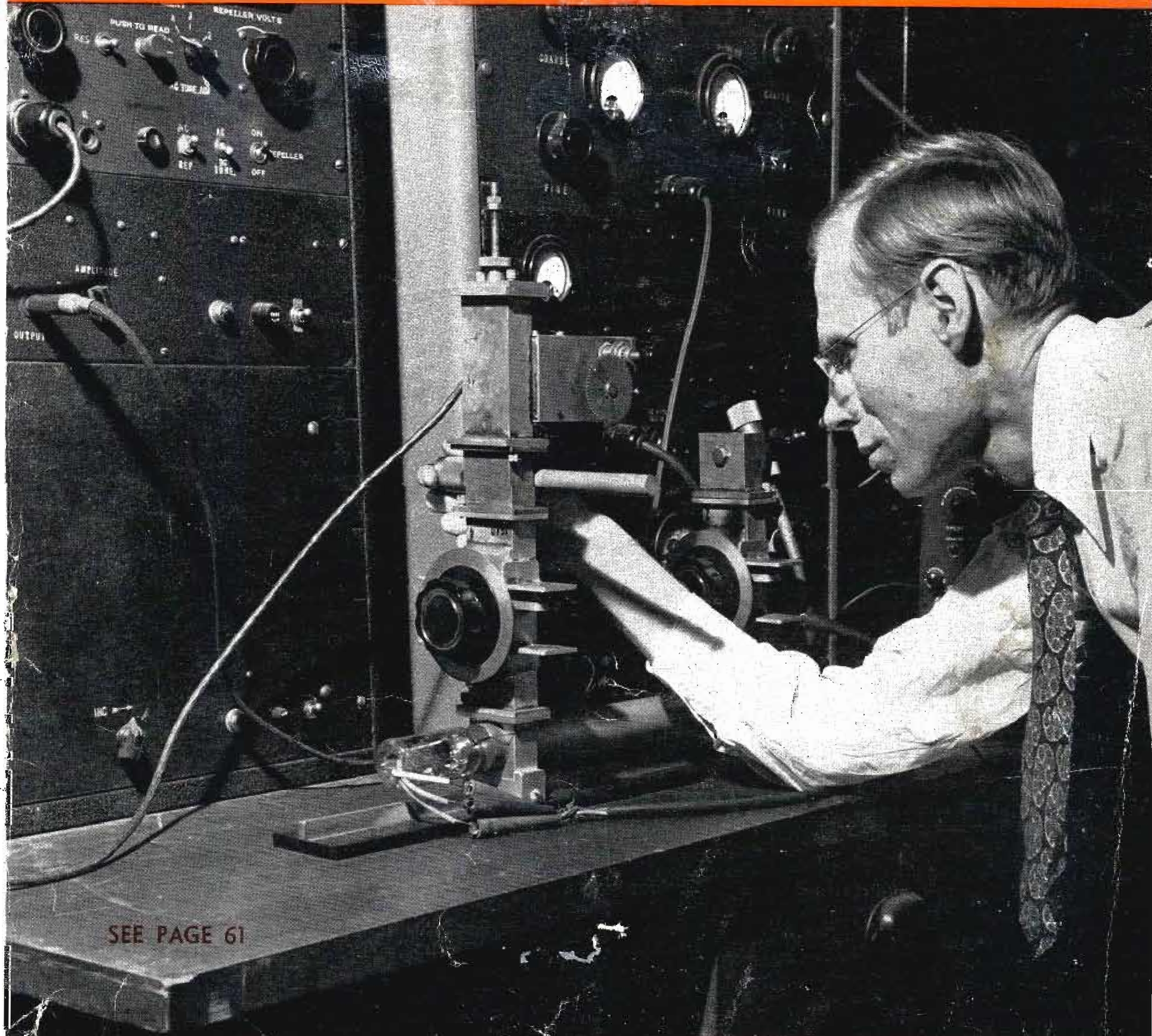
TELE-TECH

Formerly the TELE-communications TECH-nical Section of

ELECTRONIC INDUSTRIES

DESIGN AND OPERATION OF RADIO · FM · TELEVISION
RADAR AND ALL COMMUNICATIONS EQUIPMENT



SEE PAGE 61

February · 1948

ELIMINATING SPURIOUS RADIATIONS—See page 22

your product IS MORE SALEABLE WITH

C-D *Quietones*

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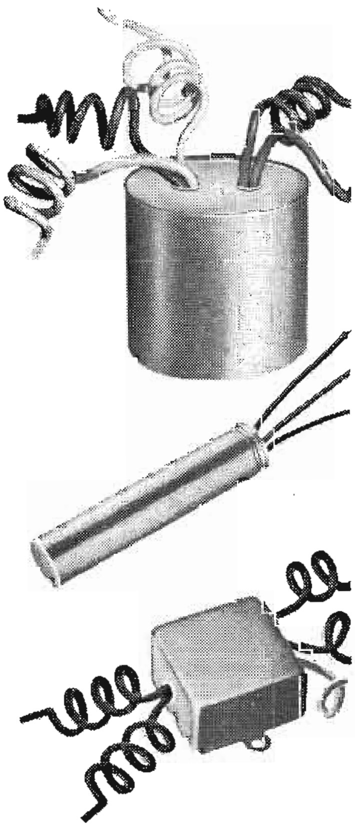

You may build the best appliance of its kind on the market — but if it sets up local radio interference—you'll have tough sledding against today's keen competition. Your customers are *demanding* radio noise-free performance in the electrical equipment they buy.

The answer, of course, is to equip *your* products with C-D Quietones. Why Quietones? First, because they're the best-engineered noise filters — second, because they guard your product's reputation by giving long trouble-free service — third, because they're designed and built to meet manufacturers' specific needs — efficiently and economically.

Speed up sales — build prestige — boost profits with C-D Quietones. Your inquiries are invited. Cornell-Dubilier Electric Corporation, Dept. J-2, South Plainfield, New Jersey. Other large plants in New Bedford, Brookline and Worcester, Mass., and Providence, Rhode Island.

Make Your Product More Saleable with C-D Quietone Radio Noise Filters and Spark Suppressors

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TELE-TECH

Formerly the TELE-communications TECH-nical Section of
ELECTRONIC INDUSTRIES

FEBRUARY, 1948

Editorial Contents

CALDWELL-CLEMENTS, INC., Publication Office, Orange, Conn., Editorial and Executive Offices 480 Lexington Avenue, New York 17, N. Y., Tel. Plaza 3-1340

BRANCH OFFICES — Chicago 6, R. Y. Fitzpatrick, 201 N. Wells St., RAN 9225; Los Angeles 5, The Robert W. Walker Co., 684 So. Lafayette Park Pl., Drexel 4388; San Francisco 4, 68 Post St., Sutter 5568.

DON'T IMPROVISE!

Rather use Du Mont Tubes in your cathode-ray oscillography because

only the RIGHT TYPE with the RIGHT SCREEN can do the RIGHT JOB!

and here's why:

Only Du Mont makes ALL types of tubes and all types of screens to serve the needs of ALL users—scientific, industrial, educational.

Regardless of what your oscillographic requirements call for, Du Mont has the *right tube* with the *right* screen. Tubes for high-accelerating potentials; multiple-gun tubes; tubes for low-accelerating or medium-accelerating potentials—all are included in Du Mont listings. And with each type there's a choice of screens for short, medium or long persistence; for photographic recording; for visual observation; for high-speed transients; for recurrent phenomena at any speed.

Definitely, for every oscillographic application there's one best tube to use—and only Du Mont provides that adequate choice. Why improvise?

As the outstanding specialist in this highly specialized technology, Du Mont maintains the highest standards of quality, precision design, and dependable craftsmanship.

DU MONT CATHODE-RAY TUBES AVAILABLE

3AP1-A	3JP11	5JP1-A	5LP11-A
3AP11-A	5BP1-A	5JP2-A	5RP2-A
3GP1-A	5BP11-A	5JP7-A	5RP11-A
3GP11-A	5CP1-A	5JP11-A	5SP1
3JP1	5CP2-A	5LP1-A	5SP2
3JP2	5CP7-A	5LP2-A	5SP7
3JP7	5CP11-A	5LP7-A	5SP11

DU MONT SCREENS AVAILABLE

P1: Medium-persistence green. High visual efficiency. For general purpose applications.

P2: Long-persistence blue-green fluorescence and yellow-green persistence. Long persistence at high writing rates. Short interval excitation.

P5: Extremely short-persistence blue for photographic recording on high speed moving film.

P7: Blue fluorescence and yellow phosphorescence. Long persistence at slow and intermediate writing rates.

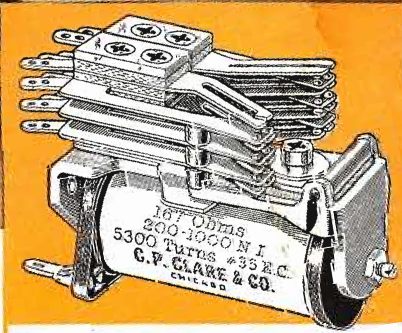
P11: Short-persistence blue. For recording high writing rates.

DU MONT IS *always* YOUR BEST BUY!

DUMONT *Precision Electronics & Television*

ALLEN B. DuMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: ALBEEDU, PASSAIC, N. J., U. S. A.

CLARE New Type "J" Relay Provides Sure, Positiv Action with Exclusive Twin-Con ... ign



Here, at last, is a twin-contact de-
ign in which the chance of contact
ailure is actually reduced to the prac-
cal limit.

clusive design of the CLARE Type
' d.c. Relay allows the twin contacts
operate independently of each
er so that one contact is sure to
e even when the other may be
ked by presence of dirt or grit.

sensational new relay combines
est features of the conventional
one-type relay with the small
d light weight developed dur-
war for military aircraft use.

ng little more than two ounces,
over two inches in length, it
turdy construction, large con-
g capacity, extreme sensitiv-
daptability to a wide range of specifications for which CLARE Relays are noted.

Modern designers, working to develop close-coupled, compact equipment to meet today's streamlined standards, welcome this highly efficient combination of capacity and small size.

CLARE Relays are especially designed for jobs where ordinary relays won't do. If you have such a relay problem, Clare Sales Engineers are located in principal cities to help you work out a Clare "Custom-Built" Relay that will just fit your needs. Write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. Cable Address: CLARELAY. *In Canada: Canadian Line Materials, Ltd., Toronto 13, Ontario.*

All These Features . . . and More . . . Provided By CLARE Type "J" Relay

Independent Spring Contacts. Dome shaped contacts on movable springs; flat discs on fixed springs.

High Current-Carrying Capacity. Twin contact points of palladium. Rated current-carrying capacity: 4 amperes, 150 watts.

New Design Large Armature Bearing Area. Hinge type armature has new design bearing providing largest possible bearing surface. Pivot pin turns in cylinder of different metal which is full width of heelpiece.

Sensitive, Efficient Magnetic Structure. Heelpiece and other magnetic iron parts are exceptionally heavy for size of relay . . . provide highly sensitive and efficient magnetic path.

High Operating Speed. Designed for extremely fast operation . . . a minimum of one to two milliseconds.

Permits Handling Large Spring Loads. Power and sensitivity permit hand... large spring load...

ARE RELAYS

with the GENERAL ELECTRIC VARIABLE RELUCTANCE PICKUP

BROADCAST STATIONS must have the finest reproduction possible for transcribed programs. Their chief engineers, the most critical customers in the world, are really tough to convince because they have the technical facilities to test every claim made for the equipment they use.

Hundreds of broadcast stations have changed over to the General Electric Variable Reluctance Pickup for studio use

Design engineers on radio-phonograph combinations are sceptics of the first order when it comes to specifying a new unit for their sets. They have to be shown.

A number of leading manufacturers are now specifying the General Electric Variable Reluctance Pickup

Letters from music lovers in increasing numbers tell us how much the General Electric Variable Reluctance Pickup has increased their listening pleasure—how it has brought out new beauty in their old recordings.

The opinions voiced by the general public should mean much to you because—they can be your customers

Write today—learn how the General Electric Variable Reluctance Pickup can help keep your production lines humming. *General Electric Co., Electronics Department, Electronics Park, Syracuse, N. Y.*

168-G1

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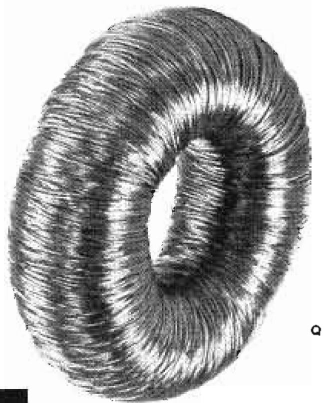
For Quality and Performance

BURNELL offers

High Q TOROIDAL COILS

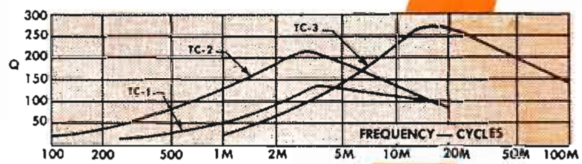
The solution of filter network problems, has been greatly simplified through the use of toroidal coils wound on molybdenum permalloy cores. Design engineers have learned to depend upon them since discovering that only these toroids possess all the necessary qualities of a good high "Q" coil.



The most available types now being supplied are

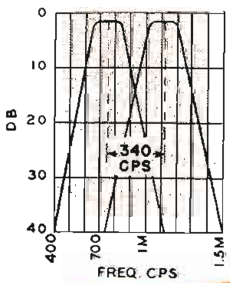
TYPE		IND. RANGE
TC-1	Any Ind. up to	7 HYS
TC-2	Any Ind. up to	20 HYS
TC-3	Any Ind. up to	350 MHYS

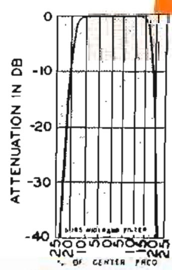
Be sure to state desired inductance.

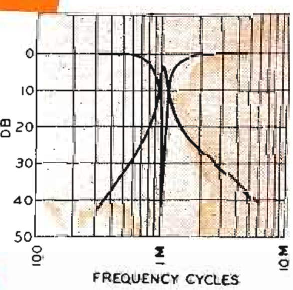


TOROIDAL COIL FILTERS

Our toroid filters have become a by-word in every phase of electronics where only the best results are acceptable. Toroidal coils wound on **MOLYBDENUM PERMALLOY DUST CORES** are the primary basis for our success in producing filters unexcelled in performance. We are producing toroidal coil filters which consistently demonstrate the value of toroidal coils. These filters cannot be matched in stability, accuracy and sharpness by filters made with the usual laminated type of coil.







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REVERE ALUMINUM TUBE
for Home Antennas

Problems encountered in the manufacture and erection of home antennas for television and FM receivers are most easily solved by using Revere Aluminum Tube. Note these features:

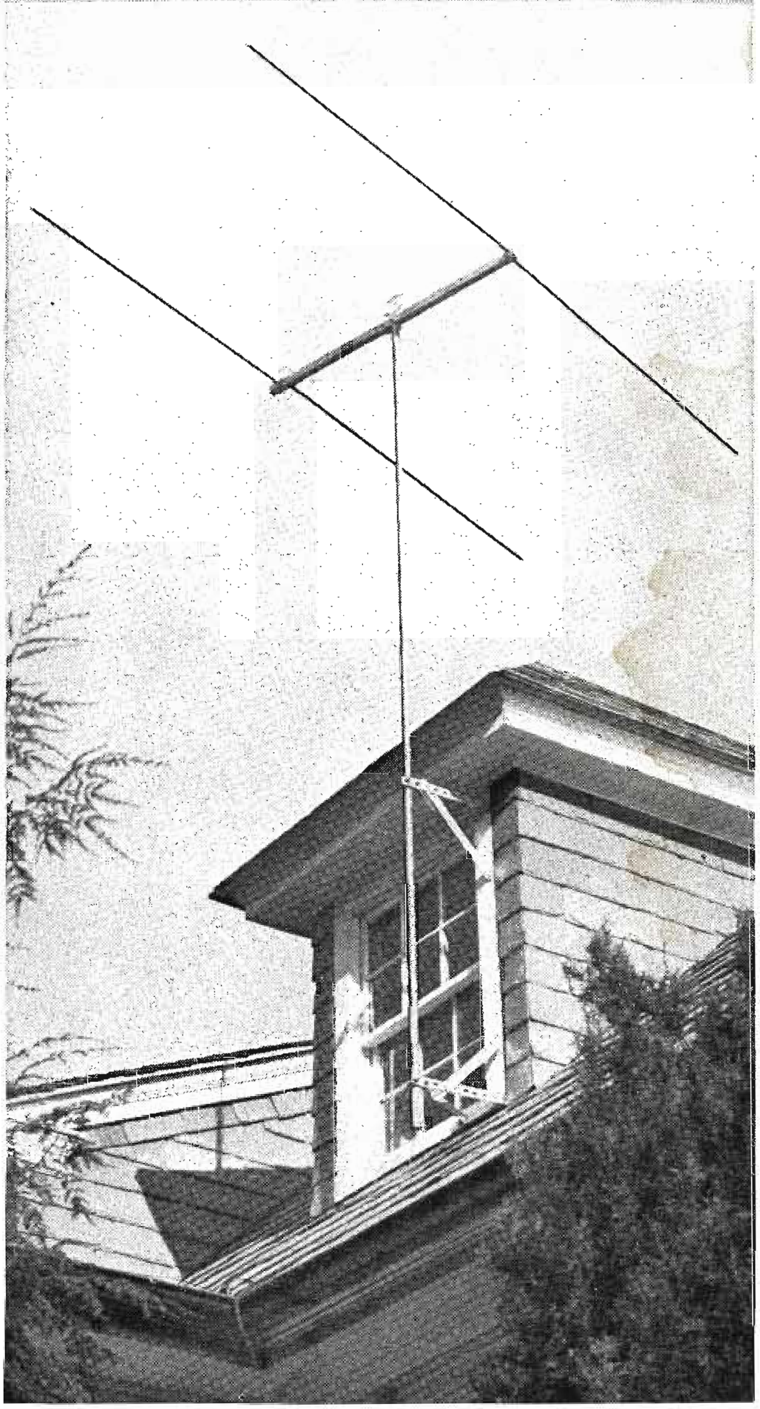
Strength. Revere 61S-T6* Aluminum has high strength for masts. Typical properties are 40,000 p.s.i. yield strength and 45,000 p.s.i. tensile strength.

Workability. Revere 61S-T4* Aluminum can be easily bent if desired for the formation of dipoles. Both this and 61S-T6* are easily cut, drilled, and threaded. Typical properties of 61S-T4* are 21,000 p.s.i. yield and 35,000 p.s.i. tensile.

Lightness. Aluminum tube, being only about one-third the weight of steel, reduces transportation charges and facilitates installation work.

Beauty. Aluminum can be anodized and given almost any desired color. Most people, however, prefer it in its silvery beauty without adornment.

Revere Aluminum Tube is available in practically any size that might be required, and thus each design can be engineered to its own requirements. Revere and any Revere distributor will gladly quote you prices and delivery dates on your requirements. The Revere Technical Advisory Service will cooperate with you on technical matters concerning the use of aluminum tube or any other Revere Metal. Revere supplies the radio industry with many non-ferrous metals and alloys, in such forms as tube and pipe, rod and bar, sheet and plate, extruded shapes and forgings.



RCA Television and FM receiving antenna, using Revere Aluminum Tube

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

• • •

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities.

*These are new temper designations effective January 1, 1948. Formerly 61S-T6 was designated 61S-T and 61S-T4 was 61S-W.

STOP

Wasting Minutes!
Wasting Mileage!
Wasting Money!

Equip Your Fleet with Federal's
MOBILE 2-WAY FM RADIO TELEPHONE

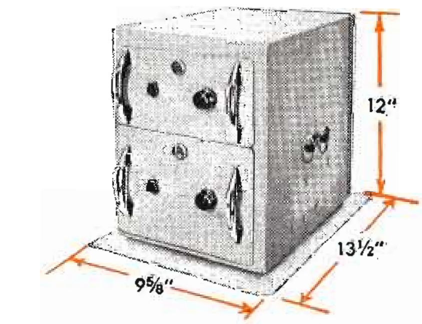
What do *you* do when you want to get in touch with one of your drivers while he's on the job? And how can he contact you? Without mobile radio, a moving vehicle is practically isolated from all contact with the outside world—and any other method of relaying messages between cars and headquarters wastes time and mileage, and costs plenty of money!

Now, with Federal's Mobile 2-way FM radio, you can keep in instant touch with any car, at any time,—for dispatching, re-routing, checking up on any job. The added efficiency of completely coordinated operation will save the cost of the radio equipment many times over!

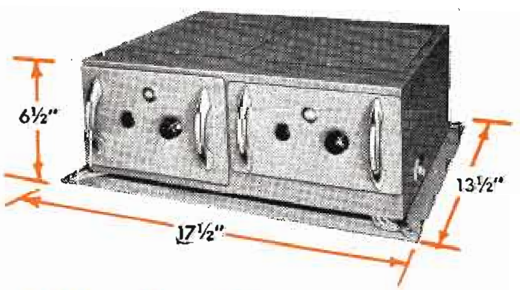
Of course, the return on the investment depends on the equipment used—its operating economy, service life and maintenance cost. And that's where Federal's high standards of quality and workmanship can pay long-term dividends. Before you select your mobile radio equipment, check these outstanding features. Write to Federal for complete information. Dept. I666.

FEDERAL FEATURES

- **Effective Squelch Action**—receiver muted until called
- **Low Current Drain**—receiver standby, 6.0 amp. transmitter standby: 30 to 44 Mc, 2.1 amp; 152 to 162 Mc, 0.415 amp.
- **Small Size**—less than one cubic foot
- **Interchangeable Units**—transmitter and receiver sections slide out for fast servicing
- **Low Maintenance Expense**—highest quality components throughout
- **Single Cable**—from dashboard control to transmitter-receiver unit.



TRY THESE FOR SIZE—choice of vertical or horizontal arrangement for most efficient use of available mounting space.



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An IT&T Associate

Federal Telephone and Radio Corporation

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

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Seven-Tower Array Using
BLAW-KNOX
Self-Supporting Towers

This seven-tower directional array was designed to protect several stations operating on the same frequency. Six towers are used during the night and the seventh, with two night pattern towers, give excellent daytime coverage. Due to the location it was necessary to place gravel fills through the ice to a depth of over 30 ft. before pile foundations could be driven to solid ground. Towers are Blaw-Knox Type CN, base insulated 225 ft. high.

BLAW-KNOX DIVISION of Blaw-Knox Company
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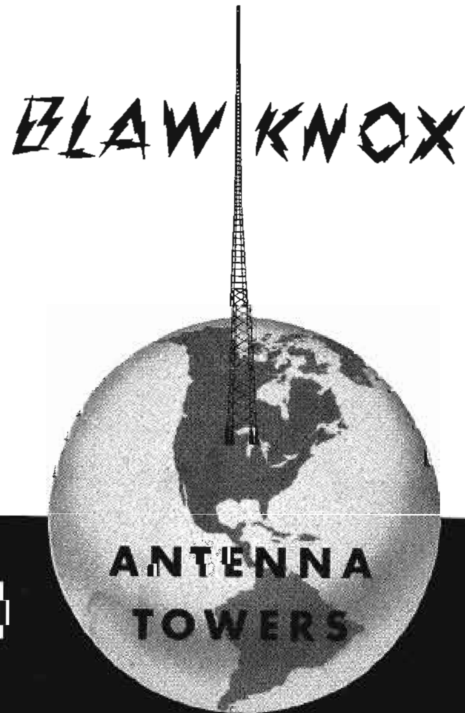

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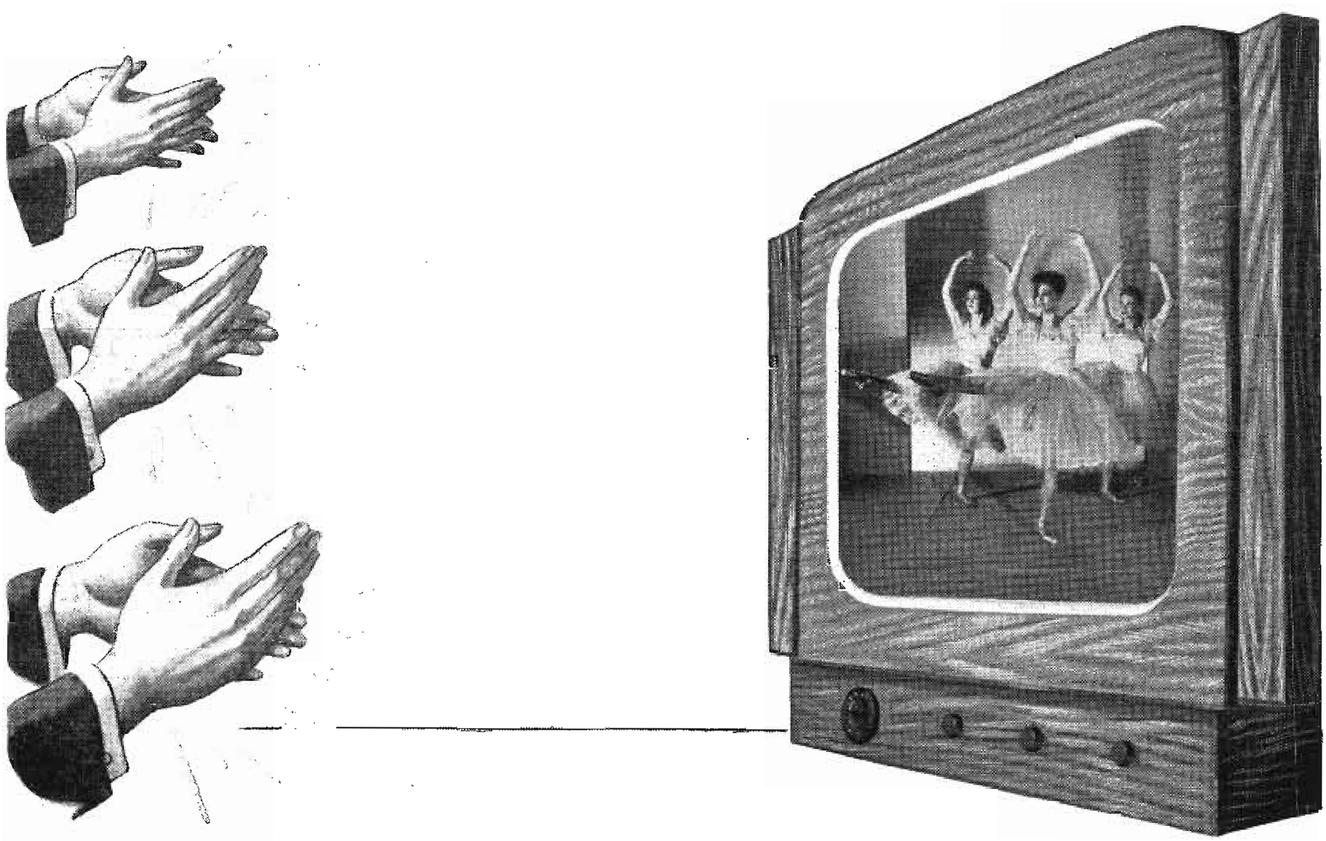
OF BLAW-KNOX COMPANY



ATV LEAD-IN LINES

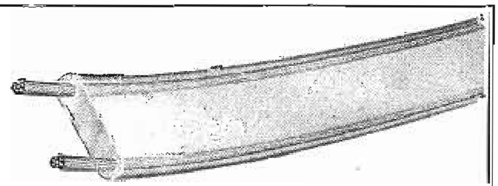
Get Good Receptions!

YOU WILL BE MORE CERTAIN to get the best receptions from your television or FM set when you specify ATV* lead-in lines.

The effects of attenuation and impedance mismatch on FM and Television reception are minimized by Anaconda Type ATV lead-in lines.

The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion. Count on Anaconda to solve your high-frequency transmission problems—with anything from a new-type lead-in line to the latest development in coaxial cables. 48446

**An Anaconda Trade-Mark*



A TYPE ATV LEAD-IN FOR EVERY NEED

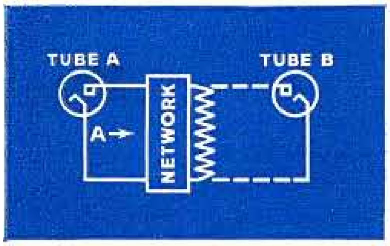
Anaconda offers a complete selection of Type ATV lead-in lines for 75, 150 and 300 ohms impedance unshielded and shielded lines of high impedance. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

ANACONDA

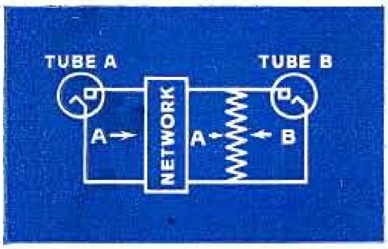
Anaconda Wire and Cable Co.

How the Doherty Circuit pays off for Broadcasters

DOHERTY CIRCUIT



CONDITION 1: **Nearly zero modulation, so amplifier has to handle carrier wave alone. Tube A is sufficient and—seeing just the right impedance in network—operates at maximum efficiency. Tube B, not needed, lies idle.**



CONDITION 2: **Carrier being modulated. Tube B, now needed, kicks in, adding its quota of power to handle the increased load and changing the impedance so that Tube A also steps up its output. Both tubes work to full capacity and at high efficiency.**

The Doherty Circuit for AM broadcast transmitters was the first to achieve *high efficiency and economy* and still retain the following important advantages of *linear* and *grid bias modulated* power amplifiers:

(1) A simple tube complement—no high-power audio tubes required

(2) No modulation transformer required—savings in space and apparatus

(3) Freedom from transient or overmodulation surges—can be heavily overmodulated at any audio frequency for long periods without damage

(4) Adaptability to large amounts of feedback derived from the final output envelope, resulting in low noise, low harmonic distortion, and low intermodulation distortion over wide variations in tube characteristics and circuit adjustment

(5) Negligible carrier shift, assuring full utilization of the assigned carrier power of the station

Gearing tubes to circuits

How a tube acts in a circuit depends, of course, upon the *impedances* which face it in the circuit. So getting the most out of tubes is a matter of getting the right impedances.

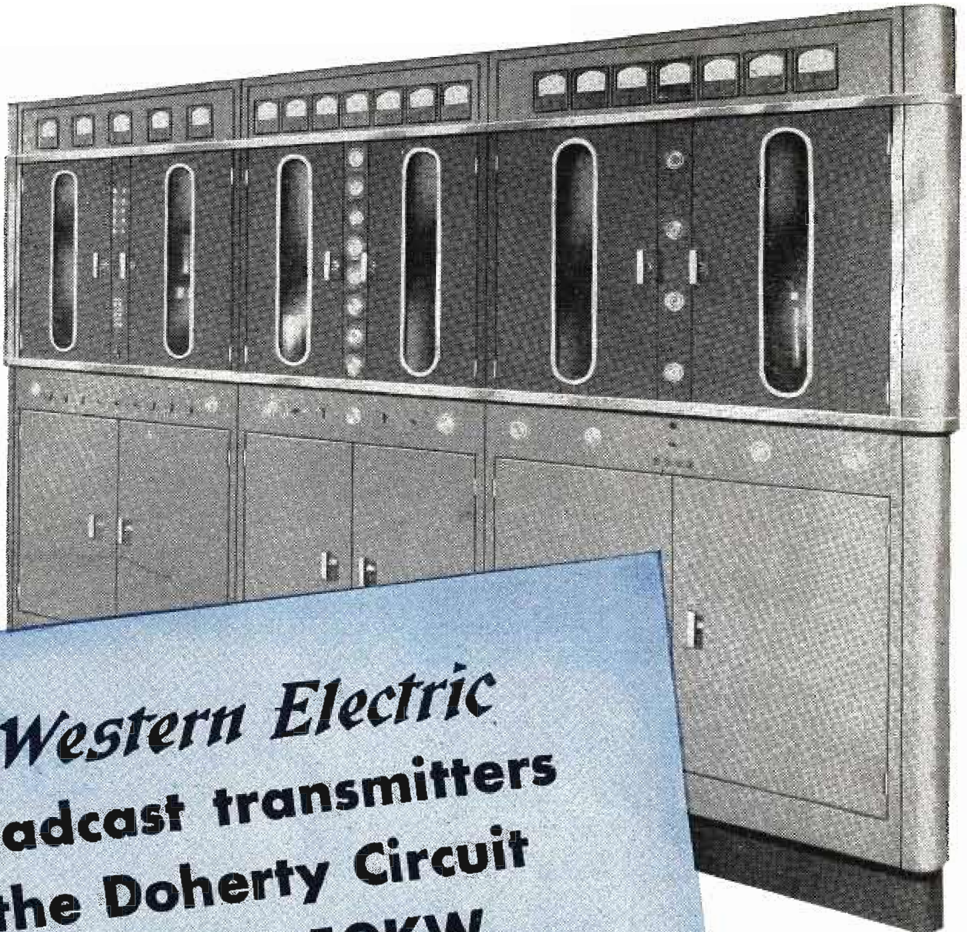
Like pre-Doherty linear amplifiers, the Doherty *High Efficiency* Amplifier Circuit has two tubes. *Unlike* them, it has a network which automatically changes impedances to best meet changing needs. Both tubes receive the signal, but—when the carrier alone is on—only *one* tube is operative. The second tube uses no power. Not until modulation is applied, raising the input voltages on both tubes, does the second tube start up. It then does two things: it contributes more power to meet the added load, and it automatically changes the impedance faced by the first tube so as to throttle it up to full output, too.

