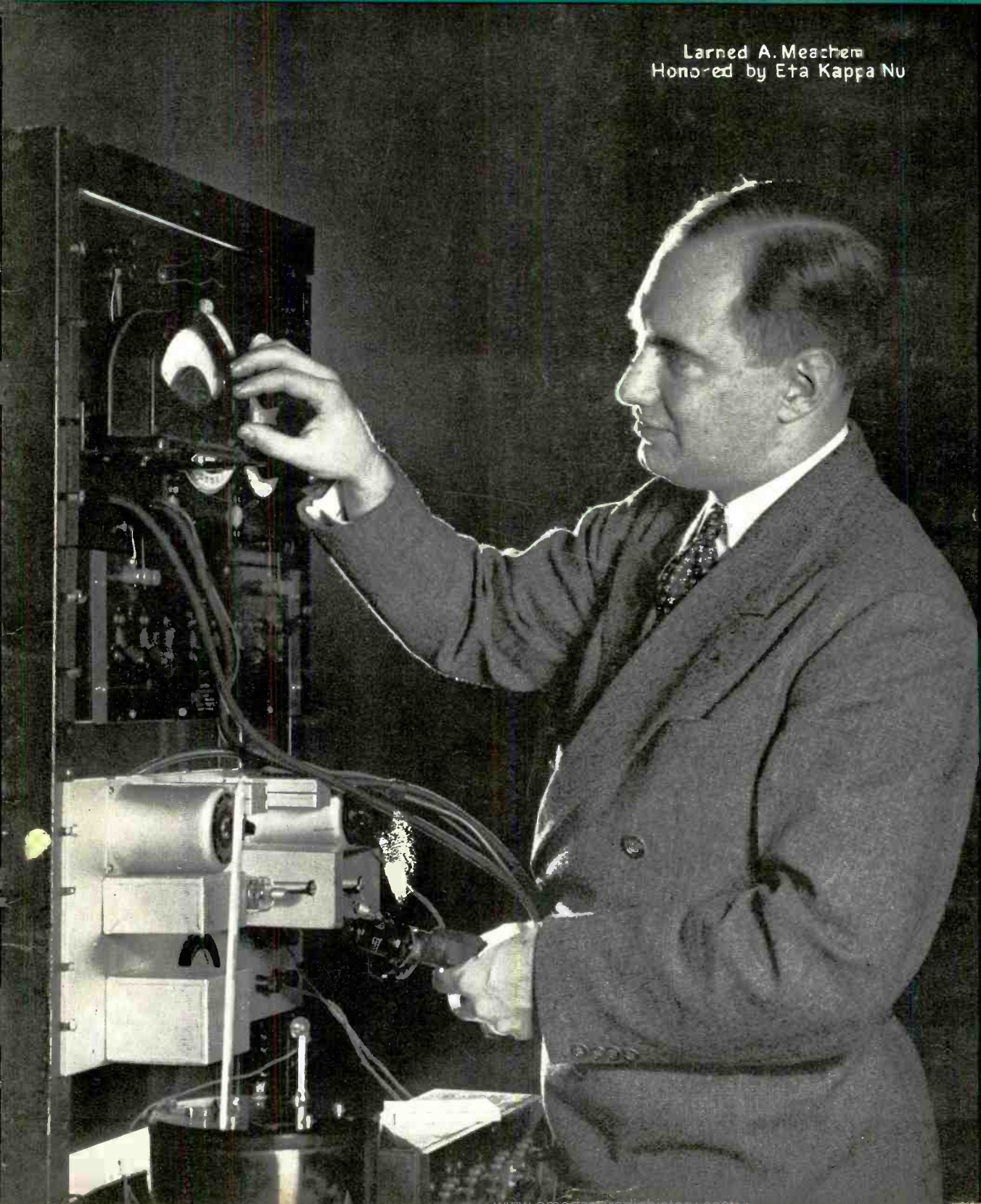


electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture



Larned A. Meachem
Honored by Eta Kappa Nu



**FEBRUARY
1940**

**Price
50 Cents**

**McGRAW-HILL
PUBLISHING
COMPANY, INC.**



Modern Engineering

Amperex tubes are not fashioned along design and engineering principles of a previous decade.

Independent research and experiment has resulted in the application of new engineering principles and an advanced concept of vacuum tube mathematics, to the design of the exclusive Amperex types, and to the redesigning of the older models.

The unquestioned leadership of Amperex in the design and production of U.H.F. tubes such as the HF 100, 200, 300, 849H, the popularity of the redesigned older models and the wide acceptance of the newly designed water-cooled line, containing structural and design improvements and refinements which enhance their efficiency and increase their longevity, are mainly due to this modern engineering.

AMPEREX ELECTRONIC PRODUCTS, Inc.
79 WASHINGTON STREET
BROOKLYN, NEW YORK

electronics

Radio... Communication
and Industrial Applica-
tions of Electron Tubes
... Design ... Engineering
... Manufacture

KEITH HENNEY
Editor

Donald G. Fink
Managing Editor

Beverly Dudley Associate Editor Craig Walsh Assistant Editor

M. L. Matthey Assistant Editor J. M. Heron Assistant Editor

Harry Phillips
Art Director



H. W. MATER
Manager

Wallace B. Blood
Sales Manager

Contents Copyright, 1940, by
McGraw-Hill Publishing Company, Inc.

MCGRAW-HILL
PUBLISHING COMPANY, INC.

JAMES H. MCGRAW
Founder and Honorary Chairman

Publication Office
99-129 North Broadway, Albany, N. Y.
U. S. A.

Editorial and Executive Offices
330 West 42nd St., New York, N. Y., U. S. A.

James H. McGraw, Jr., President
Howard Ehrlich, Executive Vice President
Mason Britton, Vice Chairman
B. R. Putnam, Treasurer
D. C. McGraw, Secretary
J. E. Blackburn, Jr., Director of Circulation

Cable Address:
MCGRAWHILL, New York
Member A. B. P. Member A. B. C.

CONTENTS—FEBRUARY, 1940

OUTSTANDING YOUNG ENGINEER.....Cover

Larned A. Meacham of the Bell Telephone Laboratories received the Eta Kappa Nu award of Recognition for Outstanding Young Electrical Engineers. Among his professional accomplishments is the bridge-stabilized oscillator which can maintain stability within 12 parts in ten thousand million

PATENTS,—HOW TO WRITE AND UNDERSTAND THEM, by Thad R. Goldsborough..... 10

A review of the usages and conventions of the patent office, of primary concern to the inventive section of the industry

A CATHODE-RAY FREQUENCY MODULATION GENERATOR, by Robert E. Shelby..... 14

A device resembling a cathode-ray tube which generates phase shifts of several hundred degrees, and thus requires less frequency multiplication than the conventional method

CONTROLLED FEEDBACK COMPRESSION AMPLIFIER, by H. H. Stewart and H. S. Pollock..... 19

Application of feedback to reduce distortion in a compression amplifier at the expense of gain which may readily be obtained elsewhere in the system

THE DU MONT PROPOSALS..... 22

Proposed changes to the television transmission standards, involving fewer pictures per second and more lines, without increase in bandwidth

CONTROL OF PHOTOMETRIC MEASUREMENTS, by Britton Chance..... 24

Use of a phototube to control the accuracy of photometer indications by monitoring the light intensity

FREQUENCY MODULATION IN TELEVISION—A SYMPOSIUM... 26 I—F-M Applied to Television, by C. W. Carnahan

II—F-M and A-M in a Television Signal, by A. V. Loughren

Two timely papers combining topics of intense interest in the electronics field, bearing on the question of standardization of the as-yet-unused television channels above 100 Mc

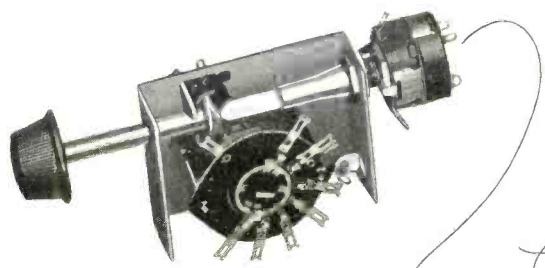
GAIN OF DIRECTIONAL ANTENNAS, by William S. Duttera... 33

A chart giving the expected voltage gain of two-element arrays for 90 and 190 electrical degrees electrical height

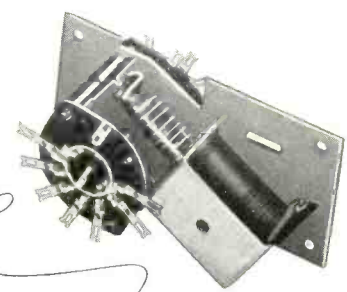
DEPARTMENTS

CROSSTALK.....	9	TUBES.....	48
REFERENCE SHEET.....	33	ELECTRON ART.....	57
TUBES AT WORK.....	34	INDUSTRY IN REVIEW.....	65
INDEX TO ADVERTISERS.....		76	

ELECTRONICS, February, 1940, Vol. 13, No. 2. Published monthly, price 50c a copy. Subscription rates—United States and possessions, Canada, Mexico and Central American countries, \$5.00 a year. All other countries, \$6.00 a year or 36 shillings. Entered as Second Class matter, August 29, 1936, at Post Office, Albany, N. Y., under the Act of March 3, 1879.
Branch Offices: 520 North Michigan Ave., Chicago; 68 Post Street, San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

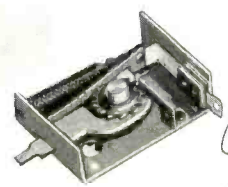


Coincidental single shaft operated selection switch, and volume or tone control. Station selection in automobile or home radio or wave band selection.

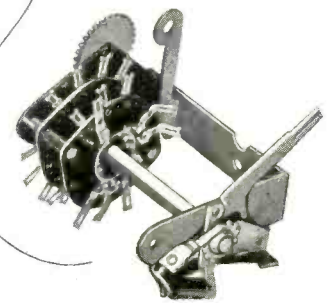


Single push button operated selector switch for Automobile or home radio. Station selection or wave band switching.

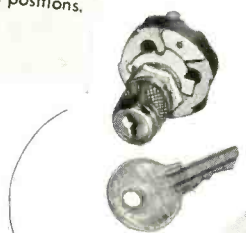
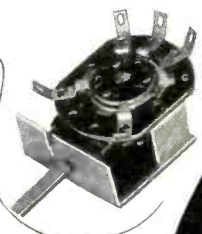
Special single contact switch to operate remote solenoid and index dial at same time.



Solenoid operation selector switch. Single push button, automobile, or home radio controlled remotely.



Single-Push operated tone switch. Selections of various tone positions.



Key operated line or tone switch, where unauthorized adjustment is imperative such as coin phonographs. Can be applied to any type of shaft operated switch.



Momentary open and closed circuit switches, Meter insertion, Record rejection, Record selection, Simple On-and-off switch.

Centralab Special Purpose Switches

Versatility . . . beside the orthodox type, we are equipped to design and create switches and controls for various special applications, including complicated switching mechanisms.

Our Engineers are capable of developing any type of special control or switch apparatus from the "idea stage" to a successfully operating mechanism.

See us about any special application problem.

**CENTRALAB: Div. of Globe Union Inc.
MILWAUKEE WISCONSIN**



VARNISHED TUBING AND

.....SATURATED SLEEVING

NOW Branded in U.S.A.

- For close to twenty years TURBO Varnished Tubing and Saturated Sleeving have been identified with the uppermost in technical factors involved in sleeve insulation for standard electrical conductors.
- To assure such factors and substantiate a top reputation, the technical manufacturing processes and facilities of the entire world were combed and sifted until a product and source supreme in every essential detail were located and established.
- TURBO was the result and has thoroughly justified the effort and painstaking upbuilding over this long period.

• *Now* the process of manufacture so long carefully guarded has been brought to the United States, . . . lock, stock and barrel, . . . so that the supreme technical properties of TURBO Varnished Tubing and Saturated Sleeving become an assured American manufacturing process.

We have not only brought this proved process to our own manufacturing plant but have implemented it with the latest developments in American mechanical and electrically controlled production methods. The result is the first real advance in flexible varnished tubing in more than twenty years—a miracle of insulation chemistry.

Truly a tribute to American ingenuity.



Where TURBO is fabricated today.

As always, shipment the same day order—from the largest to the smallest—is received.

WILLIAM BRAND & COMPANY

276 Fourth Ave., NEW YORK CITY

217 No. Desplaines St., CHICAGO, ILL.

Mica Plate and products—Varnished oil tubing, Saturated Sleeving, Varnished Cambric, Cloths and Composites



THE LINE of MOST RESISTANCE

"Up Production!"—that has been the cry at Superior in the past year. And we have "upped" production.

New equipment, additions to our plant, increased personnel — all have been correlated to meet consumer demand.

But at the end of our production is a line of resistance which unswervingly keeps the entire plant in step—the inspection and call-off tables—where speed is always secondary to **QUALITY** control. Here the mark of "SUPERIORity" is checked; here are men whose sole duty is to represent you —the customer. To these men, "*they shall not pass*" is your assurance of every job well done.

SUPERIOR TUBE CO.

[THE BIG NAME IN SMALL TUBING]

NORRISTOWN, PENNSYLVANIA

★ Information about Superior Tubing is found in the booklet illustrated. A copy is yours for the asking.

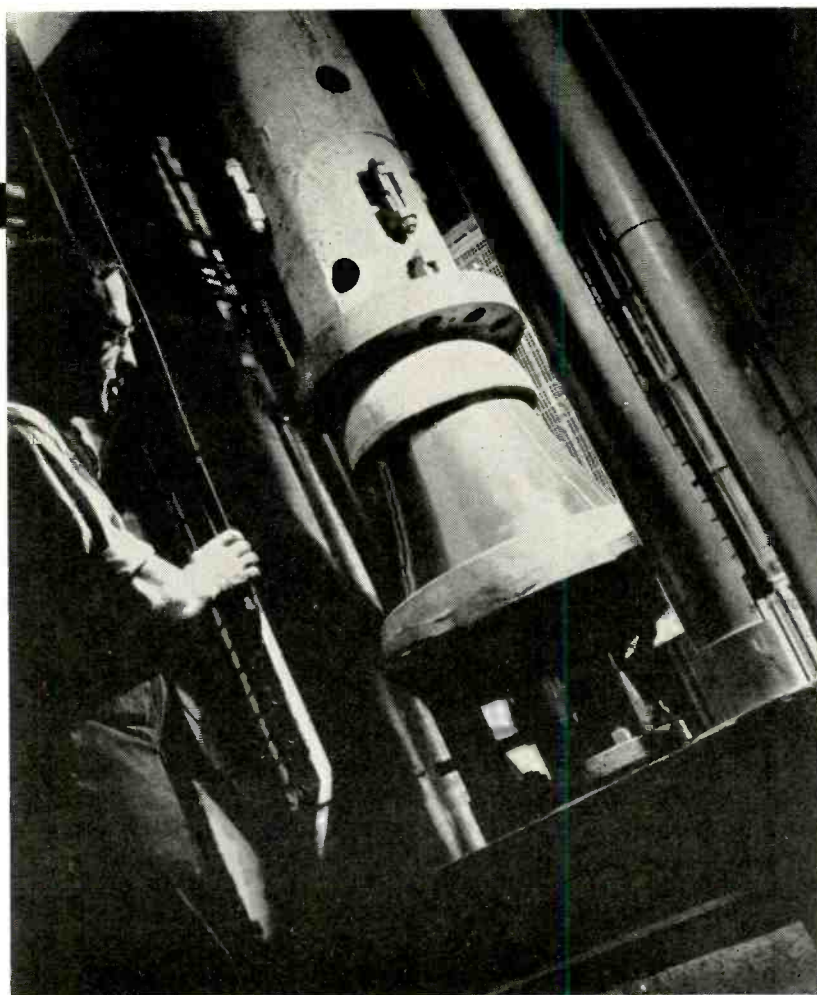


Tubing from 5/8" OD down . . . SUPERIOR  Seamless in various analyses. WELDRAWN  welded Stainless. BRAWN  Welded "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.

' ' F O R F I N E S M A L L T U B I N G ' '

THREE MILLION POUNDS

ON THIS PIECE
OF PORCELAIN



... ALL LAPP TOWER INSULATORS INCORPORATE THE SAME ENGINEERING DESIGNS

Visitors at the Lapp plant are often most amazed at this demonstration—the proof test of a porcelain base insulator with 1,500,000-lb. loading. On design test, this same unit withstood 3,000,000 lbs.

We are proud of a porcelain cone of two-and-a-half-inch wall thickness that will stand up under 3,000,000 lbs. of compression loading. But we don't claim any magic for it. It is merely the application of sound engineering principles in mechanical design and in porcelain production.

Back of every Lapp development is the same kind of thinking. Products for radio transmission include tower footing and guy insulators, porcelain water cooling systems and pressure gas-filled condensers. Every engineer contemplating installation of a new transmitter, or modernization of present equipment, should hear the Lapp story.



LAPP

INSULATOR CO., INC., LEROY, N. Y., U. S. A.

Introducing
AEROLAC



**A NEW
HIGH VOLTAGE
WIRE OF
UNUSUAL STABILITY**

Indicated for use for—

- POWER TRANSFORMER LEADS
- HIGH VOLTAGE TELEVISION CIRCUITS
- AIRCRAFT INSTRUMENT WIRING
- HIGH VOLTAGE PLATE LEADS
- WHEREVER A HIGH-TEMPERATURE-RESISTING AND HIGH-DIELECTRIC WIRE IS REQUIRED.

