dial, and Slow-motion Drive, ·0003 or ·0005	**12**	**0**
Without Knob, Dial, or Slow-motion Drive, ·0003 or ·0005	**8**	**0**

K.C. Drum Control Condensers

Drum Control Condensers are rapidly coming to the fore, largely on account of their neat appearance when mounted on a panel. There are two Dubilier K.C. Condensers of the drum control type, each obtainable in two standard capacities, ·0003 (max.) and ·0005 (max.). Both have the advantages of the well-known Dubilier K.C. Condenser.





K.C. Drum Control Triple Condenser

The K.C. Single Condenser with drum control, illustrated above, is actuated by two drums, for coarse and fine adjustment respectively.

DIMENSIONS

Maximum height, $5\frac{3}{16}$ in.

Maximum projection behind panel, $4\frac{5}{8}$ in.

Overall width behind panel, 4 in.

Size of hole required in panel, $3\frac{1}{8}$ in. × 1 in. wide.

The K.C. Triple Condenser with drum control, actuated by three drums, but without any special slow-motion device. The drums are sufficiently close together that either simultaneous or independent control of the three condensers is possible. Normally each condenser is of the same capacity, ·0003 (max.) or ·0005 (max.), but for a small extra charge combinations of these two capacities can be supplied.

DIMENSIONS

Maximum height, 5 in. ; maximum projection behind panel, $4\frac{5}{8}$ in.

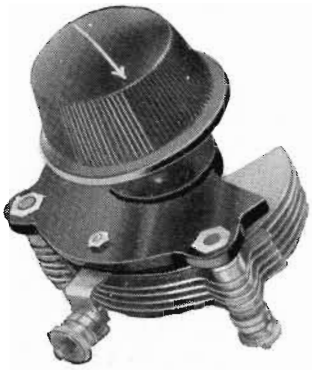
Overall width behind panel, 14 in.

Size of hole required in panel, $3\frac{1}{8}$ in. × 2 in. wide.

PRICES

	s.	d.
K.C. Drum Control Single Condenser, ·0003 or ·0005	**15**	**6**
K.C. Drum Control Triple Condenser, ·0003 or ·0005	**38**	**6**
K.C. Drum Control Triple Condenser, combinations of ·0003 and ·0005 ...	**40**	**0**

Midget Variable Condensers



Realising the need for variable condensers smaller than those generally obtainable, we have produced a midget condenser, which, whilst of sound electrical and mechanical design, occupies very little space in a radio receiver.

It is obtainable in two capacities, ·0001 (max.) and ·0002 (max.), and is particularly suitable for use as a reaction condenser. It may also conveniently be employed when a neutralising condenser of relatively large capacity is required.

The Dubilier Midget Condenser is designed for panel mounting, and is supplied complete with a neat moulded knob. One fixing hole only is required, $\frac{5}{16}$ in. clearance. Though the price is low, there has, of course, been no departure from the recognised Dubilier high standard of finish.

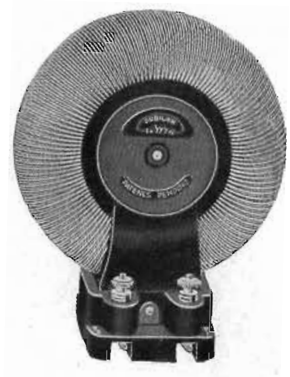
Projection behind Panel: ·0001 Condenser, $1\frac{7}{16}$ in.; ·0002 Condenser, $1\frac{3}{4}$ in.
Overall diameter, $2\frac{3}{16}$ in.

PRICE

	s.	d.
Maximum capacity ·0001 or ·0002	5	6

The Toroids

If a high frequency amplifier is to function satisfactorily the electromagnetic fields of the H.F. transformers must not be permitted to interact. The use of screening boxes is, as a rule, to be discouraged on account of the eddy current losses set up in the metal of which the boxes are made, the only completely satisfactory method being to confine the field within the limits of the windings of the transformer itself. The Toroid has no external field and screening is unnecessary. Efficiency is therefore high. There is also an absence of unwanted "pickup" from a nearby powerful station, and selectivity is excellent. A complete range of models, covering a wavelength band of from $22\frac{1}{2}$ to 2,000 metres, is available.



The various models are distinguished by windings of different colours, as indicated below, the approximate tuning ranges being as stated for each Toroid.

Distance between fixing hole centres of Holder, $1\frac{13}{16}$ in.
Overall height of Toroid in Holder, 5 in.
Overall width of Toroid in Holder, $4\frac{3}{16}$ in.
Plan size of Holder, overall, 2 in. × 3 in.

PRICES

	s.	d.
Broadcast Toroid, 230/600m. (Red)	**10**	**6**
Broadcast Toroid (with centre tapped secondary)	**11**	**6**
Long Wave Toroid, 750/2000m. (Blue)	**10**	**6**
Long Wave Toroid (with centre tapped secondary)	**11**	**6**
Short Wave Broadcast Toroid, 140/275m. (Violet)	**10**	**6**
Short Wave Toroid, 65/175m. (Red and Black)	**15**	**0**
Short Wave Toroid, 44/90m. (Yellow and Black)	**15**	**0**
Short Wave Toroid, $22\frac{1}{2}$/45m. (Green and Black)	**15**	**0**

The wavelength ranges given are those obtained when the Toroid in question is used in conjunction with a Dubilier K.C. Condenser, maximum capacity ·0005, except in the case of the two shortest wave Toroids (coloured Violet and Black, and Green and Black) for which the tuning ranges quoted apply to a condenser of maximum capacity, ·0002. The Midget Condenser (page B.8) is recommended for use with these coils.

The R.C. Coupling Units

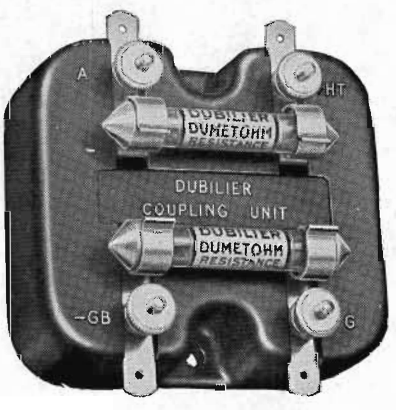
Model 1 without Valve Holder

The R.C. Dubilier Coupling Unit is designed to give uniform amplification over the entire range of audible sounds. The unit is supplied complete with two Dumetohm resistances, which have values particularly suited for use with special valves sold for R.C. coupled amplifiers. These resistances are readily detachable. It is essential that the valve preceding the Unit should be one having a high amplification factor.

The normal resistances of the Dumetohms supplied with this R.C. Coupling Unit are 1 megohm for the anode resistance and 2 megohms for the grid circuit resistance. In a number of cases, however, more satisfactory results will be obtained by the use of a lower anode resistance, depending upon the characteristics of the valves preceding and following the coupling unit.

In many cases it will be found that a resistance of ·25 megohm for the anode resistance will be advantageous. The standard resistances fitted can be changed for this value by the user, or if specially ordered the coupling units can be supplied fitted with resistances of this or any other special value.

Outstanding features of the Dubilier R.C. Coupling Unit are faithfulness of reproduction and extremely low H.T. current consumption.



DIMENSIONS

Plan, overall, $2\frac{5}{8}$ in. × $2\frac{3}{4}$ in.
Overall height, $1\frac{1}{8}$ in.
Distance between fixing hole centres, 2 in.

PRICE - **7s. 0d.**
(Complete with two Dumetohms)

Model 2 R.C. Coupling Unit combined with Valve Holder

Modern set design calls for economy of space. The combination of Valve Holder and R.C. Coupling Unit was a notable step in this direction, but components of this type have always suffered from the disadvantage of too great height. The Dubilier Combined Unit and Valve Holder occupies very little space, either vertically or on the baseboard. The valve holder may be used for the valve which precedes or follows the unit—a point worth noting.

The resistances normally fitted to this Model No. 2 Coupling Unit are the same as for Model No. 1. See also note above.

The combined unit is similar in other respects to the Dubilier Unit without Valve Holder. Both the grid-leak and anode resistances are Dumetohms and are readily detachable, whilst particular attention has been paid to finish and excellence of design.

DIMENSIONS

Plan, overall, $2\frac{3}{8}$ in. × $3\frac{1}{2}$ in.
Overall height, $1\frac{1}{8}$ in.
Distance (diagonal) between fixing hole centres, $2\frac{3}{4}$ in.

PRICE - **8s. 6d.**
(Complete with two Dumetohms)

H.F. Chokes

Few modern radio receiver circuits will function satisfactorily if a high frequency choke is not fitted at some part of the circuit. It is, however, worse than useless to employ an inefficient choke, and it was to fill the need for a well-designed and inexpensive component of this kind that the Dubilier H.F. chokes have been produced. Particular points in favour of these chokes are their neat appearance and small size, low self-capacity and the fact that the windings are totally enclosed and protected by the moulded case.

Four different types of H.F. choke are made and they are all enclosed in the same type of moulded case, the different chokes being distinguished by type letters or numbers as set out below. These four types are primarily suited each for a specific use, but their scope of utility in a radio receiver is not necessarily limited to the particular purposes which are set out below. Since different arrangements of the radio frequency circuits in the receiver necessitate different characteristics for the choke to provide the most satisfactory operating conditions, it will frequently be found that any one of these models will function satisfactorily when connected in other positions in the circuit than those specified. The purposes, specified, however, are intended as a guide in the choice of a choke for any particular circuit. Many circuit diagrams of radio receivers show an H.F. choke in one or more positions, and one or other of the types listed below will suit all ordinary radio receiving circuits.

Type 12

This choke is a general purpose or "universal" choke primarily intended for connection in the anode circuit of the detector valve of a receiver or in any similar position where its function is to prevent the passage of radio frequency currents into any part of the apparatus. It is primarily intended for connection in series with some other part of the apparatus such as an anode resistance or the primary winding of an L.F. transformer. This type is suitable generally for use on wavelengths exceeding 100 metres, and it is specially intended for use over the ordinary broadcast wavebands up to 2,000 metres.

Type 40

This choke is intended for similar uses to the Type 12 choke, but it has a larger inductance value and therefore offers greater choking effect at the higher wavelengths in the broadcasting band than does the Type 12 choke. When an H.F. choke of either of the Type 12 or Type 40 patterns is used with resistance capacity (or "R.C.") coupling and the choke is joined in series with the anode resistance of the detector valve, a small H.F. by-pass condenser should be connected between the anode and filament terminals of the detector valve when it is required to use capacity controlled reaction with such circuits. The exact capacity necessary for this condenser must usually be found by trial, but as a general guide a capacity of the order of ·0005 will usually be found sufficient.

Type AC

This choke is specially designed for use in the anode circuit of H.F. valves, as a coupling means between H.F. stages or between an H.F. valve and the detector valve of a receiver. It is intended as a replacement for a tuned anode circuit to provide aperiodic H.F. amplification which can be used over a reasonably wide band of wavelengths. This choke is designed so as to be suitable for this use over the broadcast wavebands between 250 and 2,000 metres. It may also be used as a choke in the grid circuit of either H.F. or detector valves of a receiver, particularly when used with the above method of coupling high frequency valves.

Type SW

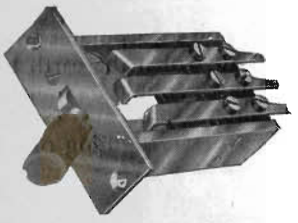
This choke is specially designed for use in short wave receivers, and is recommended for use in the anode circuit of either the H.F. or the detector valve in the receiver. It should be used with the Dubilier Short-wave Toroids and is suitable for wavelengths between $22\frac{1}{2}$ and 100 metres.

DIMENSIONS OF ALL TYPES

Base, $1\frac{7}{8}$ in. $\times$ $1\frac{7}{8}$ in. Distance between fixing hole centres, $2\frac{3}{16}$ in. Height, 2 in.

PRICE OF ALL TYPES - **4/6**

The Minicap Switch



The Dubilier Minicap Switch is a low capacity, double-pole, double-throw switch for use in high frequency and other circuits. A few of its possible uses are as follows: Reversing Switch, Series Parallel Switch for Aerial Circuit, Circuit Change-over Switch, Control Switch for both H.F. and L.F. Valves, Wavelength Control Switch (simultaneous control of tuning range and reaction).

Distance between centres of fixing holes on face plate, $1\frac{5}{8}$ in.

Dimensions of face plate, $1\frac{5}{8}$ in. × $\frac{7}{8}$ in.