For the Broadcaster, this means that the Doherty Circuit consumes only *half the power* required by old style linear amplifiers—a real triumph in circuit engineering.

It is just one of many Bell Telephone Laboratories developments which have contributed to improved efficiency, greater economy and higher quality in communications.

BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communications.



The 5 KW AM transmitter, like the 1KW and 50 KW, has the famous Doherty Circuit. Eleven years of experience proves this *High Efficiency* amplifier operates continuously for long periods with no need for retuning.

ONLY *Western Electric* AM broadcast transmitters have the Doherty Circuit 1KW...5KW...50KW

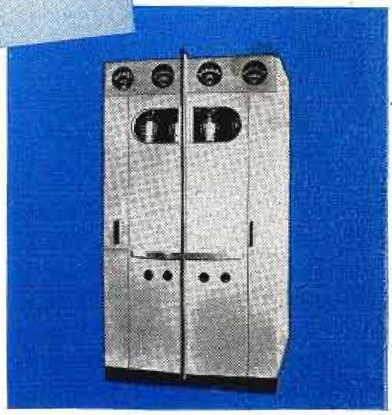
Today the Doherty Circuit is being used by hundreds of broadcast stations—making possible the use of smaller circuit elements, saving space, giving increased stability and greater ease of adjustment, and reducing the outlay for auxiliary equipment.

Other features

In Western Electric 1, 5 and 50 KW AM transmitters, you also get two other famous Bell Laboratories developments—stabilized feedback and grid bias modulation. These, together with the Doherty Circuit, are your assurance of superlative performance at rock-bottom operating cost!

Get full details

If you're thinking about a new AM transmitter, remember this: *only* Western Electric has the Doherty *High Efficiency* Circuit—unmatched today in performance, dependability, and economy! For full details, call your local Graybar Broadcast Representative or write Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y.



The 1 KW AM transmitter, with the Doherty Circuit, is extremely compact—requires floor space only 44" wide by 42" deep.

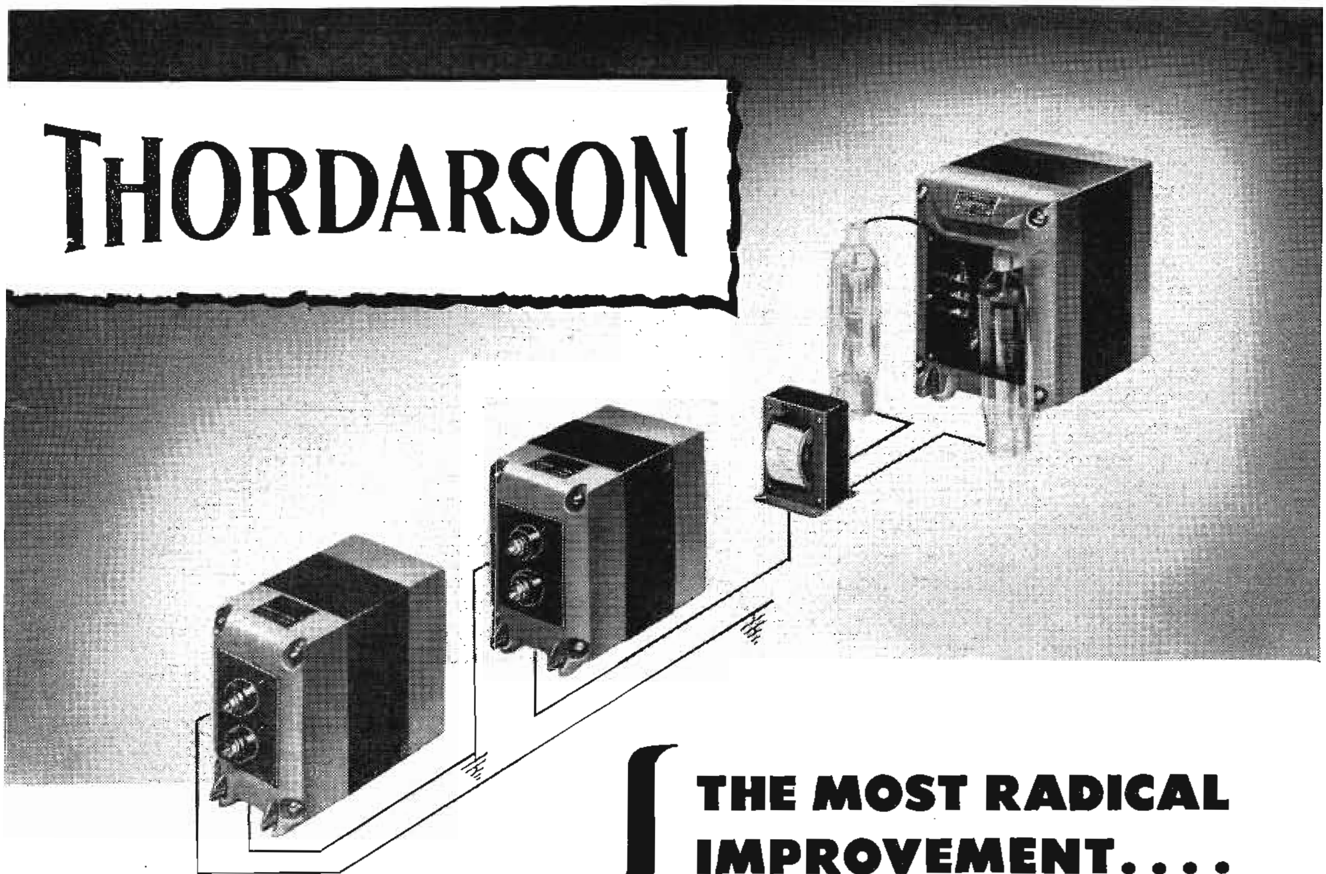
DISTRIBUTORS: IN THE U. S. A.—Graybar Electric Company. IN CANADA AND NEWFOUNDLAND —Northern Electric Company, Ltd.

—QUALITY COUNTS—

Western Electric

Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.

Distributed by GraybaR OFFICES IN 95 PRINCIPAL CITIES



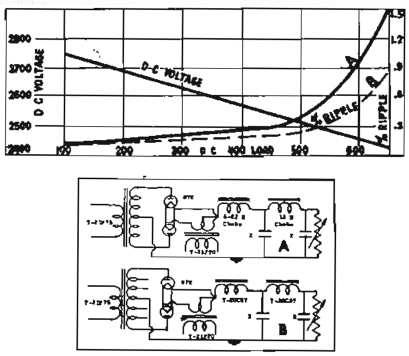
THORDARSON

THE MOST RADICAL IMPROVEMENT.... IN POWER SUPPLY FILTER CIRCUITS...

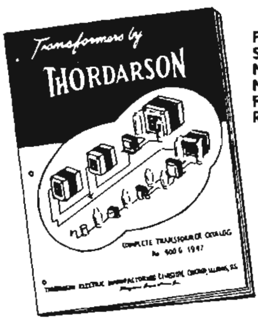
... employing two same type universal chokes that provide more efficient filtering.

Here again, is another triumph in Thordarson engineering skill. Thordarson engineers have developed a new universal type choke in sizes to meet all power requirements! This achievement offers the best possible filtering and regulation in a minimum size consistent with conservative design! One reactor moy be used in a single section filter with all the advantages of the radically swinging type. Two similar units may be employed in a two section filter more satisfactorily than the obsolete "swinging and smoothing" system, and deliver far better performance.

Let us know how we can put these new universal chokes to work for you ... Send us your requirements.



Actual Laboratory Measurements Made With The Conventional Type Filter Circuit A — (Swinging and Smoothing System) — and with the New Universal Choke Filter Circuit B Show A Decrease In Ripple Throughout The Useful Current Range of Power Supply



For Matched Power Supplies, see Your New 400GX Catalog Now Available. Furnished Free Upon Request.

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A Division of Maguire Industries

PYROVAC . . . A NEW EIMAC PLATE MATERIAL

The story's out . . . Pyrovac, a new Eimac plate material, the culmination of ten years research and millions of hours of life test data, is now in standard production—at no extra cost.

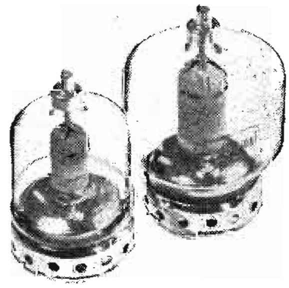
Pyrovac is truly as important a milestone of vacuum tube development as the thoriated tungsten filament. Pyrovac plates, like the thoriated tungsten filament, open a new vista for vacuum tube life performance.

This new material combines the advantages of tantalum to overloads, molybdenum's strength, weight and conductivity, and carbon's ability to dissipate heat . . . with none of the disadvantages of these materials. Tubes with Pyrovac plates are mechanically rugged, require no additional getters and they do not gas even under extreme overloads.

The life span of tubes with Pyrovac plates far exceeds that of tubes incorporating plates of conventional materials. For example, under conditions where a tube gave 3000 hours of service the same tube type with a Pyrovac plate gave 15,000 hours of life, a 400 percent increase!

Pyrovac plates are capable of handling overloads in excess of 1000%. For instance, the 4-65A plate pictured above was radiating 900 watts of heat, a 1280% overload . . . without indication that the eventual life of the tube or its characteristics were affected. We don't suggest you dissipate 900 watts of heat in your Eimac 4-65A's (you could probably do it), but this example establishes proof that Pyrovac is a superior plate material destined to become the anode standard of the vacuum tube industry.

Pyrovac plates were first incorporated in the Eimac 4-250A in the early part of 1946 and followed in the 4-125A As a result there has been universal acceptance of these tubes in all fields of electronic endeavor. . . . Further proof of the superiority of this new plate material. In the ensuing period of



Type 4-250A

Type 4-125A

time all Eimac internal anode type tubes have been converted to Pyrovac plates as rapidly as production facilities would allow.

For your assurance to obtain the most in performance and satisfaction for your vacuum-tube-dollar, insist on Eimac tubes . . the criterion of good design in any electronic equipment.

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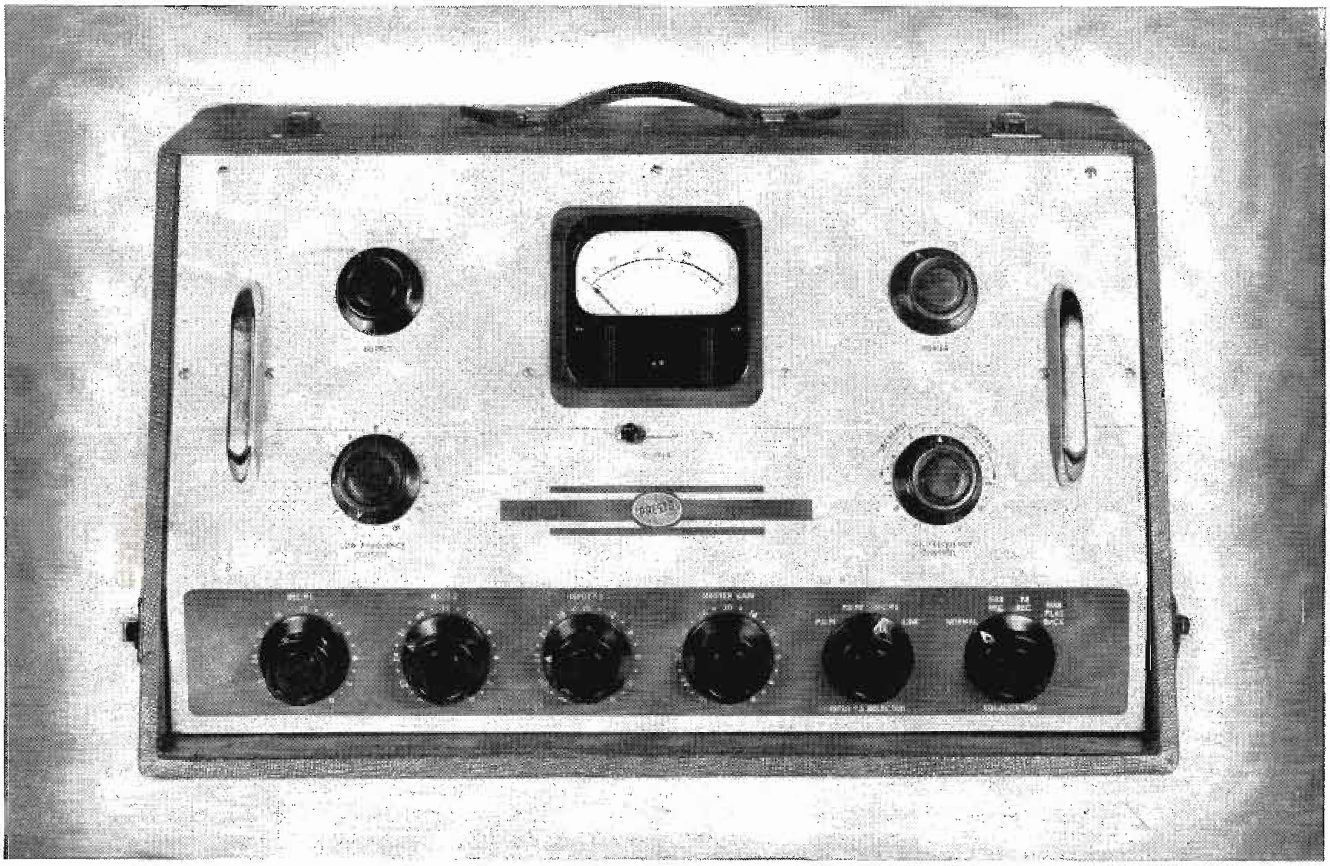

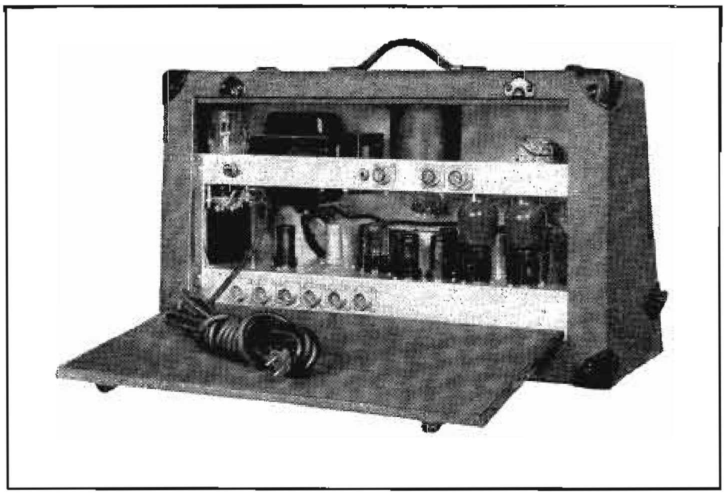

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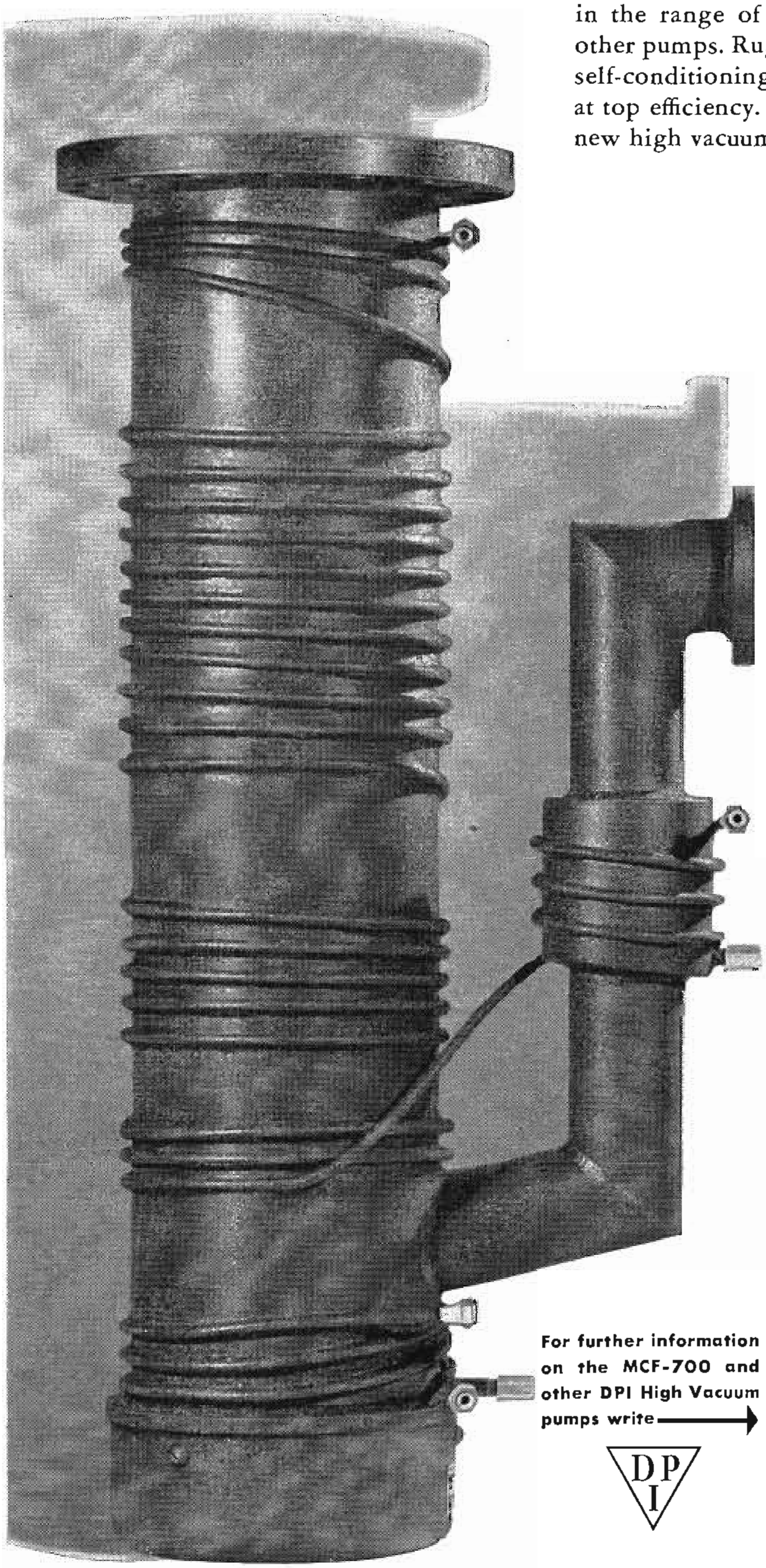


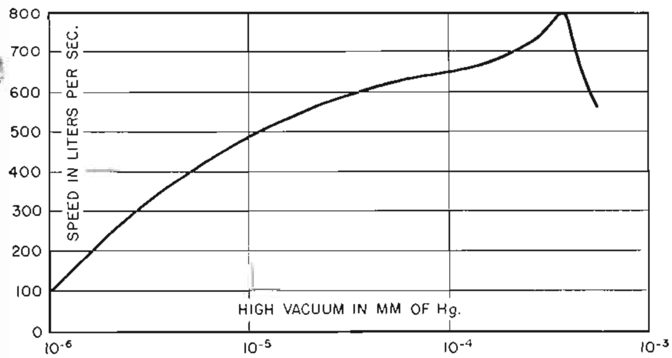
PHYSICAL DATA

High Vacuum Flange	6" i.d., 9" o.d. 8" bolt circle
Forepump Flange	2⅜" i.d., 3¾" o.d. 3 5/16" bolt circle
Height	29"
Length	14"
Width	9"
Construction:	
Casing	Seamless Steel
Jet Assembly	Aluminum and Steel
Cooling	Water
Weight	Approx. 40 lbs.

OPERATION DATA

Amount of Oil	500 grams
Recommended Oil	Octoil or Octoil-S
Forepressure	0.10 mm
Heater Power	800 watts
Heater Current	7.0 amp.
Heater Voltage	115 volts A.C. or D.C.
Speed	700 l/s
Ultimate Vacuum	5×10^{-7} at 25° C.

PERFORMANCE



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The famous New Orleans *Times-Picayune*—which has made plenty of newspaper history since its founding in 1837—is making history in FM broadcasting today.

H. F. Wehrmann, General Manager of WTPS-FM, is sparing no effort to give the New Orleans area the very finest in FM—not only in clarity of signal (which has been praised in letters from many listeners) but also in quality of programming from 10 A. M. to 10 P. M. seven days a week.

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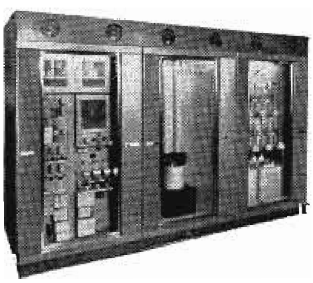
A mighty good buy!

This 10 KW gives you four exclusive Western Electric FM features that make for outstanding performance: (1) the RF Power and Impedance Monitor, (2) the Arc-Back Indicator, (3) the Frequency Watchman, (4) TRANSVIEW design cabinet. Ask Graybar what these features will mean to *you!*



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TELE-TECH

Formerly the TELE-communications TECH-nical Section of

ELECTRONIC INDUSTRIES

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

IRAC PLEASE NOTE!—Are government agencies wasting radio spectrum space? Spokesmen for civilian and commercial services using two-way radio believe so, and have requested that bureaucratic holders of unused frequencies publicly justify their reasons for "sitting" on them. The pressure is on. We said before and we say again: Stop this waste of wavelengths! Government agencies should be made to *prove* their frequency requirements.

TV RECEIVER TESTING takes almost as long as TV receiver assembling—or so it looks to visitors to modern TV production lines. Actually, of total time from assembly start to factory shipping platform, 63% of period is required for assembly; 37% for the elaborate tests and checks which each TV set must undergo. No other mass-production item in U. S. industry requires anywhere near this proportion of effort on "checking up."

TV PROJECTION instead of direct-view, for even 10-inch and 12-inch pictures may produce some pretty low-price home television sets before long. CR experts point out that such a projection tube can be produced for a few dollars, in place of the more expensive direct-view tube. And projection TV is now proving itself capable of pictures as sharp, clear, brilliant and contrasty as direct-view. So hold onto your hat!

NORTH AMERICAN FREQUENCY ALLOCATIONS. In an international meeting of technicians in Cuba recently, NARBA (North American Regional Broadcasting Agreement) representatives of Cuba, Mexico, Canada, U. S., Newfoundland and the Dominican Republic, discussed and agreed on a number of engineering matters. They also discussed policy, but held over all decisions until the treaty-making conference at Montreal in August of this year. What transpired at Havana portends difficult sledding in Canada unless certain demands are modified by that time. From the nature of radio, it would seem that equitable distribution of frequencies should be made on the basis of area and population. Yet some nations are expected to make demands which are inimical to this concept. It is hoped that cordial compromise will eventually result from an intelligent appraisal of each nation's needs; otherwise, some countries may exercise "sovereign rights" to frequencies—using any power on any channel, day or night—which will inevitably lead to promiscuous interference.

WHERE IS 500-KW BC X-MITTER built for WJZ just before Pearl Harbor but transshipped to England for the European invasion? In early 1940's when clear-channel power rises to 500 kw and 750 kw seemed likely, NBC expected to lead procession in New York with 500 kw for WJZ. But before equipment could be unloaded and erected, it was commandeered for Army use abroad, and is declared to have rendered tremendous service in both African and European landings, its great power being unjammable by puny enemy transmitters. But nobody seems to know where this BC giant is today.

SET DESIGNERS are facing a new sort of problem. Time was when all they had to worry about was the front appearance. But with the changing styles in furniture, the back of a table model may have to look just as spiffy as the front. The plastics people have this problem in their respective laps and presumably will come up with designs that will look important from any angle, let alone the front—or back.

INTERFERENCE FROM ELECTRONIC HEATING has been often blamed, not always justly, but never has such an example turned up as the Engineering Department of FCC tracked down the other day. The Civil Aeronautics Commission had complained that aviation channels extending as far north as Portland, Oregon, were experiencing trouble. To shorten the story, the source of the disturbance was located in Johnstown, Pa., where a furniture factory was using a high-power heater for drying and gluing. Adequate shielding fixed that one.

BROADENING OPPORTUNITIES FOR ENGINEERS

We are on the threshold of a great new era of opportunities for all members of the engineering profession—provided, engineers will learn to realize their full responsibility and be alert to interests beyond the laboratory and their section of specific creative work.

Engineers' public relations may well begin at home. This means a greater interest in other people in all walks of life and at all levels within their own organization, from top to the very bottom.

—E. Finley Carter, Vice-president of Sylvania Electric.

Eliminating Spurious Radiations from BC Transmitters

By DR. VICTOR J. ANDREW
Andrew Corp., Chicago

Practical methods for determining existence and extent of harmonic generation and of designing and applying corrective filters

• Even though commercial design of radio transmitters is such that most spurious signals are eliminated or greatly reduced, there are many cases where such radiation does not appear until the transmitter is in operation and must be corrected by the station engineer. Among the common cases of such are combination frequencies resulting from two different transmitters, and cases where a harmonic is particularly objectionable because it falls on the frequency of another service nearby.

The first requisite is an accurate diagnosis of their origin. Failure to find a successful cure has usually resulted from a hasty conclusion as to the nature of the trouble, and consequent improper corrective measures. One of the essential instruments needed is a simple resonant wavemeter used as a wave trap, with a wide, carefully calibrated frequency range. This instrument does not contain harmonics or respond to combination frequencies, as does a transmitter, receiver, heterodyne frequency meter, or any other instrument containing a vacuum tube. Any conceivably spurious response from this wavemeter is likely to be several octaves removed, and not in exact harmonic relationship with the primary response frequency.

A spurious response in a receiver from a spurious signal from the transmitter can be distinguished quickly by inserting the resonance wavemeter as a wave trap in the antenna lead of the receiver. The signal will drop when the wavemeter is tuned to the frequency at which the signal enters the receiver. If the fault lies in the receiver, this drop will be the correct frequency of the transmitter. If the fault lies in the transmitter, or at least somewhere external to the receiver, the wavemeter will indicate a spurious frequency at whatever point the receiver is tuned.

A direction finder is another desirable instrument for locating the source of an undesired signal. Cases frequently occur where a spurious frequency carries the program of one radio transmitter, but is actually generated in another transmitter, or in something completely foreign to any transmitter. When a direction finder is not available, useful results may be obtained with a portable radio receiver which has a signal strength meter.

Location Radiating Source

Such a direction finder or a signal strength indicator leads to the antenna radiating the signal. The signal itself is generated in some non-linear (or rectifying) device, and may be carried some distance by wires which serve as a transmission line, before it reaches the point of radiation. Before correction is made, it is ordinarily necessary to locate the non-linear device. The correction usually consists of adding or modifying networks adjacent to the non-linear device in such a manner that the spurious signal cannot reach the radiator, or else in such a manner that a contributing frequency necessary to produce the spurious radiation is prevented from reaching the non-linear device.

With the recent rapid increase in the number of broadcast stations, a new spurious frequency is sometimes formed by a combination of the frequencies of two (or more) stations. To produce the new frequency, energy from both of the base frequencies must flow through one non-linear device. Common devices for production of such interference are:

1—The final amplifier tube of one of the stations.

2—Any vacuum tube in an indicating instrument connected to the final amplifier, such as an inverse feedback rectifier, audio monitor rectifier, remote ammeter rectifier, or phase monitor.

3—The crystal oscillator tube or other low level rf or af tube in the transmitter or amplifier preceding the transmitter.

4—Rusty iron or corroded copper in the antenna system.

5—Man-made structures which are not part of a transmitter, possibly at some distance (a mile or more) from the transmitter. Poor electrical connections, old plumbing, and corroded metal roofs fall in this category.

6—The ionosphere (assuming that the debated "Luxemberg Effect" is accepted as a reality).

7—A vacuum tube in the radio receiver in which the interference is observed.

Combination frequencies usually are frequencies which are defined by $f = mf_a + nf_b$, where f is the spurious frequency, and f_a and f_b are the correct operating frequencies of two radio transmitters; m and n are any integers, positive, negative, or zero. The entire range of spurious frequencies expressed by all values of m and n are ordinarily produced when two frequencies are combined and passed through a non-linear device. However, the only one which ordinarily concerns us is the one which meets three conditions:

It is initially strong, the associated networks, transmission line, and radiator convert a substantial part of it into radiation, and finally it falls on a frequency which interferes with some other service.

Harmonic Suppression

Good engineering requires suppression of all spurious radiations. This is not always attained in the design, construction, and operation of transmitters. Strong radiations of the kinds most frequently occurring (such as harmonics) are eliminated fairly well in the manufacture of the transmitters. Other spurious radiation is usually eliminated only if it is observed either by a government monitoring station, or by someone who suffers interference from it. Even after an interfering radiation is observed, it is not always possible to identify the station responsible for it and to persuade the owners or engineers to eliminate it. A few specific cases might be cited.

The FCC ordered a broadcast station to eliminate third harmonic interference at a communications receiving station about two miles distant. Field intensity measurements indicated about 10 microvolts per meter at a mile, but there was such a large fluctuation in the field that no useful intensity measurements could be made. The loop antenna of the field intensity meter gave a bearing toward the broadcast station.

It was assumed that the harmonic (which is always generated in the final amplifier of the transmitter) was being radiated and a diagnosis was first made to determine whether the radiation was from (1) the antenna, (2) power lines, audio input, or other wires leaving the transmitter, (3) direct radiation from the final tank circuit (particularly likely because of poor shielding). When the transmitter was operated into a dummy antenna, the interference disappeared, establishing the fact that the only radiation was along the transmission line to the antenna. To our surprise the normal cure (a trap circuit resonant at the harmonic frequency, connected between the transmitter output and the transmission line input) was ineffective.

Map Characteristics

The performance of the trap was proven to be good. Supplying a signal at the harmonic frequency from a signal generator established that a signal at harmonic frequency was adequately suppressed in the trap. But when the main transmitter was fed into the line, the harmonic was unaffected by tuning the trap near the harmonic frequency, and was reduced only when the trap was tuned to the fundamental frequency

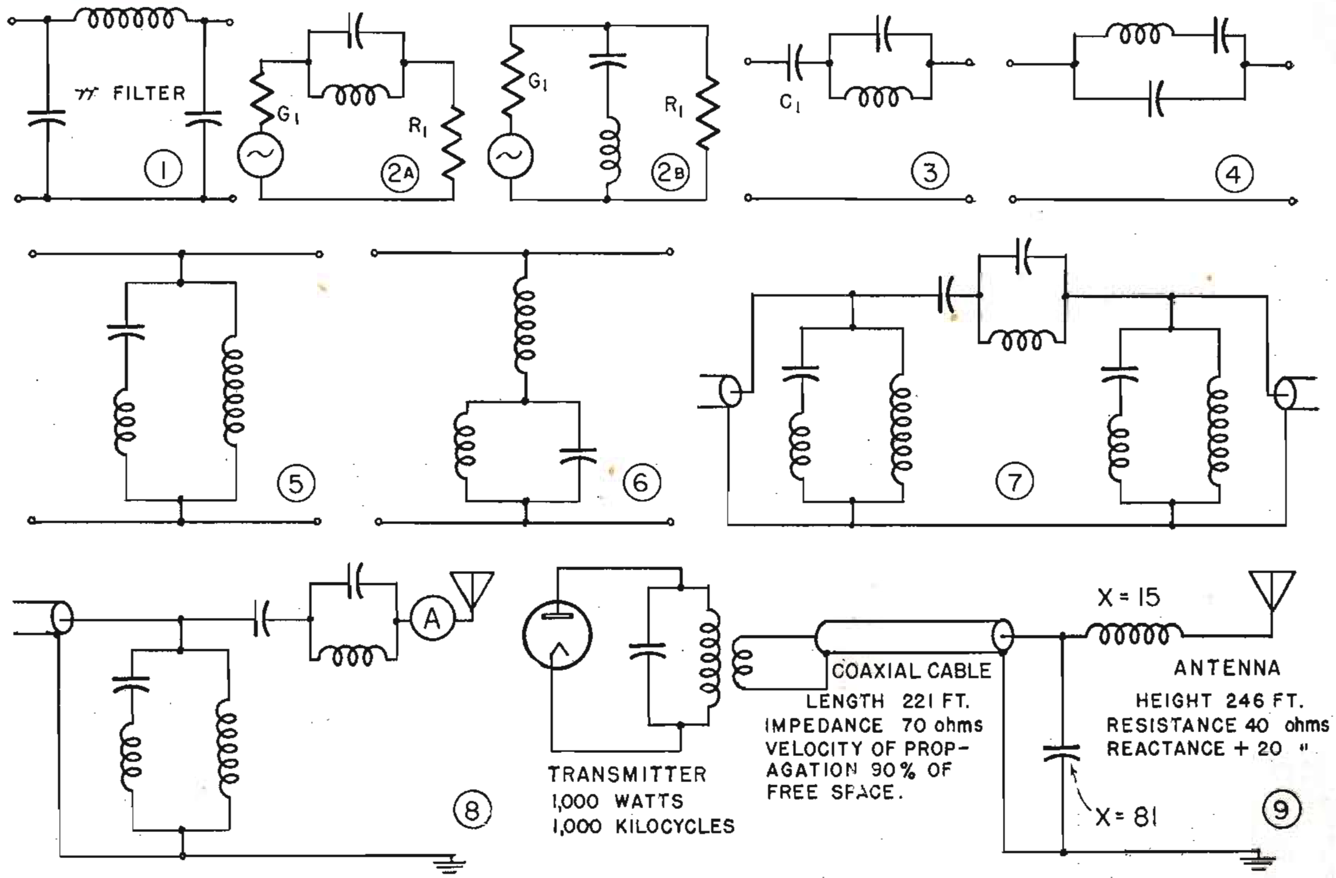


Fig. 1—Simple pi filter. 2A—Simple wave-trap filters. 3—Typt A filter with reactance a pass frequency tuned out by C_1. 4—Filter with Fig. 3 characteristics. 5—Type B filter with reactance at pass frequency tuned out by an added inductance. 6—Filter with Fig. 5 characteristics. 7—A pi filter of resonant circuits. 8—L network prevents induced antenna current from nearby station from registering on antenna meter. 9—Typical filter for rejection of 1100 kc from transmission line input

of the transmitter. This paradox seemed unbelievable for a time. The implication, however, was that the signal passed from the transmitter to the antenna at fundamental frequency, and was converted to third harmonic in the antenna.