With a voltage breakdown of over 9000 volts AC per foot immersed in mercury, AEROLAC is indicated for a wide variety of applications. It is particularly well suited for use where excessive heat is encountered as its cellulose insulation and flame-resistant lacquer impregnation are effective under temperatures where ordinary rubber insulation would deteriorate.

AEROLAC is made in a variety of sizes and colors. Samples will be submitted on request.

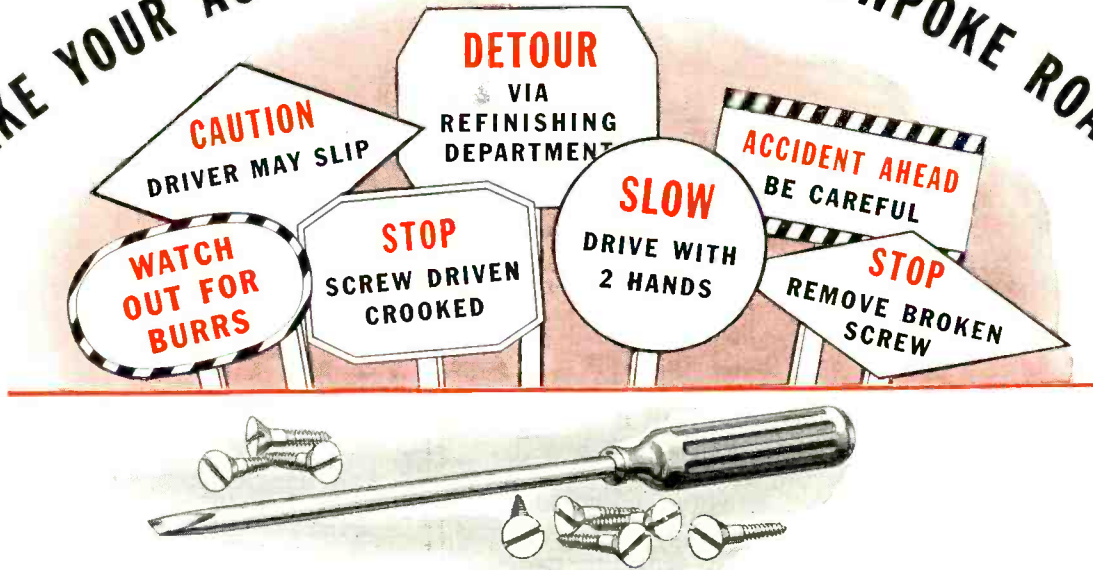


**LENZ ELECTRIC
MANUFACTURING
COMPANY**

1751 No. Western Ave.
CHICAGO U. S. A.

ENJOYING OUR 35th YEAR OF SUCCESSFUL BUSINESS

TAKE YOUR ASSEMBLY WORK OFF "SLOWPOKE ROAD"



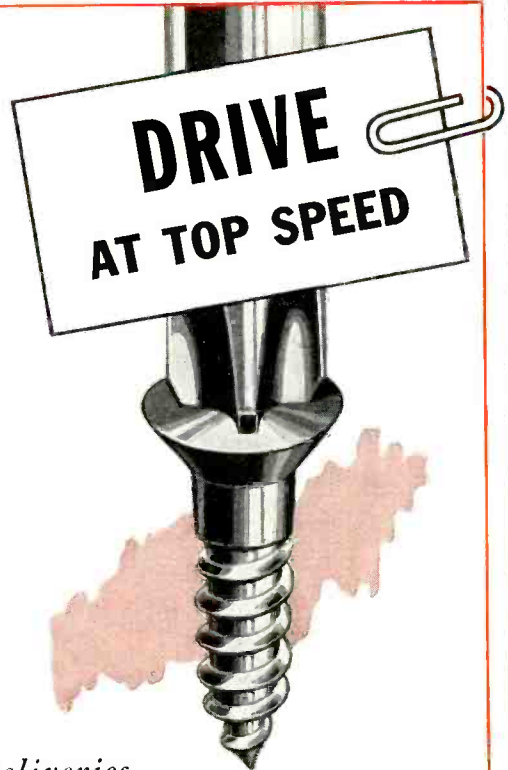
**HERE'S THE SAFE WAY
TO SPEED UP ASSEMBLIES**

Trouble meeting delivery dates has convinced many manufacturers to change to Phillips Recessed Head Screws. Conventional slotted screws cause traffic jams in the production line. Driving must be done cautiously—for there's always the danger of the driver slipping from the slot and scarring the work.

But the Phillips Driver fits snugly into the recess of the Phillips Screw—there's no danger of accidents, and faster driving methods can be safely used (power drivers for many more types of jobs than before).

Even when driving by hand, Phillips Screws require less effort. They drive straight automatically and set up tight without danger of split heads or reaming out the metal. Stronger assemblies mean better products.

So—join those manufacturers who are saving an average of 50% in assembly cost and meeting earlier delivery dates. Get in touch with one of the firms listed below.



PHILLIPS SCREWS *Speed Product Deliveries
by Cutting Assembly Time*



PHILLIPS RECESSED HEAD SCREWS

MACHINE SCREWS

SHEET METAL SCREWS

WOOD SCREWS

STOVE BOLTS

U. S. Patents on Product and Methods Nos. 2,046,343; 2,046,837; 2,046,839; 2,046,840; 2,082,085; 2,084,078; 2,084,079; 2,090,338. Other Domestic and Foreign Patents Allowed and Pending.

American Screw Co., Licensor, Providence, R. I.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corporation, New Britain, Conn.

The Lamson & Sessions Co., Cleveland, Ohio
National Screw & Mfg. Co., Cleveland, Ohio
Parker-Kalon Corporation, New York, N. Y.

Pheoll Manufacturing Company, Chicago, Illinois
Russell, Burdissall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Lock Washer Co., Chicago, Ill.



*Their use reflects
their QUALITY*

P. R. MALLORY & CO. Inc.
MALLORY

*Precision Vibrators are original equipment in
4 out of 5 auto radios*

Mallory Vibrators lead all other makes combined, as original equipment in auto radio on one basis . . . performance. No other consideration would support such broad leadership, for undependable vibrator performance could easily jeopardize a manufacturer's reputation.

Mallory manufactures both the 4 contact and 8 contact type of construction. They will exactly match the requirements of your present design . . . and offer limitless opportunities around which to build new model receivers.

Mallory Vibrators assure trouble-free long life . . . lowest operating cost per hour. Take your cue from the millions already in use and insist on Mallory . . . they cost no more.

P. R. MALLORY & CO., Inc.
INDIANAPOLIS INDIANA
Cable Address—PELMALLO

P. R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO. Inc.
MALLORY VIBRATORS

**are Original Equipment in Auto
Radio Receivers built for:**

BUICK	OLDSMOBILE
CADILLAC	PACKARD
CHEVROLET	PONTIAC
FORD	SEARS-ROEBUCK
HUDSON	WESTERN AUTO
LA SALLE	FIRESTONE
NASH	

and in Auto Receivers built by:

Canadian Marconi	Pilot
Colonial	RCA
Crosley	RCA-Victor, Ltd. (Canada)
Detrola	Radio Products
Delco (Kokomo)	Rogers-Majestic, Ltd.
Fairbanks-Morse	Sparton (Canada)
Galvin (Motorola)	Stewart-Warner
Gifillan	Stewart-Warner-Alemite (Canada)
Mission Bell	Stromberg-Carlson (U.S. and Canada)
Noblitt Sparks (Arvin)	Zenith
Northern Electric (Canada)	Western Electric
Packard Bell	



CROSS TALK

► **FLOP** . . . Through the courtesy of Radio Engineering Laboratories we have been playing with a frequency modulation receiver for a week or more. We are disappointed. Let us hasten to say that our disappointment is not with the receiver or with frequency modulation. The trouble is in another direction; and we think it is serious.

This receiver, and the Alpine transmitter are good; the band is wide, the distortion is low, the entire system is exceedingly quiet. But the programs, although taken from one of the large chains, are simply fierce. We listen from after-dinner to time to take the dog out for a walk (9 PM) and except for theme music a \$10 radio would do us just as much good as the R.E.L. job. In other words we have ears but nothing to listen to.

On Sunday the Philharmonic comes in so well that we lock the front door, pull down the blinds, take the car down the block and park it so the whole place looks as though we have gone to the country for the day, or to Florida for the winter—just to be immune from interruption. But this is just about all the good we get from the f-m system.

It seems that the serials now on the air are so plentiful and so firmly entrenched and so interspersed with other palaver that it is not until 9 PM or later that the musicians have a share of the ether. Our demands are not much; we don't want a full symphony every night. A bang-up jazz band is always tolerable, and would be mighty pleasurable with this R.E.L. receiver—but serials, like love, seem to be easy to start and difficult to stop. While love often comes to a logical and fore-

ordained end, there is never any termination to a serial.

In New York City, several other frequency modulation stations are under construction. Maybe the program they radiate will be better.

► **A.W.O.L.** . . . Now it seems that the town of Millburn, New Jersey, has a police radio system, two-way. During the holidays a little situation arose which is now in the process of a natural although somewhat anguishing solution. Let the Millburn & Short Hills ITEM tell it, "an officer whose name is as yet undisclosed was on duty in one of the police cars and the night being cold and blustery, the lone vigil was anything but conducive to the spirit of the season.

"Bethinking himself of a girl friend who might shorten the hours from dusk to dawn, she was taken along on the nightly round." As they went toward one of the "township's back areas" the officer reported his pseudo position regularly until he finally forgot to turn the send-receive switch. He left it in "transmit."

Thus it was that a startled sergeant at Headquarters heard a remarkable communication, "Aw sister, have a heart, give a guy a kiss." The ITEM does not state how many other police cars Millburn has but it implies that all of them went hunting dark lanes pronto and "the broadcast finally came to a natural end as all such inspired moments, and now a police trial is in the making."

Note to police radio men—when in doubt leave the switch in "receive" position.

► **CONFERENCE** . . . As this issue is mailed, a group of students and

broadcast engineers will be headed for Columbus, to attend the 1940 Broadcast Engineering Conference at Ohio State University. As in past years, the program is up to the minute, and the speakers are authorities in their fields. For example, the symposium on frequency modulation will be conducted by Major Armstrong, Paul de Mars of the Yankee network and Engineers Weir and Shea of G. E., all men who eminently qualified for the job. Similarly worthwhile sessions will be held on station measurements, u-h-f propagation, noise, receivers, transcriptions, transoceanic relays, television, and even the relationship between Law and Engineering. For those who can afford the time, the Conference is highly worthy of attendance.

► **AUDIENCE** . . . As we go to press, a report by Alfred H. Morton, Vice President of NBC in charge of television activities, reveals that the mailing list of their program schedule, mailed to owners of television receivers, has increased in three months from 249 names to 1005 names, and that the list is growing at the rate of 10 per cent per week. Estimates based on these figures show that there were, in the first week of January, approximately 2000 receivers, with an average audience of perhaps 8,000 people, with a potential audience of 10,000. While the number itself may not be impressive, the rate of growth, we think, will come as a shock to those who have been claiming that television is a dismal failure. The report also shows that the audience enthusiasm, as indicated by return cards on which the viewers check their reaction to the programs, is steadily climbing.

PATENTS . . . How to Write

In the rapidly moving field of electronics, patents form an important part of the literature. But patents must be written according to rules, so that reading them is not always an easy task. Mr. Goldsborough's article gives a quick insight into the writing of patents, useful not only to those who cannot afford the services of an attorney, but also to the larger group of engineers who must read patents for information.

TO SUPPORT a valid and enforceable patent, an invention must be "new" and "useful." That is to say, the invention must be original, not known nor used before, and must be operative. Furthermore, gambling devices are not patentable; neither is any invention that is contrary to law or subversive of public morals.

From the inventor's standpoint, the usefulness of a patent depends on commercial value. A patent on a non-commercial article or method would be worthless to the inventor, even though it cost him nothing to obtain. The inventor, therefore, should ascertain first if a market exists for his invention and, thereafter, the records in the Patent Office should be searched to determine whether or not it is "new." The charge for a preliminary search is never excessive and there are many patent attorneys in Washington, D. C., who will be glad to handle the details. It is advisable to have such a search made, even though the inventor, because of lack of funds, must be his own attorney in preparing and filing the application.

A patent application must comply in form with certain definite requirements set forth in the Rules of Practice, a copy of which may be obtained by writing to the Patent Office. Strict compliance with the Rules will forestall innumerable vexatious delays and misunderstandings; they should be carefully studied before the writing of an application is undertaken.

Writing the Application

If the invention is capable of illustration, it is advisable to have

the drawing made by a patent draftsman; his fee will not be high unless the invention is complicated and requires more than one sheet of drawings.

Before starting the specification, the inventor had best determine to what statutory class his invention pertains, i.e., is it an "art", a "machine", a "manufacture" or a "composition of matter?" The following definitions are offered as a guide:

An Art is a method or process whereby ingredients or instrumentalities are manipulated, combined or rearranged in order to produce a new or improved result or an old result more effectively or expeditiously. A patentable method or process may be manual, mechanical, electrical, chemical or metallurgical and may, and generally does, involve the utilization of apparatus or machinery to some extent, but it must be something more than the mere operation of a specific machine or piece of apparatus.

A Machine is an instrumentality, composed of one or a plurality of elements, which is utilized to perform some useful function in the mechanical arts, such function being the uniting, segregating or transforming of materials or energy of some sort. In other words, a machine is an instrumentality which, either alone or as utilized by the energy of human beings or animals, does work of some sort. For example, a printing press and a lathe are machines and, likewise, a crowbar and a screw driver are machines.

A Manufacture, according to the writer's understanding, is an instrumentality having passive properties.—That is to say, one which is not utilized for uniting, segregating or transforming materials or energy, but is used by itself as an adjunct to the convenience or comfort of the user, such, for example, as a wall or floor covering, a pavement or a box.

A Composition of Matter is what the name indicates, and in order to be patentable, must have such useful characteristics as are due to the

combination of the various ingredients and, therefore, something more than a mere assembly in which each ingredient performs its own function without modification because of its association with the other ingredients.

In the following pages, U.S. Patent No. 2,010,133, relating to resistors, and No. 2,073,060, disclosing a novel capacitor, will be referred to as examples.

Preamble

For the convenience of the Patent Office in classifying the patent and to facilitate searches, every patent application should start with a brief preamble explaining, generically, to what Art the invention pertains and



and Understand Them

By
THAD R. GOLDSBOROUGH

giving the specific niche in the Art wherein the invention is further to be classified. For example, the application that resulted in patent No. 2,010,133 began as follows:

"My invention relates to resistors and more particularly to resistors of types suitable for use in radio receivers, wherein noise occasioned by variation in resistance during the passage of current therethrough must be minimum."

It is to be noted, at this point, that the Preamble almost invariably contains the title of the application and of the subsequent patent. In the formal papers accompanying the application referred to, the title was "Resistor."

Following the preamble, the writer has always found it helpful to give

a brief resumé of the prior art, pointing out, if possible, the defects of prior art devices and thus laying a foundation for the invention. It must be kept in mind, however, that the application should not contain any remarks in derogation of an issued patent although the shortcomings of the patented device may be referred to.

Objects of the Invention

Having laid the foundation for the invention, the next part of the application should deal more specifically with the problems confronting the inventor. Such problems, in the application, are conventionally referred to as "objects."

A few of the objects enumerated

in the mentioned patents are quoted below:

#2,010,133. "It is, accordingly, an object of my invention to provide a new and improved resistor that shall be substantially free from noise when used in an amplifier."

#2,073,060. "It is, accordingly, an object of our invention to provide a new and improved method for forming a stable anodic film on an aluminum electrode."

"A still further object of our invention is to provide a capacitor manufacturing method such that the shelf life of the finished product shall be greatly enhanced."

The "objects" should not include the actual invention itself. For example, in the resistor patent application it would be incorrect to say: "It is an object of my invention to provide a resistor composed of asbestos, ground glass, bakelite and colloidal carbon." Such an object is totally out of place, because it is the solution of the problem, i.e., the invention per se.

After enumerating the objects, a brief description of the invention should be given. The following description appears in patent No. 2,010,133:

"The foregoing objects and other objects ancillary thereto I prefer to accomplish, in short, by first coating particles of filler material, such as asbestos, powdered glass, sand, or the like, or a mixture of filler materials, with a polymerizable resin in solution and thereafter causing conducting material, preferably graphite and/or carbon black, to be precipitated upon the coated particles from a colloidal solution thereof."

The next section of the specification called for by the Rules of Practice is a brief description of the drawings. To go from the synopsis of the invention to the description of the drawings, however, introduces a rather abrupt change into the continuity of the specification. It has been found helpful, at this point,

THE SEARCH ROOM OF THE UNITED STATES PATENT OFFICE. It is the privilege of anyone to examine a copy of any patent ever issued and, upon the presentation of the proper credentials, to examine the complete original file of any patent. It is here that all searches are made before making an application.



therefore, to use what is sometimes termed a "Liaison Paragraph."

Brief Description of Drawings

According to the Rules of Practice, each figure of the drawing should next be briefly described, and a few observations on the verbiage of conventional descriptions are not amiss.

The figures of the drawing should never be referred to as actual objects. If the invention is mechanical in nature, the figures may be described as "views." In Patent No. 2,073,060 there is but a single figure; it is referred to as follows:

"The single figure of the drawing is a conventionalized sectional view of a wet electrolytic condenser of the general type exemplified by the patents hereinbefore referred to."

In patent No. 1,977,997, disclosing an electronic control system for causing color changes in accordance with musical tones, the two figures of the drawing are described as follows:

"Figure 1 is a simplified schematic view of a complete control system comprising a preferred embodiment of my invention, and

"Figures 2 and 3 are diagrammatic detail views of portions of the system shown in Fig. 1."