Depth behind panel, 3 in.

Size hole required in panel, $1\frac{3}{8}$ in. × $\frac{11}{16}$ in.

PRICE - **5s. 6d.**

The Ducon

The Dubilier Ducon is a simple and safe means of employing the house electric lighting mains as an aerial. It plugs into any standard lamp socket, but consumes no current. It is absolutely safe, being tested at 2,500 volts before despatch.

The Ducon renders an unsightly and expensive aerial and pole unnecessary, and is an ideal device for use in flats. It is not recommended for use with crystal sets.

PRICE - **5s. 0d.**

The Neutralising Condenser

The Dubilier Neutralising Condenser has a maximum capacity of 50 micro-microfarads and a minimum of approximately 5. It is designed for base-board mounting and occupies very little space, vertically or horizontally, in a wireless set. The price of the Dubilier Neutralising Condenser is unusually low for a component of this type.

DIMENSIONS

Overall length, $2\frac{3}{8}$ in.

Overall width, 1 in.; overall height, $1\frac{1}{8}$ in.

Distance between fixing hole centres, 2 in.

PRICE - **3s. 6d.**

Filament Resistor

Dubilier Resistors are supplied in the following 21 standard values:

Resistance (ohms)	Max. Current Carrying Capacity (amps)	Resistance (ohms)	Max. Current Carrying Capacity (amps)
·0	2·0	10	·25
1·0	1·0	11	·25
1·5	1·0	12	·25
2·0	·8	15	·25
3·0	·7	20	·1
4·0	·7	25	·1
5·0	·7	30	·1
6·0	·4	35	·1
7·0	·4	40	·1
8·0	·25	50	·1
9·0	·25	—	—

DIMENSIONS

Length, $1\frac{3}{4}$ in.; diameter of caps, $\frac{11}{32}$ in.

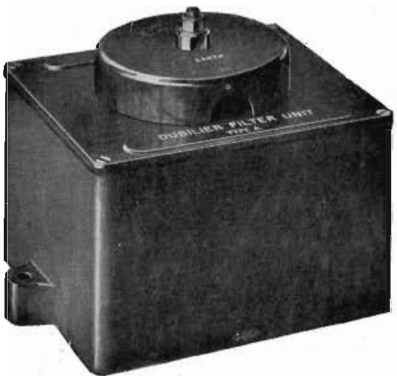
PRICE

Resistor (any standard value) - **1s. 0d.**

Filter Units

Dubilier Filter Units are complete H.T. Battery Eliminators for use on D.C. Mains. By the addition of some form of A.C. Rectifier they can be used with an A.C. supply. Four types are manufactured, having outputs and tappings as given below and each unit incorporates an earth protection condenser to which the earth lead normally connected to the set should be transferred.

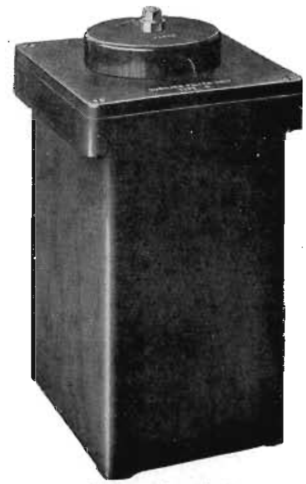
Dubilier Filter Units are GUARANTEED SAFE on any ordinary lighting or power circuit.



Type A

Type A. Total Output : 12/14 mA at 150V.
Tappings : 1 maximum and 1 detector valve tapping.

PRICE - **28s. 6d.**

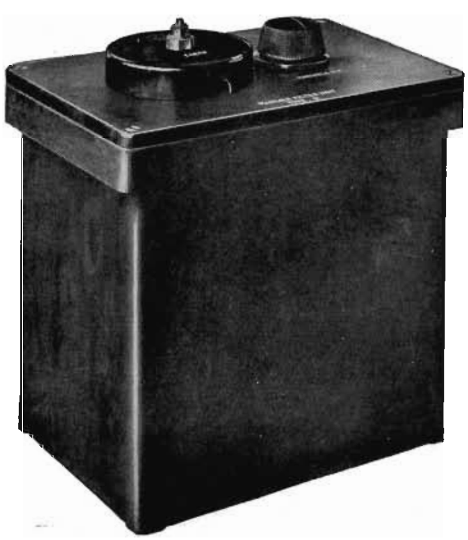

Types B and C

Type B. Total Output : 30/40 mA at approx. 180V.
Tappings : 1 fixed maximum and 6 other adjustable tappings.

PRICE - **47s. 6d.**

Type C. Total Output : 40/50 mA at approx. 180V.
Tappings : 1 fixed maximum and 6 other adjustable tappings.

PRICE - **72s. 6d.**


Type D

Type D. Total Output : 50 mA at 150/180V.
Tappings : 1 continuously variable, 1 fixed maximum and 6 other adjustable tappings.

PRICE - **142s. 6d.**

Types A and B Filters are arranged with single-stage filter circuits, the choke coils being designed to be suitable for carrying the maximum output currents specified above. Type C unit is fitted with a double-stage filter circuit, specially arranged so as to give effective filtering action when used on three-wire D.C. circuits. The Type D unit has a special double-stage circuit to give the most perfect possible filtering action.

Anti-Interference Units

These units are particularly designed as a means of overcoming interference in radio receivers arising from nearby motors and similar electrical devices taking unsteady currents. Interference of this nature cannot be overcome by shielding the receiver or by applying anything to the receiver itself, but must be suppressed at the source—for example, at the motor—by the connection of an appropriate Dubilier Anti-Interference Unit.

Electric Motors driving refrigerating plant, vacuum cleaners, sewing or mincing machines and similar domestic appliances are frequently very troublesome in this respect. Such interference arises from the interruption of the currents flowing in the motor circuit by the opening and closing of switches and by the action of the commutator of the motor. Sparking usually occurs to a greater or lesser extent at these points and sets up disturbing ether-wave transmissions of a similar general nature to those which the radio set is designed to receive. These interfering waves are often conveyed into the proximity of the receiver along electric lighting wires and similar conducting bodies.

Interference of this sort may, however, also be troublesome over distances of a quarter of a mile and more, and when it has its origin close to the receiver will often entirely prevent reception.

Dubilier Anti-Interference Units are manufactured in two main types :

1. The "CR" Units for small Domestic Motors, &c.
2. The "AIM" Units for larger Motors and Generating Equipment.

The Type "CR" Units are enclosed in moulded bakelite cases, the "CR1" Unit, for example, being also fitted with a moulded cover for the terminal connections and being designed particularly for incorporation in refrigerator apparatus.

Anti-Interference Unit Type CR1

DIMENSIONS

$5\frac{5}{8}$ in. × 4 in. × $3\frac{1}{4}$ in. high.
Distance between centres of fixing holes, $5\frac{1}{16}$ in.

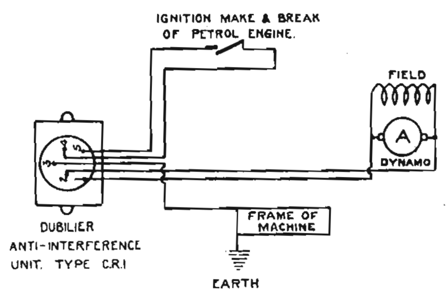
Anti-Interference Unit Type AIM. Supplied in cast-iron cases arranged for connections in steel conduit

Anti-Interference Unit Type CR2

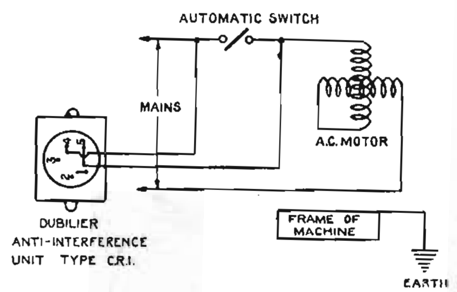
The uses to which these units are particularly suited are noted in the following table, while typical methods of connecting them to the motor circuits (both A.C. and D.C.) are given in the accompanying diagrams.

Type of Unit	Principal Use	Maximum Working Voltage	Price
CR1	For fractional H.P. Motors, refrigerating plant and similar small domestic motors. This unit is provided with three terminals for D.C. motors and two terminals for A.C. motor connections	400	**30s. 0d.**
CR2	For connection across thermostatic switches and other contacts carrying small currents only (below 1 ampere). A.C. or D.C.	250	**15s. 0d.**
CR3	For similar uses to Type CR2, but for heavier current circuits not exceeding 2 amperes. A.C. or D.C.	250	**15s. 0d.**
AIM1	For connection across motors and generators up to a maximum of 10 kW. D.C.	300	**75s. 0d.**
AIM2	For connection across motors and generators up to a maximum of 10 kW. D.C.	600	**95s. 0d.**
AIM3	For connection across motors and generators up to a maximum of 10 kW. This unit is similar to Type AIM1, but fitted with self-contained fuse holders. D.C. ...	300	**100s. 0d.**
AIM4	For connection across motors and generators up to a maximum of 10 kW. Similar unit to Type AIM2, but fitted with self-contained fuse holder	600	**120s. 0d.**
AIM5	For connection across D.C. motors or generators up to a maximum of 1 kW output. This unit is complete with self-contained fuse holder	300	**90s. 0d.**
AIM6	For connection across D.C. motors or generators up to a maximum of 1 kW output. This unit is complete with self-contained fuse holder	600	**105s. 0d.**

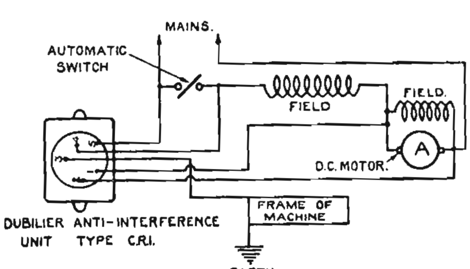
The above types of standard units will meet the majority of requirements for the suppression of interference arising from motors, generators, etc., within the sizes specified in the table. Larger motors and generators and smaller machines in special circumstances will require individual treatment and the use of Anti-Interference Units of different construction. We shall be pleased to advise regarding suitable units for use in special cases on receipt of full particulars.



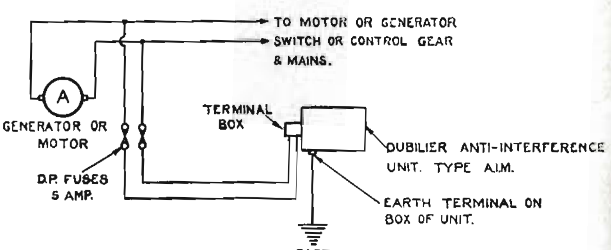
Application of CR1 Unit to Dynamo with ignition make and break on the petrol engine driving it



Application of CR1 Unit to A.C. Motor with make and break switch



Application of CR1 Unit to D.C. Motor, with make and break switch



Method of connecting AIM Unit to terminals of Motor or Generator

Section M

Mansbridge and other Paper Dielectric Condensers

Dry Electrolytic Condensers

Mansbridge and Other Paper Dielectric Condensers

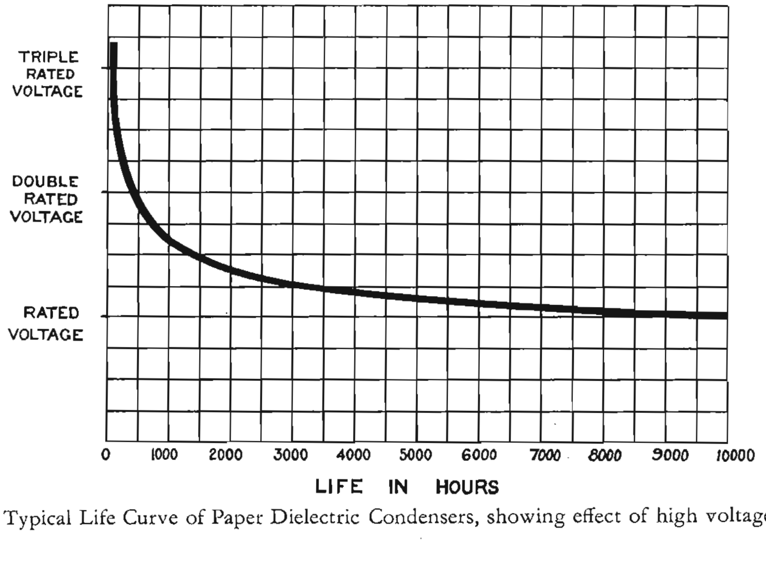
Introduction

PAPER Condensers is a term used to describe condensers in which the insulating dielectric, which separates the armatures or plates of the condenser, has a paper basis. The paper, however, is not used in a dry state, but is impregnated with other insulating material—such as wax or oil. This insulating material which is used for the impregnation of the paper serves the purpose of displacing the air which normally fills the porous interstices of the paper, and thus considerably improves the electrical insulating property of the paper. The air normally occurring in the interior of the paper usually contains moisture, as also do the fibres of the paper itself. The impregnation treatment to which the paper dielectric is subjected during the manufacture of the condenser serves to dry out this moisture and to remove the air and to replace it by an insulating material which is either solid or liquid at ordinary temperatures and which by containing no moisture gives better insulating properties to the condenser. Since not only paper but these insulating impregnating compounds are normally rather hygroscopic in nature, it is of the utmost importance that paper dielectric condensers should be enclosed in some form of hermetically sealed container to prevent access of moist air to the paper and insulating material. Paper dielectric condensers of our manufacture are supplied either sealed into a moulded bakelite container or similarly sealed into closed metal boxes. The larger sizes of condenser, and particularly those provided with oil impregnation for the paper dielectric are fitted into metal containers which are entirely soldered up, not only to render them oil-tight, but also to render them impervious to moist air. Terminal connections in this case are taken out through porcelain or bakelite bushing insulators which are carefully joined to the metal to make a perfectly airtight joint. Still larger sizes of oil-impregnated paper condensers are enclosed in steel tanks in which the lid of the tank is securely bolted on to the tank, again to make a thoroughly airtight joint.

