SEVENTH YEAR OF SERVICE

RADIO ENGINEERING

Vol. VII JULY 1927 Number 7

R. M. A. Report Number

A general review of the First R. M. A. Convention and Trade Show

Eliminating Distortion in Output of A. F. Amplifiers

Another valuable article by Mr. Hiler regarding loop characteristics and matching phase angles

The Manufacture of Vacuum Tubes

Inside information on the vacuum tube family tree

Servicing Equipment for the Radio Dealer

Dealing with the layout, tools and apparatus required

Cash Discounts

An intelligent review of the subject by Donald MacGregor Treasurer of the R. M. A.

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EDITORIAL

THE radio industry still suffers from growing pains. Unfortunately, it does not suffer alone. Everyone, down to the ultimate consumer, bears a bit of the brunt.

In working out its welfare, the radio industry has, naturally been drawn through a great deal of mud and has been directly influenced, for both good and bad, by human differences. The industry, as it stands today, is a true reflection of the character of the men in the field who have had sufficient power in the politics to be instrumental in the moulding and governing. Some have so acted that they can be proud of the result. Others may feel the prick of conscience.

In the rush to keep pace with developments many factors have been either ignored or overlooked. One very important matter has escaped notice until recently and it has grown so powerful in its dual structure that now it presents itself not only as an enigma but one of the greatest problems to be solved.

The young radio industry was mothered by the electrical manufacturers, through the medium of the National Electrical Manufacturers Association, to whom a large part of the initial credit for development of the industry rightfully belongs. The continued experience of the group was applied to the problems of the industry and proved of great value.

The industry became so large and so powerful that radio manufacturers felt the need for a specific organization. So, in the year 1924 the Radio Manufacturers' Association was instituted, with comparatively few active members, to straighten out what appeared to be chaos.

The R. M. A. grew rapidly for many reasons. Its ideals and policies were sound. It appealed to most radio manufacturers as it represented the radio industry more definately than the N. E. M. A. It appealed to them because it was the logical thing; as logical as the N. E. M. A. when it was first instituted. In other words, the industry felt that radio problems should be handled by radio men.

The result is that today there are two organizations catering to the radio industry. In many respects these organizations have cooperated with each other to the advantage of all concerned. However, there have been a few points of difference which have retarded, to some extent, the good work. The matter of standardization has been one of the problems which has remained a dilemma.

At this time, when one would expect to see storm clouds appear and hear the clamoring of a public, the sun breaks through. The forward-looking members of the N. E. M. A. and the R. M. A., in the spirit of altruism, lay their cards on the table and give profound thought to the matters which, through pure circumstance, might have made them arch enemies—if they were small men.

The R. M. A. is to be congratulated on the stand taken at the recent Chicago convention. This stand was taken at the engineering meeting on June 14th, at which time it was openly announced that, pending a meeting of the executives of both organizations, the R. M. A. would not publish any new standards—it would simply continue the necessary committee work.

The whole keynote of the R. M. A. convention and the several directors' meetings held during the period was that even though the R. M. A. had a membership of ten times that of the Radio Section of the N. E. M. A., it would not take any steps that could in any way be interpreted toward bringing about additional confusion in the industry.

RADIO ENGINEERING believes that the two organizations, in the interests of the industry, the trade and the public, should work towards a common end, that compromises should be effected so that from the two a single organization can be moulded which will represent all factors in the radio industry.

Both organizations appear to see the logic of such a plan and approve of taking the necessary steps to bring it about. They are to be congratulated for what they have already done in the interests of the industry. More power to them.
—M. L. MUHLEMAN, *Editor.*

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The Technical Magazine of the Radio Industry

Edited by M. L. MUHLEMAN

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Seventh Year of Publication

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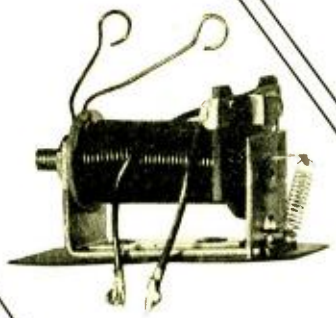

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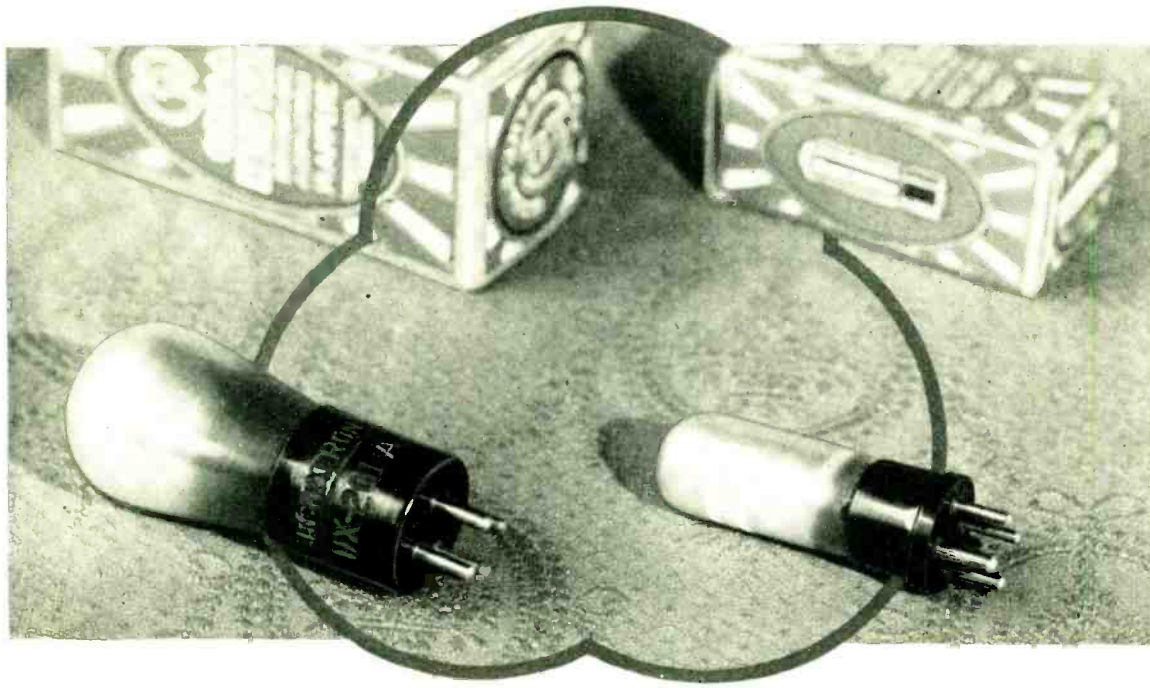

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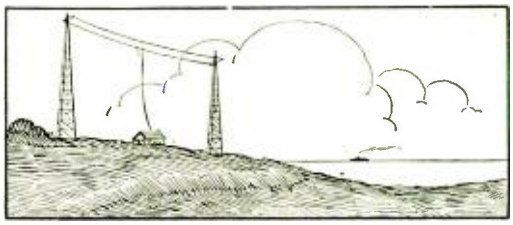


Vacuum Tubes, Their Manufacture and Application*

Some inside information on the vacuum tube family tree

By R. C. Robinson†

THE value of research is unquestionably proven by the worth of the various types of evacuated tubes or bulbs, which have been sold during the past few years. Experiments, in which some material attached to lead wires was sealed into glass vessels and the vessels exhausted, became of great commercial importance when Edison made his first incandescent lamps in 1879. The improvements in these lamps up to the present time is a most fascinating story, and represents the work of thousands of skilled researchers and the expenditure of millions of dollars. The changes from the bamboo and silk filaments to squirted cellulose, from the plain carbon to treated carbon later followed by the Gem filament, the osmium filament, the tantalum filament, and finally drawn tungsten have brought the incandescent lamp to the excellence which it has to-day, as a household necessity.

Improved Methods of Manufacturer

At the same time that these changes were being made equally important advances were going on in the art of assembling and exhausting these lamps. Edison's lamps took hours to exhaust while the present day marvel takes seconds. Originally slow acting mercury pumps were used for this work. These were replaced by Packard oil pumps, then by Gerycke oil pumps, later by rotary oil pumps, and finally by mercury condensation pumps of the Langmuir type. In order to improve the vacuum obtained with the pumps, they are assisted by different chemicals; in the earlier days by phosphorous in the presence of a glow discharge in the bulb, and later by numerous chemical compounds, known as "getters," such as various chlorides and fluorides, which when introduced into the bulb materially improve the performance of the lamp.

Equally as wonderful are the improvements in the methods of assembling the lamps. At first all of the work was done by hand, but it is now almost entirely accomplished by machinery, operators only being necessary for loading the machines and final inspection and packing of the lamps. These machines are almost human and are wonderful pieces of mechanism. They blow the bulbs,

A 100 KW water cooled transmitting tube, contrasted with a 199 type receiving tube.

make the stems from glass tubing, seal them into the bulbs, exhaust them, and even seal off the lamps. Some idea of the advance of the art along these lines is best gained by the statement that more than three hundred million vacuum lamps per year are made in approximately one-half the floor space that was necessary for one-half this number six years ago, and that the production per operator, due to the big improvement in machinery, has increased three-fold in the past eight years.

The results of these extended researches and improvements have given us a lamp seven times as efficient as Edison's, and one of the few household necessities which have steadily decreased in price. Since 1921 their price has been decreased ten times, so that now they cost us only 49% of what they did in 1914.

Electron Emission

Many scientific men, such as Fleming, J. J. Thomson, Richardson, Langmuir, etc., have studied the different phenomena observed in incandescent lamps. When the lamp is well exhausted they found an electric current would pass from the hot filament, if charged negatively, to a plate which was charged positively and sealed into the bulb opposite the filament. The results of these purely scientific investigations have been more far reaching even than those on the incandescent lamp itself. From them have arisen our X-ray tubes, high voltage rectifiers, the entire radio vacuum tube line, photo-electric cells, cathode ray tubes, etc.

Langmuir's studies of the current flowing through the space in lamps proved that a hot body in a good vacuum gives off electric particles, electrons, the quantity depending on the temperature of the hot body and the material from which it is made.

In the present day vacuum tubes three types of substances are used as the source of electrons: the oxides of certain metals as calcium, barium, stronium, etc.; the pure metals themselves as tungsten or molybdenum, and these pure metals mixed with a small amount of thoria. The oxides are coated on a wire-like platinum or nickel and give off their electrons at temperatures below the melting points of these metals. The pure tungsten filaments are operated at about 2400 degrees—2500 degrees K., and those containing thoria around 2000 degrees K. Operating at the same temperature,

*From M. I. T. Technology Engineering News.
† Engineer, Vacuum Tube Dept., General Electric Company.

A front view of one of the test sets for checking up on completed water cooled Pliotrons and Kenotrons. One tube can be seen mounted in the test rack.

the emission from thorium is about five thousand times greater than from tungsten. A pure thorium filament, however, vaporizes and melts at too low a temperature to get sufficient emission from it to make a successful vacuum tube. It, however, evaporates much slower when in the form of a thin film on tungsten and so it is used in this condition. The popular type of receiving vacuum tube, 201-A, has such a filament, a tungsten base containing one or two per cent of thoria. This thoria, at the operating temperature, slowly diffuses to the surface of the filament as thorium metal. The large emission of the thorium is thus secured at the high operating temperature of the tungsten filaments. Some idea of the quantity of electrons given off from the hot filament is gained from the fact that 6.28 x 10.19 escape per second from one square centimeter surface when the emission current is one ampere.

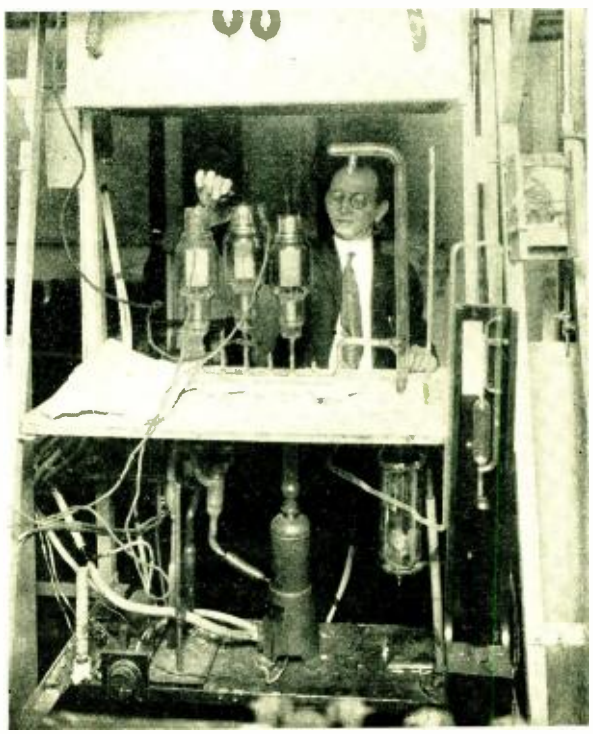
Removal of Gas

Under the influence of a high voltage between the anode and the cathode the electrons escaping from the hot filament or cathode travel at great speed to the positive plate or anode placed opposite it. If gas is present it either "poisons" the surface of the emitting cathode or modifies the electron flow so that it destroys the proper characteristics of the tube. It is, therefore, very important that all the gas possible be removed from the tube. This removal of gas necessitates a great amount of painstaking work, which in the case of some of the larger radio tubes must be carried on for fifteen or twenty hours, during which time they are connected to vacuum pumps. The elements of the tube have to be carefully prepared before they are sealed into the glass bulbs. It is very essential that these parts be freed from all dirt and grease and be kept as clean as possible, before mounting them into tubes. They are fired at a high temperature in a reducing atmosphere such as hydrogen, or in a vacuum to remove all contaminating oxides, and as much of the occluded gas as possible.

The pumping systems by which these tubes are exhausted are very elaborate, and in the case of those used for the larger tubes, sometimes cost as much as $5,000 per unit. The tubes are placed in baking out ovens and are attached to the pumping system. In order to obtain a sufficiently good vacuum three or more pumps are operated in series: the first one, or rough pump, is capable of giving a vacuum of 1 m.m. mercury; the next about .001 m.m.; and the final approximately .000001 m.m. This last pump is also assisted by chemical means, such as phosphorous pentoxide, to help remove water vapor from the tube, or by a refrigerant, such as liquid air or chilled brine, to freeze out this moisture.