The remote meter rectifier tube in the antenna turning unit was removed, but the harmonic remained. Nothing else in the antenna seemed to be capable of producing a harmonic. The field intensity meter was set up about two hundred feet from the antenna, with a long cord to the headphones, and various parts of the antenna system were disturbed while listening for any change in the harmonic.

Finally it was found that the harmonic fluttered violently when the guy wires of the antenna tower were jarred. The guys were rusty iron, apparently with poor contacts at splices or other attachment points that became generators of the harmonic. The obvious correction was replacement of the guy wires. Such problems from a little rust seem far-fetched. However, it is a matter of public record in this case that this harmonic interference on a communication frequency caused the death of an aviator.

Unusual Source

In another similar case a harmonic which did not respond to the usual wave traps was finally found to be generated in the vacuum tube rectifier at the antenna which was used for a remote antenna ammeter. This was a rectifier which produced several milliamperes dc.

There have been numerous cases recently of spurious radiations in the broadcast band at a frequency of $f = 2f_a - f_b$. For instance, where there are stations in the same city on 1000 kc and on 1100 kc, a signal is heard on 900 kc. It carries modulation of both transmitters, but much stronger modulation of the 1100 kc transmitter. On investigation it is found to be radiated from the 1000 kc station. It is produced in the final amplifier tube of the 1000 kc station, when the 1100 kc signal is received in this tube from the other station.

Correction consists of inserting a filter somewhere between the final amplifier tube and the antenna of

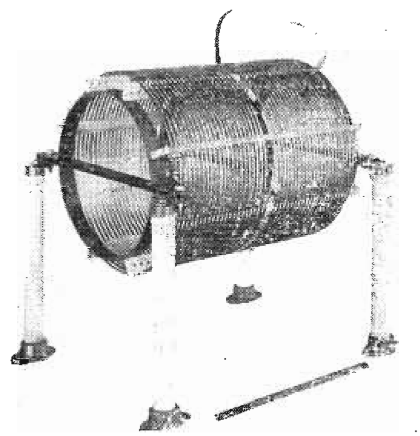


Fig. 10—Transmitting inductance well designed to give high Q factor

the 1000 kc station, and tuning the filter to reject 1100 kc. When properly tuned, the signal on 900 kc disappears. Final tuning is most easily accomplished with both transmitters in operation, and a receiver tuned to 900 kc to indicate filter adjustment. In a similar manner, the other station produces a spurious radiation on 1200 kc, and must have comparable corrective measures.

Particularly troublesome cases occur where the frequency separation is small and the distance between antennas is small. In numerous cities both 1450 and 1490 kc are assigned. The frequency separation of 2.7% is very difficult to separate with resonant circuits. In one city, stations on these frequencies have antennas only 500 ft. apart. Here an added difficulty appears: each antenna picks up so much current from the other station that the antenna current indication is inaccurate by as much as 20% when the other transmitter is operating. This trouble also has been corrected by proper filter design, but it is a severe complication to the design.

Spurious Modulation

It was found that a 250-watt broadcast station (tested without modulation) actually had a substantial modulation from the program of a higher power station several miles away, and widely different in frequency. Preliminary check showed that this signal was not coming in on the audio lines to the new station. If this was a case of picking up the spurious signal in the antenna and rectifying it in the final amplifier, a trap in the antenna lead to reject the carrier frequency of the other station would be needed. However before building the trap, the inverse feedback rectifier tube was pulled out of its socket. The spurious modulation disappeared completely! This rectifier takes its input from a small sampling line loosely coupled to the final tank circuit of the transmitter. All that was necessary was a small resonant trap in this input circuit to the rectifier.

The trap was built out of miniature receiver components, and worked perfectly! A tank built in the main transmission line from the transmitter to the antenna would have done the job too, but it would have required large and expensive transmitter components, its adjustment would have changed the loading on the transmitter, and it would have caused some loss of transmitter power.

In a similar case spurious radiation appeared as a hash 30 kc on each side of the carrier frequency. When the transmitter was not modulated, no spurious radiation was found.

Other Interference

Here again it was found that by removing the inverse feedback rectifier tube, the spurious signal disappeared. A squeal at 30,000 kc was apparently set up in the inverse rectifier in some manner, probably by feedback completely around the circuit of this rectifier, and the transmitter audio and radio circuits. A slight reduction in the amount of feedback used was all that was necessary to eliminate the trouble.

In a communications station, where the same frequency was used for transmission and reception, when receiving, the plate voltage was turned off the transmitter, but the filaments were left on. Interference was found on the operating frequency, heavily modulated at 60 cycles. The tubes were obviously generating oscillation due to plate and grid being grounded to the center of the filament. The cure: leaving the grid bias on the final amplifier when the plate was turned off.

Police were using a frequency on the third harmonic of a broadcast station. They complained of hearing the broadcast station in their cars when near the transmitter.

While examining the harmonic, we used a field intensity meter about a thousand feet from the transmitter.

It was found that the field intensity meter did not have sufficient selectivity in the input circuits, and therefore the fundamental frequency reached a tube in the receiver with sufficient amplitude to produce the harmonic in the receiver. A communications receiver with an additional wave trap at the fundamental frequency in its antenna lead disclosed the true third harmonic of the transmitter. This permitted correct tuning of the third harmonic trap in the transmission line input to reduce the interference.

The police car receivers apparently were subject to the same defect, insufficient selectivity in the input circuits, which lead to actual production of the harmonic in receiver. Correction of such difficulty cannot be accomplished at the transmitter, except by such drastic change as moving to a distant location or changing operating frequency.

We have mentioned earlier the necessity for filters where two stations have antennas near each other. In reality, where antennas must be near, the engineering problems are often simpler if only one antenna is used. Both transmitters are connected to the same antenna, with filters at the points of connection which pass the proper frequency and reject the other. There have been several installations of this type in the past, even including one where both stations used directional antennas. One tower was common to both directional systems. Other towers were not.

Monkey Chatter

The modulation sidebands of a transmitter often cause interference with reception on adjacent channels. There are two common causes: the audio frequency input to the transmitter may contain sufficient power at frequencies above 5000 cycles to cause noticeable interference on a station on the next channel. This can easily be eliminated by insertion of a 7500 cycle cutoff filter in the audio input to the transmitter.

The other cause of monkey chatter (over-modulation of the transmitter) is cured by keeping modulation down. Limiter amplifiers now in widespread use in broadcast stations have contributed greatly to correcting this difficulty.

The first filter in a transmitter output is the tank circuit. It is tuned to pass one frequency with small loss, and to offer high attenuation to other frequencies. By decreasing the ratio of inductance to capacity in the tank circuit, the attenuation of other frequencies can be improved, but at the same time the loss of power in the fundamental frequency increases.

Pi Net Suppressors

The addition of a pi or tee network in the output of a transmitter is often used for harmonic suppression. Such a network substantially attenuates all frequencies from the second harmonic upward, but is of little service where the separation between the pass frequency and the rejection frequency is small (under 30%).

Fig. 1 and Table I show design data for a pi filter suitable for harmonic suppression, for specific frequencies and load impedances. Satisfactory design for other frequencies and load impedances may be obtained by interpolation. The number of turns of inductance applies only to an inductance 6 in. in diameter, with 4 turns per inch.

Capacitances may be varied as much as 25% in order to use commercially available fixed capacitors. The currents shown for the capacitor are actual unmodulated amperes for a 250 watt transmitter. For other powers, the current varies as the square root of the transmitter power. For proper factor of safety, the capacitors should have commercial rating of at least twice the indicated values.

Filters of high selectivity such as are often required in elimination of combination frequency radiation are best constructed with one or more resonant circuits at the rejection frequency. This type of filter finds its best applications where the frequency difference between the pass and the rejection frequency is in the range from 2% to 50%.

When the frequency separation is greater than 50%, a pi filter is adequate, unless an unusually high degree of suppression is required. Where the frequency separation is less than 2%, separation usually is beyond the ability of resonant circuits. Where the frequency separation is less than 5%, it is ordinarily necessary to use a filter containing more than one resonant section.

Resonant Filters

There are two ways of connecting the resonant circuits in this kind of filter. In Type A (Fig. 2) the resonant circuit is parallel resonant, and is connected in series with the main circuit. This wave trap approximates an open circuit for the rejection frequency. The other form (Fig. 2B), a series resonant circuit connected across the main circuit, approximates a short circuit across the line at the rejection frequency.

The following formulas are useful: (1) to determine whether to

TABLE I

Operating kc	Line or antenna impedance, ohms	L=μh	Inductance turns (6" dia.)	Capacitance, μf	Capacitor Current, Amps.
600	20	5.3	4	.013	3.5
600	70	19	10	.0038	1.9
600	300	80	31	.00088	0.91
1000	20	3.2	3	.0080	3.5
1000	70	11	7	.0023	1.9
1000	300	48	20	.00053	0.91
1500	20	2.1	2	.0053	3.5
1500	70	7.4	5	.0015	1.9
1500	300	32	15	.00035	0.91

Values of components required for a pi filter for harmonic suppression for a 250 watt broacast station.

use Type A or Type B filter, to evaluate its components and to compute the results which can be obtained. They contain numerous assumptions and approximations, but have sufficient accuracy for practical use in filter design.

Here the term rejection ratio refers to the ratio of the voltage passed at the rejection frequency (f_2) after insertion of the filter to voltage passed without the filter. The loss ratio is the power dissipated in the filter at the pass frequency (f_1) compared to the power delivered from the filter to the load.

$D = (f_1 - f_2)/f_1$ the frequency separation.

X_2 = the reactance of the inductance (or capacitor) in Type A filter at f_2.

Y_2 = the reactance of the inductance (or capacitor) in Type B filter at f_2.

Q = the figure of merit of the inductance used in the filter. For typical transmitting inductances, Q may be assumed to be 300, if the Q of the capacitor is essentially high. In the diagrams the generator is assumed at the left, and the load at the right.

However, f_2 may be impressed on either left or right side of the filter, in various applications, and the filter is intended to prevent it from reaching the other side. The designation of one side as "generator" and the other side as "load" is therefore not always clear.

R_1 = the load impedance at f_1.

R_2 = the load impedance at f_2.

G_1 = the generator impedance at f_1. (G_1 is assumed to be small compared to R_1).

G_2 = the generator impedance at f_2.

In choosing between Types A and B, the former is more effective when the impedance of the circuit is lower at f_2 than at f_1, and vice-versa. Definite formulas for selection of types are:

When $R_2 G_2$ is less than R_1^2, use type A.

When $R_2 G_2$ is greater than R_1^2, use type B.

Any of the following methods may be used to determine which case prevails.

(1) If all components in the circuit are known, it is possible to make calculations of the impedance at the filter point, for both f_1 and f_2. Usually the impedance at f_2 is found

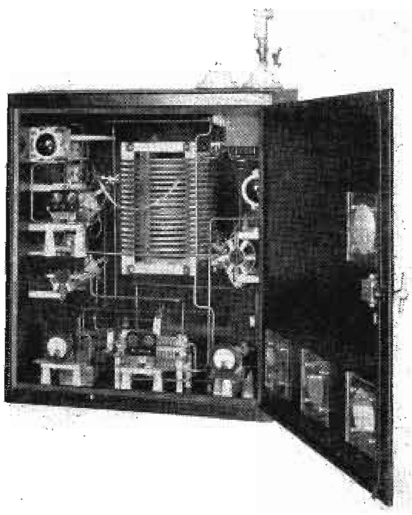


Fig. 11—Typical network incorporated in an antenna tuning unit

to be so greatly different from that at f_1, the choice is obvious.

(2) The impedances may be measured with an rf bridge.

(3) Types A and B may each be tried out, and the preferable one determined from the comparative performance of the two. If this method is followed, it is best to design the two for equal loss at f_1 (according to the formulas given hereafter), and then observe the difference in performance at f_2.

Methods (1) and (2) are applicable to determination of load impedance, and from this impedance alone, the advantage of one type of filter may be so great, or the needed performance so easily obtained, that there is no need for further analysis. These methods, however, do not readily give the generator impedance. Method (3) for this reason is sometimes the only satisfactory method.

To design a type A filter, a value of X_2 must be selected which will give satisfactory performance. Then Rejection Ratio $= (R_2+G_2)/QX_2 = R_2/QX_2$ (when $G_2 << R_2$).

Loss Ratio $= X_2/4D^2QR_1$.

Losses Must be Lowered

It is seen that a larger X_2 makes the rejection ratio lower (an improvement), but also makes the loss ratio higher (a disadvantage). Since performance in both respects is improved by increasing Q, use the lowest loss inductance available, a good capacitor, make good connections between them, and see that the housing and other objects around them do not greatly reduce the Q. Also since the loss varies as D^2, performance deteriorates rapidly as the frequency separation is decreased.

In practice, it is rarely necessary to obtain either of these performance factors lower than 0.001. Where frequency separation is small, it is sometimes necessary to allow each factor to be as high as 0.1. If either factor is higher than 0.1, the filter usually is considered useless, and the project abandoned, or a more complex filter used. If we set 0.1 as the maximum limit of each factor, and assume that Q = 300 and $R_1 = R_2$, we find that this type of filter is useful only for frequency separations of 1.7% or greater.

In resonant filters, high values of current and voltage appear in both the inductance and the capacitor. Components of suitable size must be selected to prevent failure from overheating or voltage breakdown.

In Type A filters the current is ½D times the current in the load. For example, if the frequency separation is 3% the load current is 5 amperes, the current circulating in the filter inductance and capacitor is 83 amperes. This calls for rugged components and makes it clear why severe losses may occur. The voltage across these components is the current times the reactance, and is likely also to be so high that precautions must be taken to prevent corona.

Component Selection

In selecting components, the current rating of fixed capacitors should be 1.22 times that shown to allow for rise in RMS current with 100% modulation. The voltage rating of inductances and air condensers should be 2.30 times that shown in order to allow for maximum RMS voltage with 130% positive peaks of modulation. To find peak voltage, this RMS value must be multiplied again by 1.41. Furthermore, for adequate factor of safety in commercial equipment, it is well to have actual current and voltage ratings about double again the maximum values just computed.

These current and voltage calculations are for the pass frequency (f_1). In most applications, the cur-

(Continued on page 58)

The Design of Audio Compensation Networks—Part II

By WILLIAM A. SAVORY, Audio Engineer, Englewood Cliffs, N. J.

Application of the correct equalization for various commercial phonograph recordings has an important effect on character of reproduction

THIS is the second of a series of three articles on RC compensation networks for record reproduction. The text of this part covers compensation networks for the high-frequency end of the audio spectrum. Part III will present compensation network data in chart form. See the January issue of TELE-TECH *for Part I covering the low frequency networks.*

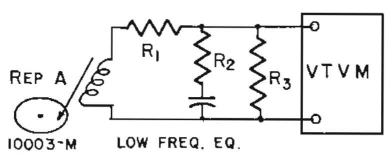
• The problem of high-frequency compensation for phonograph reproducers may be divided into two separate and distinct sections: (a), networks for correcting the inherent losses of the device itself, and (b), networks to introduce losses which complement the various "pre-emphasis" or accentuation characteristics used by the recording industry.

With regard to the second half of this problem, it is somewhat difficult to obtain reliable engineering information on the subject of so-called "high-lift" or accentuated high frequency recording characteristics, other than the NAB Lateral Recording Standards and the NBC Orthacoustic Lateral Transcription Standards. However, for reasons of better signal-to-noise ratios and improved high frequency performance from average commercial records, the trend in recent years (especially in the case of 78 rpm) has been toward an accentuated high frequency response.

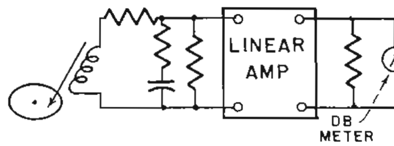
The degree of accentuation and the point in the frequency spectrum at which it begins varies somewhat in recordings of different manufacture, but it appears from critical listening tests that most of these characteristics are modifications of the NAB Lateral Recording Standard. It is realized that the last sentence is quite a statement, particularly in view of the well-known non-linearity of the human ear.[1] Nevertheless, due to the highly competitive nature of the recording industry and the dearth of accurate technical information resulting therefrom, ear response is the only criterion left to fall back on. It will perhaps be admitted though, that recordings are made in practically "99.44%" of all cases solely to please the ear.

In the first article in this series a typical phonograph reproducer of current manufacture was used as a working example. This device, arbitrarily named Reproducer A, shall again be used throughout the following. In general, the same test equipment, frequency records and measuring technics also shall be used.

The first step is to determine the response-frequency characteristic in 1 kc to 10 kc region of the reproducer, and the degree of compensation necessary to correct the indicated high frequency loss. This may be accomplished by using the working circuit of (A), or (B), below:

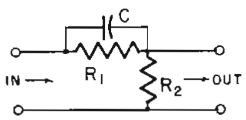


(A)



(B)

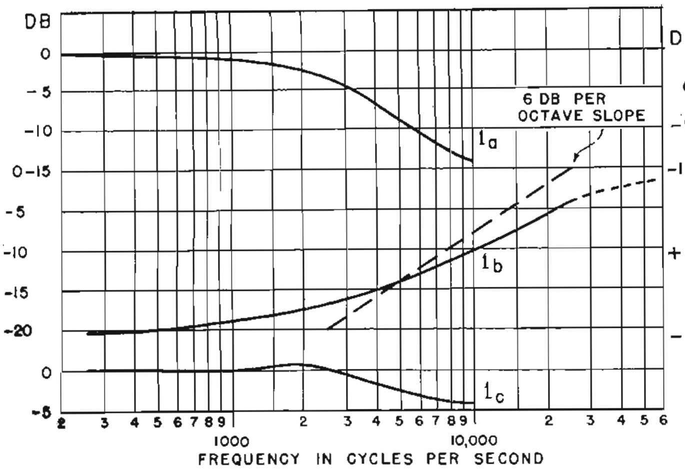
The resulting output response vs. frequency curve of Reproducer A in the 1 kc-10 kc range is shown in Fig. 1A. A high frequency correction network of the following configuration will now be considered:

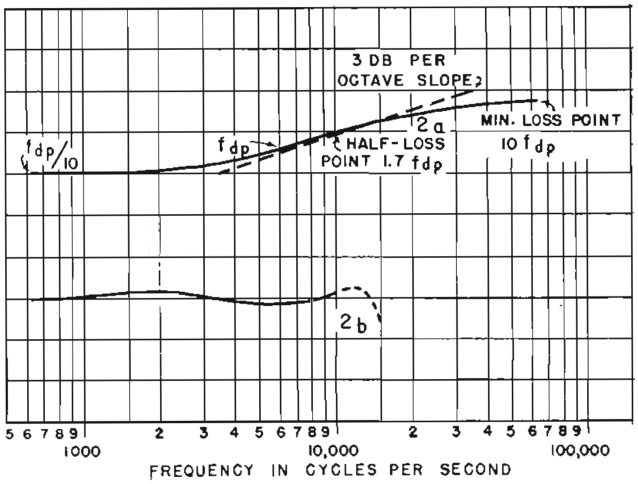


(a)

Due to the reactance characteristic of capacitor C, the maximum correction obtainable from this type of network is asymptotic to a 6 db per octave slope increasing with frequency. In order to avoid excessive attenuation in the low frequency range, this 6 db per octave slope will be restricted to a maximum of 20 db over a 10 to 1 frequency range. This is accomplished by limiting the attenuation of the loss pad (R_1+R_2) to 20 db.

Before calculating the necessary values for R_1 and R_2, consideration should be given to the eventual location of the high frequency network being discussed. Referring to (A), R_3 of the low frequency crossover network has an assigned value of 500,000 ohms in order to avoid any serious shunting effect on R_2. If a high frequency correction network is to be inserted directly after the low frequency crossover section, it would then have to represent a load somewhere in the vicinity of 500,000 ohms.





Incidentally, it is not at all necessary to restrict the network location to directly follow the reproducer. In fact, in the particular case of Reproducer A, the minimum amount of high frequency loss is experienced when the device is operated as an open-circuited generator. This implies that for the least amount of overall loss, the output of Reproducer A should be fed directly into an open grid, with compensation networks inserted at some other point. (Between the pre-amplifier tubes, for example. This method of coupling and an interstage-equalized pre-amplifier for this particular reproducer will be discussed in the 3rd article in this series.)

However, not all types of phono reproducers require open-circuit grid input coupling. In fact, many reproducers are designed to work into a designated load which is assigned and recommended by the manufacturer. Therefore, since the thought in these articles has been to cover the general case and outline network design methods for universal application, it was decided to treat Reproducer A in the manner of Part 1 of these articles.

Returning to the question of high frequency network location, one possible solution would be to replace R_3 of the low frequency crossover network with a high frequency equalizer. This requires that the sum of R_1+R_2 of (a) above be approximately 500,000 ohms. However, if R_1 is made too large, impractically small capacitor values result. With these two conditions in mind a 20 db loss pad of the simple voltage-divider type will be calculated.

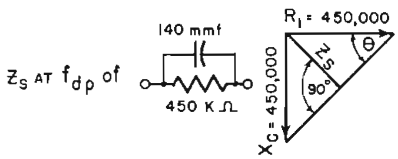
Considering only the resistive elements of (a), and assuming an input voltage of unity, the attenuation in db equals 20 $\log_{10}(R_2/R_1+R_2)$. Since 20 db represents a voltage ratio of 10 to 1, R_2 will then be $.1(R_1+R_2)$. With the 500,000 ohm figure in mind, R_1 would then become 450,000 ohms and R_2 50,000 ohms.

This closely approximates the low frequency network loading conditions in the range where X_c in the high frequency network is large. But as the frequency increases, X_c decreases and at the upper limit X_c practically shunts out R_1, leaving little more than 50,000 ohms total load. Whether or not this represents too serious a load depends in general on the degree of high frequency compensation necessary and the point in the frequency spectrum at which correction is to begin.

Referring to Fig. 1a, the 3 db loss point of Reproducer A occurs at 2500 cycles, which establishes the network design point frequency, f_{dp}. At 2500 cycles a capacitor with a reactance equal to R_1 will be selected and added to the network:

$$C = \frac{10^6}{6.28 \times 2500 \times 450,000} = 140 \text{ mmf} \qquad \text{(b)}$$

The attenuation at f_{dp} may be readily calculated by finding the ac resistance of the series arm (R_1 in shunt with 140 mmf.) at 2500 cycles and then treating (Z_s+R_1) as a simple voltage divider. The impedance of R_1 in shunt with C may be determined in the following manner:

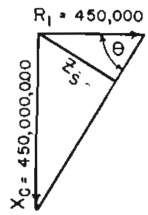


(c)

At f_{dp} Z_s will equal $R_1 \sin\theta$, and since θ is a 45° angle in the vector diagram shown, $\sin\theta$ equals .707. Therefore, $Z_s = 450,000 \times .707 = 318,150$ ohms and the attenuation of the network at f_{dp}: Att. in db = 20 $\log_{10}(50,000/368,150)$ = 20 $\log_{10}$ .135 = 20(9.130 − 10) = −17.3 db.

Since the total attenuation of the network at some remote low frequency point (say, $f_{dp}/10$) will be 20 db, this may be designated as an arbitrary zero reference point. The network may then be said to have a "gain" at f_{dp} of 20 − 17.3 = 2.7, or close to 3 db. The actual response of the network at $f_{dp}/10$ may be calculated and used as a location point in the plotting of a frequency curve:

$$Z_S = R_1 \sin\theta = R_1 \frac{X_C}{\sqrt{X_C^2 + R_1^2}} = 447,300 \text{ OHMS}$$



(d)

The Sin θ term becomes very unwieldy with numbers of such large order of magnitudes as those encountered in high Z networks of this type. However, the sine of θ at $f_{dp}/10$ will be very close to .994 in all cases of this particular network, so the series arm impedance equation may be reduced to simply: $Z_s = .994\ R_1$.

The attenuation at $f_{dp}/10$ in db = 20 $\log_{10}(R_2/R_2+Z_s)$ = 20 $\log_{10}$ .1005 = 20(9.002 − 10) = 20 db.

Another suitable point for plotting the response of the network is at or near the minimum insertion loss point, $10f_{dp}$:

X_c at $10f_{dp}$ = 45,000 ohms; R_1 = 450,000 ohms. Z at $10f_{dp}$ = $R_1 \sin\theta$ = 44730 ohms.

Here again the Sine of θ at $10f_{dp}$ becomes: .0994 in all cases, and, $Z_s = .0994R_1$.

The attenuation in db at $10f_{dp}$: $= 20 \log_{10}(50/94.73) = 20 \log_{10} .621 = 20(9.794 - 10) = -4.1$ db.

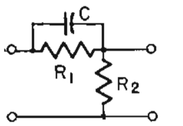
Three points in the frequency spectrum ($f_{dp}/10$, f_{dp} and $10f_{dp}$) are now available for plotting purposes. Since one of these ($10f_{dp}$) is well beyond the maximum frequency that is of interest (10 kc) in this particular problem, the attenuation of the network at 10 kc will now be calculated:

X_c at 10 kc = 112,000 ohms; Z at 10 kc = R_1 Sin θ = 111,600 ohms.

The Sin θ term will always be .248 at $4f_{dp}$ (10 kc in this particular case), and $Z_s = .248\ R_1$ at $4f_{dp}$. The attenuation at $4f_{dp}$: loss in db $= 20 \log_{10}(50/161.6) = 20 \log_{10} .309 = 20(9.490 - 10) = -10.2$ db at $4f_{dp}$.

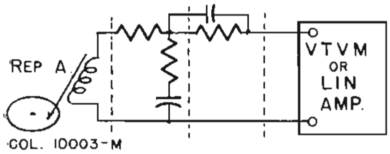
Therefore, $4f_{dp}$ establishes the half-point loss of the network, and with the other three calculated points a very close approximation of the network frequency response may be predicted by plotting. The resulting curve is shown in Fig. 1b. The dotted line represents the 6 db per octave asymptote.

A network containing these values:



C = 140 mmf
R_1 = 450,000 OHMS
R_2 = 450,000 OHMS (e)

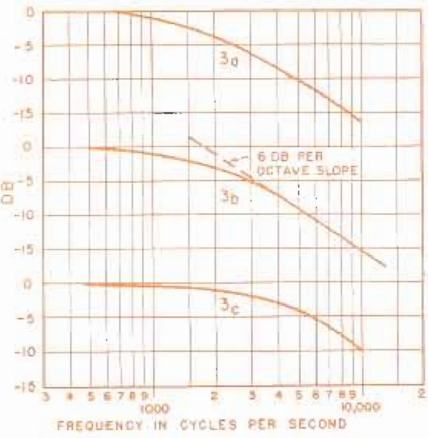
may be inserted after the low frequency equalizer, replacing R_3 of the latter configuration, and the 1 to 10 kc response measured in the following manner:



(C)

The resulting curve shown in Fig. 1c shows 10 kc to be down 5 db, but the response is "flat" enough for most practical purposes. However, if a further reduction in gain can be tolerated, this 5 db loss may be eliminated with a similar network having an output response curve asymptotic to a 3 db per octave slope over a 10 to 1 frequency range.

In this latter case, the fixed pad loss is made to equal 10 db. Assuming a total (R_1+R_2) resistance of approximately 500,000 ohms, R_2 shall be made to equal $.3(R_1+R_2)$. Suitable values for these conditions would be R_1 = 315,000, and R_2 135,000. The design point frequency



(f_{dp}) will as usual be the 3 db loss point of the curve being corrected, in this instance 6200 cycles.

At f_{dp} then, the new network will have an insertion loss of 7 db. This requires that the impedance of the series arm be $.55(Z_s+R_2)$, indicating an output/input voltage ratio of $.45 = (135{,}000/1350{,}000+Z_s)$. Multiplying through by $(135{,}000+Z_s)$: $.45Z_s = 135{,}000 - 60{,}750$. Z_s = 165,000 ohms.

X_c can now be determined: $X_c = R_1$ Tan θ, $Z_s = R_1$ Sin θ, 165,000 = 315,000 Sin θ, Sin θ = .523.

From the table of Natural Sines, θ is found to be an angle of 31.6°. Since $X_c = R_1 \tan \theta$, the tangent of 31.6° is sought in the table of natural Tangents and found to be .615. Therefore: X_c = 315,000 x .615 = 193,725 at f_{dp}, and since f_{dp} is 6200 cycles, C = 130 mmf. As in the 6 db per octave high frequency compensation network case, the sine and tangent of θ will very closely approximate the values derived above, and X_c in the 3 db per octave case at f_{dp} will always be equal to $.615R_{10}$.

The usual points: $f_{dp}/10$, $10f_{dp}$, and $1.7f_{dp}$ (3 db per octave network half loss point) will also be calculated and used for plotting a response curve. In general, the procedure is the same as that outlined for the 6 db per octave network. As this method is by now familiar the calculations involved will be reduced to the use of basic design factors. Thus, at $f_{dp}/10$: X_c = 1,937,000 ohms, $Z_s = R_1 \sin \theta$, and $\sin \theta = .982$ = 315,000 x .982 = 309,300 ohms. Attenuation in db $= 20 \log_{10} .303 = 10.2$ db.

At $1.7f_{dp}$ (half loss point in the 3 db per octave network case): X_c = 115,000 ohms, $Z_s = R_1 \sin \theta$, and $\sin \theta = .342$ = 315,000 x .342 = 107,730 ohms. Attenuation in db $= 20 \log_{10} .556 = 5$ db.

At $10f_{dp}$: X_c = 19,370 ohms, $Z_s = R_1 \sin \theta$, and $\sin \theta = .0610$ = 315,000 x .061 = 19,215 ohms. Attenuation in db $= 20 \log_{10} .876 = 1.2$ db.

Plotting the above points yields the curve shown in Fig. 2a. The 3 db per octave network is now connected in series with the 6 db per octave network and a frequency run in the 1 kc to 10 kc region is made. This curve is shown in Fig. 2b. The small rise at 10 kc is due to a natural mechanical resonance of Reproducer A at approximately 12 kc.

Basic Networks

These two basic networks may be used singly or in combination to produce 3, 6, 9, or 12 db per octave high frequency compensation curves. Both basic response curves may be arbitrarily shifted either higher or lower in frequency without changing their characteristic slopes by simply changing the value of C.

Part 2 of the high-frequency compensation problem is the consideration of loss networks to complement the high frequency accentuation characteristic employed by the recording industry. As previously pointed out, the only reliable engineering data available on the subject of high frequency recording characteristics are the standards proposed by the NAB, and the NBC orthacoustic curves. Both of these characteristics are similar to the RMA Television Transmission Standard M9-218 in the 1 kc to 10 kc region.

The correct response for reproducing the NAB characteristic is shown in Fig. 3a. Note the similarity between Fig. 3a and the unequalized Reproducer A curve shown in Fig. 1a. When plotted against each other the maximum difference between these curves is approximately ±125 db. Thus, Reproducer A without any high frequency compensation is more or less "equalized" for the proper reproduction of recordings made with the NAB characteristic. However, an even closer approach to the NAB reproducing curve may be realized very simply.

