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electronics

RADIO . . . COMMUNICATION AND INDUSTRIAL APPLICATIONS OF ELECTRON TUBES . . . DESIGN . . . ENGINEERING . . . MANUFACTURE

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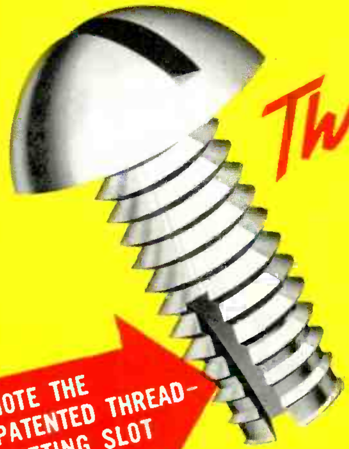
DEPARTMENTS

So cost departments say —
"It's CHEAPER to drive Phillips"

The manufacturers who were the first to standardize on patented Phillips Recessed Head Screws are the ones who have to cut costs without cutting quality — airplane factories, auto body makers, electrical appliance manufacturers, fine furniture makers. On all counts they've learned that the Phillips Screw is a low-cost fastening — faster assembly, less spoilage, fewer screws, longer tool life better worker attitude. No wonder they say, "We could not afford to be without Phillip's Recessed Head Screws."

SHAKEPROOF



Thread-Cutting SCREWS

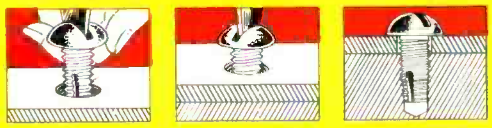
The Only Screw that actually Cuts its Own Thread

TAP *and* FASTEN *in* ONE OPERATION

NOTE THE PATENTED THREAD-CUTTING SLOT

Here is the modern metal-to-metal fastening that enables faster production, lower assembly costs, and greater holding efficiency. No more expensive tapping—you simply punch or drill a hole, insert a Shakeproof Thread-Cutting Screw, and drive it home. The patented slot cuts a clean standard machine screw thread; and, because each screw remains in its own threads, a perfect fit and tight fastening are always secured. Write for test samples.

FASTENS METAL TO METAL SECURELY!



EASY TO START — EASY TO DRIVE — A PERFECT FIT

"HI-HOOK" for all PLASTICS

This is a specially designed screw for plastic applications. Note the double-width thread-cutting slot which provides an acute cutting edge that enables easy driving in any plastic material, either molded or laminated. The screw cuts its own thread, eliminating the need for a separate tapping operation or costly threaded inserts. Send for your test samples.

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The Shakeproof Locking Thread-Cutting Screw is recommended as a permanent fastening for assemblies subjected to severe vibration which need not be dismantled for frequent servicing. Patented locking projections under the head imbed themselves into the work, powerfully resisting any backward movement of the screw. Testing samples will be sent on request.

Triple-Action LOCK WASHERS

EXTERNAL TYPE

INTERNAL TYPE

COUNTERSUNK TYPE

Here is the lock washer that thoroughly protects product performance, employing the proven Shakeproof principles of strut-action, spring-tension, and line-bite. It holds either nuts or screws absolutely tight even under severe vibration. Locking efficiency is actually improved as vibration increases. The tapered twisted teeth are forced deeper into both nut and work surfaces, setting up a more powerful lock. Regardless of the degree of vibration, the connection stays tight. Write for test samples today, indicating the types and sizes you desire.

STRUT-ACTION — SPRING-TENSION — LINE-BITE

LOCKING TERMINALS

Shakeproof offers a broad line of locking terminals to fill the varied needs of the electrical appliance industries. Cost savings are achieved by combining both soldering lug and lock washer in one piece, eliminating the need for a separate lock washer. Plain terminals are also available. Advise the type of terminal and screw size desired, and samples will be sent on request.

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2501 North Keeler Avenue, Chicago, Illinois

IN CANADA: Canada Illinois Tools, Ltd., Toronto, Ont.

U. S. PAT. Nos.

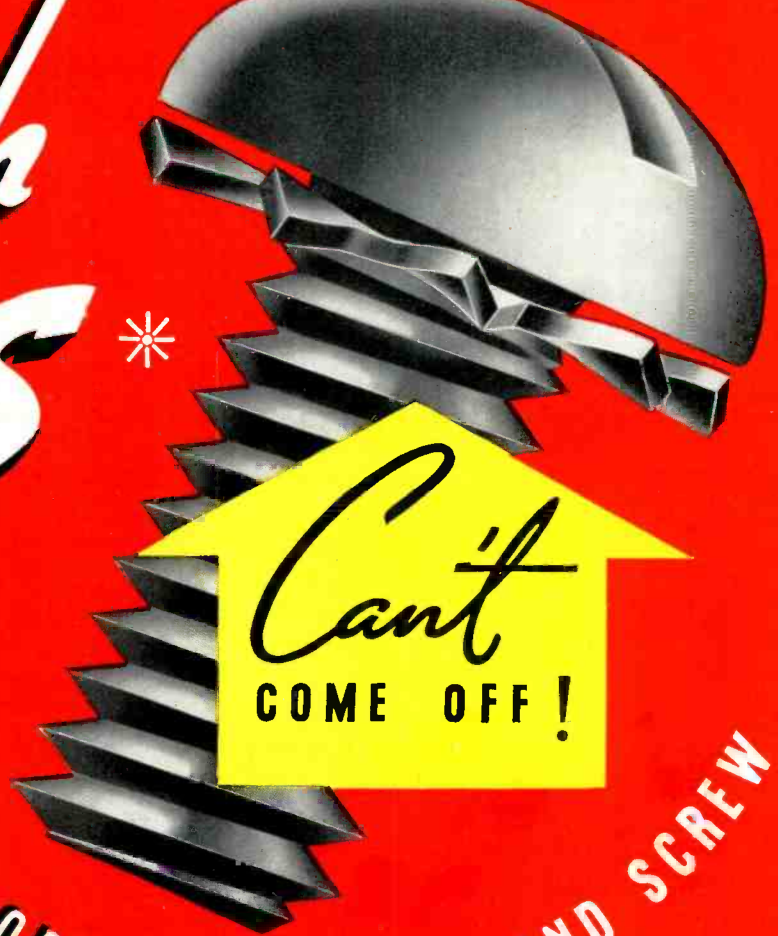
1,687,954	1,909,477	2,113,424
1,782,387	1,963,800	2,113,425
1,850,242	2,037,586	2,122,915
1,862,486	2,093,171	2,128,757
1,909,476	2,093,172	

Other Patents, Patents Pending, Foreign Patents

Save with SEMS*

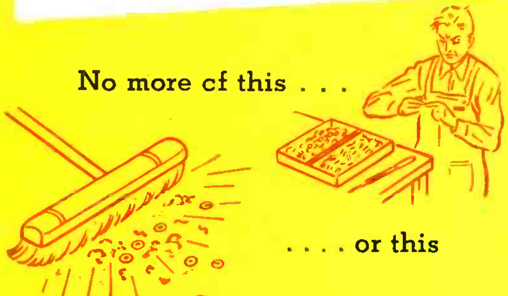
TRADE-MARK

PRE-ASSEMBLED SHAKEPROOF LOCK WASHER AND SCREW



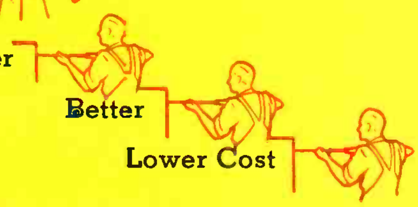
Can't COME OFF!

SEMS SAVE TIME AND MONEY!



No more of this . . .

. . . . or this



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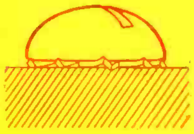
Better

Lower Cost

Correct lock washer for each size and type of screw head



Every screw LOCKED TIGHT!

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SEMS offer every metal-working manufacturer a new opportunity to reduce costs and improve fastening efficiency. SEMS speed up production by saving time formerly wasted in putting lock washers on screws. The lock washer is held in its most efficient locking position and each screw has the correct size and type of lock washer for its particular head. Waste and loss of lock washers are eliminated because the lock washer cannot come off the screw. Ordering and stock control are simplified, for both screws and lock washers are delivered as one unit, preventing unbalanced inventories. Try this new Shakeproof fastening unit—mail the post card below for price information!

** SEMS is the trade-mark of Illinois Tool Works, manufacturers of Shakeproof Lock Washers. Only genuine Shakeproof Lock Washers are used in the manufacture of SEMS.*

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Kindly send us price information on the sizes of SEMS listed below.

DESCRIPTION OF SCREW

Head	Diameter	Thread	Length	Finish

Firm Name ______________________

City ______________ *State* ______________

Signed by ______________ *Title* ______________

ELECTRONICS

NOVEMBER 1938

KEITH HENNEY
Editor

Crosstalk

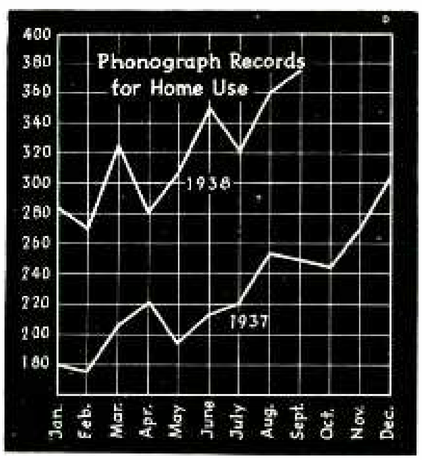
▶TUBES, Inc. . . . As part of *Electronics'* public relations program, an article in this issue endeavors to point out facts which may improve the relations between producers of vacuum tubes, and those who purchase them. Another article will talk about the tube situation from the standpoint of the consumer. Comments on this material, as on anything else published in *Electronics*, are always welcomed by the editors.

▶ BY SHORTWAVE . . . During the recent New England hurricane great sections of the northeast were cut off from all communication. No power, no mail, no radio. In a New Hampshire farm, however, our one-tube battery-operated short wave receiver brought in, hour after hour, the principal European stations, Prague, Berlin, Rome, Warsaw, London, Paris, each telling of the hour's happenings during those momentous and fatal days. Once KDKA's short wave transmitter, and W2XE were heard; all the news had to come from abroad. All of these countries put on good English news broadcasts; telling of events and of what the other countries' newspapers thought of the events.

Why don't the battery manufacturers work on the idea of a battery operated, one tube short wave set for every home, as a stand-by in case of public emergency? The batteries for this particular receiver were over a year old, and seem to be good for another year of sitting on the shelf, waiting for the lights to go out.

▶ THIS MONTH . . . Mr. Sarnoff reported on October 21 that commercial television comes in April of next year, in time to be shown at the opening of the World's Fair in New York. At this moment two men are on top the Empire State Building erecting a new antenna. As C. W. Horn says, "if that antenna doesn't work, somebody's going to get a medal".

U. S. Department of Justice entered into the review of the General Talking Pictures, Western Electric, ERPI, A.T. &T. case. The government wants the Supreme Court to state that the owner of a patent cannot tell the purchaser of a product built under the patent what he may do and may not do with it. The Department wants to know if a vacuum tube, once purchased, can be used for only those purposes which the patentee and manufacturer dictate. Can a manufacturer of a shotgun sell the arm for the purpose of shooting ducks, but prosecute the purchaser if he knocks over a goose?



As evidence of the mounting demand for phonograph records, the curve above represents figures proportional to the monthly sales of a large producer

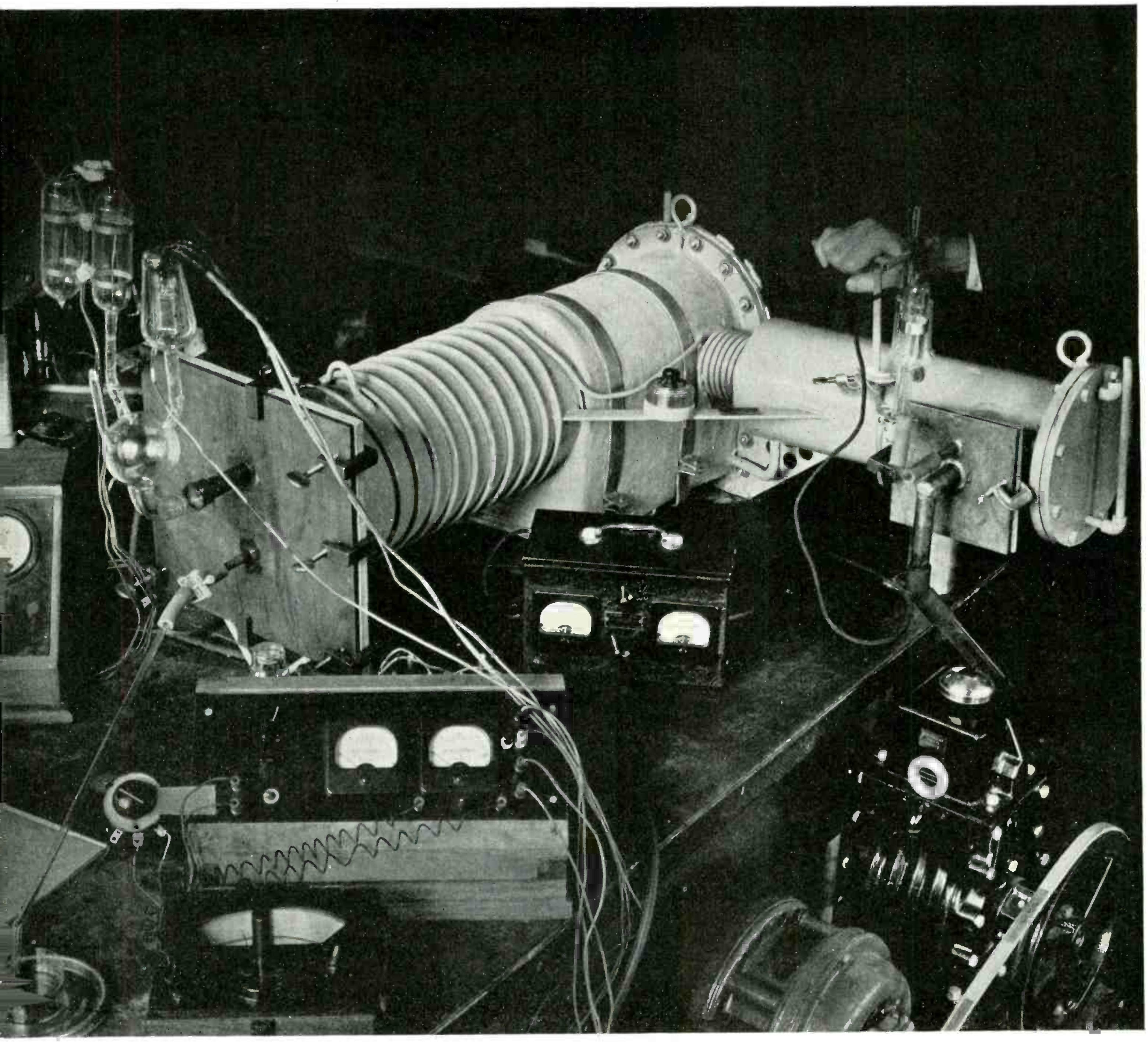
Western Electric Company, Hawthorne, held open house last year to employees and their friends. 46,000 guests attended. This year Western at Baltimore and at Kearney, held open house October 17, and October 24, respectively. What better way to improve relations with one's community than by asking the folks in? Any plant that can afford to admit the public must be a good place to work in. Many a plant we've been in wouldn't dare open its doors to the public.

▶ DIGEST . . . In October and again in this issue will be found a somewhat different manner of handling our digest of foreign literature. Instead of fairly long digests of a few papers, we have listed a great many articles with little attempt to digest the contents. Which does the reader prefer? Should the department be killed in preference to some other feature?

▶ PRIX . . . McMurdo Silver tells us that at the 1937 Paris International Exposition, his Masterpiece receiver was awarded Grand Prix in the radio and television section and that Capehart was awarded the Grand Prix in the phonograph section. See Paris edition of the *New York Herald Tribune* July 23, 1938.

▶ FOR SALE . . . Engineers Book Shop, 168 East 46th St., New York City, Miss E. N. Harder has for sale a complete file of the *Proceedings of the I.R.E.* from 1917 to 1938; Byron B. Minnium of Erie Resistor has a file of the *Marconigraph*, which preceeded the *Wireless Age*. His earliest copy is No. 2 of Vol. 1 and he would like to dispose of the copies. No prices quoted. Make your own deal.

DESIGNED FOR CARNEGIE INSTITUTION'S PROGRAM OF NUCLEAR RESEARCH, THIS OIL-DIFFUSION VACUUM PUMP IS INTENDED TO EXHAUST CONTINUOUSLY A VACUUM TUBE 26 FEET LONG AND 5 INCHES WIDE



THE PUMP, DEVELOPED IN THE RESEARCH LABORATORIES OF THE EASTMAN KODAK COMPANY, HAS A SPEED OF 1000 LITERS PER SECOND, AND WILL ATTAIN AN ULTIMATE VACUUM OF TWO TEN-THOUSANDTHS OF A MICRON

The first in a series of critical surveys of the relations between manufacturers and customers in the electronics industries

TUBES, Inc.

100,000,000 tubes a year—95 per cent of them satisfactory, the rest replaced without argument—this is the commendable record of the tube manufacturers. But undue customer pressure has forced the industry into inefficient practices which are paid for by all of us

"BY and large the tube situation is OK—far better than in many other lines of our business." This is the judgment of a salesman in one of the largest radio supply houses, selling to the public, a man who sells several hundred tubes a day over the counter and who has dealt with every complaint on the list. This is interesting evidence—not a Gallup poll to be sure—but the honest opinion of a man who has no axe to grind for anyone, a man who should know tubes from the customer's point of view if anyone does.

What does he mean by "the situation is OK"? He means that the individual buyer of tubes gets a good product at a fair price, that complaints are few and are adjusted without argument. Here are a few offhand averages from this man's experience: 95 per cent of all tubes tested at the counter in an emission test pass as satisfactory—only 5 per cent must be returned to the manufacturer for replacement. In the older, well-established types, the percentage runs nearer 99 per cent satisfactory; in some of the newer types, especially metal types, the percentage may fall as low as 90 per cent but not lower. The emission test, contrary to the opinion of many, is, in this man's view, highly satisfactory. In his experience, only 2 per cent of the tubes passed by the emission tester are returned by the customer. The other 98 per cent stay sold. A mutual conductance test, too slow for heavy store traffic but otherwise admittedly preferable, might reduce the returns another one per cent. The final one per cent would consist of tubes with undetectable high leakages, noise, and tubes intended to replace "hot" tubes (of which more presently).

These figures may or may not agree with the manufacturer's idea of satisfactory "out-of-factory" shrinkage. But on their face they constitute a remarkable record. The tube makers produce a product distinguished by the highest ratio of technical-performance-to-price in any mass production industry. Yet, their output is between 98 and 99 per cent satisfactory, as released to the public market.

The ultimate consumers, who include all of us who own radio receivers, will agree that by and large radio receiving tubes represent good value for the money. Tube life is long, far longer than we have a right to expect. The replacement policy of the manufacturers is liberal, so liberal in fact that it is taken advantage of by the rest of the industry, to everyone's detriment. Standardization, with a few exceptions, is on a high plane. On these items the consumer has little cause for complaint.

In October *Electronics* the general aspects of a public relations program were discussed. In this issue, a specific phase of public relations is covered: that relating to the problems common to producers and consumers of goods. No product in electronics is so fundamental as the vacuum tube. This product of man's inventiveness must be built right—but it must be used correctly, too.

The Editors welcome comment.

What about price? For years the tube industry has operated in the red, or so it claims, because tube prices were too low. Recent price advances have improved this situation considerably, at least to the point where manufacturers admit the possibility of some profit. Actually the facts in the tube-replacement market are these: The list prices of replacement tubes run from 80 cents to $2.50 for over 200 types which fill over 99 per cent of the market. List prices are paid by a vast army of consumers—nearly all except those who buy direct from cut-rate chain stores in the large cities and from the mail order houses. The mail order house net price, available theoretically to dealers and servicemen, but actually to all comers, is about 40 to 54 per cent of the list price, with an additional 4 to 10 per cent discount on lots of 25.

An interesting ratio is that of replacement-tube-cost to set-cost. According to *Radio Retailing's* figures, the average set in 1937 cost 53 dollars. Assuming this set contains 6 tubes, the tubes can be replaced at list prices for about 9 dollars. The tube-to-set cost ratio in this case is about 15 per cent, a reasonable figure since tubes need to be replaced at most only three or four times in the life of the set. In the smaller sets a very different picture obtains: Small sets widely retailing at 10 to 15 dollars contain tubes which cannot be replaced at list prices for half these amounts. This cost ratio of about 50 per cent must seem unreasonable to the customer, if he is aware of it.

It is hard to judge tube prices in any absolute sense. The manufacturer's cost varies so much with the manner in which he operates his business that even this seemingly basic price cannot be trusted. In one case, a kit of tubes (all tubes required by a set manufacturer for a given small-set chassis) was offered by a tube manufacturer at a price under one dollar. A competing manufacturer, hearing of this price via the grapevine telegraph, went into a huddle with his own cost department and came up with the conclusion that the price could not possibly cover the cost of materials and direct labor, let alone any overhead. It was a mystery, therefore, how manufacturer number one could stay in business. The mystery still remains, since the manufacturer still is in business. The only explanation is that reserves for depreciation of plant and equipment and for research must be missing in the calculations. By all standards, this is bad business; but its effect on the industry as a whole is apparently, and fortunately, not great.

That some part of the price paid for tubes should go into research cannot be questioned in an industry moving as fast as does tube manufacturing. All tube manufacturers maintain engineering staffs, but not all have sufficient reserves to maintain staffs whose sole responsibility is research and development. The record shows that new and valuable tube types have originated, at one time or another, in every manufacturing plant in the business. If the majority of these events seems to occur in but a few organizations, the conclusion is that these organizations are more prosperous, have larger original equipment and replacement contracts, and hence can afford the major burden of research.

From all outward appearances, it may appear that the tube-making plants have attained a degree of stability not enjoyed by other branches of the radio industry. But viewed from the inside, the situation is not so satisfactory. There is hardly a tube-plant executive in the business who does not have a pet peeve. The annoyance takes many forms, and is tolerated silently or resented openly, according to the temperaments involved. So far as any generalization can be made, the question boils down to "too much customer pressure, and too much capitulation to it." Its significance is this: if customer pressure forces better products and more efficient production, fine. But when it engenders waste through disorganized standards, and loss of efficiency through improper modes of operation, then the time has come for roundtable discussion. For waste and inefficiency, by definition and by actual count, are paid for by everyone.

Roundtable Item No. 1

Who shall make obsolete types?

At present every manufacturer makes receiving tubes listed under at least 150 different type numbers. The largest published single list contains no fewer than 249 numbers. Not all of these numbers represent different tube characteristics of course, since many represent differences in terminal connections or envelope only. But there are 50 or more types which every manufacturer would gladly eliminate from his list altogether, if he could be assured of fair treatment by the rest of the industry.

Take for example the obsolete types OOA, WD 11, WX 12, V 199, and X 199. The total annual demand for these tubes can be measured in ten thousand lots, a matter of a week's operation for any one manufacturer. That one manufacturer, if he could be singled out, could make these tubes efficiently and sell them at a low price to the people (usually the poor) who have outmoded receivers. As it is, nearly all manufacturers make a percentage of most of these types. Each plant sets up machinery for a small part of the total market, and the cost per tube inevitably goes up.

This is a clear case of waste. Some time ago, an industry move got under way to divide the responsibility equitably among the manufacturers. It was proposed that one manufacturer would make the whole industry output on one obsolete type, another the whole output on another type, and so on. This was, and still is, a very good idea. But it has failed. Why? One answer given is the pressure put on the manufacturers by the distributors of tubes.

A distributor, so the story goes, gets a small but urgent order for obsolete types. He goes to his manufacturer, who does not happen to make the tubes, but who in accordance with the industry agreement refers him to the manufacturer who does make them. This second manufacturer is a snake in the grass. Sure, he will supply the obsolete tubes, but what about a large order for other types also. The distributor says "Sorry, I'm tied up with manufacturer number one". Manufacturer number two says "Sorry, in that event the price of these obsolete tubes is very much higher. Take them or leave them." So goes the merry-go-round, and eventually manufacturer number one sets up to make the obsolete type, in competition to manufacturer number two. This is unvarnished hogwash as a way of doing business, but it happens. How can

EVERY USER OF TUBES SHOULD KNOW:

- That of the 500 different types of receiving tubes now available, only 20 types are required to satisfy the demands of 80 per cent of the market, and that 40 types cover more than 90 per cent of the demand, leaving over 400 types which must be kept available for less than 10 per cent of the market.
- That attempts to divide the load by "farming out" the responsibility for certain obsolete types to individual manufacturers have failed, due largely to pressure applied by the tube distributors and dealers.
- That new tube type-numbers have appeared at the rate of one a week for the past three months.
- That lists of preferred type-numbers—designed to guide the engineer in choosing modern, high-production, low-priced tubes—have back-fired on the manufacturers.
- That the ratings of many transmitting tubes have been pushed to the limit, and beyond, under the false standard of "more watts per dollar", whereas as more *watthours* per dollar would indicate the true economics of the situation.
- That a "hot" tube is not necessarily one operating with a cherry-red anode—rather it is one with better-than-average (and therefore unstandardized) characteristics, built to satisfy the demands of a set-design engineer.
- That as a result of this "hot" tube demand, there were once on the market no less than 5 distinguishable varieties of the 6A7 tube, which were not interchangeable in all circumstances,—a situation now happily cleaned up by cooperation between different manufacturers.
- That it is possible for a used, but still serviceable, tube to find its way back to the market *in a new carton*, the indirect result of a too-liberal replacement policy on the part of the manufacturers.
- THAT THE PRIMARY CAUSE OF THESE TROUBLES IS CUSTOMER PRESSURE, WHICH MEANS US, THE EDITORS AND READERS OF ELECTRONICS.

the situation be corrected? First it must be appreciated that such tactics make no money for anybody. Second the responsibility for obsolete types can be set up on an industry basis, perhaps under the aegis of the R.M.A., with whom the distributor would do business directly on these types.

Roundtable Item No. 2
Thumbs down on "hot" tubes

Once upon a time there was an engineer in a set-manufacturing plant who found out he could use cheaper oscillator coils in his superheterodyne circuit if the oscillator section of the converter tube had a higher transconductance. So straightway he went to his tube supplier and said, "give me a 6A7 with a little more hop, and I think there's a big order in it for you." So the tube supplier argued a little bit, mumbled about industry standards, and finally against his better judgment built the "extra hop" into the 6A7 oscillator section for this one customer. Thus a "hot" tube was born. The tubes were delivered, the cheaper oscillator coils oscillated merrily right on up to 18 megacycles, and everyone was happy. But then the sets were sold to a lot of people, who in the course of time and at the urgent behest of the industry, bought themselves replacement tubes. The dealer shelves contained only standard 6A7s; the "hot" 6A7s had gone to heaven and could be found no more. The cheap oscillator coils would not function at 5 Mc with the brand new replacement tube. No more foreign broadcasts from those sets. In some cases the ill-begotten oscillator coils gave up altogether with the standard tube in the converter socket. No more reception of any kind from those sets.

This reads like a fairy story, and perhaps it is (although it came from a highly reliable source). The fact remains that not so long ago there were five distinct varieties of 6A7 tube on the market. The differences between these tubes were not mere matters of acceptable tolerances. The differences were so great that in many cases the tubes were not interchangeable. This was a clear case of stymied standards. The matter was so pressing, in fact, that a group of six manufacturers, who shall be nameless but who account for about 90 per cent of the industry output, got together to do something about it. The 6A7 situation is now much improved.

EXHIBIT A—RECEIVING TUBE TOLERANCES

Based on the "customer limits" maintained by the RCA Radiotron Division and representative of the values maintained by the industry as a whole

Type No.	Plate Current I_b (ma.)			Screen Current I_{c2} (ma.)			Trans-conductance (grid-plate)			Trans-conductance (screen-plate)			Trans-conductance (oscillator)			Screen Current (ma.) $I_{c3} + I_{c5}$		
	Low	Av.	High	Low	Av.	High	Low	Av.	High	Low	Av.	High	Low	Av.	High	Low	Av.	High
6A8	2.1	3.1	4.0	....	3 1	....	....	....	....	325	490	700	1150	1600	2100	....	3.4	....
6K8	1 6	2.6	3.6	2.6	3.5	4 6	....	....	....	230	350	490	2200	3000	4000	3.6	6.3	9
6K7	4 9	7.0	9.1	0.9	1.65	2.4	1200	1450	1700	....	....	....	....	....	....	....	....	....
6J7	1.3	2 1	2.9	0.2	0.5	1.2	1000	1225	1450	....	....	....	....	....	....	....	....	....
6J5	6.4	9.0	11.6	....	....	....	2075	2600	3125	....	....	....	....	....	....	....	....	....
6F5	0.5	1.0	1.6	....	....	....	1175	1550	2000	....	....	....	....	....	....	....	....	....
6Q7	0.6	1.05	1.5	....	....	....	950	1250	1550	....	....	....	....	....	....	....	....	....
										(Power Watts)								
6N7	5.	7.	9.	(Per section)			2725	3210	3700	4.2	5 4	....	....	....	....	....	....	....
6F6	75	34	43	4	6.	8.	2075	2500	2925	2.75	3 4	....	....	....	....	....	....	....
6L6	62	72	82	....	5.	8.	5450	6050	6650	5.4	6.5	....	....	....	....	....	....	....
25L6	38	49	60	....	4.	5 5	7000	8200	9400	1.7	2.2	....	(110 v. plate)			....	....	....
5Y3G	125	145	....(400 v. Epp, 4 uf capacitor, 4000 ohm load)									....	....	....	....	....	....	....

All ratings at 250 v. plate unless otherwise noted.

Customer pressure for "hot" tubes has not relaxed. One variation is the request for "selected tubes", tubes within the tolerance limits but on the upper edge of the tolerance band. Such tubes, while not "hot", are at least slightly "warm". Technically, this type of tube is within the letter of the industry standards. But its effect is the same as that of the "hot" tube. Replacement tubes are made within the standard tolerances, and as many fall on the lower edge of the tolerance band as at the upper edge. The customer's chance of getting a "cool" replacement tube on the lower edge is fairly good. Hence a replacement tube may pass all tests, except the final one of operating properly in a customer's set designed to operate only with a "warm" tube.

The answer to this one is simply a matter of education, better judgment on the part of the customer, and a good stiff upper lip on the part of the tube supplier. If the tube replacement business is important enough to justify an active list of 300 or 400 tube types, it is also worth enough to make replacement tubes the exact equivalent of original-equipment tubes. Which means making original-equipment tubes to the same standards as replacement tubes, regardless of all customer arguments to the contrary.

Roundtable Item No. 3
Watthours per dollar

In the transmitting tube section of the industry, especially the part serving the amateur market, there is a very serious question in the minds of some manufacturers concerning the ratings of competing tubes. The phrase "more watts per dollar" is a clarion call to the hams, and it has produced very real advances in the true worth of tubes. From less than a watt per dollar in 1921 to 22 watts per dollar in 1938 (see table, page 16, insert, October issue),—this is a progress record not to be regarded lightly.

But there is a thin dividing line between reasonable and unreasonable ratings for tubes, at any price. A reasonable rating is one that allows a reasonable life for the tube; an unreasonable rating is one that gives more watts, but at an unreasonable expense of operating life. The product of watts output times expected operating life, *the watthours of tube operation* averaged over a number of samples, can be plotted as a curve which has a hump in it where the product is a maximum. Operation at this point best serves the pocketbook of the customer.