With the smaller types of paper condensers the efficiency of the condenser depends very largely upon the compound sealing which is used to close the opening of the metal box, and in the manufacture of Dubilier Paper Dielectric Condensers every care is taken to ensure that this compound sealing, upon which so much depends, is carried out with the utmost care.

Owing to the above-mentioned fact that the paper and impregnating material rapidly absorb moisture from the air if exposed to it, it is obvious that paper dielectric condensers should never be used without the proper containing case in which to seal them from contact with the air.

The manufacturing processes to which these condensers are subjected have been developed as



Typical Life Curve of Paper Dielectric Condensers, showing effect of high voltage tests a result of prolonged research carried out with this class of dielectric, this process having been designed to give high resistance to breakdown of the condenser and, what is even more important, extremely long operating life under normal working conditions. Whenever voltage is applied to a condenser, no matter whether the voltage is high or low, it has some effect in reducing the effective life of the condenser. No dielectric material can withstand the application of electrical stresses for ever, and a certain amount of deterioration always takes place in time, the rate of deterioration depending enormously upon the magnitude of the voltage and also upon the nature of the voltage which is applied to the condenser dielectric. No matter how well a condenser may be constructed, there is a certain, but small, leakage current through the dielectric material. This leakage is almost infinitesimal in the best quality condensers, but nevertheless a certain amount is always present, and this leakage current is greatest at any weak spots in the dielectric. The leakage current ultimately causes deterioration of these weakest spots and brings about minute heating and probably chemical changes as well. In any case, disintegration of the material inevitably takes place in time and the leakage of current thereby increases until breakdown of the dielectric material occurs. In a properly constructed well-impregnated condenser the duration of operation of the condenser under normal conditions is a very long period and under the normal rated voltage of the condenser the deterioration is so slow that the condenser will operate satisfactorily in service for a large number of years.

The life of a condenser depends upon a number of factors, the most important of which are, firstly, the materials used for the manufacture of the condenser dielectric, and particularly the mode of treatment of such materials during the manufacturing processes ; secondly, the rating of the condenser, which has direct bearing upon the life, as have any overload voltages to which the condenser may in use be subjected ; and thirdly, the type of use to which the condenser is put also has some effect upon its operating life. As a result of prolonged research work carried out in the Dubilier Research Laboratories, the general laws governing the effective life of paper condenser dielectrics under normal and abnormal operating conditions have been studied and determined, and the accompanying curve illustrates the general type of results obtained for the life of a paper dielectric condenser when it is subjected to different operating conditions. The curve indicates that properly designed and constructed condensers, if operated at their true working voltages should have at least 10,000 hours of service, and in many tests which have been carried out with Dubilier Condensers, a working life very much greater than 10,000 hours has been indicated. The curve indicates the rapid decrease in the life of paper dielectric condensers when they are operated at increased voltages ; in fact, it may be said that there is hardly any other piece of electrical apparatus more susceptible to the evil effects of overloading than the paper condenser. A 10% overload above the rated voltage may cut down the life of the condenser by 50%, while it may be seen from the curve that if the voltage is doubled the life is reduced to about 1/30th of the normal span. These figures indicate the necessity for the conservative rating of paper condensers and also the harmful effects which may result from the application of repeated high-voltage tests to such condensers.

Dubilier Paper Dielectric Condensers are normally rated to operate at one-half of the voltage at which they are tested, but it should of course be appreciated that because a condenser is rated at a certain test voltage it is *possible* to test it at a still higher voltage than that indicated, and that because such higher test voltage can be applied to the condenser it is not necessarily safe to operate it at half of such higher test voltage. Such procedure will obviously bring about a reduction in the life of the condenser, as may be seen from the curve referred to above. A test voltage very considerably in excess of the normal rated test voltage can be applied to any good paper dielectric condenser, but such application will cut off a very big proportion of the ultimate useful life of that condenser under its normal working conditions. The curve referred to above does not show the actual breakdown point of the condenser. The curve intersects the axis of zero life at the breakdown point and this should be, and normally is, considerably in excess of both the rated working and the rated test voltages of the condenser for the reason set out above.

Dubilier Paper Dielectric Condensers have many applications, both in conjunction with radio apparatus and for other industrial uses. They are eminently suited for :

1.—Telegraph and telephone circuits.

2.—For radio telephone receiving apparatus, broadcast receivers, battery eliminators and similar applications in connection with radio communication.

3.—For the elimination of sparking at contacts for which purpose special anti-interference units have been developed.

4.—For the improvement of power factor of alternating current circuits and for numerous industrial applications of similar nature, for which special types of paper dielectric condensers have been developed. For smoothing condensers for the smoothing out of rectified impulses for use in conjunction with radio apparatus, and with electro-medical and similar applications in which rectified alternating current is used.

Dubilier Condensers with paper dielectric are now available in a variety of types, each best suited for a special application or mode of use. These different types, which are listed below, each have different electrical properties, depending again upon the purpose for which they are required. Different properties result from different methods of impregnating the paper dielectric to which reference has been made above, such different methods resulting in the accentuation of any one or more desired properties of the condenser. For economical reasons then it is impracticable to employ the ideally perfect condenser for most purposes, and for many industrial applications one particular property, such for example as the insulating resistance, or for example the alternating current power factor of the dielectric, are all important properties, and the most economical condenser for such applications is designed to have the most favourable values for these particular properties, apart from the values of the other less important properties.

The main types of these condensers are set out in the following table, and it will be noted that each of these types has been given a reference letter designating the particular grade of condenser which is referred to. The types which are set out below are designated by letters which form the first part of the type number given to the various condensers which are detailed in this catalogue. These type letters are followed by other letters to indicate the different grades of condenser in each of the groupings. For example, with the Type B condenser the letter B refers to the particular class of condensers, and this is subdivided into various grades having a different working voltage, &c., such as Types BB, BC, BD, BG, BT. The LA, and other classes, are similarly subdivided into different grades of condensers suitable for various working voltages. By this classification it is not meant to imply that the uses mentioned are the only ones for which these particular grades of condenser are suitable, but the classification which is given represents usually the most economical application for that particular quality of dielectric material.

Type A. Large capacity dry electrolytic condensers, suitable only for low voltages, and intended for smoothing out ripple voltages from D.C. or rectified A.C. circuits having a nominal voltage not exceeding 6 volts.

Type B. Normal grade wax-impregnated paper dielectric condensers intended primarily for use in the circuits of radio receiving and similar apparatus, for smoothing condensers, and as by-pass condensers for telephone and loud-speaker circuits, &c. These condensers have an average insulation resistance of not less than 300 megohm-microfarads.

Type LA. High-grade wax-impregnated paper dielectric condensers having higher insulation resistance and higher electrical efficiency than the Type B condensers (*i.e.,* lower A.C. equivalent resistance or power factor). These condensers should be used whenever the direct voltage applied to them has a very considerable alternating or ripple component, since their alternating current resistance is normally lower than for the Type B condensers. They are thus particularly suited for use as smoothing condensers for the filter circuits of battery eliminators and similar apparatus. The methods of manufacture of these condensers is such as to ensure very long operating life. These condensers have an average insulation resistance of not less than 1,000 megohm-microfarads.

Type LD. These are similar condensers to the Type LA condensers but specially arranged to offer the lowest possible resistance to the flow of radio-frequency currents. They are thus particularly suited for special uses in radio apparatus where the condenser is required to by-pass small radio-frequency currents from flowing through other apparatus.

Type M. Mansbridge ("foiled-paper") type telephone condensers for G.P.O. and similar telephone systems.

Type R. Oil-impregnated paper dielectric condensers suitable for use in A.C. circuits, for power factor improvement, for high-voltage D.C. smoothing condensers, for railway signalling purposes, and for a variety of special uses.

Type RA. Special oil-impregnated condensers for electric furnace work and similar industrial applications wherein the condensers are operated at medium (or audio) A.C. frequencies up to 1,000 cycles. These condensers are specially designed to have the lowest possible A.C. losses when operating at these frequencies.

Type T. High-voltage wax-impregnated smoothing condensers specially designed for smoothing high-voltage rectified A.C. circuits for radio transmitters and similar purposes.

Dry Electrolytic Condensers for use with Mains L.T. Supply Apparatus and for Smoothing Low-voltage D.C. Circuits

DUBILIER CONDENSERS, TYPE A

For use in conjunction mainly with radio apparatus it is frequently desired to be able to smooth out irregularities in the voltage of low-voltage D.C. circuits. Such circuits may be supplied from generators or from A.C. rectifiers, but in either case, due in the first instance to commutator ripples, and in the second to rectified impulses, the waveform of the D.C. circuit is not a smooth one unless some form of smoothing filter circuit is applied to it. When such supplies are used to operate radio receiving apparatus, such for example as the filament lighting circuits of a valve receiver, an objectionable noise, or "hum," is heard in the telephones arising through these irregularities, unless an efficient smoothing circuit is used. Owing to the low-voltage of such circuits, capacities of very large size are necessary if effective smoothing action is to take place by the use of the condenser, and condensers having capacities of the order of several hundred or several thousand microfarads are usually necessary.

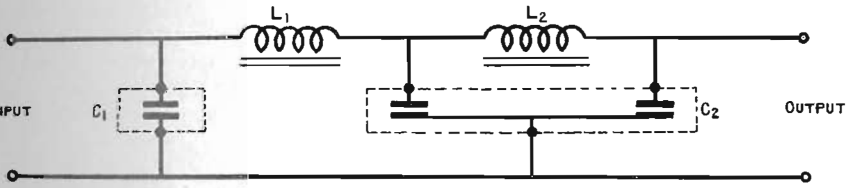
To enable such large capacities to be obtained in a reasonable space and at a reasonable cost, we have developed a special type of condenser which operates on the electrolytic principle. This condenser differs from previously known electrolytic condensers in that it is an entirely dry condenser and contains no harmful liquid with its attendant disadvantages. These condensers, as normally constructed, are available for use in circuits up to a maximum of 6 volts D.C.

The standard sizes of these Type A condensers are supplied in two grades, Types A_1 and A_2, suitable for smoothing out ripples from D.C. or rectified A.C. circuits having a nominal voltage not exceeding 6 volts, and Type AA, a superior condenser, similar in general characteristics to the Types A_1 and A_2, but being so constructed as to provide a definite voltage limiting action, which entirely avoids risk of damage to the valve filaments of radio receivers if these condensers are incorporated in a battery eliminator apparatus to provide the filament supply to the receiver.

The capacity of each unit of the condensers Type A_1, is over 1,000 microfarads, while for the Type A_2 it is between 500 and 1,000 microfarads.

It is recommended that in using these condensers in conjunction with filter circuits, the circuit arrangement shown in the accompanying diagram should be employed. In this diagram a two-stage filter is indicated with two smoothing chokes L_1 and L_2 and two groups of smoothing condensers C_1 and C_2. The first of these condensers marked C_1 is the single-unit pattern listed below, while the second one, marked C_2 is the double-unit pattern listed below. This latter condenser, it should be noted, consists of two condenser units in a single containing case provided with a common terminal.