Referring to (a), a capacitor shunted across R_2 of the high fre-

(*Continued on page 72*)

Antenna Design for Low-Angle FM Propagation

By O. O. FIET, Broadcast Section,
RCA, Camden, N. J.

"Pylon" sections are stackable for suppression of high-angle radiation—Horizontal coverage pattern is nearly circular

THE initiation of commercial FM broadcasting and its rapid growth has created a demand for a simple high-gain, high-power, omnidirectional antenna for broadcasting horizontally polarized waves. Antennas utilizing arrays of loops, current-sheet radiators or dipoles arranged on a supporting non-radiating structure have been designed for this service. This article describes the electrical and the mechanical features of the RCA Pylon antenna.

• The Pylon antenna is unique in the family of FM broadcast antennas because its entire structure serves as the radiator. There are no radiating appendages to accumulate ice, add excessive weight and wind load on the supporting structure or to cause changes of input impedance when iced. There are no maintenance or operating costs other than the usual periodic paintings.

Several standard Pylon antenna combinations for FM and television are illustrated by the sketches of Fig. 1. The combinations shown utilize cylinders and feeder lines which allow later addition of more sections if desired. Heavy duty pylon antennas are designed with increased strength in order to support an additional television antenna.

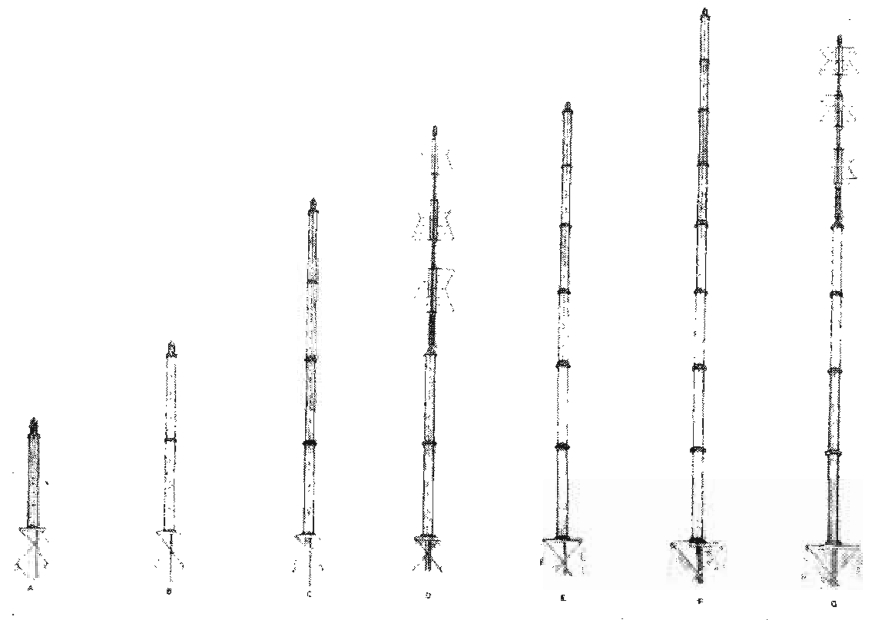
Flanged ends on individual cylinders, (Fig. 2), facilitate the handling of single sections of the antenna during shipment and installation. In most cases, the antenna and transmission lines can be completely assembled on the ground and hoisted into place. Fig. 3 illustrates a typical Pylon installation on a 260 foot tower. No soldered joints are required in the transmission line installation and a minimum of solderless coupling connections are necessary. Shackles are installed inside and outside at the top of the antenna to facilitate installation and maintenance.

The one-, two-, and four-section pylons are available in a lightweight aluminum alloy which is highly resistant to corrosion. Each section can be readily handled by two men. Heavier two- and four-section steel Pylons required to support additional television antennas, as shown in Figs. 1D and 1G, are also available.

A gas-filled concentric transmission line feeder system is installed inside the Pylon cylinders as shown in Fig. 4. Ice cannot form on the conducting surfaces of the feeder to cause excessive standing wave ratios on the main transmission line, or lower the velocity of propagation and the characteristic impedance of feeder lines. The end seals and transmission lines are protected from all hazards of lightning and weather by the metal Pylon cylinder.

Suitable transformers and broadbanding circuits are incorporated in the feeder system for the purpose of obtaining a voltage standing wave ratio less than 1.5 to 1, using a 51.5 ohm line at the input to the feeder

Fig. 1—Individual Pylon sections are stacked for FM and FM/TV applications



system. Typical operating standing wave ratios of the one-, two-, and four-section Pylons, as measured at various frequencies in the FM band of 88 to 108 mc, are shown in the graphs of Fig. 5.

Frequency Adjustments

Two sets of transmission lines are available for use with each type of Pylon, one covers the lower portion of the 88 to 108 mc band, the other covers the upper portion. A substantial overlap is provided for both halves of the FM band. In addition, a broadband feeder is utilized to match impedances at the lower half of the FM band. The standing wave ratio obtained for this portion of the band is less than 1.5 to 1 and no adjustment is necessary for a considerable portion of the lower half of the bandwidth.

Shorting bars placed near each end of the slot in the Pylon (see Fig. 6) provide a proper impedance match of the antenna for any channel in the upper portion of the FM band. The exact positioning of the shorting bars is predetermined by using the distance versus frequency curves. A simple feeder is utilized to match the input impedance for the entire upper half of the FM band. Since the antenna input impedance is approximately 50 ohms, high-Q critical reactance adjustment systems are not necessary and the inherent broadband impedance characteristic of a self-resonant antenna is thereby maintained.

Slot Tuning

Typical standing wave ratios obtained for various positions of the slot-shorting bar (used when tuning the high-band one-, two-, and four-section antennas near the center and upper-end of the FM band), are shown in Fig. 5. The locus of the operating standing wave ratio (obtained with the proper settings of the slot-shorting bar for any desired frequency) is also shown in Fig. 5. Typical resistance and reactance characteristics of the two-section Pylon antennas at the input to the impedance matching system are illustrated in Fig. 7.

Maximum horizontal power gain occurs in stacked Pylon antennas when the currents feeding each section are equal and in phase. This same current relationship is maintained, independent of frequency, by using the same lengths of identical feeder lines for all sections of the antenna. No radiator spacing or adjustments are required to maintain the proper current relationship at any operating frequency.

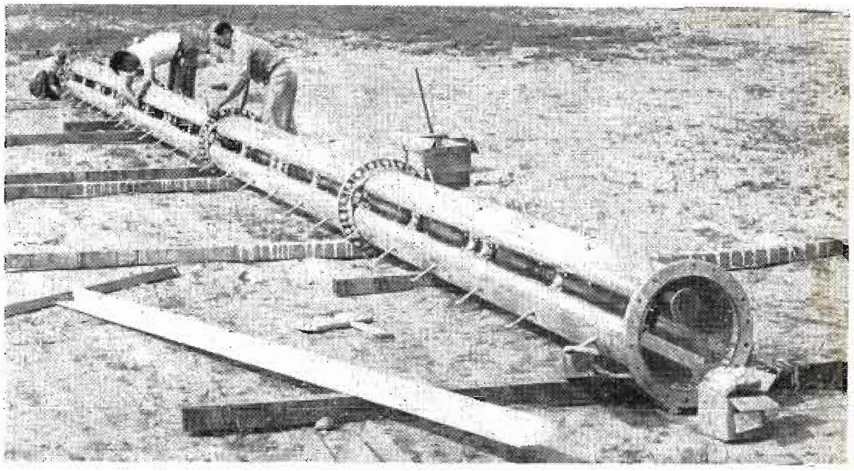


Fig. 2—Four section Pylon being assembled at antenna site

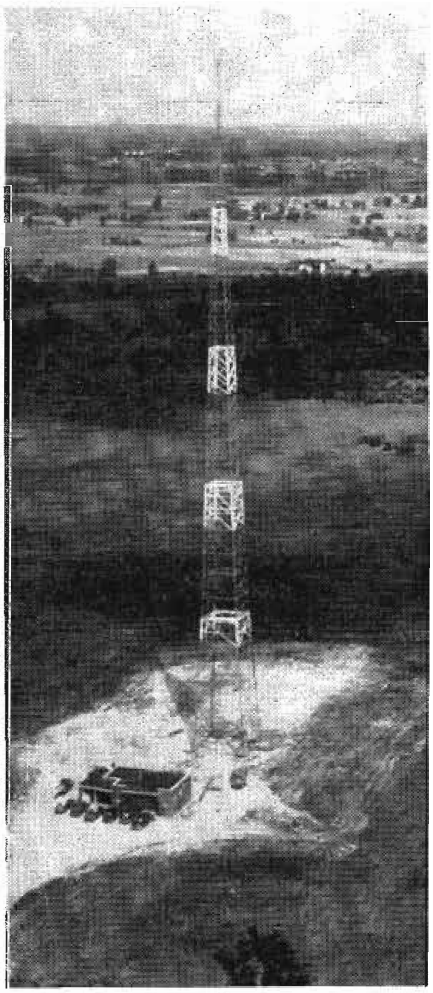


Fig. 3—Typical four section Pylon installation atop 260 ft. AM tower

Since the mutual impedance between adjacent sections is negligible, bolting the structure directly to a tower, building or pier will not adversely affect the input impedance. However, consideration should be given to the effect of the supporting structure on the vertical field pattern. A section fastened directly to a tall building, without any intervening structure to elevate its base above the large flat roof, may result in an undesirable vertical field pattern due to radio waves reflected from the roof. Since the transmission lines are inside the cylinder where it is impossible for ice to form, the vertical field pattern will not be tipped or otherwise disturbed by adverse weather conditions.

Field Patterns

The typical horizontal field pattern measured for the one-, two-, and four-section Pylon antennas (shown in Fig. 8) exhibits a tendency to become pear shaped. The horizontal gain varies about ±2 db from the nominal power gain represented by a perfect circle. The pear shaped pattern does not, however, change the horizontal coverage from circular by more than a few per cent. Typical coverage information for the Pylon antenna was calculated on the basis of ground-wave signal range propagation curves set forth in the FCC Standards of Good Engineering Practice Concerning FM Broadcast Stations. The coverage was calculated on the basis of a smooth, uniform terrain. Actual coverage contours are affected by irregular terrain and ground conditions and will not necessarily resemble exactly the horizontal pattern of the Pylon antenna. The slight directional characteristic may be used to obtain better coverage of a service area which is not circular or one in which the transmitting antenna is located off-center. This same characteristic may also be used to compensate for irregular terrain or shadows caused by buildings.

Horizontal Circularity

It is possible to obtain a nearly circular horizontal pattern by using a staggered slot arrangement for stacked sections. However, the circular horizontal pattern is accompanied by a tilted or broadened vertical pattern and consequently the horizontal gain is reduced. Since there is no practical advantage to a perfect circular horizontal pattern, the in-line slot design was chosen to permit mechanical simplification of the feeder system and utilize multiple section antennas to their greatest advantage.

Vertical patterns, of the one, two-, and four-section antennas at 108 mc, shown in Fig. 9, illustrate how stacking sections reduces wasteful skywave radiation and increases the power radiated in the horizontal plane.

Power Gain

A Pylon antenna with a power gain of 12 will give the same horizontal coverage with 1/12 the transmitter power required as when an omnidirectional antenna with a power gain of one is used. The economic and operating advantages of using a high-gain antenna and a lower power transmitter in preference to a low-gain antenna and a high-power transmitter are apparent for most FM broadcasting installations designed to cover a given market area. The power gain of the Pylon antenna can be measured by several methods. Two common methods are: (1) a comparison of the field strength produced by an unknown antenna with that of a standard antenna of known power gain, and (2) an integration of the radiated power as determined from measured radiation patterns.

The first method (substitution method) is quite simple and basic. However, difficulties due to ground reflections are encountered when attempts are made to measure the gain in the presence of the earth's surface. The undesirable effects of ground reflections can be avoided when highly directional microwave antennas are measured. Since the Pylon is relatively large, and because precise field strength measurements are required, the substitution method proves to be inadequate for consistent gain measurements at 100 mc. Experience has shown that carefully made gain measurements by the substitution method at 100 megacycles cannot be duplicated with an accuracy of greater than ±20%.

Gain may be measured approximately by comparing Pylon field strength measurements with those of a standard transmitting antenna of known gain, under identical conditions. In this method of measurement, field strength readings are continuously* recorded along a single radial from the transmitting antenna. In taking data for both the Pylon and standard antenna, the same location should be used for the center of radiation. The ratio, between the average field strength produced (on the radial) by the Pylon, and that of the standard antenna (as measured in the vicinity of a fixed distance from the transmitting antennas, may be used to estimate gain. See equation below.

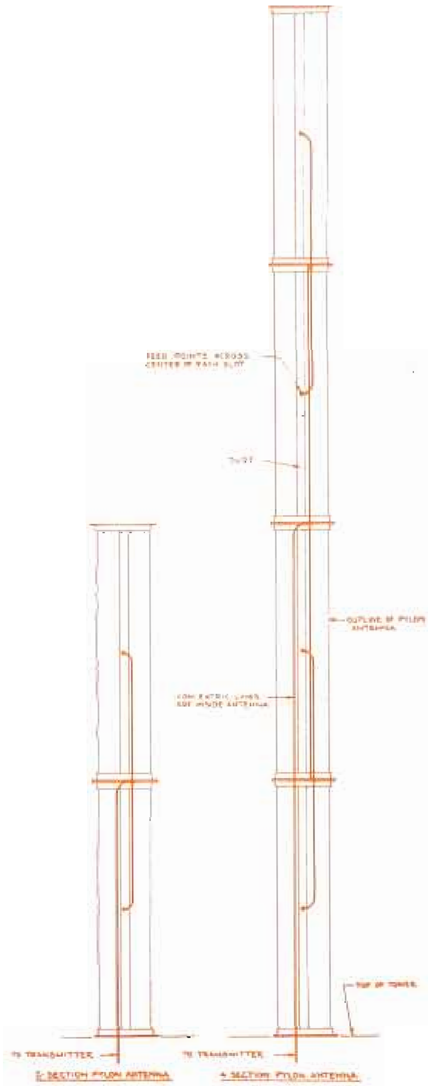


Fig. 4—Diagram of transmission line connections

$$G_p = \left(\frac{E_p}{E_d}\right)^2 \frac{P_d}{P_p} \qquad (1)$$

Where:

G_p = Power gain of unknown antenna referred to that a half-wave dipole.

E_d = Field strength produced by unknown antenna at a fixed distance and receiving antenna height.

E_d = Field strength produced by a half-wave dipole at a fixed distance and receiving antenna height.

P_d = Power input to half-wave dipole.

P_p = Power input to unknown antenna.

Gain Measurements

Equation (1) may also be used to measure the gain of antennas under free space conditions. Free space conditions are difficult to obtain, except for microwave antennas. Consequently, gain measurements by the dipole substitution method, for FM broadcast antennas, must depend upon propagation characteristics over the earth's surface. The field strength produced by a dipole, E_d, for a given power input, may be calculated or measured. It is helpful to remember that a half-wave dipole produces a free-space field strength of 137.6 millivolts per meter, at one mile, with one kilowatt input.

The second method of measuring

*See G. W. Klingman's article, "How to Make a Field Survey of an FM Station" BROADCAST NEWS No. 43, June 1946.

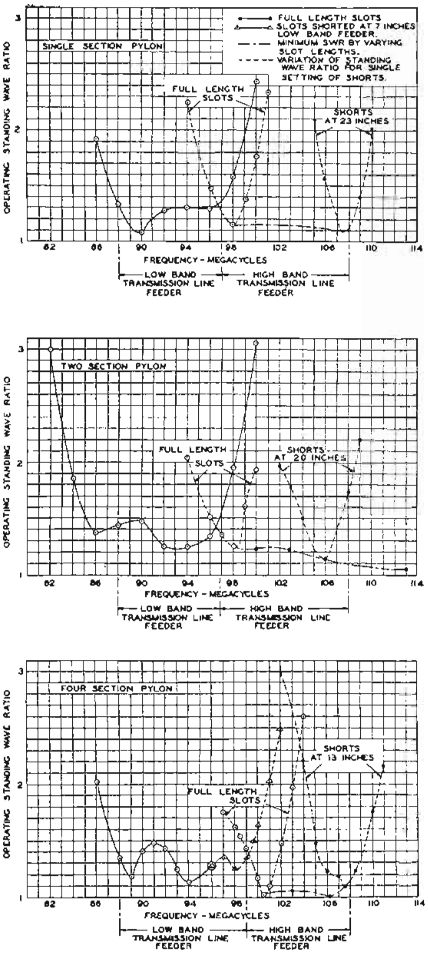


Fig. 5—Typical SWR's for 1-, 2-, and 4-section Pylons

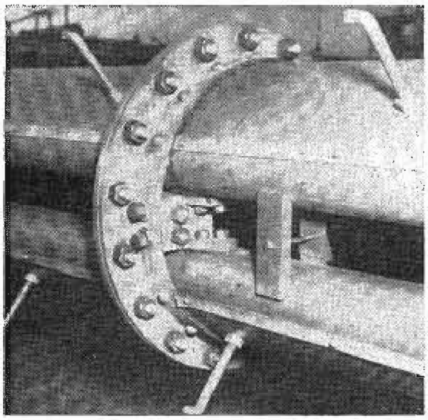


Fig. 6—Slot shortingbar for tuning individual sections

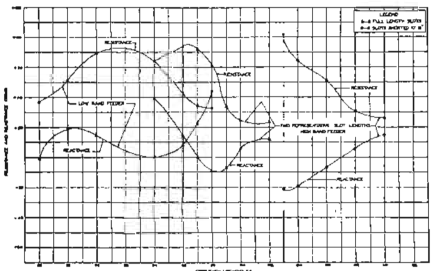


Fig. 7—Typical R and X curves for a 2-section Pylon

gain, the integration of radiated power by using measured patterns, is quite tedious and usually requires many carefully measured patterns to obtain an accurate integration of the radiated power. The accuracy obtained by practical measurements is good. Careful measurements yield calculated gains which can be duplicated within one or two per cent. The gain determined from measured patterns can be compared with a theoretical gain obtained from calculated patterns. The agreement obtained in the case of the Pylon is quite good. The vertical patterns of the Pylon antenna can be measured readily by a setup similar to that illustrated in Fig. 10. The Pylon antenna is installed on a turntable which now orients the desired vertical patterns located in a horizontal plane. A battery operated oscillator is installed at one end of the Pylon and connected to the feeder system. The battery operated oscillator eliminates the possibility of undesirable rf radiations from power leads. In ac operated oscillators the rf currents radiated are induced in the power leads.

Vertical Patterns

The receiving antenna and field intensity meter are installed at a sufficient distance from the Pylon antenna and turntable to obtain the lowest possible nulls on the vertical side lobes. The site used for pattern measurements should be a large flat area without reflecting obstructions in the vicinity. Patterns are obtained, after the field strength meter is adjusted, by rotating the Pylon antenna on the turntable and measuring the relative field strength as a function of angle of rotation. A simple pointer and dial, divided in degrees, can be installed on the turntable to indicate the angle of rotation of the Pylon. The vertical pattern in all planes through the axis of the Pylon is nearly identical. The mean of four vertical patterns measured in various planes at right angles gives an average pattern suitable for accurate gain calculations. It is important to calibrate the field strength meter scale for relative field strength if the patterns are to be used for accurate determination of gain.

Certain photographs appearing in this article are presented through courtesy of WJPG, Green Bay, Wis.

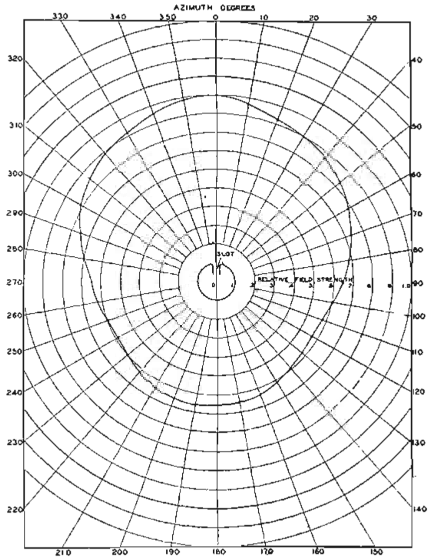


Fig. 8—Horizontal pattern for 1-, 2-, and 4-section Pylons

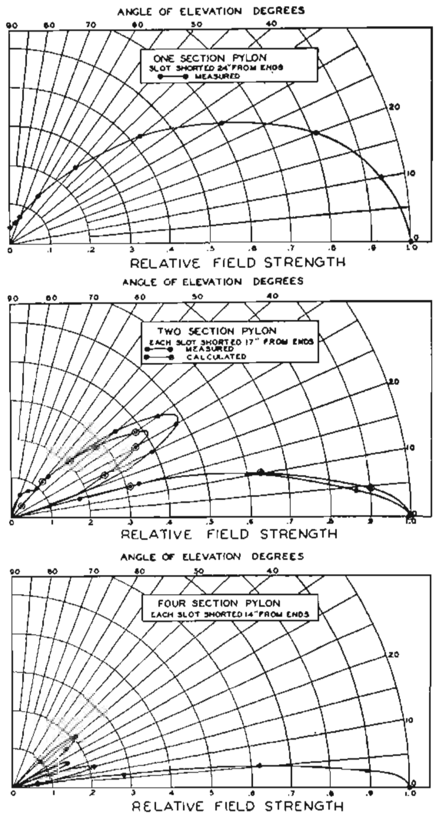


Fig. 9—Vertical field patterns for 1-, 2-, and 4-section Pylons at 108 mc

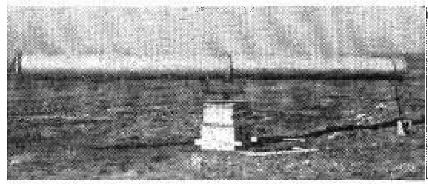


Fig. 10—Field set up for measuring vertical radiation patterns

Will Clear Channel Broadcast Plan Be Changed?

By ALBERT FRANCIS

CCBS proponents would divide US into 5 parts, put 4 high-power stations in each — Emphasize need for 750 kw for better coverage

• "NOW, THEREFORE IT IS ORDERED, . . . THAT a hearing be held before the Commission . . . on May 9, 1945 . . ." on the subject of Clear Channels and, believe it or not, the final session of the final hearing was completed October 31, 1947.

The issues originally listed by the FCC were: should the number of Clear Channels be increased or decreased; what channels shall be designated as I-A and as I-B; the minimum and maximum power authorized for Clear Channels; to what extent would the authorizing of power in excess of 50 kw affect unfavorably other stations; what is the optimum geographical distribution of Clear Channel (CC) stations; is it feasible to relocate CC stations to serve areas not now receiving service; what new rules concerning power or hours of operation for Class II stations on CCs are needed; to what extent do the CC stations render a program service suitable for listeners in rural areas; what is the desirable degree of overlap in CC station service areas and extent of duplication of program service; and finally, what recommendations should the FCC make to Congress for additional regulations in this matter and also to the State Department for changes in the North American Regional Broadcasting Agreement (NARBA).

No wonder it has taken so long to have all the evidence presented on this many-sided program! Added to the above was a separate hearing on the effect of daytime skywave on CC operation. This was covered in TELE-TECH for August 1947, page

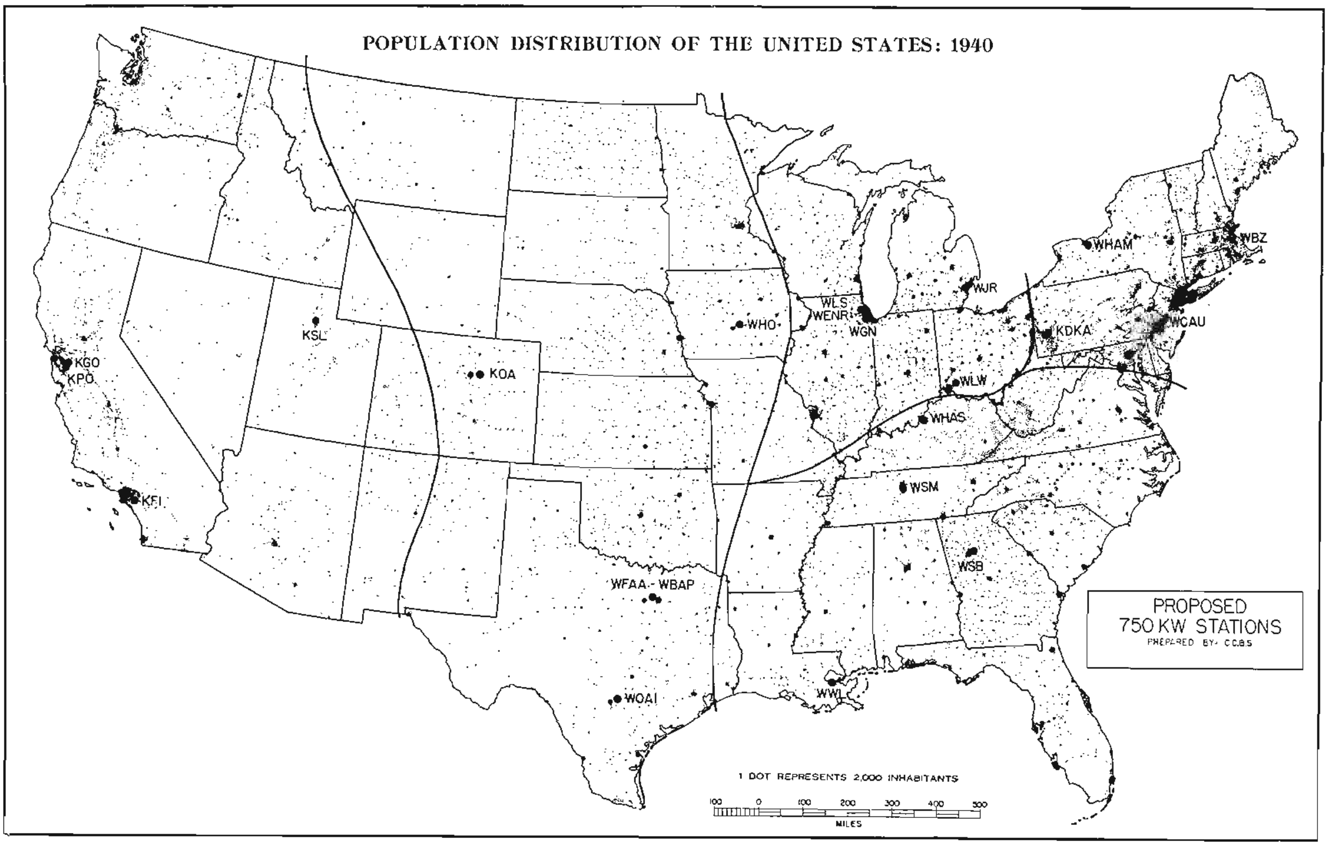


Fig. 1—Plan for 16 1-A channels and 4 1-B channels in five U. S. sectors

45. A brief review of this article will serve as an introduction to one phase of the CC subject and will show that there existed two well-defined groups, the Regional Broadcasters and their opponents, the Clear Channel Broadcasting Service (CCBS). At the conclusion of this June 1947 hearing, the position of these two groups (probably in an oversimplified manner) can be stated as follows: Regional Broadcasters recommend that the FCC reduce the number of I-A stations and allocate these channels to Class II stations so that local stations, with reliable ground-wave signals, can bring local programs to rural areas; on the other hand, the CCBS recommended that Class I stations be protected at all times from interference to their 100 microvolt contours calculated for 750 kw and that the minimum spacing between the dominant station on a CC and a limited station on the same channel be 1200 miles.

20-Station Plan

The controversy became three-sided in the final October 1947 hearing when, after CCBS offered a "20-station plan", the major networks, especially NBC, objected to the plan. But to bring out in an orderly fashion what happened at the last hearing let us view the high-lights as they occurred.

The FCC engineers first presented evidence relating to the coverage of Class I to IV stations and by maps showed which areas received A, B or C service. They also reported on Population Covered by Local Channels, Regional Channels and All Channels. Commissioner Hyde, acting as chairman, ruled that any bearing that FM might have on the subject would be ignored at this hearing. The next main proposal came from John H. DeWitt, Jr., president of WSM, Nashville, and engineering director of CCBS. The latter organization is made up of 16 independent CC broadcasters.

DeWitt's testimony reviewed a number of proposed methods for improving the present inadequate broadcasting service, then showed why, for various reasons, these were rejected. This led to the much-discussed CCBS plan which follows.

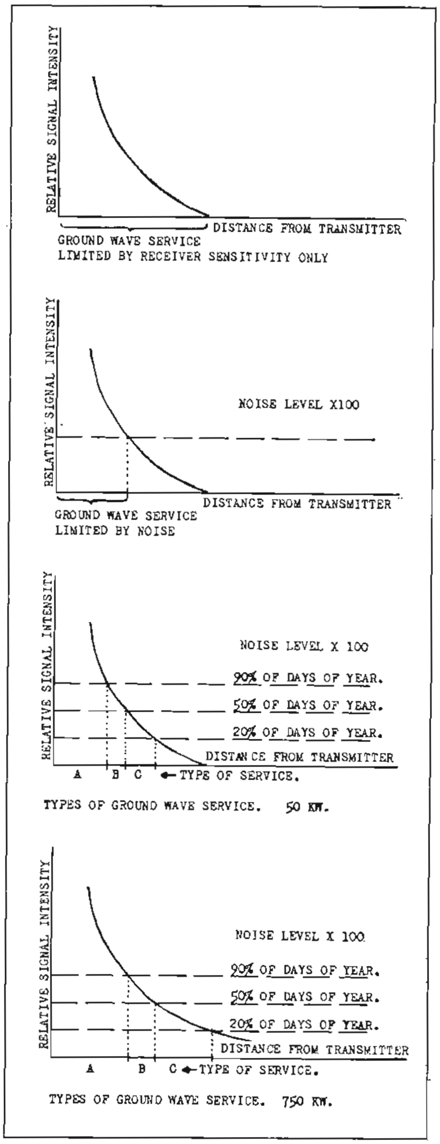


Fig. 2—Daytime transmission conditions by CCBS

A—Remove the present 50 kw power limitation on 16 I-A channels and four I-B channels used by certain named stations. Divide U. S. into 5 parts, putting 4 CC stations in each part. See Fig. 1, which shows population and location of stations.

B—Authorize an increase of power to 750 kw, minimum, for existing dominant stations on above-mentioned channels.

C—Remove 50 kw power limitation and authorize increase as above, for the remaining I-A channels and (to the extent permitted by international, engineering and economic factors) on other I-B channels.

D—Within the above limitations (international, engineering, etc.) increase the power of regional and local channels in so far as ground-wave service will be expanded thereby, particularly in daytime.

The advantages claimed for this plan are: usable in the immediate future; technically sound; not experimental; while not perfect, it would remedy inadequacy of service; at night *the entire country should have a choice of four program services* by skywave signals of reasonably satisfactory grade; affords protection against inroads of broadcasters in other North American countries.

From the voluminous data submitted by CCBS, Figs. 2 and 3 are reproduced because, to the engineering readers of TELE-TECH, these sketches showing daytime and nighttime transmission conditions convey the story much better than many words.

Two days of cross-examination followed DeWitt's presentation of the CCBS Plan. The Regional Group contended: there were questions regarding the directive antenna proposal in which stations were operated "back-to-back" on the same CC; it was impossible for various States to have any full-time stations with more than 5 kw of power, hence equitable-distribution provisions could not be carried out; there were questions concerning the interference ratios used in the exhibits.

Network Changes

The networks, also operators of CC stations, attacked the plan by questions regarding the realignment of certain stations as to their network affiliations; there were comments about the use of 100-to-1 instead of 200-to-1 signal-to-noise ratios; it was pointed out that KPO or KFI might have to leave NBC under the plan and that in other regions the same might be true about WHO, WFAA-WBAP or WOAI, similarly WSB, WSM or WBZ.

The answer to network affiliation changes was that where some stations would be lost, others would be gained in other regions; at any rate "thousands for the first time would have a choice of *four* program services". The witness said that since CCBS were the only ones to present a plan for improving coverage it was natural that the 16 independent member stations were included in the operations of the plan.

Before moving on to the next subject it should be noted that the proposed increase in transmitter power to 750 kw would cost per installation, including a 3-element directional array, $633,600 (low), $1,287,850 (high) and $975,390 (average). Average hourly costs of operation would increase from $12.11 for 50 kw to about $46.00 for 750 kw. The time required to get the higher power transmitters on the air would be from 1½ to 2 years. It was assumed all the CCBS stations would apply for 750 kw. The total cost of the change for all the stations under the plan could reach $22,927,000.