The amateur user may not consider this economic balance very seriously. Since his station is operated intermittently, his tubes stand idle in their sockets for most of the time, and operating life is not an obvious question. But it remains that the cost of every watt-minute of operation is higher in an over-rated tube than in a properly-rated one. Moreover these tubes are often part of commercial transmitters, in the police and aircraft field especially, where steady operation and reliability are vital

(*Continued on page* 83)

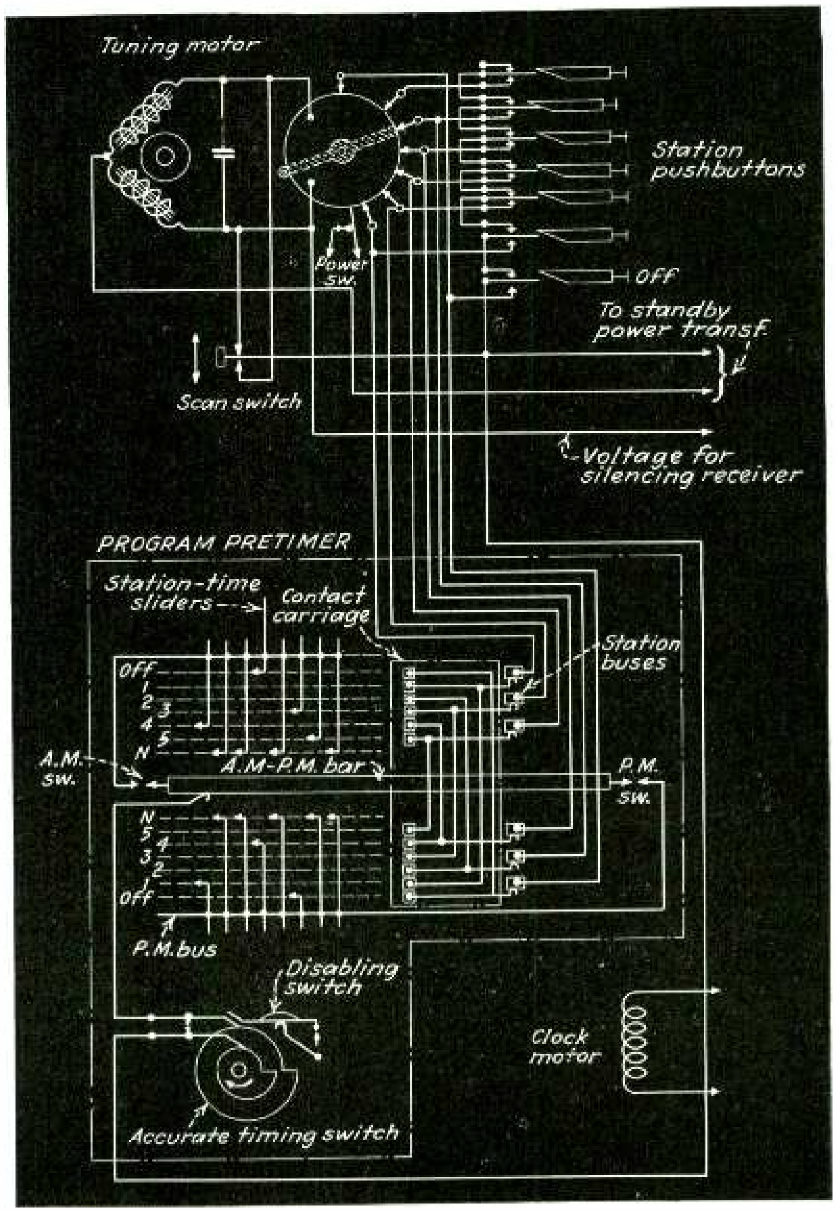
Radio Program

THE NEED for a program preselector for radio receivers has been felt for some time. Most people have favorite programs which they listen to regularly, and are often disappointed to find that they have missed a portion of a program because they have been occupied with other matters and have forgotten to turn the radio on or to retune it at the proper time. Such a device may also be used in lieu of an alarm clock, and to enable the user to listen to the radio after retiring, with the assurance that, should the listener fall asleep, the radio will be turned off at the conclusion of the program.

With the advent of satisfactory automatically tuned receivers, a part of the problem of preselection was solved, and the next logical step was the design of a preselector mechanism which was easy to set up, foolproof and of neat appearance.

The preselector shown in the accompanying photographs was developed cooperatively by the Radio Receiver Engineering Department of the General Electric Company, and the Engineering Department of the Warren Telechron Company, and is incorporated in some of the new GE receivers. As its program cycle is based on the twenty-four hour day, the confusion between AM and PM programs which existed on previous devices having a twelve hour cycle, has been obviated. The clock dial, which may serve as a regular timepiece in addition to its intended function of enabling the user to set the mechanism to correct time, is of conventional twelve hour form, and differentiation between AM and PM is accomplished by means of an indicator appearing behind an opening in the clock face.

As most of the important programs are multiples of fifteen minutes, this time has been chosen as the most desirable program unit. The ninety-six sliders, corresponding to the quarter hours of the day, are arranged, for ease in setting, in two horizontal rows corresponding to AM and PM respectively. Each slider may be set to any one of seven positions, corresponding to five different stations, "off" and "neutral." The sliders are normally left in the neutral position, where they are inactive. When it is desired to set up the preselector to tune in a station at a given time the slider corresponding to that time is moved to the vertical position corresponding to that station. If the receiver is off at that time, it will be turned on and tuned to the station indicated. If it is on another station, it will be retuned as required. When it is desired to turn the receiver off at a given time the proper slider is set to the "off" position. It is only necessary to set up sliders for the beginnings of the programs, and for the off operation, the intervening sliders being left in the "neutral" position. The preselector completes the control circuit exactly on the quarter hour and breaks it a few seconds later. It thus leaves the receiver in a condition to be actuated manually, either by the tuning knob, push buttons, or remote control, without the necessity for any selective switching. However, any



Schematic circuit for program preselector

Preselector

By D. R DeTAR,

General Electric Co.
Bridgeport, Conn.

such interference with the receiver during a program has no effect on the subsequent functioning of the preselector. The user may change the tuning or turn the receiver off during a program and may forget that he has set up the preselector for a later program. The preselector, however, will not forget and will again take control and tune in the desired program.

Setting up the program schedule for the entire day is very easy and requires but a few seconds. The schedule is indicated by the position of the sliders, and any program may be changed at any time without interfering with the others. A disabling switch is provided for rendering the device inoperative without destroying the program schedule when, for example, it is desired to go out for the evening. Upon returning it is only necessary to turn this switch on to resume the interrupted schedule.

The simplicity and compactness of the device are evident from the rear view. A large molding of phenolic material forms the decorative front panel, and supports and insulates the other parts. The 96 sliders project through slots in this panel and are supported on two metal plates at the rear. A molded carriage is propelled from left to right during the twelve hours of the AM period and from right to left during the PM period, by means of a lead screw having right and left handed threads, which is rotated continuously by the clock motor. Projections on the sliders engage contacts on the carriage corresponding to the stations to which the sliders are set. In order to differentiate between AM and PM operations a limit switch, operated by the carriage at the ends of its travel, is provided. This switch causes the AM sliders to be energized during the AM period, and the PM sliders during the PM period.

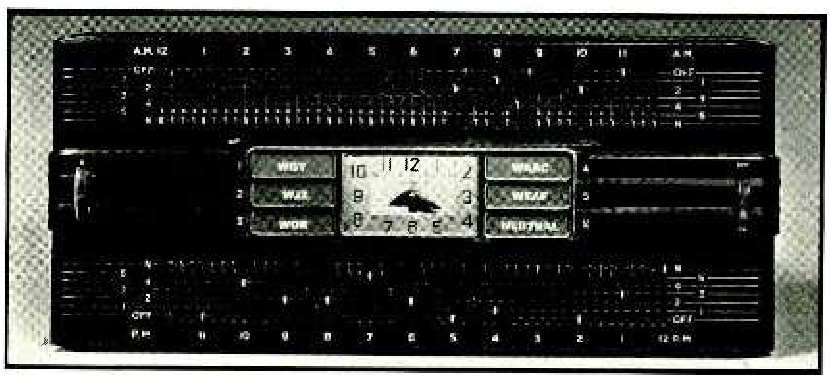
As the contact carriage moves very slowly, the accuracy with which it makes and breaks the control circuits is rather low. In order to obtain accurate timing the contacts on the carriage are arranged so as to engage the sliders several minutes before and to disengage several minutes after the quarter hour, and a cam operated switch is provided in series with the common return lead. This switch closes the control circuit exactly on the quarter hour, and opens it after ample time has elapsed for the completion of the tuning operation, in this case ten seconds.

The clock motor is of the self-starting synchronous type with enclosed gearing running in a bath of oil. As it is necessary that the shaft of this motor be kept nearly horizontal, the motor is arranged with its shaft parallel to the length of the panel, so that the preselector may be mounted either on the top or the front panel of the cabinet, as desired.

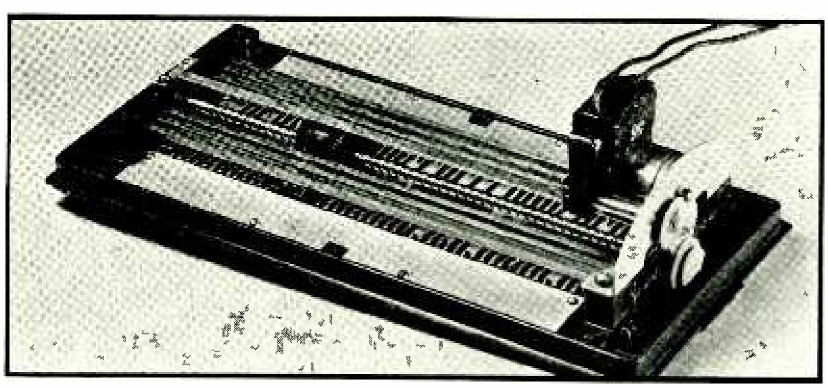
The circuit controlling the receiver is shown on the accompanying diagram. Voltage for operating the tuning motor is furnished by a stand-by transformer, floating on the power line. The power switch is opened when the tuning condenser is rotated to one extreme of its travel. The receiver is thus turned on when any station selector circuit is completed. The "off" operation is exactly the same as any station selecting operation as far as the preselector is concerned. Motor voltage, rectified by an unused diode in one of the receiver tubes, is applied to bias the first audio amplifier to cut-off to silence the receiver while the motor is running.

An extra contact may be provided on the disabling switch to light a lamp for indicating the position of the switch, so that the user may see at a glance whether or not the preselector is in a condition to assume control of the receiver at the proper time.

This preselector can readily be adapted for use with other types of automatic tuning. It should also have applications in other fields, such as facsimile receivers, bell systems for schools, etc.

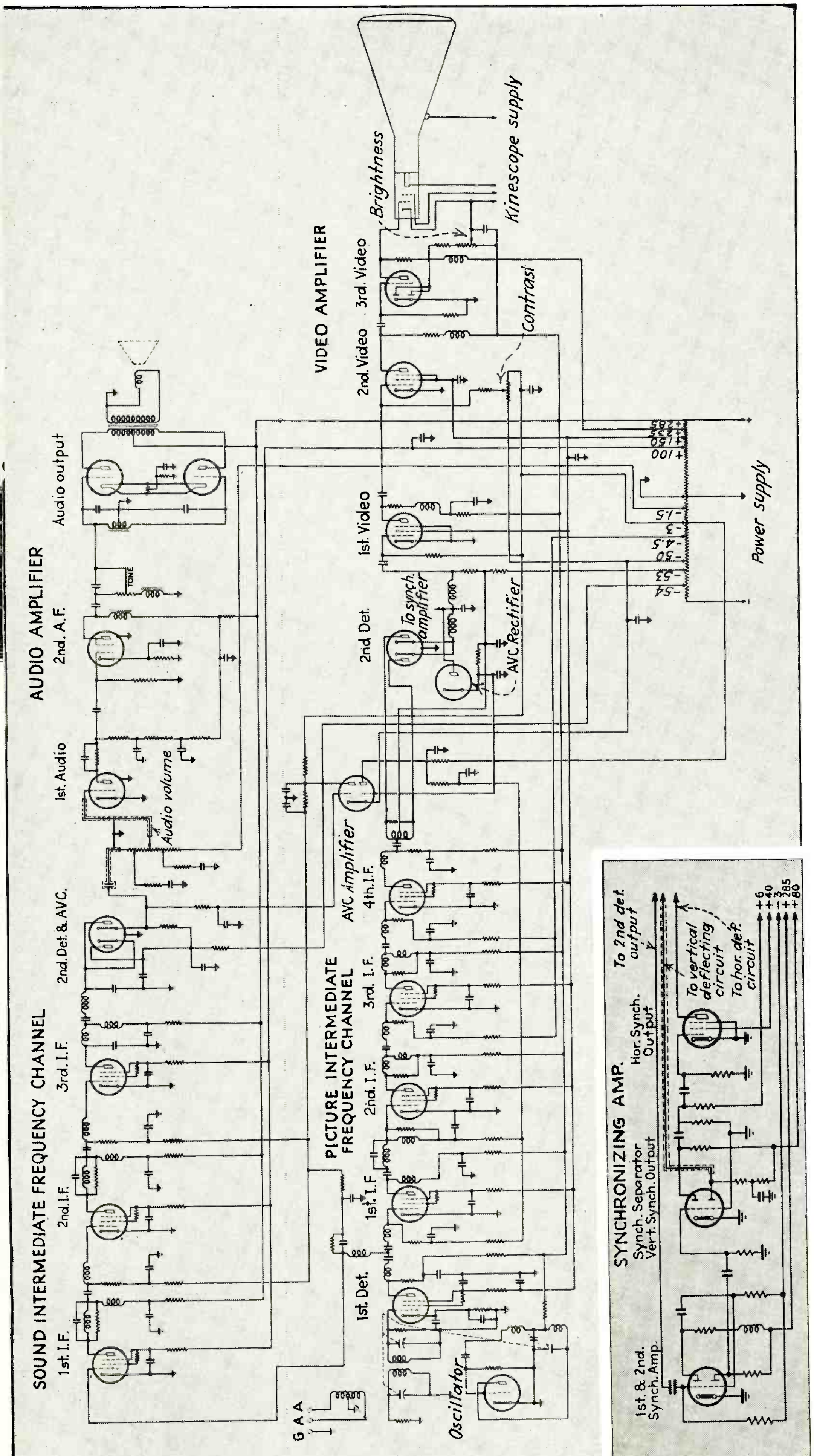


Front view of preselector showing levers for selecting a new program every fifteen minutes



Rear view of panel plate of preselector

TELEVISION



By E. W. ENGSTROM
and
R. S. HOLMES

*RCA Manufacturing Co., Inc.,
Camden, N. J.*

IN order to reproduce a true image on the television receiver screen, the scanning spot at the receiver must be moved synchronously with the exploring scanning spot at the transmitter. In addition, information must be transmitted representative of the brightness of each elementary area and this used to control the electron beam strength of the kinescope.

Synchronization of the scanning at the receiver with that at the transmitter is accomplished by transmitting characteristic pulses at the end of each line and at the end of each field. In the transmitted picture signal, these synchronizing pulses are represented by excursions of voltage in the direction representative of black in the picture and where they occupy a position corresponding to blacker than black. That is, while the picture signal occupies the portion of the total signal amplitude between a voltage representative of white and a voltage representative of black, the synchronizing occupies a region beginning at black level and extending from there in a direction opposite to that representative of white.

The wave shape of the television signal for the region near the vertical synchronizing pulse for two successive fields is shown in Fig. 2. These wave shapes are for the standards of 441 lines per frame, 30 frames per second, 60 fields per second interlaced. The two wave shapes of Fig. 2 differ because of the requirements for interlacing. At the left side of the figure are shown the last few lines of each field. At the end of each line is shown the horizontal blanking pulse, which drives the kinescope grid to cut-off (black level) during the return sweep of the line deflection.

During the time between the bot-

Fig. 1—Receiver diagram with synchronizing amplifier

SYNCHRONIZATION

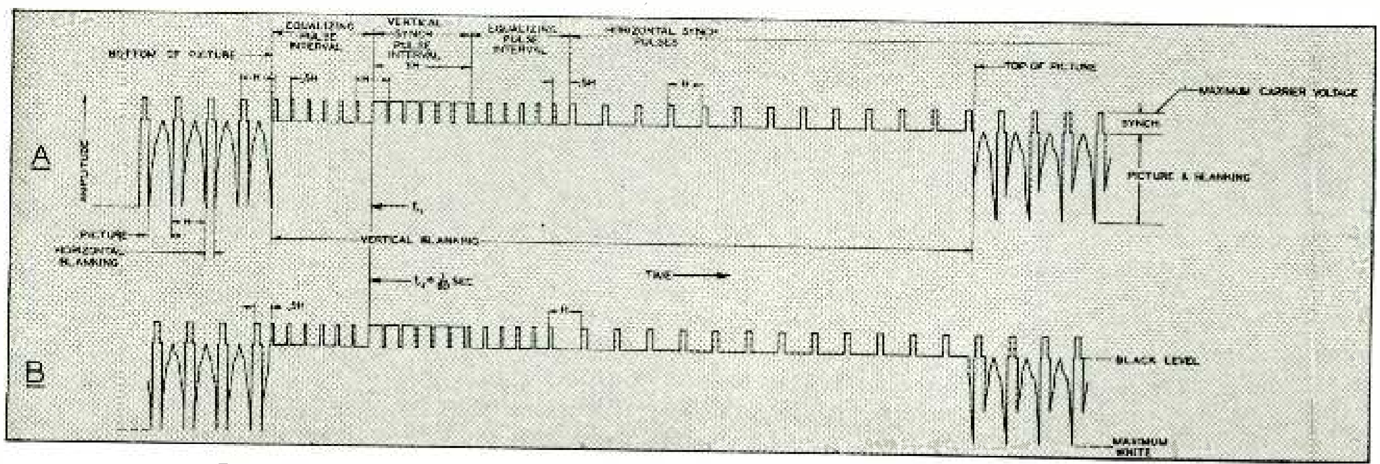


Fig. 2—Wave shape of television signal near the time of the vertical synchronizing pulse for two successive fields

tom of one picture field and the top of the next occurs the vertical blanking pulse which maintains the kinescope bias at or beyond cut-off during the vertical return sweep.

Superimposed on these two blanking pulses are the synchronizing pulses, which extend from black level in the direction of blacker than black. The horizontal synchronizing pulses are single, nearly rectangular, pulses, occupying most of the blanking period. Their positions in alternate fields are displaced by half a line, so that in alternate fields the horizontal scanning lines will be displaced by half a line, thus producing interlacing.

The horizontal synchronizing pulses are continued during the vertical blanking period in order to continuously maintain horizontal synchronization. Beginning at the front edge of the vertical blanking, the width of the horizontal pulses are made only half the width of those preceding the vertical blanking, and additional equalizing pulses are spaced half way between the regular pulses. This condition continues until three lines after the vertical pulse has passed; then the regular horizontal pulses again occur. The purpose of these equalizing pulses is to make conditions of vertical synchronization identical for the two successive fields.

The vertical synchronizing pulses for the two fields are identical. They consist of a series of pulses lasting for three horizontal line periods. The leading edge of each vertical pulse corresponds in position to the leading edge of the horizontal pulses and is used for horizontal synchronization. The total duration of the vertical pulse is sufficiently longer than that of the horizontal pulse to allow them to be separated from each other by wave shape discrimination.

The video signal appearing across the diode resistor of the picture second detector is the same as that shown in Fig. 2. This signal is impressed on the synchronizing amplifier as shown in Fig. 1. There are two stages of straight resistance coupled amplification. These stages are similar to regular video amplifier stages, and raise the video signal level to a value sufficient to give good operation of the synchronizing separator tube. This tube is essentially a distorting amplifier operating in such a manner that the synchronizing pulse portion of the video signal is passed, while the picture portion of the signal is rejected.

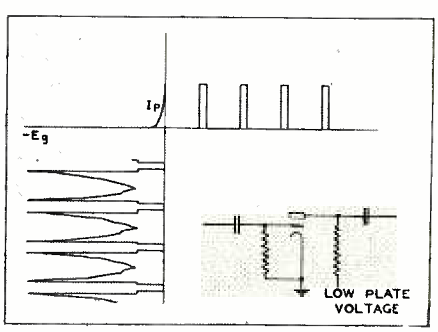


Fig. 3—Synchronizing separation operation

The operation of the synchronizing separator is illustrated in Fig. 3. The grid leak of the separator tube is returned to its cathode and is very high resistance, so that the tube is grid leak biased by the grid current flowing during the positive synchronizing pulse peaks in a manner similar to that described for the picture output tube (third video amplifier). The bias is maintained between synchronizing pulses by the charge on the grid coupling condenser. The separator tube is operated at a low plate voltage, so that plate current cut-off occurs at only a few volts negative grid bias. The video signal from the preceding amplifier tubes impressed on the separator grid is of sufficiently large amplitude that only the synchronizing pulses are passed by the tube —all the rest of the video signal occurs in the region beyond the grid cut-off of the separator tube and therefore has no effect on its plate current. In the plate circuit of the separator tube there appear only the synchronizing pulses, completely separated from the picture components of the video signal. The wave shape and amplitude of these pulses is essentially constant, regardless of variations in the amplitude of the video signal on the separator grid, provided only that the input is sufficiently large so that the synchronizing pulses swing the grid from zero voltage to cut-off. The wave shape cannot change because all synchronizing pulses are essentially rectangular. This signal, of course, consists of the

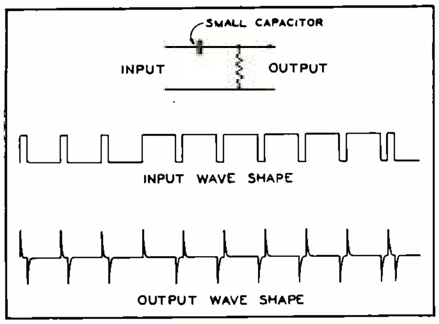


Fig. 4—Horizontal synchronizing separator circuit and waveforms

complete combination of synchronizing pulses, including vertical, horizontal and equalizing pulses.

The vertical and horizontal pulses are separated from each other by frequency selecting circuits, such as the RC circuits shown on the diagram of Fig. 1. These circuits are in the plate of the synchronizing separator tube.

The horizontal pulses pass through a high pass RC circuit as shown in Fig. 4. This figure illustrates how the vertical pulses are eliminated from the signal, but at the same time horizontal pulses are obtained from the leading edges of the vertical pulses to maintain horizontal synchronization during the vertical pulse period. The equalizing pulses, of course, are passed by this circuit and are impressed on the horizontal oscillator along with the regular horizontal pulses. They have little effect on the oscillator, however, because it is not susceptible to synchronization during approximately the first three-quarters of each scanning line. The oscillator synchronizes only on the regular horizontal pulses.

The horizontal synchronizing output tube is preferably a pentode. It acts as a buffer to prevent voltage from the horizontal oscillator from getting back to the synchronizing separator and thus into the vertical synchronizing circuit. If any cross-talk is present from the horizontal deflecting circuit into the vertical it will be detrimental to interlacing.

From the plate of the synchronizing separator tube the vertical pulses pass through an integrating circuit. The operation of this circuit is illustrated in Fig. 5 for the two periods corresponding to *A* and *B* in Fig. 2.

This circuit has a slight response to the horizontal pulses, resulting in a horizontal output voltage of saw-tooth wave shape having an amplitude of a few per cent of the input wave. During the period preceding the start of the equalizing pulses this output wave is different for alternate fields. The function of the equalizing pulses is to eliminate this difference so that the vertical pulses for alternate fields are alike within sufficiently close limits so that interlacing will be satisfactory. As can be seen in Fig. 5, the effect of the half line difference in spacing of the last regular horizontal pulses has practically disappeared by the time the first vertical pulse arrives. The filter output voltage builds up rapidly as it integrates the rectangular vertical synchronizing pulses, then dies out again after the pulses have passed, thus generating the vertical pulse which is used to synchronizing the deflecting oscillator.

Though we have referred to the action of the filters as "frequency separation," it should be understood that the filters are not particularly

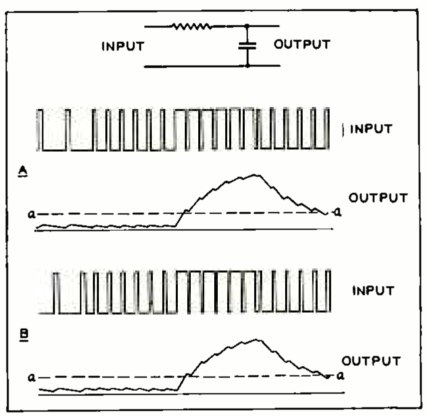


Fig. 5—Integrating circuit for vertical pulses

responsive to the frequencies of 13230 and 60 cycles per second respectively as would be the case with tuned circuits. Actually the filters are in effect selectively responsive to the pulse wave shapes. For example, the vertical synchronizing isolating filter would be equally effective if the repetition of the vertical pulses were 15 or 200 instead of 60. The duration of the pulses and not their frequency is the important characterization which allows the vertical pulse to be isolated.

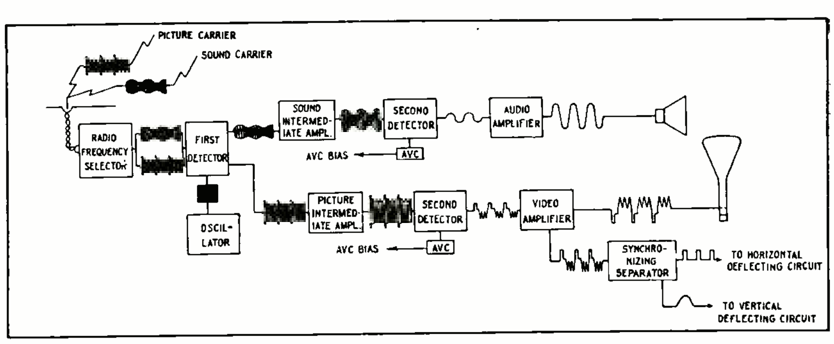
The output of this filter drives the vertical synchronizing output tube. This tube is arranged to clip the output wave at level a-a in Fig. 5, to remove the remaining effects of the horizontal pulses on the vertical, leaving only the vertical pulse above the a-a level. This clipping is accomplished by operating the tube at a slight positive bias which is fed, along with the signal, through the large series grid resistor. While this tube is also a buffer, it is not necessary that it be a pentode, since it is not so essential to eliminate cross-talk from the vertical deflection into the horizontal synchronizing. Such cross-talk has little effect on interlacing.

The RMA television signal and synchronizing pulses permit utilization by several satisfactory methods. In this discussion we preferred to describe a method of isolation of the field pulse by integration, using circuits of comparatively long time constants. Circuits of relatively short time constants may also be used. Also, the wave front of the first serration (drop to black level) may be used by the so-called "back-kick" in a circuit having small coupling capacitance.

In this article we have discussed synchronizing wave shapes and a method of obtaining satisfactory pulses for synchronizing the deflecting oscillators from the complete video signal.

The next article will describe th vertical and horizontal deflecting circuits and methods of applying their output to the kinescope for developing the scanning pattern.

Fig. 6—Block diagram of portions of television receiver so far discussed in the Engstrom-Holmes series



An Automatic Remote Amplifier

Amplifiers placed at pick-up points remote from the broadcast studio but operated from the studio provided station WJEJ with a solution of the "weekly headache" of Sunday broadcasting with a limited engineering staff

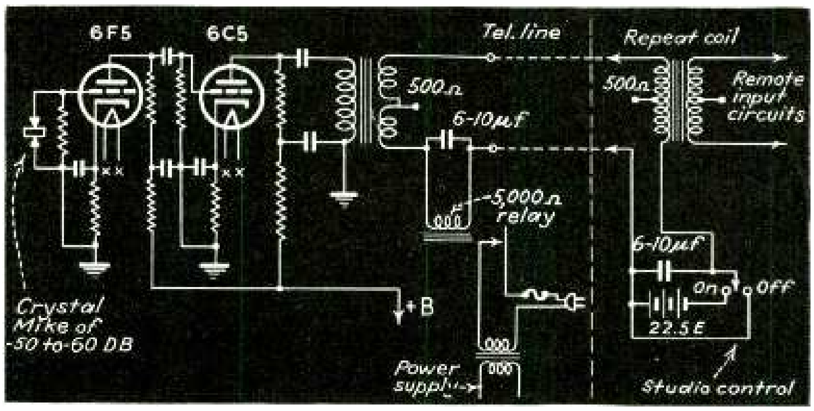


Fig. 1—Automatic remote amplifier with control relay in series with line

By G. HAROLD BREWER

Chief Engineer WJEJ Hagerstown, Md.

THE local broadcasting station, with a limited staff of engineers, has quite a busy day on Sunday, setting up and operating the various church broadcasts.

This weekly headache has been most efficiently solved at WJEJ by the construction of automatic remote amplifiers permanently installed in each church to be broadcasted. This system has been in operation for 6 months without a single breakdown.

As noted in Fig. 1, a high resistance relay of 5,000 ohms is placed in series with the telephone line at the amplifier. This relay is of the sensitive type used in vacuum tube circuits and has SPST contacts, which control the 110 a-c input to the amplifier. This relay coil, must be shunted with at least 6 to 10 μf of condensers to prevent loss of low frequency passages. A high resistance relay was selected to keep the current in the line as low as possible, so as not to upset the normal balance of the line transformers. At the studio, the point of control, there is a 22-volt battery, shunted with 6 to 10 μf of condensers and a SPDT switch. In the OFF position, the switch disconnects the battery and shorts out the condensers. for normal remote operation. In the ON position the switch turns on the automatic system by placing the battery shunted by the condensers, in series with the line, thus, energizing the relay at the remote amplifier.

Paper condensers must be used to prevent leakage of the battery current, which would tend to lower battery life. Another method shown in Fig. 2, has been tried and used, but was given up in favor of the system just described. The system shown in Fig. 2 shows the relay and control battery placed in series with the center taps and ground of the remote amplifier output transformer and the input winding of the studio repeat coil. This method of control is somewhat less expensive to construct, as it requires no bypass condensers. However, in some lines, singing may develop due to an unbalanced condition of the center taps. Furthermore it is necessary to have a good ground at both ends and this may be hard to get at the remote point.

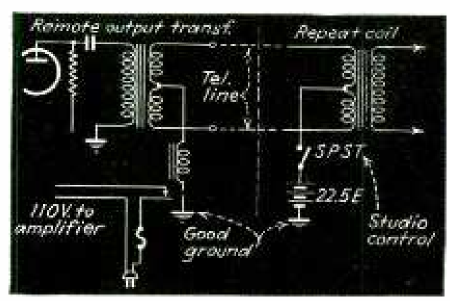


Fig. 2—Simpler control method; but less stable on long lines

Naturally, there is no one to ride gain, so the volume level must be controlled at the studio. Perfect timing of such a broadcast is obtained by the use of an electric clock at the organ console in the church. A few seconds prior to broadcast time, the organist starts playing so that the broadcast will begin with music, this method eliminates trouble due to slight differences of time.

Microphones of -50 to -60 db, such as the ordinary crystal type, will give sufficient output signal to drive the amplifier used to feed any local remote line.

These systems have more than paid for themselves by eliminating wear and tear on more expensive equipment, and the necessity of having additional men to set up and operate such broadcasts. Too, they are more dependable because of their permanent installation.

Selecting Loud Speakers for Special Operating Conditions

ALL systems having to do with the transmission and reproduction of sound fall into two broad classifications, (a) systems where fidelity is essential and (b) systems designed primarily for the transmission of intelligence. Equipment designed for (a) would not, in general, be suitable for a system in which the transmission of intelligence is of paramount importance. A system of type (b) will be required, likely, to operate through an ambient noise having a frequency characteristic and level such as to make high-fidelity transmission impossible and it is better engineering to concentrate on a system that will most efficiently transmit intelligence under the required operating conditions.

