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Tubes Within Tubes

By G. C. B. ROWE

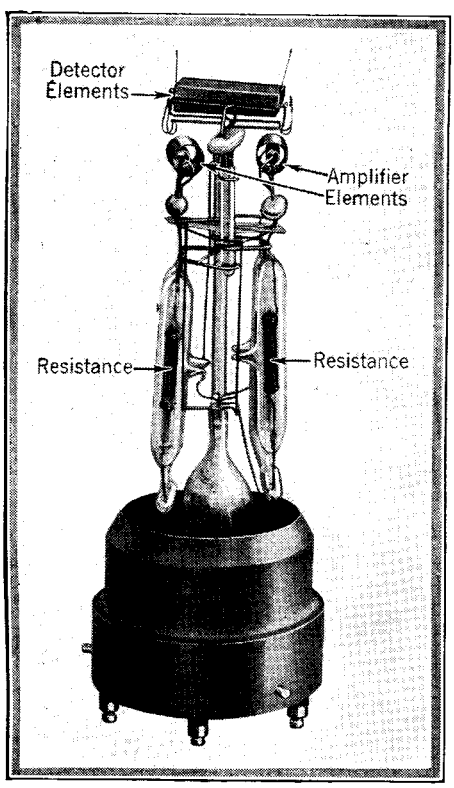
It is with great pleasure that RADIO NEWS *presents to its readers the new type of vacuum tubes developed by Dr. Siegmund Loewe of Berlin. Circuits in which these tubes are used will be shown in a forthcoming issue*

DURING the past year some very remarkable inventions have been given to the radio public for the betterment of both broadcasting and reception. These inventions have come so thick and fast recently that it is nothing out of the ordinary to pick up the morning newspaper and find that someone has perfected a device which will perform something that yesterday was deemed impossible. Yet no matter how many more sensational inventions are developed, there is always an interest in those by which better and cheaper reception of radio broadcasting may be obtained.

Among other great advances in the design of apparatus for radio receiving sets that have been made during the first half of 1926 is the development of two new vacuum tubes by Dr. Siegmund Loewe of Berlin. These tubes will be of interest to the majority of radio fans, who have a thought for the future, for their design throughout is one which has untold possibilities.

It is possible with two of these tubes to have the equivalent of a five-tube receiver; i.e., two stages of resistance-coupled radio-frequency amplification in one tube, and in the other, the detector and two stages of resistance-coupled audio-frequency amplification. In the tube first mentioned there are two sets of filaments, grids and plates, two resistances and a condenser, the latter for coupling the tubes. In the second tube there are two sets of amplifier elements, as in the first; but there is also a third set of elements, which serve as the detector. In the amplifier tube (which the first really is) each set of elements has a second grid for control purposes. These are are not needed in the other tube.

In the accompanying illustrations are several views of these two tubes. Some of the most remarkable components of the apparatus are indicated on the illustrations as resistances. These high resistances are of an entirely new type; as they consist of glass rods, with welded connections, on the surface of which is deposited a fine transparent, almost invisible metallic film, which serves as the resisting element. The whole is enclosed in a glass tube, which is highly evacuated. Thus, the element cannot be affected by atmospheric changes which would tend to alter the resistance. Furthermore the element functions as a pure resistance only, being absolutely non-inductive and free from capacity effects.



In this tube there is a detector and two stages of A.F. amplification.

IF radio did not improve continuously, we would not have broadcasting today, and we would not be on the road to television.

In this important article is fully described, for the first time in any American magazine, an invention of German origin and of the greatest importance.

You remember the days, away back in 1910 and up to 1920, when it used to be the custom to scatter the radio apparatus all over the table. From our detectors to our loose couplers, including binding posts and wiring, all instruments were loosely spread out, with no thought of a compact single unit, such as our present-day radio sets.

When we look at our present radio receiving sets we are apt to think of them as the last word in perfection. What will the radio set be five years hence? For all we know, it may be incorporated in a single tube, similar to the new Loewe tubes shown here for the first time. These new tubes mark another milestone in radio, because they have incorporated in them practically a complete radio set, except the variable condenser and inductance. Everything else is within the tube, where it is out of harm's reach, and where moisture and air can not get at the sensitive parts.