Regional Group

Their witness, Alfred Politz, discussed data from a BMB survey showing coverage of some 43 I-A and I-B stations. As usual BMB data was objected to unless officials familiar with its gathering were present to authenticate it. After Richard Wycoff testified regarding the BMB poll, the data was accepted but was not testified as engineering information. Next a statement by Gov. Folsom of Alabama offered by an attorney was not accepted because the Governor was not present to be cross-examined.

There followed testimony by E. F. Evans of ABC; C. Richard Evans of KSL; J. V. L. Hogan and E. M. Sanger of WQXR and John Preston of ABC.

Mr. Brauner, attorney, petitioned the FCC to reconsider its decision to exclude considerations concerning FM at this hearing, saying that this decision prevented the consideration of the FM network plan offered by CBS. He stated that this plan was one of the only two plans for broadcast improvement in this country and should not be ignored. A mass of data was offered by J. W. Wright, CBS chief radio engineer, dealing mainly with Network Program Acceptances and also Program Duplication Analysis.

W. S. Duttera, staff allocations engineer, testified to NBC's national coverage through CC stations and to overlap of service and program duplication. He offered as an exhibit a most impressive leatherette-bound volume, nearly twice as large as this sheet, containing 242 pages of maps, charts and tabulations.

He pointed out that, in spite of claims to the contrary, there is no duplication of service if the stations involved carry different programs or if the type of service afforded is inadequate or unreliable. He rates Type "C" service, detailed above, as "a poor grade of service subject to interference for a high percentage of the time".

Many variables must be kept in mind in considering the highly technical angles that must be observed in weighing and deciding upon the best plan for future high-power broadcasting. To render such a decision the Federal Communications Commission must not only be a many-headed body, but all of the heads are called upon, when aware of the technical points, to project their minds forward in time about 10 years to evaluate the future working of the broadcasting plan they endorse. This sounds like a job for Superman — multiplied by seven!

The next witness was R. F. Guy, Manager of Radio and Allocations Engineering for NBC, who offered evidence indicating the improved service that would result from the use of higher transmitter power than the present limit of 50 kw; called attention to the importance of maintaining Class I-A channels to protect our borders against foreign interference under the regulations of NARBA; attacked the CCBS Plan as giving, at best, four skywave services of low-reliability. Naturally, any plan which would remove stations from the NBC network would be disadvantageous, according to the witness, who said any proposal which would lead to the loss of NBC service by millions of the people is adverse to the best interests of the public.

If the CCBS plan is adopted whereby NBC would lose some large stations in exchange for smaller ones, the nighttime primary service (Type B) would be lost for some 10,000,000 people; these people would then only receive skywave signals which at best would provide reception for only part of the time.

We are coming to realize more and more that higher power at the transmitter is needed to serve more people with better radio reception.

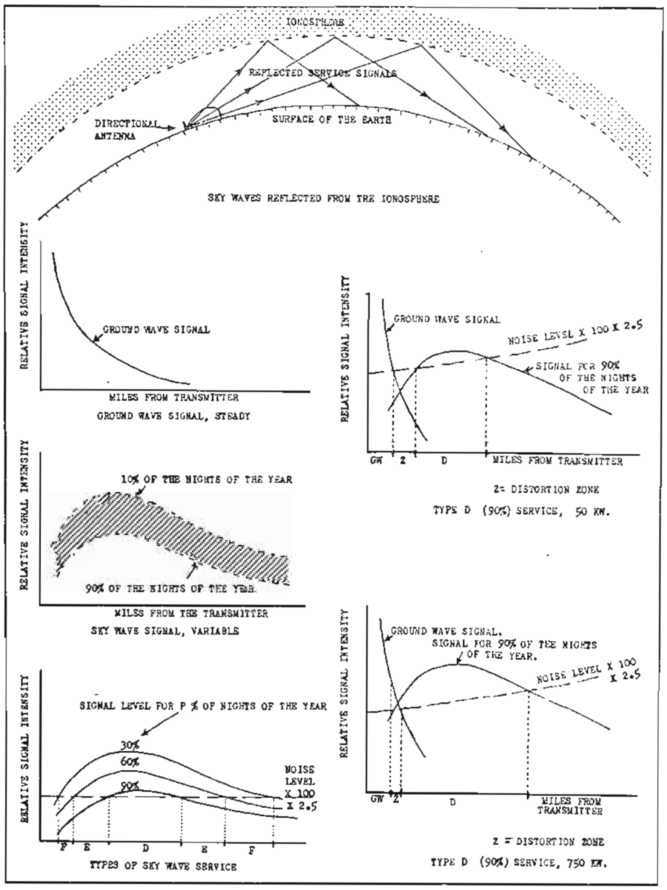


Fig. 3—Nighttime transmission conditions by CCBS

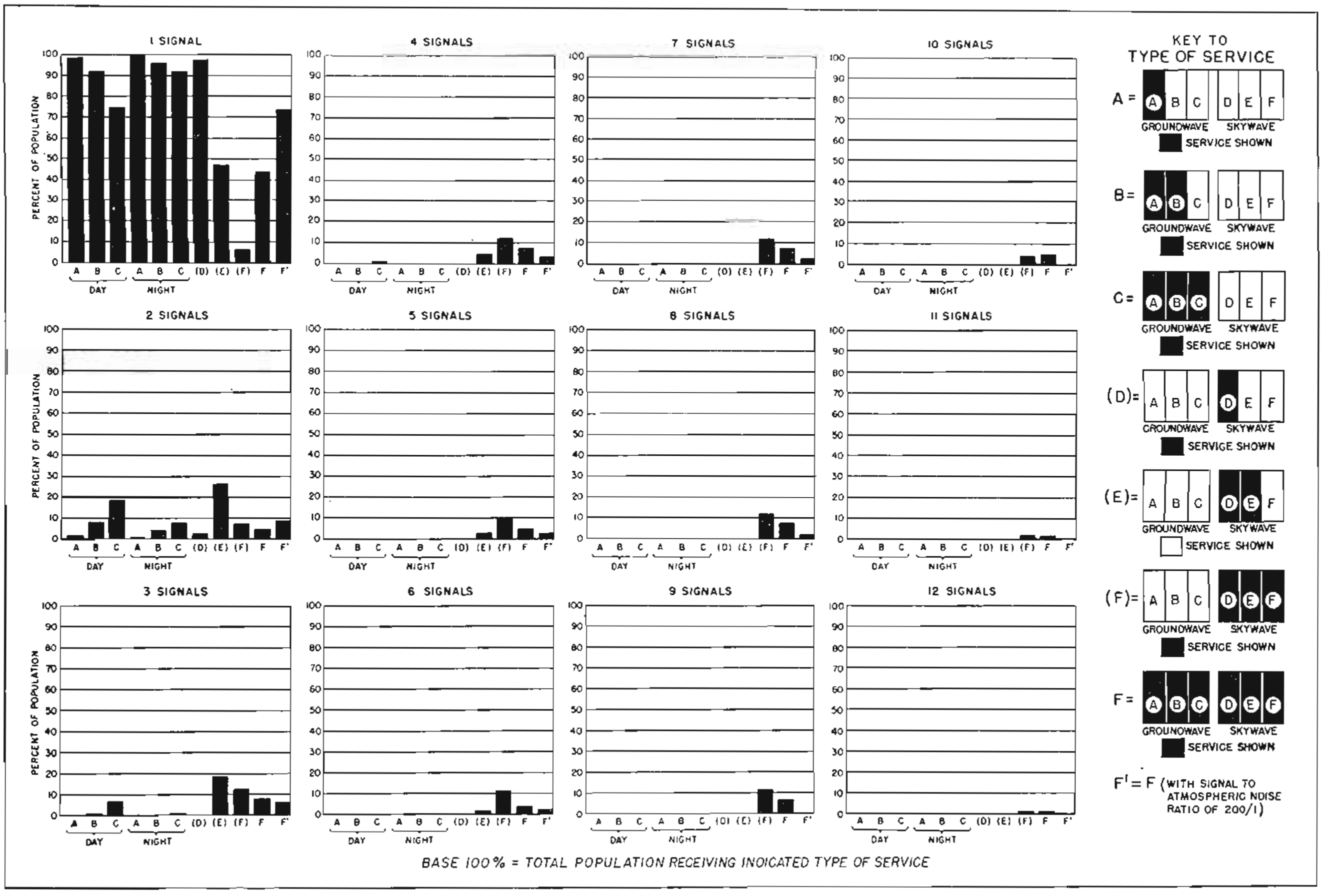


Fig. 4—Various types of NBC service by number of signals

It is expected that the FCC will lift the present limit.

The final witnesses to be heard were: M. S. Novik, NAEB; M. Hanna, WHCU; I. K. Tyler, WOSU; J. W. Dunn, WNAD; R. B. Hull, WOI; M. L. Jansen, WCAL; B. Paulu, KUOM; H. H. Leake, KOAG; R. Coleman, WKAR; S. Segal, WNYC. V. A. Sholis, director of CCBS, gave testimony that summarized the CCBS position.

Outline Objectives of International Conference

• A foundation for the International High Frequency Broadcast Conference to be held in Mexico City later this year was laid in the final sessions of the international conferences last summer in Atlantic City. When the conferences are resumed in Mexico City, they will be a continuation of the Atlantic City conference. The scope of the international meetings was recently explained by former FCC chairman Charles R. Denny, who said in part:

"When the history of this radio conference has been written, I believe that three principal aspects of its work will stand out:

"First, we will have adopted a worldwide allocation of bands of radio frequencies up to 10,500,000 kilocycles. The 1938 Cairo allocation table stopped at 30,000 kilocycles.

"Second, we have planned practical machinery for putting the new allocation table into effect. Until now every country using frequencies simply notified the headquarters of the Union of the assignments made by it and these assignments were entered on a master list with dates of notification and first use of the frequency assigned. There was no concerted international effort to make arrangements which would best conserve spectrum space. There was no planned sharing of frequencies on a time basis or a geographical basis. To meet this need we are providing for sessions of technical experts to engineer assignments on a worldwide basis.

"Third, we will have provided for a permanent board of experts—the International Frequency Registration Board which, starting with the newly engineered list, will consider every future assignment to determine whether the assignment will cause international interference.

"The second conference in chronological order was the Plenipotentiary Conference which convened last year. Its task was the revision of the Madrid Convention, the basic treaty which lays down the broad principles on which the technical regulations are founded.

"In the Plenipotentiary conference we have provided for a permanent organization which can cope with international problems from day to day as they arise. The United Nations has recognized our Union as the specialized agency for international communications."

Pulse Rise Time Response Chart

By A. J. BARACKET, Studio Development Section Allen B. DuMont Laboratories, Inc.
Passaic, N. J.

Design aids for single stage video amplifiers to meet high frequency response and rise time requirements

• Since a unit step has been found so useful in analyzing the transient response of a video frequency amplifier, pulses approximating step waves are helpful in determining transient response experimentally. A comparison is made between the output of the amplifier and its input on an oscilloscope and the time of rise of the pulse represents the amplifier's deterioration at the high frequencies. The pulse tilt showing up in the output wave represents the amplifier's deterioration of the low frequencies.

Consider the uncompensated RC coupled amplifier stage shown in Fig. 1. The effect of high frequencies on the amplification is a function of the value of the RC time constant formed by the plate load resistor R_L (in parallel with the tube plate resistance) and the stray shunt capacities shown lumped as C_s. The greater this time constant the poorer the high frequency response and consequently the greater the time of rise of the step wave or pulse.

Equivalent Circuit

Fig. 2 shows the equivalent circuit at high frequencies for this uncompensated RC coupled amplifier. On a node basis, the differential equation is

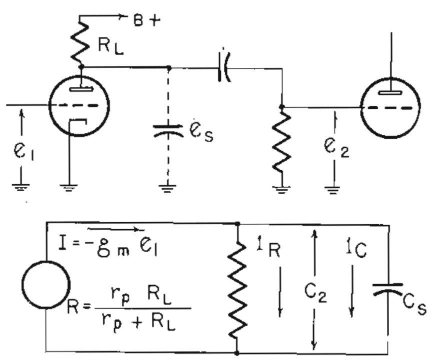
$$-gm\, e_1 = \frac{e_2}{R} + C_s \frac{de_2}{dt},$$

where e_1 represents a unit step.

Solving this relation gives

$$e_2 = g_m R(1 - \epsilon^{-\frac{t}{RC_s}})$$

For a pentode, and for a triode with r_p much higher than R_L, R may



Figs. 1 and 2—Above circuit used as basis of response analysis, with its electrical equivalent shown below

be approximated R_L. If E represents the final value of $g_m R$, designating e_2 by e, and C_s by C, $e/E = 1 - \epsilon^{-t/RC}$, or $t = RC \log_\epsilon (1 - e/E)^{-1}$

The frequency (f_H) at which the amplitude vs. frequency response characteristic is down 3 db is given by: $f_H = 1/(2\pi RC) = \log_\epsilon (1 - e/E)^{-1} \div 2\pi t$

Nomographic Solution

These relations permit an alignment chart to be made up for use in computing the RC required to give a maximum specified time to rise to a fraction e/E of the final pulse value E. Conversely, it may be used to determine the rise time that will be obtained from a given combination of load resistor and stray capacities.

The chart also gives the relationship between time of rise and high frequency cutoff of an amplifier. This relationship is $t_{90} - t_{10} = RC \log_\epsilon .9/.1 = 2.2\, RC$

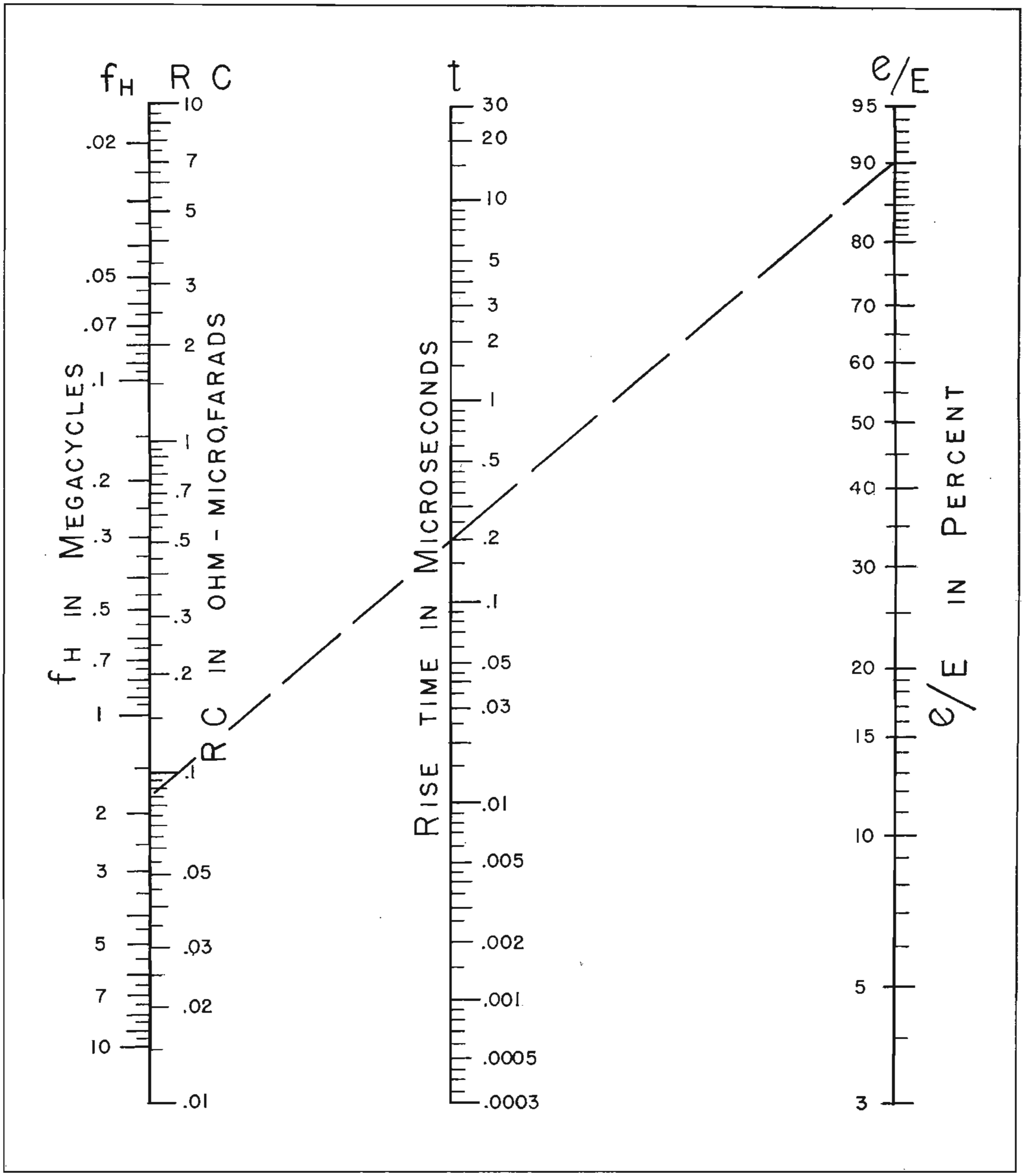
Example of Use: 0.2 microseconds is specified as the maximum time for the amplitude of an amplified step to rise from 0 to 90% of the final value. The maximum plate circuit time constant that may be used and the corresponding high cutoff frequency is obtained using a straight edge with the chart. Connect the 90% point on (e/E) scale of the nomograph with the 0.2 microsecond point on the (t) scale. The straight edge crosses the RC scale at approximately .086 ohm-μf. If, for example, C_s is 30 μμf, R_L must be no greater than 2870 ohms. f_H is found to be 1.87 mc.

Pulse Rise Time

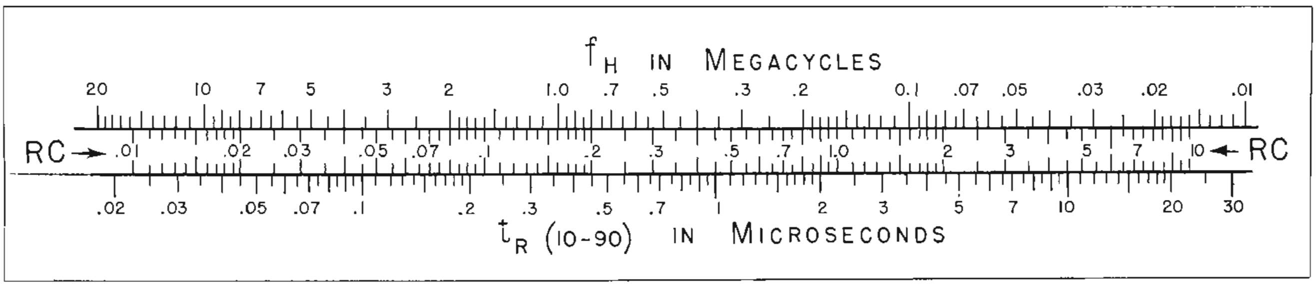
In television work, pulse rise time usually is specified in terms of the time required for the amplitude to rise from 10% to 90% of the final value. A special scale shown horizontally below gives relationships between either plate RC time constant or high frequency cutoff, and pulse rise time from the 10% to 90% amplitude points.

For example, an amplifier stage has a plate load resistor of 5000 ohms and the total shunt capacity is 40 μμf. What will be the time of rise of an amplified pulse from 10% to 90% amplitude points? Here RC = 5000 x .00004 = 0.2 ohm-μf. Opposite this value on the lower scale the t_{R10-90} scale reads approximately 0.44 microseconds, the required time rise.

Illustrations on opposite page show: Above, Nomographic solution for RC requirements to meet given circuit conditions. Below, relationships between the frequency (at which response is down 3 db), RC and the rise time are shown on adjacent scales



fH RC
t
e/E
fH IN MEGACYCLES
RC IN OHM - MICROFARADS
RISE TIME IN MICROSECONDS
e/E IN PERCENT



fH IN MEGACYCLES
RC →
← RC
tR (10-90) IN MICROSECONDS

Monitoring 'scope for Television Production Lines

By R. DE COLA, Chief Engineer,
Telequip Radio Co., Chicago*

Equipment produces synchronizing, driving and blanking signals useful for research and development work and for routine testing

• The first large scale application of cathode ray oscillographs to production problems was by the radio receiver manufacturers, where the unique features of a visual check system were quickly recognized. From this start the same methods rapidly were adopted by the radio service industry and modified versions were made available for their particular use.

Television receiver production has the same problems, but they are many times more intricate than with broadcast receivers, and so new oscillographic equipment has been developed to take care of these particular needs. A lot of time is required to test a television receiver and any special features incorporated in the oscillograph to facilitate the work lower costs.

Fig. 1 shows a production line monitoring oscilloscope particularly arranged for such tests, developed by Telequip. It features a method of trace separation. To do this the output of a 30 cps 50-50 wave is used to separate the odd and even lines of a television pattern signal. A cathode circuit output of a 30 cps multivibrator V3 of Fig. 2 drives a two-stage amplifier comprising the two parts of V2. The cathode of the output section of V2 is common to that of the video amplifier, tube cathode V4.

Two separate vertical input signals can be injected simultaneously for observation with the same time base, each with its own attenuators. These input attenuators are connected through cathode-coupled tubes to separate frequency extended amplifier tubes. The plate circuits of these tubes are parallel-connected to V-5, which is cathode-connected to a balancing tube V-6.

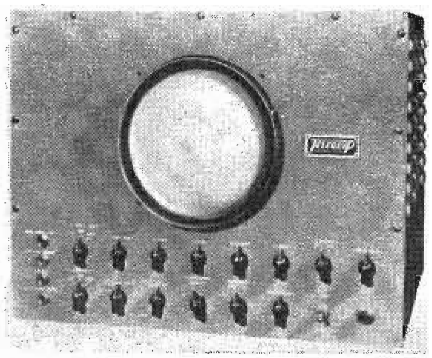


Fig. 1—Monitoring scope panel for production line tests and TV station control contains controls for attenuation and gain on the two input channels and trace separation, as well as the usual controls provided on an oscillograph

The cathodes of V5 and V6 have a common unbypassed cathode load, and the control grid of tube V6 is kept essentially at ground potential. Thus V5 and V6 are essentially driven in push-pull and are coupled to the vertical deflection plates of the 7GP4 cathode-ray tube. The responses of the two channels are essentially identical each having a sensitivity of 0.5 volts RMS per inch of vertical deflection, and uniform response from 30 to 4,000,000 cps. Maximum vertical deflection is approximately 3 in.

The synchronizing pulse for the 30 cycle multivibrator tube V3 is obtained from the 60 cycle pulse which is ultimately converted to a sawtooth voltage wave to produce horizontal deflection. The horizontal time axis may be controlled from either the internally-formed pulses or by the injection of external horizontal sweep voltages.

Phase-shift control is provided to allow full 360° phase rotation of the 60 cycle sawtooth horizontal time base. The phase shift control has four symmetrically disposed taps, which are connected to voltage sources which are essentially in quadrature, (at bottom of Fig. 2) making available a voltage of constant amplitude but variable phase depending upon the rotation of the contact arm. This voltage is impressed upon the grid of V7. Additional amplification in the second section of this tube and in the second section of V8 changes the 60 cycle sine wave into a square wave with moderately steep sides. This square wave is then differentiated by means of an RC circuit with an .0015 mfd capacitor connected from the plate of the second section of V8 (pin 2) in conjunction with a one megohm resistor.

The output of the first section of V8 is now a single narrow pulse of approximately 2% duration time, having a negative polarity (the positive peak being clipped off by section 1 of V8). This pulse is impressed upon the grid of section 2 of V9 having a plate circuit acting as an integrator consisting of a 1 mfd capacitor to ground, and the 82,000 ohm resistor from the plate to the 250 volt dc supply.

The sawtooth voltage waveform which appears on pin 2 of V9 is then coupled to the No. 1 grid of V10, its magnitude being controlled by the two megohm potentiometer, which constitutes the horizontal gain control. The second section of V10 pro-

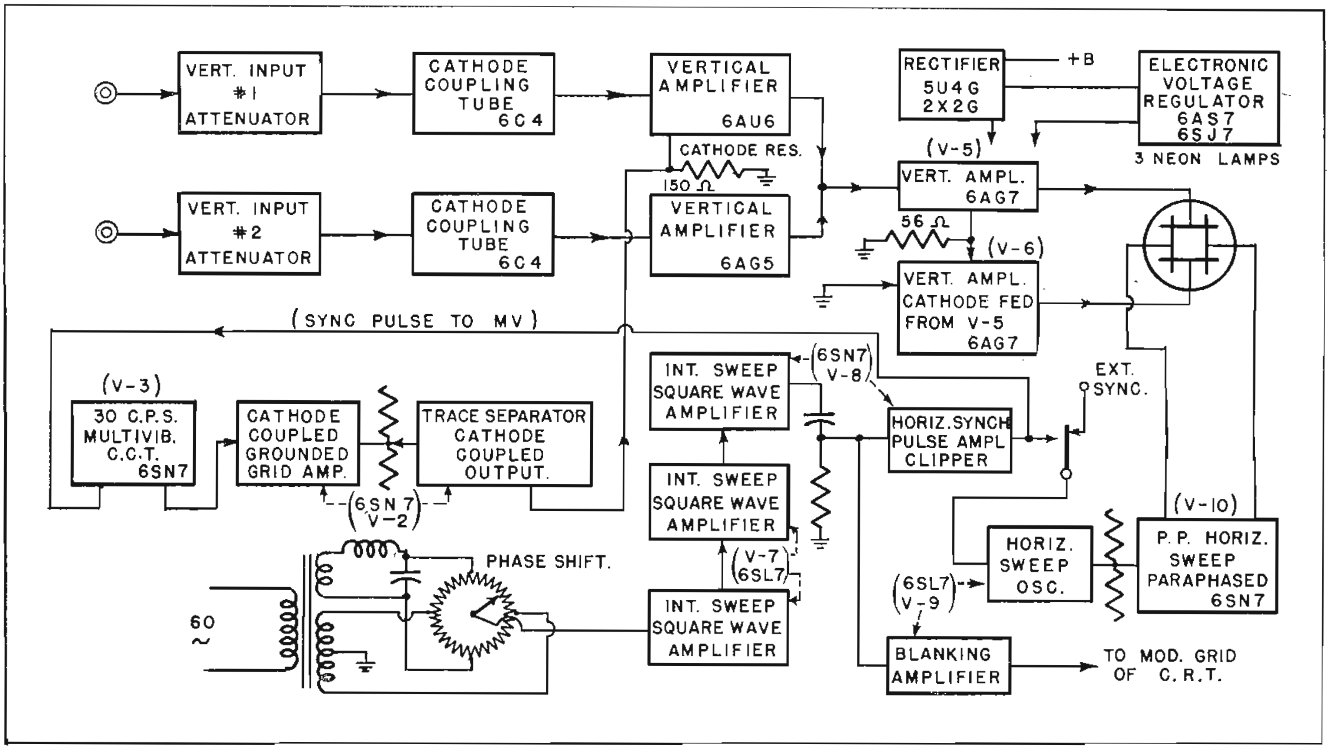


Fig. 2—Trace separation permits simultaneous observation of two signal channels, a feature of this oscilloscope

vides additional amplification for the horizontal deflecting plates of the 7GP4 cathode-ray tube.

When the block-out ON-OFF control, a two position rotary switch, is in the OFF position the horizontal time base is approximately 98% of a full cycle wave in duration, which allows observation of relatively slow phenomena. However, when this switch is in the ON position the horizontal time base is approximately 2% of a full 60 cycle wave in duration, allowing observation of much faster phenomena. When in this position approximately six horizontal lines may be observed upon the horizontal time base. This switch impresses on the control grid of the 7GP4 a 2% positive pulse, which with suitable reduction in the intensity control, allows only the retrace portion (the 2% portion) of the 60 cycle sawtooth wave to be observed.

It should be observed that the horizontal sweep direction is a function of the position of the block-out switch. With the block-out switch "OFF" the sweep direction is from right to left; with the block-out switch "ON" the sweep direction is from left to right. Another control switch is provided to connect the control grid of the 7GP4 to a jack located on the front panel to permit the injection of synthetic signals upon the control grid of the cathode ray tube when required.

Besides its use in checking amplifier characteristics this oscilloscope also finds wide application in the development and testing of television scanning oscillators, using the high speed trace (2%) and the trace separation so that the firing time of the horizontal and vertical oscillators with respect to the initiating synchronizing pulse can be examined.

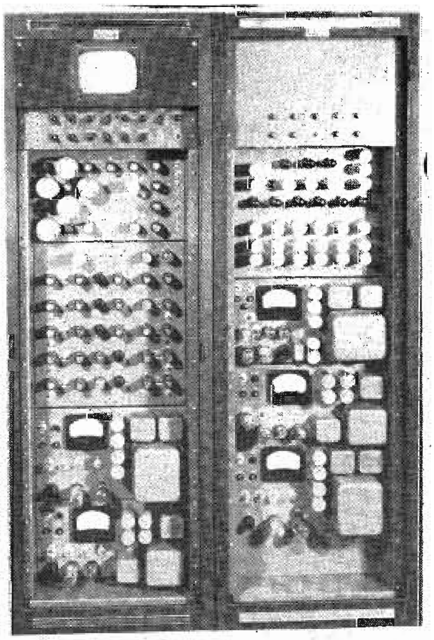


Fig. 3—Monitoring oscilloscope shown with Telequip sync generator and monoscope picture generator for checking test signals

By the use of the phase control, individual cycles of both fields may be examined, especially in the vertical blanking region, where poor synchronization is most likely to occur, and incidentally least likely to be observed upon the face of a picture tube. The phenomena of poor or random interlace can be easily observed by use of this oscilloscope and consequently the solution or cure of this particular problem may then be more readily remedied.

The dual input channels in conjunction with the associated mixing wide band amplifiers allow the examination in two different circuits. This permits observation of the phase and amplitude relations of various pulses or wave forms. This feature has also given valuable service in the adjustment and calibration of television synchronizing generators, such as that shown in Fig. 3. It is possible to observe the positions of the various signals which comprise the composite television signal and the various processes of clipping, integration, differentiation and sync. separation may all be studied with the aid of this oscilloscope.

Graphical Analysis of Speakers and Microphones

By A. J. SANIAL, Consulting Engineer*

Manual-electronic curve tracer eliminates need for making tedious point-by-point plots of frequency characteristics

• Although automatic graphic recorders have been used since the early days of the electrical art, means suitable for handling the frequency ranges and more rapid amplitude fluctuations encountered in plotting the characteristics of communication equipment were not extensively used until much later. There are many applications in this and other industries where a manually-operated continuous curve tracer will save the time of technical personnel and permit more thorough and exact analysis of the results. A quicker answer in development problems results from avoiding tedious plotting of performance curves as in analyzing loudspeakers, microphones, etc. Moreover, manual operation permits the operator to vary the paper speed at any point where wide amplitude fluctuations occur.

We therefore undertook the development of such a manual curve tracer in our laboratory, incorporating improvements in design to make greater accuracy possible in tracking, and to allow flexibility in the choice of meters that could be used. The need for varying the ratio between meter scale range and pen range, without having to redesign the whole tracking mechanism was also taken care of.

The results of this development have been highly satisfactory. One model, shown in Fig. 1, consists of a drum geared to a handwheel to which a sheet of cross-section or recording paper can be affixed. This drum motion is also transmitted by a cable drive, to a device which provides the independent variable. This independent variable can be produced by almost any apparatus which can be made to provide a signal which is a known function of the drum rotation. Thus, an electrical oscillator dial may be rotated so as to furnish a variable frequency signal to the equipment being tested; a variable transformer shaft may be turned to produce calibrated voltage changes; a calibrated optical wedge could be rotated between a known light source and a photocell device whose characteristics were to be found, etc. The unit is shown coupled to an audio oscillator.

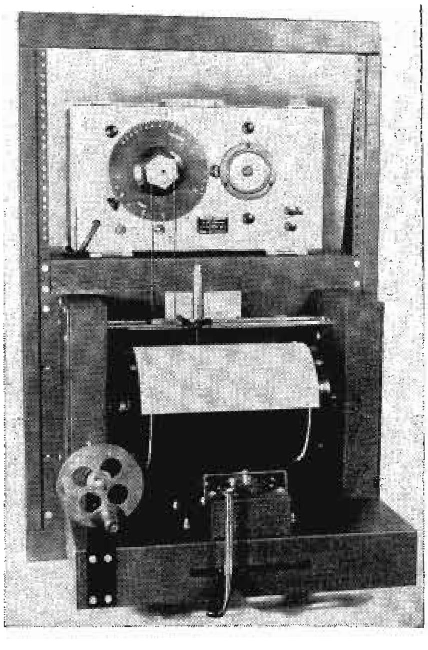


Fig. 1—Sanial curve tracer rack mounted with and coupled to BFO

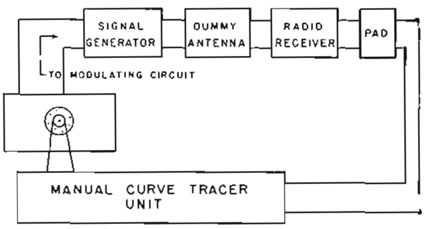


Fig. 5—Test set-up for checking receiver fidelity

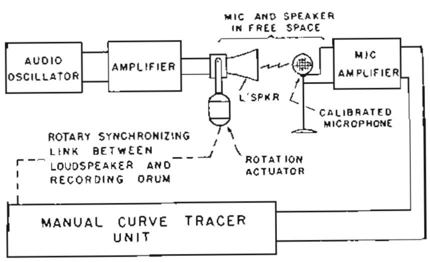


Fig. 6—Measurement of loudspeaker polar pattern with tracer

The second portion of the instrument is a manually-operated follow-up tracking mechanism. This permits the variations of a meter needle to be followed by a pointer, the motion of the tracking pointer being transmitted through a mechanical linkage to a sliding carriage which carries a pen. Hence the pen traces a line proportional to the meter deflection across a paper affixed to the drum, this movement being normal to the motion of the drum's rotation. The variations in the output of the device being tested are, after conversion to suitable electrical signals, impressed on this meter. Large scale, easily readable, curves can be traced, as the drum accommodates standard letter-size, or even larger, paper, which is easily placed taut on the drum.