Elements Heated Electrically

The exhaust operation is carried out as follows: The bulb is exhausted thoroughly while it is heated as hot as possible without actually softening the glass (400 degrees—500 degrees C, depending on the glass used) for periods varying from a few minutes to two hours according to the size of the tube. This bake-out drives the gases (principally water vapor and carbon dioxide) from the glass walls. Next the filaments are burned at temperatures higher than they will be when in service. This removes the gases from the filament, leads and supporting anchors. Finally the anodes, grid structure or other parts must be brought to incandescence to expel their oc-



Transmitting tubes being exhausted by a Langmuir mercury vacuum pump. The pump can be seen underneath the platform.

cluded gases. This may be done by heating them in a high frequency electric field, or by bombarding them with electrons from their own cathode. By using high enough voltage between the cathode and anode (100,000 or more volts in the case of X-ray tubes and high voltage kenotrons) the electrons strike the anodes with such force that the anode will be brought to a bright incandescence. It is easily possible to melt holes through tungsten sheets in this manner, temperatures over 3000 degrees K. being reached in such instances. This heating of the elements must be continued until as much gas as possible is removed from them. Presence of gas in the tube is shown by fluorescent spots on the surface of the glass bulb or by a glow in the bulb itself. When all the gas that can be removed mechanically by pumps has been drawn out, in order to still further improve the vacuum, metallic vapors such as those of phosphorous, magnesium or calcium, etc., are distilled into the bulbs and, condensing on the inside of the glass walls, unite chemically and physically with the residual gases. The tubes are then sealed off from the pumps by melting, with a gas flame, the glass tube which attaches them to the pump.

Ageing the Tubes

Before the tubes can be sold they must be aged and operated at voltages and power outputs greater than will be called for in actual service. These operations still further improve the vacuum as the electrons strike some of the gas molecules so hard that they actually drive the gas into the glass walls of the containing bulb. This effect is greater the higher the voltages used. After all these operations the vacuum in many instances is better than .000001 m.m., or in other words, there is less than one molecule of gas left of every seven hundred million originally present in the tube. To get full emission from the hot cathode, it is absolutely essential to have this high vacuum in the tubes. A very good indication of the perfection of the vacuum is afforded by the use of the so-called 3/2 power law. This law states that the maximum thermionic current between electrodes of any shape varies with the 3/2 power of the voltage between them. It holds true for practically all measurements up to the saturation point, except a few at low voltages. If gas is present in the space, the law does not hold.

Materials Used for the Elements

The materials used for parts of the tube and the spacing and shape of the parts, play a very important role in the design and performance of vacuum tubes. Copper, nickel, platinum, molybdenum and tungsten are most commonly used for the electrodes, the work which the tube has to do determining the choice of material. For low power tubes, in which the anodes do not get red hot, nickel is generally used. The larger tubes either have to be water cooled, or have their elements made from the high melting metals, molybdenum and tungsten. The electrodes are shaped and spaced according to the output and electrical characteristics desired.

(To be continued)

Reactivating Vacuum Tubes

Means for testing and restoring tubes with thoriated filaments

*By Horatio W. Lamson**

An old Arabian legend tells how Aladdin, seeking to recover his magic but unpretentious-appearing lamp which had been unwittingly discarded by a servant, went to the market place, where he astonished the populace by offering to give away new lamps for old. In a like manner a modern Aladdin might offer to give new lamps (vacuum tubes) in exchange for old without deserving much credit as a philanthropist. All of which introduces us to the subject of the reactivation of vacuum tubes by the simple process of rejuvenating their filaments.

A large part of the vacuum tubes used in radio reception today have the so-called thoriated filaments. Chief among these are UV and UX-199, UX-120, UX-200-A, UX-201-A, UX-171, UX-210, UX-213 and UX-216-B; C and CX-299, CX-120, CX-300-A, CX-301-A, CX-371, CX-310, CX-313 and CX-316-B; and corresponding tubes from other manufacturers.

The electronic emission of these tubes, that is, their plate current, depends upon the presence of a layer of thorium atoms on the outer surface of the filament. The filament is not thorium-coated, however, after the manner of the oxide-coated filaments, but is, rather, permeated throughout its whole substance with this rare element, thorium. During the normal operation of these tubes the thorium on the outer surface of the filament gradually evaporates. This would correspondingly reduce the emission current and render the tube very short-lived were it not for the fact that the thorium is continuously replenished from the interior of the filament. As long as the filament voltage in normal use is not raised over ten per cent above the rated value this evaporation and replenishing continues at an equilibrium rate, so that a constant layer of thorium is maintained on the surface.

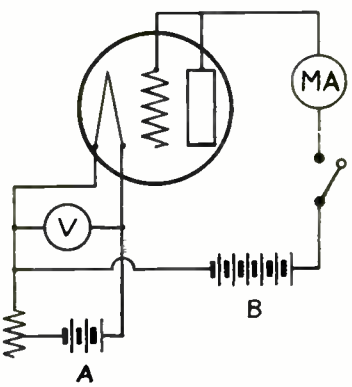


Figure 1

Circuit for testing the emission of a vacuum tube to determine if it is below normal.

When subjected to an over-voltage on the filament, however, the evaporation becomes excessive so that the thorium surface layer is partially or completely diminished, and the tube accordingly more or less paralyzed. Operating these tubes at subnormal voltages is also liable to paralyze them slowly, as the filament temperature is then so low that the process of boiling out the thorium from the interior of the filament becomes abnormally retarded. Hence, it is important that the thoriated filament tubes be run at their rated filament voltages. It may be noted here that the maximum life of the "dry cell" tubes is attained when they are operated with a voltage of 3.3 across the filament.

While the great majority of thoriated tubes after a long and useful life gradually die a natural death, others are not infrequently executed by excessive voltages. In either case, if the filament is not actually burnt out, the chances are very good that the tube may be restored to life and vigor by the simple process of reactivation.

Method of Test

Before the cure we must diagnose the disease, and so before reactivation we should test the emission of the tube to ascertain if it is actually below normal. To do this the circuit shown in Figure 1 is used. The grid and plate are tied directly together and then joined to the plus terminal of the B battery through a milliammeter. The negative B battery terminal is joined to the negative end of the filament and a key switch, normally open, is included in the plate circuit.

* *Engineering Department, General Radio Company.*

A vacuum tube reactivator which operates from a 110 volt 60 cycle line. Sockets are provided for testing, flashing and cooking. The correct voltages are maintained automatically.

The voltage across the filament, read on "V," should first be adjusted to the values specified in the accompanying table, which give also the proper values of B battery to use with the different tubes. These values should not be exceeded. Now depress the key just long enough to obtain a reading of the emission current on MA. (Disregard the change in voltmeter reading caused by the emission current.) If the emission current obtained under these conditions is zero, or any value less than the minimum specified in the table, the tube can doubtless be improved by reactivation.

Reactivation

Reactivation can advantageously be accomplished in two steps: the first known as "flashing" and the second as "cooking." In both of these processes the grid and plate of the tube should be *completely disconnected* from any external circuits.

For flashing three-volt tubes, a voltage of twelve is applied to the filament for a period of about one second. This will completely paralyze the tube as the surface layer of thorium is wholly evaporated, but the "boiling-out" process within the filament is expedited by the flashing to such a degree that, if the tube is now cooked with a voltage of four across the filament, the surface layer will be rapidly replaced, so that, in a few moments, the emission of the filament will come back to normal and the rejuvenated tube is ready for another long lease of life. A constant "cooking voltage" of four is permissible in this case because there is no emission current to expedite surface evaporation.

If a subsequent emission test shows that the filament failed to respond to this reactivation process it is evident that the tube has served its normal life or else has been so heavily overloaded that the vacuum has been impaired.

The five-volt tubes should be flashed for the same interval at eighteen volts on the filament and cooked at seven volts. Flashing is not recommended for the power amplifiers UX-210 or CX-310, or the rectifier tubes UX-213, CX-313, UX-216-B and CX-316-B. These tubes may, however, be reactivated merely by cooking them for longer intervals. The UX-213 or CX-313 at six volts and the others at nine volts on the filament.

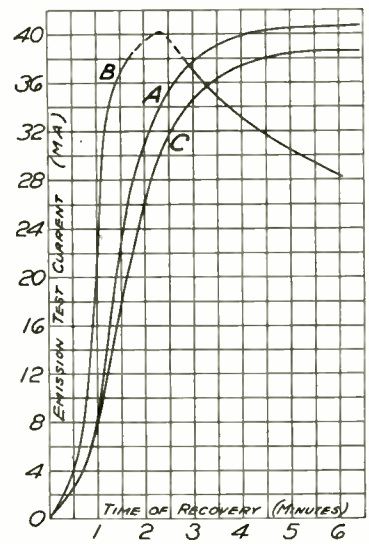


Figure 2

Some curves showing the speed of recovery of a 201-A type tube with various flashing and cooking voltages.

Speed of Recovery

Curve A in Figure 2 shows the customary normal recovery of a UX-201-A tube while cooking at seven volts, after being flashed at eighteen volts. This recovery is slow at first, then increases rapidly, and finally slows down again as a saturation value is reached. When the tube was flashed at eighteen volts and then cooked at its rated filament voltage (five volts), the same saturation current was finally attained, but only after thirty-five minutes of cooking. Likewise recovery to the same saturation current, when cooked with four volts on the filament, required a period of two and one-half hours. On the other hand, cooking at nine volts on the filament caused a prompt recovery, but the saturation current was subsequently reduced, as shown in curve B, since, in this case, evaporation from the surface (even with no emission current) exceeded the boiling-out of thorium from the interior.

Curve C shows the recovery of the 201-A tube flashed at twelve volts and cooked at seven volts. The rate of recovery and final saturation values are seen to be slightly less than curve B, where the same tube was flashed at eighteen volts. It should be stated that the data for curve C were actually taken before the data for curve B, so that the results cannot be explained by a deterioration of the tube. Thus it is apparent that the recommended voltages for flashing and cooking should be used to secure best results.

Reactivation Process Can Be Repeated

It was found that tubes could, on the average, be flashed and recovered six or eight times before showing any decrease in the saturation current, which would indicate a deterioration of the filament. This deterioration, however, was not rapid, a dozen flashings serving to reduce the saturation current by only 8 or 10 per cent. This does not mean, however, that the total life of a thoriated filament properly used may be increased tenfold by reactivation. Reactivation might be expected, perhaps, to triple the useful life of the tube.

The emission of the various oxide-coated filaments can likewise be tested but these tubes can not, of course, be reactivated.

Type of Tube		Fil. E. M. F.	Plate E. M. F.	Min. Emission
UV-199 C-299	UX-199 CX-299	3.3	50	6 m. a.
UX-120	CX-220	3.3	50	15 m. a.
UX-201A	CX-301A	5.0	50	25 m. a.
UX-200A	CX-300A	5.0	50	12 m. a.
UX-171	CX-371	5.0	50	50 m. a.
UX-210	CX-310	6.0	100	100 m. a.
UX-213	CX-313	4.0	100	50 per anode
UX-216B	CX-316B	6.0	125	100 m. a.

Chart Showing the Available Voltage for Light Socket Operation of Radio Equipment

This data, reprinted by request, will be of value to manufacturers of electric sets and socket power devices in determining consumer sales