The figures should be numbered and described in proper consecutive order. That is to say, a sectional view, if based upon a view in vertical elevation, should bear a higher number, and views of details should be described subsequent to the description of the principal figure.

Detailed Description

Contrary to the belief of many inventors, a patent is strengthened by minute and detailed disclosure, rather than weakened.

In dictating the detailed description of the invention as exemplified by the drawing, the writer has found it somewhat helpful to imagine that he is verbally explaining it to a blind man. He first describes the invention without including the numerals referring to the parts of the drawing, which numerals he later applies to the drawing and inserts into the rough draft of the specification after it has been typewritten. The numerals, of course, should run in consecutive order and, if the odd numbers only, 1, 3, 5, 7, etc., are initially used throughout the specification, the even numbers may be interpolated into the draft without disturbing the sequence, should omissions be found. When two or more figures of the drawing disclose equivalent parts,

such parts should always bear the same reference numerals in each of the views. The use of letters of the alphabet should be avoided, as well as numerals bearing subscripts or exponents such as 6_n, 9ⁿ, and the like.

Those who take up the art of specification writing for the first time are very prone to supply only a catalog of component parts at this point. To merely enumerate the various parts of the device or the various elements entering into a new composition of matter, etc., is not at all helpful.

It is not feasible, of course, to quote the detailed descriptions appearing in either one of the patents being utilized as examples; the reader is strongly urged to obtain one copy of each patent for future reference.

If the invention is in the chemical field, or relates to a composition of matter, the inventor should be sure to include reference to a number of equivalents of the various elements involved. Only by including a plurality of species of the same genus can a foundation for valid broad claims be established.

Mode of Operation

Obviously, if the invention pertains to an article of manufacture, there is no "mode of operation" to describe. If the invention pertains to an "art" or a "process," the necessary sequence of steps has been recited in the detailed description. On the other hand, if the invention relates to a machine, a circuit, or a system, it is often advisable to recapitulate the manner in which it functions, even at the risk of verbosity and repetition.

In order that the operation may be

clearly understood, a certain condition of the device or system should be assumed. Usually this is the normal condition of the device or that obtaining when the device is at rest. The operation should be followed in detail throughout a complete cycle. That is the device, or system, should be started from a condition of rest, followed through a period of normal operation and brought to rest. The description should follow the logical sequence of events as they would occur in practice. Give reasons for the various events in case they are

not entirely obvious.

Advantages of Invention

There is no obligation imposed upon the inventor to include in the specification the advantages accruing from his invention, but the custom has grown up to do so in order that the value of the invention may more clearly be apparent. In other words, the paragraph or paragraphs relating to the advantages of the invention constitute what might be termed a "selling talk"

which serves the purpose of impressing the Examiner and also is of value in the event that patentee desires later to sell his patent. For these reasons, it is always well to include, at this point, a summary of all of the advantages attained by the invention.

Claims

The claims, of course, define the boundaries of the invention, and constitute the actual subject-matter of the patent grant. Even though such is the case, it is considered best to interpose a paragraph somewhat like the following between the body of the specification and the claims:

"Although I have shown and described certain specific embodi-

ments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims."

The paragraph so inserted does not really enlarge the monopoly granted by the patent, but its use has become so universal that it is regarded, by many attorneys, almost as a fetish.

Claim writing is an art in itself. If possible, the inventor should order a copy of a very excellent book on the subject, "Patent Claim Drafting," from the author, Emerson Stringham, Box 288, Pennsylvania Avenue Station, Washington, D.C. It is well worth the price, \$5.00. Before beginning the writing of the claims, it is advisable to review the specification in detail and to make note of any new or unusual terms found therein. This for the reason that the specification constitutes the dictionary by which the claims are later construed in the event of litigation.

At the present time, the Patent Office permits only 20 claims to be filed with an original application, unless a fee of \$1.00 per claim, for each claim over 20, is paid. Such being the case, it behooves the inventor to make sure that the invention is adequately covered by 20 claims and, if not, to add as many more as may be necessary.

Each claim is supposed to define an invention separate and distinct from the other claims and, for that reason, the inventor should make certain that the differences between the claims are real and are not merely immaterial limitations.

The scope of the claims should vary from that of the broadest which the known art will permit to that of the most specific. In case the prior art is uncertain or is unknown, care should be taken to embody sufficiently broad claims to avoid dedicating any portion of the invention to the public by reason of failure to claim it. On the other hand, ridiculously broad claims covering features notoriously old in the art should be avoided.

Contrary to the "matter of fact" character of the specification, the claims afford opportunities for considerable imagination and ingenuity, and full advantage should be taken of this fact.

The term "means for," accompanied by an appropriate statement of

function, should be employed to designate broadly portions of structures or groups of elements which may be patentable without reference to the specific details constituting such structures or groups of elements.

Care should be taken not to embody the entire structure in every claim, if the arrangement embodies sub-combinations that may be of value apart from the general combination. If the invention embodies several features, certain claims should be limited to those features.

The terminology of the claims should conform, insofar as is practicable, to that of the specification. It is confusing to employ one term in a claim and another in the specification to define the same element. This is not to be construed, however, as prohibiting the use of a generic term to define an element that may have a specific designation in the specification. Claims to an article of manufacture, a composition of matter and the method of making may appear in the same patent if each is "new and useful." A few claims from patent No. 2,010,133 will illustrate this.

Claim 1. "As element of a resistor device, a particle of inert, substantially non-con-

ducting filler material, a coating of insulating material thereon, and a film of conducting material upon the outer surface of the insulating material."

Claim 5. "The process of manufacturing a material from which resistors may be formed which comprises coating a plurality of particles of inert material with an insulating layer and thereafter depositing a conducting surface film upon substantially all of said particles."

Claim 15. "A resistor element in the form of a rod constituted by a plurality of particles of insert material, substantially all of said particles having a first coating of an insulating material and an outer coating of graphite and carbon black, the said particles being in such intimate contact with each other that a substantially uninterrupted electrically conductive path is established between the ends of the rod."

If the invention is sufficiently im-

portant to warrant filing abroad, it is well to include, as the final claim, one worded as follows:

20. "The invention substantially as described in connection with the accompanying drawing."

In the United States, the foregoing claim is unstatutory; the Examiner in the Patent Office will require its cancellation. It has definite value, nevertheless, if foreign patent applications are to be filed. Such applications, by the way, should never be handled by the inventor himself, but should be entrusted to patent attorneys specializing in the foreign field.

Claims should never be of the so-called "functional" type. That is to say, the usual mode of operation of a machine cannot be claimed because it is not permissible to claim a result apart from the actual means employed to obtain the result, nor can a claim to but a single "means"

be patented. The following few examples illustrate the difference between a functional claim and a claim in proper form covering the same general subject-matter:

Bad: An electrolytic capacitor having a longer shelf-life than capacitors heretofore known. In a capacitor of the wet electrolytic type, an electrolyte that promotes

freedom from failure and unusually long shelf-life.

Good: In a capacitor of the wet electrolytic type, a film-retaining electrolyte having a higher pH value than that of a film-forming electrolyte in which one of the electrodes of the capacitor was first formed, and having a pH value at least as high as that of a film-forming electrolyte in which said electrode was subsequently formed. (Claim 6, patent No. 2,073,060.)

As exemplified by the claim immediately above, it is sometimes permissible to define an article by the method of manufacture. Such procedure should be avoided, nevertheless, if the invention can otherwise be defined, as was the case in the

(Continued on page 46)

A Cathode-Ray Frequency Modulation Generator . . .

THE device herein described is a means of frequency- or phase-modulating a carrier signal obtained from an oscillator of constant frequency and phase, such as a crystal-controlled oscillator. The majority of the known methods for generating frequency or phase modulation involve variation of the frequency or phase of the master oscillator. There is one well-known method of producing phase modulation of a carrier obtained from a constant source which involves the addition of two voltages of the same constant frequency having a constant phase difference of 90° , one voltage having constant amplitude and the other varying in amplitude with the modulation signal.

This method is limited to maximum phase shifts of the order of 30° , which means that in order to obtain a large shift at the final carrier frequency, it is necessary to employ frequency multiplication of large ratio. The method proposed here does not have this limitation. Theoretically it should give distortionless phase shift of many times 360° .

Structurally the device consists of an electron gun, two sets of electrostatic deflection plates (or magnetic deflection coils), and a target anode of special design, enclosed in an evacuated container of suitable size and shape. A typical arrangement is shown schematically in Fig. 1. It will be seen that the device illustrated is similar to a conventional cathode ray oscillograph tube. The only fundamental difference is the novel design of the target anode. Figure 2 illustrates one form which the target anode may have. It consists of two (or more) metallic plates with curved edges, upon which the electrons from the electron gun impinge. In order to obtain phase modulation in which the angular

By **ROBERT E. SHELBY**

*Video Operations Engineer
National Broadcasting Company*

shift is a linear function of the modulation amplitude the edges of the plates have a curvature given by the polar equation

$$r = a \theta \quad (1)$$

which defines an Archimedian spiral.

In operation, the electron stream is deflected in such a way that it traces out a circle on the target anode, the diameter of the circle being a variable which is directly proportional to the instantaneous value of the modulation signal. This involves no new concepts other than those associated with the familiar cathode-ray oscillograph. When controlled in this way the electron stream produces a phase (or frequency) modulated wave upon striking an anode having the special design just described.

Details of Operation

The electron gun is controlled and focused by adjusting the d-c potentials applied to the cathode, control grid, screen grid, and first anode, just as in the case of oscillograph tubes and picture tubes. The electron stream is sharply focused on the target anode and when there is no voltage applied to the electrostatic deflecting plates it is adjusted to strike the exact geometrical center of the target anode. The inputs, which consist of two carrier waves of equal frequency and almost equal amplitude but differing in phase by 90° and having the same amplitude modulation, are applied to the two sets of electrostatic deflecting plates. Figure 2 illustrates one means of supplying the inputs. The output appears in the target anode circuit, across the impedance Z_A . If Z_A is a pure resistance the output voltage

appearing across it will be a flat-topped wave. By using a target anode composed of a larger number of curved sections the fundamental frequency of the flat-topped output wave may be made any desired multiple of the input frequency. Thus it is seen that, if desired, frequency multiplication may be obtained during the process of converting amplitude modulation into frequency or phase modulation.

For a more detailed explanation of the way in which amplitude modulation is translated into phase modulation, we refer now to Fig. 3. First, with no modulation, the phase shifting network and amplitude controls are adjusted so that the electron beam describes a circle on the target anode. If the master amplitude control is adjusted so that this circle is of the size designated by c_1 (Fig. 2) then the voltage appearing across Z_A will be as shown in Fig. 4A. Note that the electron stream passes from one segment of the target to the other at points p_1 and p'_1 . If now the two deflecting voltages are decreased 50 per cent by changing the master amplitude control, all other controls being left the same, the locus of the end of the electron stream will be c_2 and the voltage across Z_A will be as shown in Fig. 4B. The electron stream now passes from one segment of the target to the other at points p_2 and p'_2 . Likewise if the master amplitude control is adjusted to give voltages 50 per cent greater than those which gave the locus c_1 , then c_3 will be the new locus, the electron stream will pass from one target segment to the other at points p_3 and p'_3 and the voltage appearing across Z_A will be as shown in Fig. 4C. Now, if the master amplitude control is reset so that the electron circle falls on c_1 and a fifty per cent modulation is then applied to the carrier in the manner indicated by Fig. 3

Fig. 1—Arrangement of generator. The structure is very similar to that of an electrically-deflected cathode-ray oscilloscope tube, except that a target anode is used in place of the fluorescent screen

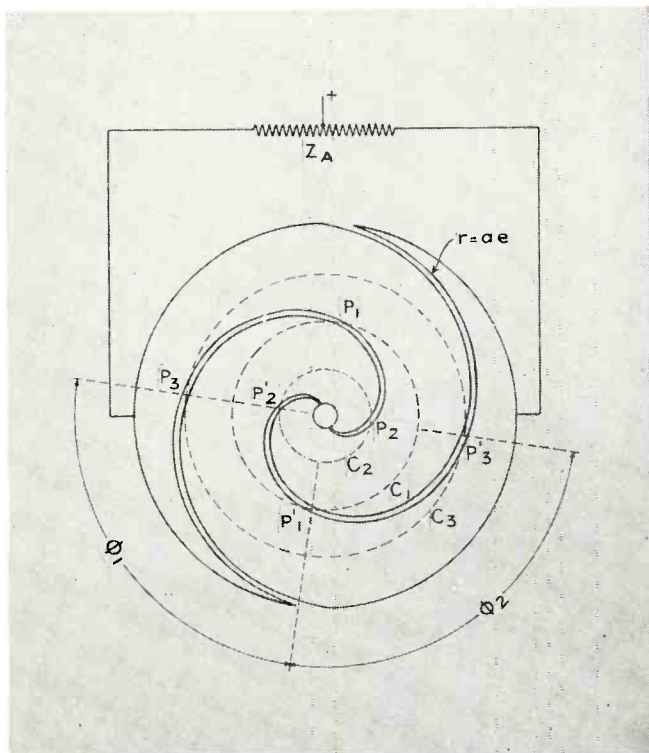
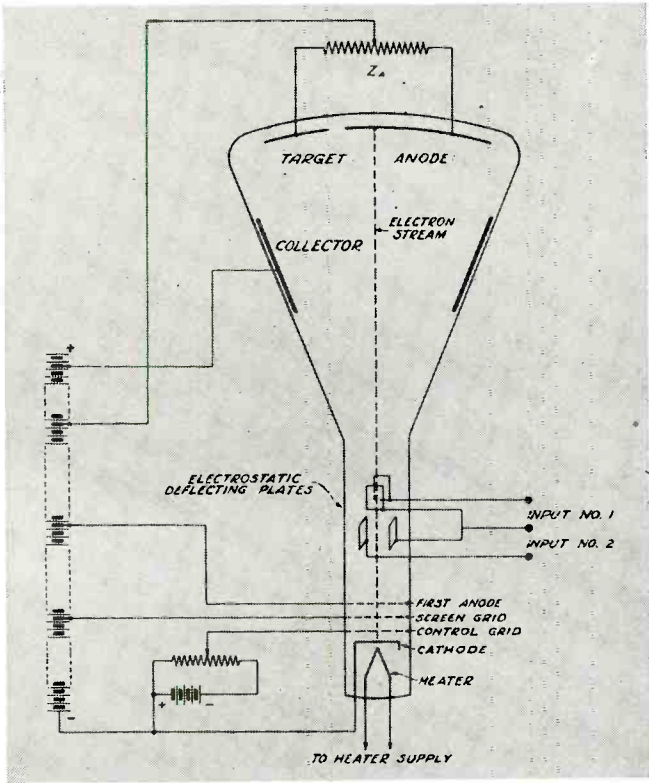


Fig. 2—Typical target anode, consisting of two metal plates divided by a pair of Archimedean spirals. The cathode ray beam scans the target in a circle of variable radius, producing square waves in the output

Fig. 3—Circuits for supplying the inputs to the generator. The carrier and modulation signal are combined in an amplitude modulator whose output is divided into two phases and applied to the deflecting plates

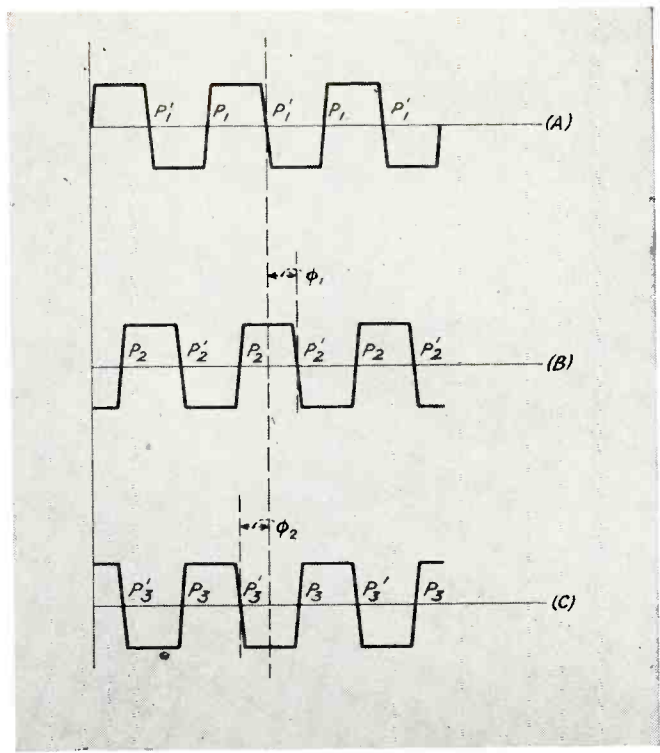
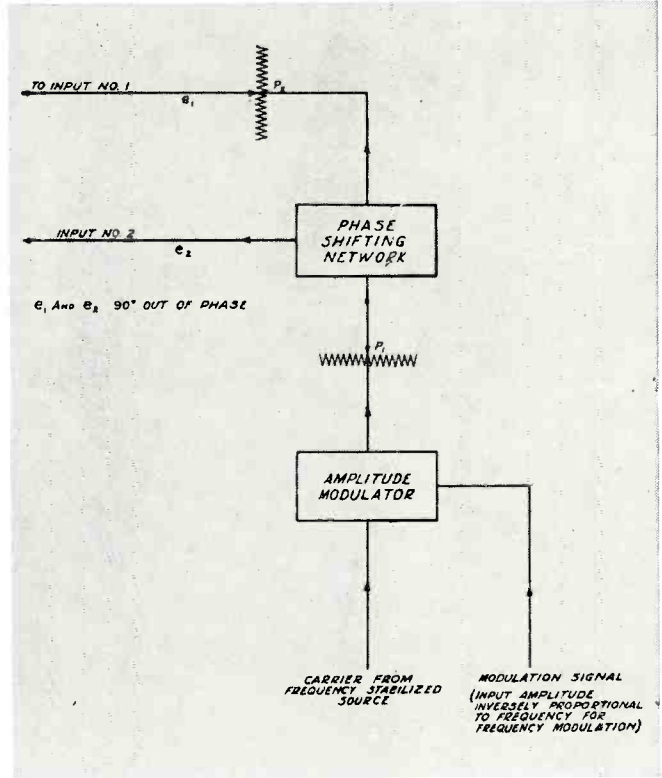