It is this problem of selecting loud speakers for use with systems where the transmission of intelligence is of paramount importance and where, at the same time, high ambient noise levels will be encountered that is considered in this paper.

Data Required

Before proceeding with the selection of loud speakers for a particular system, the energy level and frequency distribution of the ambient noise must be determined. This can be done with wave analyzer preceeded by a calibrated microphone and audio amplifier. The frequency-amplitude characteristic of the microphone and amplifier should be essentially uniform so that all noise components will be accurately presented to the analyzer input. This data is important since we desire a loud speaker whose frequency characteristic is such that its acoustic energy is concentrated in a frequency band removed from that where the noise is predominant.

Accurate data as to efficiency and frequency characteristic of all speakers mechanically suited to our application are important. There are, in general, two methods for measuring the amplitude-frequency characteristic of any acoustic transducer, viz., (a) We may apply electrical energy to the unit in the form of alternating potentials; only one frequency being applied at any given time. The acoustic output of the transducer is measured with a calibrated microphone and amplifier, whose composite amplitude-frequency characteristic is essentially uniform over the range of measurements. In this manner the output of the transducer is measured at each frequency and if the input is kept constant we, in effect, measure the relative efficiency at every desired frequency. (b) We may apply electrical energy to the reproducer in such a form that all frequencies are applied simultaneously and at a uniform amplitude. If, then, the acoustic output of the transducer be picked up by a calibrated microphone and amplifier, whose composite amplitude-frequency characteristic is essentially uniform, we may analyze the output of the amplifier with a selective audio analyzer and measure the relative acoustic efficiency over any band whose width and location are determined by the selectivity and setting of the analyzer.

Method (b) has been investigated in England by Brittain and Williams[1] as it applies to loud speakers. These authors also compared measurements made by method (b) with those made, under ideal conditions, by method (a). The agreement is satisfactory. I have made comparative measurements on telephone receivers using both methods. The curves in Fig. 1 are representative of several that were run on different types of small telephone receivers, using an artificial ear to acoustically load the unit. It is apparent that almost identical curves will be obtained by either method so that our choice will depend entirely on practical considerations involved in making the measurements.

The difficulties encountered when making measurements of loud-speaker response using method (a) are well known. Because of standing waves, set up by reflection, it is extremely difficult to obtain dependable results unless the measurements are made in the open. Even then it is desirable to suspend the microphone at a height above the ground and point the loud speaker up to avoid ground reflections. It is usually impractical to make measurements on the loud speaker under conditions approximating actual operation.

Method (b) is not subject to the foregoing limitations and, in addition, has certain other advantages. The method does not measure the performance of the loud speaker at any one frequency but measures the average response over a frequency band of width determined by the selectivity of the analyzer. Errors caused by the presence of standing waves are obliterated since the energy measured is that contained in a continuous-frequency band of finite width and not that contained in any single-frequency component. Errors caused by standing waves are also reduced by the use of warble-tone excitation for the loud speaker, but the method is not nearly so effective as excitation from a continuous-frequency source. When using warble tone, only one frequency is applied to the loud speaker at any given time; while, with a continuous-frequency source, all frequencies are applied simultaneously. Because of the inherent absence of standing waves, method (b) can be used to measure the performance of loud speakers under acoustic conditions similar to those of actual operation. Special treatment of the walls of the room where measurements are to be made is not required.

It is interesting to consider what

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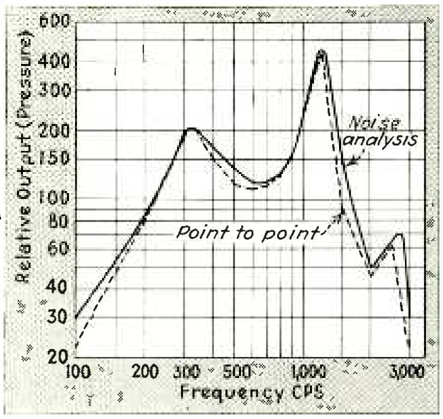

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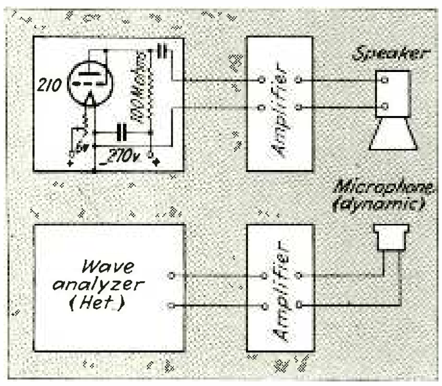

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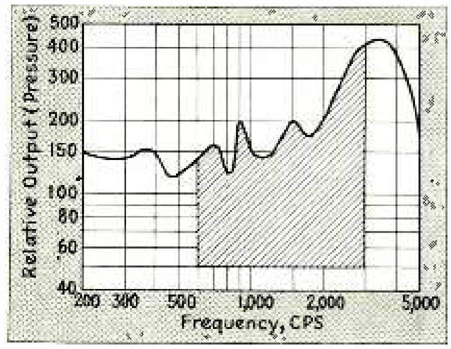

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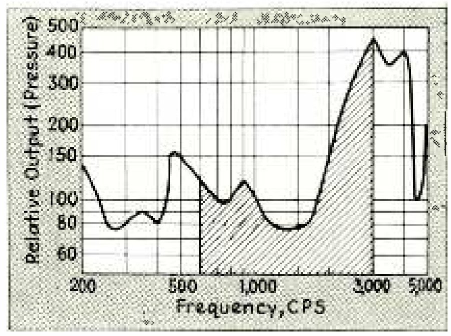

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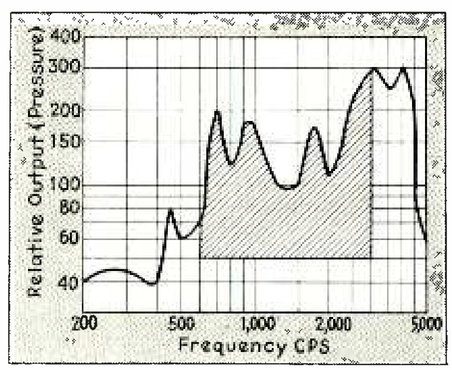

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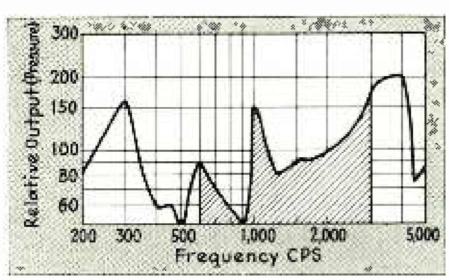

Fig. 1—Comparison of measurement by noise-analysis and point-by-point methods

Fig. 2—Set-up for loud speaker measurements

Fig. 3—Marine, double re-entrant horn; shaded area=5.75 sq. in., average relative output=193

Fig. 4—Marine, single re-entrant horn; shaded area=4.50 sq. in., average relative output=145

Fig. 5—Dynamic, paper cone, 12 inch speaker; shaded area=4.04 sq. in., average relative output=130

Fig. 6—Dynamic, paper cone, 8 inch speaker; shaded area=2.63 sq. in., average relative output=93

By

L. B. HALLMAN, JR.

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Aircraft Radio Laboratory
Wright Field, Dayton

happens if we vary the selectivity of the analyzer. If it were possible to increase the selectivity to a point where only a single frequency could pass, an infinitely small amount of energy would be transmitted by the analyzer, since only an infinitely small portion of the total energy is present in any single-frequency component. The rms value of the voltage at the output of the analyzer at any setting is proportional to the square root of the frequency band width passed. It follows, therefore, that the selectivity of the analyzer should not be greater than is necessary to show the important irregularities in the response curve of the transducer that is being investigated.

If we go to the opposite extreme and make the analyzer aperiodic the average efficiency of the transducer over the entire frequency range will be measured. This suggests a quick production method for measuring the overall efficiency of acoustic transducers.

Equipment Used

Figure 2 is a block diagram of the measuring equipment used together with a schematic of the noise source. The noise is generated by shot effect in a type 210 tube, operating as a saturated diode. It is necessary to adjust the filament temperature to a fairly definite value for maximum noise. The 100,000 ohm resistor should be carefully selected to obtain a quiet unit as otherwise the characteristic noise in the resistor may be great enough to override the noise generated by shot effect in the tube.

The noise amplifier and microphone are conventional and require no special comment. The microphone amplifier was part of a sound meter which, in addition to its function as a pre-amplifier for the wave analyzer, served as an aperiodic device to measure the average acoustic output of the loud speaker over the entire frequency range.

A wave analyzer of the heterodyne type was used; a two-section quartz filter providing the required selectivity. Since the noise measured is random in nature it is necessary to use an indicating instrument at the analyzer output which will respond only to average values. Thus we require the average value of the analyzer output over a finite time and not the instantaneous values which are erratic. It should be noted that this random nature of the noise source is probably advantageous in that the loud speaker is tested under all transient conditions likely to occur in actual operation.

The amplitude-freguency characteristic of the noise source was obtained by substituting a resistive load for the loud speaker and analyzing the voltage developed across it. In this manner the amplitude-frequency characteristic of the noise applied to the loud speaker input was determined to be essentially uniform from 50 to 15,000 cps.

Evaluating Loud Speakers Tested

The data shown were taken using the noise-analysis method. Equipment was set up as shown in Fig. 2, with the microphone five feet from, and directly in front of, the loud speaker. The object of the work was to select a loud speaker suitable for use in connection with a calling system to be installed on large aircraft. All measurements were made with constant speaker-power input.

The principal noise components encountered in aircraft are below 600 cps. Consequently this frequency was selected as the useful lower limit of the loud speaker output. Microphones to be used with the system have an upper frequency limit of approximately 3000 cps. Hence 3000 is taken to be the useful upper frequency limit of the loud speaker. Satisfactory articulation can be obtained by passing the 600 to 3000 cps band. It appears, therefore, that this band width will be satisfactory for the transmission of intelligence. The lowest output encountered was in the case of the speaker whose response curve is shown in Fig. 6. This value was used as a base upon which the shaded areas shown under each curve were contructed. The sides of the areas are the 600 and 3000 cps ordinates which represent, respectively, the lower and upper useful frequency limits. The response curve of the loud speaker forms the top of the area.

Since the microphone used in taking the loud speaker measurements is pressure operated, the reading of the indicator on the wave-analyzer output is proportional to the pressure in the sound field. That is,

$$p = CM,$$

where M is the indicator reading and C is constant.

Consider the areas A_1 and A_2 under any two of the curves shown. Let M_1 and M_2 be the ordinates corresponding to the average heights of the areas under curves 1 and 2. Then,

$$A_1 = K \log \frac{f_2}{f_1} (\log M_1 - \log M_0)$$

$$A_2 = K \log \frac{f_2}{f_1} (\log M_2 - \log M_0).$$

Where M_0 is the ordinate corresponding to the same base line of the areas, K is a proportionality factor between the units in which the areas are measured and the logarithmic products; and f_1 and f_2 are the frequency limits defining the sides of, the shaded areas. The base line, M_0, of the two areas to be compared, may be shown arbitrarily so long as it is the same in both cases, and so long as it does not rise above the curve between f_1 and f_2.

Let $K \log_{10} \frac{f_2}{f_1} = B$; a constant when the frequency-band width considered is constant and the same log-log paper is used for plotting both curves. Then,

$$A_2 - A_1 = B \log_{10} \frac{CM_2}{CM_1} = B \log_{10} \frac{p_2}{p_1}$$

and, in decibels this is expressed as

$$\frac{20}{B} (A_2 - A_1) = 20 \log_{10} \frac{p_2}{p_1} \ldots\ldots (1)$$

The constant, B, can be calculated by measuring the areas A_1 and A_2 with a planimeter and dividing by the measured width to obtain the average ordinates. Then, by scaling off on the curve sheet the height obtained for the average ordinate, the value of M is derived. The constant, B is obtained from:

$$B = \frac{A_2 - A_1}{\log_{10} \frac{M_2}{M_1}} \ldots\ldots\ldots\ldots\ldots (2)$$

After B is calculated[2] for a given frequency range and given log-log paper, to compare the average response of any two speakers over the same frequency range, measure the corresponding areas under the two curves, subtract the smaller area from the larger and multiply by $20/B$. This gives the average db increase in effective acoustic power output of the speaker represented by the larger area over that of the speaker represented by the smaller area.

For example, using the areas shown in Figs. 3 and 4 we find B, from (2), to be:

$$B = \frac{5.75 - 4.50}{\log_{10} \frac{193}{145}} = \frac{1.25}{0.124} = 10.1$$

From (1),

$$\frac{20}{10.1} (5.75 - 4.50) = 2.48 \text{ db.}$$

That is, the loud speaker, whose frequency-response curve is shown in Fig. 3, will give an average response, in the presence of the noise and with the microphone considered, 2.48 db higher than that of the speaker whose frequency-response curve is shown in Fig. 4.

In the same manner we determine the loud speaker of Fig. 3 to be 3.38 db better than the loud speaker of Fig. 5 and 5.63 db better than the loud speaker of Fig. 6.

The results of the foregoing analysis were checked by mounting the four loud speakers in a Ford tri-motored plane which has a highly noisy compartment. The speakers were all mounted in the same section of the compartment and the amplifier output wired so that it could be switched instantly to any one of the four speakers. The results of the analysis were satisfactorily substantiated; the speaker of Fig. 3 being unquestionably superior, in the opinion of four observers.

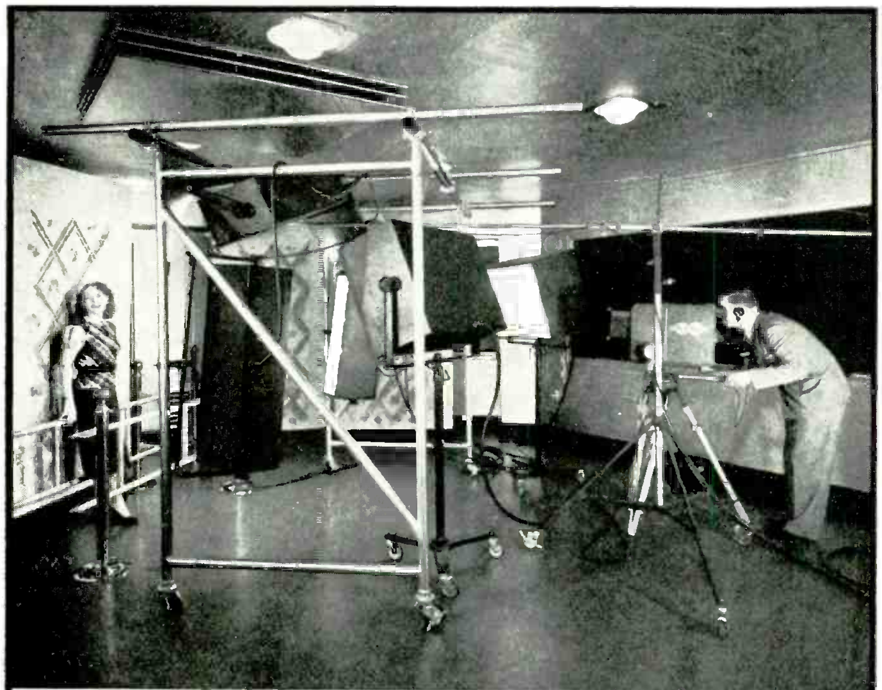
It was found that the articulation of the speaker of Fig. 5 was poor. This was probably caused by the relatively low response in the region from 1100 to 1800 cps, which frequencies are important when high articulation is essential. Strangely enough, it was the opinion of most observers, when the speakers were mounted in a quiet room, that the "quality" of speech from the speakers of Fig. 5 and Fig. 6 was better. This impression is probably created by the peaks at the low end of the spectrum which are masked out by the airplane noise.

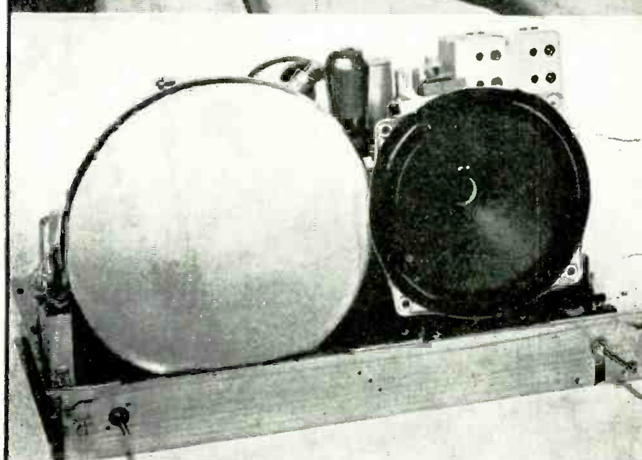
A sixteen-inch square baffle was used as a mounting for the twelve-inch dynamic unit and a twelve-inch diameter circular baffle was used with the eight-inch dynamic unit. It was realized that these baffles were not as large as the speakers would require for optimum performance, but space available in the aircraft made larger sizes prohibitive.

REFERENCES

[1] F. H. Brittain and E. Williams, Loud Speaker Reproduction of a Continuous-Spectrum Input, *The Wireless Engineer*, Jan., 1938, p. 16.

[2] Considerable error may occur when two quantities are to be subtracted and when the quotient is to be divided by a third quantity. The possible error increases as the two quantities approach each other in value—The Editor





SIGHT and SOUND

Video engineering in the news here and abroad

ABOVE are two views of the newly installed "Television Tour," at Radio City, operated by the National Broadcasting Company for the benefit of sightseers who pay 55 cents for the privilege of viewing a complete television unit in action. AT THE TOP is the studio, built especially for the purpose. One half of each group goes before the camera while the other half views them in the receivers, three of which are provided in an adjourning room. BELOW, Robert Morris, N.B.C. development engineer examines one of the receivers with Betty Goodwin, first NBC television announcer.

AT RIGHT, TOP, is the "seeing telephone" handset recently shown in London. It contains a small cathode-ray tube, and may be used as an extension on a vision receiver, or for "visible conversations" over coaxial telephone lines. RIGHT, CENTER, is a highly compact chassis of a recent German model. The cathode-ray tube employs magnetic focussing and is remarkably short for its diameter, only 11 inches long, with a 10-inch diameter screen. BELOW is a Scophony home receiver which projects a 24 by 20 inch image from a Kerr-cell-modulated mercury arc source onto a translucent screen.

A LABORATORY

By DONALD G. FINK

Managing Editor, Electronics

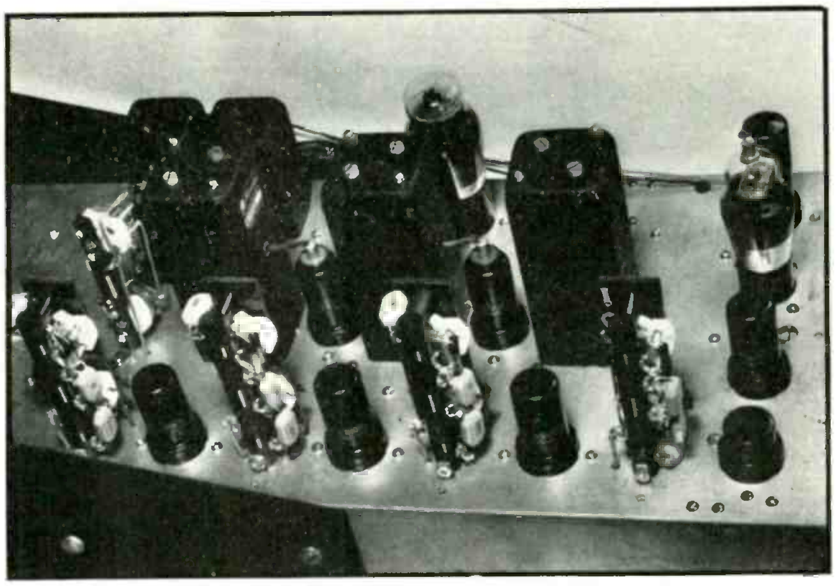


Fig. 2—Chassis layout of video channel (foreground) showing wide-band i-f coupling units with shield cans removed

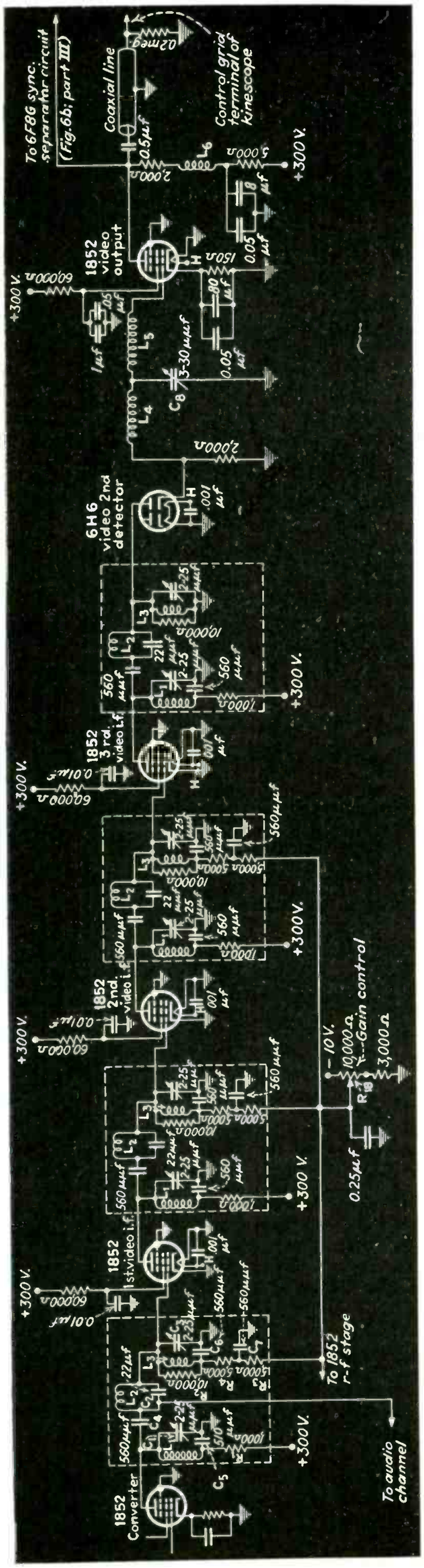


Fig. 1—Circuit diagram of video channel, from converter to control grid of the kinescope

THE video signal, as outlined in the preceding installment of this series, enters the r-f amplifier of the receiver as a carrier whose frequency is 13 Mc lower than the oscillator frequency. Consequently in the output of the 1852 converter tube (see Fig. 4, page 19, October issue), the video signal appears as an i.f. of 13 Mc with sidebands extending 2.5 Mc above and below the carrier. The sideband from 13 to 10.5 Mc is amplified in an i.f. amplifier consisting of three 1852 stages, coupled by filter networks designed to pass this wide band without frequency discrimination. At the output of the i.f. amplifier, a single section of a 6H6 diode demodulates the i.f. and produces a signal having components from 0 to 2.5 Mc. This demodulated signal is then amplified in a video amplifier and applied to the grid of the cathode ray tube. The video output stage also feeds the sync separator circuit shown in Fig. 6b, page 24, in the September issue.

The connections of the wide-band video i.f. amplifier, second detector and video output stage are shown in Fig. 1. The arrangement of the circuit parts is shown in Fig. 2 (and also in Fig. 2, page 17, October issue). Referring to Fig. 1, the 1852 converter tube feeds a coupling network consisting of three parallel tuned circuits, the first in the plate circuit of the converter, the second in the coupling connection to the following i.f. amplifier tube, and the third in the grid circuit of the latter tube. These circuits and auxiliary components are mounted within a cylindrical shield can, measuring 2½" by 4" high, represented by the dotted lines in the diagram. Four such coupling units are employed between the three i.f. stages and in the second detector input. All four of these coupling units are the same except for the following: (1) In the first coupling unit, between the converter and the first i.f. tube, a connection is made from one end of coil L_2 (the coupling coil) to the audio channel, as shown. This connection leads directly to the rejector circuit in the audio channel, shown in Fig. 4, page 19, October issue, and replaces the

TELEVISION RECEIVER—V

connection shown in that Figure. (2) In the second detector input, the coil L_3 in the detector circuit is grounded, instead of returning to the gain control R_{18} as in the other coupling units.

The second detector output is coupled to the video output stage through a T filter L_4 and L_5, while the plate circuit of the video output stage contains the peaking coil L_6. These measures are taken to preserve the wide frequency-response required in the detector and output amplifier.

The picture channel of *Electronics'* receiver, including the wide-band i-f coupling units, video detector and output stage, completes the Super-heterodyne receiver unit

Wide-band i.f. coupling units

The coupling units shown within the dotted lines in Fig. 1 must be constructed exactly according to specifications if their band-pass characteristics are to meet the requirements of the 10.5 to 13 Mc band. The specifications outlined below are based on the design of engineers in the Commercial Application Section of RCA, Radiotron Division, and are acknowledged with appreciation. The coupling units are to be described more fully by C. C. Shumard of RCA in an article to appear in an early issue of *QST*.

The coupling unit assembly is shown from two aspects in Fig. 3, while the dimensions of the coils and their spacing on the coil form are shown in Fig. 4. The unit consists of three coils, designated as L_1, L_2 and L_3 in Fig. 1. These coils are all wound on a ½-inch hard rubber mandrel. Coils L_1 and L_3 are 23.5 turns of No. 30 enamelled magnet wire, close wound. Coil L_2 is 41 turns of the same wire. The variable capacitors C_1 and C_3 which tune the coils L_1 and L_3 are Hammarlund 3-25 $\mu\mu$f air-dielectric units, type APC-25. The capacitor C_2 tuning L_2 is a midget 22 $\mu\mu$f fixed unit. Selected fixed capacitors having this exact capacitance may be obtained from any condenser manufacturer.

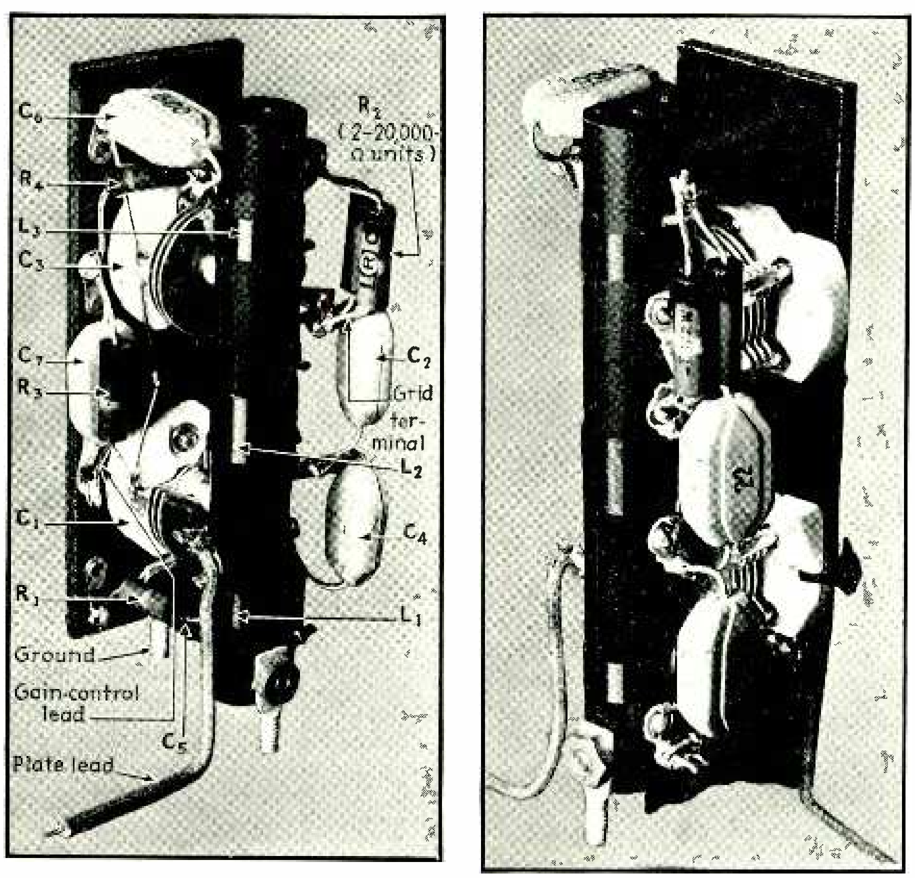


Fig. 3—Two views of the video i-f coupling unit. The labels correspond to Fig. 1.

The blocking and by-passing units, marked 560 $\mu\mu$f in the diagram, are not critical. Any midget-sized unit of 500 to 600 $\mu\mu$f may be used. The resistors used are ½-watt fixed carbon units.

The assembly of the coils, capacitors and resistors is shown in Figs. 3 and 4. Care should be taken to follow the design carefully, else stray capacitances may make it impossible to bring the circuits into the proper alignment. The positions of the parts are labelled in Fig. 3 to correspond to Fig. 1. The position of the i-f coupling unit with respect to the tubes it couples is shown in Fig. 5. The 1852 tubes employ single-ended construction, and their sockets should be so placed that the shortest possible leads are taken from the grid and plate terminals to the coupling units.

The alignment of the coupling units consists in adjusting the capacitors C_1 and C_3 in each unit. In the present case, it was found that the proper position of C_3 is very nearly its minimum capacitance, while that of C_1 is somewhat less than one-half maximum capacitance. These adjustments may be made as follows: The coupling unit is inserted between the first and second 1852 i.f. amplifier tubes. An unmodulated signal from the standard signal generator is applied between the grid of the first 1852 and ground. The signal voltage should be fixed at about 0.5 volt, and should be variable in frequency from 10 to 13.5 Mc. The output is measured by connecting the deflection plates of a cathode ray oscilloscope directly across the plate load of the second

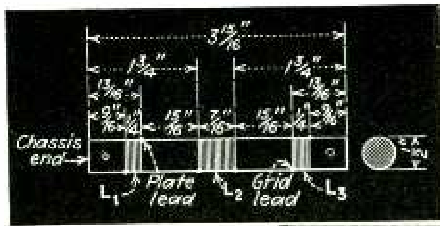


Fig. 4—Dimensions of coupling-unit coil assembly

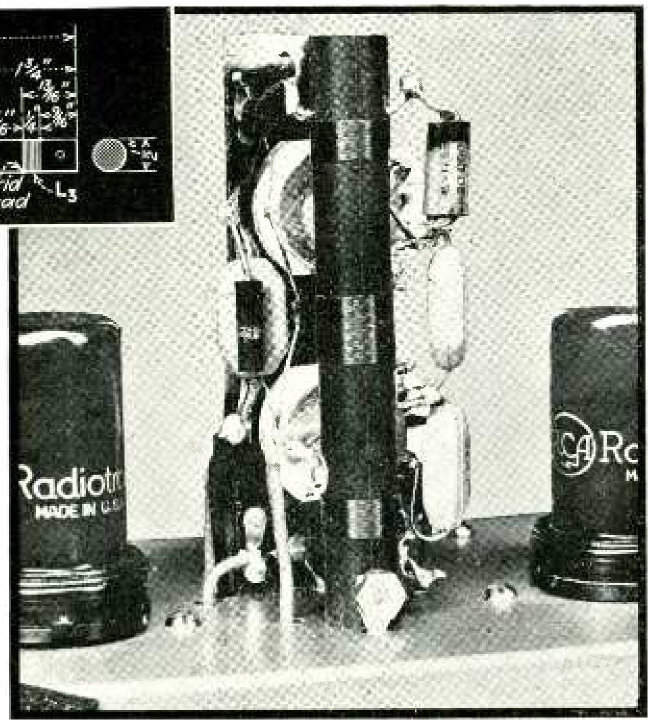


Fig. 5.—Coupling unit in relation to i-f amplifier tubes

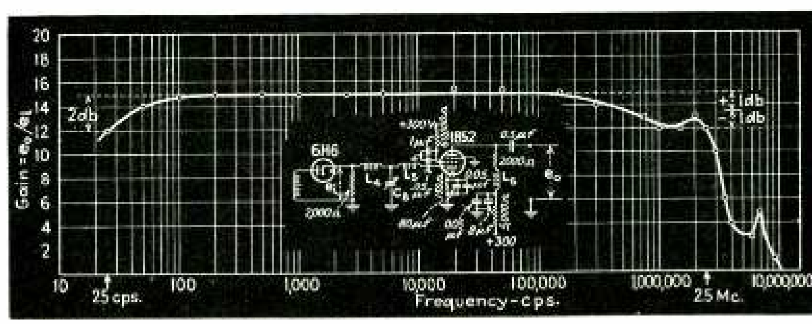


Fig. 6—Frequency response of the video output stage, measured by the method outlined in the text

1852 tube. The frequency of the signal is then swept from 10 to 13.5 Mc and the amplitude of deflection observed in the oscilloscope. The capacitors C_1 and C_3 are then adjusted until the deflection is as nearly uniform as possible over the band from 10.5 to 13 Mc. Peaks will be noticed near the edges of the band, but the peak nearest 13 Mc should be kept the smaller of the two since in this region both sidebands are active. The valley in the curve occurs at about 11.5 Mc. This is the frequency, it will be remembered, at which the rejector circuit in the audio channel is adjusted. The effect of the rejector circuit on the video pass-band is to raise the level of the valley and to improve the overall response.