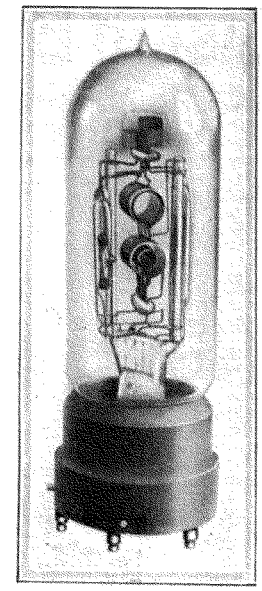
Not only that, but the tube actually contains three vacuum tubes, all under one glass housing.

Great things are predicted for a complete unit of this kind, and only time will tell how much further this innovation will lead us into radio advancement. —EDITOR.

ELIMINATING UNDESIRABLE CAPACITIES

One of the greatest drawbacks to the proper functioning of many radio receivers is that the leads, connecting the various instruments in the sets, have certain capacity effects, which are difficult to eliminate. However, in the tubes of Dr. Loewe, the length of the leads is reduced to a minimum; inasmuch as tube elements, resistances and condensers are all contained in one glass shell. It goes almost without saying that this is a tremendous advantage.

A problem that must be overcome by vacuum tube manufacturers is the evacuation of the tubes; and this is rendered more difficult by the gases that remain in the different

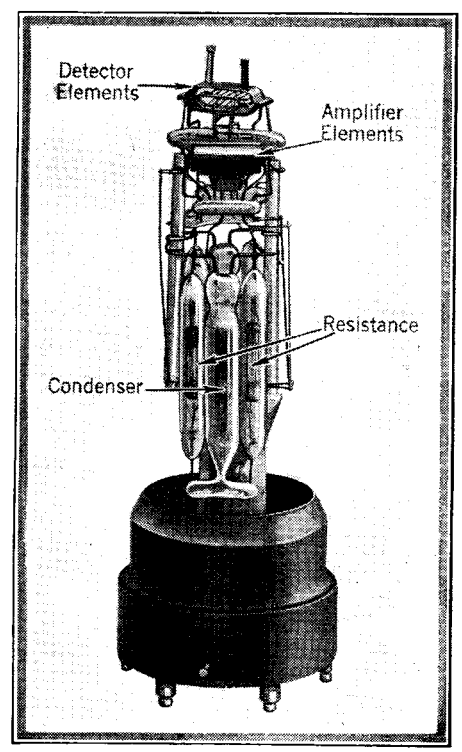


The Loewe vacuum tubes are six inches from prongs to tip of the glass shell, which is one-and-three-quarters inches in diameter. These tubes require a special socket having six connections.

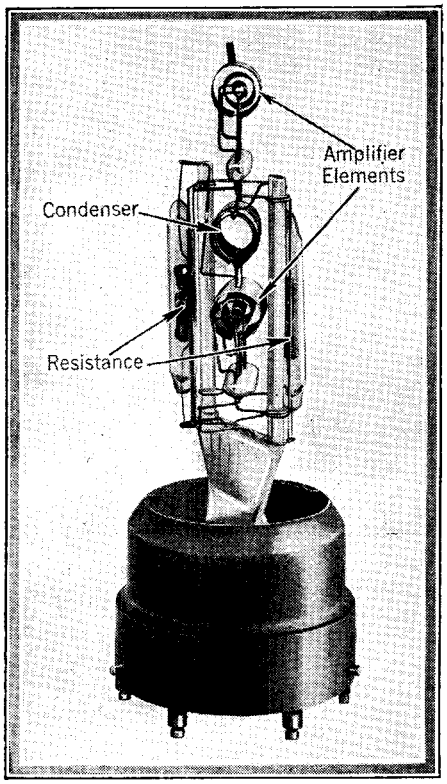
elements after the vacuum pump has done its work. These "residual" gases often interfere seriously with the correct operation of the tube; as the degree of vacuum is gradually lessened during its life. It is a well-known fact that, if a vacuum tube is to function at maximum efficiency, there must be as little interference as possible in the paths of the electrons between the filament to the plate; and any quantity of gas, however minute it may be, will reduce the over-all efficiency of the tube. Therefore, in these multi-element tubes the resistances are enclosed in glass tubes, and the metal parts, such as the tube elements, condensers, and connecting wires, are reduced in size and length as far as is practical.