In connection with statements of the capacity value of condensers of this type it should be noted that there is frequently some ambiguity in the values due to the methods of measurement used. Since these condensers are intended for use in a filter circuit in which they are permanently subjected to a steady polarising voltage and offer their condenser effect to the superimposed alternating current ripple voltage, the capacity value which is the only one of real interest is their effective value to the A.C. component of the voltage under these conditions. The capacity of these condensers can, by means of special apparatus, be measured under such working conditions, and the capacity values we quote represent the true effective capacities of our condensers measured in this way.



L.T. Filter Circuit, using Type A condensers

Type A_1 Condensers

Maximum working voltage, 6 volts D.C.

	Box Length L	Box Width W	Box Height H	Overall Width D	Overall Height O	Price
Single Unit Condenser	3⅝ in.	2⅝ in.	5½ in.	4⅜ in.	6 in.	**12/6**
Double Unit Condenser	6 in.	2⅝ in.	5½ in.	6¾ in.	6 in.	**18/6**

Type A_2 Condensers

Dimensions as for Type A_1.

Prices: Single Unit, **9/6** ; Double Unit, **15/-**

Type AA Condensers

Prices and particulars on application

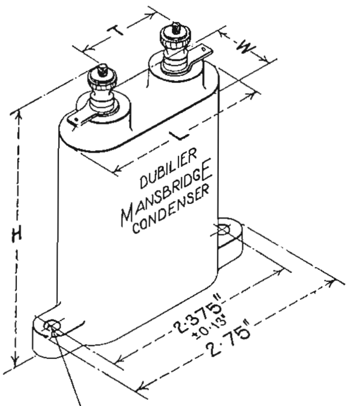
Paper Dielectric Condensers for D.C. Circuits of Radio Receiving Apparatus

DUBILIER CONDENSERS, TYPES BB, BC, BD, BG, BT; and LAA, LAC, LAG

In the circuits of radio receiving apparatus, large capacity paper dielectric condensers have a number of uses. For the smaller capacity coupling and tuning condensers (capacities below 0·01 microfarad) mica dielectric condensers of the various types set out in Section B of this catalogue are commonly employed. For the larger capacity condensers, the paper dielectric condensers of one of the types included in this section are suitable. These condensers are most suitable for capacities between 0·5 and 10 microfarads, depending upon the type of condenser and the uses to which it is applied. These condensers are most commonly employed as by-pass condensers, for which purpose they may be connected across the H.T. supply or supplies to the receiving apparatus, while they are also frequently used as by-pass condensers of radio and audio-frequency currents past other parts of the apparatus, such, for example, as the audio-frequency transformer circuits and the loud speaker circuits. Since in the majority of uses for these condensers they are subjected only to D.C. voltages, condensers of this class are given D.C. ratings only. Since the electrical stresses on the dielectric are more severe when the applied voltage is an alternating one as compared with when it is a direct one, the condensers should not be subjected to the same value of A.C. voltage as the rated D.C. voltage. For safety, as a general rule, where a condenser of this class is subjected to A.C. voltages only, the applied A.C. voltage should not exceed approximately one-half of the rated D.C. voltage for the particular class of condenser which is chosen. In the case, for example, of a filter circuit condenser for a loud-speaker output filter, the condensers would be subjected generally to alternating current voltages, and this limitation of voltage should be borne in mind when choosing the appropriate class of condenser to employ for any particular apparatus.

In the case of intervalve coupling condensers for audio-frequency amplifiers, where the condenser is used as a coupling between successive valve stages, the condenser will be subjected to the anode voltage applied to the valves as well as to an alternating component superimposed upon it. With high-power amplifiers it should not be overlooked that this alternating current component may reach a considerable voltage value comparable with that of the anode voltage of the valves, and allowance should be made for this voltage in choosing the appropriate type of condenser to use for this application. In such cases where the condenser is subjected to D.C. voltages with an A.C. audio-frequency voltage superimposed upon the steady D.C. potential, as also is the case when the condenser is used for smoothing D.C. circuits, the peak of the variable voltage applied to the condenser should not exceed the peak voltage rating given under each of the grades of condensers tabulated below. In such cases the *steady* D.C. voltage may obviously be less, and may be considerably less than the peak voltage which is specified.

The condensers included in this section of the catalogue are several grades of the B type and LA type of condensers to which reference has already been made, the various grades having different voltage ratings. The Type BB condensers referred to below are enclosed in moulded bakelite boxes while the remaining types are enclosed in metal boxes.



Type BB Condensers

TYPE BB CONDENSERS

Moulded bakelite boxes.
Maximum working voltage, 200 volts D.C. (peak).
Tested at 400 volts D.C.

This class of condenser has been specially designed for incorporation in Broadcast Radio Receivers and similar apparatus. They are supplied sealed into substantial moulded bakelite boxes with two screw terminals

TYPE BB CONDENSERS—*continued*

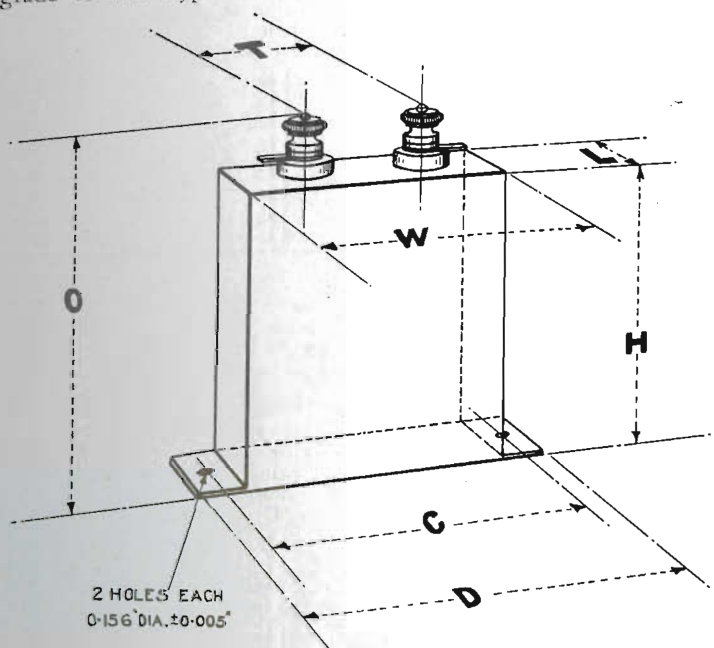
at the top. This pattern of condenser is supplied only for a working voltage of 200 volts D.C., the condensers being tested at 400 volts D.C. The table gives dimensions for the two standard sizes of boxes in which these condensers are supplied.

Capacity (micro-farad)	Overall Height H	Width of box L	Thickness of box W	Terminal Spacing T	Price
0·5	3 in.	2 in.	$\frac{11}{16}$ in.	1 in.	2/6
1	3 in.	2 in.	$\frac{11}{16}$ in.	1 in.	2/6
2	3 in.	2 in.	1 in.	1 in.	3/6

TYPE BT CONDENSERS

Metal boxes with screw terminals. Maximum working voltage 200 volts D.C. (peak). Tested at 400 volts D.C.

This series of condensers is of exactly similar grade to the Type BB condensers above, but includes a wider range of capacity values, while the condensers also are enclosed in metal boxes fitted with screw terminals and solder tags, similar to those on the Type BB condensers as shown in the accompanying illustrations.



Type BT Condensers.

The dimensions of these condensers for each of the capacity values, together with the prices, are set out in the following table :

Capacity (microfarad)	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Spacing T	Overall Width D	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 P	Price
0·5	$2\frac{1}{16}$ in.	$\frac{9}{16}$ in.	$2\frac{1}{4}$ in.	$2\frac{3}{4}$ in.	$\frac{15}{16}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	—	2/6
1	$2\frac{1}{16}$ in.	$\frac{3}{4}$ in.	$2\frac{1}{4}$ in.	$2\frac{3}{4}$ in.	$\frac{15}{16}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	—	2/6
2	$2\frac{1}{16}$ in.	$1\frac{1}{16}$ in.	$2\frac{1}{4}$ in.	$2\frac{3}{4}$ in.	$\frac{15}{16}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	—	3/6
3	$2\frac{1}{16}$ in.	$2\frac{1}{16}$ in.	$2\frac{1}{4}$ in.	$2\frac{3}{4}$ in.	$\frac{15}{16}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	1 in.	5/-
4	$2\frac{1}{16}$ in.	$2\frac{1}{16}$ in.	$2\frac{1}{4}$ in.	$2\frac{3}{4}$ in.	$\frac{15}{16}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	1 in.	6/-

For use in special apparatus where dimensions are limited we can supply a condenser of similar general type to these Type BT condensers, but of smaller dimensions, fitted with solder tags only, and rated for a maximum working voltage of 150 volts D.C. (peak), the condensers being tested at 300 volts D.C. These condensers are normally available in three sizes only, *viz.*, 2, 3, and 4 microfarad capacity, and are known as Type BA condensers. They should only be used where space is extremely limited and the working voltages are lower. *Prices and particulars on application.*

TYPES BC, BD, and BG CONDENSERS

These series of condensers are of similar construction to Type BT condensers, but are designed for higher working voltages.

All these condensers are constructed with solid metal foil electrodes, so that energy losses in the condensers due to the resistance of the conductors are reduced to a minimum.

TYPE BC CONDENSERS

Maximum working voltage 250 volts D.C. (peak). Tested at 500 volts D.C.

Capacity (microfarad)	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Spacing T	Overall Width D	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 P	Price
1	1¾ in.	¾ in.	2¼ in.	2¾ in.	¾ in.	2¾ in.	2¼ in.	—	**3/3**
2	1¾ in.	1⅜ in.	2¼ in.	2¾ in.	¾ in.	2¾ in.	2¼ in.	—	**4/3**
3	1¾ in.	1¾ in.	2¼ in.	2¾ in.	¾ in.	2¾ in.	2¼ in.	1 in.	**5/6**
4	1¾ in.	2⅜ in.	2¼ in.	3 in.	¾ in.	2¾ in.	2¼ in.	1 in.	**7/-**
5	1¾ in.	1¾ in.	4¾ in.	5½ in.	¾ in.	2¾ in.	2¼ in.	1 in.	**9/-**
6	1¾ in.	1¾ in.	4¾ in.	5½ in.	¾ in.	2¾ in.	2¼ in.	1 in.	**9/9**
8	2⅝ in.	1¾ in.	4¾ in.	5½ in.	1½ in.	3⅝ in.	3⅛ in.	1 in.	**13/-**
10	3⅜ in.	1¾ in.	4¾ in.	5½ in.	1½ in.	4⅜ in.	3⅞ in.	1 in.	**16/-**

TYPE BD CONDENSERS

Maximum working voltage 350 volts D.C. (peak). Tested at 750 volts D.C.

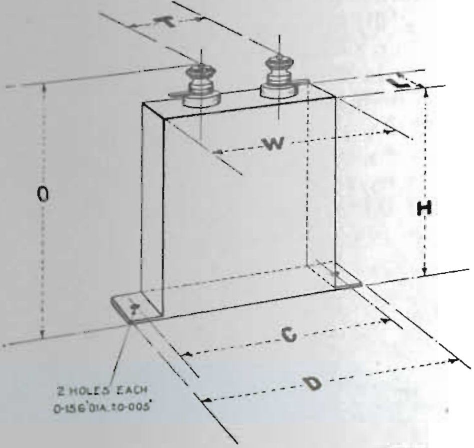
Capacity (microfarad)	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Spacing T	Overall Width D	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 P	Price
1	1¾ in.	1 in.	2¼ in.	2¾ in.	¾ in.	2¾ in.	2¼ in.	—	**3/6**
2	1¾ in.	1¾ in.	2¼ in.	2¾ in.	¾ in.	2¾ in.	2¼ in.	1 in.	**4/9**
3	2¼ in.	2½ in.	2¼ in.	3 in.	1 in.	3¼ in.	2¾ in.	1¾ in.	**6/6**
4	2¼ in.	2½ in.	2¼ in.	3 in.	1 in.	3¼ in.	2¾ in.	1¾ in.	**8/3**
5	1¾ in.	1¾ in.	4¾ in.	5½ in.	¾ in.	2¾ in.	2¼ in.	1 in.	**10/-**
6	2⅝ in.	1¾ in.	4¾ in.	5½ in.	1½ in.	3⅝ in.	3⅛ in.	1 in.	**11/-**
8	2⅝ in.	2⅝ in.	4¾ in.	5½ in.	1½ in.	3⅝ in.	3⅛ in.	1¾ in.	**14/-**
10	3⅜ in.	2⅝ in.	4¾ in.	5½ in.	1½ in.	4⅜ in.	3⅞ in.	1¾ in.	**17/-**

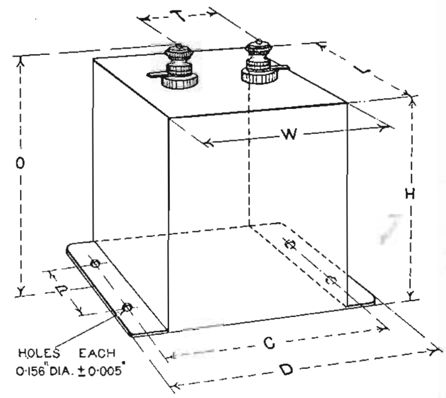
TYPE BG CONDENSERS

Maximum working voltage 500 volts D.C. (peak). Tested at 1,000 volts D.C.