Fig. 4—Square wave outputs of the generator, lettered to correspond with the scanning circles shown in Fig. 2, opposite. The phase shift results in frequency modulated waves when the signal is passed through a frequency multiplier

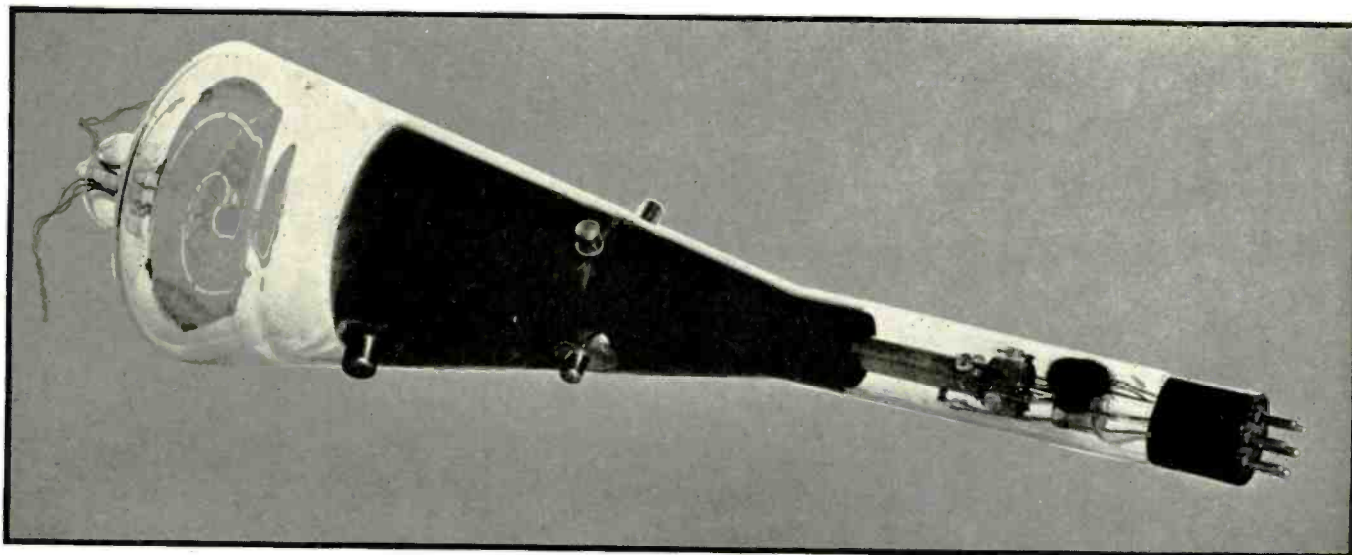
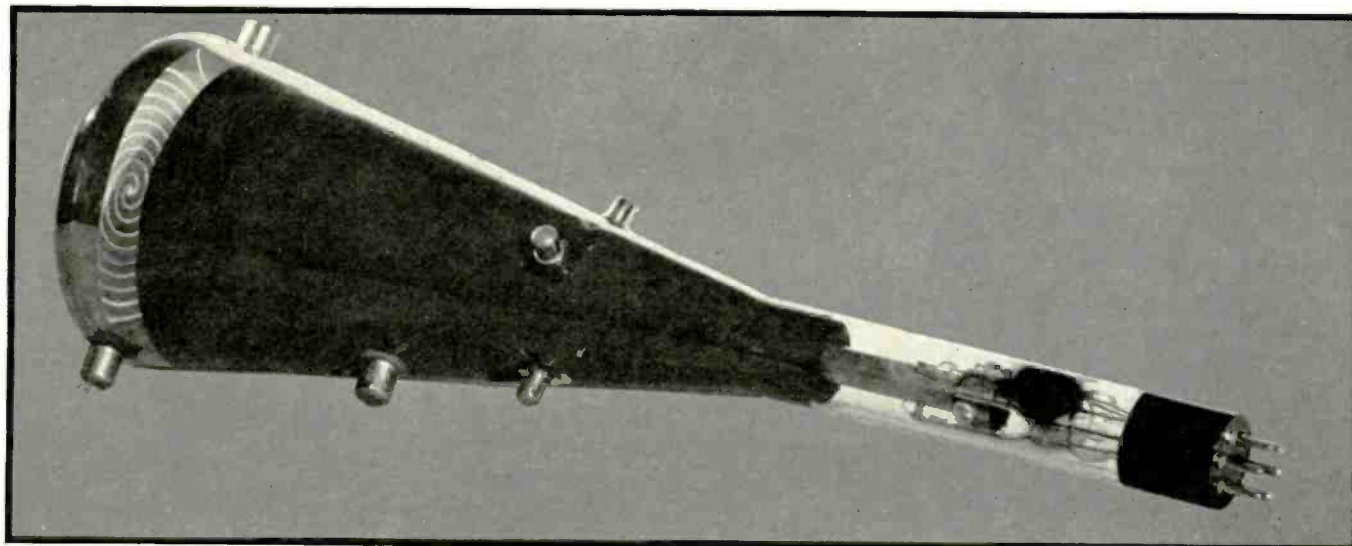


Fig. 5—Early form of the cathode-ray frequency modulation generator, mounted in a standard oscilloscope tube envelope. The target anode is composed of spirals which make one complete turn

Fig. 6—Later form of the generator. The spiral anode makes five complete turns, and hence the degree of phase shift, for a given change in scanning radius, is proportionately increased



the locus of the end-point of the electron stream will expand and contract between the limits c_2 and c_3 and the output wave will shift in phase between the limits indicated by Fig. 4B and 4C.

The amount of maximum phase shift in the device described above will be determined by the curvature of the target anode boundary—that is, it will depend upon the value of a in the equation $r a \theta$. For the target illustrated in Fig. 2 the phase shift is plus and minus approximately 90° when the input is amplitude modulated 50 per cent. Amplitude modulation of 75 per cent on the input will give shift of plus and minus 135° , etc.

It should be noted that this device is fundamentally a generator of phase modulation—not frequency modulation. However, any phase modulator may be made to produce the equivalent of frequency modulation by means of a network in the audio input having a characteristic that is inversely proportional to frequency. It will be understood that whenever the cathode ray modulator is referred to as a generator of frequency modulation, the use of such a network is implied.

Variation of the anode voltages will cause the sensitivity of the electron stream to vary so that for constant voltages on the deflecting plates the size of the circle described

on the final anode by the electron stream will vary as the anode voltages vary, thereby producing a form of phase modulation. This means that the d-c voltages supplied to the electron gun must be well-filtered and free from fluctuations.

Auxiliary electrodes may be added to the modulator tube for control or monitoring purposes. For example a fluorescent screen may be provided beyond the target anode, so that the electron stream will produce a pattern upon it when it passes between segments of the anode or beyond the outer edges of the anode plates. Additional electrodes, located in the same plane as the final anode, but electrically separate from it, may be

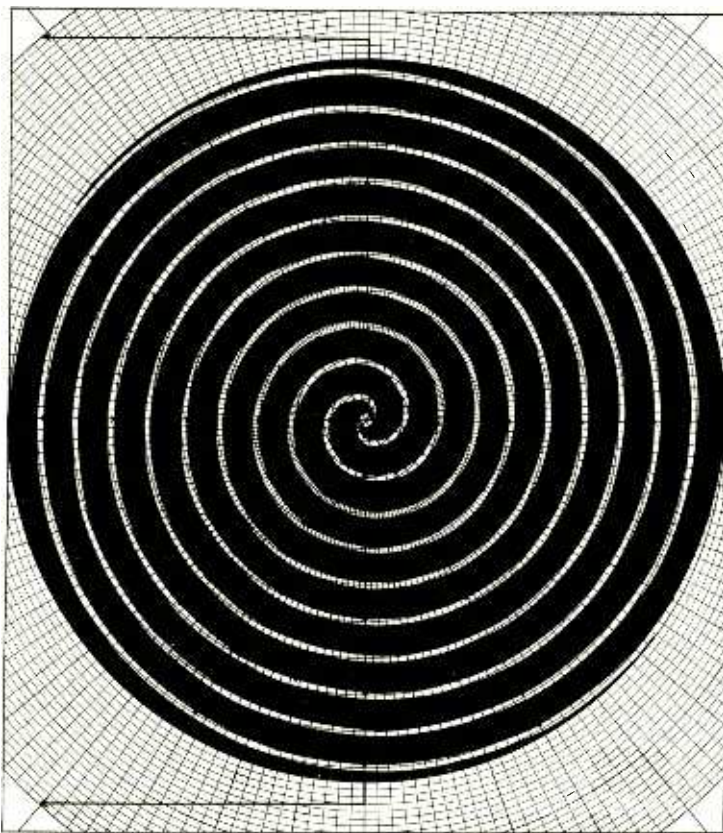


Fig. 8—Spiral anode of five turns, similar to that shown in the tube in Fig. 6. The spirals were formed by scribing through a platinum film on a mica support, thus separating the surface into two insulated segments

end of the tube. Electrical connections to the two electrodes of the target are brought out through this same seal.

The spiral of this target was designed to give a maximum over-all phase shift of 360° —that is to say, for this particular target the value of a in the equation $r = a \theta$ is $\frac{1}{\pi}$ inches per radian (the diameter of the target is approximately four inches). In order to facilitate adjustment and to judge operating performance four concentric circles and sixteen radial lines were marked on the surface of the target with willemite. The entire surface of the target was also covered with a very thin coating of willemite. This results in the electron beam tracing out a visible path on the target, which is helpful in testing the tube.

In constructing this tube the Radiotron engineers made provision for utilizing secondary emission from the target anode to provide additional output. This was done by providing a separate collector for secondary electrons in the form of a coating on the inner wall of the tube.

Figure 6 shows a photograph of a later model. The general design is

the same except that the target anode consists of a conducting coating deposited directly upon the inner surface of the large end of the tube and the spiral in this case contains five complete cycles. The configuration of this target is shown by Fig. 8.

Figure 7 shows a schematic of the transmitter set-up employed to test the frequency modulator tube. That portion of the circuit enclosed by the upper dotted rectangle represents a conventional r-f transmitter. It was of the crystal-controlled type with buffer amplifiers and frequency multiplier stages driving a final amplifier delivering a carrier output of approximately two kilowatts.

The crystal-controlled oscillator in the transmitter was used as the primary source of stabilized r-f voltage, the amplifier chain in the transmitter being broken between the buffer amplifier and the first doubler stages for insertion of the cathode ray phase modulator and associated apparatus, as shown.

To obtain the 90° phase relationship between the voltages on the two sets of deflecting plates of the cathode ray tube, a phase-splitting network consisting of a capacitive reactance in series with a pure re-

sistance was employed, one set of deflective plates being connected across the capacitive reactance and the other set across the resistance. In this set-up the internal capacity between one pair of the deflecting plates was utilized as the capacitive reactance. A parallel tuned circuit was bridged across the other set of deflecting plates to permit tuning out the reactance of the variable resistor and also that due to the capacity between these deflecting plates, thus obtaining a purely resistive impedance. The variable resistor in this circuit was used to adjust the relative amplitudes of the voltages on the two sets of deflecting plates, and the amplitudes of the two deflecting voltages were adjusted simultaneously by means of the variable resistor R_1 in series with the d-c plate supply to the modulated amplifier.

The output circuit connected to the two halves of the target anode was tuned to the fundamental crystal frequency and coupled inductively to the grid of an amplifier which in turn fed a frequency doubler. The succeeding stage fed a shielded r-f transmission line, the other end of which was coupled to the 860 stage in the transmitter which ordinarily operated as a doubler but which was used as a straight amplifier in this case. From that point on the various stages of the transmitter were operated in their usual manner.

The transmitter was located in the Empire State Building and reception tests were made with a frequency modulation receiver located in the Development Laboratory in Radio City. These tests showed that the cathode ray frequency modulator performed as predicted. When properly shielded against stray magnetic fields and provided with well-filtered d-c potentials, it introduced no measurable distortion and was perfectly stable in its operation.

In conclusion, acknowledgment is made of the cooperation of the RCA Radiotron Laboratories in constructing and supplying the tubes used in these tests and of the helpful suggestions offered by Radiotron and NBC engineers. The author also wishes to acknowledge with deep appreciation the encouragement and cooperation extended by Professor E. H. Armstrong of Columbia University during the early tests on this device.

Compression with Feedback

A practical volume-limiting feedback amplifier for broadcasters, which makes use of a tube in the feedback path whose plate resistance is varied as the volume changes. Low distortion and constant frequency response result

THE use of volume-limiting amplifiers or compressors in connection with radio transmitters is now fairly common and several excellent designs have been developed. It is felt, however, that an amplifier in which distortion is reduced by compression, should be of interest.

Unlike other electronic limiters where the gain is controlled by a variable- μ tube or a variable attenuator network, the gain is here reduced, when compression begins, by employing a negative-feedback circuit in which the percentage of output signal fed back to the input, increases with increasing input. This is accomplished by developing a bias in the output circuit of an auxiliary amplifier fed from the input side of

By H. H. STEWART and
H. S. POLLOCK

Queen's University, Kingston, Ontario

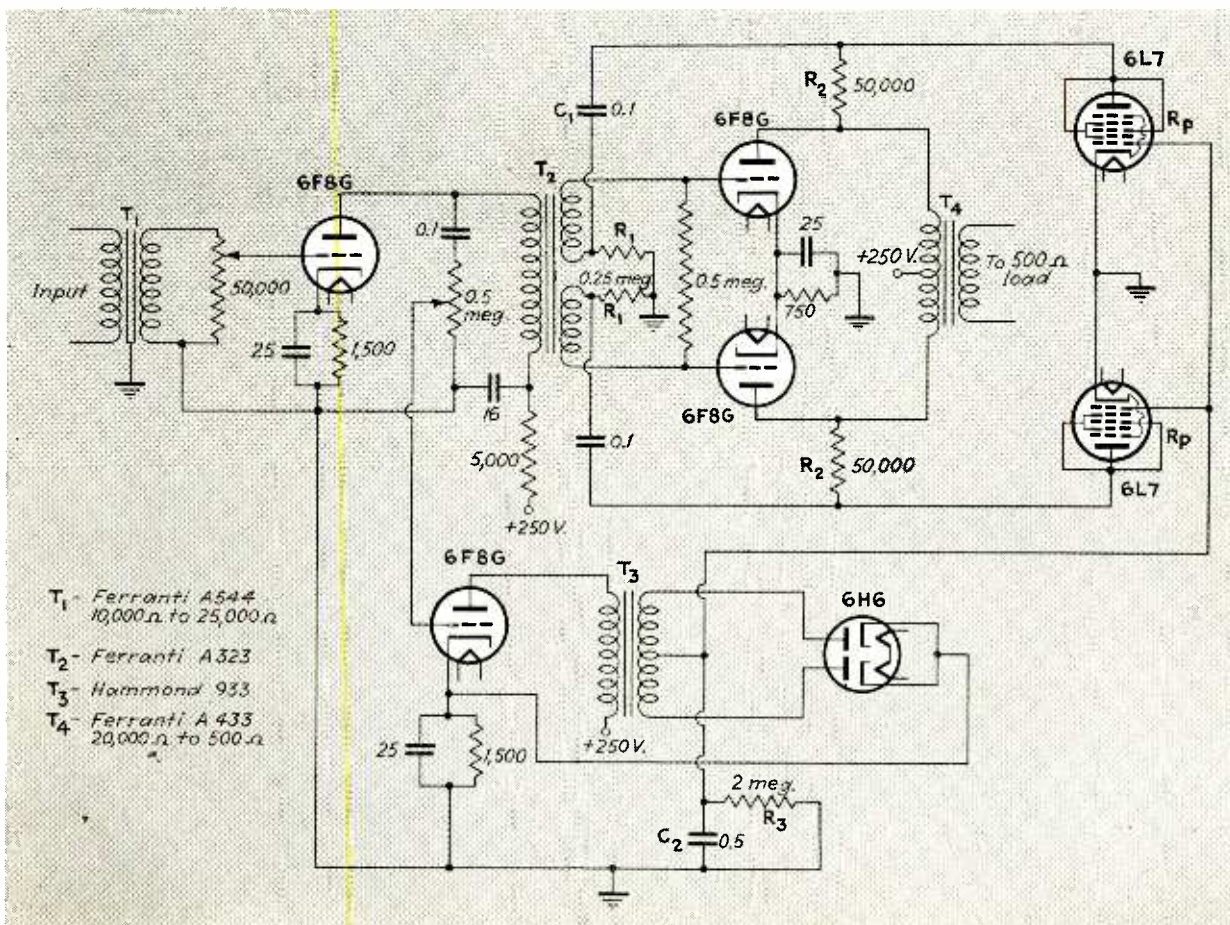
the compressor, which is used to control the plate resistance of a tube acting as one of the elements of the feedback circuit. Since the distortion in a negative feedback amplifier is reduced when feedback increases, it will be held down to a low value under compression.