In the tube which has two stages of resistance-coupled amplification, the condenser is placed between the two sets of tube elements. It is shaped like the plate elements of the tubes (i.e., cylindrical) and its dielectric is mica. However, in the other type of Dr. Loewe's tubes, the condensers separating the stages of amplification are enclosed in glass tubes; to reduce as much as possible the escape of the gases into the glass shell.

It may be seen upon inspection of the



Side view of the tube shown at the left, showing the position of the different parts.



Dr. Loewe's tube containing two stages of resistance-coupled radio-frequency amplification.

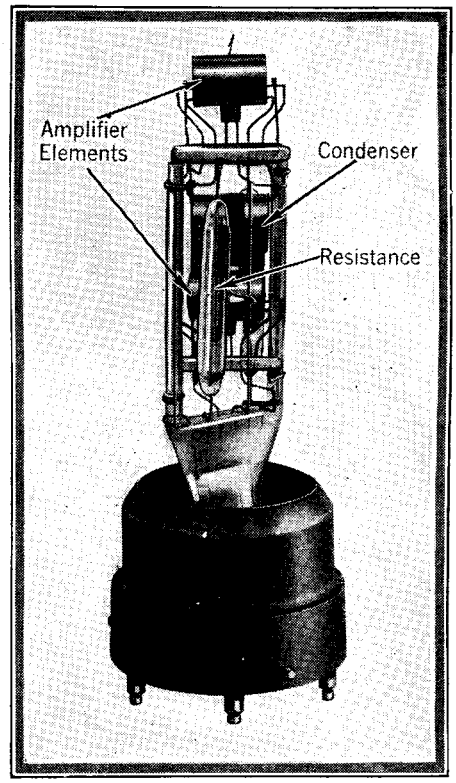
illustrations of the tubes, that the one which contains the three tube elements is of construction quite different from the other; although both tubes have six prongs on the base for external connections. It is claimed by the inventor that the former tube, if connected into any tuning circuit, will give distortionless reception at loud speaker strength, and that interference from static is reduced to a minimum. The two sets of amplifier elements are arranged in approximately the center of the tube, the resistances and condensers being placed vertically below the tube elements. The elements of the detector tube are in a horizontal position at the very top of the tube.