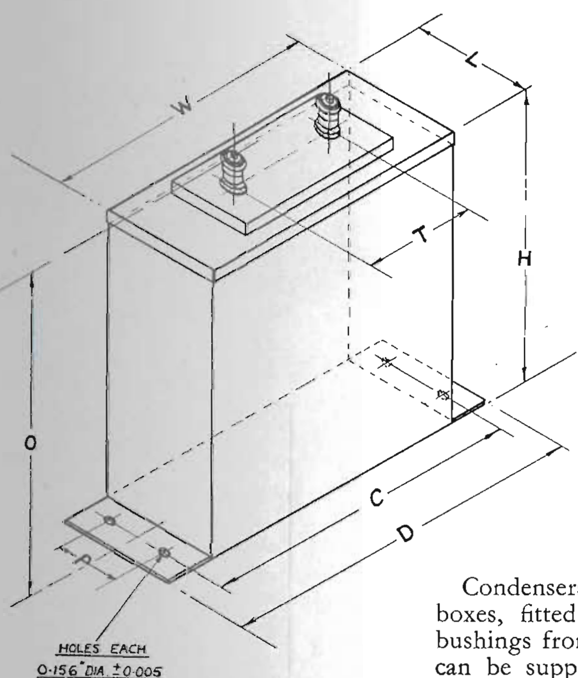
Capacity (microfarad)	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Spacing T	Overall Width D	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 P	Price
1	1¾ in.	1¾ in.	2¼ in.	2¾ in.	¾ in.	2¾ in.	2¼ in.	1 in.	**5/9**
2	3½ in.	1¾ in.	2¼ in.	2¾ in.	¾ in.	4½ in.	4 in.	1 in.	**8/-**
3	2⅝ in.	2½ in.	4¾ in.	5½ in.	1 in.	3⅝ in.	3⅛ in.	1¾ in.	**12/-**
4	3⅜ in.	2½ in.	4¾ in.	5½ in.	1 in.	4⅜ in.	3⅞ in.	1¾ in.	**14/6**
5	4 in.	2½ in.	4¾ in.	5½ in.	1 in.	5 in.	4½ in.	1¾ in.	**17/-**
6	4¾ in.	2½ in.	4¾ in.	5½ in.	1 in.	5¾ in.	5¼ in.	1¾ in.	**20/-**
8	5¾ in.	2½ in.	4¾ in.	5½ in.	1 in.	6¾ in.	6¼ in.	1¾ in.	**27/-**
10	5 in.	3⅜ in.	4¾ in.	5½ in.	1 in.	6 in.	5½ in.	2½ in.	**34/-**

DIMENSIONS OF CONDENSERS, TYPES BC, BD, and BG

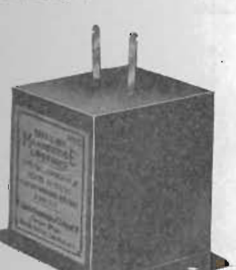




Normal Arrangement of Small Capacity Condensers



Normal Arrangement of Large Capacity Condensers



Alternative Arrangement of Condensers with tags for soldered connections

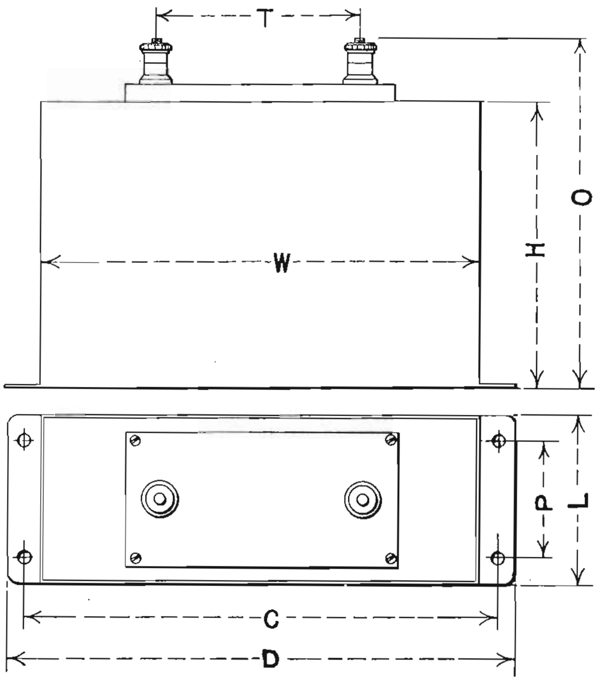
Condensers of this class are normally supplied in sealed metal boxes, fitted with two screw terminals insulated by bakelite bushings from the metal case, but when specially ordered they can be supplied with tags for soldered connections in lieu of the screw terminals. In the latter case the tag connections project upwards from the top of the condenser case, the tags being surrounded by the sealing compound used to fill the open tops of the cases. The box dimensions are the same for both types.

In the Types BC and BD, the larger capacity condensers above 4 microfarads capacity are supplied in taller boxes than the small capacities, the terminals for these condensers being mounted on an insulating panel attached to the lid of the metal box. With the Type BG condensers this change is made for all sizes above 2 microfarads. This change in the height of the condenser boxes is indicated in the tables by the transverse line which separates each table into two parts.

CONDENSERS TYPES LAA, LAC, and LAG

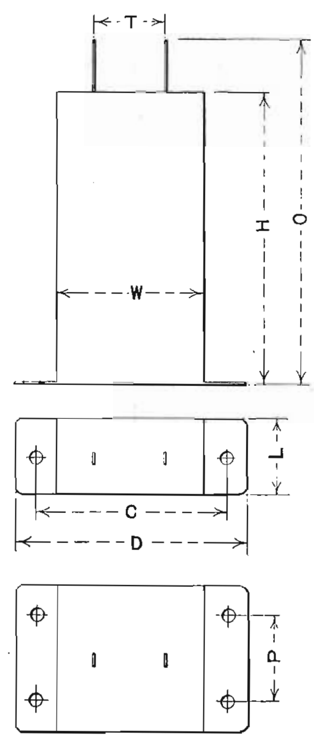
These three grades of condensers belong to the general LA type condensers to which reference has already been made. Condensers of this type can be constructed for higher operating voltages than the Type B condensers, while in addition they have a higher insulation resistance. They are a superior grade of condenser constructed in accordance with improved methods of impregnation designed to give very long life under normal operating conditions. These condensers can be supplied with screw terminals or with tag connections, the former being the standard arrangement unless specially ordered. Condensers of either of these three classes are recommended particularly for use in circuits where they are subjected to audio-frequency ripple voltages in addition to steady D.C. potentials, such for example in smoothing circuits for A.C. rectifiers, intervalve coupling condensers, etc., since the electrical losses in condensers of this type are somewhat lower than in the B type of condensers.

DIMENSIONS OF CONDENSERS, TYPES LAA, LAC, and LAG



Normal Arrangement with screw terminals

Alternative Arrangement with tags for soldered connections



TYPE LAA CONDENSERS

Maximum working voltage 350 volts D.C. (peak). Tested at 750 volts D.C.

Capacity (microfarad)	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Spacing T	Overall Width D	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 P	Price
1	$1\frac{3}{4}$ in.	$\frac{5}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	$\frac{3}{4}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	—	**4/9**
2	$1\frac{3}{4}$ in.	$1\frac{3}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	$\frac{3}{4}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	—	**7/-**
3	$1\frac{3}{4}$ in.	$1\frac{3}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	$\frac{3}{4}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	—	**10/6**
4	$1\frac{3}{4}$ in.	$1\frac{5}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$\frac{3}{4}$ in.	$2\frac{3}{4}$ in.	$2\frac{3}{8}$ in.	—	**12/6**
5	2 in.	$1\frac{3}{4}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	1 in.	3 in.	$2\frac{1}{2}$ in.	1 in.	**15/3**
6	$2\frac{1}{4}$ in.	$1\frac{3}{4}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	1 in.	$3\frac{1}{4}$ in.	$2\frac{3}{4}$ in.	1 in.	**18/3**
8	$2\frac{3}{4}$ in.	$1\frac{3}{4}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$1\frac{1}{2}$ in.	$3\frac{3}{4}$ in.	$3\frac{1}{4}$ in.	1 in.	**24/9**
10	$3\frac{1}{4}$ in.	$1\frac{3}{4}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$1\frac{1}{2}$ in.	$4\frac{1}{4}$ in.	$3\frac{3}{4}$ in.	1 in.	**30/-**

TYPE LAC CONDENSERS

Maximum working voltage 750 volts D.C. (peak). Tested at 1,500 volts D.C.

Capacity (microfarad)	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Spacing T	Overall Width D	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 P	Price
1	$2\frac{1}{8}$ in.	$\frac{7}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	1 in.	$2\frac{7}{8}$ in.	$2\frac{1}{2}$ in.	—	**6/3**
2	$2\frac{1}{8}$ in.	$1\frac{3}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	1 in.	$2\frac{7}{8}$ in.	$2\frac{1}{2}$ in.	—	**8/9**
3	$2\frac{1}{8}$ in.	$1\frac{7}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	1 in.	$2\frac{7}{8}$ in.	$2\frac{1}{2}$ in.	$1\frac{1}{4}$ in.	**13/3**
4	$2\frac{1}{8}$ in.	$2\frac{1}{4}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	1 in.	$2\frac{7}{8}$ in.	$2\frac{1}{2}$ in.	$1\frac{1}{4}$ in.	**17/6**
5	$2\frac{7}{8}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	1 in.	$3\frac{7}{8}$ in.	$3\frac{3}{8}$ in.	$1\frac{1}{4}$ in.	**21/9**
6	$3\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$1\frac{1}{2}$ in.	$4\frac{1}{4}$ in.	$3\frac{3}{4}$ in.	$1\frac{1}{4}$ in.	**26/-**
8	$4\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{3}{4}$ in.	$1\frac{1}{2}$ in.	$5\frac{1}{4}$ in.	$4\frac{3}{4}$ in.	$1\frac{1}{4}$ in.	**34/-**
10	$5\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{3}{4}$ in.	$1\frac{1}{2}$ in.	$6\frac{1}{4}$ in.	$5\frac{3}{4}$ in.	$1\frac{1}{4}$ in.	**41/6**

TYPE LAG CONDENSERS

Maximum working voltage, 1,200 volts D.C. (peak). Tested at 2,500 volts D.C.

(These condensers can be used in rectified A.C. circuits delivering not more than 1,200 volts D.C. where the *peak* voltage of the D.C. circuit does not exceed 1,500 volts.)

Capacity (microfarad)	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Spacing T	Overall Width D	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 P	Price
0.5	$2\frac{1}{8}$ in.	$\frac{7}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	1 in.	$2\frac{7}{8}$ in.	$2\frac{1}{2}$ in.	—	**7/9**
1	$2\frac{1}{8}$ in.	$1\frac{3}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{4}$ in.	1 in.	$2\frac{7}{8}$ in.	$2\frac{1}{2}$ in.	—	**9/9**
2	$2\frac{1}{8}$ in.	$2\frac{1}{4}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	1 in.	$2\frac{7}{8}$ in.	$2\frac{1}{2}$ in.	$1\frac{1}{4}$ in.	**15/-**
3	$3\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$1\frac{1}{2}$ in.	$4\frac{1}{4}$ in.	$3\frac{3}{4}$ in.	$1\frac{1}{4}$ in.	**21/-**
4	$4\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{3}{4}$ in.	$1\frac{1}{2}$ in.	$5\frac{1}{4}$ in.	$4\frac{3}{4}$ in.	$1\frac{1}{4}$ in.	**28/-**
5	$5\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{3}{4}$ in.	$1\frac{1}{2}$ in.	$6\frac{1}{4}$ in.	$5\frac{3}{4}$ in.	$1\frac{1}{4}$ in.	**34/-**
6	$6\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$4\frac{3}{4}$ in.	$5\frac{3}{4}$ in.	$1\frac{1}{2}$ in.	$7\frac{1}{4}$ in.	$6\frac{3}{4}$ in.	$1\frac{1}{4}$ in.	**40/-**

Condenser Blocks for Battery Eliminators, Mains Driven Radio Receivers, &c.