The curve tracer and BFO combination, used primarily for taking frequency response curves of loudspeakers, microphones, amplifiers, etc. is shown in the block diagram,

*168-14 *32nd Avenue, Flushing, N. Y.*

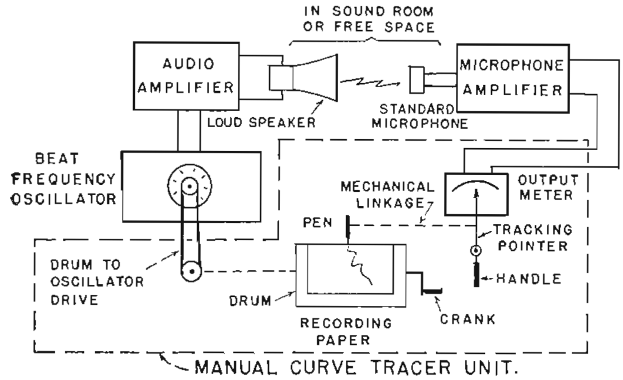


Fig. 3—Block diagram of main components in acoustical test set-up

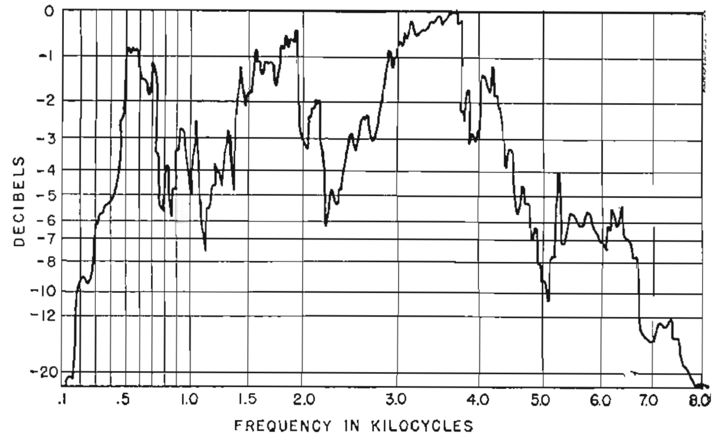


Fig. 4—Speaker response characteristic made in a few seconds by curve tracer

Fig. 3, with a typical curve from a loudspeaker, Fig. 4. Fig. 2 shows how the tracer is operated, and also the method of setting up a loudspeaker and microphone for acoustic measurements although it is understood that the latter must be placed in an acoustic sound-room, or in an outdoor location free of reflections, high noise level, etc.

Fig. 5 illustrates how the curve tracer may be used to measure receiver fidelty characteristics, and the set-up in Fig. 6 plots the polar diagram of a loudspeaker acoustical output. Many other uses may be found for the graphic recorder, some of which are listed as follows: (1) microphone frequency response from artificial voice; (2) headphone response on artificial ear; (3) audio amplifier or network response; (4) constant current loudspeaker equivalent impedance versus frequency; (5) amplifier overload characteristics and (6) polar directivity of a beam antenna.

A standard 3 in. decibel meter is used, although provision is made in the design so that almost any meter up to 4 in. square can be used. If the ordinary db meter, with its nonlinear scale, is not satisfactory in some applications, due to the excessive scale compression at the low end, a special db meter, with a substantially linear logarithmic scale of about 20 db, can be procured. Applications requiring a linear logarithmic scale covering 30 decibels or more can make use of a microammeter actuated by one of the electronic voltmeter circuits that have an output voltage proportional to the logarithm of the input voltage.

There have been many graphic recorder designs which incorporated elaborate and complicated electro-mechanical systems to interpret the message of the delicate sensing element. But added components and circuit complexity only increase the susceptibility of the system to erratic operation and breakdowns. Since the operator is on hand to conduct the experiment anyway, he may as well be doing something useful.

Although the first reaction to a device requiring the use of both hands and visual controlled follow-up is that it is awkward and difficult to master, the opposite is actually the case. Any normal person can use the instrument with ease after tracing a few trial curves, and from then on the manipulation becomes almost automatic. The practical result is that once a laboratory becomes accustomed to its use, it will never go back to the point by point method, if it can be avoided. Indeed, it is the tendency of the technical personnel to devise certain extensions or accessories to enable them to use the curve tracer on other jobs.

This graphic recorder can be mounted in a 19 in. relay rack. It is 14 in. high and 13 in. deep. The db meter and the bakelite drum are the most expensive components, coming to about thirty dollars. Total cost of all parts is in the neighborhood of one hundred dollars, although a number of these parts are specially machined.

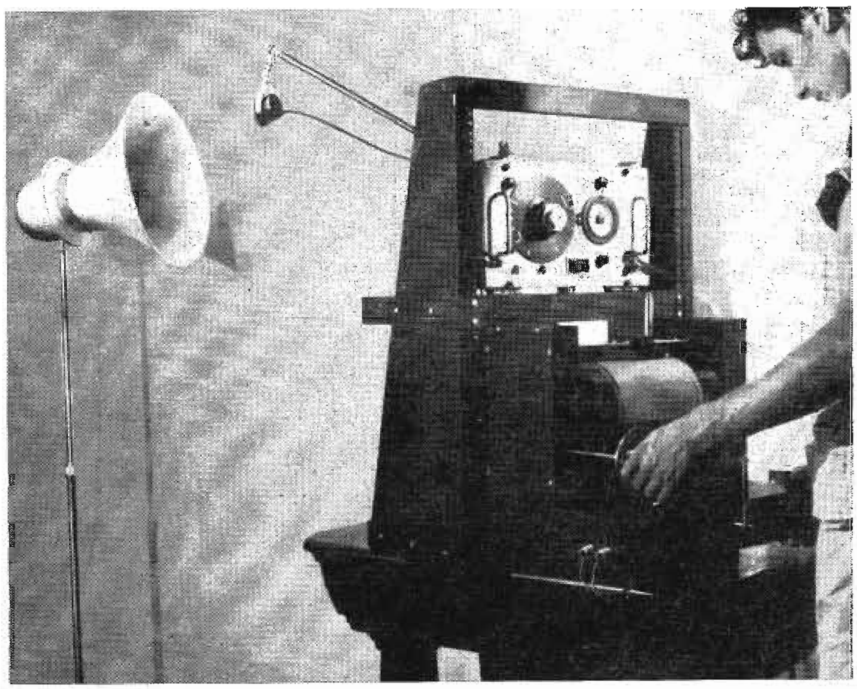


Fig. 2—Test set-up for rapid plotting of loudspeaker frequency characteristics

Frequency and Modulation Monitor for TV and FM

By C. A. CADY, Engineer
General Radio Co., Cambridge, Mass.

Pulse-count detection circuit used for high-quality demodulation of FM Signal—Frequency ranges from 30 to 162 mc and 160 to 220 mc

• The new General Radio type 1170-A FM monitor incorporates the pulse-counter circuit for high-quality demodulation of a frequency-modulated wave. Unlike the tuned-circuit discriminator, the pulse-counter detector is inherently linear and can operate over a wide range with a minimum of critical circuit elements. Moreover, excellent stability is achieved using standard circuit components.

The functional arrangement of the monitor is shown in Fig. 1. A harmonic of a crystal oscillator beats with the incoming signal to produce an intermediate frequency of 150 kc. This low intermediate-frequency operation produces a maximum ratio of modulation swing to center frequency, thus resulting in a maximum sensitivity of the system. This beat passes through amplifiers and limiters to a counter-type discriminator. The dc output of the discriminator actuates the center-frequency indicator, while the ac output, after suitable filtering, operates the modulation indicators and furnishes a signal for distortion and noise measurements, as well as for audio monitoring.

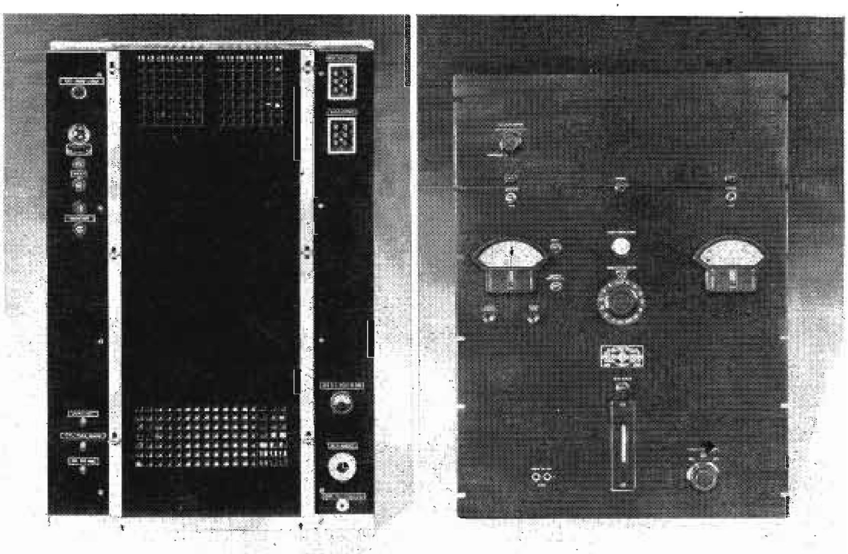
The discriminator is shown in elementary form in Fig. 2. The two diodes are connected in parallel but in opposite sense. The time constants of the RC circuits are made small compared to the time of one-half cycle of the intermediate frequency, so that the condenser is charged to the peak value of the square-wave and then completely discharged, during each half-cycle. The output of the discriminator, which appears across the resistor R_2 in series with the righthand diode, consists of unidirectional pulses of constant shape and amplitude.

When the transmitter is unmodulated, the discriminator output has a dc component equal to the average value of the voltage across R_2 and a series of ac components at the pulse repetition frequency and its harmonics. The dc component varies linearly with the transmitter frequency and consequently can be used to actuate the center-frequency indicator.

When the transmitter is frequency modulated, the pulses are "bunched up" or "spread out" when referred to a time base. The dc component is not affected by the modulation except to the degree by which the average, or center, frequency changes under modulation. Modulation also produces in the discriminator output components of the modulation frequency, which are used to operate the modulation indicators and to feed the audio output circuits of the monitor.

With one exception, vacuum-tube diodes are used throughout the monitor rather than crystal rectifiers. Crystals are not yet commercially available with characteristics as uniform as those of tubes. In particular, crystals exhibit a fluctuation with time in the ratio of front-to-back resistance, which precludes their use in circuits where long-period stability is desired. The single crystal rectifier used in the monitor operates the rf level indicator and the warning circuits and supplies the bias on a control tube. For these functions, variations in characteristics have little effect.

The FCC has required the use of the standard 75 microsecond de-emphasis network in the measuring instruments. This results in a flat frequency response for the entire system between the transmitter



General Radio Type 1170-A for TV and FM

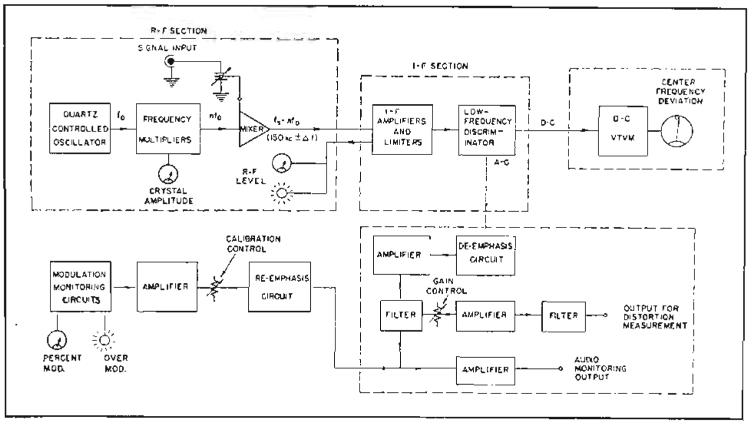


Fig. 1—Functional block diagram of the monitor

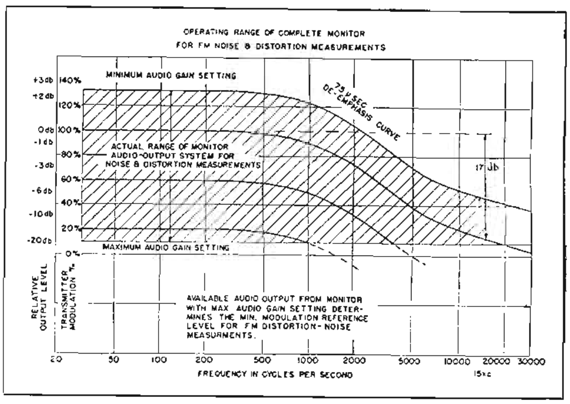


Fig. 3—Operating range of the monitor for distortion and noise measurements

audio input and the measuring device, and so duplicates the conditions actually obtained between studio microphone and home receiver output. Measurements of noise and distortion are, however, referred to a given modulation percentage and frequency. The output voltage available for operation of the distortion and noise meter is thus reduced at the high audio frequencies, and this limits the minimum modulation at which distortion measurements can be made. Fig. 3 shows this characteristic.

The very low distortion levels that will normally be measured in FM transmitters impose rigid requirements on all units of the measuring system, and these include (1) the test oscillator, (2) the FM monitor, and (3) the distortion meter. For this reason it is highly important to keep the residual distortion in any one unit as low as possible, since the minimum indicated level may equal the sum of all components in the system. Cancellation effects may reduce the indicated level below this amount, but, by the same token, readings of the transmiter may be incorrect, should its level be so low as to approach the residual level of the measuring instruments.

The monitor is arranged mechanically so that the various circuits are segregated through the use of individual chassis assemblies. This makes all parts accessible and facilitates maintenance and tube replacements.

The new monitor gives (1) a continuous indication of center frequency without the necessity of frequency-calibration checks; (2) an indication of percentage modulation (positive, negative, and full-wave) and a flashing-lamp indication of over-modulation; (3) a high-fidelity output for distortion measurements — less than 0.2 per cent distortion introduced by monitor; (4) a 600-ohm circuit for audio monitoring; (5) the monitor is designed for television audio service as well as for FM broadcasting.

SPECIFICATIONS:

Transmitter Frequency Range: 30 to 162 mc with type 1170-P1 rf tuning unit; 160 to 220 mc with type 1170-P2 rf tuning unit.

Input Sensitivity: 1 volt rf or better.

Discriminator: Pulse-counter type linear to better than 0.05% over a range of ±100 kc (133% modulation).

Center Frequency: Indication: Meter is calibrated in 100-cycle divisions from —3000 to +3000 cycles per second. No zero set is necessary for each reading, and no second crystal is provided. Accuracy: Crystal frequency, when monitor is received, is within ±10 parts per million of specified channel frequency. Zero reading is adjustable over ±3000-cycle range to bring monitor into agreement with frequency-measuring service. Center-frequency indication is then accurate to ±200 cycles per second.

Percentage Modulation: Indication: Meter is calibrated from 0 to 133%. Additional db scale is provided. Switch selects positive or negative peaks or full-wave (peak-to-peak) indication. One hundred per cent modulation corresponds to 75-kc deviation for FM bands. Single internal adjustment of meter circuit changes calibration to read 100% at 25-kc deviation for television audio monitoring. Meter ballistics meet FCC requirements.

Output Circuits: Distortion and Noise Measurements: Terminals are provided for connecting a Type 1932-A distortion and noise meter, and a gain control is provided. Residual Distortion: Less than 0.2% at 100-kc swing (±133% modulation). Response: 50 to 30,000 cycles per second ±½ db. Standard 75-microsecond deemphasis circuit is included. Residual Noise Level: —75 db or better referred to 75-kc deviation; —65 db or better for 25-kc deviation.

Audio Monitoring Output: Impedance: 600 ohms, unbalanced. Output: Zero dbm at 75-kc deviation (100% modulation).

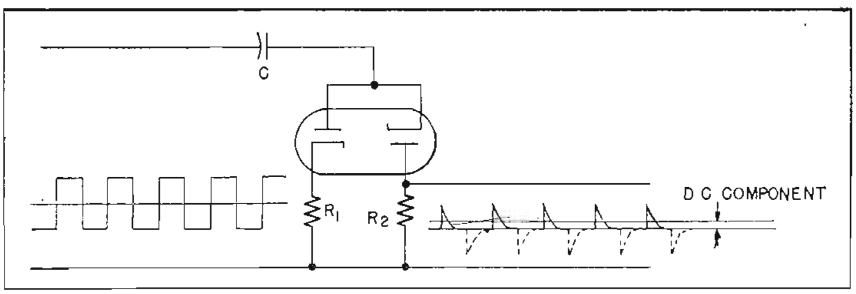


Fig. 2—Elementary schematic of discriminator with input waveform (left) and output waveform (right)

Circuit Design for Gas-Discharge Regulator Tubes

By WILFRED G. HOYLE, Electrical Engineering Branch
National Research Council, Ottawa, Canada

Graphic presentation of formulas derived to insure that all types of tubes are operated within their prescribed ratings

A formula is derived which insures that the tubes are always operated within their ratings, and carry no greater tube current than is necessary. The general effect of the formula is to limit the minimum permissible supply voltage. For the common regulator tube (types VR75, VR105, and VR150) simple versions of the formula are obtained and are presented in the form of nomograms which should cover the majority of practical cases.

• Voltage regulator tubes of the gas-discharge type are generally used in the circuit of Fig. 1. The choice of circuit parameters is subject to the following three considerations:

(1) The tube current must at all times lie in the range between the maximum and minimum values specified by the manufacturer.

(2) If, for some reason, the full range of tube current is not used, it is preferable to reduce the maximum value and keep the lower limit unchanged.

(3) The per unit (or percentage) variation of the supply voltage is known. Generally, this will be the variation in the 115 volt ac line, from which the dc power is most commonly obtained.

The required output voltage E_o determines the tube type; knowing the tube type, we determine $I_{(max)}$ and $I_{(min)}$ from the manufacturer's data. The factors $I_{o(max)}$ and $I_{o(min)}$ depend on the nature of the load, while k, recall, is known from the character of the power source. Knowing these, then, the problem is to find suitable values for E_i and R. We proceed as follows:

Minimum tube current occurs when the supply voltage has its minimum value and the load current is a maximum; this condition we write as: (1)

$$E_i(1-k) = E_o + R\,[I_{(min)} + I_{o(max)}]$$

Maximum tube current is obtained with maximum input voltage and minimum load current. That is (2)

$$E_i(1+k) = E_o + R\,[I_{(max)} + I_{o(min)}]$$

We show next that the limitation on the maximum permissible value of the tube current sets a minimum limit to the permissible input voltage; this, of course, is fairly obvious, physically. Combining equations (1) and (2), eliminating R, and rearranging, we obtain

$$\frac{I_{(max)} + I_{o(min)}}{I_{(min)} + I_{o(max)}} = \frac{E_i(1+k) - E_o}{E_i(1+k) - E_o} \quad (3)$$

Since k is inherently positive, the fraction which represents the right side of this equation is always greater than unity; also, any reduction in E_i decreases the numerator at least as much as the denominator. The result, therefore, of any decrease in E_i, will be an increase in the overall value of the fraction. Since the other three currents are fixed, $I_{(max)}$ must increase as E_i decreases, if the equation is to hold. When $I_{(max)}$ is equal to the manufacturer's rating, then E_i may not be decreased further.

For design purposes, equation (3) is preferably rearranged as follows: (4)

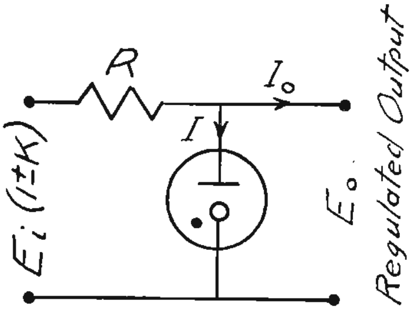
$$E_i = \frac{E_o}{1 - k\,\dfrac{I_{(min)} + I_{(max)} + I_{o(min)} + I_{o(max)}}{[I_{(max)} - I_{(min)}] - [I_{o(max)} - I_{o(min)}]}}$$

The limiting case of this equation, when $I_{(max)} = I_{rated}$, and $E_i = E'_i$, we write as (5)

$$E'_i = \frac{E_o}{1 - k\,\dfrac{I_{(min)} + I_{rated} + I_{o(min)} + I_{o(max)}}{[I_{rated} - I_{(min)}] - [I_{o(max)} - I_{o(min)}]}}$$

All the quantities on the right of equation (5) are known and it can be solved to obtain E'_i. Next.

Fig. 1—Basic voltage regulator circuit



List of Symbols

E_o — Output voltage (regulated)
E_i — Supply voltage
E'_i — Minimum permissible supply voltage
k — Per unit variation in the supply voltage
R — Regulating resistance
$I_{(max)}$ — Maximum tube current
I_{rated} — Maximum permissible tube current
$I_{(min)}$ — Minimum tube current (also permissible minimum)
I_o — Regulator output current
$I_{o(min)}$ — Minimum required output current
$I_{o(max)}$ — Maximum required output current

VOLTAGE REGULATOR TUBE TYPES
VR75-VR105-VR150

Depending on type of load, use Fig.2 or Fig.3 to determine minimum permissible supply voltage. For any supply voltage equal to, or greater than this minimum, Fig.4 then gives the correct value of regulating resistance.

Fig.4 Required regulating resistance R for any supply voltage E_i.

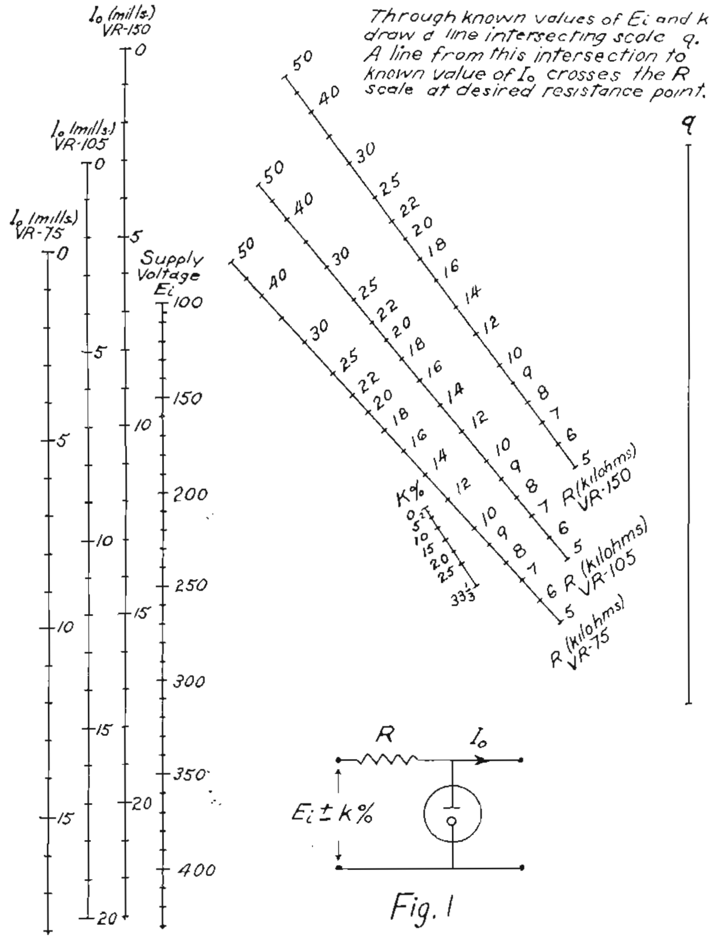


Fig. 1

Fig.2 Minimum permissible supply voltage when load current is constant.

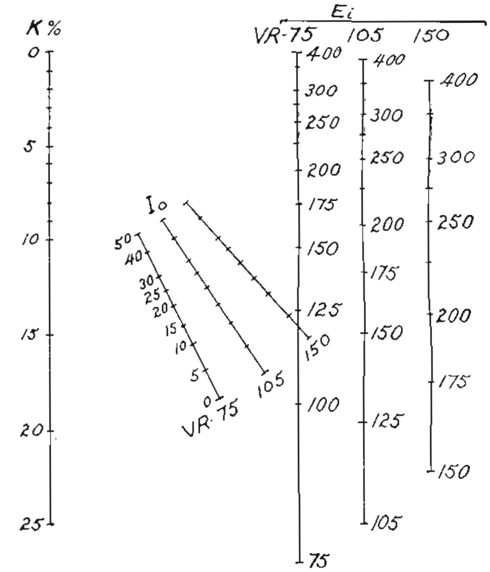
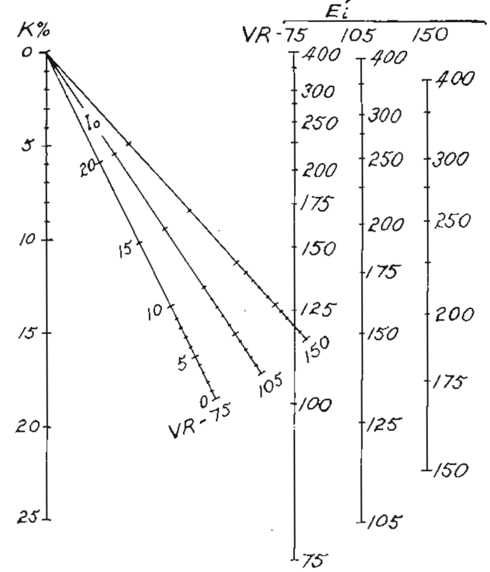


Fig.3. Minimum permissible supply voltage when load current varies between I_o and zero.



any convenient value of E_i, equal to, or greater than E'_i is chosen and inserted in equation (1) to obtain R; the design is then complete.

Since, for convenience, the value of E_i selected is usually greater than E'_i, $I_{(max)}$ is usually less than I_{rated}. If, for some reason, the value of $I_{(max)}$ is wanted (it is not needed), it can be obtained by inserting in equation (4) the value of E_i actually used.

Equation (5) has two special cases, which, because of their common occurence, are of particular importance:

Case A. Load current constant.

For this type of load, $I_{o(max)} = I_{o(min)} = I_o$ and equation (5) becomes

$$E'_i = \frac{E_o}{1 - k\,\dfrac{I_{(min)} + I_{rated} + 2I_o}{I_{rated} - I_{(min)}}} \qquad (6)$$

For the three common regulator tubes VR75, VR105, and VR150, equation (6) reduces to

$$E'_i = \frac{E_o}{1 - k\,\dfrac{35 + 2I_o}{25}} \qquad (7)$$

where the values 30 milliamps and 5 milliamps have been used for maximum and minimum tube current ratings.

Case B. Load current may be reduced to zero.

In this case $I_{o(min)} = 0$ and equation (5) becomes

$$E'_i = \frac{E_o}{1 - k\,\dfrac{I_{(min)} + I_{(max)} + I_{o(max)}}{I_{(max)} - I_{(min)} - I_{o(max)}}} \qquad (8)$$

For the three tube types VR75, VR105, VR150, this reduces to

$$E'_i = \frac{E_o}{1 - k\,\dfrac{35 + I_{o(max)}}{25 - I_{o(max)}}} \qquad (9)$$

where, as before, 5 and 30 milliamperes have been used for the

(*Continued on page* 69)

Voltage Amplification Formulas

By HAROLD J. PEAKE, Naval Research Laboratory, Washington

• The amplification equations shown on the accompanying chart are derived by the use of the equivalent plate-circuit theorem. The capacitances due to tube and wiring are considered as negligible.

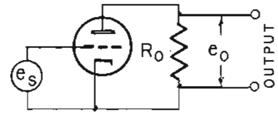
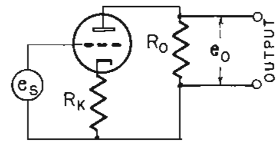
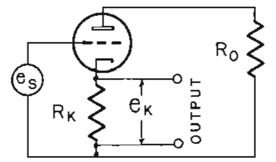
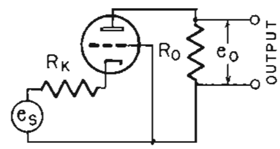
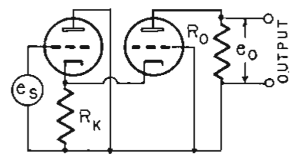
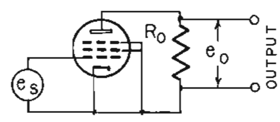
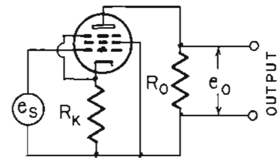
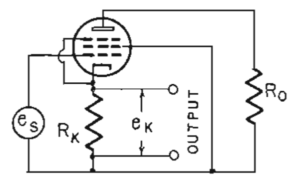
For the grounded-cathode pentode amplifier, the assumption that $r_p \gg R_o$ is made.

The formulas for the degenerative pentode and the cathode-output pentode amplifiers involve the use of two approximations: (1) the cathode current is not changed by a change in plate voltage (i. e., the plate conductance is zero), and (2) the grid-plate and grid-screen transconductances are in the same ratio as the dc plate current and the dc screen current.

The grid-cathode transconductance can be determined by addition of the grid-plate transconductance plus the grid-screen transconductance, and the screen-cathode transconductance by addition of the screen-plate transconductance and the screen conductance. The grid-plate transconductance is usually given in the tube data; however, the grid-screen transconductance, the screen-plate transconductance, and the screen conductance must be determined graphically from the tube characteristics.

List of Symbols

A = voltage amplification.
e_k = ac cathode potential.
e_o = ac plate load potential.
e_s = ac signal potential.
g^k_{G1} = grid-cathode transconductance.
g^{G1}_{G2} = grid-screen transconductance.
$g^P_{G1} = g_m$ = grid-plate transconductance.
g_{G2} = screen conductance.
g^k_{G2} = screen-cathode transconductance.
g^P_{G2} = screen-plate transconductance.
I_{G2} = dc screen current.
I_P = dc plate current.
μ = tube amplification factor.
R_K = cathode resistance.
R_o = plate load resistance.
r_P = tube plate resistance (ac).

TYPE	CIRCUIT	GAIN FORMULA
TRIODE: GROUNDED CATHODE		$A = \frac{e_o}{e_s} = -\frac{\mu}{1+\frac{r_P}{R_o}}$
TRIODE: CATHODE DEGENERATION		$A = \frac{e_o}{e_s} = -\frac{\mu R_o}{R_o + r_p + (\mu+1) R_K}$
TRIODE: CATHODE OUTPUT		$A = \frac{e_K}{e_s} = \frac{\mu R_K}{R_o + r_p + (\mu+1) R_K}$
TRIODE: GROUNDED GRID		$A = \frac{e_o}{e_s} = \frac{(\mu+1) R_o}{R_o + r_p + (\mu+1) R_K}$
TWIN TRIODE: CATHODE-FOLLOWER GROUNDED-GRID. (IDENTICAL TRIODE UNITS)		$A = \frac{e_o}{e_s} = \frac{\mu R_o (\mu+1) R_K}{r_p(r_p+R_o)+[(\mu+1)R_K][R_o+2r_p]}$
PENTODE: GROUNDED CATHODE		$A = \frac{e_o}{e_s} \cong -g^P_{G1} R_o = -g_m R_o$
PENTODE: CATHODE DEGENERATION		$A = \frac{e_o}{e_s} \cong \frac{g^K_{G1} \cdot R_o}{1+R_K(g^K_{G1}+g^K_{G2})(1+\frac{I_{G2}}{I_P})}$
PENTODE: CATHODE OUTPUT		$A = \frac{e_K}{e_s} \cong \frac{g^K_{G1}}{\frac{1}{R_K}+g^K_{G1}+g^K_{G2}}$

Survey of World-Wide Reading

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Measuring Life-Periods of Radioactive Substances by CRO

S. Rowlands (Nature, London, England, August 9, 1947, p. 191).

A cathode-ray oscillograph is used for the determination of the life-periods of short-lived radioactive nuclei. The method is based on the different radiations accompanying the transition from the original substance to the daughter substance and the subsequent transition from this daughter substance to a third substance.