INTERNAL CONSTRUCTION

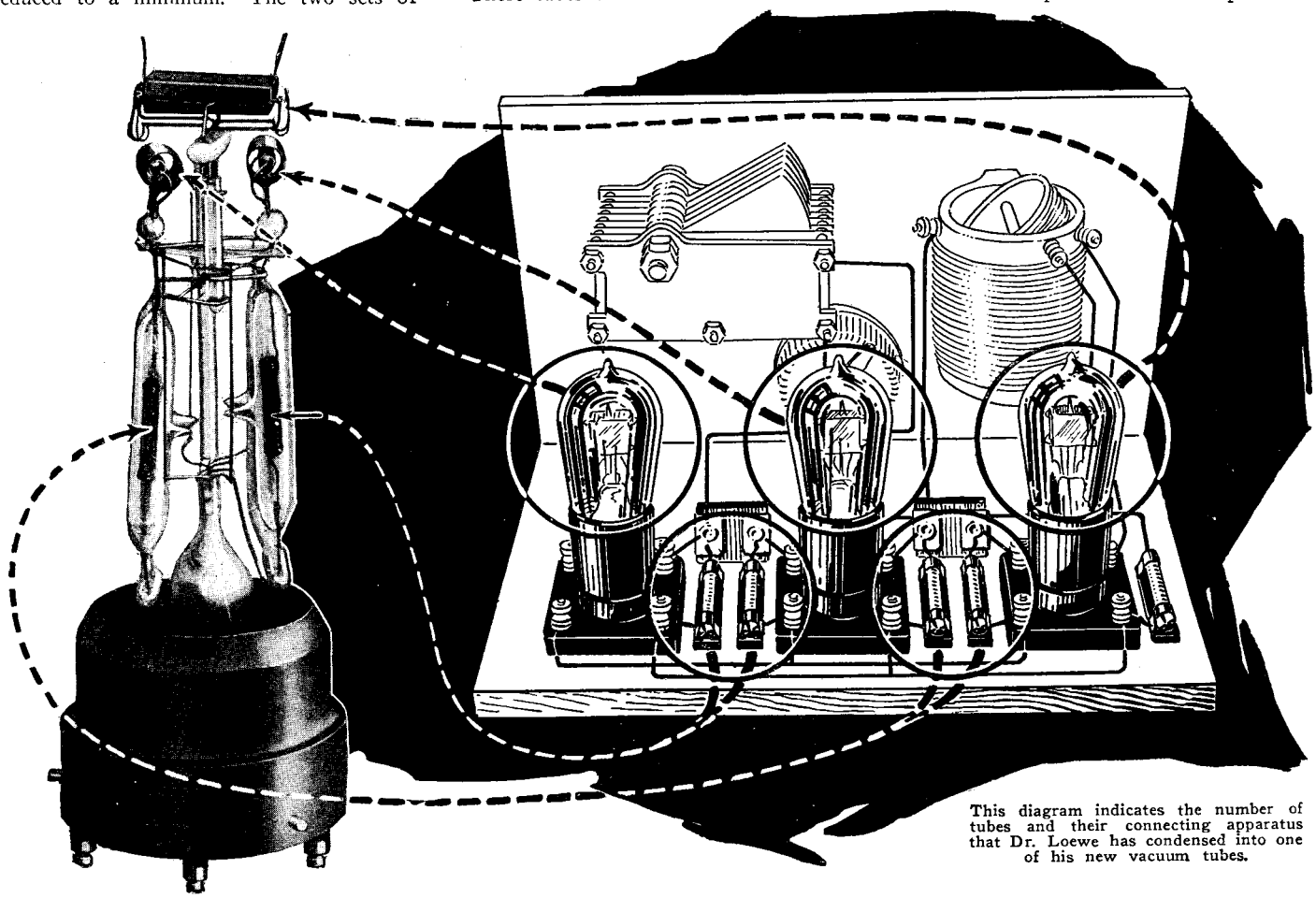
In the tube which has two stages of resistance-coupled amplification, there is an extra grid element in each of the amplifier elements. This extra element can be seen by closely inspecting the illustration in the upper left corner of this page. In the top "tube" will be found three concentric rings, which show the plate of the tube (the outside circle); the regular grid element, and the control grid, which is the inside circle and therefore the one that is nearest the filament. This second grid stabilizes the two stages of amplification to a remarkable extent, by the introduction of a negative bias of anywhere from 9 to 18 volts. The filament of the tube is a single stretch of wire that is run parallel to the axis of the cylindrical plate and through the middle of the control grid. The two filaments in this amplifier tube are connected in parallel and operate from a battery of 4 volts, which is almost universal practice in European tubes, just as in this country the great majority of our tubes are operated from a 6-volt battery.

The interior of the second type of tubes invented by Dr. Loewe, which are shown at the bottom of the preceding page, is quite different from that of the first type. The two sets of amplifier elements have but one grid each, instead of a control grid, and the construction of the detector elements is unlike the others both in shape and size. The plate element of the detector is more or less rectangular in shape, the grid and filament being suspended horizontally within this rectangle. As in the other tube the three filaments of the tubes are connected in parallel, the necessary potential being 4 volts for their operation.

These tubes of Dr. Loewe will doubtless be forerunners of a new race of vacuum tubes. Of course, even though they operate at a very high efficiency at the present time, yet as more experiments are made there will be refinements and improvements that will make the tubes even more efficient. Certainly the inventor of these tubes is to be congratulated on his achievement in bringing the radio art a step further towards perfection.



Another view of the vacuum tube shown at the left of this page. The resistances used are of the type shown on page 32.



This diagram indicates the number of tubes and their connecting apparatus that Dr. Loewe has condensed into one of his new vacuum tubes.

addendum from *Radio News for September, 1926*

Tubes Within Tubes

IN the July, 1926, issue of RADIO NEWS, appeared an article by G. C. B. Rowe entitled "Tubes Within Tubes." In that article we neglected to state that the vacuum tube described, containing in addition to the thermionic elements a complete resistance-capacity-coupling system, is the result of work done by Dr. Sigmund Loewe, on the thermionic elements, and by Baron Von Ardenne, on the circuit arrangement. This work was done in the Loewe laboratories in Berlin.