	Total Number of Domestic Lighting Customers	Number of Domestic Lighting Customers Using Alternating Current (By Voltages)								Number of Domestic Lighting Customers Using Direct Current (By Voltages)					
		Voltages													
		100	104	105	108	110–115	118–120	125–127	220	110	115	120	125	220	225
United States	14,532,930	2,480	92,170	21,220	196,930	9,436,657	1,745,550	1,680	388,500	26,980	8,690	366,970	1,060	21,670	150
New England	1,318,700	.....	67,300	.....	.....	1,140,450	109,740	.....	.....	.....	.....	1,210	.....	.....	.....
Middle Atlantic	3,461,300	760	.....	1,407	187,700	2,514,000	395,280	720	3,500	450	1,780	355,100	280	260	.....
South Atlantic	966,700	.....	22,570	540	.....	762,430	179,840	770	240	230	.....	.....	80	.....	.....
East North Central	3,829,600	30	1,130	18,490	9,230	3,183,950	405,730	.....	191,240	3,440	1,670	7,660	.....	6,880	150
West North Central	1,565,850	1,260	120	.....	.....	1,338,620	190,850	80	880	6,450	4,350	1,460	700	11,080	.....
East South Central	498,500	.....	1,050	.....	.....	488,970	340	.....	1,080	3,650	.....	1,540	.....	1,870	.....
West South Central	861,650	430	.....	720	.....	730,220	119,830	.....	6,110	2,100	760	.....	.....	1,480	.....
Mountain	464,330	.....	.....	.....	.....	443,900	15,140	110	4,450	2,500	130	.....	.....	100	.....
Pacific	1,566,300	.....	.....	.....	.....	1,056,340	328,800	.....	181,000	160	.....	.....	.....	.....	.....
New England:															
Maine	152,000	.....	.....	.....	.....	109,760	41,200	.....	.....	.....	.....	1,040	.....	.....	.....
New Hampshire	63,200	.....	2,020	.....	.....	28,050	33,130	.....	.....	.....	.....	.....	.....	.....	.....
Vermont	59,600	.....	.....	.....	.....	59,600	.....	.....	.....	.....	.....	.....	.....	.....	.....
Massachusetts	686,000	.....	.....	.....	.....	640,420	35,410	.....	.....	.....	.....	170	.....	.....	.....
Rhode Island	95,500	.....	65,280	.....	.....	30,220	.....	.....	.....	.....	.....	.....	.....	.....	.....
Connecticut	262,400	.....	.....	.....	.....	234,800	.....	.....	.....	.....	.....	.....	.....	.....	.....
Middle Atlantic:															
New York	1,554,800	.....	.....	1,470	.....	830,600	366,780	720	.....	130	.....	355,100	.....	.....	.....
New Jersey	659,000	760	.....	.....	.....	655,490	.....	.....	2,280	320	.....	.....	.....	150	.....
Pennsylvania	1,247,500	.....	.....	.....	187,700	1,027,910	28,500	.....	1,220	.....	1,780	.....	280	110	.....
South Atlantic:															
Delaware	23,300	.....	.....	.....	.....	23,300	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maryland	180,700	.....	.....	540	.....	32,640	147,290	.....	.....	230	.....	.....	.....	.....	.....
District of Columbia	65,000	.....	.....	.....	.....	65,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
Virginia	127,200	.....	.....	.....	.....	119,100	8,100	.....	.....	.....	.....	.....	.....	.....	.....
West Virginia	95,300	.....	.....	.....	.....	93,060	2,230	.....	.....	.....	.....	.....	.....	.....	.....
North Carolina	137,700	.....	.....	.....	.....	137,700	.....	.....	.....	.....	.....	.....	.....	.....	.....
South Carolina	71,600	.....	22,570	.....	.....	47,880	380	770	.....	.....	.....	.....	.....	.....	.....
Georgia	133,700	.....	.....	.....	.....	132,910	470	.....	240	.....	.....	.....	80	.....	.....
Florida	132,200	.....	.....	.....	.....	110,830	21,370	.....	.....	.....	.....	.....	.....	.....	.....
East North Central:															
Ohio	1,012,000	.....	.....	1,130	.....	1,002,020	3,530	.....	1,170	670	770	.....	.....	2,710	.....
Indiana	435,000	.....	1,060	17,360	9,230	367,980	36,650	.....	460	270	.....	80	.....	1,680	150
Illinois	1,300,000	.....	.....	.....	.....	1,106,290	1,700	.....	189,530	1,230	670	580	.....	.....	.....
Michigan	723,000	30	70	.....	.....	665,220	196,670	.....	.....	800	.....	.....	.....	970	.....
Wisconsin	359,600	.....	.....	.....	.....	524,460	164,090	.....	80	470	230	7,000	.....	1,520	.....
West North Central:															
Minnesota	395,000	.....	.....	.....	.....	312,200	77,200	.....	.....	900	.....	.....	.....	4,700	.....
Iowa	278,250	.....	.....	.....	.....	271,360	980	.....	470	3,250	850	750	.....	590	.....
Missouri	427,900	.....	120	.....	.....	320,690	105,280	.....	.....	400	600	70	.....	740	.....
North Dakota	33,200	560	.....	.....	.....	19,360	3,890	.....	.....	5,620	940	170	640	2,020	.....
South Dakota	48,600	.....	.....	.....	.....	45,810	180	.....	.....	2,300	.....	160	.....	150	.....
Nebraska	136,300	.....	.....	.....	.....	127,530	2,000	80	410	3,200	390	310	60	2,320	.....
Kansas	246,600	700	.....	.....	.....	241,670	1,320	.....	.....	780	1,570	.....	.....	560	.....
East South Central:															
Kentucky	163,600	.....	1,050	.....	.....	160,350	.....	.....	.....	1,100	.....	.....	.....	1,100	.....
Tennessee	179,000	.....	.....	.....	.....	176,380	.....	.....	1,080	.....	.....	1,540	.....	.....	.....
Alabama	111,400	.....	.....	.....	.....	108,560	340	.....	.....	2,500	.....	.....	.....	.....	.....
Mississippi	44,500	.....	.....	.....	.....	43,680	.....	.....	.....	50	.....	.....	.....	770	.....
West South Central:															
Arkansas	92,300	.....	.....	.....	.....	90,380	.....	.....	.....	1,600	.....	.....	.....	320	.....
Louisiana	98,050	.....	.....	.....	.....	40,420	53,050	.....	3,990	80	50	.....	.....	470	.....
Oklahoma	180,800	430	.....	720	.....	177,840	.....	.....	1,710	100	.....	.....	.....	.....	.....
Texas	490,500	.....	.....	.....	.....	421,590	66,780	.....	410	320	710	.....	.....	690	.....
Mountain:															
Montana	62,950	.....	.....	.....	.....	56,640	5,830	.....	.....	330	90	.....	.....	60	.....
Idaho	50,800	.....	.....	.....	.....	47,430	3,220	110	.....	.....	.....	.....	.....	40	.....
Wyoming	27,400	.....	.....	.....	.....	26,410	950	.....	.....	.....	40	.....	.....	.....	.....
Colorado	150,800	.....	.....	.....	.....	144,440	1,740	.....	4,450	170	.....	.....	.....	.....	.....
New Mexico	20,400	.....	.....	.....	.....	19,070	1,330	.....	.....	.....	.....	.....	.....	.....	.....
Arizona	30,550	.....	.....	.....	.....	30,550	.....	.....	.....	.....	.....	.....	.....	.....	.....
Utah	107,800	.....	.....	.....	.....	105,730	2,070	.....	.....	.....	.....	.....	.....	.....	.....
Nevada	13,630	.....	.....	.....	.....	13,630	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pacific:															
Washington	266,500	.....	.....	.....	.....	90,370	175,970	.....	.....	160	.....	.....	.....	.....	.....
Oregon	145,300	.....	.....	.....	.....	14,580	130,720	.....	.....	.....	.....	.....	.....	.....	.....
California	1,154,500	.....	.....	.....	.....	951,390	22,110	.....	181,000	.....	.....	.....	.....	.....	.....

Cash Discounts

Their use and abuse: as seen by a manufacturer

*By Donald MacGregor**

FRANK OSGOOD, proprietor of the flourishing Radio Shop on Main Street that bears his name, approached his place of business filled with enthusiasm for the day's work. At his door he was greeted by his salesman, young Wright:

"Good morning, Mr. Osgood. We have made a fine start today. I sold a storage battery a few minutes ago, and managed to short-change our customer 20c. Pretty good, eh?"

Can you imagine the utter look of dismay,—the lines of righteous indignation,—on the face of our honest friend Osgood had he really been greeted with this startling bit of news? —BUT, that very day Osgood deducted 20c as a *cash* discount from the bill for a storage battery which had been sent to him *three weeks* previously by his jobber!

This little incident illustrates one of the strange inconsistencies of modern business practice. Sharp bargaining and questionable tactics were common, —almost universal,—20 years ago, but in modern business it is generally conceded that the homely old phrase "Honesty is the Best Policy" has proved its truth,—in everything excepting the matter of cash discounts!

Not only dealers like Osgood are guilty of this pernicious habit, but likewise jobbers, and manufacturers too, make a practice of taking something which is not theirs when their bills are passed for payment. In fact, this particular phase of business is so commonly conducted in a "dishonest (a harsh word, but what other will suit?) manner that almost all Trade Papers and Associations have given up hopes of collecting worth-while data on the subject. Time after time questionnaires have been summarized in some particular industry proving that terms are, say, 2%—10 days, 30 days net, when, as a matter of fact, it is common knowledge that 75% of the concerns in that industry permit cash discounts on a "10th prox" basis.

Ordinarily a manufacturer, jobber, or dealer will gladly give you a straight-forward, honest, answer to your questions regarding his intimate business details. He will tell you his average hourly rate, his bonus plan, his advertising policy, and almost anything else if he knows that the information will be used for the good of his industry as a whole,—everything else, that is, excepting the answer to your inquiry concerning his cash discount terms. Here he falters. He will either give you an evasive answer, or if he does reply direct then take that information as coming from a man who considers himself justified in telling an untruth. Nine times out of ten his published cash discount terms and those he actually allows are quite different. So here we find a business practice that is unsound and unfair at both ends: The supplier does not enforce his published terms, while at the other end, the buyer takes discounts not permissible by the terms of his purchase.

Cash Discount a Valuable Asset

The question quite naturally arises, why should cash discounts be abused? The answer probably lies in several facts, chief among them the increasing realization of business men in general that cash discounts constitute one of their most valuable assets. Aside from the improved standing and general reputation for financial responsibility that a business man gets by discounting bills, there is the direct financial return of cash discounts. For instance, an average radio dealer can pay the expenses of his service man or can buy and maintain a large electric store sign by means of his earned cash discounts. Jobbers can pay a substantial share of their catalog expense or run their delivery truck on cash discount earnings. Even relatively small manufacturers can support their Credit Departments by means of the same revenue. Realizing, as most business men now do, that these things can be accomplished where the financial structure permits the taking of cash discounts, it is little wonder, then, that here and there some men were found who took the discount a few days after the allotted time, thereby gaining even greater benefits. Gradually, the number of houses following this unfair practice has increased until, unfortunately, many otherwise honest business concerns have been drawn into the habit, presumably thinking that taking unearned cash discounts is just as legitimate as bargaining for lower prices from their suppliers. But it isn't. A cash discount is something that is earned, it is a premium for prompt payment in cash. A cash discount taken as much as 30 days after the rendering of a 2% 10 day bill is not a cash discount, but is a trade discount which the buyer is taking on the assumption that his supplier will either not dare to question the deduction, or else will pass it by as being too small a matter to quibble over.

Analyzing Cash Discounts

Few business men stop to analyze mathematically the value of cash discounts, although the process is a simple one. For instance, let's assume that a manufacturer offers terms of 2% 10 days, 30 days net. This means that on a $1.00 purchase a deduction of 2c. may be made if paid within 10 days, which, in effect, merely means that the discount is earned by paying in cash 20 days prior to the end of the 30 day net period. Thus it is, that by sacrificing the use of 98c. for 20 days the purchaser is able to earn 2c. Since every year contains approximately 18 periods of 20 days, then 2% earned in 20 days is at a rate of 36% per year. From this must be deducted, of course, the loss of interest on the 98c. at current rates for each period. However, it is apparent that even when making this allowance the net earnings of cash discounts will average about 30% per year. It is evident, therefore, that discounts taken beyond the agreed-upon terms will yield the buyer even larger returns. This fact is one of several that have influenced many business men to disregard the dictates of their conscience in the question of terms.

In the early days of radio, terms of 2% 10 days, 30 days net were as near standard as anything could be at that time. In fact, many firms of known financial soundness gladly paid cash for merchandise during seasons in which the demand exceeded the supply many-fold. However, conditions soon changed. As the industry trended towards more normal channels, profit margins became less and less, and more pressure was placed on Sales Departments. By a combination of over-ambitious salesmen anxious to accept orders regardless of terms, and weak-kneed credit men, the 2% 10th prox practice gradually gained ground. Now it is common for buyers to claim that their bookkeeping costs are disproportionately high because of the detail work involved in taking cash discounts on a 10 day basis.

Hardly a day goes by but that manufacturers receive letters reading something like this:

Gentlemen:

"Practically all of our suppliers have given us the privilege of discounting our bills on the 10th prox. We request similar terms from you in view of the fact that this plan will reduce the number of remittances to a minimum and will greatly facilitate our bookkeeping work and permit us to give better all-around service. We feel sure that you will be glad to co-operate

*Vice President—All-American Radio Corporation.

with us in granting these terms which 90% of our other suppliers have already given."

Yours very truly,

In the same day's mail Mr. Manufacturer frequently finds checks from houses capitalized at millions of dollars, these bills being paid within the 10 day period of his terms. In general, the greatest pressure for EOM (end of month) terms comes from the smaller and weaker organizations. Fortunately for the industry, there is a keen realization among many of the larger radio manufacturers and jobbers that the tendency towards loose and flexible terms is dangerous and must be stopped soon if unsatisfactory conditions are to be avoided. Manufacturers particularly, are, or should be, vitally interested in this question because the average manufacturer cannot pass the burden of longer terms on to his suppliers. He buys from steel and wire mills and similar sources where very strict terms are customary. He must pay his bills either on a net basis or with only a 1%, or possibly ½ of 1%, cash discount which must be taken within five, or at the most, 10 days.

A Vicious Cycle

The experience of other industries has pointed out many of the dangers that lie in the path of allowing unearned cash discounts. As usual human nature plays its important part. The man who succeeds in his effort to obtain 2% 10th prox terms from a 10 day supplier, will sooner or later demand 2% on the 25th proximo, and likely as not, he will continue the process by deducting cash discounts from trade acceptances (obviously an absurd procedure: T. A.'s are far from being *cash!*), returning slow-moving goods without proper authorization (frequently transportation collect!), and taking allowances for freight that were not provided for nor contemplated in the original selling agreement. It is a vicious cycle without end.—unless suppliers stick to their published terms.

It is the very distinct danger that a minority of manufacturers and jobbers may force on the radio industry unwanted and unsound terms that prompts this article. There need be no pressure for *uniform* terms, that would probably not only be unnecessary but illegal—but there must be a definite stand taken by all forward-looking business men to discourage, on the one hand, the practice of changing terms to suit the wiles of customers, and on the other hand, the taking of discounts not honestly earned. Would you permit your cashier to deliberately short-change your customers?

Matching the Rectifier Tube With the Power Unit*

Life of tube is shortened by excessive working voltage and incorrectly designed power equipment

IT is doubtful whether the average person fully appreciates the delicate balance existing between rectifier tube and power unit for satisfactory operation. Especially is this true with gaseous rectifiers. Excessive hum, distortion, premature wear of rectifier tube or power unit, and even the breakdown of one or more of the components, are generally traced to lack of proper engineering in the first place, or to the use of rectifier tube and power unit which were never intended for use together.

The gaseous rectifier is designed for a given working voltage, supplied by the split secondary of the transformer. Excessive voltage will shorten the life of the tube, while insufficient voltage will fail to operate the tube at its proper capacity. The tube itself has a certain voltage drop, which controls the voltage delivered by the radio power unit. This voltage drop can be reduced by the tube manufacturer if desired, but while such procedure will result in a higher voltage output from the power unit, it will place an extra strain on the filter system, resulting in at least an increased hum, which may or may not be directly audible but which nevertheless has an influence on the quality of the set, or at worst a breakdown of the filter condensers now subjected to excessive wear and tear. It is well to note that the filter condensers in the average commercial radio power unit are designed for a given service, with little allowance for severe overload. Furthermore, condenser specialists have found out through extensive laboratory and life tests that an overload of 10 per cent. on the usual paper condenser reduces the life by at least 50 per cent., with an accelerated reduction of life beyond that point in geometrical progression.

Gaseous rectifier tubes must be designed for specific transformer, choke coils, filter condensers and resistance networks. There is nothing interchangeable about the arrangement. Satisfactory results—clean-cut filtering with an absolute minimum of hum, together with long and economical life—can be obtained only by engineering the rectifier and the associated components as one job. The commercial success of the gaseous rectifier tube, now found in the vast majority of radio "B"-eliminators, is due to the fact that the promotors of this type fully appreciated the delicate balance involved, and approved of the use of their tube only with radio power units that met certain rigid specifications. Only in this manner, then, has it been possible to insure the desired results.

If higher voltages for the radio receiver and power amplifier are desired, the safe and sane solution is to replace the existing radio power unit with one of higher power. The expedient of replacing the usual rectifier tube with one of higher voltage output is bound to cause dissatisfaction and even to jeopardize the filter condensers, leading to costly repairs. Replacements of rectifier tubes should be of the same type as the original tubes, in order to maintain the original engineering that entered into the production of a satisfactory radio power unit.