The first radiation is intercepted by a Geiger-Muller counter and starts the swingle sweep on the oscillograph, while the second radiation, intercepted by a different suitably selective counter, controls the vertical deflection. The trace is provided with marks indicating equal, known time intervals.

Observations on the distribution of the pulses enable an estimate of the half-life of the radioactive daughter substance to be made. It appears that the coincidence method gives more accurate results. However, it is thought that the present method is adaptable for very short life-period measurements.

A 60-Cycle Modulator

O. J. M. Smith (The Review of Scientific Instruments, November, 1947, p. 855).

In a balanced modulator a dc or low-frequency voltage applied to the control grids is heterodyned with a 60-cycle voltage applied to the suppressor grids to provide a signal which can be readily amplified or presented on an oscilloscope. The circuit may also be used in connection with an ammeter for direct currents between 0.01 to 2.5 microamperes, provided the input impedance is a calibrated wire-wound precision unit. The modulator operates satisfactorily for inputs between one millivolt and one volt and from dc to 30 cycles per second.

Two 1620 tubes are connected as the balanced modulator; for signals smaller than 1 millivolt only one tube is used. A shielded transformer, which balances out the zero-signal 60-cycle component, feeds the output to a 6J4 connected as a selective amplifier by means of a 60-cycle parallel-T feedback network and a 120-cycle parallel-T series output network. For input signals exceeding 20 millivolts, this second stage may be made inoperative by a switch to avoid overloading of the 6J4.

Broadcasting Station I.N.R. in Brussels

F. Mortiaux, General Managing Director of the I.N.R.'s Technical Department (Documentation and Information Bulletin of the International Broadcasting Organization, November, 1947, pp. 1145-1157).

The technical equipment is decentralized and semi-automatic. Decentralization permits the amplifiers and control apparatus to be located near their respective studios; only the switching needs to be done from a central control room. There are 19 true studios, 5 recording cells, three transmitters, 5 recording machines, 2 general mixing panels.

Color Sensitivity of Phototubes

A. Cramwinckel (Journal of the Society of Motion Picture Engineers, December, 1947, pp. 523-529).

The color sensitivities of cesium-oxide, gas-filled, and vacuum phototubes, cesium-antimony vacuum phototubes, and selenium photovoltaic cells are compared with the surface brightness of the light from a tungsten ribbon lamp as a function of temperature. This comparison permits evaluation of the efficiency of a photocell used for scanning a sound track with a variation in the temperature of the lamp.

Measurements of the phototube current over a wide temperature range of the lamp filament were therefore made for the different phototubes studied. The relative galvanometer readings for the 4 types of tubes measured and the amount of radiated energy as well as the true and the color temperatures of the lamp filament are given in the table below:

T_{true}, °K	T_{color}, °K	Cs-Sb Vacuum	Selenium	Eye	Cs_2O Gas	Cs_2O Vacuum	Energy
1700	1718	(0.25)	(0.57)	0 73	1.65	(2.37)	13.7
1800	1820	0.68	1.32	1.61	3.20	4.33	18.4
1900	1921	1.68	2.86	3.32	5.76	7.39	23.8
2000	2023	3.76	5.69	6.51	9.98	12.0	30.7
2100	2125	7.94	10.7	11.9	16.5	18.9	39.0
2200	2227	15.2	18.6	20 4	26.1	28.4	48.5
2300	2330	26.9	31.0	33.1	39.8	41.4	59.8
2400	2432	45.5	49.5	51.4	57.5	58.5	73.4
2500	2535	74.3	76.6	77.6	80.9	81.5	89.0
2564	2600	100	100	100	100	100	100
2600	2638	118	116	115	112	111	107
2700	2741	180	169	163	151	147	127
2800	2844	273	242	288	200	193	150
2900	2948	412	341	310	262	253	176
3000	(3052)	605	471	416	339	327	207
3100	(3157)	(885)	(642)	545	(435)	(415)	241
3200	(3262)	(1280)	(874)	708	(550)	(522)	280
3300	(3367)	(1820)	(1180)	911	(695)	(654)	324
3400	(3473)	(2560)	(1550)	1150	(865)	(805)	370

WASHINGTON

Latest Electronic News Developments Summarized
by Tele-Tech's Washington Bureau

★ ★ ★ ★ ★ ★

NEW LINEUP AT FCC—Two new Commissioners, Chairman Wayne Coy and Commissioner George E. Sterling, elevated from Chief Engineership, have brought FCC up to full seven-number strength and also have definitely strengthened stature and competence of agency. Most fortunate because of frequency problems was selection of Sterling, a government career radio engineer and a real "merit" choice. He fills the shoes of veteran Commissioner E. K. Jett, who for 16 years had been topflight and for several years chief engineer of radio regulatory commission and previously had been 18 years in Navy radio. Mr. Jett, one of the ablest government officials in the field of radio, parted from government services after 37 continuous years to become Vice President and Radio Director of the Baltimore Sunpapers' television, AM and FM stations. His departure is a tremendous loss to the radio industry because of his capability and far-sightedness in determining radio problems, but it was due to the unconscionably low top-government salaries. Commissioner Sterling was the logical choice to fill this vacancy. Chairman Coy has a fine reputation for his administrative ability and also has had three years in operation of radio broadcasting stations as the chief executive in charge of the Washington Post AM and FM stations.

TELEVISION STATIONS COMING ON THE AIR WITH GREAT RAPIDITY—Predictions of television as a future multi-billion-dollar industry of the United States which were voiced at the outset of 1948 by such radio industry leaders as RCA president Sarnoff, Philco president Ballantyne, NBC Executive vice president Mullen and Television Broadcasters Association president Poppele, are NOT founded on "hot air" but are buttressed by the facts of the progress of the video industry as indicated by the number of applications to the FCC. In its annual report, the FCC pointed significantly to the fact that in the 1947 governmental fiscal year (ending June 30), television broadcast station authorizations and applications had more than doubled over the 1946 period. But in the last half of 1947 television soared even more with the yearend count of 17 stations on the air, 55 construction permits and 84 applications for video stations. The video receiver sales are likewise on the march.

FM BROADCASTING SHOWED BIGGEST GAIN OF ANY BROADCAST SERVICE—Of all broadcasting services, FM recorded biggest and most material gain during FCC's 1947 fiscal year, Congress was informed by the Commission, and now with the prospect of 1,000 FM stations on the air at the end of 1948, FM is becoming a truly nationwide broadcast service. Already FM stations are operating or are authorized in more than 600 communities. Facsimile is slated for big impetus in 1948; the interest of newspaper publishers has intensified growth of the facsimile medium, and it may be noted that former FCC Commissioner Jett, now radio director of the two important Baltimore Sunpapers, plans to enter testing of this service.

UMBRELLAS OVER MOBILE RADIO SERVICES—Because the applications for mobile radiotelephone services have been pouring in like a virtual cloudburst from the taxicab, bus, truck, telephone companies, limited common carriers, automobile clubs, power and gas utilities, petroleum industry, logging industry and a host of smaller inidustries, the umbrella simile is apropos. Frequencies are so scarce that operations of these various services, squeezed into a pair or so of channels, suffer from interference and uncoordinated operations. This has led to the offer of the various industries to join together with other related mobile service users to coordinate the utilization of frequencies and to establish the best possible operating procedures and equipment standards. Examples of this coordination include the fusing of the interests of the bus and trucking industries; the plan for all Limited Common Carriers to get under one roof; and the coordinated program of the power, gas, steam and water utilities in their operation of radio. In addition, Dr. Daniel Noble, able vp and chief engineer of Motorola, has proposed a setup of a national committee, regional committees and local groups of mobile users to establish uniform operating practices and equipment standards.

MISCELLANY—Network television received big impetus with FCC approval of $76,130,000 American Telephone & Telegraph construction program for 1948 which will extend coaxial cable links as far west as Chicago and St. Louis and into deep south, together with coaxial cable between Los Angeles and San Jose, Cal.; ten cities in east to be joined for video. . . . Dr. Edwin H. Armstrong, inventor of FM, scored heavily in recent FCC hearings against Commission engineers who had forced shift of FM broadcasting from low to upper bands.

ROLAND C. DAVIES
Washington Editor

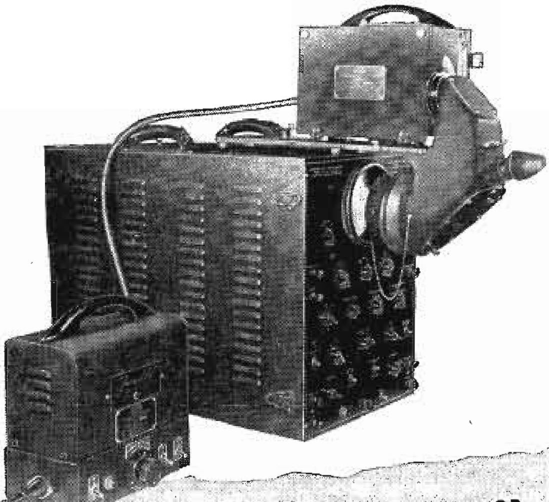
For any kind of oscillographic recording . . .

DU MONT TYPE 271-A and/or DU MONT TYPE 314

Oscillograph-Record

CAMERAS

to convert your oscillograph into a recording instrument



TYPE 314 CONTINUOUS-MOTION AND/OR SINGLE-FRAME CAMERA

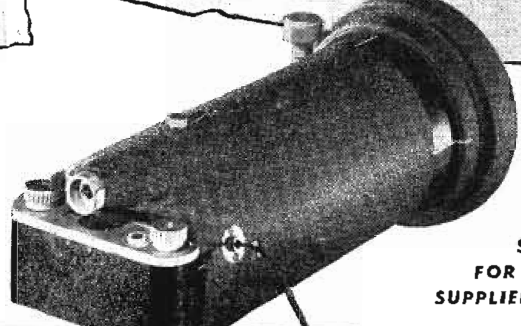
In addition to single-frame exposures, the Du Mont Type 314 Oscillograph-Record Camera provides continuous-motion photography. Recommended for recording continuous, changing processes, and where variations to be studied require an extended period of time. Film speed electronically controlled within range of 1 inch per minute to 5 feet per second. Applicable to widest variety of uses such as study of Welding, Biology, Switches, Electric Shavers, Synchronous Motors, Fluorescent Lamps, Guided Missiles, Oscillator Drift, Voltage Stabilizers, Nuclear Physics, Hydraulics, Mechanics, Dynamic Unbalance, Cylinder Pressure, Acoustics, etc.

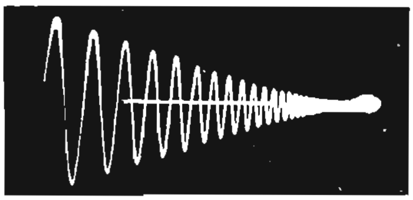
Type 314 Oscillograph-Record Camera, Cat. No. 1217-E (f/2.8 lens) $980; Cat. No. 1366-E (f/1.5 lens) $1,155; delivered in U.S.A.

TYPE 271-A SINGLE-FRAME CAMERA

For single-frame exposures of high-speed transients, or for multiple exposures to record a family of curves, the Du Mont Type 271-A Oscillograph-Record Camera is your ideal selection. And the cost is well within reach of the modest instrument budget. May also be used to good advantage with Du Mont Type 264-A Voltage Calibrator for amplitude and wave-form measurements. Equipped with f/3.5 lens. Uses standard 35 mm. film. And remember, this camera is readily fitted to any 5-inch oscillograph.

Type 271-A Oscillograph-Record Camera, Cat. No. 1216-E, $162.50 delivered in U.S.A.

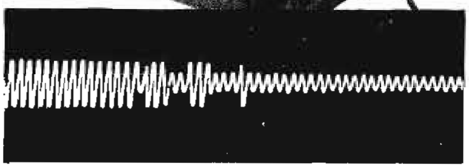




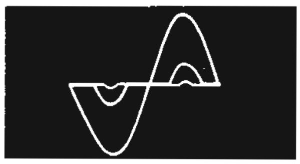
Typical high-speed recording: 2 mc transient (with Du Mont Types 281 and 286 Cathode-Ray Oscillographs using Type 271-A).

DETAILED SPECIFICATIONS FOR EACH CAMERA, SUPPLIED ON REQUEST.

Output voltage of Type OB2 Voltage-Regulator Tube, with sudden applications of resistive load, using Type 314 Continuous-Motion/Single-Frame Camera.



Plot made on Type 314 of starting current of small synchronous motor. (Note variation in current as the rotor "hunts" for its synchronous speed).

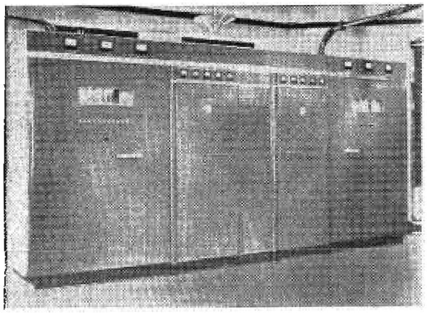


Triple exposure made with Type 271-A while varying constants of peak-clipping circuit.

DUMONT *Precision Electronics & Television*

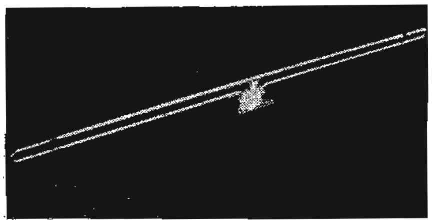
ALLEN B. DuMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: ALBEEDU, PASSAIC, N. J., U. S. A.

Communications Components



FM Transmitter

Incorporating the Phasitron modulator, Type BT-4-A 10-kw FM transmitter is completely self-contained and is built around the standard 3-kw FM broadcast transmitter. The Phasitron modulator uses only 14 tubes and accomplishes direct crystal control with a single crystal, and ±75 kc swing at the output frequency with a frequency multiplication of only 432. No frequency comparison or conversion circuits are needed. The grounded-grid high power amplifier utilizes two newly-developed hf-triodes. Protective features include sequence interlocks, supervisory control lights and other safety provisions. The transmitter has 43 air-cooled tubes: 17 rf, 2 af, and 24 rectifiers.—**Transmitter Div., General Electric Co., Syracuse, N. Y.**

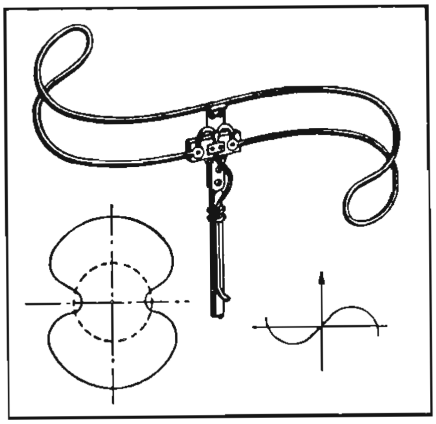


Folded Dipole

Designed to serve as receiving or transmitting antenna in the 85 to 150 mc range, the H-K folded dipole can be tuned to any frequency within this range. Due to folded construction and use of a 300-ohm ribbon transmission line, correct impedance over a wide frequency range is possible.—**Communications Equipment Div., Heintz and Kaufman, Ltd., 50 Drumm St., San Francisco, Cal.**

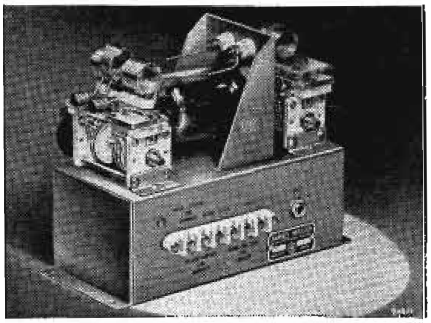
Power Supply

The 103 multiple power supply contains two continuously variable plate supplies, a variable grid voltage supply and a heater supply. The B supplies can be adjusted from 0 to 300 V, and are rated at 120 ma. Output ripple voltage is less than 5 millivolts over the entire range. The C supply is variable from minus 50 to plus 50 volts, and has a ripple voltage of less than 1 millivolt. The heater supply furnishes 6.3 V at 5 amps. The B supplies are regulated by two 6Y6 control tubes and are isolated from the chassis, to permit grounding the positive terminal. The C supply originates from a separate power transformer. The unit operates on 105 to 125 V, 50-60 cycles.—**Kepco Laboratories, 142-45 Roosevelt Ave., Flushing, N. Y.**



Omnidirectional Antenna

Taco type 624 "S" folded dipole is a non-directional horizontally polarized antenna for reception from several television or FM transmitters located at various points. The antenna is ⅜ in. non-corrosive aluminum tubing, and has a new-type mounting clamp to assure rigidity. The bakelite terminal block mounts a strain insulator for attaching a 300-ohm ribbon type transmission line. A 5-ft mast and 60 ft. of transmission line are supplied.—**Technical Appliance Corp., Sherburne, N. Y.**

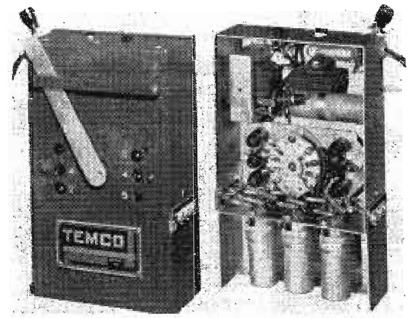


Amateur Power Amplifier

This 75 watt output power amplifier can be operated by means of plug-in indicators on the 2, 6, 10, 15, and 20 meter amateur bands. It is a compact unit, utilizing an 829B tube. Special inductors are available for commercial applications. Provision is made for either panel or table mounting.—**The James Millen Mfg. Co., Malden, Mass.**

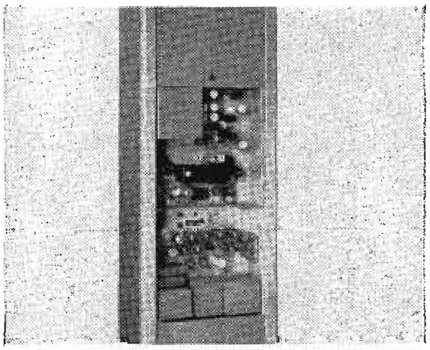
FM Modulator Unit

Model 500 narrow-band FM reactance type modulator is designed for direct coupling to the VFO or crystal socket of a conventional pentode or triode oscillator. The low-priced amateur unit permits operation of phone transmitters on CW ratings.—**Bee-Bee Electronic Co., 2692 W. Pico Blvd., L. A. 6, Cal.**



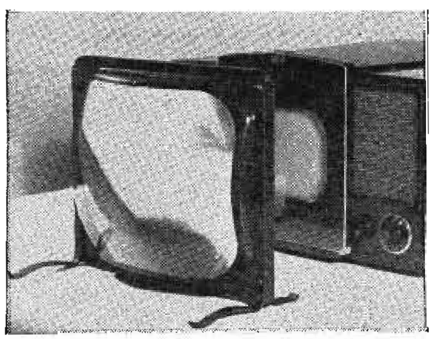
Television Booster

The Telebooster is a flexible, high gain amplifier for use with any type television receiver and transmission line to increase the signal strength in fringe areas. The unit has a simple mechanical connecting link for easy fastening to the receiver. It is self-powered, operating from 115 V, ac.—**Temco Service Corp., 345 Hudson St., New York 14.**



Television Signal Source

Model PT102 TV monoscope signal source produces a complete composite video signal for testing television equipment from camera to receiver. The signal consists of an Indian Head and a combination of geometric patterns of black lines on white background. The Monoscope unit contains a video amplifier flat to 8 mc; a blankng amplifier; mixer; horizontal and vertical sync, speed, centering and linearity controls; monoscope tube; and horizontal and vertical deflection circuits. A high voltage power unit and a regulated power unit are part of the equipment. Resolution is greater than 600 lines.—**Polarad Electronics Co., 9 Ferry St., New York 6.**



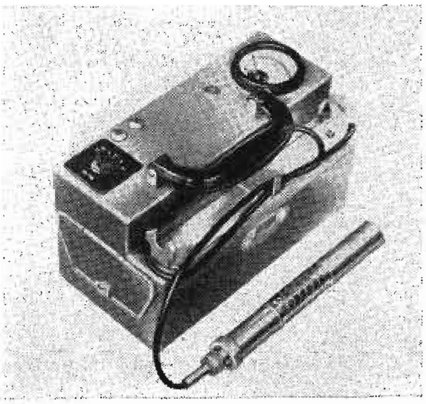
TV Enlarging Lens

This magnifier has been developed for use in enlarging the images received on 7-in. and 10-in. TV screens to the equivalent of those received on a 15-in. tube. The magnifier is a hollow plastic lens filled with a clear oil, is lighter than solid glass or plastic.—**RCA Victor Division, Camden, N. J.**

TEST EQUIPMENT

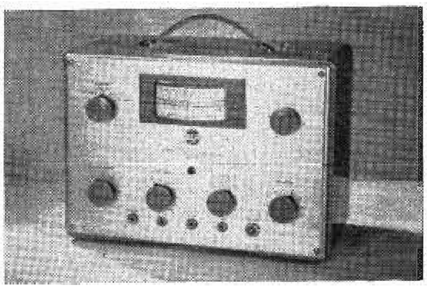
Audio Test Generator

When used in conjunction with an audio oscillator and an oscilloscope, the "Sine Wave Clipper" is useful in examining frequency and transient response of audio circuits. Driven by any standard audio oscillator, the instrument provides a clipped sine wave, which is then applied to the equipment under test. The distortion of the wave introduced by the equipment is made visible on an oscilloscope. If driven by 10 volts RMS, the unit will supply an output 3.7 V from peak to peak of a clipped sine wave, 7.4V for a double clipped sine wave, and 3.4 V RMS for a sine wave. **Barker & Williamson, Upper Darby, Pa.**



Radiation Meter

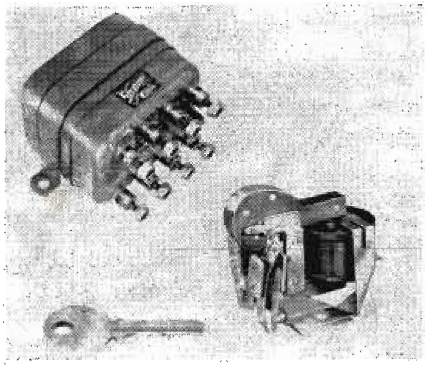
Model MX-5 radiation meter is a portable Geiger-Mueller counter weighing only 9 lb. and is for the detection and measurement of X, beta and gamma radiations. It is battery-operated with the self-quenching G-M tube mounted on a 3-ft. probe. A selector switch gives three operating ranges, 20, 2 and 0.2 mr/hr. The circuit eliminates the need for zero control, permits rapid meter response and extends battery life to 400 hours. An external control is provided to compensate for change in battery voltage and tube characteristics and permits calibration under any operating condition.—**Beckman Instruments, National Technical Laboratories, South Pasadena, Calif.**



FM Sweep Generator

Furnishing all signals necessary for the alignment of frequency-modulated circuits over the FM band from 88-110 mc, this portable RCA Type WR-53A sweep generator consists essentially of an electron-coupled oscillator, frequency-modulated by push-pull reactance tube modulators. IF-output from one microvolt to 0.1 V can be selected by step and line attenuators. For IF alignment, the unit provides an FM signal tunable from 8.3 to 10.8 mc. For rf, mixer and local oscillator circuits, an unmodulated or amplitude modulated signal is provided.—**Radio Corp. of America, RCA Victor Div., Camden, N. J.**

Parts for Design Engineers

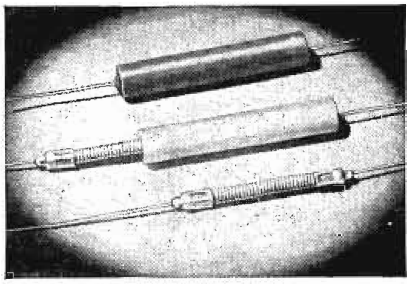


Miniature Relay

A 400-cycle miniature relay has been added to the "Aerotrol" line, which provides stable performance in aircraft under accelerations as high as 30 G's. The magnetic circuit is fully laminated and so arranged that a sharp rise in force occurs just before the armature seals in. The coil is impregnated with a silicone compound for protection against high humidity. Any desired contact combination is available. Weight is 3½ oz. with standard mounting; dimensions are 1½ by 1¾ by 2⅝ in. The HY-G 400 cycle relay is also available Stratopaxed for aircraft use.—**Cook Electric Co., Chicago 14, Ill.**

Floor Stands

Model St-3 is a three-legged stand with a low center of gravity and rubber cushioned feet. Extended height is 72 in., closing height being 40 in.; diameter is 18⅝ in. It is provided with No. 27 microphone coupling. Model ST-R is identical except that it has a heavier round base.—**Universal Microphone Co., Centinela at Warren Lane, Inglewood, Calif.**



Midget Wire-Wound Resistors

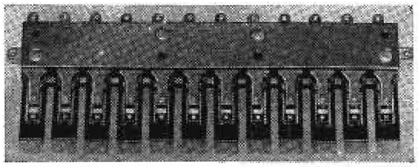
Ceramic-cased midget wire-wound resistors, "junior" version of the Greenohm power resistors, have a wire winding on fibre-glass core, with axial bare pigtail leads clinched to the ends, placed in a steatite tube filled and sealed with inorganic cement. Type C7GJ measures 1¾ by 5/16 in., with 2 in. leads. It is rated at 7 watts in values from practically zero to 5000 ohms max. Smaller Type C4GJ measures 1 by 5/16 in. and is rated at 4 watts, with maximum available resistance of 1000 ohms.—**Clarostat Mfg. Co., 130 Clinton St., Brooklyn, N. Y.**

Soldering Iron

The Lenk soldering iron has a metal-clad heating element, fin-type heat dissipators to keep the handle cool and a heavy-duty service-type cord. It has a one-piece chrome-plated, swaged tube and operates on 110 v ac, 75, 100 or 150 watts.—**Lenk Mfg. Co., 30-28 Cummington street, Boston, Mass.**

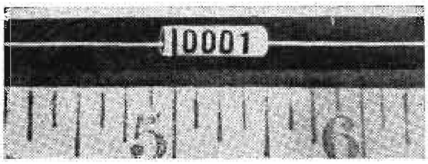
Telephone Inductor

Telemike is a midget inductor unit, measuring ¼ in. in thickness and 1 in. in diameter, which fits over the outside of the earpiece of a standard telephone. The device is designed to operate in conjunction with a radio receiver, phono or mike amplifier, or recorder for group listening or recording of two-way telephone conversations.—**Miles Reproducer Co., Inc., 812-814 Broadway, New York 3.**



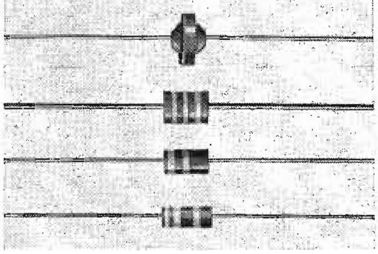
Gang Limit Switch

This 12-gang open blade switch, incorporating the Acro rolling spring principle, is available with normally open, normally closed or double throw contacts on any pole or combination of poles. The gang switch is a single unit, permanently fastened together with countersunk rivets for flush-mounting. Center blade and rolling spring are both heat treated beryllium copper; other parts are cadmium plated. The unit is rated at 10 amps., 125 V. ac and requires an operating force of 4½ to 6 oz. Maximum movement differential is 1/16 in., minimum overtravel 1/16 in., and minimum release force 2½ oz.—**Acro Electric Co., 1442 Superior Ave., Cleveland 14, Ohio.**



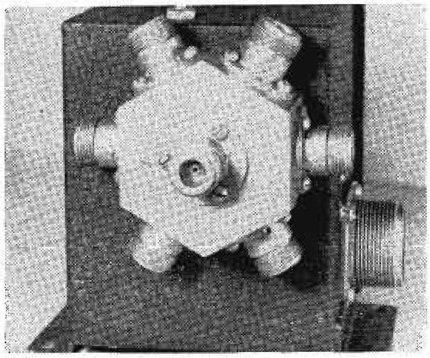
High "Q" Capacitors

Designed for applications where "Q", leakage resistance, and moisture resistance are important factors, these new-type high "Q" capacitors are available in capacity ranges from 5 mmfd. to 0.1 mfd. in voltage rating from 500 to 10,000 V. Leakage resistance of the units is better than ½ million megohms, power factor is .01%; they are practically unaffected by humidity conditions.—**Dumont Electric Corp., 34 Hubert St., New York.**



JP Molded Capacitors

Type JP molded capacitors are embedded and have a disc of high dielectric constant material molded between the end plates. They have leakage resistance greater than 100,000 meg; are practically unaffected by humidity, and have a Q varying from 100 to 200 for small values to 100 for the larger sizes. They are made in a complete range of sizes from 0.34 to 100 mmf and can be furnished to plus or minus 10% tolerance.—**Jeffers Electronics, Inc., Dubois, Pa.**

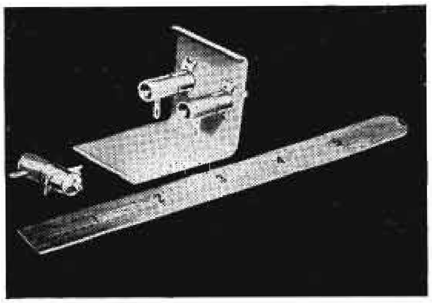


Coaxial Switches

This series of coaxial switches has low cross-talk characteristics and low voltage standing wave ratio. The units are solenoid-operated, for 115 V, 60 cycle, remote control. VSWR is less than 1.25: 1 to 6000 mc and less than 1.8:1 to 10,000 mc. Type D, for use in antenna array monitoring systems, is a single circuit, six position unit, operated by a remote selector. It is used with the RG-8/U cable.—**Designers for Industry, Inc., 2915 Detroit Ave., Cleveland 13, Ohio.**

Constant Voltage Transformer

This 7½ KVA constant voltage transformer was designed to deliver regulated power to electronic equipment used in instrument landing systems and other radio aids to navigation. Using the constant voltage transformer as power source, the installations are protected against damage from high-voltage levels and sudden surges.—**Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.**



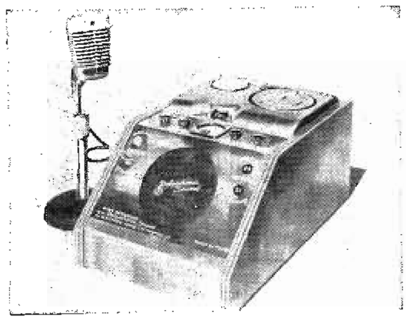
Trimmer Capacitors

Type 531 and 532 tubular trimmers have low minimum capacity, high ratio of tuning range, (1 to 8 mmfd.); and require little space. Power factor 0.1% maximum; rated voltage 350 V dc; dimensions approximately ⅜ in. diameter by 1 5/16 in. at maximum capacity. Type 531 is for panels .015 in. to .039 in. thick; type 532 for panels .04 in. to .065 in. thick.—**Erie Resistor Corp., 640 West 12 St., Erie, Pa.**

Industrial Television

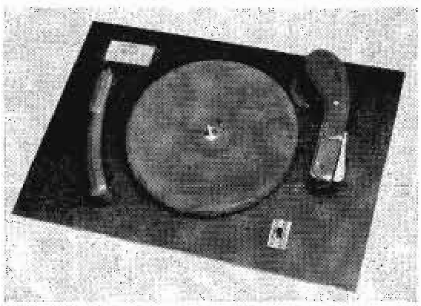
The Diamond Utiliscope shows on a cathode-ray screen a picture of a process or condition at a remote or inaccessible point. The unit may be used to observe water levels in remote boilers, coal feed to pulverizers, presence of smoke, the inside of oil wells, readings of electric meters etc. The complete system, which is designed for continuous operation at 145° F, consists of a camera with deflection units, two small power units, and a monitor. A Farnsworth image dissector is used in the camera, permitting a simplified circuit. The installation operates, on 60 cycle, 105 to 125 V.—**Diamond Power Specialty Corp., Detroit 31, Mich.**

SOUND EQUIPMENT



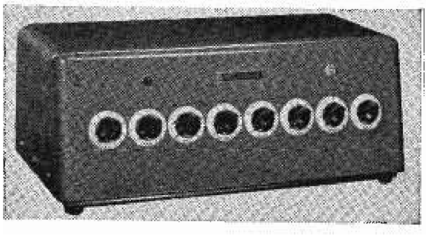
Wire Recorder

Built around a special high-fidelity amplifier circuit, the "Polyphonic Sound" wire recorder is in the medium-price range. It is complete with amplifier and a built-in 6-in. speaker, which has a range up to 10,000 cps. A 15-in. dual channel auxiliary speaker is also available. Input facilities consist of a low-level input for microphone and a high-level input or direct connection to a radio receiver or record player. The microphone furnished has a response of 60 to 10,000 cycles. Standard equipment includes a fifteen-minute recording spool. While designed for table-top operation, the unit is supplied with a portable carrying case.—**Electronic Sound Engineering Co., 4344 W. Armitage Ave., Chicago, Ill.**



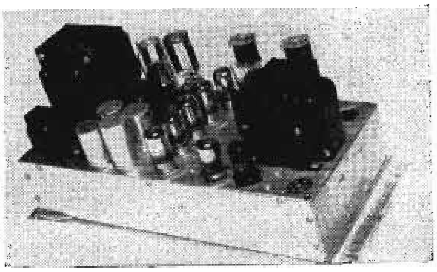
Recording Chassis

This low-cost recording and playback chassis for 12-in. records has visible groove-depth adjustment, pantographic movement for equally spaced inside-out recording, and a lift lever to permit the operator to locate the stylus in the groove location after the lead screw has been disengaged. The RC recording unit has a 10 in. turntable driven by a heavy-duty, 110 volt, 60 cycle motor at 78 rpm. A crystal pick-up is provided.—**Universal Microhone Co., Centinela at Warren Lane, Inglewood, Calif.**



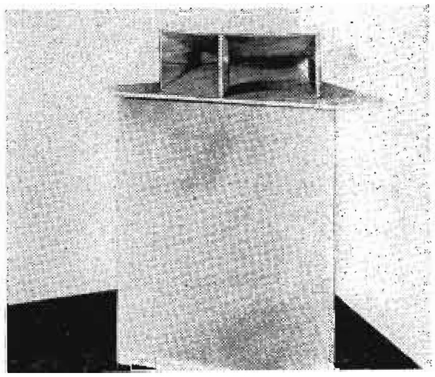
Audio Amplifier

Model 8430 high-fidelity amplifier delivers 30 watts output at less than 4% harmonic distortion (47 watts peak) with a frequency response flat to ±2 db from 30 to 18,000 cps. Four tone controls provide independent attenuation for the microphone channels to minus 19 db at 10,000 cps and to minus 10 db at 40 cps., as well as equalization for the music circuits from plus 11 to minus 11 db at 40 cps, and from plus 10 db to minus 24 db at 10,000 cps. Three high-impedance microphone channels with separate gain controls and one high impedance line input are provided. Available output impedances are 4, 8, 16, 250, and 500 ohms. The amplifiers operates on 110-130 V, 50-60 cycles.—**Neill & Peterson Co., Inc., 1811 Carrol Ave., Chicago 12, Ill.**



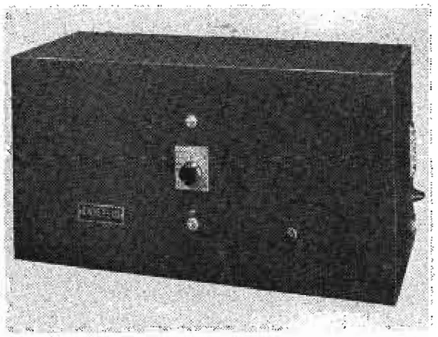
Audio Amplifier

The Brook Model 10-D audio amplifier is a 30-watt rack-mounting unit with 75 db gain. The unit uses triodes throughout. Frequency response is flat from 20 to 20,000 cycles within two-tenths of a db. At five watts output harmonic distortion is 0.6% and intermodulation distortion is 0.2%. Total distortion at 30 watts is under 2½%. Noise level is 70 db below full output. The self-contained power-supply permits connecton of external equipment up to 90 ma at 250 V, and 5 amps. at 6.6 volt.—**Brook Electronics, Inc., 34 De Hart Place, Elizabeth, N. J.**



Sound Reproducer

The Klipsch 2-way speaker system uses a horn for the low frequency as well as the high frequency range. The low-frequency horn is folded and uses the corner of a room as an integral part of the acoustic system, occupying only 14 cubic ft. of space. The non-resonant character of the reproducer affords reprodution of transients without hangover. Response of the system is flat from 40 to 10,000 cycles and extends from 30 to 15,000 cycles. The dividing network is a constant-resistance, parallel type, providing 12 db per octave attenuation, and has cross-over frequency of 50 cycles. Model 1A is rated at 20 watts. Impedance is 16 ohms.—**Broeiner Electronics Laboratory, 1546 Second Ave., New York 28.**



Way Station Amplifier

Designed for continuous service the 710-A way station receiving amplifier for low level signals from telephone transmission lines incorporates automatic volume control, a noise squelch circut, and noise suppression filters. The unit will boost low level signals or voice to loudspeaker volume and suppresses unwanted line noises. A large number of amplifiers may be connected on a line due to their low bridging loss.—**R. W. Neill Co., 1811 Carrol Ave., Chicago 12, Ill.**

Tele-Tech Reports . . .