The adjustment of each of the coupling units is accomplished in the same fashion, except that the final unit is tested between the last 1852 tube and the second detector. In this case the signal is modulated at 400 cycles and the amplitude of the output registered in the output of the detector or output amplifier. The response of the whole amplifier is then measured by applying a 400-cycle-modulated signal at 5 millivolts to the between grid of the 1852 converter and ground, and sweeping the frequency from 10 to 13.5 Mc, taking care to maintain a fixed voltage input at all frequencies in this band. The output is registered by the amplitude of the demodulated 400-cycle output in the plate circuit of the output amplifier.

In all of this work, the problem is greatly simplified if the signal generator is equipped with a frequency-modulator capable of swinging through the desired band at a rapid rate. Such a frequency-modulated generator may be constructed and calibrated in terms of a point by point comparison with the standard signal generator. If any amount of development work on receivers is in prospect, such a generator is well worth the trouble of constructing it.

Figure 7 shows the response of the entire i-f amplifier, and of the effect of the audio rejector circuit on the response. The gain of the amplifier, with a 5 millivolt 40 per cent modulated signal applied to the converter, is such that full output (20 volts peak to peak) is obtained from the video output stage when the volume control is set at about minus five volts. Some trouble may be experienced with feedback if more gain than this is attempted, but no more than this is needed for a signal input from the antenna of 1 millivolt, assuming a gain of 5 in the r-f stage.

Second Detector and Video Output Stage Design

The measured response of the video output amplifier is shown in Fig. 6, together with the circuit and the points of measurement. The measurement circuit contains the *T* filter L_4, L_5 and C_8, which considerably improves the performance. This circuit is similar to that described by W. S. Barden before the I.R.E. Annual Convention last June and reported on page 15 of the July issue of *Electronics.* The coils L_4 and L_5 are 120 turns each, of No. 34 enamelled wire close wound on one-half inch forms, and are mounted at right angles to each other. The capacitor C_8 is a 3-30 $\mu\mu$f mica dielectric trimmer unit. The other capacitances in the filter network are the output capacitance of the 6H6 and the input capacitance of the 1852. By adjusting the mica trimmer, the peak of the response can be set at or near 3 Mc providing flat response within one db up to 2.5 Mc. A peak of response is also obtained, as shown, in the region of 6 Mc but is of no consequence since the i-f amplifier cuts off far below this limit.

The plate circuit of the video output stage might also be filter-coupled to the cathode-ray tube grid, but the additional gain and frequency response serve no purpose in view of the i-f amplifier performance. The peaking coil L_6 is 55 turns of No. 34 enamelled wire on a ½-inch form, and is placed some distance from L_4 and L_5.

The measurement of the frequency-response of the output stage was carried out as follows: the deflection plates of the cathode-ray oscilloscope were coupled through the oscilloscope amplifier across the 2000-ohm output resistor as shown in Fig. 6. A source of 1 volt, rms, was applied to the input of coupling filter, as shown. For the region from 25 cycles to 10,000 cycles, the source was a beat frequency oscillator, and the gain was determined by measuring the oscilloscope deflection at input and output, at a given setting of the oscilloscope amplifier. For frequencies above 10,000 cycles, the input was 1 volt from the standard signal generator, calibrated directly by the vacuum tube voltmeter included in the instrument. The frequency was increased point by point from 10,000 to 7,000,000 cps (10 to 7000 kc) and the amplitude measured by the oscilloscope deflection. For frequencies above 10 kc, the oscilloscope amplifier was removed, and the calibration determined from the deflection factor of

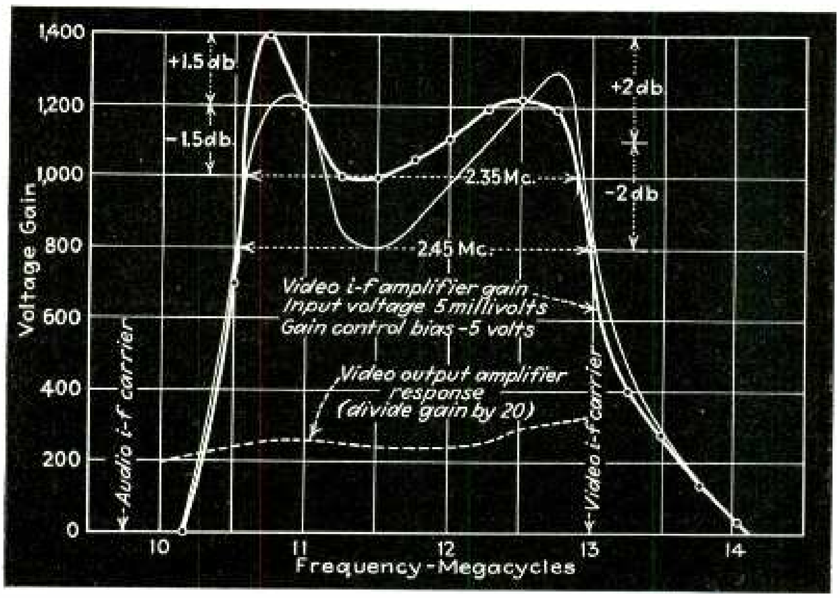


Fig. 7—Band-pass characteristics of the complete video i-f amplifier. The fine line indicates the response when the audio rejector circuit is not connected. The heavy line shows the effect of the rejector circuit in raising the valley of the curve

the oscilloscope tube. At 10,000 cycles the two methods of measurement were found to indicate the same gain.

It would also be of interest to measure the phase shift in this amplifier as a function of frequency (for example by the method outlined suggested by Seeley and Kimball in the October 1937 issue of the *RCA Review*, page 180), but this measurement involves extra equipment and has not been undertaken as yet.

The low frequency response of the amplifier deserves mention. It will be noticed in Fig. 1 that high capacitance by-passing is used in the screen, cathode, and B supply circuits, and that two capacitors are used in each case, the smaller unit to insure proper by-passing at the higher frequencies. The lowest frequency of importance is 60 cycles, provided that no d-c amplification is desired. However, if gradual changes in the background illumination of the picture are to be reproduced correctly, d-c amplification is necessary. The coupling in the signal circuit is conductive from the second detector to the video output stage load resistor, and hence d-c amplification is carried through to this point. But between the output resistor and the coaxial line a 0.5 μf capacitor is inserted to avoid applying the plate voltage of the output stage to the kinescope control grid. If the kinescope power supply and the receiver power supplies are completely isolated, that is, if they do not employ a common ground, then it is possible to connect the control grid to the output load resistor directly, rather than through the 0.5 μf coupling capacitor.

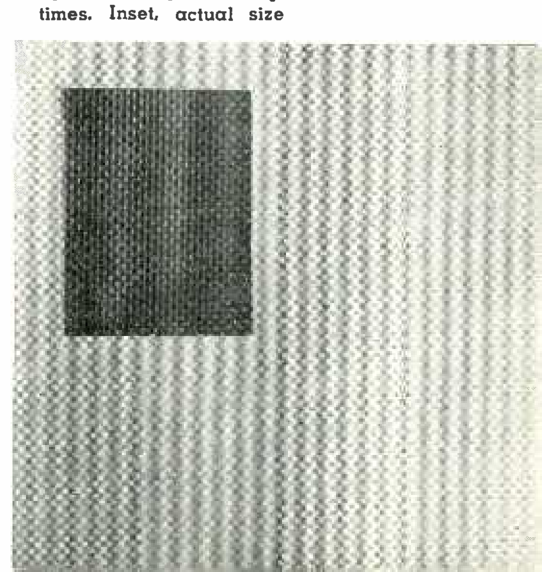
In operation, the presence of the coupling capacitor and the consequent removal of the d-c component from the signal seem to make no serious difference in the enjoyment of the programs. In this case changes in over-all brilliance are obtained only by manual adjustment of the brightness control.

The output of the video stage is connected to the kinescope control grid terminal through a coaxial line 19 inches in length, leading from the receiver chassis directly upward to the cathode-ray kinescope mount above. This line consists of a grounded brass tube, ½-inch inside diameter, through which runs coaxially a No. 34 enamelled wire. The wire is held concentrically by two hard-rubber plugs at either end of the brass tube in which are mounted small eyelets. The lead wire is soldered in tension to these eyelets.

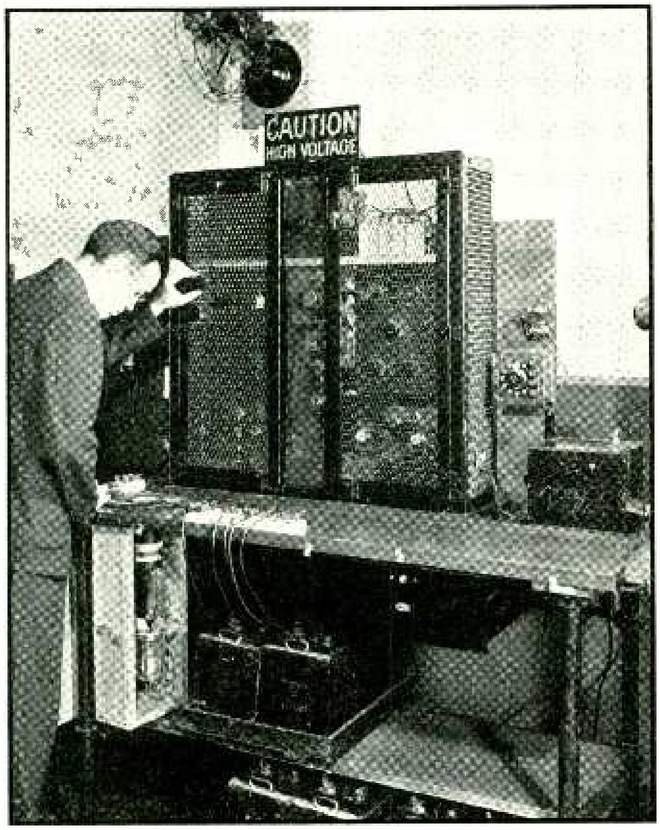
To show the performance of the video amplifier, a signal of 2.5 Mc was applied to the input of the coupling filter (with the detector in place) and an attempt made to synchronize horizontal scanning circuits with the output. This was straining the sync performance considerably, but the image on the kinescope screen would remain stationary for as long as a second or two, so that it could be photographed. The result is the image shown in Fig. 8. The signal level producing the pattern is about 12 volts at 2.5 Mc produced by an input signal of 1 volt from the signal generator. The pattern contained about 200 vertical dark bars and 200 vertical bright bars in a picture width of 7 inches. hence the width of each bar is about 7/400 or 1/60th of an inch. This represents the width of the ultimate picture detail to be expected from the 2.5 Mc picture signal. The reproduction in Fig. 8 is a magnification of these details of about four times, while that in the inset is actual size.

In the sixth and final installment in this series, the adjustment of the video and audio channels and scanning circuits will be described for actual operation with a signal received from the Empire State Building NBC transmitter. The final installment will also contain the full circuit diagram of the equipment, together with cost estimates of each section.

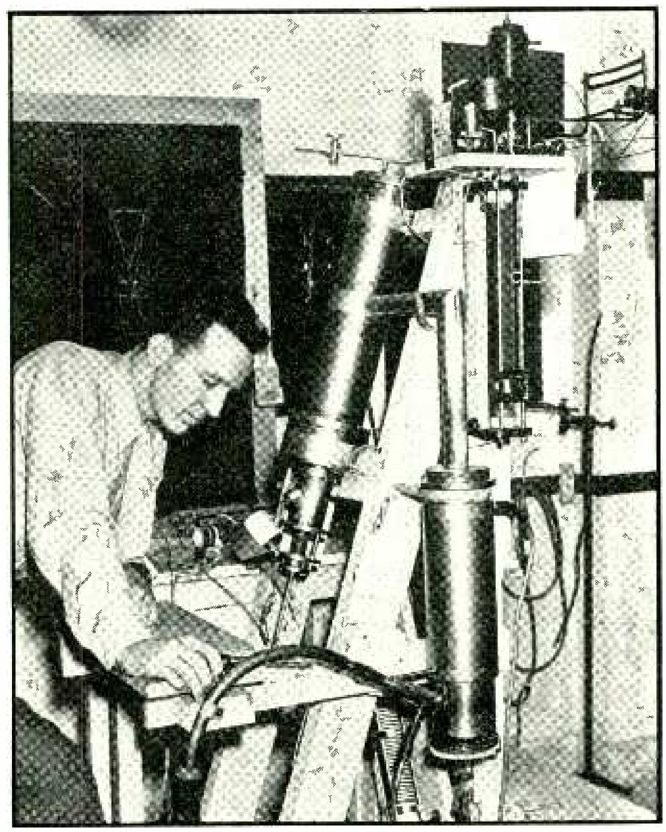
Fig. 8—Pattern obtained with 2.5 Mc signal, enlarged nearly four times. Inset, actual size



ELECTRON



An electron microscope at the Bell Telephone Laboratories for studying thermionic emission of various cathode materials. The thorium eruptions on page 33 were photographed with the aid of this equipment



An electron microscope for studying photoelectric emission is being constructed at the California Institute of Technology under the direction of Prof. W. V. Houston. It is shown here undergoing preliminary tests

THE relatively new branch of physics known as electron optics is opening up new avenues of research in its application to electron microscopy. In the more advanced types of electron microscopes magnification and resolving power are obtainable which are far in excess of those possible with the ordinary light microscope. Not only may one expect that electron optics, per se, will make new contributions to man's knowledge, but the greater useful magnifications resulting from the electron microscope should prove an invaluable aid to other fields of research.

Perhaps it is well to recognize that electron miscroscopes may be divided into two types. In the first of these, usually characterized by relatively low magnification, an image of an electron emitting surface is formed by a suitable electron-optical system and is projected onto a fluorescent screen where it may be observed visually or photographically. The purpose of this type of microscope is usually the study of cathode materials and surfaces, and only electron emitting surfaces may be examined. In the second type of electron microscope, an electron beam is employed to irradiate some independent object whose form and relative mass may be defined on a fluorescent screen or photographic plate in much the same way as in a photomicrographic camera. But the light rays and glass lenses of the light microscope are replaced, respectively, by the electron beams and electric or magnetic fields of the electron microscope.

The first type of electron microscope has its electrical analogue in the ordinary magnifying glass. Several special tubes have been built experimentally for the construction of electron microscopes of this type, some of which have been fairly elaborate in an effort to reduce to a minimum the various aberrations. At least two electron microscope tubes have been made available commercially—one by the Allen B. Du Mont Laboratories in this country and one by the General Electric Co., Ltd. of England. Special tubes are not always required, however, for by proper adjustment of its first and second anode potentials, an ordinary cathode ray tube may be converted into an electron microscope for the examination of its cathode surface.

The great importance of the electron microscope of the second type—to which the majority of this article is devoted—lies in the fact that it extends the magnification and resolving power considerably beyond that obtainable with the visual or even the ultra-violet microscope. The

MICROSCOPES

practical limit of magnification with the visual microscope is about 2,000×, whereas with the ultra-violet microscope, magnifications of 6,000× have been attained. Magnifications of as much as 30,000× have been obtained with the electron microscope, and the resulting photographs are sufficiently sharp and clear as to permit an additional optical enlargement of 3×. Thus is it possible to obtain magnifications of the order of 100,000× and thereby make visible the form and outline of bacteria, viri, colloids and other very small particles which, up to now, could be detected only by the effects they produce. The benefits which will accrue to the medical and biological sciences alone through the extension of this new aid to visual observation can hardly be estimated.

In passing it is interesting to observe that the electron microscope is the practical embodiment of pure and perhaps highly abstract research; the electron microscope is also an excellent example of the illustration that when one form of scientific approach appears to have established limitations on man's ability to probe nature, a totally new and refreshing approach may often extend well known avenues of activity as well as open up entirely new ones.

Principle of the Electron Microscope

Comparatively few electron microscopes are, to date, in complete operation, and each of the existing models is different in some of its details from the others. Electron microscopes of the second type have been built by Siemens and Halske in Germany under the pioneering efforts of Ruska, in the College of Technology in London with the assistance of the Metropolitan-Vickers Electrical Co., the California Institute of Technology in this country and perhaps by others as well. Complete details of all of these instruments are, at present, not available. But the laws of physics are no respector of national borders; consequently the general principles of operation outlined here may be regarded as applying, in general, to high magnification electron microscopes. Details of the three instruments enumerated above, however, may be expected to show variations from one another.

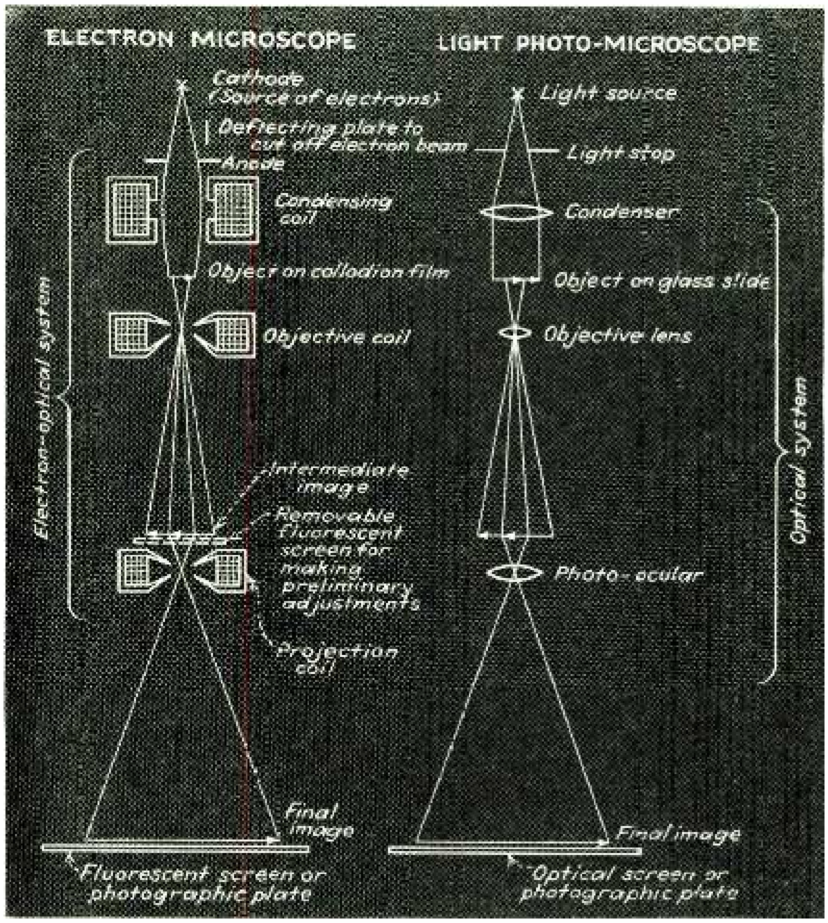
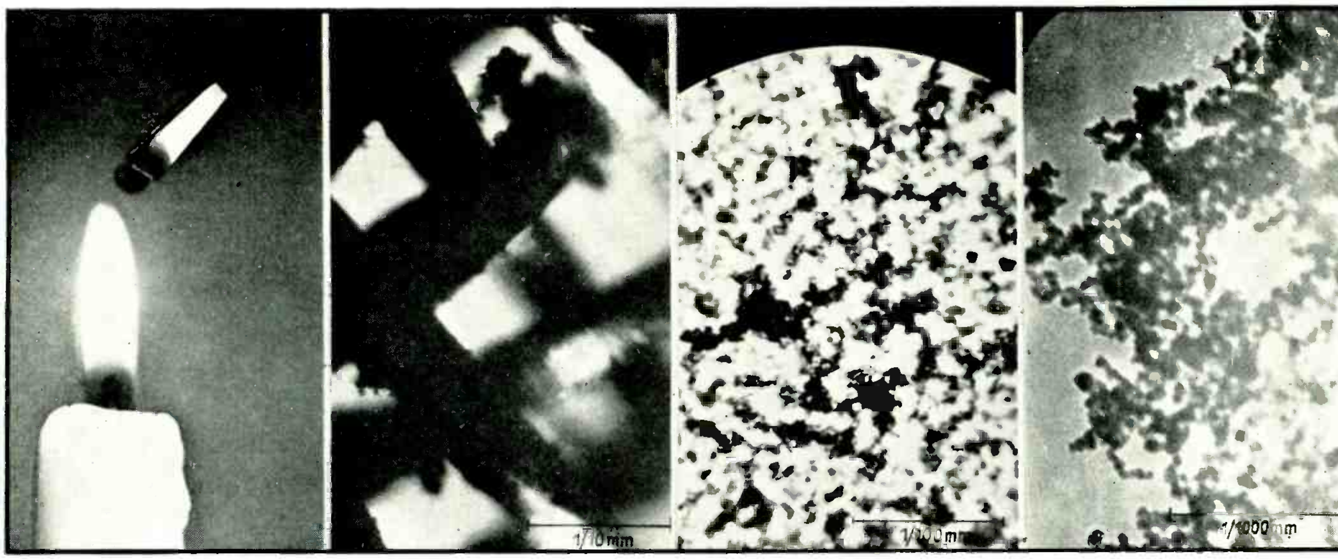


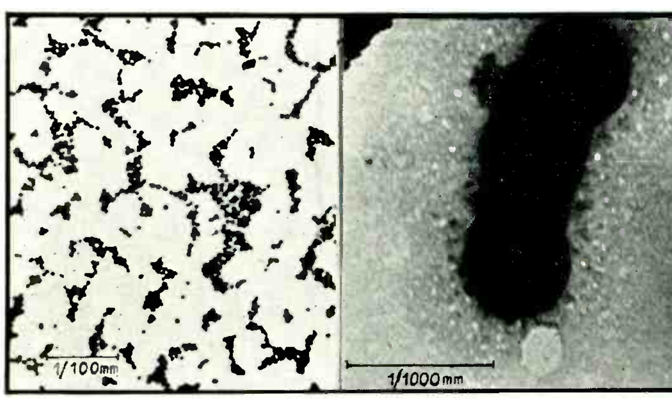
Diagram showing the geometric optics of the two stage electron microscope and its optical analogue. The light rays and glass lenses of the light microscope are replaced in the electron microscope by electron beams and electric or magnetic fields, respectively, but the situation in the two systems is very similar

The modus operandi of the electron microscope is indicated in the diagram which also shows the corresponding optical analogue. The essential elements consist of a source of radiation, the electron-optical system composed of properly constructed electric or magnetic fields which refract the electron beam, and the necessary screens or photographic plates for making visual or photographic observations. Auxiliary equipment which, although not indicated in the diagram, is very essential to the practical operation of the microscope, includes pumps for maintaining the desired degree of vacuum within the microscope tube, the necessary high voltage transformer - rectifier-filter-regulator voltage supply, and the various voltage and current controls which are used for obtaining the desired conditions of focussing and magnification by properly refracting the electron beam through the magnetic coil systems shown.

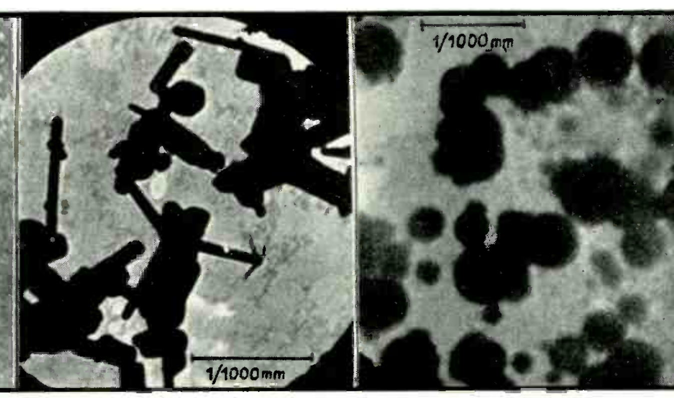
The source of electron radiation, corresponding to the light source in the visual microscope, may be either a hot or a cold cathode. The emitted electrons are accelerated with voltages which may be as high as 100,000 volts. The high voltage electron



A series of four photographs at various magnifications showing the blackening of a silver wire screen by soot. The wires in the screen are 0.002 inch in diameter. From left to right the magnifications are 1×, 190×, 2,000×, and 23,000× respectively. With a magnification of 190×, some soot particles may be seen in the wire mesh. At 2,000× (representing the maximum magnification obtainable with the light microscope) small branches of soot flakes are revealed. When magnified 23,000× in the two stage electron microscope, it is seen that the small branches of soot consist of combination of small hexagonal scales. Photographs made with microscope shown on the cover



The picture at the left shows pus bacillus stained and magnified 1000× as seen in the ordinary light microscope. The illustration at the right shows the bacillus magnified 20,000× in the Siemens two stage electron microscope without the necessity of staining. Size and form of these bacilli may be easily distinguished from other agents at these greater magnifications



Shown above are two commercial forms of zinc oxide which would be practically indistinguishable when examined by the ordinary light microscope. The difference in structure is clearly evident when examination is made with the electron microscope. The illustration at the left is magnified 16,000× while that at the right is magnified approximately 18,500×

beam is necessary to obtain the high resolving power and magnification which is the main advantage of the electron microscope. The useful portion of the beam passes through an aperture in the anode after which it is acted upon by a condensing coil which condenses the beam in a manner similar to the collimation of the light rays in the optical system.

The condensed beam then impinges upon the object under observation which is held in a special locking and adjusting chamber since the object is contained within the vacuum system of the microscope. The electron beam is then refracted to form an image on a fluorescent screen in the intermediate image plane. This intermediate image is especially useful when making preliminary adjustments, since it is observed and accurately focussed at relatively low magnification. In the Siemens instrument, the magnification in the intermediate plane is about 80×. By means of an object shifting device, that part of the image which is to be further magnified is brought over an opening in the center of the intermediate screen. The electron rays for this part of the image are then condensed by a projection coil in such a way that the intermediate image is further magnified as much as 350×. The resultant magnification is the product of the magnification of the individual electron-lens systems. The final image, which may be magnified as much as 30,000×, may be photographed directly from a fluorescent screen which also makes the image visible, or, as is done in the Siemens instrument, the photographic plate may be introduced within the vacuum system of the microscope and an image can then be formed by the electron beam falling directly on the photographic plate.

The most important part of the microscope are the electron lenses, for the refraction of the electron beams in traversing the electric or magnetic fields provides the basis for electron microscopy. Unlike the light optical lenses, the refractive indices of electron lenses are not constant for a given medium. The electron lenses may consequently be regarded as possessing varying indices of refraction, depending upon the electric or magnetic constants of the system. As a result, the focal length of the electron lenses is not fixed, but may be adjusted by varying the electric or magnetic fields of the electron lens. It is customary, where large magnifications are required, to use magnetic fields for bending the electron beams. Lenses of short focal length, which are required for large magnifications, are obtained by large magnetic fields, i.e., by increasing the current through the coils, or by using coils of many turns of wire. The shape of the ferro-magnetic curcuit, and the use of materials of high permeability, with proper distribution of air gaps, is an important consideration in designing a practical electron-optical lens system for electron microscopes. To maintain the focal lengths of the electron-optical system sufficiently constant during the time necessary for the exposure of the photographic plate, the current through the various coils must be maintained to a high degree of precision, for current variations would produce various types of aberrations and distortions.

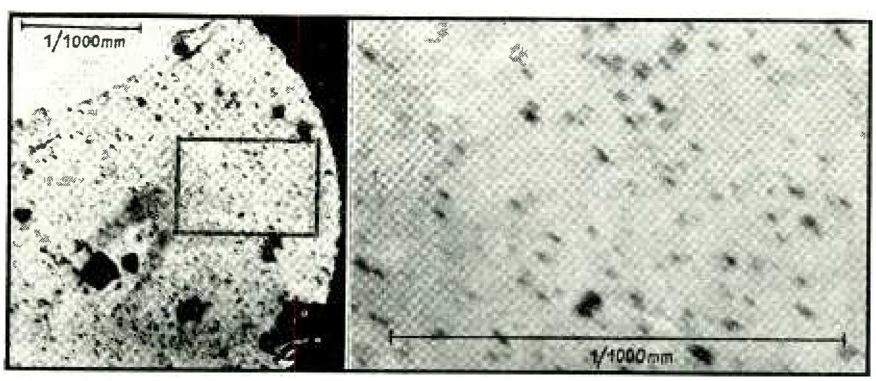
Due to the large magnifications obtained, great care is required in the design and construction of the component parts of the microscope. Since the object may be magnified as much as 30,000×, a horizontal displacement caused by vibration and amounting to only 10^{-4} mm would result in displacements or variations of as much as 3 mm on the photographic plate; such swings would make it impossible to obtain sharp images of the object.

In order that the form and mass distribution of the object may be determined, it is necessary that the object be suspended on some electron-optically transparent substance, much as the object in a light miscroscope is placed between transparent glass slides on the mechanical stage. The medium selected for the electron microscope should be characterized by low absorption of the electron beam, ability to withstand the effects of the beam for fairly long periods of time, and appreciable mechanical strength. These requirements can be met by selecting a high accelerating potential for the electrons, and employing a very thin membrane of only 1/100,000 mm thickness for the support of the object under observation. Highly satisfactory membranes may be made of a weak solution of collodicn in amyl-acetate which is dripped on a large surface of water. The amyl-acetate evaporates quickly and leaves a thin film of collodion on the water. Then the water is drained from the bottom of the container and the collodion is allowed to set over an aperture of perhaps 0.03 to 0.3 mm.

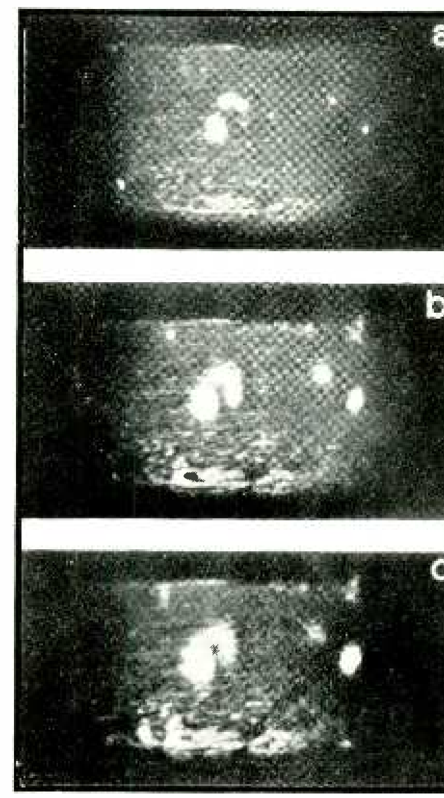
The object to be observed is placed on the extremely small surface of the stage. Then the microscope is focussed by means of a suitable trial object or fine wire mesh so that after inserting the real object through the locking chamber, only a slight amount of further adjustment is required. Upon placing the object with its support into the microscope, the object is moved around until the most desirable portion is found in the screen in the intermediate image plane. Final adjustments are then made on the final image plane, after which the photograph may be made.