Referring to Fig. 1, the input stage of the main amplifier is a triode using one section of a 6F8G, the other section acting as the auxiliary amplifier for the 6H6 control rectifier. The input stage is transformer

coupled to a pushpull output stage using another 6F8G. Negative feedback is used on this stage. The feedback factor is determined by R_1 , R_2 , and the plate resistance of a 6L7. When R_1 and R_2 are fixed at suitable values this feedback factor can be controlled within limits by varying the plate resistance of the 6L7's, since they are effectively in parallel with resistors R_1 . If the bias on the 6L7's is increased negatively, plate resistances increase and the feedback factor increases. Since gain decreases as the feedback factor increases, an increasing input signal, increasing the bias on the 6L7's will decrease the gain and thus produce compression.

With an initial positive bias on

Fig. 1—The feedback amplifier developed by Messrs. Stewart and Pollock. The 6L7's, controlled by the lower 6F8 and the 6H6, act as variable elements in the feedback path



the 6H6, the control of the auxiliary amplifier gain will delay compression till any desired output, within the limitations of the amplifier, is reached. In this particular case, since a separate power supply is used, the bias is conveniently obtained from the cathode of the auxiliary amplifier.

The rectifier circuit is of the usual type. Fast action is obtained through the use of a step-down rectifier transformer with the moderate value of $0.5 \mu\text{f}$ for C_2 . The releasing time may be controlled by R_3 . With an amplifier plate resistance of 7700

current range corresponds to a input range of 20 db.

The input-output characteristics shown in Fig. 2 indicate the operation with and without compression. The compression curves bend slowly because of the fact that the increasing negative bias on the 6L7's decreases the plate current, thus reducing the voltage drop in R_2 and increasing the plate voltage on the 6L7's. This tends to decrease the plate resistances, thus reducing the rate of resistance increase at first. The use of a high inductance choke in parallel with R_2 would make the

r_p = the plate resistance of an output tube,

and R_L = the plate load on one tube.

Let G_f = the gain of the output stage with the circuit as shown and with no compression (zero bias on the 6L7's),

G_c = the gain of the output stage with full compression

(6L7's biased to cut off),

B_f = the feedback factor with no compression,

B_c = the feedback factor with full compression, and

R_p = the plate resistance of a triode-connected 6L7 at zero grid bias. Then, neglecting the reactance of C_1 in comparison with R_1 and the effect of the feedback circuit on the load impedance of the output stage,

$$B_f = - \frac{R_1 R_p}{R_1 + R_p} \frac{R_1 R_p}{R_1 + R_p} + R_2$$

$$= - \frac{R_1 R_p}{R_1 R_p + R_1 R_2 + R_2 R_p}$$

$$\text{and } B_c = \frac{-R_1}{R_1 + R_2}$$

$$\text{Then } G_f = \frac{G}{1 - B_f G}$$

$$\text{and } G_c = \frac{G}{1 - B_c G}$$

The compression range in db then =

$$20 \log \frac{G_f}{G_c}$$

As an example, in the circuit shown, the values are as follows:—

$$\begin{aligned} \mu &= 20 & R_1 &= 0.25 \text{ megohms} \\ r_p &= 7700 \text{ ohms} & R_2 &= 50000 \text{ ohms} \\ R_L &= 10000 \text{ ohms} & R_p &= 5300 \text{ ohms} \end{aligned}$$

$$\text{Hence } G = \frac{20 \times 10000}{17700} = 11.3$$

$$B_f = \frac{250000 \times 5300}{250000 \times 5300 + 250000 \times 50000 + 50000 \times 5300} = 0.0938$$

$$B_c = \frac{250000}{300000} = 0.835$$

$$G_f = \frac{11.3}{1 + 0.0938 \times 11.3} = 5.5$$

$$G_c = \frac{11.3}{1 + 0.835 \times 11.3} = 1.09$$

and the compression range =

$$20 \log \frac{5.5}{1.09} = 14 \text{ db}$$

The maximum measured compression range as indicated on Fig. 2 by the horizontal or vertical intercept between the two constant gain lines

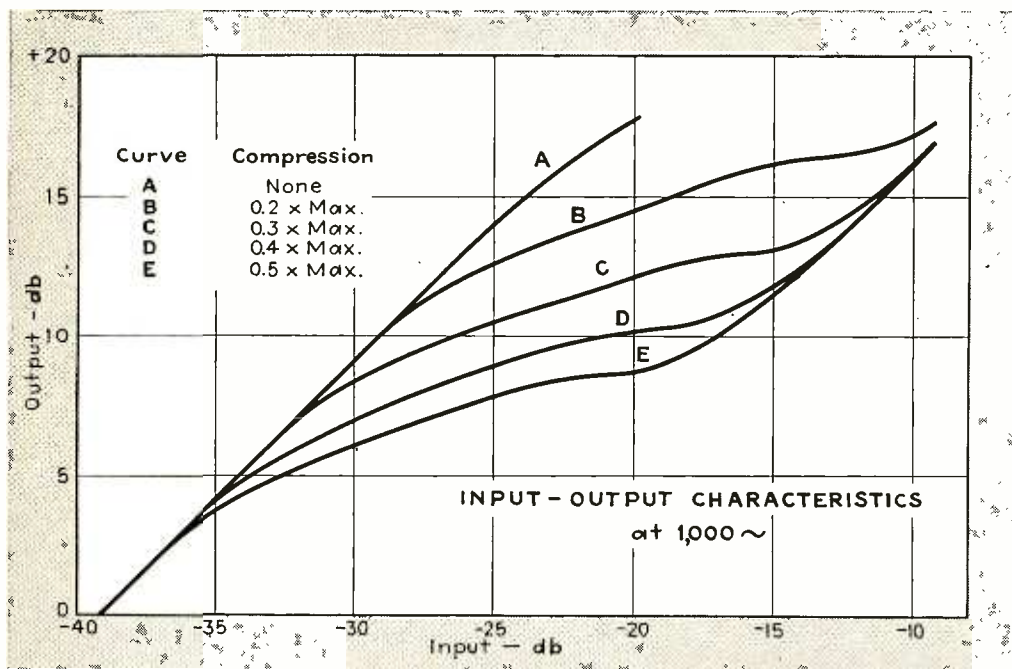


Fig. 2.—Input-output characteristics of the amplifier, taken at 1000 cps for five different degrees of compression. About 20 db compression in the output is available over the range from -40 to -20 db input

ohms, a transformer ratio from primary to one half secondary of 2:1, and a resistance of 1000 ohms for the 6H6, the acting time is 1.5 milliseconds. The releasing time, with $R_3 = 2$ megohms, is 1 second.

Plate currents are metered by one meter with a switch and suitable shunts in the cathode circuits, not shown in the diagram. Change in current in the 6L7's gives an indication of the amount of compression. It is interesting to note that the d-c current in this circuit, between the start of compression and the cutoff point, varies inversely with the input signal level in db and the total

compression curve flatten rapidly but might introduce other difficulties.

Compression is limited because of the limited variation in feedback-factor. The compression range may be derived by making a few simplifying assumptions. Consider the output stage and its feedback circuit made up of R_1 , R_2 and R_p . Let G = the gain of the output stage without feedback, then

$$G = \frac{\mu R_L}{R_L + r_p}$$

where μ = the amplification factor of an output tube,

or their projections is about 13 db. The useful compression range is somewhat less than this, being about 10 db. The discrepancy between the measured and the calculated compression range is due to the use of nominal values in the calculated example.

The curves in Fig. 3 show the effect of compression in reducing distortion. As shown, the distortion under compression actually goes down with increasing output, for a limited range. This may be due in part to the rate of gain reduction being greater than the rate of inherent distortion increase. Also, any distortion in the feedback circuit contributes to output distortion, and when the 6L7's are driven beyond cut off this factor will disappear at the compression limit. It will be noted from the curves that this is where the distortion under compression goes through minimum. A push-pull compressor stage with a balanced feedback network is necessary to eliminate transient distortion due to compressor action, as well as being desirable from the standpoint of low inherent distortion. Noise and hum level is low, being 75 db below 6 milliwatts output. This is due in part to the use of a separate power supply of the regulated type.

The frequency characteristics are shown in Fig. 4. The characteristic without compression was made flat within 0.5 db from 30 to 11000 cycles by adjustment of the loading on the input and interstage transformers. With compression the characteristic rises somewhat at high and low frequencies, due to a fall in side amplifier response. This characteristic is included as a possible matter of interest although it does not have much significance under actual operating conditions, since the energy producing compression is chiefly on the lower intermediate frequencies. Curve 3, Fig. 4, is a frequency characteristic with fixed 60 cycle voltage on the side amplifier circuit. This gives a better idea of the frequency response under compression.

The amplifier described has been placed in broadcast service (at CFRC). Experience shows that it is able to handle all ordinary peaks. There are no thumps when compression takes hold and the general operation, as indicated by listening tests, is quite smooth.

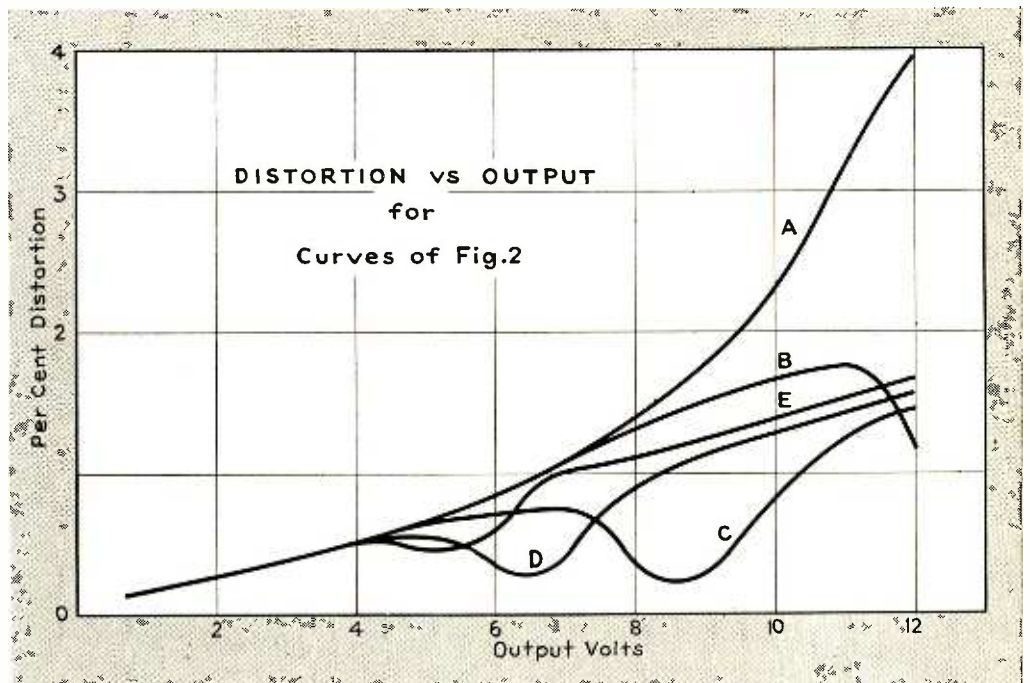


Fig. 3—Distortion curves of the amplifier as a function of output voltage, taken for the five degrees of compression shown in Fig. 2. The distortion is reduced more than two per cent in all cases, at maximum output

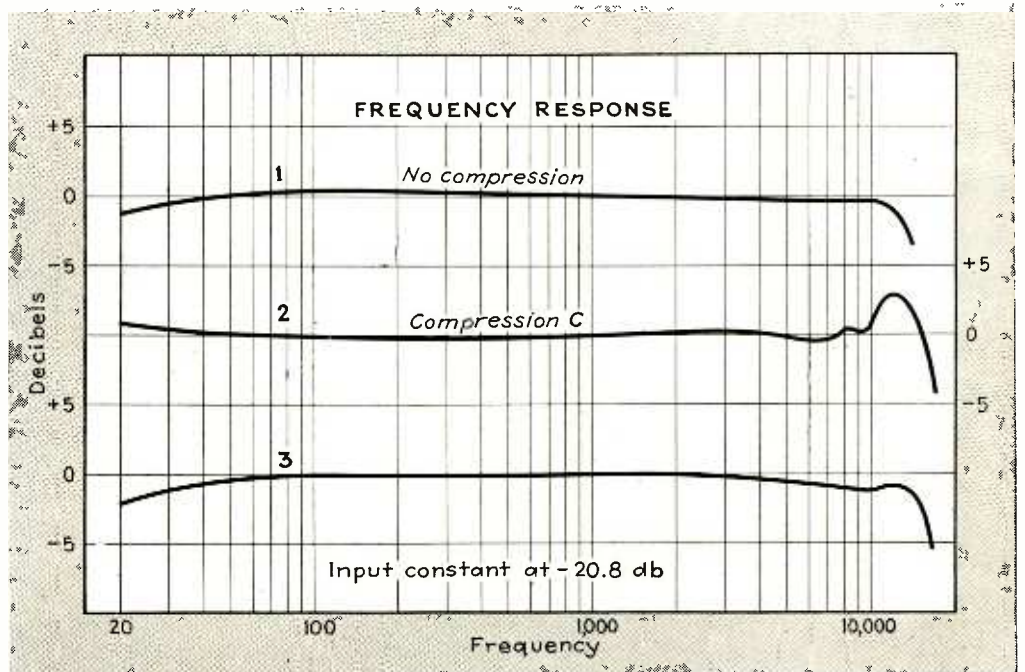


Fig. 4—Frequency response curves of the compression amplifier with constant input for two of the cases shown in Fig. 2. The lowest curve was taken with 60 cps applied to the side amplifier circuit to simulate compression conditions

The DuMont Proposals

The DuMont Laboratories demonstrate 625-line television images at 15 pictures per second, using a "flickerless" screen material and a modified vertical synchronizing pulse. Change in transmission standard proposed for images throughout range from 441 to 800 lines

IN December, the Federal Communications Commission requested the membership of the R.M.A. Committee on Television to witness a demonstration proposed by the Allen B. DuMont Laboratories in Passaic, New Jersey. The DuMont organization had undertaken a series of experiments to determine whether or not the present television transmission standards might be improved upon without upsetting the established 441-line system. The demonstration was to show what had been accomplished in this endeavor, and it was accompanied by three definite proposals

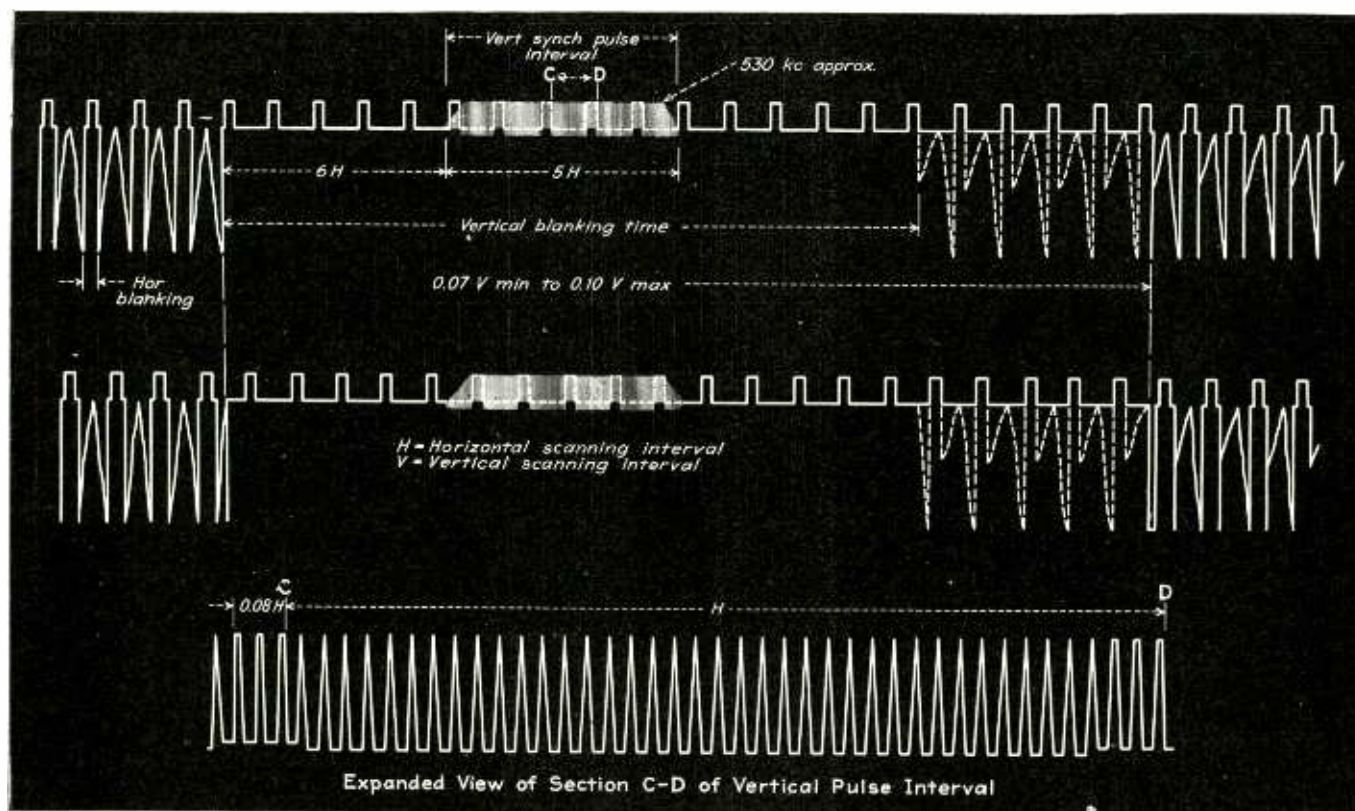
for changes in the present R.M.A. standards. These changes, it was claimed, would permit pictures of higher definition to be sent within the present six megacycle station channel, and further would permit receivers to synchronize with images sent at 441-lines, 30 pictures per second (the present standard) or at a higher number of lines at a smaller number of pictures per second. The demonstration was held, and it was witnessed by a large number of engineers active in television development, both in the membership of the R.M.A. Committee and outside it. At the time of

writing no published statement has been made by the Committee concerning its opinion of the proposals, and it is understood that they are being studied further before a report is made to the F.C.C.