* *Technical Service Dept., Raytheon Manufacturing Company.*

A Substitute for the Voltage Regulator Tube*

THE necessity of some form of line voltage control is now fully appreciated in radio power units. Especially is this need apparent with the better types of radio receivers, in which the various tubes may be carefully adjusted and biased for certain plate voltages which are in turn dependent on a definite line voltage. The voltage regulator or glow tube, with its automatic regulation of voltage within narrow limits, presents one solution. This device is being applied to factory-built, home-made, and existing radio power units for controlling the plate voltages of the receiver and first amplifier tube, but not the higher voltage for the power tube.

A simpler solution, and one which is rapidly gaining in popularity, is the use of a suitable variable resistance inserted in the primary or input circuit of the transformer, as a means of compensating for line voltage increase or decrease. Indeed, this method, while it is not automatic as in the case of the glow tube, has a decided advantage in that, by controlling the input or line voltage, it also adjusts the various voltage taps including the power amplifier to the desired degree, in a single operation.

A heavy-duty variable high resistance with a 25-watt rating and a resistance range of from 25 to 500 ohms, is required for this service. In the case of "A-B-C" radio power units, requiring a still greater input, larger variable resistors are available.

The adjustment of the line voltage may be determined by a high resistance voltmeter across any voltage tap, or by loud-speaker results.

* *Technical Dept., American Mechanical Labs.*

Report of the First R. M. A.

THE opening of the first R.M.A. Convention and Trade Show in Chicago on June 13th heralded the coming of a new era in radio merchandising. The show itself has been of obvious benefit to the entire industry. There was a great deal of anxiety shown by many during the early part of the show due to the fact that a number of manufacturers were holding back exhibition of their fall models. It was felt by many that the reluctance of these manufacturers to exhibit their new products would defeat one purpose of the trade show and retard all of the plans made for the coming season. It is obvious now that those manufacturers who failed to attend the trade show and exhibit their products are due for much disappointment in sales figures during the coming year, particularly when it is considered that there was an attendance of 14,800 dealers and jobbers at the show during the week and that these dealers and jobbers not only represented every state in the Union but Cuba, Australia and other foreign territory as well. These men have had the opportunity of reviewing all of the new products and have gained a definite idea as to the trend of development and a very clear conception of the present patent situation. The result will be that they will line up stock at a much earlier date and possibly assist in starting the radio season much earlier than usual.

The Trend of Developments

There were no revolutionary ideas evident in the design or circuits of any of the receivers or accessories exhibited at the show but the advancement in production methods and mechanical construction are sufficient to allow one to state that great improvements have been made since last season. Practically all of the receivers exhibited had strong metal framework with all of the electrical parts shielded. In fact, knowing the grief brought about by weak mechanical construction in the past, manufacturers have put a great deal of thought into the sturdiness of their sets. Some manufacturers are now employing the telephone switchboard type wiring, oversize bearings for all moving parts and metal framework considerably thicker than they have been in the past.

It is refreshing to note the excellence of mechanical design and the absence of cheap materials. More moulded parts are employed in the construction and without a doubt many, if not all, of the receivers could be thrown out of a second story window without doing them much damage. Most dealers and jobbers have learned by experience that sturdiness is a very important factor and certainly they are going to run into less grief through breakage of sets and parts.

Electrified Receivers

Most of the set manufacturers exhibited both electrified and battery operated receivers. Considering the fact that some smaller time has been spent upon the design and development of electrified sets, dealers and jobbers will do well to continue pushing battery operated sets as well as the newer electrified units. Needless to say, many of the receivers are laboratory developments and have been completed within a short time and it is difficult to know just how these sets will operate in the hands of the consumer. The new A. C. tubes are a very recent development and in this case, as well, it is difficult to determine what the reaction will be on the tubes as well as the sets employing them. The fact that these receivers have operated surprisingly well in the laboratories is merely an indication that there is a good chance of them going over. However, past experience has shown that many laboratory receivers and sets incorporating unseasoned developments quite often fall flat once they reach the open market.

Rectifier Tubes

Regarding electrified receivers, it will be noted that many new rectifier tubes, capable of passing anywhere from 100 to 350 milli-amperes, have been placed on the market by numerous manufacturers. Some of these tubes, with a low output, are marketed to fill what, to many, still seems to be an unrealized demand. Difficulty has been experienced in many socket operated receivers due to the fact that they were worked too close to the output of the rectifier tube. A redesign of the receivers has been made and rectifier tubes with an output in the vicinity of 100 milli-amperes are utilized in place of the former tubes having an output of 65 milli-amperes. In competition

PRESIDENT, R. M. A.

C. C. Colby

TREASURER

D. MacGregor

1st VICE-PRESIDENT

T. K. Webster, Jr.

Convention and Trade Show

with the "A—B—C" eliminators, employing higher output rectifier tubes and the new A. C. tubes, are numerous "A" power units being marketed by a score of manufacturers. These, no doubt, will be popular for some time to come as they have already reached the hands of the consumers and in most cases proven satisfactory. Besides, a great deal of developmental work has been done on them during the year so that they are actually superior to the ones first introduced.

Better Parts

We find other parts manufacturers supplying really good filter chokes with correct impedence ratings. Up until the present time there have been very few satisfactory filter chokes manufactured although it is hard to state the reason. There are also numerous manufacturers who have placed power resisters on the market and are selling directly to manufacturers and consumers. Most of the resisters are of the wire wound type although there are a few employing special resistive materials and in the variable class, a few of the carbon compression type. Those exhibited at the show appear to be exactly what has been needed for some time and according to the ratings claimed by the manufacturers will help to prevent many "B" eliminators, "C" eliminators and "A—B—C" eliminators from going wrong in the consumer's hands.

All of these small items go hand in hand in making up the various power units manufactured and most of the merchandising men who attended the show have had it impressed upon them that socket power devices are much closer to being fool proof than former models.

2nd VICE-PRESIDENT

V. W. Collamore

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L. S. Baker

EXECUTIVE SECRETARY

M. F. Flannagan

Loud Speakers

We find no great progress made in the design of loud speakers although many of the same types sound better this year than they did last due principally to the improvements made in audio frequency amplifiers and power amplifiers. Some of the new exponential horn speakers and curved horn speakers are very interesting in their design and give very faithful reproduction.

General Survey

According to a survey made by the *Trade Show and Convention Daily* of the total number of exhibitors at the convention, 40% were displaying table type receivers and 37.8% consoles. A further examination of the consoles showed that 12.6% have built-in cone speakers and 61.5% are equipped with a long air column horn.

It is interesting to note that 70.5% showed cone speakers while 21.8% have horn or air column speakers.

"A" power units which have an electrolyte of some sort lead those which are totally dry by 68.5% to 14.1%.

With the "B" units the situation is reversed with 58.1% of these using the gaseous content, filamentless tubes and 20% being electrolytic.

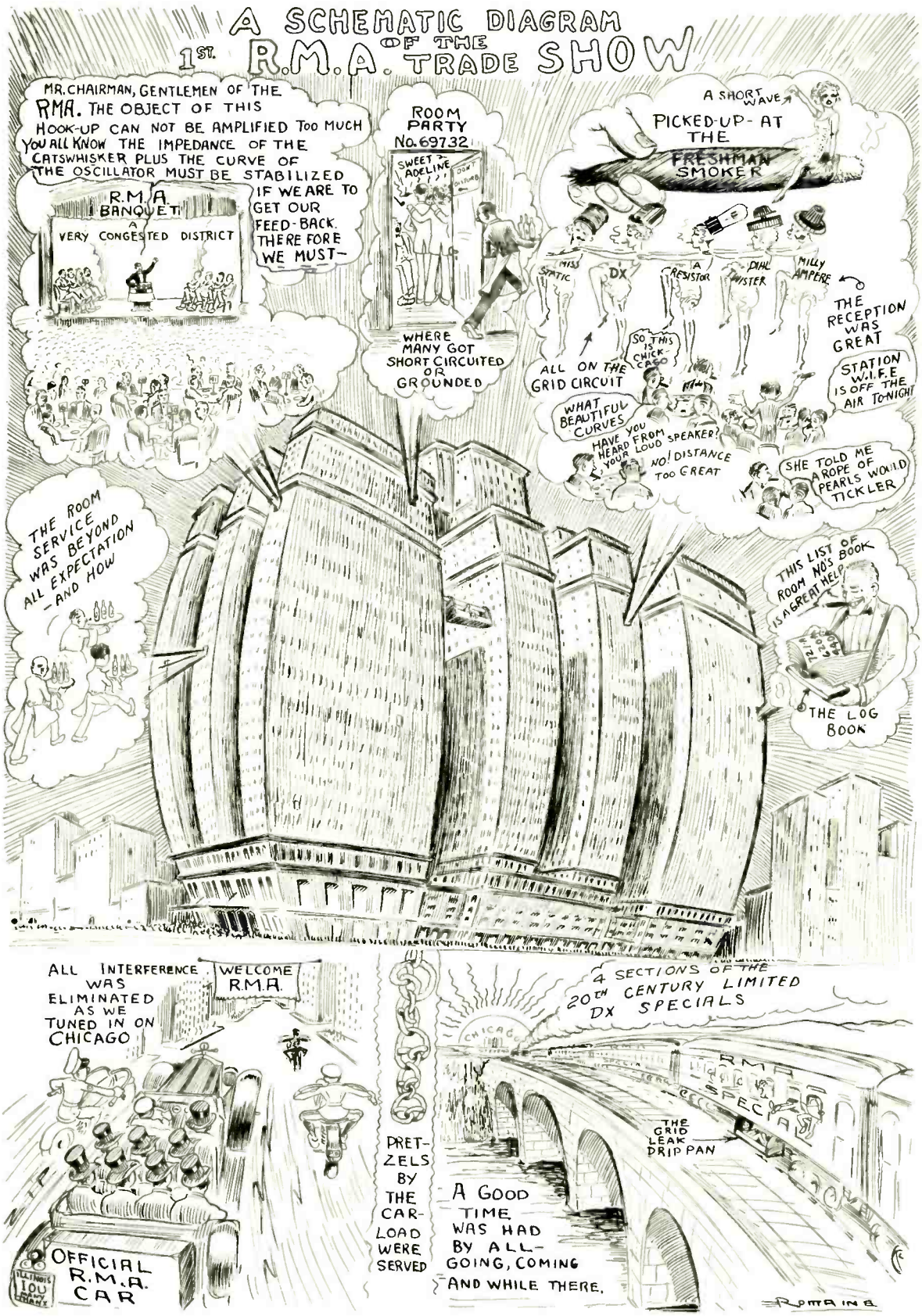
Batteries fall below the socket power units as only 21.8% exhibited storage batteries and 34.2% dry batteries. The dry batteries are, of course, mostly of the "B" and "C" type while the storage are 6-volt "A" batteries.

It is also interesting to note that 10.9% displayed tubes and 21.8% furniture.

The parts manufacturers made a good showing with a figure of 41.3%.

3rd VICE-PRESIDENT

J. B. Hawley



Eliminating the Loop Characteristic in the Power Tube of A. F. Amplifiers

Interesting facts regarding constant resistance structures for output circuits and "matching phase angles"

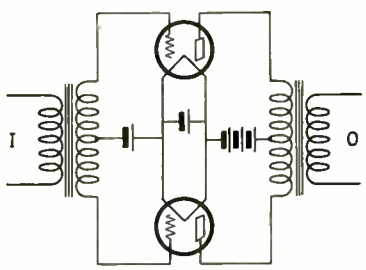
*By E. E. Hiler**

This, the fourth article of a series by Mr. Hiler, contains some comparatively new facts regarding audio frequency amplification.

Mr. Hiler has been working on arrangements for eliminating distortion, due to looped characteristics, in the output of audio amplifiers. He covers, among other things, a special constant resistance structure, which actually contains inductance and capacity, designed for this purpose.—EDITOR.

THAT a vacuum tube itself may cause harmonic distortion regardless of the type of apparatus used in connection with it is an interesting fact. In the June issue we referred to harmonic distortion caused by the looped characteristic. This article will deal particularly with the causes and cure for this kind of distortion in connection with the last tube of an audio amplifier.

It is a well known fact that the amplification factor or "Mu" of a tube changes with the value of the "B" battery voltage impressed across the plate and filament of the tube. In Fig. 1 is shown the plate circuit of a tube illustrating the distribution of the voltage changes (e_o) and (e_p) due to signals being impressed upon the grid of the tube. The result of the changes (e_p) is illustrated by the curve of Fig. 2 showing a typical "looped characteristic"† It is easy to show that as the impedance (Z_o) is increased and (r_p) remaining constant that a smaller and smaller portion of the total voltage change ($e_o + e_p$) is effective across (r_p), i.e. (e_p). Consequently the amplification factor is not affected by these voltage changes as much as when (Z_o) is small. Also if the original "B" supply voltage is large in comparison with the A. C. voltage changes or signals, then the amplification is not affected by the voltage changes as much as when the ratio is smaller. Both of these factors, the "B" supply and the external impedance, affect the loop characteristic. We may safely say, therefore, that with high "B" voltage and a low volume of signal the loop degenerates into the straight line EOF of Figure 2 and also that as Z_o is increased the loop gets narrower and narrower approaching EOF as a limit.



- PUSH - PULL AMPLIFIER -

Fig. 3. Standard form of push-pull circuit

Impedance variation in loud speakers

Since the impedance of loud speakers varies with frequency and gets smaller and smaller as the frequency of the music gets lower, it is clear that the loop characteristic is mostly evident at the low frequencies producing raspy unmusical tones of the base notes especially if they are of generous amplitude. In the previous article we showed how this difficulty was overcome in the interstage coupling devices of the tuned double impedance type by making the impedance between tubes three times that of the previous tube at the lowest frequency to be encountered. But the last tube of the amplifier works into a loud speaker where the power available in same is the important factor instead of the voltage available in same and, therefore, the problem presents a different aspect and is not so easy to solve.

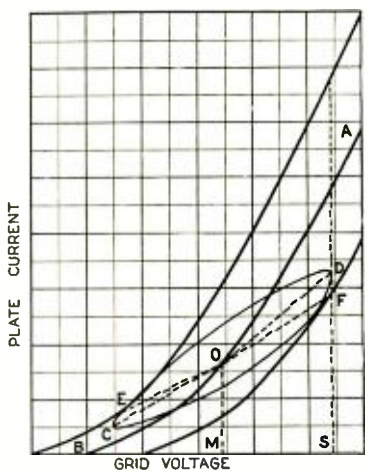


Fig. 2. Loop characteristic curve of vacuum tube

Non-reactive and push-pull circuits

In the push-pull amplifier of Fig. 3 the voltage change on one tube is opposite to that on the other and the consequent distortion of one tube is balanced out by the other in the output transformer. Also in the non-reactive circuit of Fig. 4 the phases of succeeding tubes are 180° apart and the loop characteristic distortion of one tube is balanced out by the loop characteristic distortion of the next tube. However it is necessary to have an even number of tubes and to have the amount of distortion in each pair of tubes the same by adjusting the voltages and impedances to offset the difference in amplitude in signals from one tube to the next. Even with this type the output circuit of the last tube must be non-reactive in order to perfectly balance out the distortion of the next to the last tube.