The modern radio receiver utilising thermionic valves normally needs to be energised from three distinct electrical sources, *viz.*, H.T., L.T., and Grid Bias. All these three sources of current can be obtained from the electric supply mains by appropriate apparatus, which is usually referred to under the name of "Battery Eliminator." Some battery eliminators supply all three sources of energy to the receiver, while others supply only the H.T., or only the L.T., leaving the remaining sources in the form of accumulators or other batteries. All types of battery eliminators make use of condensers in one form or another, and for many of them special types of condenser constructions can be employed.

The general principles underlying the operation of these battery eliminators have been described in many articles in the technical press and elsewhere (see, for example, *Journal of the Institution of Electrical Engineers,* Vol. 5, p. 705, July, 1927); but in all of them some form of filter circuit consisting generally of inductances and condensers is employed. The precise arrangement of apparatus necessary to provide H.T. or L.T. supply to a radio receiver depends in the first place upon whether the electric supply network or system to which the apparatus is to be connected is a direct or alternating current one. In the former case, the simple filter circuit can be adopted, while in the latter some form of rectifying apparatus is necessary in addition to the filter. In either case some form of potentiometer device or similar means of subdividing the total potential output of the apparatus is usually incorporated, and in this connection also condensers are desirable to prevent reaction effects between the various stages of the radio receiver which is connected to the battery eliminator apparatus.

While the type of condenser which can be employed in such an apparatus necessarily depends upon the normal working voltage of the apparatus, yet a considerable variety of choice is open as to the exact arrangement of condensers which may be employed in such apparatus. In addition, since the apparatus is connected to electric supply systems, frequently of considerable size, it should be borne in mind that serious results may arise in the event of accidental short circuit of the apparatus through the failure of condenser dielectric and other conditions. For this reason a very conservative rating of condensers for use in such apparatus is desirable and only the highest efficiency condensers should be employed in such apparatus. Whilst almost any of the types of condensers described in this catalogue may be used to construct such filter circuits, certain varieties of these condensers mounted in a single case to form a condenser block have considerable application in the construction of such filters. The exact arrangement and distribution of capacity values which are used in these condenser blocks depends upon the design of the filter circuit which is adopted in any given apparatus. A number of examples of typical condenser blocks are, however, illustrated, and in many cases such types of condenser blocks will meet all ordinary requirements for battery eliminator condensers.

In connection with the use of condensers in apparatus of this type, it should be remembered that the condensers are called upon to smooth out ripple voltages from the circuit, such ripple voltages arising from commutator ripple, &c., on D.C. circuits, or from the rectified impulses in the case of A.C. circuits used with some form of rectifying valve or other rectifying apparatus. This being the case, the voltage to which the condenser will be subjected in battery eliminator apparatus is one which imposes more severe stresses upon the condenser dielectric than does a steady D.C. voltage, the ripple voltage representing the superimposition of an alternating voltage upon the steady D.C. output voltage of the apparatus.

In considering the condensers to be used for any given apparatus, the peak values of this ripply voltage should be borne in mind to ensure that the peak voltage of the circuit, taking this to be the steady D.C. voltage plus the peak of the ripple voltage, does not exceed the rated D.C. (peak) voltage for which the condenser is suitable. The accompanying diagrams A, B, and C represent three typical arrangements of battery eliminator filter circuits. Of these, the first one "A" shows a single-stage filter consisting of a choke coil with a condenser C_1 connected across the supply circuit, the output terminals being connected across this smoothing condenser. A further lower voltage output terminal is derived by the use of a resistance R connected in series with a further smoothing condenser C_2, the output terminal connected to this point giving a lower output voltage than the main output terminals of the apparatus. In addition to these two condensers C_1 and C_2, forming part of the filter circuit, an additional

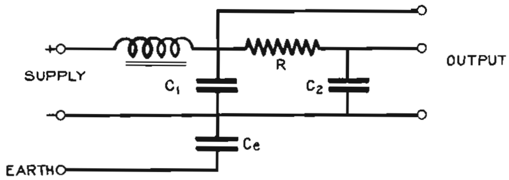


Diagram A

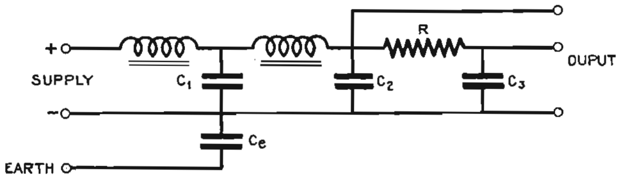


Diagram B

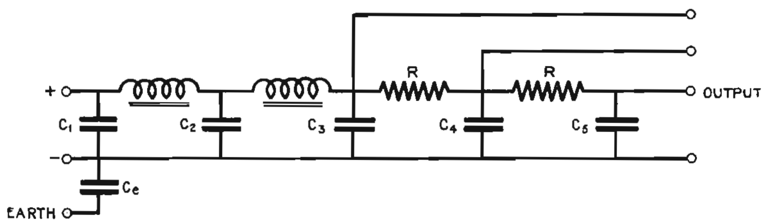


Diagram C

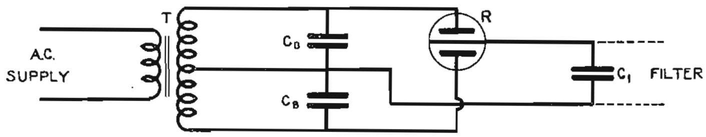


Diagram D

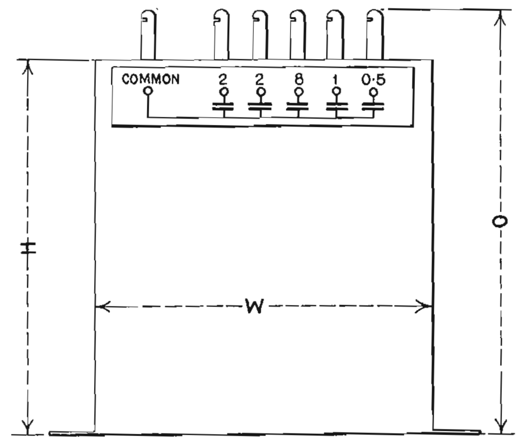
Four typical Filter Circuits for Battery Eliminators, using condenser blocks

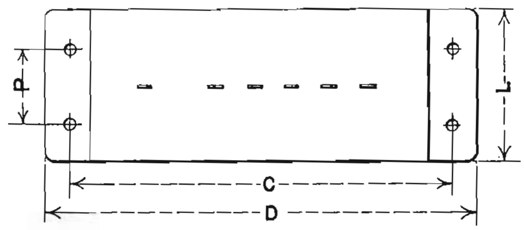
condenser C_e is shown connected between the negative pole of the apparatus and the earth terminal. A condenser of this type should always be fitted between such apparatus and the earth connection of the radio apparatus, in order to avoid short-circuiting of the supply circuit to earth by the radio earth connection. (See Wiring Rules issued by the Institution of Electrical Engineers.) The three condensers C_1, C_2 and C_3 in this diagram can either be chosen from separate condenser units of any of the types listed in this catalogue which have suitable voltage rating, or can be combined together into a single containing case forming a condenser block for this eliminator apparatus. Such a condenser block would be fitted with one common terminal for the three condensers and with three other insulated terminals.

The second diagram "B" illustrates a two-stage filter circuit employing two choke coils and two main smoothing condensers C_1 and C_2. A further condenser C_3, connected in series with the resistance R provides a means for obtaining a lower voltage output tapping from the apparatus. A two-stage filter circuit of this type gives more effective smoothing action than does the single-stage filter circuit shown in diagram "A," provided that the capacities of the condensers are sufficiently large to avoid disturbances due to the resonance arising from the closed circuit formed by the condensers and the inductance coils. In this diagram also the earth condenser C_e connected between the negative and earth terminals is also shown, and the four condensers C_1, C_2, C_3, and C_e can again be combined into a single condenser block having one common terminal and four other terminals for the condensers.

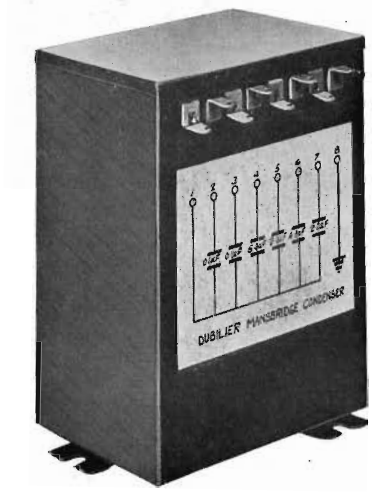
A rather more complex filter circuit is sketched in diagram "C," showing again the two-stage filter with two choke coils and two output filter condensers C_2 and C_3 and two additional condensers C_4 and C_5 for two further output voltages used in