More Detail Within Six Megacycles

The fundamental limitation to the detail of a television image is the space in the ether available to the transmitting station. The F.C.C. allocations are based on a total band of six megacycles for each station, this band including the sight as well as the sound transmissions for that

Detail of the video signal proposed by the Allen DuMont Laboratories. The signal is the same as the R.M.A. Standard video signal except in the vertical synchronization pulse interval (top, center). Here a 500 kc sine wave is introduced. This sine wave is readily separated from the rest of the wave by the use of a 500-kc tuned circuit



station. No change in this total bandwidth is proposed. However, it is proposed to increase the number of lines in the image and at the same time to reduce the number of pictures sent per second. The R.M.A. standards set up 441 lines per picture and 30 frames per second.

The bandwidth occupied varies as the square of the number of lines and as the first power of the frame repetition rate. Thus if the number of lines is increased by a factor n , the number of frames per second must be decreased by n^2 . Alternatively, if the number of frames is decreased by a factor m , the number of lines may be increased by a factor \sqrt{m} . The first proposal made by the DuMont organization is that the frame rate be given *either* of two values, 30 pictures per second interlaced at 60 fields per second (the R.M.A. standard), *or* 15 frames per second interlaced at 30 fields per second. It is proposed that transmitters and receivers be built capable of operating at either of these rates. When the 30 frame rate is in use, the number of lines is necessarily in the neighborhood of 400 or 500, to permit operation within the six-megacycle band, using single side-band transmission. With the 15 frame rate, (reduction by a factor of 2), the number of lines may be increased by 1.41 times, that is to some value between 575 to 700 lines. If the value of 441 is used in the first case, the value with the reduced frame rate becomes $1.41 \times 441 = 625$ lines. This latter value was used in the demonstration. The result is an increase of 41 per cent in the vertical resolution of the picture, and a 41 per cent increase in the horizontal resolution, which is equivalent to doubling the number of picture elements (corresponding to halving the number of frames per second).

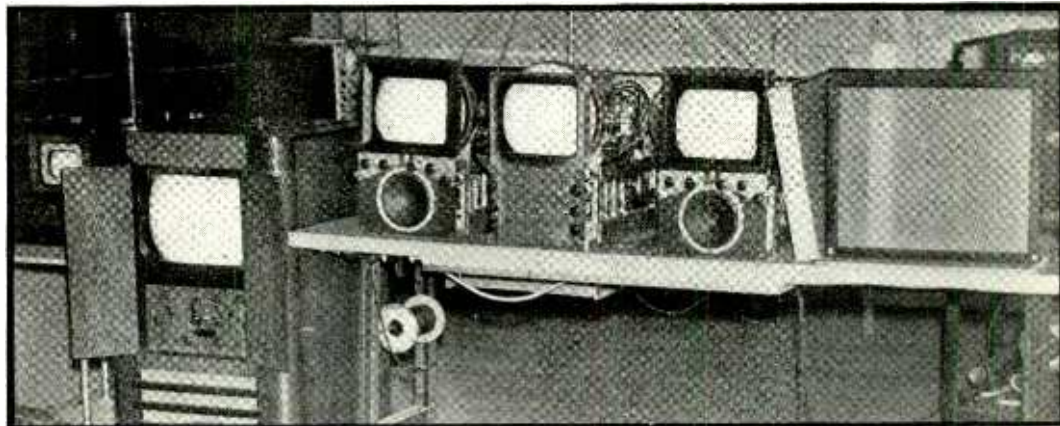
The question remains whether a frame repetition rate of 15 pictures per second is sufficiently high to avoid flicker and to permit the proper representation of motion in the image. The flicker problem is definitely increased with the slower frame rate, as the demonstration showed, when the usual fluorescent materials are used in the picture tube. In fact with such materials, the flicker is so noticeable that the entertainment value of the picture is very seriously impaired.

The DuMont engineers have found at least a partial answer to this problem by developing a new type of fluorescent phosphor which has a persistence characteristic suited to the 15-frame repetition rate. This phosphor, which glows with a vivid orange color, develops an illumination which persists for approximately 1/15th second and then rapidly dies away. By the use of such a phosphor, the screen may be illuminated substantially continuously at all points when a 15-frame per second rate is used. The flicker is thereby very much reduced (if the persistence were exactly 1/15th second and the decay instantaneous there could be no flicker at all). The phosphor demonstrated displayed a barely perceptible flicker when operated at 15 frames per second, but the amount of flicker was so small that it could be neglected.

comes a serious limiting factor. In fact, the standard rate of 30 frames per second imposes a limitation in this respect, for example during a fencing match or a juggling exhibition. The proposed 15-frame rate is correspondingly inadequate for such subjects. The question of the suitability of 15 frames per second, from this point of view, thus rests on the types of subject matter offered to the camera.

Making the Standards Flexible

The next proposal made by the DuMont organization is that the number of lines in the picture (441 in the R.M.A. standards) should be made indefinite, and that the transmitting and receiving equipment should be capable of operating at any number of lines per frame between 400 and 800 (possible values



The receivers demonstrated: left to right, a five-inch Westinghouse receiver, the new 20-inch DuMont receiver, three DuMont receivers for comparing 441 and 625 images at 30 and 15 frames per second, and (extreme right) a translucent screen for viewing motion pictures in comparison with the television images

The desirability of developing a phosphor of this type which would display a white light was admitted by Mr. DuMont, and he displayed conviction that such a material would result from research.

The question of whether a frame repetition rate of 15 per second would suffice for the representation of rapid motion in the image depends principally on the subject matter. For many types of subject, in which the motion is not too rapid, 15 frames per second is completely satisfactory. In the demonstration a film was shown in which the representation of motion was entirely adequate at 15 frames per second. When the subject matter moves rapidly, however, the frame rate be-

441, 567, 625, or 735). The higher values could be used, within the six megacycle channel, only with the 15-frame-per-second rate. With the number of lines thus left open to change it would be possible to make improvements from time to time.

However, such changes in the number of lines could not be made readily with the synchronizing system standardized by the R.M.A. Accordingly, the DuMont engineers have developed a new type of vertical synchronizing pulse which is capable of controlling a receiver at any rate required, for any number of lines from 400 to 800 lines. The only change noticeable in a properly constructed receiver, when the

(Continued on page 63)

A LIGHT REGULATOR

By BRITTON CHANCE

THIS device resulted from a study of the accuracy of photometric measurement with a single photocell. The apparatus comprises two high gain photometers illuminated by the same light source, one for controlling the intensity and the other for observing changes in this controlled intensity due to light absorption. Changes in light absorption are measured with an error of one part in ten thousand.

There are three pertinent types of errors.

1. Tube characteristic variations. Modern vacuum phototubes have excellent stability and life. Amplifier tubes, carefully selected for low grid current, showed no significant variations.

2. Circuit parameter variations. These are avoided by using components of adequate size to avoid heating.

3. Voltage fluctuations. As far as the phototubes and amplifiers are concerned, adequate stability can be obtained by the use of regulators such as shown by Bousquet.¹ The ripple can be diminished by the substitution of a battery for the neon tube. The supply for the light becomes the most serious problem. A-c regulators will hold the voltage constant to ± 1 per cent. Batteries used on their optimum characteristic will do somewhat better than this. However, it has been pointed out by Müller² that the illumination from a lamp varies as the third or fourth power of the voltage, requiring a voltage stabilization of millivolts to obtain a 0.1 per cent accuracy in illumination.

For such an obvious reason as this photoelectric control of the illumination was developed.

Two types of regulators were used. The first type operated from

ac and utilized a thyatron. It was characterized by a wide range of control and an incapability of operating faster than once every 1/50 of a second when using 50-cycle supply. In other words the large current handling capabilities of a thyatron enabled us to obtain a relatively large output. However, we can only control the point during the forward cycle at which the thyatron fires, so this point must be ascertained from an integrated output of the light intensity since the last time of firing. Obviously there are some inherent difficulties due to this, but very good stabilization can be obtained.

The mode of application of such a

control may follow any conventional method (Fig. 1). In this case a reactor has been shunted by a thyatron. This gives a satisfactory control of the current. Also no attempt has been made to cause the thyatron to supply the total lamp power as this usually gave rise to undesirable results. In a typical case, the photocell was connected to a d-c amplifier which in turn controlled the thyatron by the amplitude method in conjunction with a 90 degree lagging grid voltage. In this circuit 1.43×10^{-4} lumens change on the photocell caused a correction of 0.125 lumens in the light intensity, a ratio of 1:875. Obviously the actual degree of stabilization of the

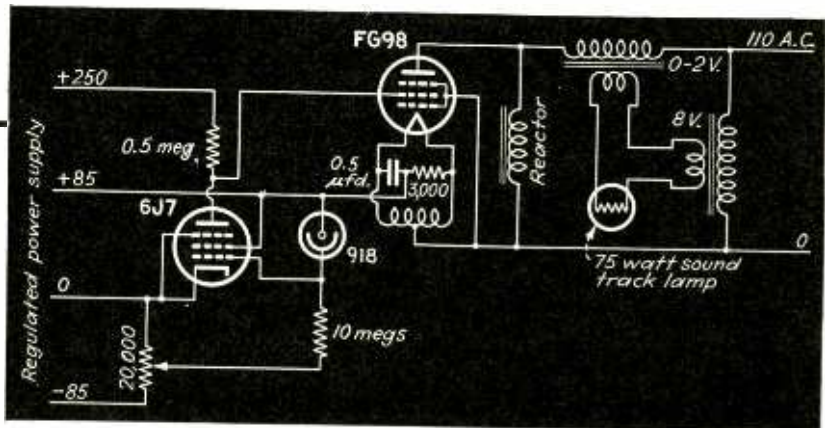


Fig. 1—Circuit diagram of a control unit which makes use of a reactor shunted by a thyatron. It has large current capacity, but is limited in its speed of action

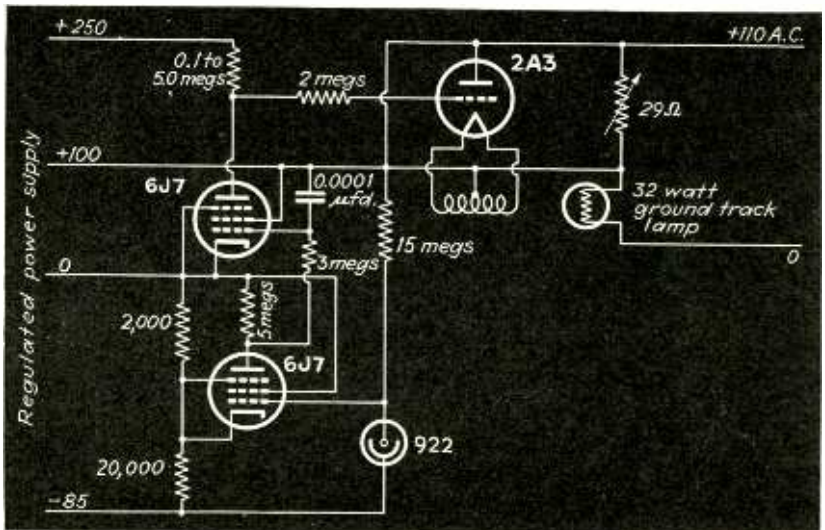


Fig. 2—A light control unit in which a triode shunts a resistance and which is characterized by rapidity of action. Rapid color changes may be measured accurately

light intensity depended entirely upon the percentage variation of the input voltage. This input voltage was obtained from a Delta regulator, so the variation of the input was probably less than 1 per cent, and consequently the variation of the light intensity 1/875 of this.

While the use of the thyatron gave a rather good ratio of output to input the control was affected to some extent by the "hum" of the lamp and tended to hunt if the gain of the photocell amplifier or range of control was too large. Also the control operated only once every positive half cycle and did not give a "dc" light.

The second type of regulator, shown in Fig. 2 was designed to give a "dc" light and to have the control responsive to very rapid changes of light, in order to safely measure rapid color changes. The principle is similar except that dc is used throughout and a triode shunts a resistor, instead of a thyatron shunting a reactor. As the d-c supply fluctuations were quite small, only a small range of control was necessary and was amply supplied by a 2A3. High gain was necessary in the photocell amplifier so a 6J7 buffer stage was inserted and the photocell was operated so as to give a very large output, the tube drop being 75 volts and the current 17 ma. A check of 6J7 grid currents showed that they could easily be avoided near the operating point not only by observing the usual precautions as to low heater, screen and plate voltages but also by using a large value of plate load resistor which shifted the operating grid voltage towards more negative values

where the large grid currents were not observed. In this way low grid currents were drawn and a substantial gain was obtained from the buffer stage. The next 6J7 controlled the 2A3 directly. The input-output ratio is 1/618.

There are a few precautions to be observed. Especial care must be taken that no voltage divider supplying more than one circuit element can give rise to a regenerative effect and set the control oscillating. Hence separate dividers are supplied for all elements. The insertion of a simple a-c feedback circuit between the 2A3 and 6J7 amplifier is helpful to damp oscillations. The power supplies are regulated to prevent any slow drifts and also to ensure filtering as the control circuit could easily modulate the light at the ripple frequency which is undesirable in this application. The lamp must be soldered into its socket and all external sources of a-c light must be avoided.

This second circuit has enabled reproducible measurements of an intensity of 0.1 lumens with an error of 9×10^{-6} lumens. The expected error from observing the variations of the light control current led to the value of 9.26×10^{-8} lumens for the error, so presumably other factors contribute to the photometer errors.

As these improvements in light source stability permitted the use of far greater gain in the photometer, several significant modifications have been made. The photometer which is referred to was developed for measuring small, rapid light changes with variable sensitivity and a d-c calibration.

The final design employed feed-

Fig. 3—In the final design shown here, the output of the phototube is amplified in two stages and the 6C5 is used for feed back directly to the phototube

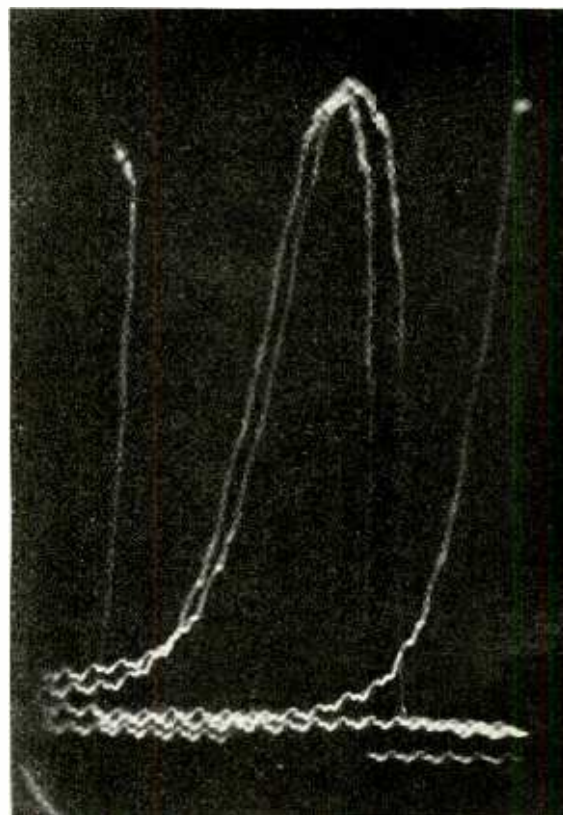
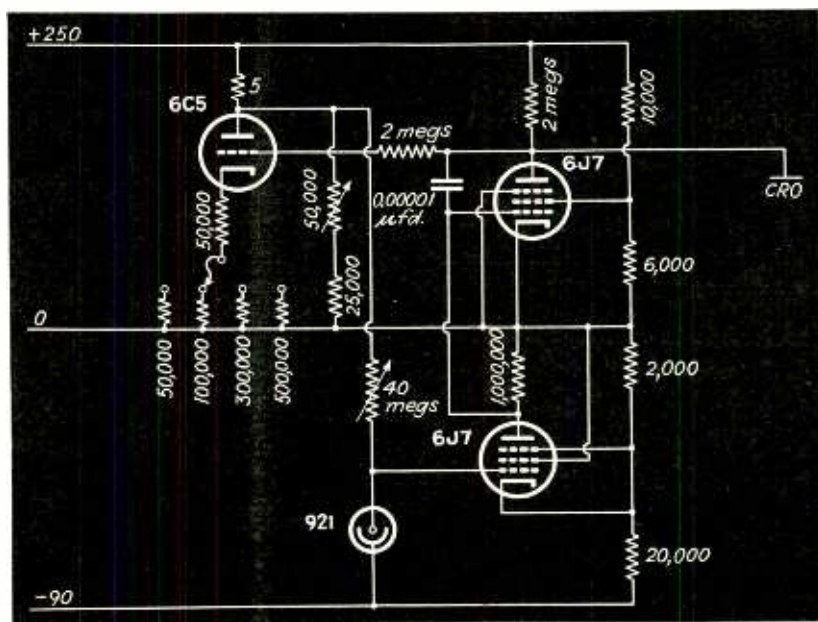


Fig. 4—Typical curves of color disappearance from a methylene blue solution in 0.02 second which were obtained with the apparatus described

back to improve the frequency characteristic and to obtain variable calibrated sensitivity over a wide range. The output was sufficient to operate the ordinary five inch cathode-ray tube.