The object, which often consists of bacteria, very fine tissues, or other organic matter is subjected to the electron beam for the duration of the adjustments and the exposure of the photographic plate. To minimize the bombardment of the object, provision is made to deflect the beam through the use of deflecting plates or magnetic coils which may be arranged inside or outside of the instrument above the upper locking chamber.

References:
"New Electron Microscope," by L. C. Martin, R. V. Whelton, and D. H. Parnum. *Jour. Sci. Instr.*, Vol. 14, No. 1. Jan. 1937, pp 14–24
"A Magnetic Electrom Microscope of Simple Design," by J. H. McMillen and G. H. Scott, *Rev. Sci. Instr.*, Vol. 8, No. 8, August 1937, pp 288–290



Small colloids of only 5 to 10 $\times 10^{-6}$ mm in size may be examined visually or photographically with the aid of the electron microscope, opening up new fields of research to the physicist and chemist. The picture at the left shows colloidal silver magnified 15,500×. The part within the rectangle is magnified to 59,000×



A series of photographs with the electron microscope which shows the increase in area of the electric discharge from a hot filament as a globule of thorium is ejected from the incandescent filament. Magnification is about 110×

"Electron-Optical System of Two Cylinders as Applied to Cathode Ray Tubes," by D. W. Epstein. *Proc. I. R. E.*, Vol. 24, No. 8, August 1936, pp 1095–1139
"On Electron Optics," by V. K. Zworykin, *Jour. Frank. Inst.*, Vol. 215, No. 1289, 1937, pp 535–555
"Applied Electron Optics," by V. K. Zworykin and G. A. Morton, *Jour. Opt. Soc. Am.*, Vol. 26, No. 4, April 1936, pp. 181–189
"A Note on Davisson's Electron Lens Formula," by L. H. Bedfors, *Proc. Phys. Soc.*, Vol. 46, part 6, No. 257, November 1934
For those who read German, the original articles by Ruska, in Zeits. f. Phys. may be consulted

By C. J. LE BEL
Recording Consultant

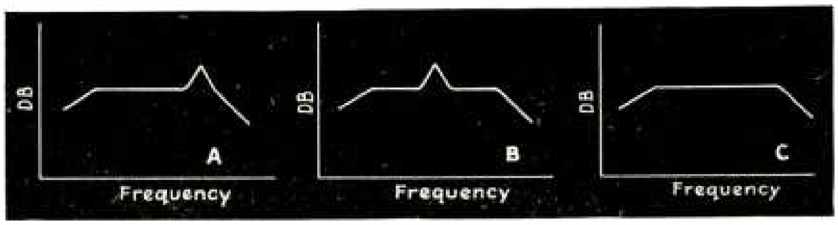


Fig. 1—Effect of improper equalization

Advanced Disc

WE have come a long way from the very poor quality direct playback discs of a few years ago. The recorder then had little to work with and needed little knowledge to handle it. Today practice has advanced greatly. While there are many 1935-quality recording studios still in existence, there is no doubt that the 1938 broadcast station or recording studio is getting most of the business—and expects 1940 knowledge of its engineers.

Now, advanced quality, as I have said, calls for advanced engineers. These are not supermen; they are ordinary persons who have learned to give careful attention to details—the "trifles" overlooked in 1935. This article will take up the points that mark the difference between just "making a record" and turning out a modern product. Frankly, many of the details are "old stuff" to the experienced wax recorder, but there are so few practitioners of that art that the repetition will do no harm.

The main points to be considered are:

1. Extension of frequency range
2. Minimizing distortion
3. Control of surface noise or scratch

Modernization of Recording Equipment

In modernizing a system the first question is rebuilding versus buying a completely new job. I feel that the "theory of the 10 per cent" preached by Buckner Speed, has been most useful. This states that equally good results can be secured by a complete rebuilding of a system, or by improving each part 10%. In most cases this means selecting and improving the weak spots only. Specifically, the amplifiers are usually still quite good. The machine's turntable motion is likely to be as uniform as when purchased. The feed mechanism seldom wears badly if properly cleaned and lubricated. This leaves the audio sources and the cutter as the worst spots.

The sources—tuner, dubbing pickup, and microphone—may be gone over with care. Probably the pickup will need replacement. This will leave the tuner more subject to interchannel interference (the system frequency range being doubled). The pickup will have a uniform response and therefore, as explained in a previous article, will be lacking in bass response. The microphone characteristics will be imperfect in one respect or another, usually at the high frequency end.

The cutter is a serious problem. A new one can be bought, increasing the range only slightly and possibly having other defects. New cutters can be built or the old ones revamped. Either is apt to be a two year job and homebrew cutters are never satisfactory. If the cutters were the best in their day, it is usually wisest to double their frequency range by equalization. The technique will be discussed below.

The preceding discussion has shown that we now have an uncoordinated mass of equipment—each part with its individual defect so far as frequency response is concerned. The task of the engineer is to measure these defects and to order, from a reliable manufacturer, the necessary corrective networks. Summarizing from experience, networks have the following functions:

1. To remove irregularities in frequency response characteristics
2. To shift the balance of tone quality
3. To limit the frequency range to that of the source—use of filters, when rerecording old records; interchannel monkey-chatter filter for tuner, etc.
4. To compensate for characteristics of the ear—loss of bass as volume is reduced.

The network must be applied with care to avoid undesirable irregularities and to prevent interaction between units. The first point may be illustrated by three steps in equalizing the response of a cutter.

In Fig. 1A we have a well-known cutter as sold. In Fig. 1B the frequency range has been doubled but a 3½ db peak at 2500 cycles remains. By itself the peak is not too bad, for passable quality. However, in rerecording through the same system the peak doubles and becomes 7 db —entirely too much in view of its location, and so the second equalizer is added to remove it, in Fig. 1C. The hump has been removed from the important frequency range.

Achievement of the second point is best shown in Fig. 2, a block diagram originally prepared for a large studio.

It can be seen that every part is specific in nature; there is no such thing as a general purpose high equalizer, for example. Such as have been so called are really brighteners, i.e., devices to brighten the general tonal balance, not cure-alls.

Even the bass-boost unit for the pickup must be carefully designed. When dubbing off copies it must match the cutter bass response accurately. When used for sound effects and musical background, a somewhat sharper curve seems to be more desirable.

The question may be raised: Should the networks be bought or made? In view of the equipment necessary to make, adjust, and test, plus the time required to design and make, the answer seems rather clear: Supply curves where possible, or a description of the function, to a designer skilled in this field. There are innumerable factors to be considered, and which trap the unwary possessor of only a textbook knowledge of design and construction.

Carrying forward the discussion

The concluding installment of a series intended to help the recording engineer get the most from his equipment. Extension of frequency range, minimizing of distortion and control of surface noise, factors which make the difference between passable and excellent results, are discussed

Recording . . . .

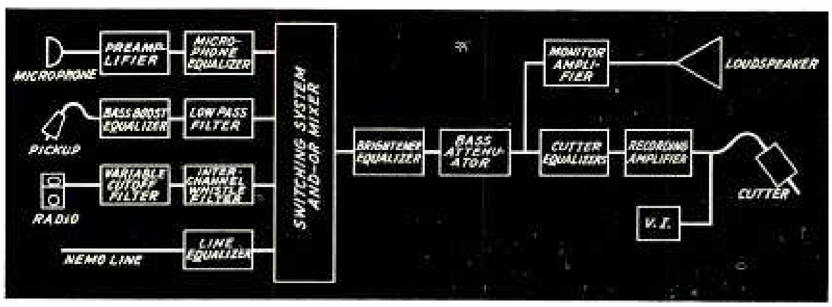


Fig. 2—Layout of a complete recording studio, showing equalizers and boosters employed

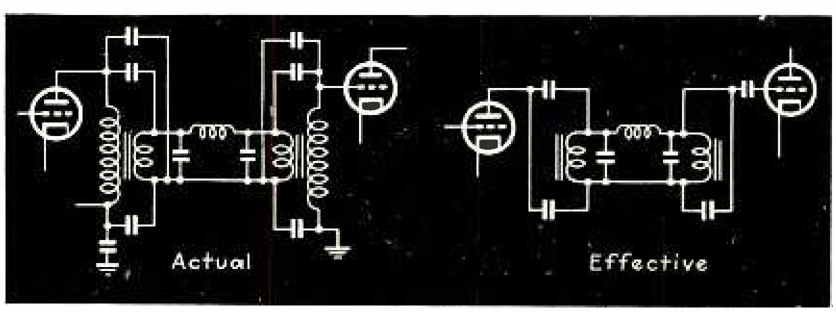


Fig. 3—Effect of capacitances in a filter used to couple two stages

of cost and results, it should be pointed out that there are two types of equalizers in use, the simple single resonant circuit and the constant resistance types. The constant resistance type is absolutely necessary only for boosts of over 15 db in a single equalizer—which is never required in the disc recording field. The constant resistance type, because of its complexity, also costs twice as much. In return it has one advantage—the presenting of constant impedance to the circuit, regardless of setting, which allows operating several in tandem without interaction difficulty and obviates the use of isolating pads. The film recorder, large studio, and the specialist in recording may require this.

A somewhat analogous situation exists in the filter field, where we have the constant-k type, providing a gradual cutoff curve and the m-derived type with a cutoff of great sharpness when desired. Again, one costs twice as much as the other. The moral of course is, do not ask for any sharper cutoff than necessary.

The point may therefore be made that an equalizer or filter should be bought in terms of results. The skilful designer who knows both network design and the recording field, can often cut the cost of a unit 30 per cent or 40 per cent by choosing a unit most appropriate for the purpose, rather than the theoretically most elegant design. Again it should be emphasized that telephone line, transmission disc recording, and film recording are separate fields. Units for the latter two fields must fulfill different requirements, and the designer should know them intimately to keep costs down.

In laying out a system of this type the question of mismatch must be considered. In an ordinary circuit a heavy mismatch produces relatively little effect, but when a filter or equalizer is used at a circuit impedance other than the design value the transmission characteristics change greatly. A particularly prevalent trouble ensues when a filter is used between a resistance source and an amplifier input coil. The transformer is very much like a pair of binoculars—a means of viewing something at the other end, enlarged or reduced. An input transformer enables the line (and filter) to view the first stage grid circuit—which is practically an open circuit at all except the highest frequencies. The safest and easiest general remedy is to terminate the line with a fixed resistor of the same value as the nominal circuit impedance, i.e., 200 ohms for a "200 ohm line". Many of the older amplifiers terminated the input circuit in a resistor across the transformer *secondary*. With most input transformers available today this is a bit unwise, since they tend to lose high frequency response when loaded. The method illustrated terminates the line without loading the transformer.

Another point of importance is the necessity of proper testing. In particular this means testing at levels approximating recording values. For amplifiers it is wise to test at maximum recording level, and also at 30 db under that point. For cutters this means at a little below usual maximum level, and also as far below as one can obtain a usable optical pattern.

In connection with testing large installations using jack strips and double prong plugs for patching, the situation shown in Fig. 3 has arisen:

Here a low pass filter has been inserted in a line between two amplifiers, for example. The interwinding capacitances of the two coupling transformers have been schematically shown. Unfortunately these two capacitances are practically never equal, that is, the line is badly unbalanced to ground and to the secondary. The result is that when the filter is supposed to be cutting off, the signal passes along through a circuit composed of the two wires in parallel, and the ground. No filtering action results. If the patching is reversed in polarity the capacitive unbalance is altered—sometimes beneficially, sometimes otherwise. Two remedies are available. In one case ground one terminal of the amplifier input transformer—usually one side but preferably the center tap in the few cases where that will help. In the other solution add a line to line transformer (1:1 ratio) as shown in Fig. 4. This will allow random patching without concern about polarity. It is a pity that such an expedient is necessary, but the lack of effective interwinding shielding in our best high fidelity transformers is a sad fact. It should be pointed out that the above difficulties become serious only above 5000 cycles.

A further difficulty arises when one attempts to test filters with an ordinary amplifier and volume indicator. The average volume indicator using a series resistor multiplier reads correctly only at center scale on all ranges but one. Readings taken elsewhere are therefore likely to be inaccurate.

To overcome this, some test at constant output (and volume indicator reading), varying the gain control and recording the reading. This may cause more difficulty for the scale on the average ladder type mixer pad is correct only at high attenuation. Probably the best answer is to use either a precision attenuator at the input, or to use a volume indicator with T pad multiplier.

After securing a set of curves, be realistic in interpretation. An amplifier can be held to close tolerances. To hold a cutter to the same limits is next to impossible.

This brings us to the next point, the question of interpretation of results. As the writer has said many times, the ear is the final judge of all recording results. An overall response curve is a guide, an indication of progress in adjusting, but definitely not the final criterion.

Needless to say, the "ear" is not one ear; it is the collective ear of several judges. Too many studios have been ruined by depending on one ear—and that of tin! There also ought to be a law to compel studio owners to take audiometer tests.

Seriously speaking, one further thing is necessary—a good disc reproducing system. It should be as wide range as the best customers' system. A record designed to sound best on a low fidelity system will sound very bad indeed on wide range equipment. Adjust the reproducer characteristics until the average good competing disc sounds best. For studios doing a great deal of 10" and 12" artist recording, ordinary 78 rpm pressings form a good standard; if the main business is 16"—as in most radio stations—the best standard is one of the leading makes of transcriptions.

Having set up and adjusted a good reproducing system, the next step is to adjust the balance of tone of the recording system till the results satisfy. This is uually done by raising all the frequencies above 1000 cycles with the equalizer marked "brightener" in the block diagram, the amount of boost being adjusted to suit the ear. Very often, when recording speech, it is desirable to decrease the bass, hence the bass attenuator shown. It should not be a filter network, which cuts far too sharply. The object is to decrease in intensity, not to wipe out.

It should be pointed out that the brightener produces no real extension of frequency range even though a superficial glance at the curves would indicate so. This is a good example of the saying that wide range is not necessarily high fidelity.

While on the subject of high fidelity, a remark on an obscure form of distortion would be appropriate. Certain blanks do not cut very easily; furthermore, many studios have the habit of using a stylus far beyond its useful life. In either case the effect is the same—even if the increase in surface noise is not excessive, there is an increase in high frequency distortion. Apparently the groove wall is compressed during cutting, only to yield a few millionths of an inch after the sapphire has passed. The result is a form of crossmodulation, and being most evident at the higher frequencies, is rather hard to measure with instruments at present easily available. Nevertheless the lack of "cleanness" in such a record is quite evident, however hard it is to identify the reason.

It may be remarked that there is no particular relation between easy cutting and short record life—easy cutting involves reaction to stress in shear, whereas long life involves chiefly strength in compression. There is, therefore, no particular reason to use a hard cutting blank on the assumption that long life will thereby be secured. A good example can be taken from the mechanical field, where the easy cutting properties of brass are proverbial, yet the durability of brass as a bearing is equally well known.

One part of the problem of wide frequency range is that of making it

(*Continued on page* 82)

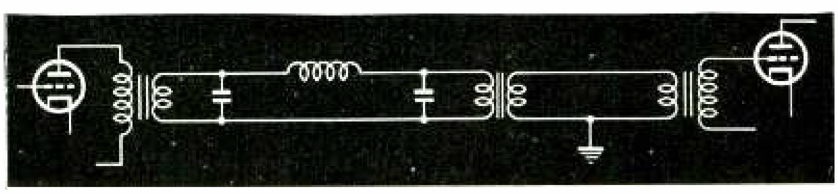


Fig. 4—A remedy for the situation shown in Fig. 3

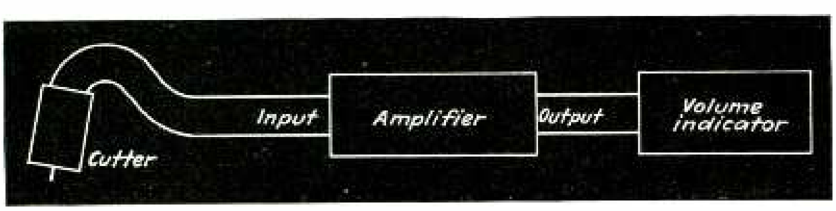


Fig. 5—Method of checking noise generated in cutting groove

Transmitting Tube Chart

This reference sheet gives the maximum ratings and the plate dissipation of transmitting triodes, tetrodes, and pentodes for Class C telegraphy or plate modulated telephony. Supplementary table provides method of conversion for other modes of operation

By BEVERLY DUDLEY
Associate Editor

A SINGLE usable chart giving the most essential characteristics of transmitting power tubes presents somewhat of a problem, not only because several multi-element structures are available, but because a wide range of power must be covered, and many modes of power tube operation are in common use. The chart on the reverse side of this sheet shows the maximum (d-c component) plate voltage and plate current, E_b and I_b, respectively, when the tubes are operated for Class C plate modulated telephony or Class C telegraphy. The plate current and voltage factors are given on the logarithmically spaced co-ordinates making an angle of 45° with the edges of the chart. Where several alternative ratings are permissible, that corresponding to maximum plate voltage is selected. The corresponding plate current may, therefore, be less than the maximum permissible plate current at some lower plate voltage. In a few cases tubes of the same type number but of different manufacture have two ratings. In such cases the more conservative rating is indicated.

The power output and plate dissipation, shown on the logarithmic co-ordinates parallel to the edges of the chart are to be regarded as representative and approximate values for Class C operation. The power output depends upon the efficiency of the external plate circuit. The plate dissipation depends upon the design of the tube and the materials from which it is constructed. Individual cases may deviate from the representative conditions.

A large number of tubes of various types, and for various modes of operation was examined and the ratio of the plate loss to the plate input determined. The results are shown in the table on this page. From this table the relation, the plate dissipation $P_p = 0.4\, E_b I_b$ was selected as being representative for most cases of practical operation. Since, the plate input is the sum of the plate loss and the power output, the power output is given by $P_o = (1 - K) E_b I_b = 0.6\, E_b I_b$. The chart is based on these relations. Maximum and minimum values for $K = P_p/P_i$ where P_i is the input power, are given so that the user may determine the range for which the approximate power relations are found to apply. It is also possible to use this table to determine the approximate power output and plate dissipation for other modes of operation than Class C.

It was not possible to indicate on the chart the manufacturers of the various tubes shown. However, it may be convenient to know the catalog numbering system in common use, as a guide to determining probable manufacturers of a given tube type. This data may be determined from the list below:

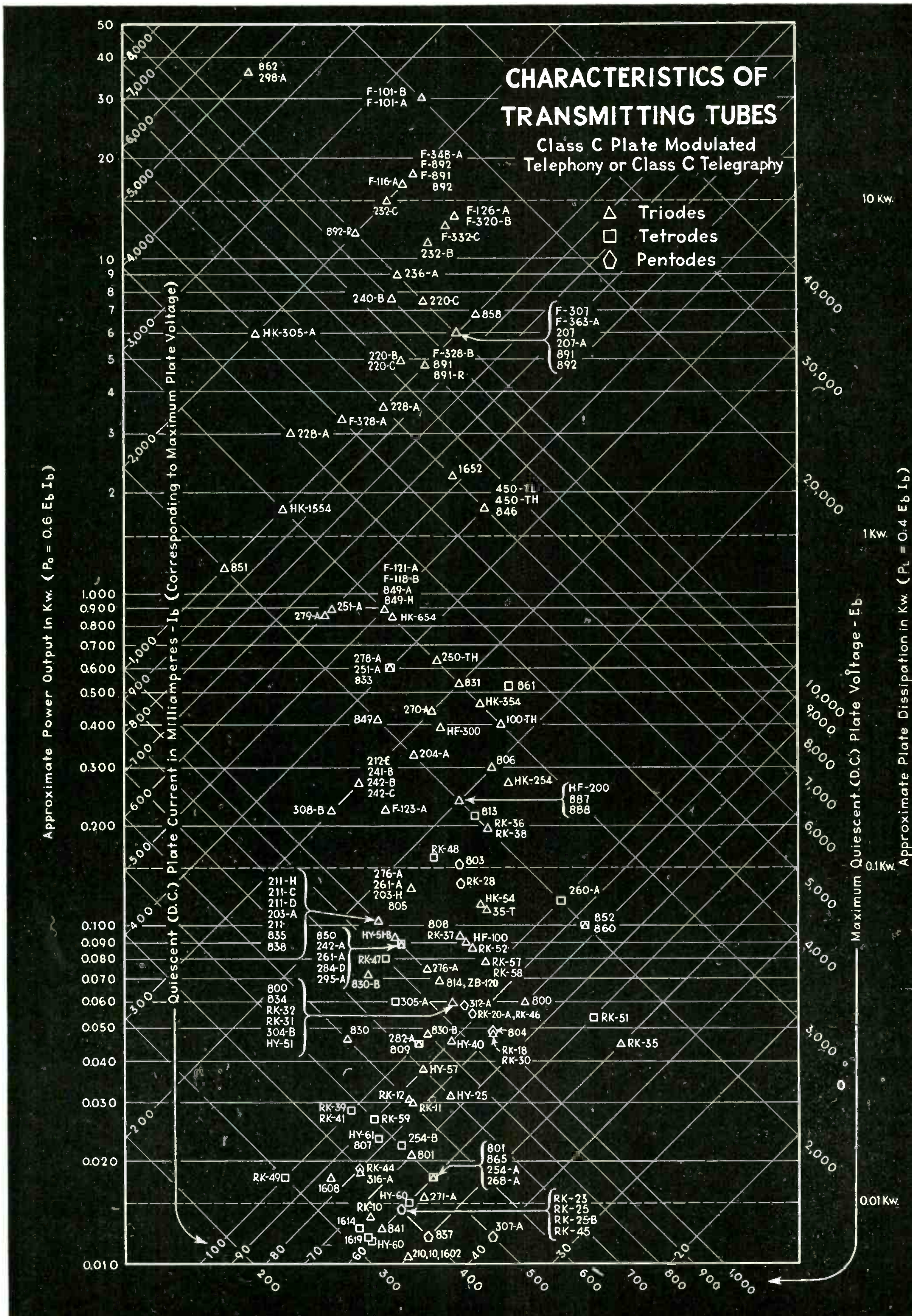
Ratio of Plate Dissipation to Plate Power Input

$$K = P_p/P_i = P_p/E_b I_b$$

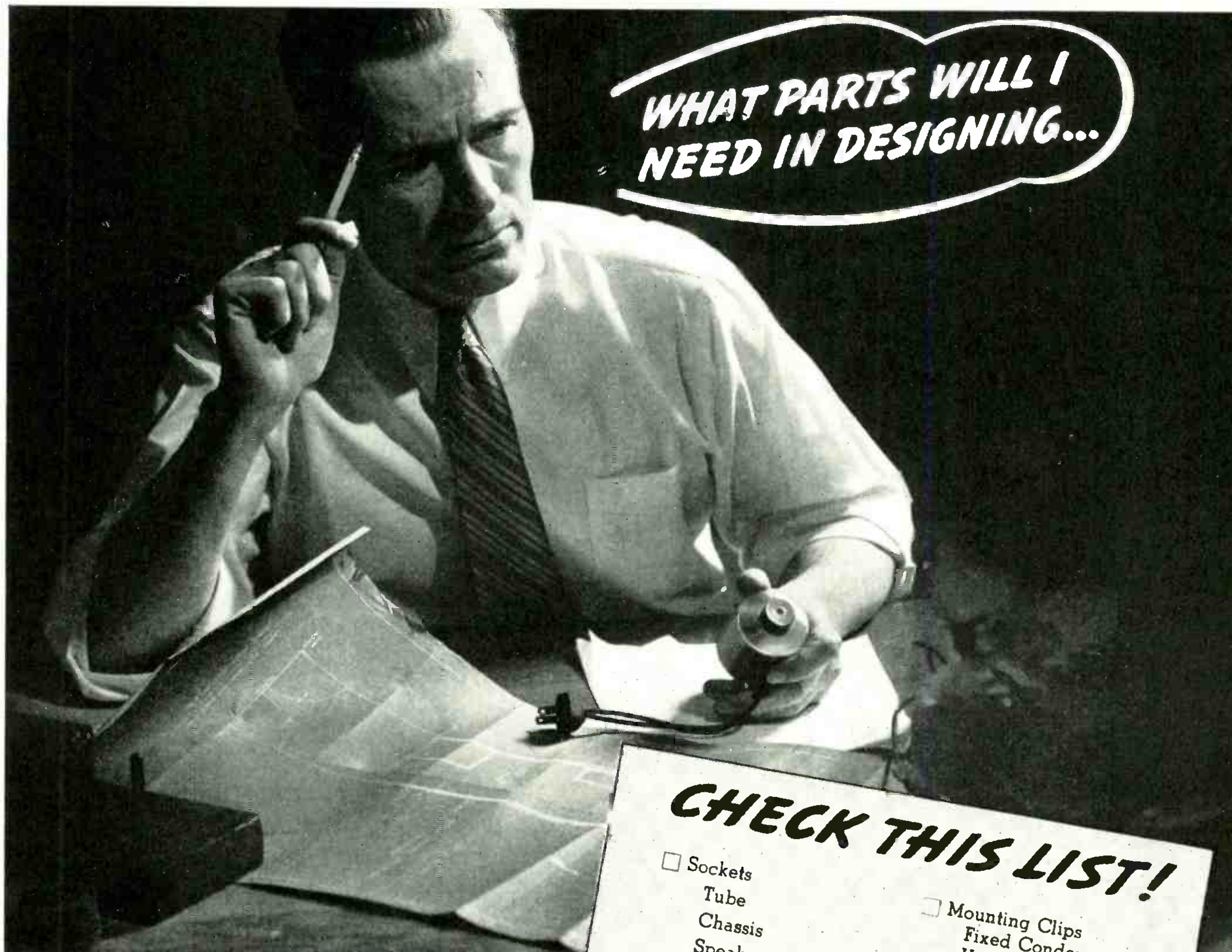
Tube Operation	Values for K: Maximum	Minimum	Representative
TRIODES			
Class B audio amplifier	0.60	0.25	0.40
Class B radio telephone	1.00	0.60	0.70
Class C plate mod. tel.	1.00	0.22	0.43
Class C telegraph	1.00	0.25	0.42
TETRODES			
Class B audio amplifier	....	....	0.42*
Class B radio telephone	0.67	0.67	0.67
Class C plate mod. tel.	0.47	0.33	0.40
Class C telegraph	0.45	0.33	0.36
PENTODES			
Class B telephone	0.75	0.67	0.70
Class C plate mod. tel.	0.42	0.34	0.40
Class C grid mod. tel.	0.75	0.67	0.70
Class C telegraph	0.67	0.33	0.40

* One case, only.

Manufacturer	*Tube Numbering*
Amperex Electronic Products, Brooklyn, N. Y.	200 to 400; 800 to 900; HF; ZB
Collins Radio Co., Cedar Rapids, Ia.	C prefix
Eitel-McCullough, Inc., San Bruno, Cal.	TH or TL prefix
Federal Telegraph Co., Newark, N. J.	F prefix
Heintz and Kaufman, So. San Francisco, Cal.	HK prefix
Hygrade Sylvania Corp., Emporium, Pa.	200 to 300; 800 to 900
Hytronic Labs., Salem, Mass.	HY prefix
Raytheon Production Co., Newton, Mass.	RK prefix
RCA Mfg. Co., Harrison, N. J.	200 to 300; 800 to 900; 1600 to 1700
Taylor Tubes, Inc., Chicago, Ill.	200 to 300; 800 to 900; T and HD prefixes
United Electronics, Newark, N. J.	300 to 400; 900 to 1000
Western Electric Co., New York, N.Y.	200 to 400.



ELECTRONICS REFERENCE SHEET



CHECK THIS LIST!

- ☐ Sockets
  - Tube
  - Chassis
  - Speaker
  - Battery
  - Antenna
- ☐ Plugs
  - Chassis
  - Speaker
  - Battery
  - Connector
  - Shielded
  - Antenna
- ☐ Terminal Strips
- ☐ Bias Cell Strips
- ☐ Soldering Lugs
- ☐ Binding Posts
- ☐ Tip Jacks
- ☐ Dial Pulleys
- ☐ Dial Lamp Sockets
  - Screw Shell Type
  - Bayonet Shell Type
  - Bayonet Snap-in Type
- ☐ Dial Lamp Shields
- ☐ Grid Clips
- ☐ Grid Clip Shields
- ☐ Plug Buttons
- ☐ Contact Strips
- ☐ Mounting Clips
  - Fixed Condenser
  - Variable Condenser
  - Shield Cans
  - Coils
- ☐ Vibrator Plugs
- ☐ Vibrator Grounding Clamps
- ☐ Fuse Housings
- ☐ Fuse Blocks
- ☐ Teenuts
- ☐ Trimounts (snap fasteners for)
  - Dials
  - Name Plates
  - Auto Radio Covers
- ☐ Auto Cover Wedges
- ☐ Auto Cover Springs
- ☐ Cable Clamps
- ☐ Knob Springs
- ☐ Spacer Sleeves
- ☐ Cup Washers
- ☐ Antenna Connectors
- ☐ Formed Brackets
- ☐ Grounding Springs
- ☐ Ferrules
- ☐ Metal Grommets
- ☐ Moulding Fasteners
- ☐ Spring Tempered Parts
- ☐ Miscellaneous Metal Stampings
- ☐ Miscellaneous Bakelite Stampings
- ☐ Miscellaneous Fibre Stampings

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TUBES AT WORK

NEW applications of public address, phototubes for traffic control and surface testing, and a controllable directional microphone, are in the news this month.

New Applications for High-Power Public Address Systems

TWO RECENT APPLICATIONS of public address systems having extremely high powered output have recently made their appearance. At Atlantic City, RCA Victor engineers have set up 60-watt loudspeakers atop each of the tents of the beach patrol. The speakers are mounted on swivels so that they can be turned to any direction required.

Signal Corps portable address system

A working radius of about ½ mile is achieved north or south of the station or offshore. Among the uses of the system are: warning bathers who venture too far out, playing of phonograph records for entertainment, and the location of lost children. The latter cases average two or three per day.

A similar system of higher power has recently been built by the RCA Manufacturing Co. for the U. S. Army Signal Corps. This public address system was used to carry addresses to a throng of 250,000 people at the Gettysburg battle field where President Roosevelt and Governor Earle recently made addresses, dedicating the Eternal Light Peace Memorial. The system has been built to occupy the interior of a 2½-ton truck, and consists of six speakers each of 100-watt capacity, and capable of a sound radius greater than a mile. Two high fidelity theatre-type speakers, mounted on either side of the truck, operate through large grilles. The truck is equipped with the necessary microphones and amplifying equipment, together with phonograph turntables, and a recording device for making records suitable for instantaneous playback.

The loudspeakers are mounted on collapsible steel tripods, 20 ft. high, which support the speakers in groups of three. The position of the loudspeakers on the tripods can be arranged to provide coverage in any desired direction, or all points of the compass at once. Power for the installation is obtained either from outside supply lines or directly from the gasoline-operated generator contained within the truck.