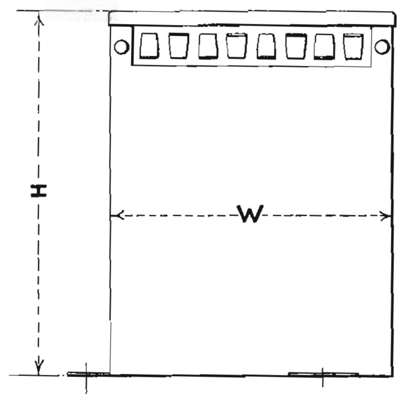
[*Continued on page* M.16

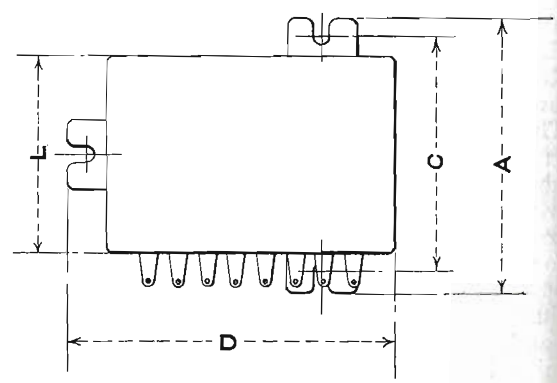




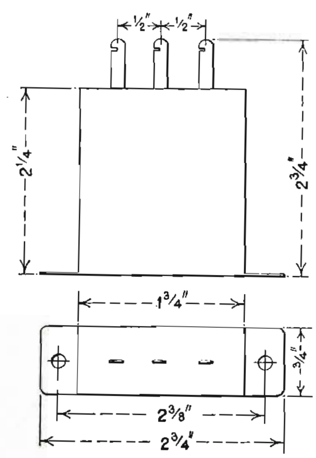
Condenser
Blocks
with
top terminal
tags







Condenser
Blocks
with
side terminal
tags



Bridging Condenser, 0·1 + 0·1 microfarad

Total Capacity (micro-farads)	Capacity Tappings (micro-farads)	Test Voltage D.C	DIMENSIONS										Price
			Type of Dielectric	Width of Box W	Depth of Box L	Height of Box H	Overall Height O	Terminal Tag Position	Overall Width D	Overall Depth A	Distance between centres of fixing holes C	Distance between fixing holes when more than 2 per side P	
6	2, 2, 2,	500	B	$3\frac{7}{8}$ in.	$1\frac{3}{4}$ in.	$2\frac{1}{4}$ in.	$3\frac{1}{4}$ in.	Top	$4\frac{7}{8}$ in.	$1\frac{3}{4}$ in.	$4\frac{3}{8}$ in.	1 in.	**9/9**
		600	LA	$2\frac{1}{4}$ in.	$1\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$2\frac{5}{8}$ in.	$2\frac{3}{4}$ in.	$2\frac{1}{4}$ in.	—	**18/3**
		1200	LA	$3\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$3\frac{5}{8}$ in.	$3\frac{1}{8}$ in.	$2\frac{5}{8}$ in.	—	**26/-**
8	2, 2, 2, 1, 1	500	B	$2\frac{3}{4}$ in.	$1\frac{3}{4}$ in.	$4\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	Top	$3\frac{3}{4}$ in.	$1\frac{3}{4}$ in.	$3\frac{3}{8}$ in.	1 in.	**13/-**
		600	LA	$2\frac{3}{8}$ in.	$1\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$2\frac{3}{4}$ in.	$2\frac{3}{4}$ in.	$2\frac{1}{4}$ in.	—	**24/9**
		1200	LA	$4\frac{1}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$4\frac{5}{8}$ in.	$3\frac{1}{8}$ in.	$2\frac{5}{8}$ in.	—	**34/-**
10·2	4, 6, 0·1, 0·1	500	B	3 in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$3\frac{3}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**16/6**
		600	LA	$3\frac{3}{4}$ in.	$1\frac{3}{4}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$4\frac{1}{8}$ in.	$2\frac{3}{4}$ in.	$2\frac{1}{4}$ in.	—	**30/6**
		1200	LA	$5\frac{3}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$6\frac{1}{8}$ in.	$3\frac{1}{8}$ in.	$2\frac{5}{8}$ in.	—	**42/-**
12·7	6, 4, 1, 1, 0·5, 0·1, 0·1	500	B	$3\frac{3}{4}$ in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$4\frac{1}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**20/6**
		600	LA	$3\frac{5}{8}$ in.	$2\frac{5}{8}$ in.	$5\frac{1}{2}$ in.	6 in.	Top	$4\frac{5}{8}$ in.	$2\frac{5}{8}$ in.	$4\frac{1}{8}$ in.	$1\frac{3}{4}$ in.	**37/6**
		1200	LA	$4\frac{1}{8}$ in.	$4\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	6 in.	Top	$5\frac{1}{8}$ in.	$4\frac{1}{8}$ in.	$4\frac{5}{8}$ in.	3 in.	**53/-**
14	2, 2, 8, 1, 1	500	B	$3\frac{3}{4}$ in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$4\frac{1}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**22/3**
		600	LA	$4\frac{3}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	6 in.	Top	$5\frac{3}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{4}$ in.	$1\frac{1}{4}$ in.	**42/-**
		1200	LA	$4\frac{1}{8}$ in.	$4\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	6 in.	Top	$5\frac{1}{8}$ in.	$4\frac{1}{8}$ in.	$4\frac{5}{8}$ in.	3 in.	**58/-**
14	4, 4, 2, 1, 1, 1, 1	500	B	$3\frac{3}{4}$ in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$4\frac{1}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**22/9**
		600	LA	$4\frac{3}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$5\frac{1}{8}$ in.	$3\frac{1}{8}$ in.	$2\frac{5}{8}$ in.	—	**42/6**
		1200	LA	$4\frac{1}{8}$ in.	$4\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$4\frac{1}{2}$ in.	$5\frac{1}{8}$ in.	$4\frac{5}{8}$ in.	—	**59/-**
14	6, 2, 4, 2	500	B	$3\frac{3}{4}$ in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$4\frac{1}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**22/-**
		600	LA	$4\frac{3}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$5\frac{1}{8}$ in.	$3\frac{1}{8}$ in.	$2\frac{5}{8}$ in.	—	**41/6**
		1200	LA	$4\frac{1}{8}$ in.	$4\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$4\frac{1}{2}$ in.	$5\frac{1}{8}$ in.	$4\frac{5}{8}$ in.	—	**58/-**
14·2	2, 2, 8, 1, 1, 0·1, 0·1	500	B	$3\frac{3}{4}$ in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$4\frac{1}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**23/6**
		600	LA	$4\frac{3}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$5\frac{1}{8}$ in.	$3\frac{1}{8}$ in.	$2\frac{5}{8}$ in.	—	**43/-**
		1200	LA	$4\frac{1}{4}$ in.	$4\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$4\frac{5}{8}$ in.	$5\frac{1}{8}$ in.	$4\frac{5}{8}$ in.	—	**59/6**
14·2	6, 2, 4, 2, 0·1, 0·1	500	B	$3\frac{3}{4}$ in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$4\frac{1}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**23/6**
		600	LA	$4\frac{3}{4}$ in.	$2\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$5\frac{1}{8}$ in.	$3\frac{1}{8}$ in.	$2\frac{5}{8}$ in.	—	**43/-**
		1200	LA	$4\frac{1}{4}$ in.	$4\frac{1}{8}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$4\frac{5}{8}$ in.	$5\frac{1}{8}$ in.	$4\frac{5}{8}$ in.	—	**59/6**
18	6, 2, 6, 2, 2	500	B	$4\frac{1}{4}$ in.	$2\frac{9}{16}$ in.	$4\frac{7}{8}$ in.	$4\frac{7}{8}$ in.	Side	$4\frac{5}{8}$ in.	$3\frac{9}{16}$ in.	$3\frac{1}{16}$ in.	—	**28/6**
		600	LA	$3\frac{1}{4}$ in.	$3\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$3\frac{5}{8}$ in.	$4\frac{1}{2}$ in.	4 in.	—	**54/-**
		1200	LA	$5\frac{1}{4}$ in.	$4\frac{1}{4}$ in.	$5\frac{1}{2}$ in.	$5\frac{1}{2}$ in.	Side	$5\frac{5}{8}$ in.	$5\frac{1}{4}$ in.	$4\frac{3}{4}$ in.	—	**75/-**
0·2	0·1, 0·1	A.C. 1000	LA	$1\frac{3}{4}$ in.	$\frac{3}{4}$ in.	$2\frac{1}{4}$ in.	$2\frac{3}{4}$ in.	Top	$2\frac{3}{4}$ in.	—	$2\frac{3}{8}$ in.	—	**3/-**

conjunction with the resistances R. The earth condenser C_e is also shown in this diagram, and in addition a further input condenser marked C_1. This condenser is essential when the filter is used in conjunction with a rectifier apparatus on an A.C. supply circuit, as it provides the main smoothing capacity for the rectifier. Where either of the previously sketched filter circuits in diagrams "A" and "B" are used on an A.C. circuit with a rectifier, the main smoothing condenser must be added to the diagrams in similar manner to diagram "C." This main smoothing condenser should be given as large capacity as possible, and a value of 6 to 8 microfarads is commonly adopted. For the intermediate smoothing condenser between the filter chokes in the case of a double-stage filter, that is to say the condenser marked C_1 in diagram "B" and C_2 in diagram "C," a capacity of about 4 microfarads is very commonly employed, while the output capacity marked C_1 in diagram "A," C_2 in diagram "B," and C_3 in diagram "C," may also have a value of the order of 4 microfarads, although smaller values are sometimes used if space is a consideration. The condensers connected across the individual voltage output tappings—that is, C_2 in diagram "A," C_3 in diagram "B," and C_4 and C_5 in diagram "C," should have values of not less than 0·5 microfarad each, although a capacity of at least 1 microfarad should be used whenever possible.

The earth condenser marked C_e in the three diagrams may conveniently have a value between 0·1 and 0·5 microfarad, the exact value of this condenser not being at all critical.

Where these filter circuits are used in conjunction with rectifier apparatus on A.C. circuits, it is usually desirable to fit bridging condensers across the transformer feeding the rectifying valve or other apparatus. In diagram "D" two such bridging condensers marked C_B are shown connected across the two halves of the secondary winding of the transformer T. The mid-junction point of these two condensers is joined to the mid-point of the transformer secondary and to the negative terminal of the output circuit. A rectifying apparatus of the two-wave rectifying type is indicated at R, while C_1 in this diagram is the main smoothing condenser which forms the initial condenser of the filter or smoothing circuit and is marked C_1 in diagram "C." This pair of bridging condensers is conveniently made up as a single unit either incorporated into the main condenser block or preferably used as a separate condenser. Capacity values of 0·1 microfarad each or 0·25 microfarad each are convenient values to be employed. These two condensers, which, it will be noted, are connected directly across the transformer secondary and as such are subjected to alternating current voltages. They should therefore be liberally rated to avoid risk of breakdown of the condenser dielectric. Since with many rectifying arrangements used for battery eliminators giving H.T. supply to radio receiving apparatus an output voltage of the order of 150 to 200 volts is required on the D.C. side of the apparatus, the transformer secondary which feeds the rectifying device may have a voltage of the order of 300 to 350 volts A.C. on each half, so that the two bridging condensers C_B should each be suitable for this voltage. Condensers tested at not less than 1,000 volts A.C., or, say, 2,000 volts D.C., are suitable for this use in order to ensure reliability of operation.

Some typical arrangements of condenser blocks incorporating groups of condensers of the types required for use in battery eliminator circuits are shown in the accompanying illustrations, and the dimensions and capacity values of a number of these typical condenser blocks are also tabulated below. Other condenser blocks with different capacity values can be manufactured to individual requirements.

In the case of a battery eliminator apparatus supplying the filament circuit of a radio receiver, an arrangement of filter circuit of the single or double stage filter type is commonly employed, but in this case the capacity value of the condensers which must be used is very much larger than in the case of the H.T. eliminator circuits. The Dubilier Type A Condensers listed in this catalogue are suitable for use in such L.T. filter circuits.

For Grid Bias supply a resistance is commonly connected in the H.T. battery eliminator apparatus in order that the current flowing in this circuit may produce a voltage drop down this resistance which can be used for the grid bias circuit. This resistance, when used, should also be shunted by a by-pass condenser of 1 or 2 microfarads capacity. Condensers of either the B or the LA types listed in this catalogue are suitable for this purpose.

Radio Frequency By-Pass Condensers
(Paper Dielectric) Type LD

It is frequently required to use condensers to by-pass radio-frequency currents round transformers, generators, and other parts of radio apparatus where it is essential that the condensers should offer a very low impedance to the flow of small radio-frequency currents. For such applications we manufacture a special type of paper dielectric condenser of similar general construction to the Type LA condensers, but with a modified construction of the condenser plates, so arranged to maintain the radio-frequency resistance of the condenser at as low a figure as possible. The cross section of the conductors used in these condensers is maintained large and of large surface area further to lower this radio-frequency resistance, while the condenser cases are fitted with substantial terminals to which soldered cable lug connections can be arranged. The general construction of this type of condenser is illustrated in the accompanying photograph, and they can be supplied in a range of capacity values suitable also for various operating voltages.

Prices and further details on receipt of particulars of precise requirements

Special By-Pass Condenser. Type LD

Mansbridge Type Telephone Condensers
Type M

Mansbridge Telephone Condensers

In order to comply with various Government specifications we manufacture a range of Mansbridge condensers with paper dielectric constructed with foiled paper electrodes for the condenser. The accompanying illustrations show two types of these condensers as supplied to British, Colonial, and Foreign Government Telegraph departments. Condensers of this type are specially designed for high insulation resistance and to have the various other properties and be suitable for the various tests specially called for in the various Government and other specifications for condensers of this class. These condensers are largely used in Telephone Exchanges and telephone instruments connected to extensive Telephone Systems. They can be constructed in a variety of dimensions and capacity values to meet the conditions called for in the specifications.

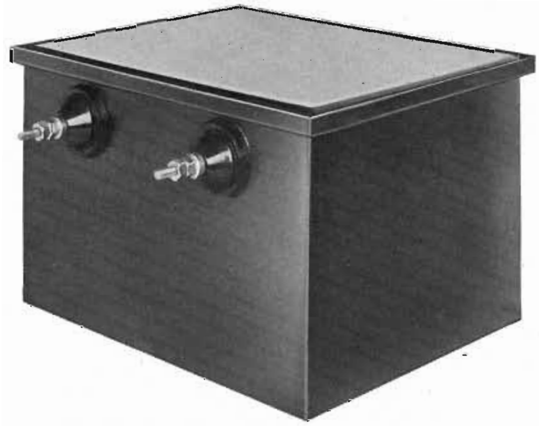
Prices on application and receipt of detailed specification.

Dubilier Paper Dielectric Condensers
Type R

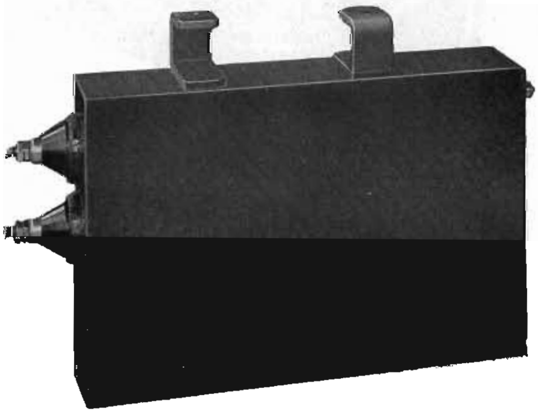
Condensers of this class include paper dielectric condensers which are treated with an oil impregnation and are enclosed in oil-filled containers. They have a variety of uses in the small sizes for laboratory and experimental work, and in the larger sizes for many industrial applications.