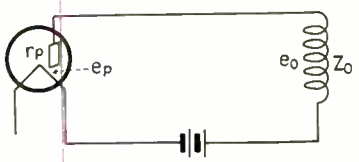


Fig. 1. Representative output circuit

Matching of phase angles

Referring again to Fig. 1, let us assume that the impedance Z_o represents the impedance of a loud speaker at a certain frequency. Then the relative power developed in the loud speaker by the signal can be shown as in curve of Fig. 5 to be dependent on the relation between r_p and Z_o. For any one phase angle of Z_o it was shown in the June article the maximum power obtainable is when the external impedance equals the internal impedance. This is the so-called matching of impedance. We will now demonstrate the fact that "matching of phase angles" has an even greater affect on the power developed than the "matching of impedances" although for absolute efficiency both should be matched. This important principle is stated very clearly in *"Transmission Circuits for Telephone Communication" by K. S. Johnson, page* 16 "the maximum amount of power which it is possible for a receiving device to absorb from a source having an electromotive force E. and an effective resistance R_s is the square of the electromotive force (E) divided by 4 times the effective resistance ($4R_s$) and is obtained when the impedance of the source and the receiver are conju-

* *Hiler Audio Corporation.*

† *See "Thermionic Vacuum Tube," Van der Bijl, page* 175.

gates." A concrete example of this to illustrate is:—

Impedance of source, 10 ohms resistance and 20 ohms capacitative reactance or (10 — j 20) and impedance of receiver to match 10 ohms resistance and 20 ohms inductive reactance or (10 + j 20). In this example both the impedance and phase angles are "matched."

When working out of a vacuum tube the impedance of the source has no reactance at audio frequencies so that its impedance can be expressed as $r_o + j\,o$ and the conjugate would be $r_o - j\,o$ where $r_p = r_o$.

On page 186 of *"Thermionic Vacuum Tube" by Van der Bijl* the formula for the power "P" in an external impedance "Z_o" is

$$P = u^2 e^2_g \frac{Z_o \cos \Phi}{(r_p + Z_o)^2} \qquad (1)$$

cos Φ in this, is the power factor and is dependent on the relation between r_o and x_o of impedance Z_o. Where r_o is the effective resistance and x, the is the effective resistance and x_o the Z_o.

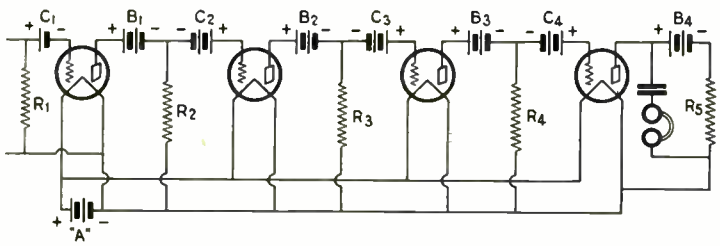


Fig. 4. Non-reactive amplifier circuit which overcomes the "loop characteristic." Note that a positive "C" voltage is employed on the grid of each tube

The condition for maxium power in Z_o is therefore satisfied if $/Z_o/$ (absolute value) is equal to r_p and the phase angle equals 0° 0' with consequent power factor of 100% or cos Φ equals unity.

$$P_1 = u^2 e^2_g \frac{r_p \times 100\%}{(r_p + r_p)^2}$$

$$= \frac{u^2 e^2_g}{4\ r_p} \times 100\%$$

Now, if the phase angle had not been "matched," for instance (a common angle, 45°) the power would be

$$P_2 = u^2 e^2_g \frac{r_p \times 70.7\%}{(r_p + r_p)^2}$$

$$= \frac{u^2 e^2_g}{4\ r_p} \times 70.7\%$$

Again if the phase angle were matched but to eliminate loop characteristic the impedance Z_o were made equal to 3 r_p instead of equal to r_p

$$P_3 = u^2 e^2_g \frac{3\ r_p \times 100\%}{(r_p + 3\ r_p)^2}$$

$$= \frac{3\ u^2 e^2_g}{16\ r_p} \times 100\% \text{ or } \frac{u^2 e^2_g}{4\ r_p} \times \frac{3}{4} \times 100\%$$

Eliminating the constant

$$\frac{u^2 e^2_g}{4\ r_p}$$ from P_1 P_2 and P_3

we have $P_1 = 100\%$

$P_2 = 70.7\%$

and $P_3 = 75.\%$

Hence P_3 is more efficient than P_2 and the difference between them is that in P_2 the impedance was matched but the phase angle was 45° and in P_3 the impedance was not matched but the phase angle was matched at 0°.

Therefore we can eliminate the loop characteristic in the last stage by simply keeping the impedance high and matching the phase angle to offset the loss in power due to not matching the impedance.

Constant resistance structures

This leads us up to a discussion of constant resistance structures. A simple form is given in Fig. 6 and you might well ask how can this circuit maintain a constant impedance (Z) of zero phase angle at all frequencies since it contains not only inductance but capacity and both of these vary with frequency.

For instance if we let 2 π f = W, the impedance of the capacitative arm will be $R_1 - j\frac{1}{wc}$ and that of the inductive arm will be $R_1 + jwL$. Both of these impedances vary with frequency but can be made to vary in such a manner that the impedance of the parallel combination will be the same for all frequencies. The proof of the fact that this condition will be met providing

$$R_1 = R_2 = \sqrt{\frac{L}{C}} \qquad (2)$$

is as follows—

$$Z = \frac{(R_2 - j\frac{1}{wc})\ (R_1 + j\,w\,L)}{(R_2 - j\frac{1}{wc}) + (R_1 + j\,w\,L)}$$

By performing the multiplication indicated in the numerator and the addition in the denominator and then multiplying both numerator and denominator by the conjugate of the denominator

$$[(R_1 + R_2) - j\,(wL - \frac{1}{wc})]$$

we get

$$Z = \frac{(R_1 + R_2)\ (R_2 Lw - \frac{R_1}{cw}) - (R_1 R_2 + \frac{L}{C})\ (Lw - \frac{1}{cw})}{(R_1 + R_2)^2 + (Lw - \frac{1}{cw})^2}$$

$$j\ \frac{(R + R_2)\ (R_1 Lw - \frac{R_1}{cw}) - (R_1 R_2 - \frac{L}{C})\ (Lw - \frac{1}{cw})}{(R_1 + R_2)^2 + (Lw - \frac{1}{cw})^2} \qquad (3)$$

The second fraction of the equation for Z is the reactance component of Z as indicated by the fact that it is preceded by the quadrantal operator (j) = $\sqrt{-1}$. Therefore if we make this component equal to zero the reactance component will be neutralized and we will have left only the resistance component. In order to do this it is only

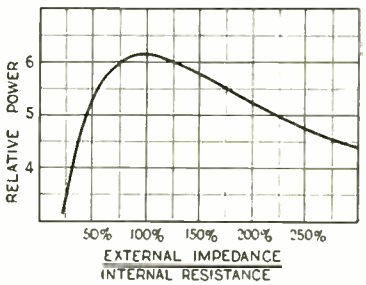


Fig. 5. Relative power curve, showing change with variation of impedance

necessary to equate the numerator of the reactance component to zero and after simplification we get

$$Lw\left(R_2^2 - \frac{L}{C}\right) + \frac{1}{cw}\left(\frac{L}{C} - R_1^2\right) = 0$$

Consequently, if $R_2^2 = \frac{L}{C}$ and $\frac{L}{C} = R_1^2$ the above expression will reduce to zero.

It is therefore evident that the condition necessary is for

$$R_1 = R_2 = \sqrt{\frac{L}{C}}$$

If these values are substituted in the formula for Z (see (3)) then Z reduces to simply $Z = R_1$ and is independent of frequency.

Fig. 7 shows how this principle is applied to a loudspeaker circuit, the inductance of the loudspeaker being L, the effective resistance of the loud-

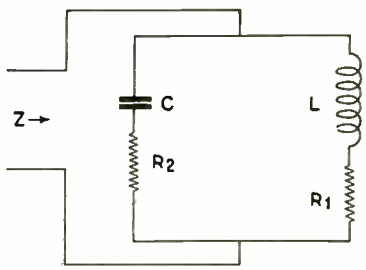
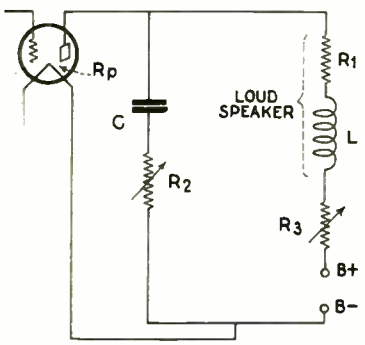


Fig. 6. Simple form of constant resistance structure

speaker being R_1 and R_2 is an additional resistance in series with the loudspeaker to make $R_1 + R_2$ equal to R_3.

Practical Application

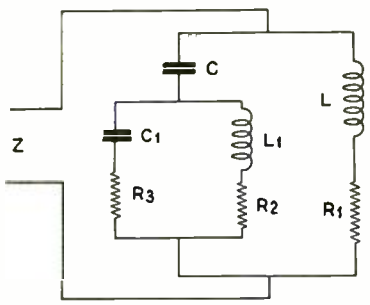
In Fig. 8 we have a constant resistance structure within a constant resistance structure, necessitated by the fact that an output choke and condenser is usually used to keep the D. C. out of the windings of the speaker. The principle is the same however, except that we have two additional factors to balance. The application of this to a typical circuit is shown in Figs. 9 and 10. It is unnecessary to



$$3\,Rp = R_1 + R_3 = R_2 = \sqrt{\frac{L}{C}}$$

Fig. 7. Simple form of resistance structure applied to loud speaker

add any resistance in series with the output choke since the amount of iron used usually gives us sufficient effective resistance, due to hysteresis and eddy current effects, to balance. The values shown will give good results but it is a good plan to be able to vary the capacity of the .04 mfd. condenser from .01 to .08 mfd. and the resistances, shown as variable, from 5,000 to 25,000 ohms. Always, keep the resistance in series with the loudspeaker at a smaller value than the resistance in series with the condenser in order to balance out the iron losses of the



$$Z = R_1 = R_2 = R_3 = \sqrt{\frac{L}{C}} = \sqrt{\frac{L_1}{C_1}}$$

Fig. 8. "Wheels within wheels" type of constant resistance structure

loudspeaker. The output condenser can be as low as 1/10 of a mfd. depending on the output choke used and the value of the impedance of the entire circuit desired.

Adjustment

In testing for best results listen for low frequency notes and with a switching arrangement throw in or out the entire structure. You will notice that the raspiness of loud, low tones will disappear when the circuit is balanced and its impedance is 3 or 4 times that of the tube used. In setting up a switching arrangement a double-pole, double-throw switch can be used so

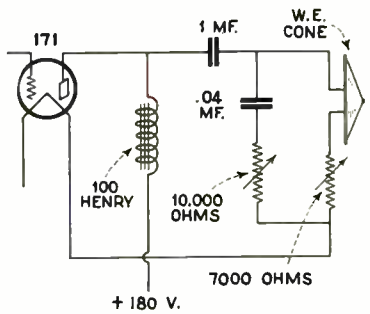
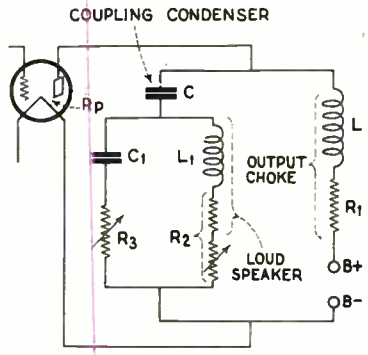


Fig. 10. Schematic diagram of "wheels within wheels" type

that in one position the 7,000 ohm resistance will be shorted and the 10,000 ohm resistance open and in the other position the 10,000 ohm resistance will be connected and the 7,000 ohm resistance no longer shorted. By this means a quick comparison can be obtained and we believe you will be pleased with the results. One case when this principle is of particular advantage is that of a tuned double impedance amplifier so set up as to give a rising characteristic to the low frequencies with the idea of making a small cone or small horn sound like a larger one. In this case the low tones are of generous amplitude and with low impedance loud speakers considerable distortion of extra loud, low notes results, making a milli-ammeter in the last tube jump too vigorously. However, with the output circuit properly adjusted, as outlined above, the needle steadies itself and the distortion disappears with the result that the low tones are round and full. No affect on the high frequencies is apparent with the arrangement working correctly. But if the condenser shown in Fig. 10 is connected directly across the loud speaker without properly balancing the circuit, then you will find that the high frequencies are reduced slightly.



$$3\,Rp = R_1 = R_2 = R_3 = \sqrt{\frac{L}{C}} = \sqrt{\frac{L_1}{C_1}}$$

Fig. 9. "Wheels within wheels" type of structure applied to loud speaker, output choke and condenser

Cross Licensing of Patents Forecast in Electrical Industry

THE resolution adopted by the Policies Division of the National Electrical Manufacturers Association, covering the investigation of cross licensing of patents will be of interest to manufacturers of electrical goods making radio apparatus and supply equipment. The resolution follows:

"WHEREAS, the electrical industry is under heavy annual expense due to patent litigation and

WHEREAS, the result of this condition is uncertainty and lack of confidence in the minds of the purchasing public as well as unfavorable feeling between the different organizations in the industry and

WHEREAS, the National Automobile Chamber of Commerce has demonstrated the practicability of a system of cross licensing patents which has been effective for a number of years in the automotive industry and has resulted in strengthening the confidence and development in that industry, therefore

Be it Resolved, that the Policies Division of the National Electrical Manufacturers Association, in regular meeting assembled, requests its President to have such a committee or individuals, as he may consider expedient, investigate the situation regarding patents in the electrical industry with a view to determining whether some modification of the plan utilized by the National Automobile Chamber of Commerce may be made applicable to electrical manufacturing industry and

Be it Further Resolved, that the findings of such a committee or individuals be presented to this Division for further action.