In the same issue an article entitled "New Radio Devices of Fixed Precision," describes a quartz resonator used for accurately determining and measuring radio frequencies. The original idea of the luminous quartz, as employed in this device, is due to Prof. Giebe and Dr. Adolph Schiebe, both of the German Bureau of Standards. These scientists worked in conjunction with the laboratories of the Loewe Radio Co. of Berlin, in the development of the resonator.

New Radio Devices of Fixed Precision

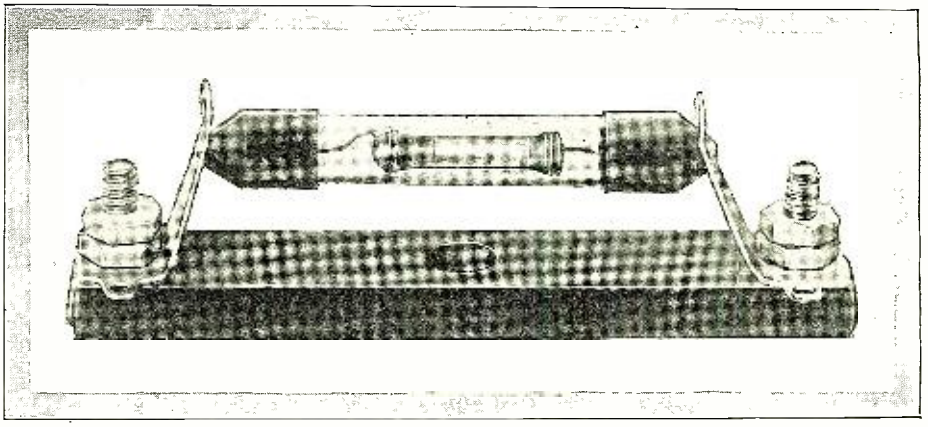
In addition to packing the parts of a radio receiving set into two vacuum tubes, Dr. Siegmund Loewe has constructed tiny apparatus which is hermetically sealed, and therefore does not vary, to measure wave-frequencies with an error less than a hundredth of one per cent.

NOT only has Dr. Loewe devoted a great deal of time to the development of his new vacuum tube, but he has turned his attention to other phases of radio as well. In this article are described two more of his inventions that will be instrumental in furthering the science to which he has devoted such a great portion of his life.

A NEW FIXED RESISTANCE

The resistances, mentioned elsewhere in connection with the coupling of the amplifiers, are also made separately. The external tube is of the same size as the grid leaks and resistances, with which the American radio fan is familiar, and so fits the holders, such as are used in this country. The outside glass tubes are evacuated, so that there can be no variation in the resistance value, due to changes in atmospheric conditions as previously mentioned.

These resistances can be used in any place where fixed resistances are required; and, due to their construction, there is little chance that the values will change. These resistances can carry a continuous load of 0.1 watt and will stand a peak load of 0.5 watt.

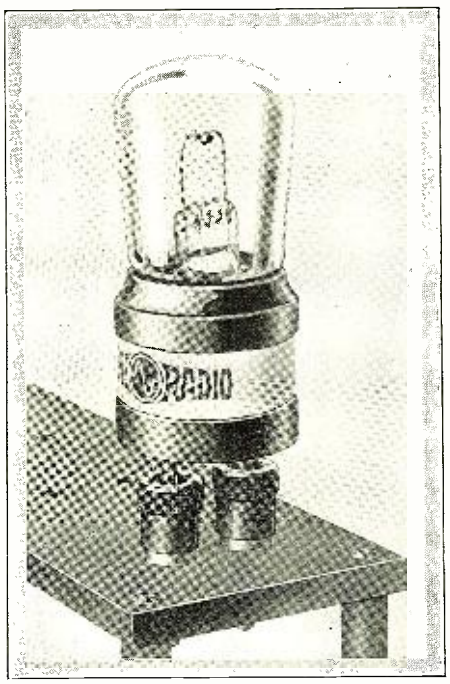


Another of Dr. Loewe's radio developments, a new type of high resistance. The small glass tube suspended in the larger one is covered with a metallic film, which acts as the resistance element.

A TUBE FOR MEASURING WAVE-LENGTHS

In previous issues of RADIO NEWS there have been various articles concerning "piezo-electric" crystals and the nature of their vibrations. For instance, quartz in the form of a rod may be made to vibrate mechanically at a very high frequency under the influence of an alternating electrical field; if this frequency corresponds to one of the elastic natural frequencies of the crystal.