The circuit, shown in Fig. 3, consisted of two voltage regulated power supplies, a 90 volt supply for the low gain stages and a 250 volt supply for the output. The phototube, a 921, worked into a 40 megohm load and gave an output of 220 volts. The small variations in this voltage were amplified by a directly coupled 6J7 giving a gain of about 25. The output controlled a 6J7 stage. A 6C5 was used for feedback directly to the photocell.

Figure 4 shows a curve obtained from such an apparatus. It shows in triplicate the disappearance of color from a 0.0005 per cent solution of methylene blue.

Submitted to the Faculty of the Graduate School of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Ph.D.

This is a section of a thesis on the Accelerated Flow Method for Rapid Reactions to appear shortly in the Journal of the Franklin Institute.

¹ Bousquet—*Electronics*, July, 1938.

² Müller—I and E Chem. (Anal. ed.), January, 1939.

FREQUENCY MODULATION

I

F-M Applied to a Television System

By C. W. CARNAHAN, *Hygrade-Sylvania Corp.*

IT is the purpose of this paper to consider the possibilities of a frequency modulation system in the transmission of television signals. Some of the advantages of this form of modulation are pointed out, and the conditions necessary for the transmission and reception of signals acceptable according to present standards are given.

Current interest in frequency modulation is centered on the wide band, noise suppressing system developed by Major E. H. Armstrong. It is probably only a matter of time before a similar system will be used in the transmission of television.

In the meantime it is of interest to examine the case for narrow-band frequency modulation in the region from 40 to 110 Mc.

Band Width Considerations

In the wideband noise-suppressing frequency modulation systems now in use for sound transmission, the width of the radio frequency band is enough greater than the highest modulating frequencies to make it possible to assume that the overall response of the radio frequency amplifiers, including the converter, to a change in signal frequency, is practically instantaneous. If the radio frequency channel width is of the same order as the highest modulating frequency, this assumption can no longer be made. If a sudden, instantaneous, change is made in the signal frequency, the frequency of the amplifier output will not change instantaneously to the new value.

We will consider first the response of a typical converter circuit, shown in Fig. 2. This is shown as a series R, L, C circuit for convenience in deriving the response. Figure 1 shows the typical video signal and its frequency modulation equivalent. The frequency is $\omega_1/2\pi$ prior to $t = 0$, and $\omega_2/2\pi$ after that.

Figure 3 shows the envelopes of the responses of the tuned circuit in terms of $\frac{\omega_0 t}{2\pi}$, where ω_0 is the nominal band width, to the type of signal shown in Fig. 1, for various values of ω_1 and ω_2 . Two responses are shown for each pair of frequencies, one corresponding to a transition from ω_1 to ω_2 , and the other to a transition from ω_2 to ω_1 .

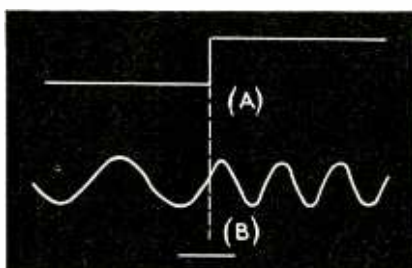
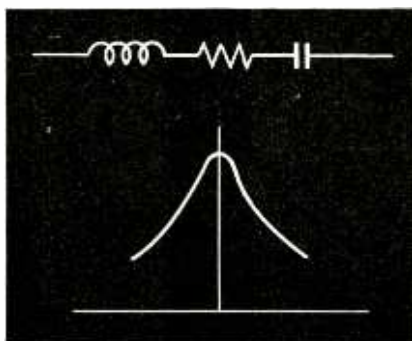


Fig. 1—General television signal and frequency modulation equivalent

Fig. 2—Typical f-m converter circuit and characteristic



The dotted line in the top figure represents the response of the tuned circuit to a suddenly applied voltage at the resonant frequency. This represents the response of the circuit to an amplitude modulated signal. It will be observed that, while the forms of the frequency modulation responses are different, the time constants of all the responses are sensibly equal to that of the amplitude modulation. We may conclude from this that, as far as time of response is concerned, frequency modulation requires the same band width as amplitude modulation.

It will be noticed that, considering any one pair of frequencies, the form of the response depends on the direction in which the transition is made. One clue to the reason for the difference between the responses is as follows: The removal of the first frequency sets up a transient response at the resonant frequency. This response then beats with the new frequency. The beat shows up as oscillations about a simple exponential curve. Due to the asymmetry of the two applied frequencies with respect to the resonant frequency, the frequency of the beat will depend on the magnitude of the departure from resonance, and, for any pair of frequencies, will depend on the direction of the transition.

The signal which we have applied to the converter is ideal in the sense that it contains all frequencies, with no attenuation. In practice, there is a radio frequency amplifier of limited band width ahead of the converter, so that the ideal signal that we have considered never occurs. To be specific, let us assume that the radio frequency amplifier has an ideal band pass characteristic, with linear phase characteristic and infinite attenuation beyond the band limits. An ideal signal consisting of a sudden change in frequency is applied to the input. Figure 4 shows the output of the filter for transi-

(Continued on page 30)

II

Interspersed F-M and A-M in a Television Signal

By A. V. LOUGHREN, *Hazeltine Service Corp.*

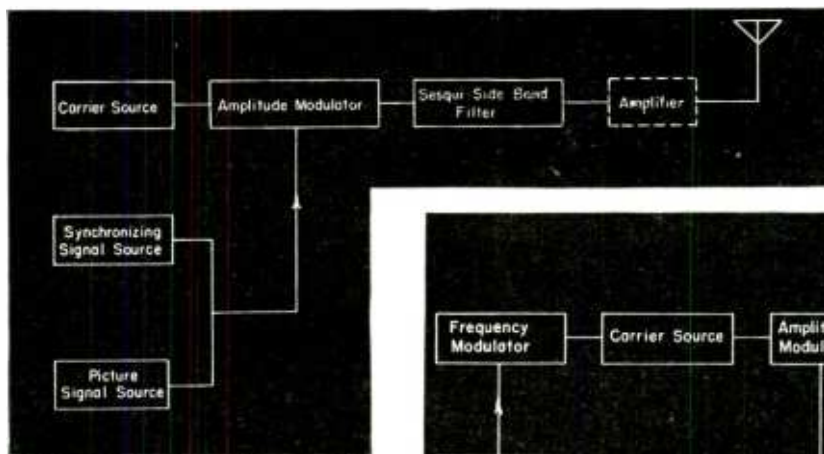


Fig. 1—Standard amplitude modulation television transmitter

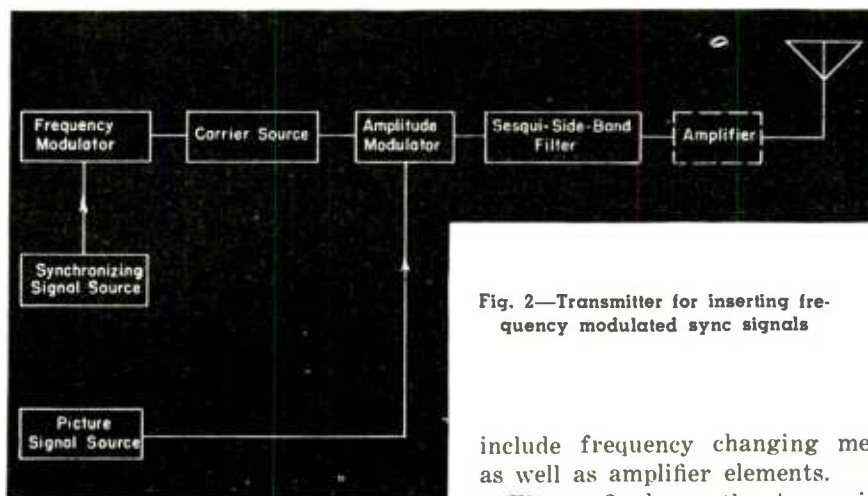


Fig. 2—Transmitter for inserting frequency modulated sync signals

IN the transmission of television synchronizing signals, there are advantages to be secured by utilizing the capabilities of frequency modulation, even though the picture signal is transmitted in the present manner by amplitude modulation. It is proposed that this improvement be considered for use in any television system for which the synchronizing signal has yet to be determined, for example, in systems operating in channels above 150 Mc. This proposal is applicable to any form of synchronizing pulses, but gives much more freedom in the choice of their pattern and in the choice of methods of separating the vertical and horizontal pulses.

It is a common practice in television signal design to combine all of the transmitted information into a single video-frequency signal

which is then used to modulate the radiation from the transmitter. The usual practice modulates the amplitude of the radiation; it has been proposed, however, by several workers to modulate the radiation frequency instead. The step of combining the picture and the synchronizing signals before modulation requires that both signals be applied to the transmitter through a common modulator and that they be radiated as modulation components of the same kind.

The alternative signal design principle presented in this article involves modulating the radiation separately with picture and synchronizing signals, choosing for

each a suitable type of modulation. In a preferred application of this principle, amplitude modulation is retained for the picture signal while the synchronizing signal is represented by frequency modulation.

Figure 1 shows the transmitter arrangement for the present R.M.A. signal, in which both picture and synchronizing signals are transmitted by amplitude modulation. The amplifier shown dotted at the right may be used or omitted, depending on the power level at which the modulator operates; if used, it may

include frequency changing means as well as amplifier elements.

Figure 2 shows the transmitter arrangement for the new signal. Separation of the modulation processes for the two signal components and introduction of a frequency modulator are the only essential changes in the transmitter as compared with Fig. 1.

Requirements of the Television Channel

A brief study of the television signal channel requirements shows that for picture purposes the entire available sideband width of about 4 Mc may well be used. For accurate reproduction of the R.M.A. synchronizing signal,¹ including the

¹ See May and November 1939 R.M.A. Engineer or Fink—"Principles of Television Engineering," McGraw-Hill Book Co.

slopes of the pulses, a band whose effective transmission extends from zero to 1.3 Mc is required. As a minimum requirement about half this band width is needed; this restricted band preserves at least a vestige of the necessary black "step" in the signal preceding each synchronizing pulse.

Today television system design is based on electronic rather than mechanical scanning. Practical electronic systems all require finite retrace intervals, and during these the picture information cannot be used. These intervals or any desired portions of them may therefore be devoted to synchronizing signal transmission without degrading the picture. In the R.M.A. signal, synchronizing and picture information share the composite signal channel not only on this time basis but also on an amplitude basis. The signal design reserves an amplitude region

formed by modulating the amplitude of the radiation in accordance with R.M.A. standards except that no synchronizing information is applied (the retrace intervals are just black) and also modulating the frequency of the radiation with the R.M.A. composite synchronizing signal, using the transmitter of Fig. 2. The frequency excursion should be preferably about 2 Mc in the direction of the major sideband. In other respects, such as sesqui-sideband operation, the radiated wave of this example agrees with R.M.A. standards except that the steepness of the slopes on the synchronizing pulses will be reduced by perhaps 25 or 50 per cent from their present magnitudes in order to retain all frequency-modulation sidebands within the uniform transmission band of the transmitter and thus avoid second-order amplitude-modulation terms associated with

pared with R.M.A. signal operation and a readjustment of the brightness control is necessary. In other respects, the operation of the receiver will be normal unless the i-f channel to the synchronizing circuits has an appreciable decrease in gain at the frequency of the synchronizing pulse, in which case realignment of that channel is required.

A receiver designed specifically for the new signal is shown in block form in Fig. 3. The picture channel along the upper line of the diagram may be entirely conventional. It appears preferable, however, to depart from the conventional practice to the extent of not attenuating the carrier 6 db prior to detection, but instead providing suitable attenuation in the low-frequency portion of the video amplifier characteristic. This practice permits taking advantage of having the d-c restoration at black rather than at some "infra-black" level.

Since the synchronizing signal includes no amplitude modulation components, as radiated, it is necessary that the receiver circuits provide frequency selection prior to detection. In the conventional receiver whose operation was described above, the 6 db carrier attenuation played this role. The new receiver will show much better signal-to-noise ratio and a further gain in margin of amplitude selection of synchronizing from picture, by using a band-pass filter tuned to the i-f synchronizing pulses for this frequency selection; the width of pass-band is a compromise between noise acceptance and signal delay, and is set at 0.5 Mc. This element is shown in the lower row of apparatus in Fig. 3. In the output from this filter synchronizing pulses are present with a margin of at least four-to-one as compared with picture components, and the subsequent amplitude selection offers no difficulty.² Further, the relatively narrow pass band and the wide amplitude margin produce a major im-

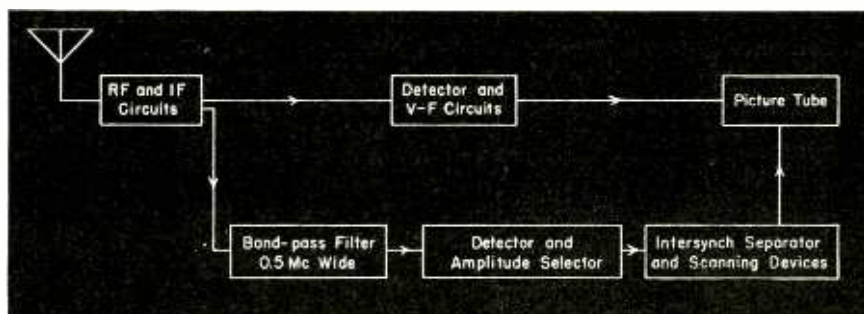


Fig. 3—While conventional receivers will react normally to the proposed signal, the above receiver has been designed especially for it

exclusively for each component of the signal, 20 to 25 per cent of the total amplitude range being reserved for synchronizing. It may be shown that time sharing alone is not enough, and that the R.M.A. amplitude sharing or some equivalent is a necessary supplement thereto. For if there is no distinction other than timing between the two components of the signal, the receiver must be capable of responding to the absolute phase of the incoming signal if it is to perform the separation with certainty—and the design of a device sensitive to absolute phase is essentially the solution of the problem of operating without synchronizing signals.

An example of the use of the new design principle will illustrate both the method of practicing it and some of its advantages. The radiated wave of this example will be

the synchronizing signals.

Effect on a Conventional Receiver

If the new signal is applied to a conventional television receiver, certain differences in operation result as compared with the R.M.A. signal. The conventional receiver is assumed to attenuate the signal carrier 6 db in its i-f circuits and to perform the synchronizing signal amplitude selection at a point in the receiver later than the introduction of this attenuation. In consequence, the synchronizing pulse amplitude will exceed the black level by two-to-one both at the picture-tube grid and at the point of amplitude selection as compared with the normal margin of four-to-three or five-to-four. As a consequence, amplitude selection is made very much easier. The d-c restoration level in the picture circuit is appreciably altered as com-

²The four-to-one ratio arises from the following:

1. Synchronizing is radiated 2 Mc off the carrier, but at peak radiation intensity.
2. Video sidebands in the synchronizing filter pass band may be represented, in the worst case, by a single sideband at synchronizing frequency.
3. The maximum intensity of a single sideband, in a modulated wave, can not exceed one-fourth of the maximum intensity of the complete signal. (The exceptions to this latter rule are not significant in this case.)

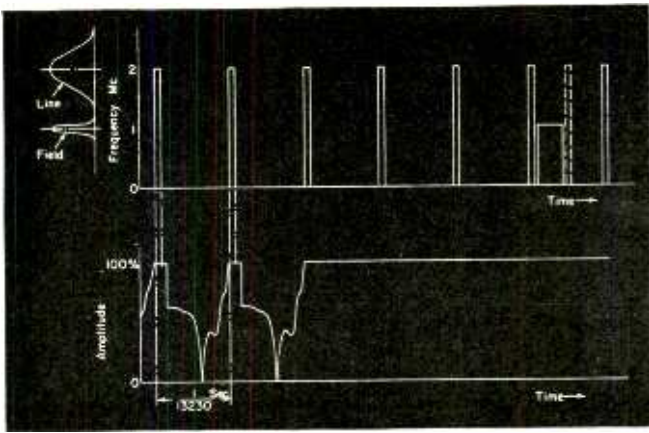


Fig. 4—Modulation content of a signal having different frequency excursions for horizontal and vertical sync pulses

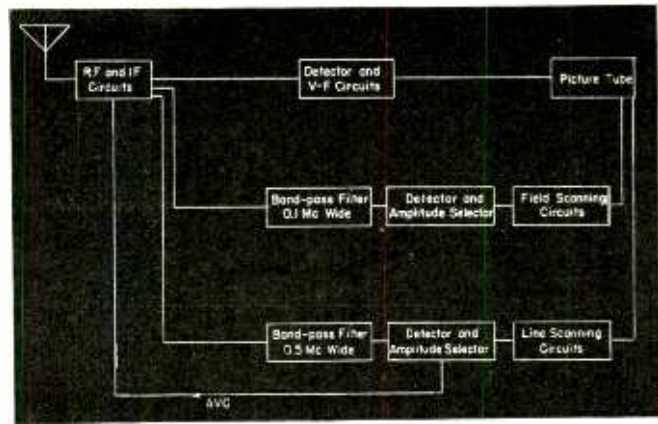


Fig. 5—Receiver designed for use with the modulation signal shown in Fig. 4, using separate scanning filters

provement in the synchronizing signal-to-noise ratio.