The Radio Service Problem

Dealing with the shop layout and testing equipment

By J. Ray Blaich

Part II

THIS article will deal with some of the apparatus that was mentioned in last month's article together with suggestions for layouts and wiring diagrams. But, first of all let us consider the shop.

Most certainly the shop must be well ventilated and well lighted. Bad air and eye-strain will most certainly detract from the efficiency of the service department and since we are out to make a go of this thing let us get the ground work right by having good air and the right light. Just a word about the light. The writer is informed that a light directly over the operator's head, or slightly to the rear, is the ideal situation. The reason advanced for this placement of the light is that it will allow sufficient light on the work and at the same time will not shine into the eyes of the operator. Actual test has proven that if the light, covered with a suitable shade to keep the light rays from striking the wall ahead of the bench from where they would reflect, is placed about two feet above and just slightly behind the operator it is least tiring. So much for the light. Kindly remember that the foregoing and the following are merely suggestions and individual cases may be adjusted to best suit the needs of the operator.

The Test Bench

The bench seems to be a sadly neglected part of the service department, therefore, bear with me a moment until we consider this part of our equipment. First of all, the top should be made of closely matched hard wood boards. Hard wood is specified because it wears well. It is no fun to work on a bench that is subject to severe "slivering." The boards should be closely matched to avoid small parts such as tiny screws, lock washers and the like from falling through onto the floor. We can't make money looking for lost parts nor can we charge this time to the customer. The height of the bench will depend on the size of the operator. The important fact to remember is that it is easier to work in an upright position than bent over the work. A bad posture persisted in will grow on you. Between thirty-six and forty inches high seems to be about right.

Now here's a new one. I am going to suggest that the bench be made in the shape of a right angle. This, of course, does not mean that you must go to a lot of trouble constructing such a bench. Here's the idea. Suppose that you are working on a set on a regular straight bench, where are you in the habit of putting the various tools that are necessary for the job? Chances are that you either pull them out of a drawer under the bench or from a near-by box and drop them on the bench somewhere, convenient or otherwise, just as soon as the immediate use for any particular tool is over. Consequently, most of the time your bench will be a mess of tools and wire. It means also that you will waste a lot of time looking for the screwdriver that you had just a moment ago but now seems to have disappeared entirely. Why not put a little extension on the bench to the right, if you are right handed and to the left if left handed. On this extension build a convenient tool rack for the tools used most. This will keep the tools in sight at all times. Of course, when you finish with a tool it will be necessary to replace it in the notch or slot in the tool rack made especially for that particular tool. This all sounds very difficult on paper but when put into practice the tools seem to come half way to meet you when needed.

Outlets

Another suggestion for the bench is the placing of the current outlets. There should be two of them placed under the front edge of the bench and preferably to the right of the operator. Each one should have a pilot light. The pilot light will save you an argument with the Underwriters. A fuse block located somewhere under the bench will save steps and time in case of a short circuit. Two outlets have been specified, one for the soldering iron and one for testing "B" battery eliminators and miscellaneous work requiring current from the city service. It has been found real convenient to have a resistance of about twenty ohms and capable of carrying approximately one hundred watts without overheating, connected by means of a single pole double throw switch in one side of the soldering iron cord. The switch makes it possible to cut in the resistance or short it at will. Use of the resistance will prevent the iron overheating and still it will be hot enough for the work. Of course, if you have a long steady soldering job the resistance is not used.

Tools Required

While we are on the subject of tools let us consider some of the more essential ones used by the service man. A good kit to begin with is:

SCREWDRIVERS

1—Jeweler's (for meter work).
1—$\frac{1}{8}$ inch blade, 6 inches long.
1—$\frac{1}{8}$ inch blade, 3 inches long.
1—$\frac{1}{4}$ inch blade, 6 inches long.
1—$\frac{1}{4}$ inch blade, 3 inches long.
1—$\frac{1}{8}$ inch blade, offset (length optional).
1—$\frac{1}{4}$ inch blade, offset (length optional).

PLIERS

1—long nose, 5 or 6 inches long over all.
1—round nose, 5 or 6 inches long over all.
1—square jawed, 5 or 6 inches long over all.
1—square jawed, 8 or 10 inches long over all.
1—diagonal cutters, 5 or 6 inches long over all.
1—end cutters (for cutting small screws and heavy wire).

WRENCHES

1—set socket wrenches (straight handle preferable).
1—set open end wrenches, sizes 3/16 to $\frac{3}{4}$ or 1 inch.
1—bicycle (monkey) wrench capable of opening 1 inch or more.

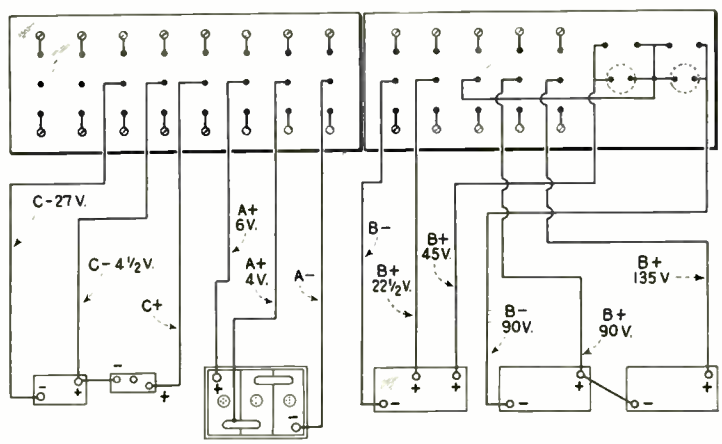


Fig. 2. Rear wiring of the power panels

1—6 or 8 inch Stilson wrench.

EMERY WHEEL
Any good cutting material will do, it need not be emery.

KNIFE
A husky one with a notch filed in the back of the blade for skinning wire.

SOLDERING IRON
A light or medium weight tip will suffice.

DRILLS
High speed, sizes 1/16 to 1/2 inch. A handle with suitable chucks go with this outfit.

HACK SAW
For sawing metal.

A keyhole saw and a carpenter's brace with several size wood bits come in handy at times and may be added, if desired, but are not absolutely necessary except in the event of the installation of a power plant operated from the lighting current where ventilation must be provided in the cabinet. The individual operator may augment this list with various additions as the need arises.

Testing Equipment

Now let us turn our attention to some of the apparatus used for testing. First of all we must have a source of power for the radio set under test. Referring to Fig. 1 you will find a suggested layout for a power panel. The apparatus used by the writer is two 7 by 18 inch insulation panels, held in an upright position with angle irons and wooden supports. Passing across the panel at the center are several single pole double throw switches. Along the bottom is a row of binding posts for making connection to the panel by means of the cable with which many present day sets are equipped. The top row of connections are phone tip jacks and are used with sets that do not have a cable but binding posts instead. To connect such a set to the panel, connecting wires must be supplied. A piece of flexible wire of suitable length with a phone tip at one end and a universal test clip at the other end makes a convenient connecting wire. At the extreme right of the panel you will notice two lamps. These are 40 watt, 110 volt lamps used as protective resistances in case of a short circuit in the set under test. They spell real life insurance for the radio tubes—there is no use of heating a set of "B" batteries or burning out a set of tubes because of a short in the set. A single pole single throw switch has been provided for each of the lamps to act as a short across the lamp, if needed. Two lamps have been used for several reasons, one of which is: 180 volts or even 135 volts of "B" battery might burn out a single lamp. The other reasons will be explained a little later. Fig. 2 shows the wiring of the power panel and is self explanatory. The writer would like to emphasize one "don't" and that is: don't use a "B" eliminator as a source of "B" power for your power panel. The ideal source of power is an "A" battery of at least 100 ampere hours capacity, a storage "B" battery and two dry-cell "C" batteries. In the event that you do not wish to consider the storage "B" battery use the "heavy duty" type of dry-cell "B" battery. In Fig. 2 the charger is not shown but should be included. If further protection for the batteries is desired a three to five ampere fuse may be inserted in series with the negative "A" lead. A neat installation can be made by constructing a bench about a foot from the floor for the batteries and charger. This will keep them off the floor and out of the way when you clean up. Wires run from the batteries through the work bench to the back of the power panel in the form of a cable will add to the appearance of the finished installation.

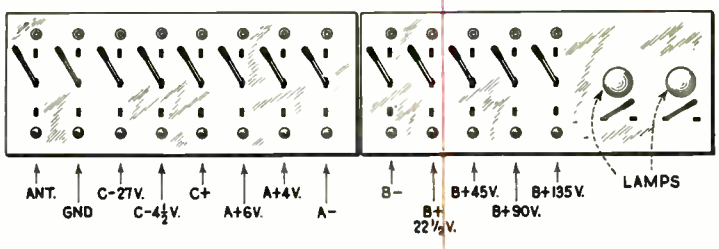


Fig. 1. Layout details of the power panels

The Test Box

Fig. 3 shows the hookup of a piece of apparatus that will prove of unestimatable value to the service man. This instrument will pay for itself in time saved in short order. With it the "A," "B" and "C" batteries may be tested without disturbing a single connection. It will check the continuity of the radio set without the aid of batteries other than those used to run the set. Tubes may also be tested and the plate current of any tube in the set checked. Referring again to Fig. 3 it will be noted that the instrument comprises the following:

1—Double range voltmeter (high ohms per volt type).

1—D. C. milli-ammeter (same diameter as voltmeter).

1—Tube socket (UX type).

5—DPST switches (midget jack switch type).

1—DPDT switch (midget jack switch type).

1—Plug and cable made from an old UX 199 base, a wooden plug drilled from end to end so that a four wire cable will go through and connect with four prongs of the UX base. The plug may be held in place in the base either with sealing wax or short pins. Be careful not to short the cable with the pins, if used.

The writer will leave the design to the builder and go immediately to the operation of the test box.

Now that we have our power panel and test box we may proceed with the first of our "routine tests." The receiver is connected to the power panel and notice taken of whether or not the lamps on the power panel light. If not, everything is alright so far. If the left hand lamp lights alone there is a short between the "B neg." and "B 45." If the right hand lamp lights the short is between "45" and "90" while if both lamps light dimly "neg" and "90" are shorted. If both lamps light fairly bright the entire "B" battery is shorted. We shall proceed to the continuity test next.

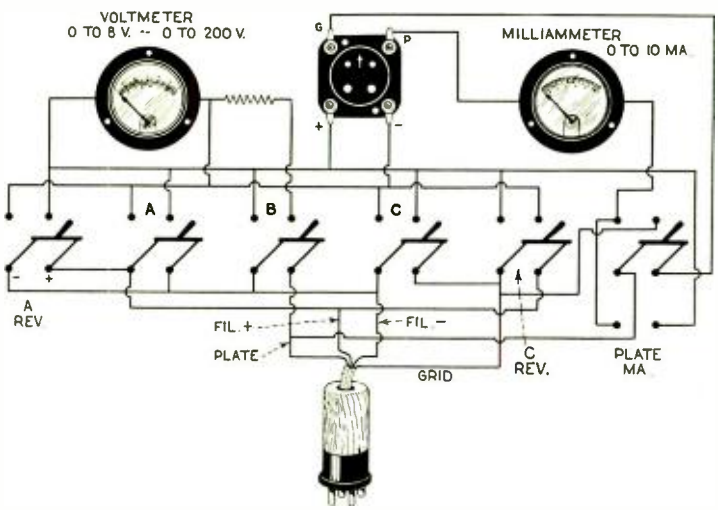


Fig. 3. Schematic diagram of the special test box designed for service work

The test box is pressed into service at this stage. The plug of the test box is inserted into the different tube sockets of the receiver under test and the various switches on the test box are closed one at a time and indicate as follows:

"A"—This switch connects the meter to the filament connections on the socket and gives the "A" voltage on the low scale.

"A-Rev."—Gives the "A" voltage if the socket happens to be reversed. Some receivers have the filament connections reversed at the socket. While this does not affect the operation of the receiver it would cause the test box meter to read backward unless provision was made for it.

"B"—Gives the voltage of the "B" battery at the socket and indicates whether the primary of the transformer and associated wiring is OK.

"C"—Checks the "C" battery voltage at the socket as well as the continuity of the transformer secondary, etc., when the "A" is connected in the standard manner.

"C-Rev."—The same as "C" when the "A" connection is reversed.

"Plate MA" and "A" (Both closed at the same time)—With the plug inserted in a socket of the receiver and a tube placed in the test box socket the milli-ammeter will indicate the current drawn by the tube while the voltmeter will show the filament voltage. By throwing the "Plate MA" switch to the opposite position a change in plate current will take place. This is an indication of the condition of the tube.

To test a receiver using the series filament hookup all the tubes should be used in their respective positions in the receiver. When a tube is removed from the receiver to make room for the test plug this tube should be placed in the test box socket. In this way the tube is still in circuit through the test box and cable and the proper load is maintained which will insure accurate readings on the test box meter, provided the high resistance type of meter is used.

A test box of very similar characteristics may be obtained at present as a commercial product.

In the next article we shall consider a "dummy antenna," a multi-purpose oscillator and more of the "routine test."

Why Paper and Why Mica in Fixed Condensers?

Mica and Paper are equally as important but each find special uses

*By Harry F. Houck**

THE reasons for using mica as the dielectric in certain condensers and paper for others, are governed by many factors passed upon by the engineering as well as the production staff of the condenser manufacturing establishment. What is more, there are certain economic considerations which decide the dielectric that shall be employed. So well are these various factors defined that the mica condenser has a clearly delineated field of uses, while the paper condenser, likewise, has another clearly delineated field of uses.

First of all, mica is admittedly a better dielectric. It has far greater electrical strength than paper, which is to say that for a given mass of material, it will withstand greater voltages without breakdown. At the usual operating voltages in radio reception, a mica condenser should have virtually a perpetual life, while the carefully built paper condenser should have a life of from ten to fifteen years in contrast with the poorly built paper condenser with an indefinite lease of life which may be measured in hours or days or weeks or months.

* *Chief Engineer, Dubilier Condenser Corporation.*

Thickness of Mica the Main Drawback

However, mica cannot be worked as thin as paper, which is the main drawback to the employment of this material in large capacity condensers. Mica cannot be worked to thicknesses less than 2 mils, while paper, on the other hand, can be worked to 0.5 and even 0.4 mils. Hence the mica condenser, with its considerably thicker dielectric, must have larger plates and more of them to equal the capacity of the paper condenser with its much thinner dielectric. The mica condenser will be much bulkier, therefore, for voltage ratings below 1,000, but at 1,000 volts and above, the properly built paper condenser must have six "papers" or layers of paper for the dielectric, which causes the paper condenser to be almost as large as the mica condenser. Above 1,000 volts, obviously, the mica condenser comes into its own more and more as the voltage increases, since the marked plurality of papers necessary in the corresponding paper condenser soon makes the latter impractical.