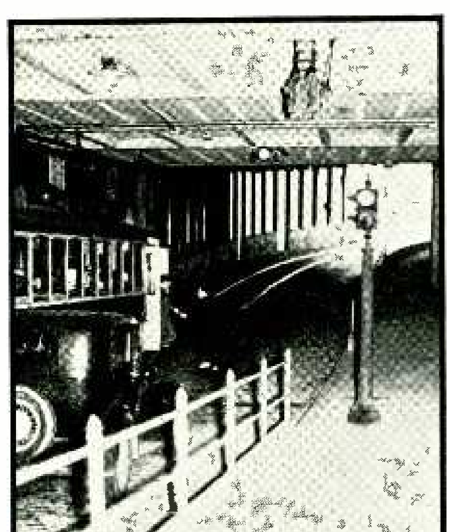
• • •

Phototubes Applied As Traffic Safety Aid

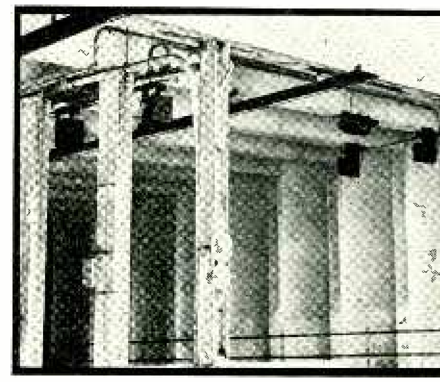
By R. M. SHERMAN

A PROBLEM CONFRONTING traffic engineers in New York recently was a trolley-car stop in a narrow tunnel which had become a scene of numerous accidents. The motorist, driving rapidly into the dark tunnel, all too often neglected to see the halted trolley-car. The result was that passengers, debarking from the street-car, as well as those crossing to it from the curb, were in constant danger from passing automobiles.

To remedy this, the engineers turned to the phototube. A bank of two of these cells was erected at the entrance to the tunnel of the eastbound trolley-car, and a similar "bank" at the entrance to the tunnel of the westbound car. Then, in the middle of the tunnel, just before the trolley stop, were placed traffic lights on stanchions, as well as lights overhead near the roof of the tunnel. The Figure shows this outside bank of cells. When this beam is interrupted, by the trolley pole the two traffic lights in the middle of the tunnel turn red, and by the time the trolley gets to them traffic has been effectively halted. To allow the motorist ample warning that he will be stopped in the tunnel, a light at each entrance turns from green to yellow at the same time that the inside lights become red.



The trolley-pole intercepts the beam controlling the traffic signal



Detailed view of traffic-light control

Some means had to be provided to turn the lights back to green when it was no longer necessary to halt traffic. For this purpose a second bank of cells was so arranged that when the trolley starts up again, the beam of light falling upon them is interrupted by the trolley pole.

• • •

A Directional Microphone with Controlled Characteristics

By A. J. EBEL

University of Illinois

MODERN BROADCAST microphone technique demands that microphones with directional properties be used for certain types of pickups. The bi-directional quality of the "velocity" type microphone has demonstrated its usefulness and the more recently developed uni-directional microphone is rapidly filling a definite need in the field of "on stage" pickups. A microphone whose directional characteristics could be varied continuously from the control point by the control operator during the actual broadcast should prove of even greater value.

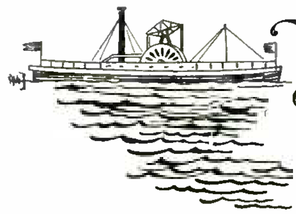
Since the velocity type microphone responds to the pressure gradient of the impinging sound wave its response is proportional to the cosine of the incidence angle ϕ or,

$$E_v = A_1 K_1 \cos \phi \qquad (1)$$

where K_1 is a constant of proportionality which expresses the conversion efficiency of the microphone, and A_1 is a constant that expresses the voltage reduction occasioned by attenuator A_1 (see Fig. 1)

The diaphragm type microphone responds to the absolute pressure of the

(*Continued on page* 42)



They said it couldn't be done - - -

NOT long before the first steamboat crossed the Atlantic, a student set out to prove that the feat was impossible, because the fue required would take more space than the ship itsel

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UNTIL recently, some engineers thought that, while Magnetic pick-up reproduction afforded sharp, clean-cut definition and consistent day-to-day uniformity — it was doubtful if this principle could ever be successful much beyond 5,000 cycles (because of the heavy moving mass needed to carry the magnetic flux). Then AUDAX Relayed Frequency MICRODYNE confounded these sceptics by attaining 10,000 cycles with a response within plus or minus 2 db.

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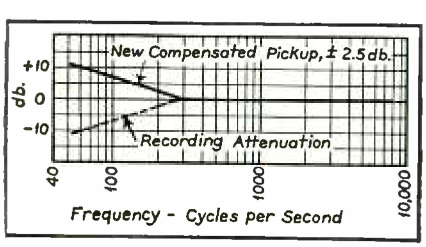

Curves showing actual response of one of the new MICRODYNE models

The tremendous improvement in records has impelled AUDAX to strive toward pick-ups worthy of them. The latest commercial disc materials have been perfected to the point where as high as 8,000 cycles can be reproduced without objectionable surface noise. MICRODYNE, astonishing in its *facsimile* realism, is the standard by which others are judged and valued . . . and is used in studios, radio stations, laboratories, quality sound systems, better grade combinations, and wherever superior reproduction is required.

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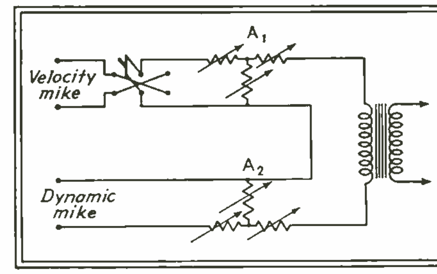

Fig. 1—Control circuit of microphone

sound wave which is the same in all directions. Therefore if the microphone is suspended with its diaphragm horizontal to reduce diffraction effects, its response is independent of the incidence angle or

$$E_d = A_2K_2 \qquad (2)$$

Where K_2 and A_2 are corresponding constants for the diaphragm type microphone.

Now if the outputs of these two microphones and their associated attenuators are combined the resultant voltage will be given by,

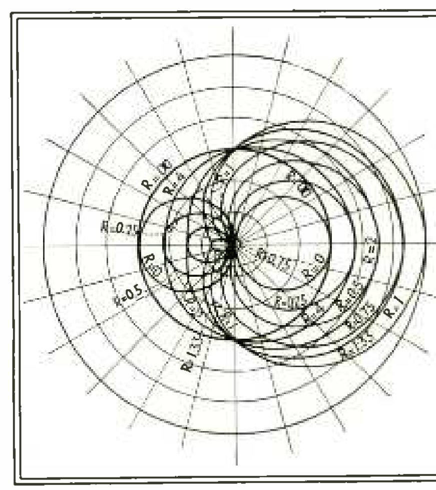

Fig. 2—Plot of polar response (Eq. 4)

$$E_r = A_1K_1 \cos \phi + A_2K_2 \qquad (3)$$

Letting $\frac{A_1K_1}{A_2K_2} = R$, equation (3) becomes

$$E = A_2K_2\,(R \cos \phi + 1) \qquad (4)$$

Fig. 2 shows a plot of the above for several values of R. It may be seen from these that the directional pickup patterns available with this microphone are many and varied.

Fig. 3 is a photograph of the microphone assembly. The microphones used in this particular setup are an RCA 44A and a WE 630 A, although any velocity and any pressure operated element might be combined if their outputs are similar. The hanger, made of $\frac{1}{8}$ in. brass strip $\frac{3}{8}$ in. wide, is fastened to the velocity mike by removing nameplate mounting screws, and the eight ball is mounted in a standard type socket machined from 1 in. stock. The dimensions of the hanger will vary with the microphones used and therefore are not given here. The phasing

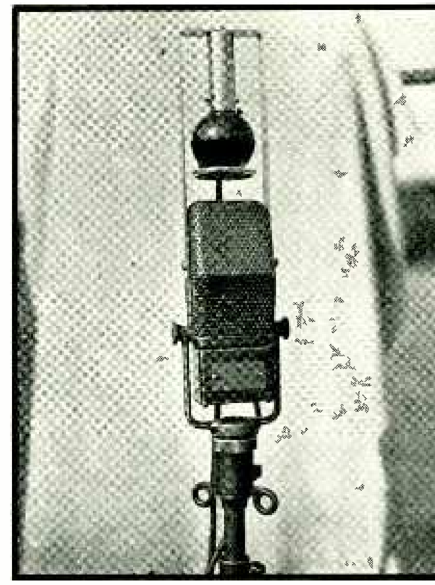

Fig. 3. Assembly of two microphone units

unit which effects the variation of R may be built to individual requirements. The necessary components are the phase reversal switch, two low noise level attenuators and the output transformer. A remote pickup amplifier designed for low level mixing is ideally suited to this use and no alterations need be made unless possibly the addition of the phase reversal switch.

Preliminary adjustments are made by placing a sound source in front of the microphone and adjusting the relative output from each of the component microphones for minimum total output. Then the microphone should be oriented 60 degrees and the output level of the diaphragm type microphone reduced by means of A_2 till the total output is again minimum. This is then the adjustment for $R=5$. Adjustments for all other values of R, less than one, are made in a similar manner, the microphone being turned so that the sound source is in the predicted minimum and adjusted for minimum total output. It is well for the operator to experiment

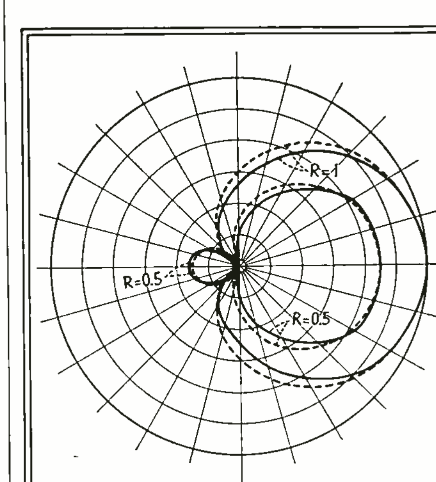

Fig. 4—Measured response of microphone

The Little Acorn
Grows a Sturdy Oak

Along about this time of year we like to pause for a moment in our *forward* thinking and turn back the calendar to see how far we've come and what has been accomplished here. Each of our four years has brought many changes, but we note they all are physical changes. The plant has expanded, the personnel multiplied, new machines have increased and bettered our production. But we all still seem to be of the same mind as when we first took root — to let nothing tempt us from our original plans for building a single-purpose business, unique in its field. Fine small tubing is what we make, and *fine* small tubing has made us—thanks to an ever-growing list of customer-friends.

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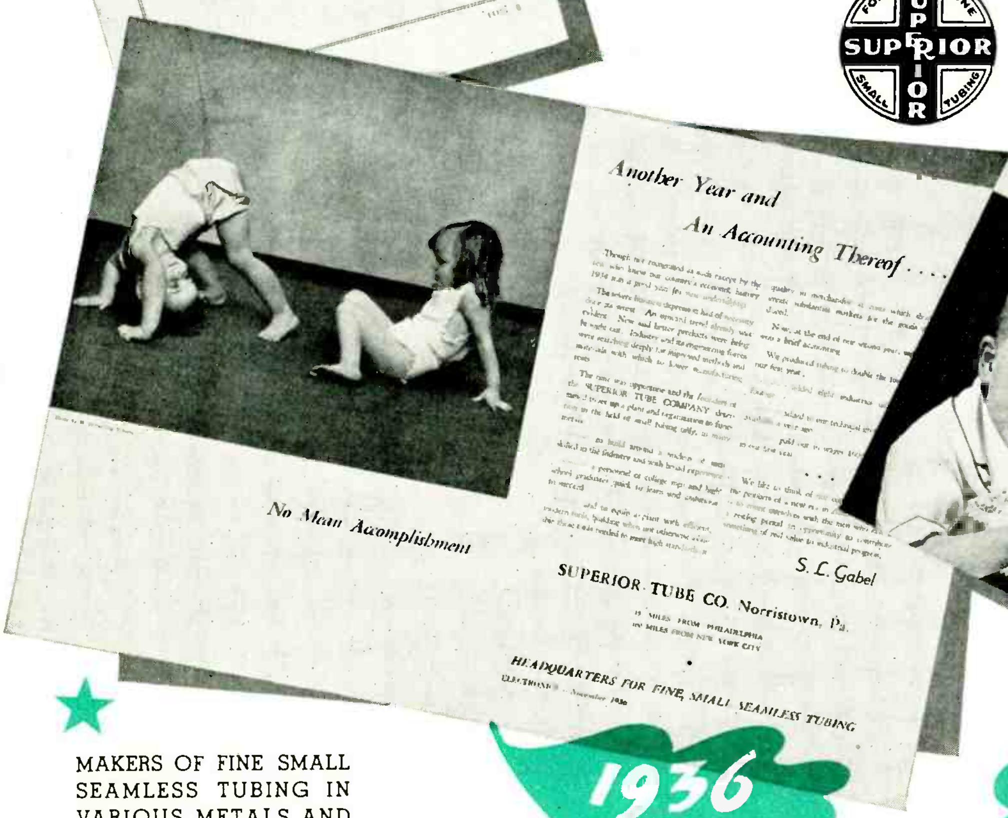

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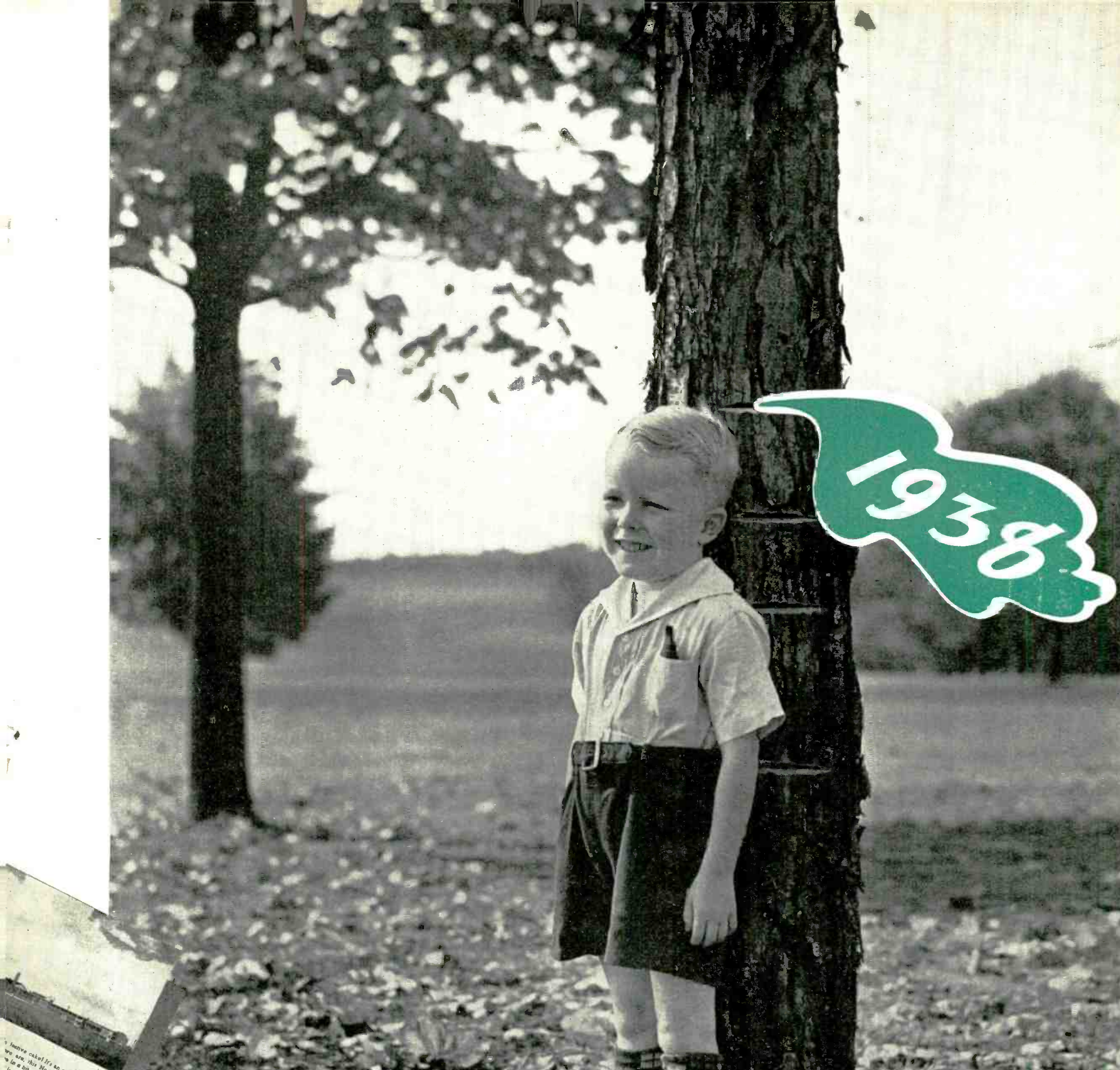

R TUBING

a bit with the microphone so that he will know how to go from one pattern to another during a pickup. Adjustment for patterns obtained when R is greater than one is very difficult and the patterns obtained are not especially useful. The use of the fader calibrations is probably the best method short of actual measurement of the pattern in this case.

That the microphone operates according to calculations is shown by Fig.

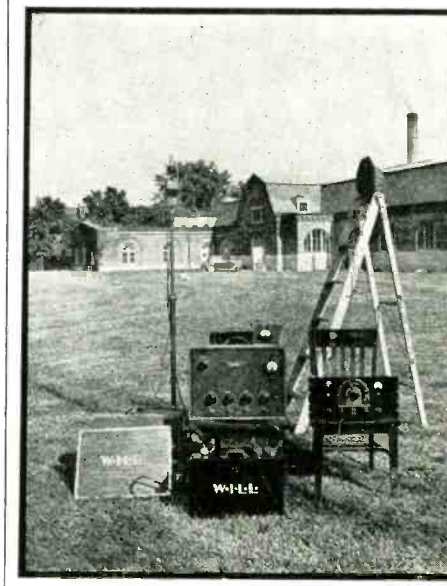

Fig. 5—Measuring equipment set up out doors

4 which is a plot of the calculated and observed patterns for two values of R. The measuring setup is shown in the photograph in Fig. 5. The variations from the calculated pattern are due in part to the physical size of the elements used, which was neglected in the calculations, and in part to the residual noise level which made a high degree of accuracy impossible. Measurements shown were made at 500 cycles. Measurements were also made at 1000, 3000, and 5000 cycles, which showed the same relative minima and maxima but the pattern was distorted somewhat due to standing waves in the measuring setup. At the higher frequencies where the distance between the elements becomes a considerable fraction of a wavelength the pattern will actually be distorted but the distortion is not serious enough to affect the quality of the instrument.

The output level for this microphone is essentially the same as that of either of the component microphones.

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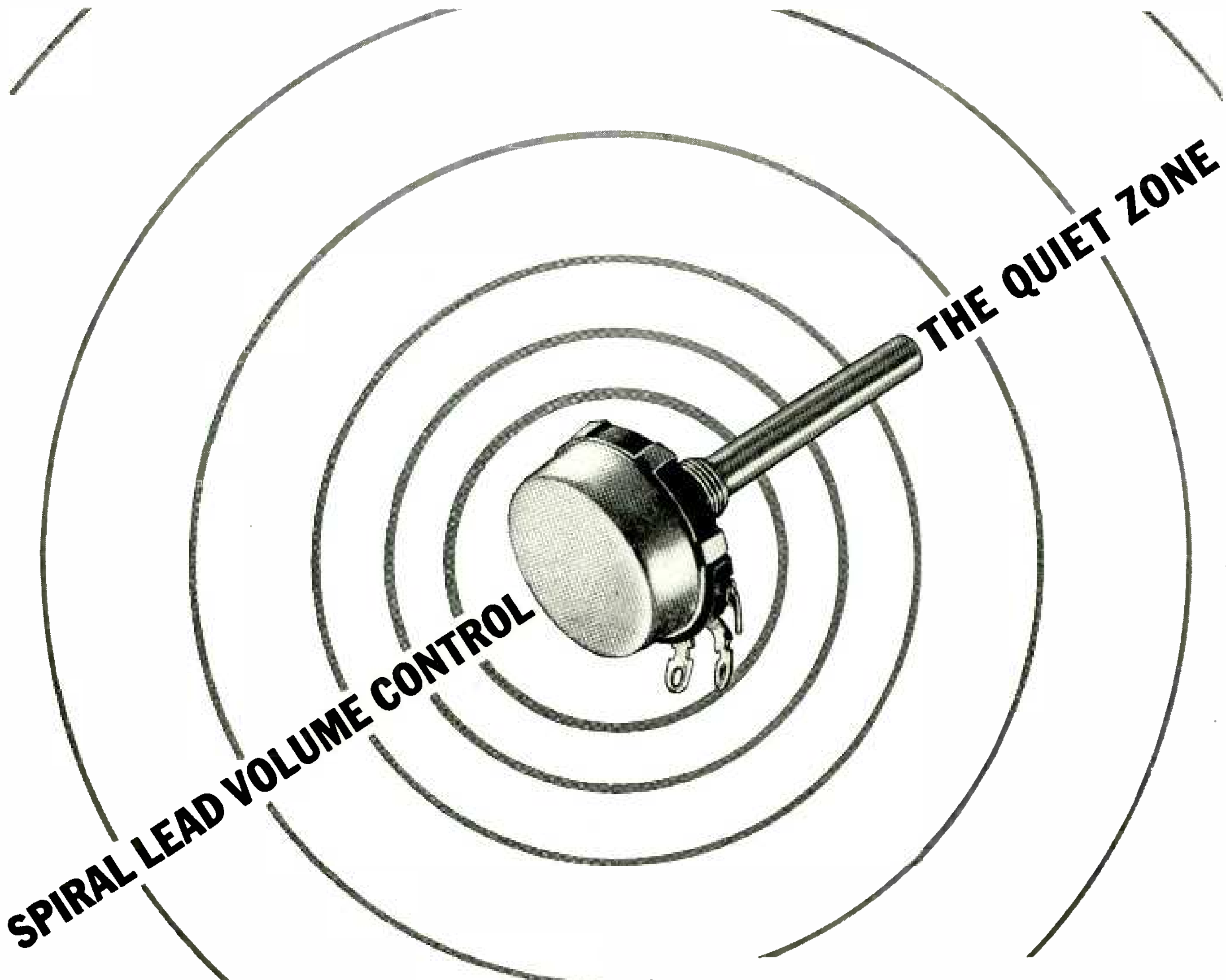
Phototubes Save Coating Metals

By ALEXANDER BALL
Berlin

THE COMMERCIAL production of protective metal coatings on other metals is widespread and highly developed. In



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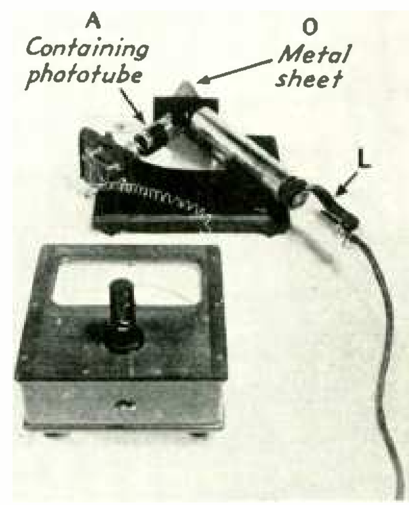
the beginnings of galvanoplating practice, such surface coatings mostly served to make non-precious metals look like precious ones. But soon they came to serve as a protection against corrosion.

Despite this well-developed practice, the basic theoretical knowledge of electro-platers about corrosion and its prevention is still defective in essential points, and it is really surprising, that scientific research appears to have neglected the essential aspects of the problem for so long, although it is a highly practical one and involves the saving or loss of very substantial sums of money. This can be explained only by the fact that, as described in the following, phototubes are required for refining the galvanoplating process, and the use of phototubes on a large scale is a comparatively recent acquisition of modern science and industry.

Two German scientists, Dr. Max Schlotter and his assistant Dr. Schmellenmeier, have tackled the task of exactly defining the value of metal coatings from a new angle: They show that the rule-of-thumb "The thicker the coating, the better the protection" is, where it is not actually erroneous, at least uneconomic, as it often leads to unnecessary waste of coating metal and disregards other vital factors that may make the thickest of metal-coatings almost valueless. And they prove this assertion by means of an ingenious device, in which a phototube plays a prominent role.



Assembly of phototube surface tester

An essential point in plating practice is the structure of surfaces, the surface to be coated as well as the surface of the plate itself. This outside structure of metals can be defined very simply and with sufficient exactness for all practical purposes by the optical effect of its lustre, i.e. the reaction of the surface to light. A surface reflecting light with mathematical precision in accordance with the well-known optical laws, is called "lustrous", whereas a surface diffusing the light is non-lustrous or dull.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A NEW MICROPHONE
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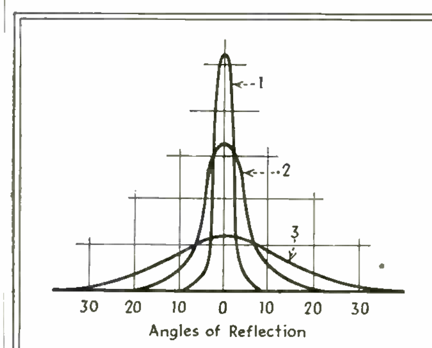
Western Electric

It is already known that an electroplated metal is the more endangered by corrosion, the more pores there are in its surface. For the pores are the points where corrosion first sets in and from where it attacks the surrounding metal coating as well as the underlying base metal. Dr. Schlotter and Dr. Schmellenmeier have now proved by extensive tests that

1. The number of pores is proportional to the roughness of the underlying surface of the base metal. The rougher, i.e., the duller the surface of the base metal is, the more pores appear on the surface of the finished electroplated object;
2. a certain degree of lustre indicates when the coating is sufficiently thick to prevent the appearance of pores and therewith to prevent corrosion. After reaching this stage, any further coating becomes superfluous and a mere squandering of material.

It is easy to see the practical importance of these deductions. On the one hand, the present practice of leaving



Variation of reflected light with reflection angle

the base metal in electroplating unpolished, will give way to the polishing of metals prior to bringing them into the electro-bath. On the other, each individual plant may easily fix a scale indicating the minimum lustre of the electroplated objects they turn out and therewith defining the safety against corrosion they afford; or buyers may ascertain, by measuring the lustre, whether electroplated goods are sufficiently corrosion-proof.

For these purposes, an instrument measuring the lustre of metals had to be developed. And this is the point where the phototube comes in and may open, in view of the great numbers of instruments required for the above-mentioned tests, a good potential market.

The instrument designed by Dr. Schlotter and Dr. Schmellenmeier (see photo) consists of a source of light L, a bulb of low voltage (18 volt, 45 watt) with a filament wound around a straight core. A beam emitted by L passes a slot and a system of lenses and falls on the surface to be tested, O, whence it is reflected to the slot S of the light-catcher A. A reflection of the spiral filament of S is then found on S. Behind S, there are provided a pane of

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opal glass and, two inches behind this, the phototube referred to. As the objects to be tested are frequently large thin sheets of metal apt to be not absolutely plane, they can be pressed down to a plane support by a disc leaving only a small piece of 2 mm width of the surface under observation. In order to avoid interfering reflections, the edges of the disc are blackened. The light-receiver A is mounted on a rail and may slide in the plane LOS about a turning point lying exactly under O. So the whole field of diffuse reflection from O may be covered by A. Since the source of light is arranged so as to reflect the light from O under an angle of 45 degrees, it is sufficient when A covers a quadrant extending to both sides of this preferred direction. The lesser the lustre, the more diffuse becomes the reflection and the more light falls on the quadrant outside this direction. The more or less powerful reaction of the phototube is recorded in known manner. So the diffusion of light

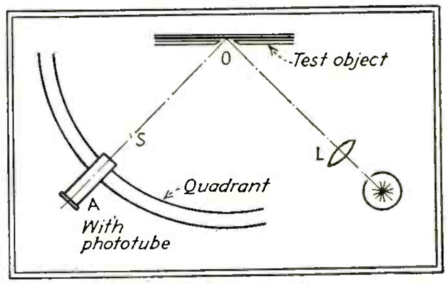


Diagram of surface tester. By moving phototube in quadrant circle, reflected light is measured at various reflection angles.

is recorded in a more or less elevated curve. When the test metal is very bright, i.e., when almost all of the reflected light is concentrated upon and around the point where the beams fall on the photo-electric cell under a 45 deg. angle, the peak of the curve is high and its sides slope downward very steeply. It can be assumed that the light emitted by the filament of L is distributed equally over the whole surface the beam covers, as the beams emitted by a tungsten filament at 2500° Centigrade follow approximately to the Lambert law of radiation. The width of the slit before the bulb L is .8 mm and equals the width of the slit S before the light-catcher A. Under ideal conditions and with ideal reflection, the curve of light distribution on the tested surface must be triangular, the base of the triangle having a length of 1.6 mm, i.e. twice the width of the slit. In reality, the curve is always rounded off, because slight errors cannot be eliminated altogether and no surface, not even that of good glass mirrors, is so lustrous as not to diffuse a small part of the light reflected.

But, taken all in all, the instrument seems to have a chance of becoming almost indispensable in electroplating shops.

BOOK REVIEW

Radio Laboratory Handbook

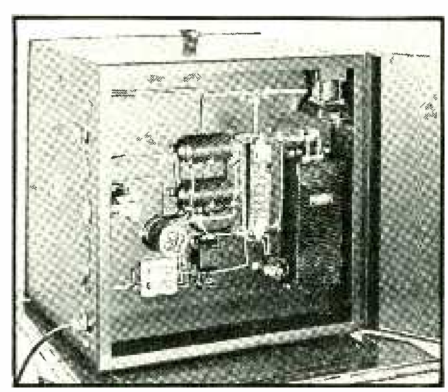
By M. G. Scroggie. *Iliffe & Sons, Ltd., London. 384 pages, 211 illustrations. Price, 9 shillings.*

THE AUTHOR, well known in England because of his writings on technical radio subjects, has written this convenient volume for the professional engineer as well as for the amateur. It lacks the heavy, detailed mathematical treatment which makes some laboratory manuals dreary reading, and throughout aims at the practical aspects of the subjects under treatment. Many useful, but frequently neglected subjects, are treated, such as, for example, the choice of suitable laboratory space, heating, lighting, and wiring the laboratory, layout of equipment in the laboratory, and optimum use of available space.

Of the twelve chapters, four deal with laboratory instruments, including their characteristics, good and bad features, ratings, and ranges. Two chapters discuss measurements, and one chapter is entitled "Dealing With Results". This last chapter contains the type of material which the student and less experienced laboratory worker will probably find extremely useful, since it discusses such matters as rearrangement of formulas, what factors may be neglected, precision of measurements, deceptive formulas, methods of calculation, and related problems.

All in all, the author has presented a refreshing picture of what is usually a dull subject, and has done so in a manner as will benefit the beginner as well as the experienced laboratory worker.—BD.

PHOTOTUBE GUARDS BALLOTBOX



A phototube counter installed on this ballot box gives an audible signal as a ballot is cast, and registers the total count. Any attempt to "stuff the ballot" by inserting two ballots at once is revealed by the difference between the photoelectric count and the number of ballots found in the box. The device was first used at the American Bowling Congress

THE ELECTRON ART

Each month the world's technical literature is scanned to see what physicists and engineers are doing with tubes, for presentation in tabloid form to Electronics' readers

An Electron Operated Thermostat

An electron controlled temperature thermostat, which maintains temperature constant to within a few thousandths of a degree for periods of several hours is described by Julian M. Sturtevant in the September issue of the *Review of Scientific Instruments*, under the title, "A Thyratron-Controlled Thermostat." Essentially the thermostat is an elaboration of that described by Benedict in the *R.S.I.* for August, 1937, but has been made more sensitive, rugged and operates from the 110-volt power line rather than from batteries.