The accompanying photographs illustrate some typical forms of these condensers, one being a unit which is used very largely in building up condensers for the improvement of power factor of alternating current circuits, and others having applications for railway signalling, telegraph and cable circuits.

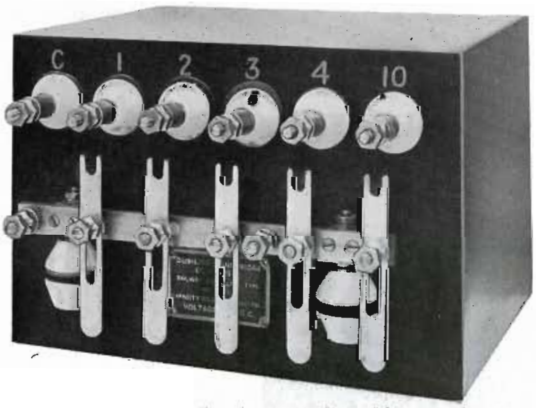
The railway-signalling condensers illustrated are of two patterns, one being adjustable between capacities of 1 and 20 microfarads and the other having a fixed capacity only. They are employed in conjunction with the relays, &c., used for track circuit signalling on electric railways. Condensers of this type are normally built in two grades, one suitable for use on tracks having a working voltage up to 600 volts D.C., and the other suitable for use on tracks having a working voltage up to 1,500 volts D.C. Both grades are supplied in various patterns of adjustable and fixed capacity condensers to meet the individual requirements of the designers of signalling apparatus of this type.



Type R Condensers—A Unit Condenser for power-factor improvements



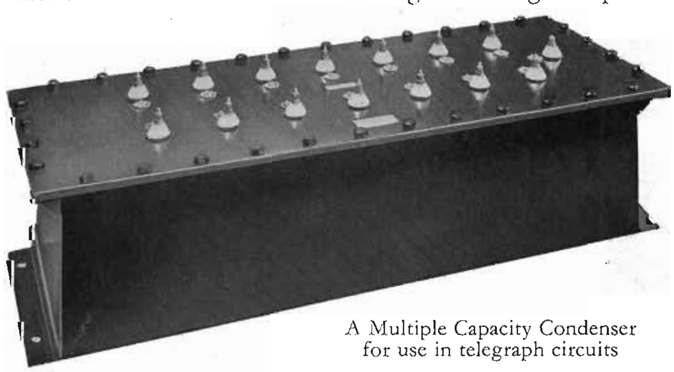
Railway-Signalling Condenser, fixed capacity type



Railway-Signalling Condenser, adjustable capacity type

For use in telegraph and cable bridge and artificial line circuits, adjustable capacity condensers are manufactured of similar type to the pattern illustrated, condensers of this class being totally enclosed and oil-filled are suitable for use in tropical climates.

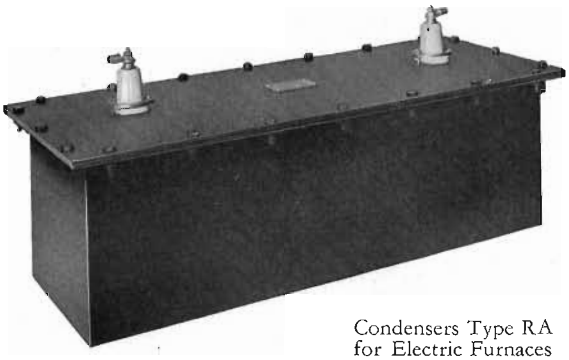
For further information regarding the use of condensers of this type on alternating current circuits for power factor improvement, see Section P of this catalogue.



A Multiple Capacity Condenser for use in telegraph circuits

Dubilier Paper Dielectric Condensers

Type RA



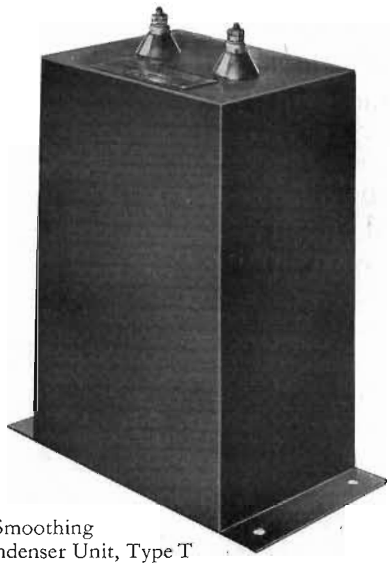
Condensers Type RA
for Electric Furnaces

These condensers are of similar general construction to the Type R condensers detailed above, but are specially designed to have as low power factor as possible to enable them to be used in alternating current circuits of higher frequencies, such, for example, as 500 cycles. The condenser of this class which is illustrated is a unit used in the construction of condenser banks for use in conjunction with electric furnace circuits operating at 500 cycles. Condensers of this type are constructed for various operating voltages, such, for example, as 1,000 and 2,000 volts at 500 cycles. Other sizes and ratings can be supplied to meet individual requirements.

Prices on application and receipt of detailed specification

Type T

These condensers are primarily designed for use in high voltage D.C. circuits, and are usually constructed in the form of small units enclosed in wax-filled metal containers which can be grouped together to form a large condenser bank by connecting the units together in series-parallel with appropriate potential dividing resistances to ensure adequate distribution of the total voltage between the units of the condenser bank.



A Smoothing
Condenser Unit, Type T

A Smoothing Condenser Bank

The accompanying illustrations show a single unit and also a smoothing condenser bank built up with units of this class, but of different shape.

For further information regarding other patterns of smoothing condensers, see Section T of this catalogue.

The individual units used in constructing condenser banks of this type can be supplied in a variety of sizes, capacities and voltage ratings, some typical examples of which are tabulated below.

Capacity (microfarad)	Test Voltage	Price £ s. d.
1	6,000 volts D.C.	2 0 0
2	6,000 ,, ,,	4 0 0
3	6,000 ,, ,,	6 0 0
4	6,000 ,, ,,	7 10 0
1	12,000 ,, ,,	7 15 0

Dimensions and other particulars regarding these condensers will be supplied on application, and quotations for further sizes and types will be given on receipt of detailed requirements.

Paper Dielectric Condensers for Special Purposes

The various types of condensers which are illustrated represent a few examples only of the multitudinous applications of paper dielectric condensers. In many cases special applications involve the preparation of new types or special designs of these condensers so as best to meet the electrical conditions.

We invite enquiries for condensers for special requirements, and in all cases where the exact kind of condenser wanted is not illustrated or listed in this catalogue.

Section R

Radio Receiving Sets

Radio Receiving Sets

The "Westminster" Portable Radio-Gramophone

THIS apparatus combines the advantages of a portable radio receiver with a portable gramophone, together with the additional advantages of having electrical reproduction for the gramophone. The general arrangement of the apparatus may be seen from the accompanying illustration, which shows the set opened for use. A self-contained loop aerial is mounted inside the apparatus for the reception of radio signals and a two-position switch is provided for long and short wave reception of broadcast transmissions. By a simple change-over switch the apparatus is changed over from radio reception to gramophone reproduction, using the turntable which is normally carried in the back of the apparatus and which fits into the receptacle provided at the top of the apparatus. The electrical pick-up device carried by an arm is also arranged to plug into a receptacle on the top of the receiver so as to utilise the amplifying apparatus of the radio receiver for the reproduction of gramophone music, &c. A powerful Garrard gramophone motor is fitted for operating the gramophone turntable and the usual speed control for the gramophone is fitted to the panel of the radio receiver. A volume control for the gramophone reproduction is provided on the same panel, together with a start-stop lever for the gramophone motor. The radio portion of the apparatus is arranged to have single dial tuning with a simple control of regeneration on the loop aerial of the receiver.

An indicator lamp showing on the front of the apparatus indicates when the valves are switched on.

All batteries, L.T. and H.T., are self-contained in the back of the receiver, as also is the loud speaker equipment. For the H.T. batteries, large double-capacity cells are fitted giving a longer life for these batteries. The turntable and electrical pickup, together with the winding handle for the gramophone motor are housed in a space provided inside the back of the apparatus, so that when closed up none of these parts project from the case of the apparatus.

Price: 40 Guineas complete

British and Foreign Agents

BRITISH ISLES

RADIO

ABERDEEN
Thomson & Brown Bros., Ltd., 74, Huntly Street.

BIRMINGHAM
S. Wilding Cole, Ltd., 62, Moor Street.

BRADFORD
F. Riddiough & Son, Simes Street, Westgate.

CARDIFF
Brown Bros., Ltd., 86–88, Adam Street.

DUBLIN
Brown Bros. (Ireland), Ltd., Dunlop House, Lower Abbey Street.

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Thomson & Brown Bros., Ltd., 2c, King Street.

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Thomson & Brown Bros., Ltd., 126, George Street.

GLASGOW
Thomson & Brown Bros., Ltd., 65, Mitchell Street.

MANCHESTER
The Manchester Radio Co., Ltd., 155, Oxford Road.

NEWCASTLE-ON-YTNE
Thompson & Brown Bros., Ltd., Carliol Street.

SHEFFIELD
S. Wilding Cole, Ltd., 61, Norfolk Street.

SOUTHAMPTON
Brown Bros., Ltd., 33, Carlton Crescent.

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CARDIFF
D. J. Thomas, A.M.I.E.E., 13, Kelston Road, Whitchurch.

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W. Brown & Co. (Engineers), Ltd., 89, Douglas Street.

MANCHESTER
L. Backhouse, A.M.I.E.E., 28, Piccadilly.

ABROAD

RADIO

AUSTRALIA
Amalgamated Wireless (Australasia), Ltd., 47, York Street, Sydney, N.S.W.

AUSTRIA
W. Wohleber & Co., Zieglergasse 11, Vienna VII.

BELGIUM
La Radiophonie Belge, 25 Rue Van Helmont, Brussels.

CZECHO-SLOVAKIA
H. Steflicek, Na Vaclavce 31, Prague.

DENMARK
Poul Petersen, Store Kirkestraede 1, Copenhagen.

FRANCE
Société des Condensateurs de Trévoux, 52, Rue de Dunkerque, Paris.

GERMANY
Deutsche Dubilier Kondensator G.m.b.H., Hallesches Ufer, 12–13, Berlin, S.W.11.

HOLLAND
Nederlandsche Seintoestellen Fabriek, Post Box, 32, Hilversum.

HUNGARY
United Incandescent Lamps & Electrical Coy., Ltd., Ujpest 4, near Budapest.

ITALY
Ing. S. Belotti & C., Corso Roma 76–78, Milan (14).

JAMAICA
M. R. de Cordova, "Haining," Cross Roads, St. Andrew.

JAPAN
Sale & Co., Ltd., 1 Yaesu-Cho, 1 Chome Kojimachi-Chu, Tokyo.

NEW ZEALAND
G. W. Arnold, Ltd., Dominion Farmers' Institute, Featherston Street, Wellington.

NORWAY
Norsk Marconikompani, Raadhusgaten 5b, Oslo.

SOUTH AFRICA
British General Electric Co., Ltd., Magnet House, Corner Loveday and Anderson Streets, Johannesburg.

SPAIN
Casa Radio Urrestarazu y Compania (S. en C.), A. de Recalde 46, Bilbao.

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Ulrich Salchow, Kl. V. Kyrkogata 12, Stockholm.

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Société Générale des Condensateurs Electriques, Fribourg.

U.S.A.
Dubilier Condenser Corporation, 10, East 43rd Street, New York City.

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Edward F. Ablitt, A.M.I.Mech.E., Queensland Building, 84–88, William Street, Melbourne, Victoria.

FRANCE
Société Générale des Condensateurs et Appareils de Protection Electrique, 27, Rue de Mogador, Paris (9).

ITALY
Ing. S. Belotti & C., Corso Roma 76-78, Milan (14)

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Carrick Wedderspoon, Ltd., Christchurch.

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Trevor Williams & Co. (Pty.), Ltd., Wilkinson's Building, 482 Smith Street, Durban.

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Ulrich Salchow, Kl. V. Kyrkogata 12, Stockholm.

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