Comparative Cost

In the matter of cost, the mica condenser is virtually prohibitive for large capacities at 1,000 volts or less. The manufacture of the mica condenser is far costlier than is the case with the corresponding paper condenser. Each piece of mica must be individually tested. Then the assembly calls for the stacking of alternate sheets of mica and tinfoil, one by one. By way of contrast, the paper condenser starts out with paper and tinfoil in rolls, which have been passed upon beforehand. The assembly is purely a matter of winding the inter-larded tinfoil and paper into a compact roll, on automatic machines.

The discrepancy in production cost between mica and paper is reflected in the final price of the respective condensers. Thus taking a 1 mfd., 1000-volt condenser as the basis for comparison, the paper condenser will cost in the neighborhood of $5, while the mica condenser will cost about $25. Translating these figures into terms of radio power unit practice, in which at least 10 mfd. is required for a good "B"-eliminator, it will be noted that the comparison shows $50 for the paper and $250 for the mica.

Specific Fields for Both Types

From the technical standpoint, there is a clean-cut distinction between the proper sphere of the mica condenser and that of the paper condenser. The former, aside from its necessary application to radio transmission, is essential in the radio-frequency end of reception, where radio-frequency energy is being handled. Mica has the necessary permanency of capacity, low phase angle, and ideal power factor. Paper does not make for such precise, highly efficient performance. Hence the growing tendency of late on the part of some to substitute tiny paper condensers for the usual mica condensers in the radio-frequency end of reception is to be deplored. Grave losses in efficiency are bound to result, and variation in capacity is almost certain to alter the critical balance of the radio-frequency circuit. Even on the plea of economy, which can be the only excuse for the use of small paper condensers, the diminutive paper condensers cannot justify themselves for the reason that in the corresponding mica condenser the small quantity of materials together with the relatively simple assembly for the small capacity condenser provides little differential in cost between paper and mica.

In the audio-frequency end, however, where low-frequency currents are handled and where the capacities run very much greater, it is quite another story. Here the paper condenser is altogether justified, while the mica condenser would be economically unsound, as well as entirely unnecessary. The only advantage that could possibly be gained through the use of mica would be virtually indestructible condensers of endless life.

Constructional Developments

The Strobodyne Receiver

THE Strobodyne receiver, described by Lucien Chretien in the August issue of *Radio News* contains a number of new features which places it in a field by itself. The Strobodyne is virtually a Super-heterodyne receiver, at least in that class, but employs an entirely new principal for the frequency changer. This principal is based upon the operation of the Stroboscope which is primarily used for determining the frequency of revolving objects. The Strobodyne, instead of employing the usual oscillator tube which feeds an oscillating current to the first detector tube in order to create a beat note with the incoming signal frequency, uses a single tube, also oscillaring at radio frequency, which tube takes the place of both the first detector or frequency changer and oscillator in the usual super-heterodyne.

Principle of Operation

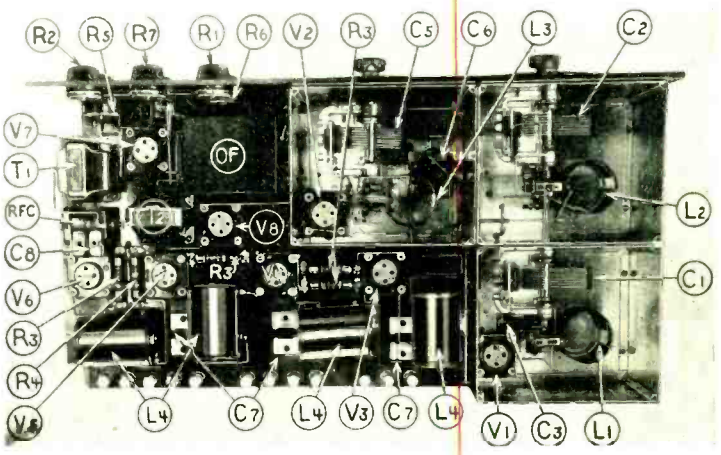
The action of this unit borders super-regeneration and in operation amplification takes place only when the grid of the tube is of negative value. When the grid of the tube is charged with a positive voltage the grid-to-filament resistance is exceedingly low and amounts to a short across the grid coil and no amplification takes place. It is obvious that, in the first place, excessive regeneration is obtained through each negative half of the cycle. When the tube reaches the point of oscillation a beat note is created, the frequency of which is dependent upon the frequency of the incoming carrier wave and the frequency of the local oscillations. This intermediate frequency is amplified in the usual manner.

The Strobodyne is practically the same as any superheterodyne circuit in other respects.

Those who wish a more detailed outline of the functioning of the receiver, can obtain the information from the July issue of *Radio News* wherein the theory of the Strobodyne circuit was explained in detail.

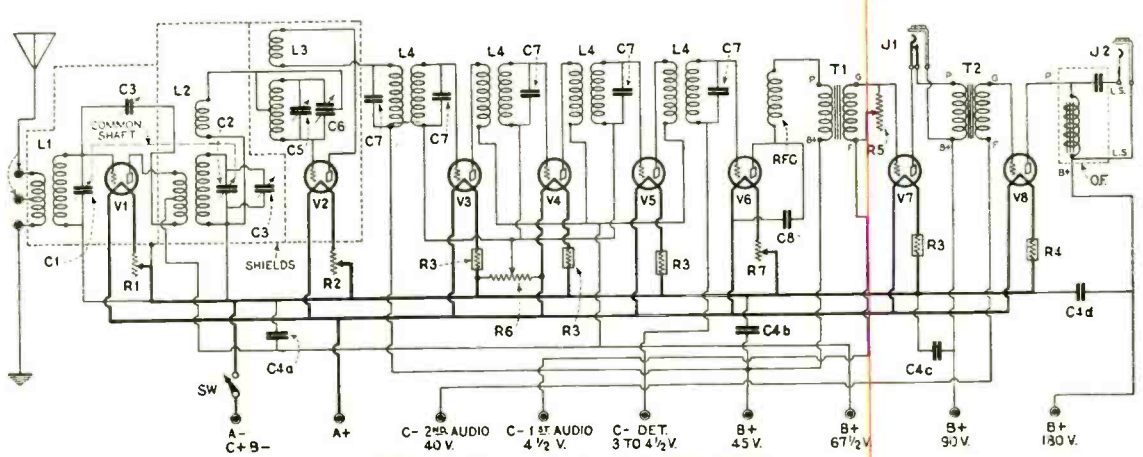
LIST OF PARTS FOR THE STRODODYNE

C1, C2, C5—3 Variable condensers, .00035 mfd.



Top View of the Strobodyne Receiver

L1—1 Special autocouple, tapped.
L2—1 Special autocouple.
L3—1 Standard autocouple.
L4—4 R. F. tuned units, plug-in type.
C7—5 Matched fixed condensers.
T1, T2—2 A. F. transformers.
OF—1 Output filter.
R. F. C.—1 Radio frequency choke.
C6—1 Compensating condenser (2 stators, 1 rotor).
R1, R2, R7—3 Rheostats, 20 ohms.
R6—1 Potentiometer, 400 ohms.
C4—4 By-pass condensers, 0.5 meg.



Schematic diagram of the Strobodyne receiver

The completed tuned double impedance A. F. amplifier. The last unit is an output filter

CS—1 By-pass condenser, .002 mfd.
SW—1 Filament switch.
J1—1 Double circuit short jack.
J2—1 Single circuit short jack.
R3—4 Filament ballasts, 5V, ¼ amp.
R4—1 Filament ballast, 5V, ½ amp.
R5—1 Variable resistance, 100,000 ohms.
C3—2 Balancing condensers.
3 Shields.
8 U. X. tube sockets.
12 Binding posts.
2 Dials.
1 Panel, 8" x 24" x 3/16".
1 Sub-panel, 12" x 25¼" x ¼".
6 dozen machine screws, 6/32, 1" long, with nuts.
1½ ft. angle bras ½" x ½".
2 Rolls rubber covered wire.
1 cabinet, 8" x 24" x 12½".
1 Brass shaft ¼" dia. 10¼" long.
7 201 type tubes.
1 112 type tube.

Tuned Double Impedance A. F. Amplifier

Kenneth Harkness has designed a compact, three-stage, tuned double impedance audio amplifier which can be attached to any receiving set by means of a battery cable, or mounted directly on the sub-panel or baseboard of a receiver, to form a component part of the set. The complete unit measures 6 inches by 9 inches.

The amplifier is designed in accordance with the latest specifications of E. E. Hiler, the inventor of this new system of audio amplification.

The tuned double impedance units used in the construction of the amplifier contain special values of coupling condensers for each stage which give a resonant effect at low frequencies resulting in increased amplification of frequencies between 30 and 200 cycles.

As shown in the wiring diagram the amplifier also includes an output filter unit to protect the loudspeaker and stabilize the operation.

The principles underlying the operation of this amplifier have been explained in detail by Mr. Hiler in recent issues of RADIO ENGINEERING. Its characteristics may be briefly summarized as follows:

1. Uniform loudspeaker output from 30 to 10,000 cycles. The poor response of the average cone speaker below 200 cycles is offset by increased amplification of these low frequencies.

2. Complete and automatic elimination of "motor-boating." "Motor-boating" is caused by oscillations at frequencies below 30 cycles. The frequency characteristic of the tuned double impedance amplifier cuts off sharply at 30 cycles. There is little or no amplification below this frequency; consequently, there is no "motor-boating."

3. Greater undistorted power output. For explanation of this characteristic see Hiler's article in June RADIO ENGINEERING.

4. Rectification, distortion and "tube blocking" are completely eliminated. The "impedance grid leaks" of this amplifier prevent all possibility of rectification or tube blocking, common sources of distortion in ordinary resistance and impedance-coupled amplifiers.

5. High voltage amplification per stage. The amplifier utilizes the maximum voltage amplification of the tubes employed. There are no low resistance grid leaks to reduce the amplification.

From a consideration of the above characteristics it will be realized that clear, undistorted reproduction can readily be obtained with an amplifier of this type.

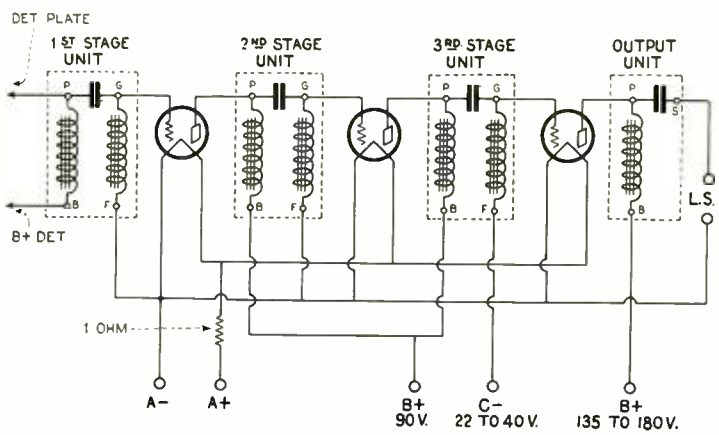
Parts Employed and Constructional Details

The parts used by Mr. Harkness in the construction of this amplifier are as follows:

3 Tuned double impedance couplers first, second and third stage types)
1 Output filter unit.
1 Bakelite panel, 6" by 9", with three tube sockets attached.
1 Panel supports.
7 Battery terminals.
2 Loudspeaker posts.
1 Fixed 1 ohm resistance.

The assembly of the amplifier is shown in the photograph on this page. The fixed filament resistance is the only part mounted underneath the panel.

The unit connects to the receiving set in the usual manner. The battery terminals at the rear connect to the batteries themselves or to the corresponding binding posts of the receiver. The loudspeaker tips are inserted in the binding posts provided for the purpose. The input of the amplifier connects in the plate circuit of the detector tube in the receiver. An R. F. choke should be inserted between the detector plate and the amplifier input with a .001 mfd. condenser to by-pass R. F. currents from the plate of the detector tube to filament. Type 201-A tubes are used in the first two stages of the amplifier and a type 112 or 171 in the last stage.



Schematic diagram of the three stage tuned double impedance A. F. amplifier

Audio Frequency Tests

Editor, RADIO ENGINEERING:

For quite a while I have had some ideas which I intended to mention to you and I believe that they have a practical value if a magazine such as RADIO ENGINEERING would put them into execution.

The first one is about the testing of audio frequency transformers. Until now, this work has been done in laboratories equipped with the necessary apparatus to plot the curve of the various transformers submitted for test. However, this method only shows what frequencies a transformer amplifies; it does not show what frequencies will be heard through the speaker. It happens in a great many cases that some experimenters buy good transformers expecting some marked improvement in the quality of music received through a particular set, but find out that it does not make any difference.

My idea is to let the buyers judge for themselves by having some broadcast station send out standard audio frequencies just as the Bureau of Standards is now sending out standard wavelengths to calibrate wavemeters and receivers. For instance, an audio oscillator could be set up in front of the microphone and after being set to a particular frequency a continuous sound of say 100 cycles emitted by the station.

In this manner everyone interested in knowing how their set amplifies the various audio frequencies could judge for themselves.

At the same time this would show what passes through the detector, audio amplifier and loud speaker working together. The test on each frequency could last a few minutes so as to allow comparative tests to be made of various amplifiers, speakers, etc.

I believe this service would be welcomed by most experimenters and builders of sets.

R. E. Lacault,
R. E. Lacault Radio
Electric Laboratories.

Thank You

Editor, RADIO ENGINEERING:

I subscribed to your magazine RADIO ENGINEERING because I think it is one of the best of its kind.

Another thing, I thought I would get it on the first of every month, but up to date I have had to send you a card for every issue before I finally received it.

The March issue came about the 15th of the month. This month's (April) issue has not been received yet.

When a person is as anxious to read a magazine as I am, every day of delay on your part is very exasperating.

Please send the April issue as soon as possible, for I'm anxious to read the article on the application of series filaments to a tuned R. F. receiver.

S. M. Miles,
Akron, Ohio.

Regarding Manufacturers' Literature

Editor, RADIO ENGINEERING

Many radio manufacturers still persist in sending literature, intended for consumers, to jobbers, dealers and professional set builders. This material very seldom, if ever, includes any technical information regarding the products.