A resistance type thermometer, in one arm of a modified Wheatstone bridge forms the essential controlling element of this thermostat. Two other arms of the bridge are fixed resistors, while the fourth arm is variable and may be adjusted manually. The source of voltage for the bridge is taken from the 110-volt line and the output is applied to an audio transformer of the double button microphone to grid type having a ratio of 22 to 1. This voltage is then applied to the grid of a type 57 tube where it is amplified and then applied to the grid of the type 45 tube for further amplification. The output of the 45 tube operates a type FG 57 thyratron whose plate circuit contains the heating elements of the thermostat.

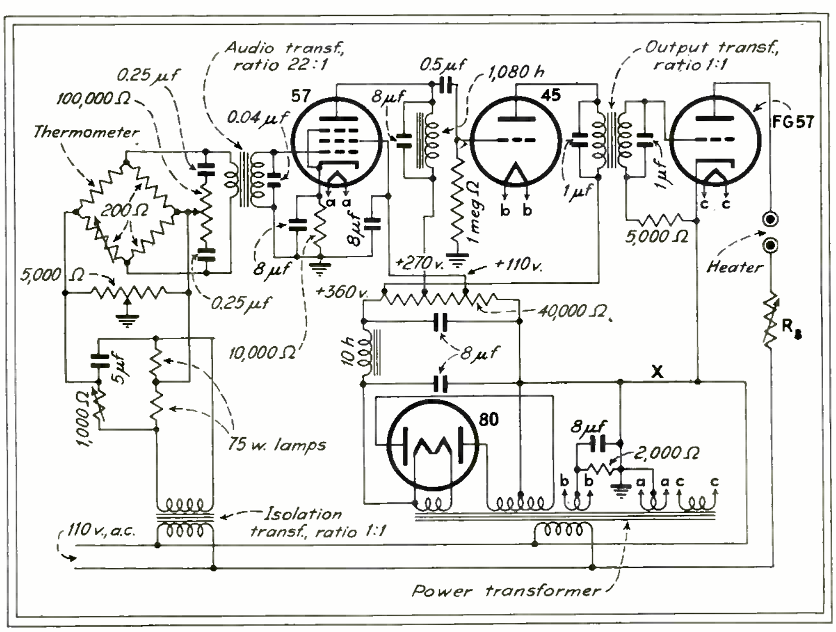
It is advisable to shield the bridge and the amplifier thoroughly, because sufficient amplification is used so that pick-up voltages may otherwise be troublesome. Shielded leads connecting the transformer T_1 to the amplifier are recommended. It is further suggested that the transformer T_1 be situated so as to have no inductive coupling with other equipment in the thermostat. A suitable position for this transformer may be determined by short circuiting the primary winding and moving the transformer about until no voltage is observed at the grid of the thyratron.

With the resistance thermometer in the bath and maintained at the desired temperature, the 5000 ohm voltage dividers is adjusted so the circuit may be balanced to provide 0 voltage at the grid of the thyratron when the resistance of the variable bridge arm, is suitably adjusted. This adjustment serves to neutralize various voltages arising from leakage or coupling effect.

The variations with signal amplitude of the phase shift in the amplifier is sufficient so that it is unnecessary to supply more than a very small component of voltage other than that arising from the off-balance of the bridge in order to secure continuous control. This component is obtained by a slight change in the setting of the voltage divider, the best setting being that which gives a maximum rate of gain with respect to bridge off-balance of the plate current passed by the thyratron. The resistor R_s is adjusted so that the maximum current the thyratron will pass is about twice that needed to maintain constant temperature.

If the resistance of the thermometer increases beyond the point of bridge balance by more than about 0.2% the thyratron abruptly starts to pass maximum current. This results in a complete loss of temperature control, so that the temperature of the bath must be within a few tenths of a degree of the desired point before the control is entrusted to the thyratron.

Curves are given showing the precision of operation of this thyratron controlled thermostat. In one of the curves covering an operating period of fifty hours, the room temperature changed from about 22° to about 27.5° C. whereas the temperature of the thermostat controlled bath did not vary more than about 0.003° C. from its mean or normal value.



Schematic wiring diagram of the thyratron controlled thermostat which is capable of maintaining the temperature of a bath constant to within about 0.003° C of its proper value. For this degree of control to be accomplished the ambient temperature should not vary more than a few degrees from its normal value

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Current Articles on Electronics and Related Subjects

CIRCUIT PROPERTIES

Theory And Design Of Progressive Universal Coils—A. A. Joyner and V. D. Landon, *Communications*, Sept. 1938, pp. 5-8, 11, 50: Factors determining the pattern, i.e., choice of winding pitch, cam throw, and number of crosses per turn. Condensed design procedure.

Transients Of Resistance Terminated Dissipative Low-Pass And High-Pass Electric Wave Filters—W. Chu and C. K. Chang, *Proc. I.R.E.*, Oct. 1938: Derivation of formulas for the transient receiving-end currents of resistance terminated dissipative T and π-types of low and high-pass filters. Data on damping constants vs. various terminating resistances and amounts of sections.

Coupling Networks—W. L. Everitt, *Communications*, Sept. 1938, pp. 12-18, 50: Design features of two (L) and three (T or π) terminal networks.

Simplified Solution For Antenna Inpedance Matching Networks—A. Vollenwelder, *Broadcast News*, July 1938, pp. 26-27, 30-31: Derivation of constants for T-network used for matching transmission line to antenna.

On The Optimum Dimensions Of High Frequency Bifilar Lines—C. Poledrelli, *Alta Frequenza*, July 1938, pp. 435-446:

(Continued on page 59)

DELCO APPLIANCE
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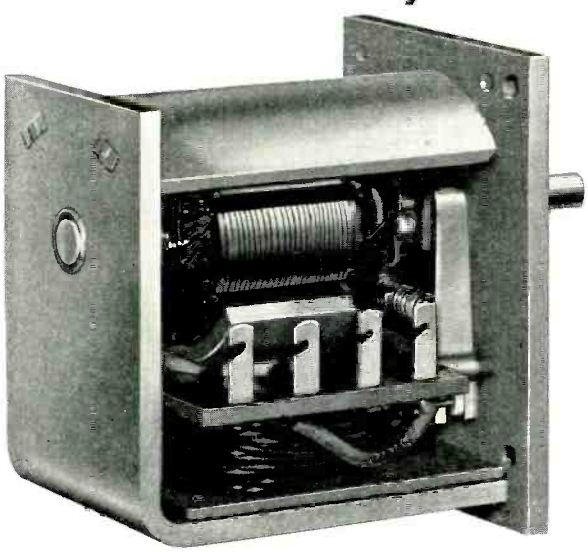

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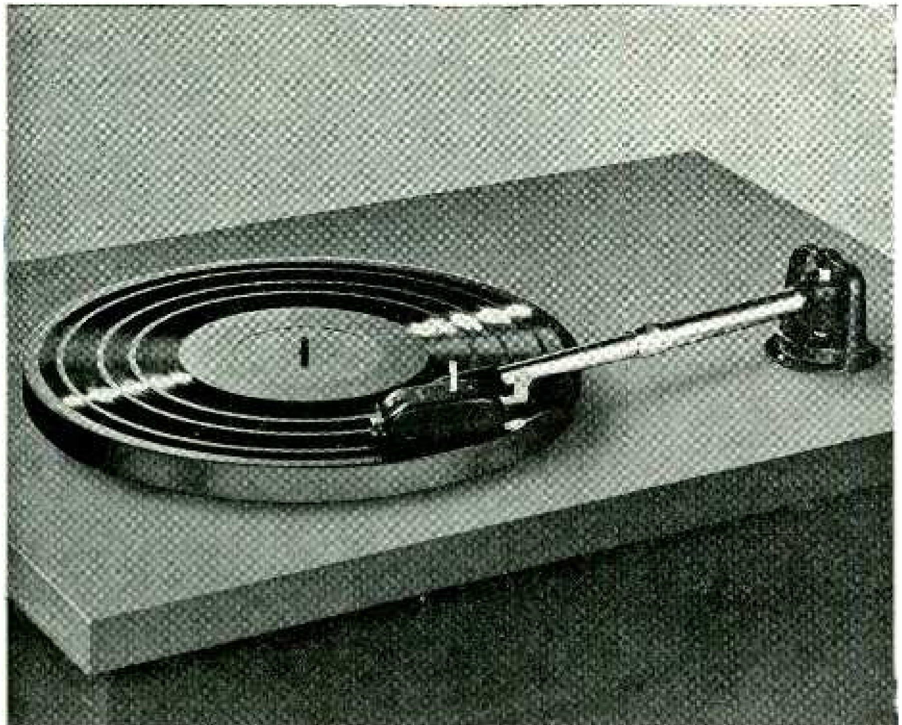
Reversible, compact, economical, this Delco Appliance motor is the smoothest and quietest we have yet offered, due to its new rigid heavy steel riveted frame, big self-aligning bearings and special commutation.

Note, too, the variety of mounting requirements provided for in the bracket design, the accessibility of the terminals for quick connecting and the sturdy terminal block that assures secure anchorage.

It will pay you to examine this motor and then let our engineers study your needs and make their recommendations.



(Continued from page 58)

Limits of validity discussed. Comparison with Reukema's data. Chart with values for various line terminations.

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The Measurement Of Secondary Emission In Valves—L. R. G. Trelvar, *W. E.*, Oct. 1938, pp. 535-542: Critical study of several methods. Method of measuring emission from various caesium-oxide surfaces.

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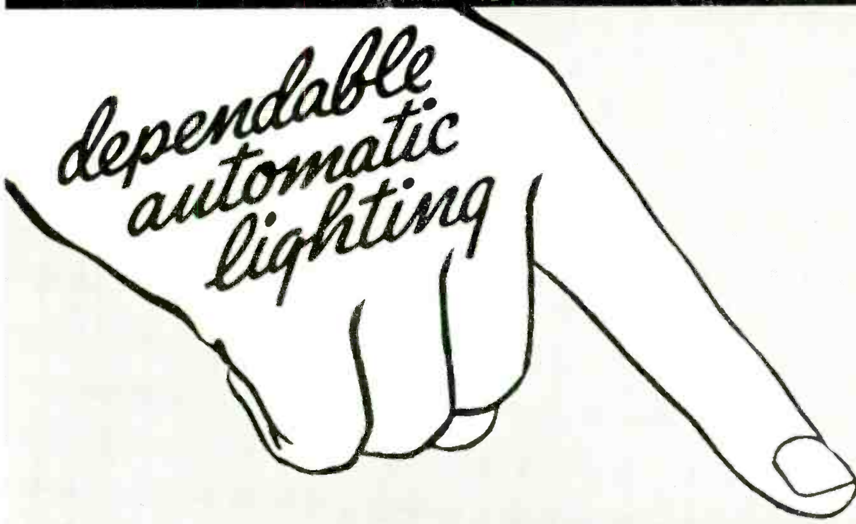
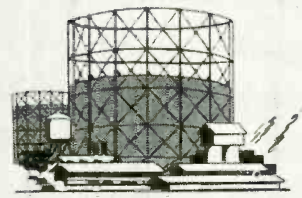
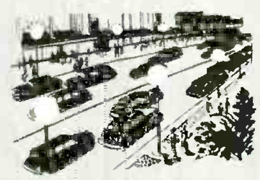
HERE'S THE CONTROL THEY USE FOR...

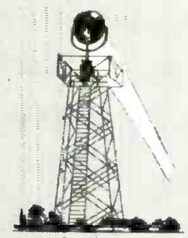




OBSTRUCTION MARKERS



STREET LIGHTING



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***PHOTRONIC ILLUMINATION CONTROL RELAY**

The most practical, most economical lighting control unit. The light target used is the small Photronic (photoelectric) Cell, which can be mounted any distance away and easily wired to this compact relay control panel. No amplification used. Separate "on" and "off" relays, calibrated in foot-candles, permit quick and independent setting of both the "on" and "off" illumination values. Uses no energy when not operating; consumes but 2 watts during the brief operating cycle.

*PHOTRONIC—*A registered trademark designating the photoelectric cells and photoelectric devices manufactured exclusively by the Weston Electrical Instrument Corporation.*

Safety at night along our airlanes with automatically controlled airway beacons, as well as automatic safety lights atop gas tanks, radio towers, power plant chimneys and other obstructions on our airways. *Safety* in harbor piloting with friendly and automatic warning lights marking shoals and reefs. And greater safety on our streets . . . economy, too . . . now that street lighting in many of our cities is automatically maintained at safe illumination levels. And wherever else that illumination is the key to safety . . . or to efficiency or economy, such as sign lighting, factory lighting or the like . . . WESTON Photronic Illumination Control invariably is employed. Because the *simplicity* of Photronic Control assures safety, dependability and economy in the highest degree. The WESTON engineer in your vicinity will gladly give you full details on Photronic Illumination Control, as well as on WESTON direct-reading Illumination Meters, and other Photronic devices. Call on him, or write to . . . Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.

WESTON *Illumination Control*

mission line with another outer conductor, $\lambda/4$ long, shorted at top to line. Antenna projects above this for a $\lambda/4$, giving an equivalent length of $\lambda/2$. Electrically equivalent to a center-fed doublet.

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Apparatus For Direct Recording The Pitch And Intensity Of Sound—J. Obata and R. Kobayoshi, *J. Accous. Soc. Am.*, Oct. 1938, pp. 147-149: Tube with quadratic characteristic used in wave form adjuster. Symmetrical compression used. Pitch is indicated on a log scale. Brief description of apparatus.

An Adjustable Tuning Fork Frequency Standard—O. H. Schuck, *J. Acous. Soc. Am.*, Oct. 1938, pp. 119-127: Design features of an adjustable tuning fork as a portable frequency standard.

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Mutual Conductance Meter—C. B. Aiken and J. F. Bell, *Communications*. Sept. 1938, pp. 19, 24-25, 50: Balance independent of impedance in plate circuit. Only one calibrated resistive element is required.

A Radio Frequency Phase Meter With Many Uses—G. H. Brown and G. Swift, *Broadcast News*, July, 1938: RCA 300-A phase meter capable of measuring angles from 0-360 deg. Freq. range from 200-1600 KC. Primary application is adjustment of time phase in directional antenna arrays.

London Radio Exhibition

By John H. Jupe
London, England

Television for all was no mere advertising phrase at the 1938 Radio Exhibition in London. It was a hard reality and one designed to suit all sizes of pay envelopes.

This year, one hundred of the largest firms in the radio industry in Great Britain made a united effort to give television to the man in the street. Prices for television receivers of excellent technical quality ranged from about $100 for "vision only" to more than $1,100 for receivers capable of being viewed by 750 people at once.

Most sets employed cathode ray tubes but there is no uniformity of color of the screens, although bluish-black seems to be the most popular. One receiver uses a very hard tube with a second anode voltage of 25,000 volts.

The British Broadcasting Corporation erected a large and well equipped studio capable of accommodating several stages. One of their several television vans, made to monitor television scenes away from the permanent studio, handled the shows and passed them on to the transmitter by a special cable.

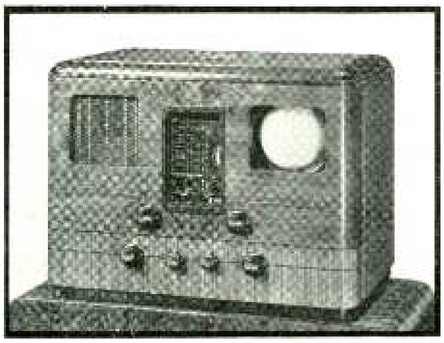

Table model television receiver on display at London exhibit

The B.B.C. realized that the whole success of television depends to a large extent on the reaction of the public to this show, and acted accordingly.

On the whole, prices of radio receivers are about the same as last year although most manufacturers are giving better value for the money. Push button tuning was shown by practically all manufacturers, but in several cases the mechanical construction of the switches was poor.

From a technical point of view, there were two very interesting exhibits. One of these was a television receiver by Scophony Ltd. with a quartz crystal in a liquid as a light control instead of the usual cathode ray tube. This set also used a system of rotating mirrors for scanning, driven at 30,375 revolutions per minute. The driving motor was in two parts. One of these was an induction motor to run approximately to speed and to supply friction and windage losses. The second was a phonic wheel to supply the synchronizing power. Considering the high speed at which the discs rotate, the receiver was silent in operation and the motor is reputed to have a long life.

The other ingenious exhibit was a small radio accessory to enable the radio receiver to be controlled from any room in the house in which there is a power outlet. Control of the radio receiver is effected through the use of the accessory which transmits the necessary controlling impulses to the receiver over the power wiring of the house.

Textile Industry Uses Photo Tubes

One application of the phototube in the textile industry is contained in an article by C. W. LaPierre and A. T. Mansfield writing in the September issue of *Electrical Engineering* under the title "Photoelectric Weft-Straightener Control." The paper describes a successful automatic means for squaring up cloth in the final drying and stretching process, thus making it possible to raise materially the textile finishing standards in this respect.

When automatic control of weft straighteners is used, some method of detecting the skew of the thread becomes necessary. The photoelectric tube is used to determine the amount of skew in the thread as the cloth passes over a pair of optical slits. In Fig. 1 the optical slit, designated by the letters *A* and *B*, are placed approximately at right angles to one another so that the angle between each slit and the weft thread is approximately 45 deg.

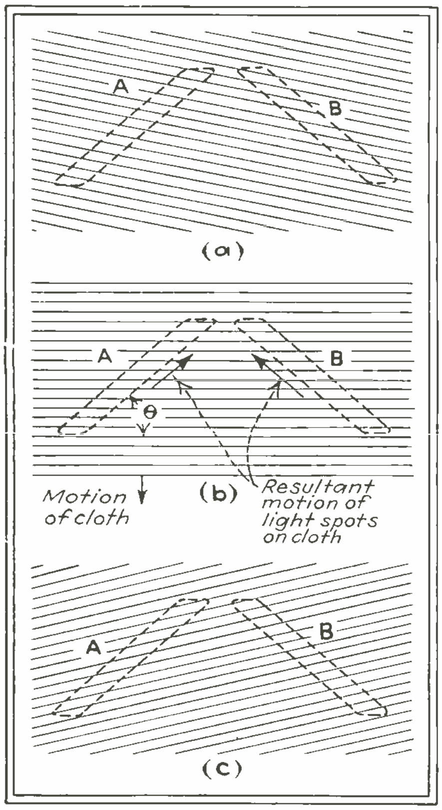

Fig. 1—Diagram illustrating operation of photoelectric weft-straightener

when no skew occurs. The Fig. 1b shows that an equal number of weft threads passes before each optical slit when the cloth is free from skew. In Fig. 1a, which shows skew in one direction, there are fifteen weft threads across slit *A* and only nine across slit *B*, whereas in Fig. 1b which shows skew in the opposite direction the reverse situation is true. If the weft thread can be made to intercept two spots of light, as shown in Fig. 1, a comparison of the rates at which the two spots are interrupted, will indicate the direction and magnitude of the angle of skew.

To carry into effect the principle of operation given in Fig. 1, two factors are necessary; first, suitable scanning detectors which will give an impulse for each weft thread interception in the manner just described, and second, a control circuit which will compare the impulse rate from the two scanning detectors and operate the straightener motor when necessary to make the two detectors generate impulses at the same rate.

The authors describe various component parts of the complete weft straightening control, outline the essential characteristics of the electrical system, show a schematic wiring diagram of the control unit and illustrate their paper with a number of photographs of textile equipment.

Electron Lenses

AN ARTICLE on "An Analytical Study of Electrostatic Electron Lenses" by E. Sudata appears in the October issue of the *Electrotechnical Journal* published by the Institute of Electrical Engineers of Japan at Tokyo. In this paper the motion of an electron in axially symmetrical electrostatic fields is mathematically analyzed to find the necessary and sufficient conditions for the formation of the electron images.

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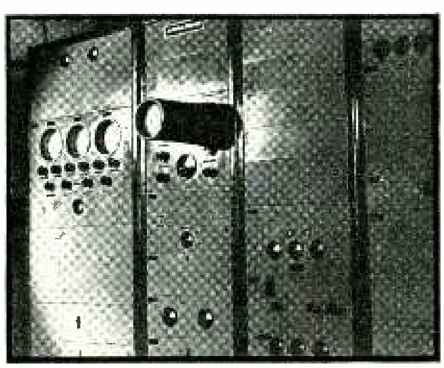
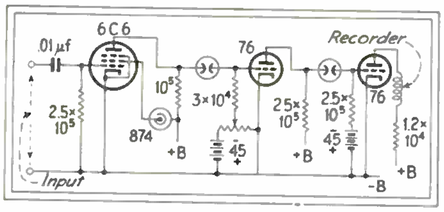
Television Monitoring Panel



The monitoring panel, shown above, contains three cathode-ray tubes for viewing the outputs of three camera channels simultaneously. The remaining tube is a wave-form oscillograph. The equipment was built and is installed by Le Materiel Telephonique, I. T. and T. subsidiary

Amplifier for Impulse Counting

AN INTERESTING TYPE of multi-stage amplifier is described by F. A. Korff in the August issue of the *Review of Scientific Instruments*, under the title "A Neon Tube Coupled Amplifier Circuit for Radio Cosmic Ray Receivers." Although the amplifier described was originally designed for use in cosmic ray detecting devices, the essential ideas involved are applicable to a number of industrial control problems where it may be desired to provide a definite and relatively large change in the output circuit of a control device with a relatively small variation in voltage of an input device. The figure shows a schematic wiring diagram of the elements of this amplifier. The 6C6



biased to cut-off, serves as a detector. When a positive impulse is received by the grid of this tube, the 6C6 becomes conducting. For the condition of cut-off, the 6C6 is non-conducting and the neon tube connected to its plate circuit glows because current flows from the 250 volt plate supply through the plate resistance to the neon tube and returns through the grid resistor of the first 76 amplifier. When the 6C6 becomes conducting, the voltage drop through it is small compared to that across the neon tube, so that the latter is effectively short-circuited and ceases to glow. When the positive pulse is removed from the grid of the detector tube, the 6C6 stops conducting and the voltage in its plate circuit builds up to that required to again initiate discharge of the neon lamp. Consequently, the neon tube normally glows for grid voltages which are less positive than the cut-off bias but is extinguished for grid voltages on the detector which are more positive than the cut-off bias voltage.

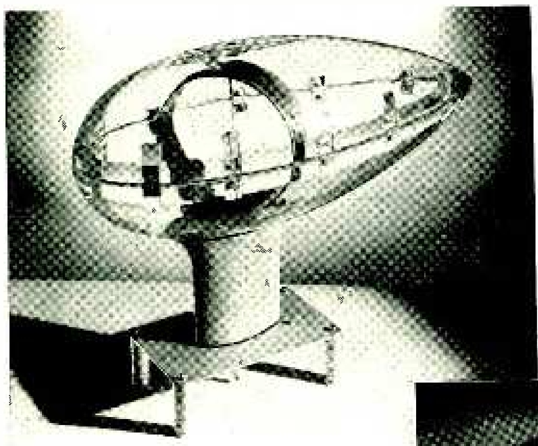
The sudden starting and stopping of the discharge of the neon tube transmits a large voltage change to the grid of the first type 76 amplifier and a recording relay in the plate circuit of this amplifier might serve as a recording or counting device. Such a relay would normally be closed and would snap open when the signal is received.

Since it is usually more desirable to produce a record with positive rather than negative pulses, another and similar stage of amplification with neon tube coupling is provided.

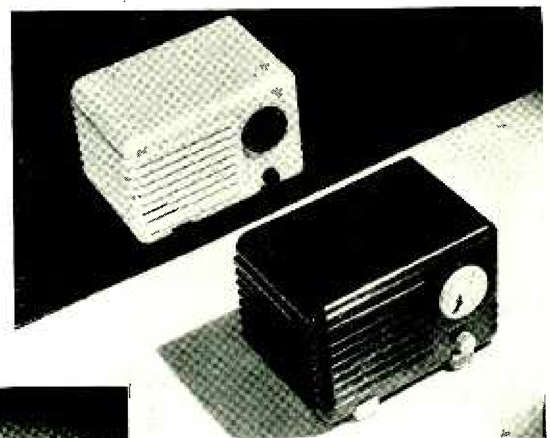
It is pointed out that the neon tube coupling device may be replaced by any other gas discharge tube, such as the type 874 regulator employing argon. Additional control of the operating characteristics may be obtained through the use of resistances in series with the neon tube.

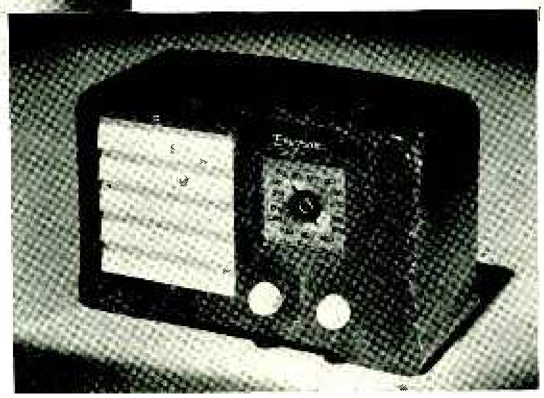
THE INDUSTRY IN REVIEW

Prize Winners in Plastics Competition



Annually, *Modern Plastics* awards prizes for outstanding designs using plastics. These photos are of prize winners in the 3rd Annual competition





Above—Loop housing and direction finder, Lear Developments Co., Inc.—first award, transport group. Right—Honorable mention, decorative group, Emerson college radio

Above—Second award in the decorative group. Two cabinets for Pee Wee small receiver made by Detrola, typical examples of plastics use by radio set manufacturers

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New Multi-frequency Aircraft Equipment

RADIO is becoming increasingly important in the safe navigation of aircraft. Winter flying with attendant "snow static" has occasioned an extensive rehabilitation of all existing radio equipment. Practically all air lines are at present replacing their radio equipment with improved and more efficient apparatus. One method of helping to overcome some of the difficulties of "poor receiving conditions" has been to increase the power of the ground stations. One very interesting arrangement of apparatus is that typified by equipment used by the Eastern Airlines and T.W.A. This apparatus was built for these companies by Thomas L. Siebenthaler Manufacturing Company of Kansas City. Heretofore, in order to have multi-frequency operation a very elaborate transmitter with intricate switching arrangements coupled with large, expensive, high dissipation tubes operating at low frequencies has been a necessity. For the output formerly used, this arrangement was fairly satisfactory though it was impracticable for higher power operation.

In the new design the motif has been to have a complete r-f unit for each frequency. In this arrangement every circuit can be adjusted for just the right loading for each frequency. Changing frequency is accomplished by switching low frequency circuits with standard relays from the operator's position. One important consideration is that more than one channel can be used simultaneously. At the present time the transmitters are used in groups of five or ten representing the number of channels desired at a particular ground station. A single power supply capable of operating one telephonic and two telegraphic channels without cross-talk is provided. A single modulator is used for all channels.

Each r-f channel has been reduced to bare necessities without in any way detracting from utility or dependability. Each section uses small screen grid tubes as the crystal oscillator and first buffer, a larger screen grid tube such as the 803 as the final buffer and a pair of Eimac 450T tubes connected in parallel as the final amplifier. A plate voltage of 4000 is used on the final amplifier. The transmitters are normally designed for 2½ kw in the antenna or 2.8 times the available plate dissipation although the actual performance is considerably better than this. During actual tests the input to the final amplifier was 4000 watts and as near as could be determined the plate efficiency was between 80 and 85 per cent. This means that of the 4000 watts input considerably better than 3 kw is delivered to the antenna. Such performance is a tribute to the merits of this type of design. On telegraphic services the antenna power is in the order of 4 kw.

The cost of this type of equipment is less than trying to make a single multi-frequency transmitter of comparable power. All r-f sections are identical in layout so that a semi-production method of manufacture is possible.

The modulator uses a pair of 450T tubes in class B and this unit is capable of completely modulating any r-f section.

To assure good regulation the power supply is a polyphase arrangement that is capable of a plate current of 3 amps at 4000 volts.

News

✦ A new organization called the International Balsa Corp., with headquarters in Jersey City has been formed not to fabricate or manufacture but rather to serve as a medium through which various companies who specialize in using Kiln-dried Balsa Wood will be able to contact parties interested in having the products manufactured. The Company also plans to develop more scientific and efficient means of working and processing balsa wood, which is used where lightness and strength, insulation, isolation, etc., are important . . . New manufacturer of dynamotors, converters, and gas electric plants is Eicor, Inc., 515 S. Laflin St., Chicago. Joseph Nader is President and Chief Engineer. The new firm will specialize in standard merchandise with special emphasis on the engineering facilities available for special designs to fit individual needs . . . Edward F. McGrady, former Assistant Secretary of Labor, and at present Vice President and Director of Labor Relations of RCA was elected to the Board of Directors to fill the vacancy created by the recent death of James R. Sheffield. Mr. McGrady was also elected a Director of RCA Communications, Inc., an RCA subsidiary . . . General Communications Products Co., Los Angeles, Cal., manufacturers of acoustigraph dictating machines, has taken over General Communications Products Inc. The new officers are: S. A. Sollie, President; Berard F. McNamee, Chief Engineer; and Simon Yerkovich, Mechanical Engineer in charge of Design . . . H. D. Von Jenef has been appointed Chief Engineer of the Million Radio and Television Laboratories, Chicago. He was recently associated with Televiso Co., as Consulting Engineer . . . For further improvement of employer and employee relations Sparks Withington Co., Jackson, Mich., announce the inclusion of hospitalization benefits in the Company's group program which covers life insurance and sickness and accident protection . . . Cornell-Dubilier Electric Corp., pay dividends of 10 cents per share on all common stock of the Company . . .

Literature

Electrical Sheet Steel. 32-page booklet "Armco Electrical Sheet Steel" describes various electrical sheet steel grades and includes charts and statistical tables. American Rolling Mill Co., Middletown, Ohio.

Radio Equipment. Fall and Winter Catalog No. 73 includes receivers, sound systems, PA systems, television kits, test equipment, accessories and parts for service men and set builders. Wholesale Radio Service Co., Inc., 100 Sixth Ave., New York City.

Portable Radio Equipment. And special products are illustrated and thoroughly described in Catalog No. 289. Radio Engineering & Mfg. Co., 26 Journal Square, Jersey City, N. J.

Phase-Inverter Circuit. A self-balancing phase-inverter circuit is described in Application Note No. 97. Operation of single-ended tubes is described in Application Note No. 98. RCA Mfg. Co., Harrison, N. J.

Speakers. 16-page catalog lists variety of sizes, types and models and includes technical data. Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.

Phototube Relays. Technical Bulletin B gives all information on Series R2. Application Note No. 1 thoroughly describes a liquid level control using the style No. R2-10 phototube relay. Luxtrol Co., 54 West 21st St., New York City.

Cable Connectors. A new line of plugs designed especially for airplanes is thoroughly described in Bulletin K. Cannon Electric Development Co., Inc., 420 West Avenue 33, Los Angeles, Cal.

Ceramic Insulating Materials. Properties of ceramic listed in revised bulletin. American Lava Corp., Chattanooga, Tenn.

Wires. All types of wires listed in Catalog No. 38. Alpha Wire Corp., 50 Howard St., New York City.

Wiring System. For industrial plants and commercial buildings. Described and illustrated in Catalog No. 386 "Trol-E-Duct". Bull Dog Electric Products Co., 7601 Jos. Campau Ave., Detroit, Mich.

Bulletins. Receiving Antenna System for Commercial Installations; New and Improved Equipment for Type 333 ⅜ in. Co-Axial Transmission Line; and R-F Switches for Commercial Service. Described in three leaflets. Communication Products, Inc., 245 Custer Ave., Jersey City, N. J.

Radio Catalog. Catalog No. 1038-R lists antennas and other miscellaneous accessories of L. S. Brach Mfg. Corp., 55 Dickerson St., Newark, N. J.