This effect is obtained by placing a specially-formed quartz rod between two condenser plates of an electrically-oscillating circuit. The occurrance of resonance between the electric and elastic oscillations may be found by measuring the current strength in the oscillating circuit; a sudden decrease of the current occurring just before the resonant point is reached. It has been discovered that the elastic oscillation of the quartz crystal, which takes place in the condition of resonance, may be made visible by a luminous effect. This effect is obtained by placing the two condenser plates together, with the quartz crystal between them, in a glass tube and evacuating this to a pressure in the neighborhood of 10 or 15 mm. of mercury. The condenser plates are connected to the external circuit by means of lead-in wires, which are run through the prongs in the base of the tube.

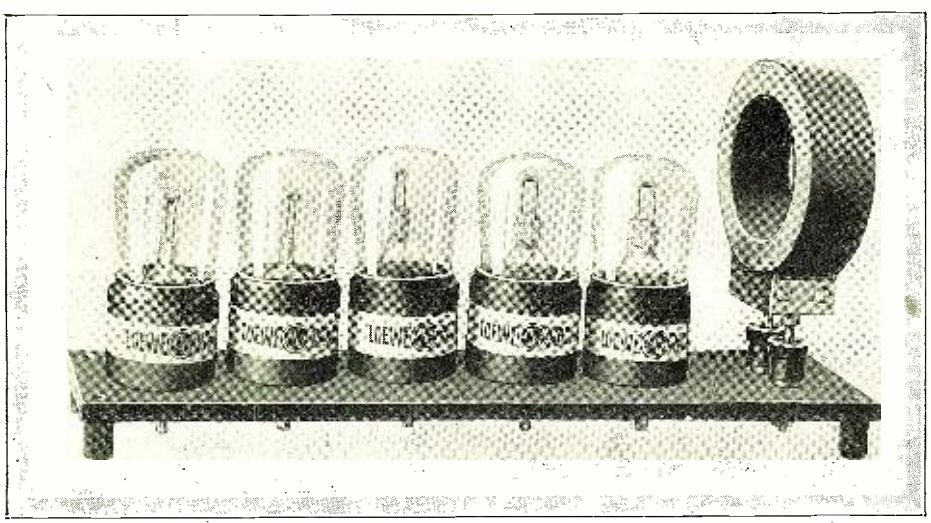


One of the quartz-crystal tubes for the measurement of the frequency of radio-frequency currents.

The alternating electrical field of such an oscillating circuit will cause, by reason of the electrical polarization of the quartz rod, alternating deformations in the latter. These, in the condition of resonance, will have the effect of generating the elastic oscillations. The deformations due to these oscillations will give rise to secondary alternating voltages upon the quartz rod, which bring the rarified gas contained in the tube to luminescence.

The resonance is extremely sharp and therefore the luminous effect may be adjusted down to one hundredth of one per cent. (.0001) of the wave-length. By the proper choice of the condenser plates and the degree of vacuum, the discharge is made to occur throughout the discharge space. A quartz resonator of this type affords a very accurate indicator for the measurement of wave-lengths. One of the accompanying illustrations shows a quartz resonator tube, which is filled with a special gaseous mixture, including helium and neon.

Extraordinary accuracy of wave-length measurements can be obtained with this instrument. Although the frequency may be easily calculated from the given wave-length, there will be some uncertainty because of possible errors in computing the exact velocity of light. For this reason these tubes are calibrated so that they will give readings in frequencies instead of wave-lengths, thus making them independent of the velocity of light.



The coil on the right is for coupling the wave-meter to the oscillating circuit to be measured.

ELECTRICAL MEASUREMENTS

By means of indirect methods, capacities and inductances may be measured very exactly by means of these resonators. Since the calibrated quartz crystal is placed within an evacuated glass tube, the measuring instrument can be regarded as absolutely unvarying, so long as the quartz and the glass tube remain uninjured. Since it has been found practically impossible to detect any influence of the variations in temperature, these "frequency standards" can be regarded as being entirely independent of the temperature.

The resonators will respond, if excited by a potential as low as thirty volts; but only in case the exciting current has a frequency (within 1/100 of 1 per cent.) identical with the resonance frequency of the quartz crystal. On account of the low potential used, the

(*Continued on page* 91)