We of the trade are not all nit-wits and it is not only important to us, but the manufacturers as well, that we have specific details on the products we handle.

Is there any good reason why we should be kept in the dark? Why can't all manufacturers prepare special descriptive matter for the trade so that we can talk intelligently to our customers and give them facts in their own language. Many a sale has been lost due to lack of information on the product.

I think it would be well for every manufacture to remember that there is a jobber, a dealer or a professional set builder standing between him and the consumer in most every case.

We in-betweens are in business to help the manufacturers help us. Why can't manufacturers take the same attitude and assist us by supplying specific technical details in their literature.

S. F. Peters,
Portland, Ore.

Audio Frequency Amplifiers

Editor, RADIO ENGINEERING

Ever since the newer developments have been made in A. F. amplifiers there have been numerous technical articles in all radio publications covering the theoretical superiority of certain systems. According to available information; not considering advertisements, of course, some A. F. systems are far better than others when it comes to amplification of low frequencies. In fact, some systems show, theoretically, so much advantage over other systems that it appears foolish to consider any of the older types. Actual curves prove the points of superiority. However, from the practical standpoint, there seems to be no great difference between any of the systems. Insofar as the impression on the ear is concerned the much trodden-upon two stage transformer coupled amplifier sounds just as good as a resistance or impedance coupled job—output in watts being equal.

I have conducted any number of experiments in this line and used people who could hear well over a wide band of frequencies. In every case one amplifying system responded as well as the next. This would seem to indicate that most, if not all, loud speakers, fail to operate on frequencies much below 60 or 80 cycles. If such be the case, why all the yelling over A. F. systems which amplify or over-amplify low frequency notes?

Possibly I am all wrong in my observations. Still, I would like to see the matter discussed in your readers' column.

E. T. Woodard,
Mount Vernon, N. Y.

A Warm Compliment from a Cold Climate

Editor, RADIO ENGINEERING:

Please put me down for two years subscription for your excellent magazine. The copy I received, has been read very carefully and much information derived from the same. I already take every radio magazine I can find on the stands, and have subscribed for others, but your magazine has more up to date news than any I have seen, and I have seen many.

Start me with the July issue and please send me the April and May issue as you mentioned in your letter to me. Very interested in the Hiler Series.

Alvin Stenso, 7LB,
Ketchikan, Alaska.

NEWS OF THE INDUSTRY

Los Angeles Radio Exposition

Having broken all records in the west in assigning every square foot of exhibit space in Ambassador Auditorium, Los Angeles, in less than four weeks time, the committee for the fifth annual National Radio exposition, otherwise known as "the radio show beautiful," has taken figures on and is proceeding to erect a temporary pavilion alongside the auditorium, capable of adding 72 booths to the show, making a total of 212.

From a standpoint of floor area alone, the event, which will be held September 4 to 10, is reported assured of being the largest radio show as yet constructed on the Pacific coast.

This condition, according to Waldo T. Tupper, managing director, will be relieved as a result of construction of the pavilion, which alone will add 20,000 square feet to the 50,000 square feet of exhibit space within the auditorium, making a total of 70,000.

The event will have seven stages for entertainment, in addition to a demonstration area for the spectacular and educational exhibit of a "phantom" or radio controlled automobile.

Los Angeles radio expositions have been declared distinctive and outstanding, partly as a result of the physical arrangement of the exhibits and the elaborateness of the decorations. This year an effort is being made to surpass all predecessors in artistic effects.

A recent innovation in Los Angeles radio shows, was Tupper's cutting of the time from 9 to 6 days. At the offset, the wisdom of this move was questioned, but it was found that a larger crowd was attracted during the 6 days than attended when the show lasted longer. It was an instance of intensifying the exposition and thereby increasing its interest.

Lombard J. Smith, general chairman, has just approved plans for a magnificent entrance, surmounted by search lights, 40 feet high.

Applications are on file in the committee's headquarters for a large proportion of the remaining space, and the purpose of the committee now is being directed toward setting a new attendance mark.

Murdock and Spartan in Sales Tie-Up

Negotiations were completed last week whereby the products of the Spartan Electric Corporation, of New York, and Wm. J. Murdock, Chelsea, Mass., pioneer radio manufacturer, will be handled on a nation-wide basis by Maurice S. Despres and Julian M. Jacobs.

These two members of the radio fraternity have been identified with the industry for many years. Both Mr. Despres and Mr. Jacobs have held the position of sales manager of the respective organizations they have been identified with and have in this position gained the friendship and knowledge of manufacturers, jobbers and dealers throughout the country.

In entering the popular price field the Murdock Company completed an arrangement with the Adler Manufacturing Co., of Louisville, Ky., whereby Adler Royal cabinets will be sold by Murdock to their distributors.

Record Attendance at R. M. A. Show

The R.M.A. Convention and Trade Show held during the week of June 13th to 17th, 1927, at the Stevens Hotel, Chicago, Illinois, according to figures furnished by the Hotel, drew a jobber and dealer attendance of 14,800, press attendance of 1,750 and an R. M. A. membership attendance of 2,800.

The Banquet held on Thursday Evening, June 16th was attended by 2,200.

Estimates by the Hotel shows that there was over $150,000 spent at the Hotel and approximately $55,000 at other hotels. As near as can be estimated there was approximately $500,000 spent by those attending the Convention and Trade Show, including railroad fare, during the week.

King Manufacturing Co. Licensed Under Radio Patents Ltd.

Canadian radio interests represented by Radio Patents Limited are beginning the licensing of responsible manufacturers under the patents held by this group the franchises issued being similar to those granted in this country by the Radio Corporation of America.

The facts of this license were brought to light by a statement by R. W. Webb, president of the King Manufacturing Company announcing the licensing of the company he represents not only by Radio Patents Limited of Canada but by the Radio Corporation of America. The American license is issued to the King Manufacturing Company of Buffalo by the Radio Corporation of America and covers 140 patents held by that company covering practically every phase of radio set construction.

The Canadian license covers patents originally owned by the Canadian General Electric Company, the Westinghouse Company, De Forest, Marconi, Northern Electric Company and the Standard Radio Company, while the American license covers patents of the Westinghouse Company, General Electric and American Telephone and Telegraph Company.

The Canadian license, which is the first one of its kind, was issued to King Quality Products, Ltd., of Bridgeburgh, Ontario.

D. S. Spector to Study Radio Conditions in Europe

D. S. Spector, general manager of Federal-Brandes, Inc., manufacturers of Kolster radio receivers, sailed June 24 on the Majestic for England. He plans to spend six weeks abroad studying radio conditions in Europe.

During the trip on the Majestic he will study the conditions of broadcast reception while crossing the Atlantic.

Rainbault Co. Take Over Walbert Line

The John P. Rainbault Company, 50 Church Street, New York City, N. Y., have been appointed as Eastern representatives of the Walbert Manufacturing Company.

In addition to the Walbert line of batteryless receivers, The John P. Rainbault Company are also Eastern representatives of the Balkite products and the Magnavox Speakers.

Rocke Takes Over Dongan New York Office

The appointment of Arthur Rocke as New York representative of the Dongan Electric Manufacturing Company, manufacturers of radio and bell ringing transformers, has just been announced by C. S. Swanson, sales manager of the Dongan Company. The Detroit manufacturer is playing a prominent part in the introduction of power unit parts for the new rectifier tubes while its standard lines are widely known throughout the industry. Mr. Rocke, formerly sales manager of the Apco Mfg. Co., is one of the best known radio men in the eastern jobbing trade and, in the last few years, has built up a large business on a few selected radio, electrical and automotive lines which he represents.

Hiler Double Impedance Tuned Audio Amplifier

Special Offer !

Complete, guaranteed three-stage amplifier—ready to operate

$14.75

List Price — $29.50

To demonstrate the clear, musical, realistic tone quality of the new Hiler system of tuned double impedance audio amplification, we offer dealers and set-builders the opportunity to purchase this compact three-stage amplifier, size 6" x 9", at the special price of only $14.75—50% off list. Designed in accordance with specifications of E. E. Hiler, inventor of the system. Licensed under Hiler patents. Satisfaction guaranteed or your money back. Only a limited number available at this price. Mail your order NOW.

Tuned Double Impedance Kit (Set of 3 tuned couplers and output filter unit). **$11.50** List $23.00

K.H. Radio Laboratories, Inc.

Kenneth Harkness, Mem. I. R. E.
Pres. & Chief Engineer

181 Sullivan Street
New York, N. Y.

Dealers and Set Builders—Write for Agency Proposition

NATIONAL
B-POWER SUPPLY

A newly designed B-Eliminator, with special features not hitherto offered to the public, will be announced in the near future. The unit is small, light, simple and easy to set up. The price will be attractive.

The new NATIONAL B-POWER SUPPLY is manufactured under license association with Radio Corp. of America, General Electric Co., Westinghouse Electric & Manufacturing Co., and the American Telephone & Telegraph Co.

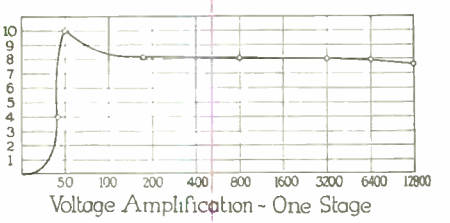
BE SURE YOU GET THE GENUINE

NATIONAL
RADIO PRODUCTS

NATIONAL CO., INC. W. A. READY, PRES., MALDEN, MASS.

Send for Bulletin E-7

TUNED
DOUBLE IMPEDANCE
Giving
Rising Characteristics on Low Frequencies



A curve flat from 150 to 10,000 cycles and rising between 150 and 30 cycles offsets the falling characteristics of loud speakers and output circuits. A sharp cut-off below resonant peak prevents motor-boating. Four times power output feature retained. Naturalness as well as clearness is result of accurate laboratory research on loud speakers and double impedance amplifiers. Combinations of tuned and untuned stages can be made to fit any condition thus producing straight line results as you hear it.

Licenses for the use of the DOUBLE IMPEDANCE System are being issued to a limited number of established manufacturers — Infringers will be prosecuted under Patents 1589692 and 1615224. (Other patents pending.)

Demonstrations may be arranged by appointment.

Dealers and Distributors:

Leading Manufacturers throughout the industry are using Double Impedance Audio Amplification in their 1927-28 sets and construction kits.

We will gladly supply you with a list of our licensees. A limited number of additional licenses will be issued to established manufacturers. Demonstrations may be arranged by appointment.

HILER AUDIO CORP.

10 Argyle Terrace, Irvington, N. J.

NEW DEVELOPMENTS OF THE MONTH

Polymet Metal Base Rheostats and Potentiometers

The Polymet Manufacturing Corporation is making a new line of Rheostats and Potentiometers. The bases of these are made of the highest quality, ball polished, nickeled brass. This

Polymet metal base rheostat

type construction allows heat absorption far more readily than does the usual type. The wire element is firmly held in place due to the groove method of winding the resistance; no glue is used. A specially designed contact arm of spring phosphor bronze assures positive, even contact over the entire range from zero to maximum.

New Eby Socket

The H. H. Eby Manufacturing Company, of Philadelphia offer to the trade a new tube socket incorporating the following features:

A 3-point wiping contact, extending along the length of the tube prong. The contacts float in a containing cavity and come out the bottom of the socket, so that they may be brought

The new Eby tube socket

down thru the sub-panel and all wiring may be concealed. Connections are made directly to the contacts, which are tinned to facilitate soldering. There are no riveted, eyeletted or screw connections in the socket—all connections being made right to the contact members which in turn are firmly clamped on the tube prongs.

The design is such that the socket will lend itself to any mounting arrangement. It can be mounted on top or underneath a metal or bakelite panel and provision is also made for wood panel mounting.

It is designed to closely follow the line of the tube base—the round portion of the socket is the same diameter as the tube base. Furthermore, there are no metal parts visible from the top; all that shows is the moulded case with the rounded parts polished and the flat surfaces finished in a new stipple effect. The bottom is closed with a bakelite plate so that the socket is completely contained in the moulded case.

New Polymet Molded Condensers

The Polymet Manufacturing Corporation has developed a new line of fixed mica condensers.

Polymet moulded fixed condenser

These are molded in genuine bakelite. Each condenser is guaranteed by the manufacturer to an accuracy of plus or minus 5%.

Convenient, well-tinned soldering tabs are a notable feature of this construction. Each condenser is fitted with screw holes to facilitate mounting.

Kelvin Full-Wave Rectifier

The "Kelvin" full-wave rectifying tube announced by the Eureka T. & M. Co., of 42 Walnut St., Newark is now ready for distribution. It is the latest development of the Wakefield Mfg. Co., of Newark.

The use of a special gas mixture and improved internal construction allows the "Kelvin" tube to give a larger out-

The Kelvin full-wave rectifier tube

put of current and voltage and give a longer life than similar tubes now on the market for use in "B" eliminators.

The tube is of a tipless construction and is extremely rugged and at the same time simple in design. Its manufacturer guarantees the tube for a one year life. The sole distributors are the Eureka T. & M. Co.

New Sonatron Tube for "B" Eliminators

The Sonatron Tube Company of 108 West Lake Street, Chicago, have developed a surface cooled, gas filled, full wave rectifier tube that is designed to work in any 'B' eliminator which requires a gas filled filamentless tube.

One of the salient features of the Sonatron SH-85 Rectifier Tube is the cone-shaped corrugated cap inside the tube which keeps it at an even temperature by bringing about a surface-cooled area that constantly relieves the tube of excess heat.

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Readers interested in products not listed in these columns are invited to tell us of their wants, and we will inform the proper manufacturers. Address Readers' Information Bureau.

Addresses of companies listed below, can be found in their advertisements—see index on page 846.

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Carter Radio Co.

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Zierick Machine Wks.

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BRACKETS, SUBPANEL:
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National Co.

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COILS, IMPEDANCE:
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Zapon Co., The

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LUGS:
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Zierick Machine Wks.

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Westinghouse Elec. & Mfg. Co.

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International Resistance Corp.
Lynch, Arthur H. Co.
Micamold Co.
Polymet Mfg. Corp.
Ward Leonard Electric Co.

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International Resistance Corp.
Polymet Mfg. Corp.
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K. H. Radio Laboratories.
Muter, Leslie F., Co.
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Silver Marshall, Inc.
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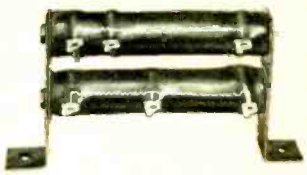

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