Microdyne. Audax Microdyne bulletin also describes products of Audak Co., 500 5th Ave., New York City.

Capacity and Resistance Bridge. Manual of measurement furnished free with each Aerovox bridge, but the data may be obtained separately for 50 cents. Aerovox Corp., 70 Washington St., Brooklyn.

Die Castings. "Zinc Alloy Die Castings in Industrial Equipment" is a pictorial review showing uses of zinc alloy in relays, couplings, time switches, recorders, etc. New Jersey Zinc Co., 160 Front St., New York City.

Home Antenna. A new 1939 addition of vertical home antenna equipment and other products of J. F. D. Mfg. Co., 4111 Ft. Hamilton Parkway, Brooklyn, N. Y.

Characteristic Chart. Classified radio tubes of Tung-Sol Lamp Works, Inc., Newark, N. J. Another technical bulletin lists six tubes not listed in the above mentioned chart. Bulletin 38-1 "Heater-Cathode Leakage As A Source of Hum" is also available.

Graphoid Surface. The why and how is discussed in a technical series which deals with the theory and application of non-oily yet unctuous graphite surfaces in Bulletin 220.4. Folder 626 covers treatment of screw threads with colloidal graphite. Acheson Colloids Corp., Pt. Huron, Mich.

Transformers. For broadcast, aircraft, industrial, amateur, and replacement service. United Transformer Corp., 72 Spring St., New York City.

Hardware Service. For radio, sound, television, electrical and specialty apparatus. Catalog No. 51. Federal Sales Co., 24 S. Jefferson St., Chicago, Ill.

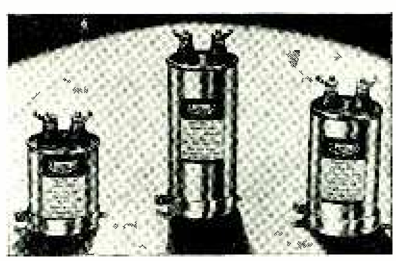
Laminated Phenolic Insulation. "Dilecto" is a well edited 42-page catalog which gives up-to-date information on the various uses of phenolic. It includes properties and dielectric strength charts which are based on NEMA Standards. Continental-Diamond Fibre Co., Newark, Del.

St., Chicago, for those interested in motor problems and new developments in the industry. A. H. Falk of Bell Telephone Laboratories has an article on soft solders in *Dutch Boy Quarterly* which is devoted to practical and technical discussion of paint materials, lead, and related products. National Lead Co., Room 2020, 111 Broadway, New York City. *Pick-ups* is a periodical devoted to developments in sound transmission and contains an article on a new co-axial antenna. Western Electric Co., 195 Broadway, New York City. *Du Mont Oscillographer* describes the cathode ray tube, polarograph developed by Messrs. Muller, Garman, Dorz, and Petras, of New York University. Published by Allen B. Du Mont Laboratories, Passaic, N. J. *Aerovox Research Worker* continues its series on practical methods of testing condensers. Aerovox Corp., 70 Washington St., Brooklyn, N. Y. *Automatic Electric Review* describes the largest Strowger network in North Carolina serving 33,000 subscribers.

New Products

Condensers

A SERIES OF transmitting capacitors known as TQ are announced by Cornell-Dubilier Electric Corp., Plainfield, N. J. They are available in ratings from 1 μf 600 volt to 2 μf 2000 volt d.c. These are hermetically sealed in round drawn aluminum containers and are impregnated and filled with Dykanol.



Auto filter units constructed to withstand excessive temperatures and vibration are also announced. Catalog No. 161 describes the entire series.

Acoustic Compensator

NOW AVAILABLE FOR lower priced microphones are models RSHK and RBSK of Amperite Co., 561 Broadway, New York. The unit is a mechanical shutter that gradually closes the back of the microphone. An air cushion is formed behind the ribbon which changes its operations from velocity to pressure. The unit will make a microphone immediately adjustable to close or distance pickup.

Gas-Filled Condensers

WITH THE INTRODUCTION of a gas-filled condenser, Lapp Insulator Co., Inc., Le Roy, N. Y., enters a new field of manufacturing endeavor. The condenser consists of a gas-filled metal chamber in which sturdy metal plates, securely held and close spaced, utilize the high dielectric qualities of nitrogen under pressure. All gasket seals are self-sealing, while a single ceramic bowl the full diameter of the tank supports and insulates the rotor resulting in very little loss and with no change in capacitance with change in temperature. All metal parts are non-magnetic being of aluminum or bronze.

The unit is practically failure proof, is compact, and will provide maximum capacity for given external dimensions. A range of 54 units is available viz.: 7.5 kv, 40 amps; 10 kv, 60 amps; and 15 kv, 100 amps (voltage rating carrier RMS based on continuous operation 1000 kc, 100% modulation). Fixed, adjustable, and variable types are available. Bulletin No. 153 is available.

Unidirectional Microphone

MODEL D9T OF American Microphone Co., Inc., 1915 S. Western Ave., Los Angeles, Cal., embraces unidirectional pick-up with a good response and high output, ruggedness, immunity to weather conditions, and circuit adaptability. A technical bulletin is available.

Battery Charger

B-L RECTIFIER TYPE portable railroad battery charger is a recent development of B-L Electric Mfg. Co., St. Louis, Mo., for either lead-acid or nickel-iron batteries. Its charging rate is 200 amps for a 40 volt, and 100 amps for an 80 volt battery. It has automatic charge rate control and utilizes the B-L forced-draft cooled dry metallic rectifiers.

New Tubes

RCA Mfg. Co., Harrison, N. J. A transmitting beam power amplifier designated as No. 813. Technical bulletin available. Also the following:—6SF5 high-mu triode, 6SJ7 triple-grid

detector amplifier, 6SK7 triple-grid super-control amplifier and 6SQ7 duplex-diode high-mu triode.

RCA Mfg. Co., also recently announced six new octal-glass tube types as follows: 1A5G power amplifier pentode; 1A7-G pentagrid converter; 1C7-G power amplifier pentode; 1H5-G diode high-mu triode; 1N5-G r-f amplifier pentode; and 6W7-G triple-grid detector amplifier. The first five of these tubes are intended for use in low-drain, battery-operated receivers. The filaments of these tubes are designed so that they will operate satisfactorily when connected directly across a 1.5-volt dry battery.

National Union Radio Corp., Newark, N. J. Nine inch Videotron television picture tube. Type 2109.

Raytheon Production Co., Newton, Mass. Argon filled thyratron. Type 2A4G.

Multicoupler Antenna

A new all-wave system for apartment houses, schools, hospitals, etc., which can serve about 20 radios simultaneously is announced by General Electric Co., Bridgeport, Conn. Other antennas may be used on the same building without any interference. It is easy to install and is inexpensive.

Portable Amplifier

Two new portable systems are available from the Transformer Corp. of America, 69 Wooster St., New York City. They are rated at 30 watts output and one model has a dual channel remote control box with additional cable.

Have You Asked Yourself WHO READS ELECTRONICS?

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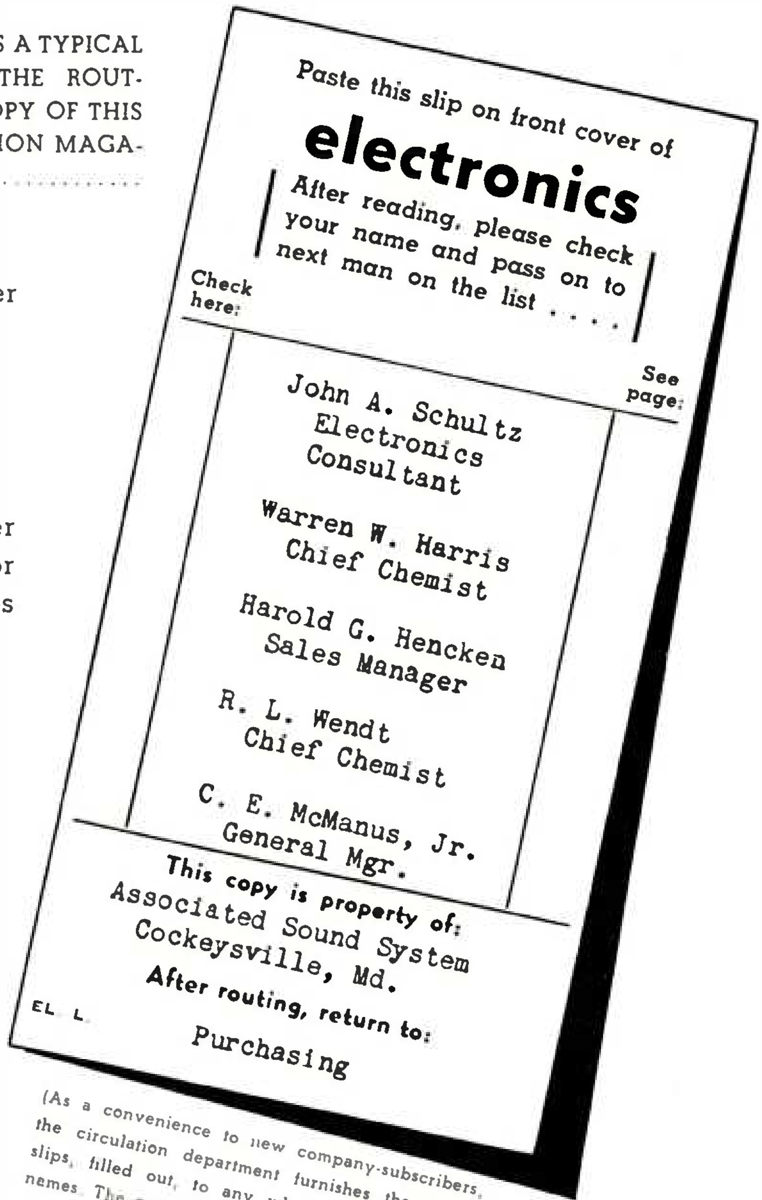
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Add ELECTRONICS to Your Sales Organization

Audio Frequency Relay

A SENSITIVE instrument utilizing telephonically applied sound to control secondary circuits through other relays is manufactured by Sigma Instruments Inc., Belmont, Mass. Types AF-1 and AF-2 are useful as pick-up devices for remotely controlled circuits. By coupling them to any telephone line or speech channel they permit the voice or other sound, at a good distance, to initiate switching operations and are adaptable by microphone connection, to service in alarm systems, door openers, counters, etc. Sensitivity ranges are the same for both types. Field resistance is 700 ohms. Impedance at 1000 cycles is about 10,000 ohms, while the power required to actuate either relay is a capacitance as low as 0.02 μf which will provide sufficient coupling for good operation from a speech circuit, or, it may be operated from a phototube circuit without an amplifier.

Antenna Ammeter

A REMOTE INDICATING antenna current meter using a current transformer, a vacuum tube rectifier, and a d-c indicating instrument has been developed by Victor J. Andrew, 6429 S. Lavergne Ave., Chicago, Ill. It eliminates difficulties due to lightning damage to thermocouple meters. A type 1-V tube acts as rectifier. Models are available to measure currents up to 75 amps at 6,000 volts.

Spun Glass

A NEW ADVANCE in battery construction involves the use of patented spun glass retainer mats that hold the active material securely in the plates and provide extra insulation against short circuiting. Because of this feature manufacturers of batteries offer a 2½ year guarantee and adjustment policy. Our attention has been called to three such constructed batteries: Vesta, "Royal" of Vesta Consolidated, Inc., Chicago, Ill.; The New National "110" of National Battery Co., St. Paul, Minn.; and "Glass-Klad" of Gould Storage Battery Corp., Depew, N. Y.

Spot Welder

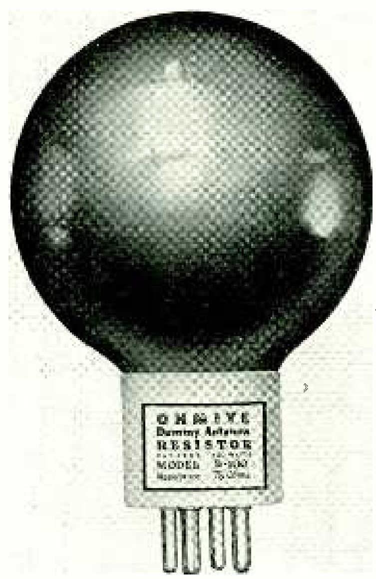
EISLER ENGINEERING Co., 740 S. 13th St., Newark, N. J., announce the novel features of their new welding unit is that both the upper and lower horns can be lengthened or shortened to the desired type and size of work. The spot welders are made with different styles of welding tips and in this unit the water goes through the entire arm. Can be purchased for foot, air or motor operation and comes in three different sizes.

Resistor Tester

FOR TESTING resistor tubes and line-cord resistors, Model 160 introduced by Clarostat Mfg. Co., 285 North 6th St., Brooklyn, N. Y. The panel carries a meter or indicator, a prong-selector switch, an octal socket and a UX socket. An a-c outlet receptacle is included for plugging in a resistor line cord as well as a pin jack for testing different cord leads. Physical dimensions are $5\frac{3}{4}$ x $5\frac{3}{4}$ x 2 in. high.

Dummy Antenna

"VACUUM TYPE" RESISTOR has been developed by Ohmite Mfg. Co., 4835 Flourney St., Chicago, Ill., to provide a simple, accurate and convenient means of checking, (stage by stage, if desired), the output and efficiency of h-f radio transmitters used in amateur, aviation communications, police and broadcast services.



Model D-100 is built like a vacuum tube with a glass bulb, and is rated at 100 watts with a resistance of 73 ohms. Units may be combined in series. Parallel, and series-parallel groups for increased power capacity. The output of the transmitter is determined by Ohm's law.

Inductors

A ROTATING coupling coil at the electrical center of the "Hi-Q" inductor enables exact adjustment of coupling in interstage or output circuits. All sizes will couple into transmission lines of 75 ohms impedance, and this value increases with the h-f inductors so that the 10 and 20 meter types will couple into any impedance up to 600 ohms. The inductors are wire wound on ceramic forms, effectively resist temperature, atmospheric and mechanical condition. E. F. Johnson Co., Waseca, Minn.

Noise Generator

A RADIO-INTERFERENCE kit announced by RCA Victor enables radio dealers and service engineers to demonstrate the effectiveness of noise eliminators and antenna installations. It consists of a generator, a vibrator, a dummy antenna, and a receiver coupling transformer.

Transmitter Kit

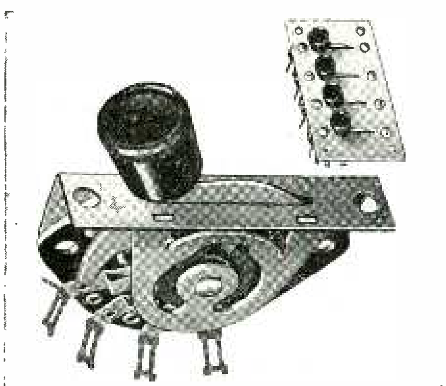
MODEL 20-P IS a complete phone and C. W. Transmitter designed by Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill. It is portable, includes power supply, is crystal controlled, and will operate on any frequency from 1.6 to 60 Mc. Frequency change is accomplished by two plug-in coils while meter switching is incorporated for important circuits or oscillator keying. Descriptive material is available.

Rectox Rectifiers

DESIGNED TO COUNTERACT galvanic action and electrolysis on underground pipes by maintaining a small direct current from ground to structure. Efficiency is at maximum value over a wide range of loads, being slightly lower at 25% load than it is at 100% load. Ratings range from 3 to 50 volts, 1 to 125 amps d–c output. Descriptive Data 27–450 is available from Westinghouse E. & M. Co., East Pittsburgh, Pa.

Lever Action Switch

CENTRALAB, Milwaukee, Wis., announce low-capacity lever-action selector switches for broadcasting, receiving, amateur radio, public address, and industrial signaling fields. The switches



are available singly or they can be ganged by means of a mounting plate that is also furnished by the manufacturer. Bulletin No. 628 describing the toggle switch and Bulletin 694 describing mounting plates are available.

Crystal Microphones

Models MU-2 and MU-4 of Asiatic Microphone Lab., Inc., Youngstown, O., are wide range, multi-unit, pressure operated devices having an output level of –56 db. Acoustic over-loading is entirely eliminated while noises from mechanical vibrations are minimized through the use of special floating interior suspension. MU-2 is constructed with two double diaphragm, yoke driven crystal units using four diaphragms. The MU-4 assembly employs four units using eight diaphragms. Both are furnished with 25 ft. single wire shielded cable and three prong socket connector.

Isolation Transformers

To reduce electrical line radio interference, Thordarson Electric Mfg. Co., Chicago, announce a new line of transformers with plug-in connections, and an electrostatic shield between primary and secondary. They keep line noises and r-f out of the power lines to reduce interference created by electrical therapeutic machines in medicine and surgery; beauty and barber shop equipment, mixers, refrigerators, vacuum cleaners, etc.

Thordarson also announce a new 60 watt public address system for larger installations.

Intercommu-Paging System

Operadio Mfg. Co., St. Charles, Ill., combine paging and intercommunication in one system in their new Model 190 which operates on one set of wires. By means of a selector switch the master station may page ten outlying stations simultaneously. Outlying stations cannot call or converse with each other.

Battery

A pint sized "Eveready" "Air Cell" battery measuring 8 ins. high and weighing ¾ pounds with the ability to power one of the new 1.4 volt radio sets for 1,500 hours describes a new product of National Carbon Co., 30 East 42nd St., New York City. It gives a level volume of power and does not require recharging. All Eveready B batteries are now "Layer-Bilt".

Filing Gadgets

For keeping track of inumerable small parts is this system of unit bins of Noggle Products Co., Ann Arbor, Mich. The bin housing may be screwed to a wall or to a panel which may be fashioned into a portable kit thereby saving time and energy.

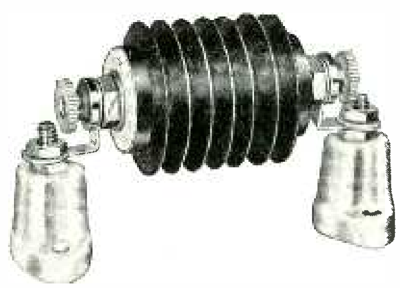
Reactor

A CONTINUOUSLY variable polyphase reactor manufactured by Raytheon Mfg. Co., Waltham, Mass. develops a drop of 300 volts at 50 amps per coil and is useful when it is necessary to have smooth control of a-c power. Mechanical resonance and the use of biasing springs reduces vibration.

Units are also available for varying the anode potential when exhausting large rectifier tubes having outputs up to 300 amps. The devices are custom built to give voltage and power requirements. Bulletins are available.

Air-Cooled Resistor

UTILIZING an old principle of increasing heat radiation with fins, Precision Resistor Co., 332 Badger Ave., Newark, N. J., announces their new air cooled Microhm wire wound power resistor. This resistor will be made in standard size units 2" long by 1⅜" OD, and can be furnished in values up to 50,000 ohms with a 50 watt rating. At full



rating, it will run at approximately 375° F. Spool ends tapped and threaded for 6/32 screw to provide for various mounting requirements, and connections. Can be banked for higher wattage ratings, or units can be assembled for tapped resistances. Resistance accuracy standard at 3%. Compact, light in weight.

Vitreous Enameled Resistors

THE NEW Aerovox Pyrohm Jr. wire-wound vitreous-enameled resistors are of low temperature coefficient of resistivity and are wound on refractory tubing. The assembly includes terminal connections, is coated with powdered glassy enamel tightly fused to the wire, terminal connections and tubing. Connections can be made either to the soldering lugs or to 2 in. bare pigtails. Units come in 10 and 20 watt sizes, and in wide range of resistance values.

The same refinements are found in the new Slideohm adjustable resistors available in 25, 50, 75, 100 and 200 watt ratings. One slider band is supplied with each unit.

Advanced Disc Recording

(*Continued from page 36*)

available, i.e., that of reducing surface noise to the point where the widest frequency and volume range become possible. Control of surface noise—given high quality electrical equipment—resolves itself into a systematic quality control scheme for stylii and discs.

Certain old timers in the recording field have found useful the method of control shown in Fig. 5.

Here the cutter is used to generate a voltage while cutting a blank groove. If the cut is smooth, the voltage generated will be very small. The rougher the cut, the greater the vibration of the cutter armature, and hence the greater the voltage produced and the volume indicator reading. In other words, we have a method of measuring smoothness and quietness of cut. This is an invaluable way of checking the edge of stylii. Even the best of lapidaries does not turn out sapphires of completely uniform quality and so the defectives can be sorted out quickly and accurately.

Use of Method in Acceptance Tests of Blanks

Lately the method has been used to check and compare blanks. Some makes vary greatly in quality from week to week, and a measurement on a sample or two will tell immediately whether or not to accept the shipment without risking a program in testing. Certain disc makers have their process under such complete control that testing is unnecessary; but testing stylii will probably always be necessary since they are hand made.

In writing this series of three articles the writer necessarily has had to hit the high spots. If anything has been left out, it has been due to space limitations—the entire disc field is too large to be covered in less than several books. Disc recording today still has its "mysteries" and "secrets" as had the medieval trades, and only when a really good book is published, will these become known to any but the most expert.

Tubes, Inc.

(*Continued from page 15*)

factors. The recent trend of the industry to advertise watthours per dollar is therefore to be encouraged on all sides.

Roundtable Item No. 4
Deliberalizing the replacement policy

The tube manufacturers offer directly or indirectly to replace free of charge any tube within six months of date of purchase if it fails to operate satisfactorily, providing that the filament or heater is not burned out and that the envelope of the tube is not broken. Although this offer is made only to dealers and servicemen it is often passed on by them directly to the final customer. It requires very little imagination to picture the abuses to which such a replacement policy may be (and often are) subjected.

The theory is that any good tube which is not abused should last six months, and then some. If a failure occurs within that time, without abuse, the customer is entitled to some redress. All this is admitted. But the question still remains: what constitutes tube failure? The replacement policy provides no means of establishing abuse, if it exists and it is detectable (as often it is not). The net result is that anyone who returns a tube with a good filament or heater and a whole envelope, has a very good chance of getting a new tube for it, free of charge.

Most dealers are on guard against skullduggery in replacing tubes. Some concerns require that the original salesslip be shown to establish the date of purchase. They test the tube in the counter tester, and they may even question the customer about the manner in which the tube was used. But in the long run if the customer insists he gets a new tube. The allegedly defective tube is then passed on, willy nilly, to the manufacturer who forks over a replacement.

All dealers are not as circumspect as this. It has been known to happen that a dealer, selling a customer a set of new tubes, returns the old ones part and parcel to the manufacturer for replacement. This is a good way of making a profit equal to one hundred per cent of the selling price, provided that you can get away with it. The manufacturers have protected themselves by using cryptographical marks on the bases of the tubes to show the date of manufacture, but this can guard only against free replacement of tubes which have been in sets for periods well over the six-month's limit.

The fact is that every manufacturer gets thousands of tubes for replacement, and replaces them only to find that the returned tubes have no observable defect. To destroy these tubes, if they are in new condition, is obviously a waste of every commodity which goes into the making and marketing of the tube. So, when it can be established by tests (which incidentally are universally more exhaustive than the tests on new merchandise) that the returned tubes are in fact new and perfect tubes, back they go into stock in nice new cartons. This practice is technically sound but it packs a load of dynamite as a merchandising policy. The manufacturer is on the defensive to prove that his tests have eliminated tubes which test up to the new tube standard but which may have had five months and 29 days of service in someone else's receiver.

In this case, practically everyone in the tube business agrees on the answer: Replace tubes on a less liberal basis and thus remove the temptation to chisel. But so long as the replacement policy is used as a sales argument it can be deliberalized only by the industry as a whole. Such a solid front can be marshalled, and in time it may well became a fact, especially if the abuses continue.

Roundtable Item No. 5

Educating the customer on tube ratings

The foregoing items for discussion around the industry roundtable are matters of intense interest to executives in the tube business, and to the more foresighted of their customers, but they are very small potatoes when viewed alongside the prime fact of the business: an annual output of 100,000,000 standardized tubes, testing better than 95 per cent perfect, the other five per cent replaced without argument, and all this with a product requiring more technical control per cubic inch than any other exhibit in the mass market. The avenue for future improvement lies almost directly along the line of better customer education, a program designed to bring about a better understanding of the relationship between tube performance and circuit design. Tubes ratings are at present quite thoroughly misunderstood by a great many engineers who are responsible for high production schedules. This lamentable situation can be remedied by the simple act of emphasizing and re-emphasizing the facts. Facts about maximum anode- and screen-voltage ratings, maximum allowable grid-return resistors, optimum values of oscillator grid current, facts about the relationship of heater voltage to tube life, and facts about manufacturing tolerances.

On the latter subject, we offer exhibit A, the customer limits of the tolerances maintained by the RCA Radiotron Division on a group of tubes selected by the editors as being representative of actively used r-f pentodes, converters, low- and hi-mu triodes, output and beam power tubes, and rectifiers. Every responsible circuit engineer who wants information on the tolerances of these or other tube types may obtain them for the asking. The importance of designing on the basis of the minimum tolerance limit needs no emphasis. But this elementary precaution often is totally disregarded, especially by the industrial engineer and who may design a circuit on the basis of a single tube bought from the local dealer. This table, the first of its kind to be generally published, will repay careful study by everyone who has not considered the problem. And having studied it, *do not* ask the manufacturer for selected tubes. He probably won't give them to you, but if he does, nobody benefits.

Another highly worth-while attempt on the part of the industry to educate customers is the dissemination of lists of preferred tube type numbers. The preferred tubes are those which have been well-received by the industry at large, tubes which are made under high production schedules, and possess, consequently a higher quality-to-cost ratio. The manufacturers like to make these tubes, and the customers should like to use them, because they have proved their worth and because they represent the best value for the money. But not every individual outside a tube plant knows what types should be used. Many an industrial engineer continues to design circuits around the type 27 triode, because he always has used them, without realizing that the 6J5 or 6J5G are a far better buy for the money, for nearly every purpose.

Manufacturers who have issued preferred tube lists, either publicly or privately, have not always been pleased with the results. Usually the customer responds by following the advice, and his choice of tubes is more intelligent than it otherwise would be. But when such a list is generally available, it is too often taken as an indication of the market selling conditions in that particular manufacturer's line. Competing manufacturers may then adjust the price of their tubes to cash in on the market, or to disorganize the market of the other fellow. This is strictly intra-industry soiled linen. The customer has little to do with it, one way or the other, except of course that he favors the lowest price on a tube of given quality.

But in nearly all the other problems herein considered, the customer can improve the situation in three ways: Study the ratings and tolerances of tubes before designing circuits around them; do not make demands for selected tubes; do not return tubes for replacement if they have been abused in any way. These are obviously good engineering rules. But if they were more universally observed, tube values would be even higher than they are at the present time, which, we repeat, is pretty high at that.

No discussion of the tube industry's problems could be complete without giving active attention to the yeoman service rendered the industry and its customers by the RMA Committee of Vacuum Tubes. This committee has established mechanical standards and tolerances which are universally adhered to. It sets up the standard values of the ratings of all new tube types and through the RMA Data Bureau assigns type numbers. It acts as a clearing house of information, and interprets the standards as practical working rules. No small credit is due this group for the fact that "by and large the tube situation is OK".

U. S. Patents

Tuning Indicator. Patent No. 2,124,023. J. E. Albright and W. L. Carlson, RCA.; No. 2,122,267, 2,122,268, and 2,122,269 to H. M. Wagner, RCA; No. 2,122,567, D. E. Foster, RCA; No. 2,122,562, W. F. Ewald, Telefunken, and No. 2,123,001 to K. A. Chittick, RCA.

Control Circuit. Method of controlling the output of a radio receiver by changing the frequency of the energy carrier of a received signal to an intermediate frequency, variably amplifying signal in accordance with the signal strength of the signal so that an increase in the signal causes a diminished amplification, changing the frequency to an audio frequency and independently controlling the amplification of the modified signal by said amplified but unmodified signal after a selection of the latter sufficient to render the independent control action sharper than the variable amplification action. K. W. Jarvis, RCA. No. 2,115,813. 31 claims.

Noise Reduction. Combination of a source of noise impulses superimposed on a modulated high frequency carrier, and signal and control channels connected in parallel to source, control channel including a sharply tuned wave trap for rejecting the modulated carrier and converting the noise into similar successive wave trains of opposite phase. V. D. Landon, RCA. No. 2,113,212.

Automobile Lighting System. Approaching automobiles affect each other's lighting systems to avoid blinding. F. M. Harris, Merchantville, N. J. No. 2,131,888.

Sorting. Two patents to D. C. Cox, Electric Sorting Machine Co., Grand Rapids, Mich., on means for sorting as to color etc. Nos. 2,131,095 and 2,131,096.

Adjudicated Patents

(D. C. N. Y.) Latour patent, No. 1,614,136, for thermionic amplifying apparatus, claims 9 and 11 *Held* not infringed. *Latour Corporation* v. *E. B. Latham Co.*, 23 F. Supp. 869.

(D. C. N. Y.) Latour reissue patent, No. 16,461, for audion or lamp relay or amplifying apparatus, claims 1, 11, 15, and 18 *Held* valid and infringed. *Latour Corporation* v. *E. B. Latham Co.*, 23 F. Supp. 869.

LEGAL NOTICE

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

Of Electronics, published monthly at Albany, N. Y., for October 1, 1938.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared D. C. McGraw, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Electronics, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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D. C. McGRAW, Secretary.
McGRAW-HILL PUBLISHING COMPANY, INC.

Sworn to and subscribed before me this 26th day of September, 1938.

[SEAL] H. E. BEIRNE,

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(My commission expires March 30, 1940)

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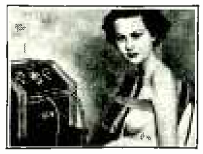

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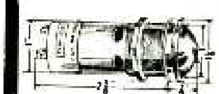

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FOREMOST IN THE ELECTRONICS FIELD FOR OVER 20 YEARS!

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INDEX TO ADVERTISERS

SEARCHLIGHT SECTION

Classified Advertising

NEW RCA 813

gives 260 watts output with less than 1 watt Driving Power!

IT'S A FACT! This sensational new RCA Beam Power Transmitting Tube actually requires less than one watt driving power to give 260 watts output in Class "C" Telegraph service. Needing no neutralization, a pair of 813's makes a bang-up final for that quick-band-change, high-power transmitter.

The new 813, is among the finest transmitting tubes RCA has ever developed, employs a new stem structure which makes practical a compact tube—only 7½" long —having very short heavy leads and low lead inductance. Because of its design, this new high-power beam tube can be operated at full ratings up to 30 megacycles without neutralization.

Other noteworthy features of this new tube are: Heavy-duty thoriated-tungsten filament, oversized graphite plate, dome-top bulb with cushion mount supports, low screen current, and a new Giant 7-pin base having short shell and wide pin spacings.

Typical Operation (Class "C" Telegraphy)

Filament Voltage
10 volts (a. c. or d. c.)

Filament Current
5 amperes

D-C Plate Voltage
2000 volts

D-C Screen Voltage
400 volts

D-C Grid Voltage
-90 volts

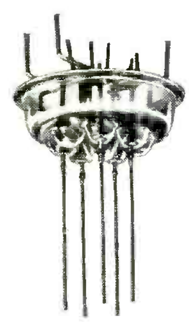
D-C Plate Current
180 milliamperes

D-C Screen Current
15 milliamperes

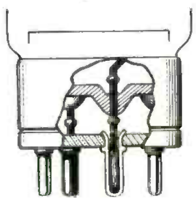
Driving Power
0.5 watt

Power Output
260 watts

Price, $28.50



View of moulded glass stem assembly showing individual lead seals.



Cut-away view showing short, heavy leads to terminal pins.

RCA Radio Tubes

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