The television pot is boiling and manufacturers are thinking, planning and talking television. We learn, for instance, that . . .

With the trend towards larger pictures, it is not surprising that *Monsanto Chemical Co.* is experimenting with the manufacture of television lenses and that *RCA* is dropping its 7-in. television set.

* *

***Liquid Lens Co.*, a New York firm, has developed a plastic lens that literally hangs onto the front-end of a receiver kinescope. (Most lenses are simply mounted in front of the picture tube). This company fills with oil the air gap between the tube face and the back lens. The space inside the lens is also filled with oil. This reportedly gives a 180 degree viewing angle and a 2½-times larger picture. (Watch March Tele-Tech for details.) Another company is known to be experimenting with 36-in lenses.**

* *

***Radio & Television, Inc.*, (Brunswick) is planning to assemble its own television chassis (a reversal of its policy of buying assembled radio chassis) because the company hopes to develop several exclusive television features. Company is now experimenting with different tuning methods and tuning assemblies and expects to bring out its own form of tuning dial. It is predicted that the dial will be a modification of the DuMont tuning dial with provision for 13 channels.**

* *

***Air King* is planning a television receiver to sell slightly under $200. It will use a 10-in. tube, have about 21 tubes and provide for 12 channels. Look for Air King television to be on the market this fall.**

* *

***Stromberg-Carlson* reports that one-third of its 1948 production will be television, representing a 10-time increase in television production over 1947.**

* *

***Pilot* expresses an aloofness to television for the present with a let's-not-get-into-the-scramble look. But laboratory lights are burning late and the company "will come out with something sensational late in the fall."**

* *

***Freed Radio* is another who claims to be on the side lines—waiting. If Freed comes out with a television receiver this year, it will be with a '49 model television-and-FM only console with phonograph in a deluxe cabinet to retail between $1200 and $1500.**

Loud Speaker

Hyper-Mag loud speaker has a parabolic projector coupled with the Hyper-Mag magnet. The center dome with its parabolic projector is designed to provide broad high frequency distribution, and the special magnet design to provide a high quality, efficient unit for FM and wired music installations. The eight inch speaker offers linearity of response from 100 to beyond 10,000 cycles at low distortion. The magnet design concentrates the flux density in the working air gap with minimum leakage loss; affords maximum energy with minimum size and weight; reduces power input, and minimizes service problems.—Radio Music Corp., Port Chester, N. Y.

New Wire Recording Company

Formation of the Wire Recording Corporation of America is announced by the company's president, J. J. Sullivan. The new organization has taken over the assets and manufacturing facilities of the St. George Recording Equipment Co. Manufacturing and sales will be conducted in new headquarters at 1331 Halsey St., Brooklyn, N. Y.

Transmitter Radiations

(Continued from page 26)

rent and voltage at the rejection frequency (f_2) is so much smaller that it may be neglected. This is so however in some cases, such as operation of two transmitters into one antenna.

For the design of Type B resonant filters the corresponding formulas are:

Rejection Ratio $= (R_3+G_2)Y_2/R_2G_2Q$
Loss Ratio $= R_1/4D^2QY_2$

Here the voltage across each component in the filter is ½D times the voltage across the load and the current is found by dividing the voltage by the reactance.

The insertion of a Type A network in series with a circuit introduces a new reactance in the circuit at f_1. This may be tuned out by an equal and opposite reactance, as shown in Fig. 3. If $f_2 > f_1$ the added reactance must be capacitive. If $f_1 > f_2$ it must be inductive.

In a different arrangement of the three components accomplishing the same end (Fig. 4), the two upper components are series resonant at the pass frequency, and therefore form a zero impedance. They have an inductive reactance at the higher rejection frequency, and a parallel capacitance of the same value of reactance forms a parallel resonant circuit, which approximates an infinite impedance at the rejection frequency.

The small difference in performance of these two circuits permits choice from ease of adjustment, and commercially available components. In the form shown in Fig. 3, the parallel resonant circuit must be tuned to (f_2) first. Then the series capacity C_1 may be tuned for (f_1) without disturbing the (f_2) adjustment. In Fig. 4, the circuit must be tuned first at (f_1), and then the (f_2) tuning does not affect the (f_1) adjustments.

Since tuning adjustment must be made to closer than 1%, construction must be used which will be stable against mechanical shocks and temperature changes. In each three-element group, at least two elements (including the third element) must be continuously variable. It is ordinarily necessary to have these variables so constructed that they can be adjusted with full power on the transmitter, and with all doors closed and other electrostatic shields in place. In any ordinary cabinet construction, opening a door will detune the inductances several percent.

The Type B filter has similar possibilities for adding a third component to neutralize the effect of the filter at (f_2). Figs. 5 and 6 correspond in principle to Figs. 3 and 4.

Where a simple resonant filter does not offer good enough performance, resonant groups may be used to replace single elements in a pi or tee network, as shown in Fig. 7. This network permits complete tuning at (f_2) first, and then tuning at (f_1) without disturbing the (f_2) adjustments. To attain this independence of adjustment, one of the things necessary is to see that stray inductive and capacitive coupling between components is kept small.

This nine-element filter is in use

where stations on 1450 and on 1490 kilocycles are located within a quarter mile of each other.

In designing these filters consisting of two or more Type A and Type B groups connected in L, pi, or tee arrangement, the loss in each group must be kept low enough so the sum of these losses will not be objectionable. The rejection ratio in each group may be kept quite low, but the total rejection increases rapidly as the number of groups is increased, and so is as high as desired.

Where two antennas are so close together that the antenna ammeter of one shows an objectionable amount of current picked up from the other station, an L or tee arrangement of these groups must be used so that a Type A group is nearest the antenna and is designed to have a high enough impedance at (f_2) to reduce the antenna current to a harmless value.

For a numerical example of network design assume the previous example of a station operating on 1000 kc and another nearby on 1100 kc. A spurious signal is heard on 900 kc with the program of the 1100 kc station dominant. However, a direction finder, field strength indicator, or other means indicates that the spurious signal is being radiated from the 1000 kc station. The inverse feedback, audio monitor, remote ammeter, and any other similar rectifiers are disconnected without improving the situation. The presumption therefore is that the final amplifier of the 1000 kc station is the tube producing the spurious frequency. The correction consists of inserting a filter between this tube and the antenna which will reject the 1100 kc signal.

The constants of the station at 1000 kc are all known (Fig. 9). The antenna impedance is known to be 40+j20 at 1000 kc, and 50+j50 at 1100 kc. The L network is correct for matching the antenna impedance to the 70-ohm line at 1000 kc. By recomputing the performance of the antenna tuning network at 1100 kc, it is found that the load at the end of the transmission line is 107 − j58 at 1100 kc. Then by computing the transformer effect through the transmission line, it is found that the load at the input to the transmission line (where the filter is to be inserted) is 35+j19, or an impedance of 40 ohms.

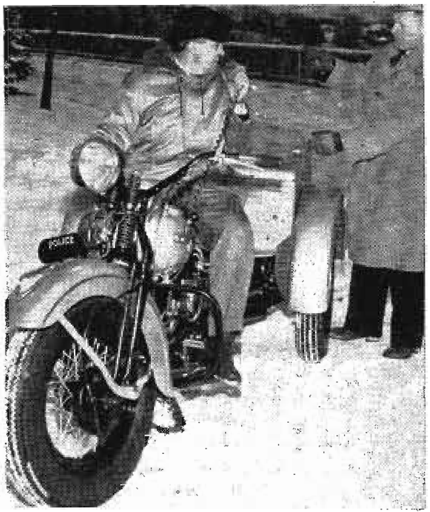
On the generator side we need not make an exact calculation, but we know that the small pickup coil offers low impedance, and is little affected by the tank circuit at this frequency which is not the resonant frequency of the tank circuit. Therefore both R_2 and G_2 are smaller than R_1, so we may be sure that we have the condition $R_2 G_2$ less than R_1^2, and the Type A filter will be most effective.

The formulas for performance, after substituting $D = 0.1$, $Q = 300$, $R_1 = 70$, and $R_2 = 40$ are: Rejection ratio $= 0.13/X_2$; Loss Ratio $= 0.0012\ X_2$.

We select a value of $X_2 = 10$. Then the rejection ratio is 0.013, or 1.3% of the objectionable frequency is passed by the filter. The loss factor is 0.012, or a power loss of 12 watts in this 1000 watt station.

Calculating shows the current in the inductance and capacitor is 5 times the current in the load, or 25 amperes. The voltage across the inductance is 250 volts. Any transmitting components will handle this voltage, plus modulation peaks.

NEWS OF THE INDUSTRY



"Megacycle" motorcycle: First 2-way FM radio installed on police Servi-Car by the Harley Davidson Motor Co. is tested by Chief Engineer William J. Harley as Radio Engineer Victor Sierpinski spreads arms to indicate short antenna length of only 18 in. The new radio communication equipment weighs only 27 lb. and operates on the vhf 152-mc band

130 Papers, 26 Sessions, 170 Displays at IRE Meet, Show

Giving promise that the Institute of Radio Engineers' 1948 Annual Convention and Radio Engineering Show scheduled for the Hotel Commodore and Grand Central Palace, New York, March 22-25, will be the largest in the history of the institute, the planning committee reports a diversified technical program that will consist of 130 papers in 26 sessions. Possibly more than 170 exhibitors will have displays. Theme of the convention will be "Radio-Electronic Frontiers."

Technical papers to be read will include reports on frequency modulation, navigation aids, circular polarization, signal transmission methods, amplifiers, passive circuits, tube design and engineering, superregeneration, transmission, nuclear studies, industrial application of electronics, electronic circuits, components and supersonics, television, tube manufacture, signal measurements, computers, broadcasting and recording, propagation, microwaves, receivers, active circuits.

The annual banquet will be held Wednesday, March 24 and the President's luncheon will be on Tuesday noon, March 23. The opening session Monday, March 22, will be convened by Dr. H. B. Richmond who will speak on "An Engineer in the Electronics Industry—Prospect, Preparation, Pay." A cocktail party will be held Monday evening, March 22.

IRE has acquired two-and-a-half floors of space in the Grand Central Palace building in order to accommodate demands for exhibit space from more than 170 exhibitors.

THE COVER

The beam traveling wave tube, shown on the cover in a test set-up operated by Dr. John R. Pierce of Bell Telephone Laboratories who developed the tube, was designed to give high gain with many times the bandwidth possible when any other type of microwave tube is used. The beam traveling wave tube not only permits high gain, but also allows a bandwidth eighty or more times greater than can be obtained with any other type of tube. The tube is expected to be particularly useful in broadband communications systems such as television and pulse modulation.

Radio-Television Output Hits All-Time High

Industry production records were broken in 1947 when RMA members reported an output totaling 17,695,677 sets. Production by all manufacturers is expected to exceed 18,500,000 compared with 15,000,000 in 1946.

Television output totaled 178,571 against 6,476 for 1946.

FM-AM receivers totaled 1,175,104 against 181,485 in 1946.

Automobile and portable receivers totaled 3,029,637 and 1,153,458 respectively.

Production for December totaled 1,705,918 receivers of all types. Of these, 29,345 were television and 191,974 were FM-AM; 72 percent of all production was in table models, 13 percent were radio-consoles and 15 percent were portables.

AIEE Tube Conference

Special electron tubes for use in electronic instruments will be the subject of a conference of the AIEE Subcommittee on Electronic Instruments on March 29-30 in Philadelphia's Benjamin Franklin Hotel. The results of the committee's survey of instrument manufacturers, industrial laboratories, and others interested in a special tube program will be presented as well as a tentative list of special tubes prepared by the committee.

Sylvania Center Physics Lab

Ground for the first building to house the Sylvania electronic research development at Bayside, L. I., was broken recently with the start of work on the 57-acre site. Known as Sylvania Center, the first building will be occupied by the physics laboratory and will cost nearly a million dollars fully equipped. The entire center will be devoted to development of electronic and lighting equipment, television, FM and radar.

Armstrong Requests FCC Action On TV Channel 1

Major Edwin H. Armstrong, inventor of FM, achieved a moral victory during the recent hearings in Washington on disposition of TV channel 1 (44-50 megacycles), by establishing that the FCC "had been engineering advice from its staff on the relative efficiency of the low and high FM bands." Consequently, the FM inventor has requested that the hearings be reopened to permit further examination by the Commission of FM fading between 50 and 100 mc.

Major Armstrong hit hard at testimony presented by Edward W. Allen, Jr., Chief of the Technical Information Service of the FCC, and Kenneth A. Norton, formerly employed by the same section. Most of the material presented, in countering the charts and testimony of the FCC engineers, was based on Major Armstrong's tests at Westhampton Beach, N. Y., since July, 1947, comparing two signals of the Alpine station, one on 92.1 mc and one on 44.1 mc. Each of the stations has about 100 kilowatts power, which the FM inventor noted "is enough to permit highly accurate measurements to be made."

In general, he contended, the testing conditions at Westhampton Beach are "ideal" for checking the accuracy of theoretical predictions. Recalling that the recordings taken from Sept. 7 to Nov. 3 were presented to the FCC at the hearing, Major Armstrong pointed out that they showed that for approximately 50% of the days in that period the "upstairs" signal suffered severely from fading, whereas the 44.1 mc signals were not substantially affected.

Major Armstrong's brief was critical throughout of the FCC engineers' testimony, and he pointed to several instances where Mr. Allen had conceded errors during the hearing, and that the latter also had prepared an errata sheet covering some of the miscalculations in his testimony. The FM inventor charged that the Commission staff members had attempted to prove that a physical fact — FM fading at the higher frequencies—does not exist, and that even if their computing methods were not subject to criticism, the finding could not be supported in the light of his observations.

CONVENTIONS AND MEETINGS AHEAD

March 22-25—IRE Convention and Radio Engineering Show, Grand Central Palace and Hotel Commodore, New York.

April 14—IRE Conference, Chicago, Illinois Institute of Technology.

April 24—Regional Television Conference, IRE Cincinnati Section, Cincinnati, Ohio.

April 26-28—IRE Spring Meeting on Transmitters, Syracuse Hotel, Syracuse, N. Y.

May 10-15—Radio Parts and Electronic Equipment Shows Inc., Show, Hotel Stevens, Chicago.

May 17—National Association of Broadcasters, 26th Annual Convention and Engineering Conference, Los Angeles.

IRE-RMA Spring Meet

The IRE-RMA spring meeting on transmitters has been scheduled for the Syracuse Hotel, Syracuse, N. Y., April 26, 27 and 28. The spring meeting committee will consist of the following: Dr. W. R. G. Baker, General Electric; E. A. LaPort, RCA International Division; M. R. Briggs, Westinghouse; V. M. Graham, Sylvania; J. J. Farrell, General Electric; Mrs. M. E. Kinzie, General Electric. Mr. Farrell will handle arrangements for the technical program, while L. C. F. Horle, chief engineer of RMA and L. G. Cumming, IRE technical secretary will arrange technical committee sessions.

The tentative program calls for technical sessions during the mornings of the three-day meeting, committee meetings on the afternoons of April 26 and 28, and an inspection trip to G-E's electronic park on the afternoon of April 27. The spring dinner meeting will be held on Tuesday evening, April 27.

New FCC Line-Up

Coincident with the appointment of Wayne Coy to the Chairmanship of Federal Communications Commission, a number of other changes have been made in that organization. George E. Sterling, who has been chief engineer, has been elevated to be a commissioner; John A. Willoughby, who has been assistant chief engineer, has been made chief engineer; late in January Commissioner Jett resigned to become affiliated with the Baltimore Sunpapers, after 37 years of government service.

Chairman Coy takes over the unexpired portion of the term of former Chairman Denny, running until June 30, 1951, who left FCC Nov. 1 to become vice-president and general counsel of the National Broadcasting Co. He has been radio director of the Washington Post. Both Sterling and Willoughby have been long with FCC. Willoughby started with the Bureau of Standards in 1916 and transferred to the Federal Radio Commission in 1930. Sterling has been with the Commission since 1937, having entered government service in 1923 as a radio inspector in the Commerce Department's Bureau of Navigation.

TV Channel Changes

As a result of discussions between the U. S. and Canada designed to eliminate interference between broadcast stations, the FCC proposes to make the following television channel changes:

Reassign channel 9 from Cleveland to Canton, Ohio; assign channel 7 to Akron; reassign channel 11 from Akron to Cleveland; withdraw channel 13 from Buffalo; consider pending applications in the light of the new channels and modify construction permits accordingly.

Frank E. Butler

Frank E. Butler, early radio engineer, inventor and writer, and former staff member of Caldwell-Clements publications, died last month at the age of 70. As Dr. Lee DeForest's chief assistant, he collaborated in the invention of the first audion tube in 1907

Time Signal Changes

Effective January 30th, the technical broadcasting services from radio station WWV of the National Bureau of Standards were modified so that each of the eight radio carrier frequencies 2.5, 5, 10, 15, 20, 25, 30 and 35 megacycles are now being broadcast continuously day and night. Standard audio frequencies of 440 and 4000 cycles per second are transmitted on the carriers 10, 15, 20, and 25. The 440 cycle frequency, which is the standard of musical pitch (A above middle C), is broadcast on 2.5 and 5 megacycles.

With the new system the audio frequencies are interrupted at precisely one minute *before* each hour and at each succeeding five-minute period. They are resumed precisely on the hour and each five minutes thereafter. The exact moment to which the time refers is the moment of interruption of the audio frequencies of 440 and 4000 cycles per second. The audio frequencies will continue to be interrupted for one minute to allow for the time announcement, for station identification by voice at the hour and half hour, and to afford an interval for checking radio frequency measurements free from the presence of audio transmissions.

LETTERS TO THE EDITOR

Kilomegacycles; Megamegs

Dear Sir:

I can hardly believe I am alone in suspecting that the writer of the paragraph entitled "Begacycles", page 27, December, 1947, issue of your excellent magazine, must have had his tongue in his cheek, in defining units of 1,000 megacycles. I suspect that his proposal was put forth in an attempt to elicit suggestions for the larger-unit prefixes which now appear to be desirable in the electronic art.

Accordingly, may I recommend serious consideration of the proposal of Kenneth B. Warner, Secretary of the A.R.R.L., that we could advantageously use the term *kilomegacycles,* the meaning of which is perfectly obvious, easily expressed in conversation as *kilomegs,* and not readily confused with any currently used prefix, word or phrase?

May I go further and suggest that for millions of megacycles, we use the terms *megamegacycles,* again easily handled conversationally as *megamegs?* This would be following the "micromicrofarad" path. Kilomegacycles nicely abbreviates to kmc; megamegs to mmc.

There would appear to be in this proposal no greater order of bastardization of Greek roots, coupled with the desirable absence of confusion with existing accepted prefixes, than was originally employed in electing "mega" to describe million.

McMURDO SILVER,
President,
McMURDO SILVER CO., INC.
Hartford 3, Conn.

PERSONNEL

Joseph H. Gillies has been named vice-president in charge of radio division operations of Philco Corp. He will be responsible for coordination of engineering, purchasing, planning, material control and production of all Philco radio, television and other electronic products. He was previously in charge of Philco's radio production.

Leslie M. Graham has been appointed sales manager of Emerson Radio & Phonograph Corp. He was formerly the company's Midwest representative. He succeeds **Charles O. Weisser** who has been named West coast representative. **Stanley Abrams** returns to the company's eastern offices as sales promotion manager.

Virgil M. Graham, director of technical relations for Sylvania, has been elected chairman of the Joint Electron Tube Engineering Council. The objective of the Council is to standardize data and engineering practice for electron tubes.

H. Ward Zimmer has been appointed vice-president in charge of all manufacturing operations for Sylvania Electric Products, Inc. He was formerly in charge of the company's Radio Tube Division.

Emmett P. Rodemann, electrical engineer, and **Virginia Withington** have both recently joined the Kollman Instrument Division of Square D Company. Their respective assignments are research and project engineering.

William Clausen has been named vice-president in charge of manufacturing of the Farnsworth Television & Radio Corp.

James A. McGregor has been named president of the Microwave Equipment Co., Verona, N. J. He was formerly an engineer with the American District Telegraph Co.

Vice Admiral George F. Hussey, Jr., wartime chief of the Navy's Bureau of Ordnance, has joined the American Standards Association as administrative head of that organization. **Cyril Ainsworth,** who has been in charge of the technical activities of the ASA, will serve with Admiral Hussey as director of operations.

Commander Newell A. Atwood has assumed duties as Electronics Officer at the New York Naval Shipyard, succeeding Captain R. M. Huebl who remains at the naval post as Industrial Engineering Officer.

Neal McNaughten, former chief of the allocation section in the FCC engineering department's broadcast division, has joined the staff of the National Association of Broadcasters as Assistant Director of the Engineering Department.

L. W. Long, formerly manager of the substation section of the Allis-Chalmers' West Allis electrical department, has been named general manager of the company's Boston Works. R. O. Bell succeeds Mr. Long as manager of the substation section at West Allis.

Tracy Diers has been appointed Director of the Division of Experimental Radio Transmission of the Mahler Research Foundation in New York. He will intensify research in world-wide communications, using the facilities of his FM station W20QK-FM.

William O. Spink has been appointed field engineer for the Radio Division, Sylvania Electric Products Inc. He will cover Michigan, Ohio and Indiana territories.

Robert A. Elliot has been named manager of broadcast audio sales of the RCA Engineering Products Department. He formerly served in engineering sales with RCA and studio engineer and night manager of WQXR in New York City.

Gets TV Call Letters

WPIX are the new and permanent call letters of the television station operated by The News Syndicate Co., Inc., publishers of the New York Daily News.

NEW BOOKS

Ultrahigh Frequency Transmission and Radiation

By Nathan Marchand, Lecturer in Electrical Engineering, Columbia University, published by John Wiley & Sons, Inc., New York, 1947, 322 pages, $4.50.

The author prepared this book for use by the college students as a textbook in a prepared course and for use by practicing engineers for self-instruction.

The book discusses transmission line theory and elements of vector analysis, as well as fundamental electromagnetic equations. One chapter each deals with plane electromagnetic waves, radiation, antenna arrays, and wave guides. A section is also devoted to a study of current distribution in branched and shielded transmission lines.

Physical Principles of Wave-Guide Transmission and Antenna Systems

By W. H. Watson, Professor of Mathematics in the University of Saskatchewan, published by the Oxford University Press, Oxford, New York City, N. Y., 1947, 208 pages, $7.00.

The aim of this book, which is addressed to physicists and engineers, is to describe the way in which the technic of handling radio frequency transmission-lines has been extended to deal with propagation in wave guides.

The first chapter introduces the circle diagram for transmission line computations and reviews transmission line theory. The second chapter is concerned with the propagation of electromagnetic waves in the guide, while the third chapter deals with detection and measurement of the wave. Other chapters discuss wave guide coupling by slots in the walls of the guide, wave guide arrays, and other short-wave coupling and radiation apparatus.

IRE TV Session Feb. 28

An all-day symposium on Television is being arranged by the New York Section IRE to be held on Saturday, February 28, 1948, at the Engineering Societies Bldg. A full and varied program is planned. Sessions will be chairmaned in the morning by Arthur Loughren and in the afternoon by Murray Crosby. The day-long program is given below:

10:00—Andrew Alford: "Television Receiving Antenna".

10:30—H. Kallmann: "Television Antenna and R.F. Distribution Systems for Apartment Houses".

11:00—E. L. Clark: "Automatic Frequency Control of Sweep Oscillators".

11:30—Don Fink: "Standards for Testing Television Receivers".

2:00—P. F. G. Holst: "Intermediate Frequencies for Television Receivers".

2:30—S. W. Seeley: "I.F. Amplifiers for Inter-carrier Systems of Sound Reception".

3:00—Marico Valdettaro: "Television Channel Selection Systems".

3:30—G. F. Fredendall: "Standardization of Transient Response of Television Transmitters and Receivers".

Regulator Tubes

(*Continued from page* 47)

where, as before, 5 and 30 milliamperes have been used for the rated maximum and minimum tube currents. As equations (7) and (9) cover the majority of cases likely to be encountered in practice, they have been presented as nomograms in Fig. 2 and Fig. 3 respectively. It should be noted that, in the nomograms, k is given as a percentage, rather than as a per unit value. A few simple numerical examples will illustrate the use of the above equations in practical design.

Example 1: It is desired to use a VR105 to regulate the dc voltage supply for a small electronic instrument; the load required is 15 milliamperes, and is of a fixed nature. Power is to be obtained from the 115 volt ac line through the usual transformer-rectifier-filter arrangement. The expected line voltage variation is 10%, with an additional 5% allowance to cover the variation at different locations. Thus $k = 0.15$ in this case.

Using equation (7), we have

$$E'_1 = \frac{105}{1-0.15\,\dfrac{35+(2\times 15)}{25}} = 172 \text{ volts.}$$

This is the minimum voltage which can be used without exceeding the tube maximum current rating of 30 milliamperes, but there is nothing to prevent us using a higher voltage except economy. The most readily available standard transformer - rectifier - filter components give a voltage of 250 at the required load. We choose, then the value $E_1 = 250$ volts. Next, putting this value in equation (1), we obtain

$$250\,(1-0.15) = 105 + R\,(5/1000 + 15/1000)$$

$$R = 5{,}375 \text{ ohms}$$

In practice, of course, the above results would have been obtained by using the nomograms of Fig. 2 and Fig. 4 in turn.

Example 2: In a radio receiver, it is desired to use a VR105 to regulate the voltage supplied to the rf and IF screens and to the converter stage. Normal total current flow is 15 milliamperes, but on local stations the action of the automatic gain control reduces this current effectively to zero. In this case, then, equation (9) must be used. We have, assuming that $k = 0.15$, as in example 1

$$E'_1 = \frac{105}{1-0.15\,\dfrac{35+15}{25-15}} = 420 \text{ volts.}$$

The nearest available voltage is 450. Inserting this value is equation (1), we find

$$450\,(1-0.15) = 105 + R\,(5/1000 + 15/1000)$$

$$R = 13{,}400 \text{ ohms}$$

These two examples have been chosen deliberately to exhibit the striking difference in design parameters necessitated by the *type* of load. The variation in supply voltage, the tube type, and the *nominal* load currents are the same; from a superficial examination, one would expect identical design requirements.

It is instructive to compute the maximum tube current which would flow if example 2 had been incorrectly designed on the basis of equation (7). Taking the minimum supply voltage of 172, and inserting this equation (2), with

TELE-TECH

Advertisers February 1948

the corresponding value R = 2050, we obtain $I_{(max)} = 45$ milliamperes, and overload of 50%.

This emphasizes the importance of using equation (6) or equation (7) *only* in those cases where the load current is fixed. When the load is composed of vacuum tubes with indirectly-heated cathodes, and the supply voltage is obtained from a directly-heated rectifier, serious transient overload can occur in designs assuming a fixed load current exists.

The above paper forms part of a thesis presented to the Faculty of Graduate Studies and Research at McGill University, Montreal, in partial satisfaction of the requirements for a Master's degree in Electrical Engineering.

Compensation Networks

(Continued from page 29)

quency compensation network will introduce 3 db of attenuation at any frequency where X_c is numerically equal to R_2. Above this design-point frequency the attenuation curve is asymptotic to a six db per octave slope. At $.3f_{dp}$ the curve begins its departure from the minimum loss point. With this design information and R_2 equal to 135,000 ohms, a 700 mmf. capacitor is required for a 3 db loss at f_{dp} (1700 cycles). Fig. 3b shows the curve resulting from the addition of the 700 mmf capacitor to the network.

Other characteristic high frequency "roll-off" curves may be experimented with. For example, many 78 rpm domestic recordings appear to sound more natural when reproduced by a system equalized as in Fig. 3c. This characteristic may be obtained by omitting the 3 db per octave section of the high frequency equalizer and shunting R_3 of the 6 db per octave section with a 450 mmf capacitor.

In the 3rd and final article of this series, methods of combining the compensation networks and the basic design factors derived in Parts 1 and 2 will be summarized in chart form. An equalized preamplifier incorporating these networks will also be discussed.

REFERENCE

Harvey Fletcher and W. A. Munson, "Loudness, Its Definition, Measurement, and Calculation." Journal of the Acoustical Society of America, Vol. VI, No. 2, pp 82-108, Oct., 1933.

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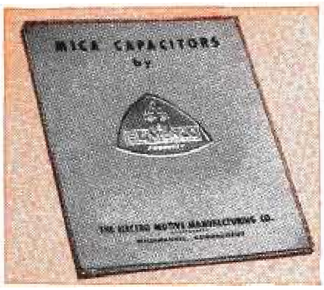

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