Advantages of the New System

Contrasting the system of the above example with the R.M.A. standard system, we find the following advantages for the new system:

- (1) Without increasing the peak transmitter power an increase in picture signal is obtained which corresponds to a 60 or 70 per cent increase in peak transmitter power; the received picture signal-to-noise ratio is improved to the same extent.
- (2) An entirely new method of synchronizing-signal selection is now available. Since the synchronizing information is now concentrated in a frequency band approximately 2 Mc above the carrier, frequency selection may be employed prior to detection to materially increase the margin of selection for synchronizing signals.
- (3) The synchronizing signal may be selected in the receiver with an amplitude margin over picture components in its own frequency band of four-to-one in the new signal as against four-to-three (or five-to-four) in the standard signal.
- (4) The received synchronizing signal-to-noise ratio shows an improvement corresponding roughly to the amplitude selection comparison of (3).
- (5) The radiated wave now has no "infra-black" amplitude. Consequently d-c restoration arrangements at the receiver can be based on the black level rather than on some arbitrarily "infra-black" level. To make use of this possibility, it is necessary that the equalizing

circuit provided in the receiver to correct for the missing sidebands be located in the video-frequency rather than i-f circuits.

It is interesting to note that the new signal requires no explicit sharing of the available amplitude range at the transmitter. Instead, advantage is taken of the fact that the maximum intensity of any one sideband cannot exceed one-fourth the maximum intensity of the complete signal. By use of frequency modulation, the radiation may be shifted in frequency during synchronizing intervals to a region where this margin becomes effective. The modulation capabilities of the signal are only partially utilized by amplitude modulation, so there is still room for the frequency modulation representing the synchronizing signals.

In the foregoing example, improvement in several aspects of performance is obtained with a relatively minor modification of the R.M.A. system. It is interesting to note that further material gains are possible if the entire signal is designed with the principle of interspersed modulation in mind. To illustrate this statement, a second example will be used. In this example, field and line-synchronizing signals will represent different frequency-modulation excursions of the carrier and may hence be separated by frequency selective means prior to their detection in the receiver. As a consequence of this separation, it will be possible to operate the receiver avc from the line-synchronizing signal rather than from the composite synchronizing signal as is the practice when the R.M.A. synchronizing wave is used, with the resulting advantage that the a-v-c time constant instead of being long

compared to the picture period need only be long compared to the line period. The transmitter shown in the block diagram of Fig. 2 is suitable for radiating this signal.

Figure 4 shows the modulation content of the signal. The upper portion of the diagram represents the frequency-modulated synchronizing information while the lower portion shows amplitude-modulated picture signals. Standard R.M.A. practice has been followed in the construction of this signal where suitable. For example, the line-blanking interval is 15 per cent and the line-synchronizing signal duration 8 per cent, respectively, of the line period. The field-synchronizing signal consists of a single broad pulse; since it is completely distinguished from line pulses by its frequency of transmission, it is unnecessary to provide equalizing pulses and a long duration signal for use with slow integrating circuits. The field pulse has such duration that it does not interfere with transmission of line pulses in either field of the interlaced scan; a single line pulse of the alternate field is shown, dotted, immediately after the field pulse, to illustrate this relation.

Pass-band Characteristics

Suitable pass-band characteristics for synchronizing signal selection in the receiver are shown at the left of the diagram. A relatively narrow pass band for field-frequency pulses is centered 1 Mc from the carrier, and a relatively wide pass band for line-frequency pulses is centered 2 Mc from the carrier. The width of the line pass band represents a compromise between reduction of noise on the one hand and delay in synchronizing signal transmission on the other. For the line-

F-M Applied to Television

(Continued from page 26)

synchronizing pulses relatively little delay is tolerable; a band width of 0.5 Mc is used. Relatively great delay may be permitted in the field-synchronizing signal channel; here the band width is reduced to the point where it is determined by system frequency tolerance requirements. The choice of frequency deviation for the line pulses is a compromise between best transmission conditions for synchronizing signals and the desirability of limited band width for inexpensive receivers. Here, a logical compromise seems to be 2 Mc. Frequency deviation for field pulses is chosen to produce minimum interference from both picture and line synchronizing signals; it is accordingly half of the line pulse deviation.

A receiver for use with the signal of Fig. 4 is shown in Fig. 5. The upper line of the diagram may be patterned after a conventional receiver or may preferably employ low-frequency attenuation in the video circuits rather than carrier attenuation in the i-f circuits. The two lower rows of apparatus are in general similar, each including its frequency selector, its detector and amplitude selector, and its corresponding scanning generator. The line-frequency circuit, however, includes the a-v-c connection back to the i-f circuits which is required if advantage is to be taken of the system's adaptability to fast avc.

The system of this second example includes all the advantages of the system discussed first. In addition it makes "inter-synch" separation prior to detection possible and advantageous; the a-v-c time constant may be decreased to one-hundredth of the value currently required, with a consequent decrease in the duration of disturbances caused by bursts of noise interference or by power-line transients.

The advantages of transmitting the synchronizing signals by interspersed frequency modulation are based on fundamental principles which lead to more effective utilization of the transmitter power. The added freedom of design in the synchronizing circuits of the receiver is attractive and its potentialities far exceed those realized in the examples described. Therefore this system is worthy of full consideration for those services in which this question remains to be standardized.

tions involving frequencies symmetrically placed with respect to the midband frequency. The envelope amplitude is shown, as well as the instantaneous frequency. Our interest in the amplitude function is confined to seeing that the amplitude modulation is small enough to be successfully removed by the limiter in the receiver.

In general, the response of the band pass filter to the sudden change in frequency is about the same as the response to a sudden change in amplitude at constant frequency. The same oscillations are observed, due to the ideal characteristics. The time constants are approximately the same, the response time being about one cycle at a frequency equal to the band width. Transitions occupying more than half the band width show fairly large oscillations in amplitude and frequency. Taking this fact into consideration, a peak to peak frequency deviation equal to one half the total band width, or a deviation ratio of one half, is probably the optimum.

Single Sideband Transmission

Turning now to single sideband transmission, Fig. 5 shows the overall radio frequency characteristic now used for selective sideband amplitude modulated transmission. The essential requirements for this type of transmission are that sufficient band width be provided to transmit one sideband of the highest modulating frequency, and that the carrier be located halfway down the sloping portion of the filter.

The same method may be used for frequency modulation, with some differences. In the first place, any converter circuit that is used for frequency modulation will have a radio frequency characteristic that has a linear slope over the frequency swing. Hence, it is relatively easy to arrange an overall frequency characteristic exactly similar to that used for amplitude modulation, with the frequency deviation region centered on the sloping portion of the characteristic.

As may be seen, this is exactly equivalent to the amplitude modula-

tion scheme only for frequency changes in the vicinity of the carrier. For transitions closer to the edge of the band, the high frequencies will be overemphasized, while transitions on the other side of the carrier will be deficient in highs. Thus the picture detail will depend somewhat upon the brightness. If it is arranged so that picture white is produced by frequencies towards the edge of the band, where the high frequencies are emphasized, the unavoidable variation of spot size with brightness will tend to even out the non-uniformity in frequency response. The amount of non-uniformity may be reduced by decreasing the deviation ratio, at the expense of decreasing the converter sensitivity.

Unbalanced converter circuits seem to be necessary, to provide the additional amplification of the higher sideband frequencies. The balanced variety, where the carrier falls on the resonant frequency of the tuned circuit, will not provide the correct shape in the radio frequency characteristic.

The optimum shape of the radio frequency characteristic, and the optimum deviation ratio, are matters that should be left to experiment to decide. What we have attempted to show is that single sideband transmission of frequency modulation should be no more difficult than with amplitude modulation, and that, while the resulting signal will differ in some respects from the amplitude modulated signal, the overall effect should be the same as regards picture transmission.

Advantages of Frequency Modulation

Up to this point we have been concerned chiefly with the mechanics of a frequency modulation transmission over a comparatively narrow channel. Having found this to be feasible, let us now turn our attention to some of the advantages of frequency modulation.

Most of the classical advantages of frequency modulation should apply to the transmitter. The final stage could be operated class C at the maximum plate dissipation of the tubes. This should result in approximately

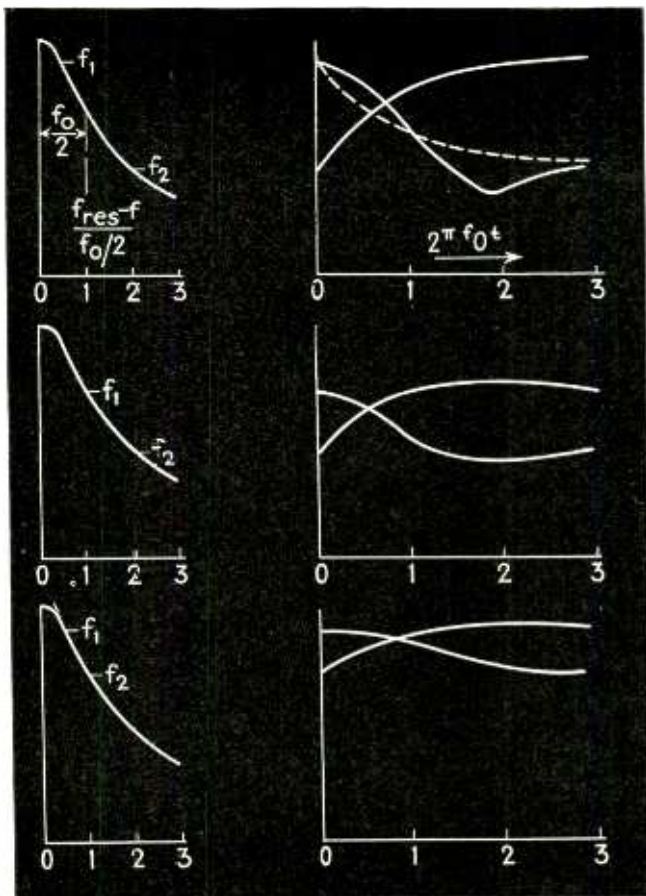


Fig. 3—Envelopes of responses of the circuit in Fig. 2 to the generalized signal shown in Fig. 1

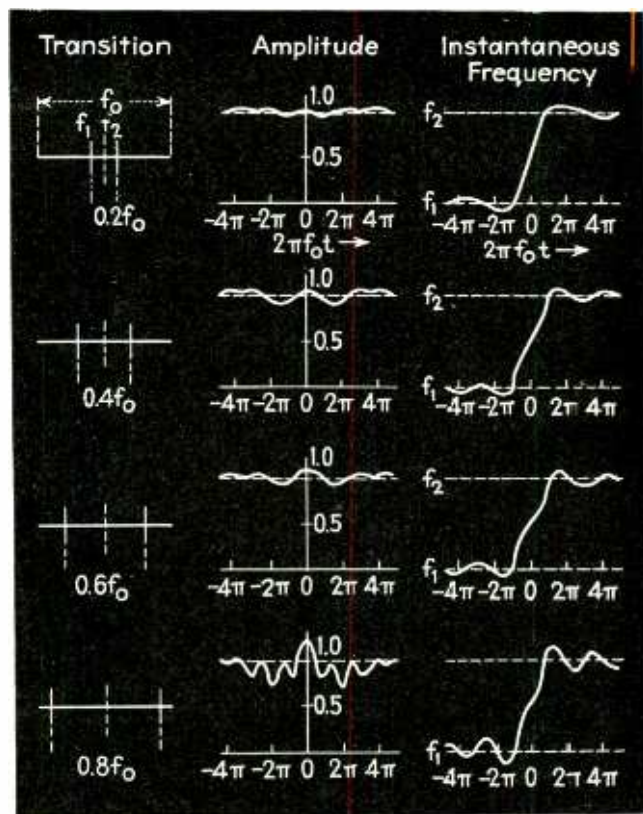


Fig. 4—Output responses of an ideal bandpass filter to symmetrical frequency transitions of the general signal

four times the average power output of a grid modulated amplitude modulation stage and considerably greater efficiency.

Low level modulation, followed by amplifiers having the desired radio frequency characteristics, would obviate the necessity of a high video level, and would accomplish most of the sideband attenuation before the final stage is reached. Compared with low level class B amplitude modulation, no attention need be paid to linearity in the frequency modulation amplifiers.

Predistortion of the high frequency components of the video signal could be accomplished, if desired, without increasing the peak power output in the final stage. If a frequency swing of one half of the converter slope is used, only 50 per cent of the converter slope is occupied by the normal peak to peak video signal. Predistortion of the high frequency components to compensate for aperture distortion, for example, increases the peak-to-peak video signal, and, on an amplitude modulation basis, this means a large increase in the peak power output of the final stage.

At the receiver, the most important question is the comparison be-

tween amplitude and frequency modulation in the matter of signal to noise ratio. No adequate treatment of the effect of noise on a television image and its proper evaluation has yet appeared. However, for purposes of comparison, we may consider three particular types of noise which are prevalent in television reception.

Crosby² has treated the first two types of noise, and from his results it appears that for equal average carrier amplitudes at the antenna, the signal to noise ratios for amplitude and frequency modulation receivers will be about the same if the total frequency deviation in the frequency modulation receiver is one half of the total radio frequency band width. However, with this deviation ratio at the receiver, it is still possible, with the same transmitter output stage as used in an amplitude modulated transmitter, to radiate four times the average power with frequency modulation. Thus, the average carrier amplitude at the f-m receiver is doubled, and so is the signal to noise ratio.

It is apparent, then, that to realize this gain in signal to noise ratio for the frequency modulation receiver, we must make the deviation ratio larger than that shown in Fig.

5B. To do this, we may extend the deviation width, leaving the carrier and converter slope unchanged, as in Fig. 6A, or we may decrease the converter slope, as in Fig. 6B, shift the carrier somewhat, and leave unoccupied sections of the converter on either side of the extended deviation band. Which of these two radio frequency characteristics gives the best results in terms of picture response, is best left for experiment to decide.

The effect of reflections in the frequency modulation system will be reduced fifty per cent, regardless of the deviation ratio. This is because the frequency of the reflected components will always lie within the deviation band, and since the interference produced by any reflected component is proportional to the difference in frequency between the direct signal and the reflection, and is equal to the interference produced in an amplitude modulation system only when this difference is equal to the deviation width, the average peak interference will be one-half that experienced by the a-m system. When the video signal remains at a constant level longer than the delay time of the reflection, there will be no interference, since the frequencies of the direct and reflected sig-

nals will be the same. Hence we may expect an effective reduction of reflection effects greater than the fifty per cent decrease in peak interference.

Synchronizing Functions

Two important functions in the receiver are the separation of the synchronizing impulses from the video, and a further separation of the vertical from the horizontal impulses. With present receivers employing amplitude modulation, the separation of the video from the synchronizing impulses is on an amplitude basis, while the two synchronizing signals are further separated on a basis of waveform difference.

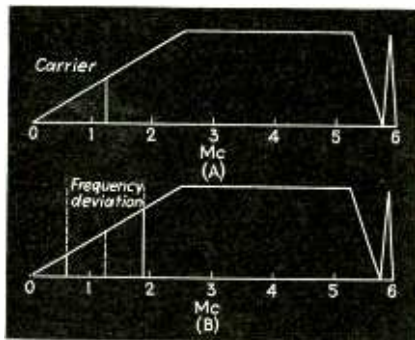


Fig. 5—Selective sideband characteristics for amplitude (A) and frequency (B) modulated signals

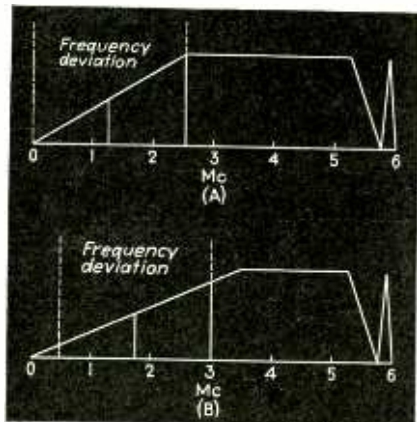
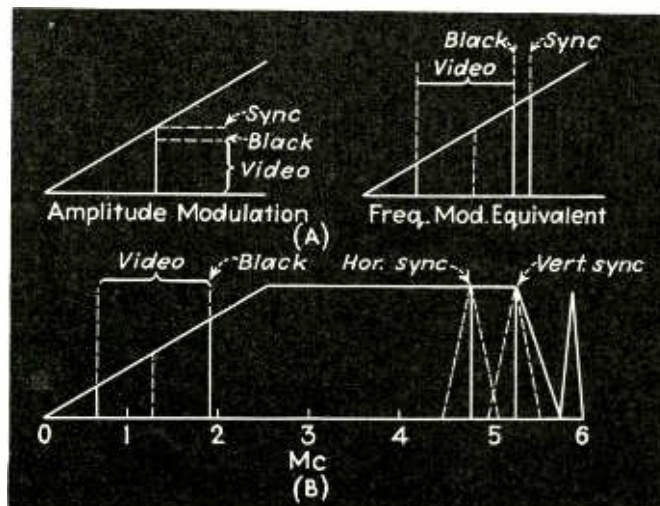


Fig. 6—Methods of extending deviation width of f-m system

Fig. 7—A possible means of using frequency modulation in synchronizing functions



Some novel synchronizing means become possible in a frequency modulated system. Figure 7 shows one of these. If we consider the frequency modulation equivalent of the present amplitude transmission scheme, we find that the synchronizing impulses are represented by a practically discrete frequency component some twenty per cent removed from the region occupied by the video components. Since the two components are already separated in frequency, it is possible to exaggerate this difference, and make the entire separation on a basis of frequency. Thus, in Fig. 6, the two synchronizing pulses are removed to the far end of the band, and the two pulses are assigned to frequencies differing by one half megacycle. The synchronizing signals are then selected by means of two sharply tuned circuits, and are separately rectified. In this manner, separation of the synchronizing pulses from the video, and the separation of the vertical from the horizontal is accomplished at the same time.

Let us examine further the separation of the vertical from the horizontal. In the receiver, the output of the limiter feeds two tuned circuits, which are resonant at the two synchronizing frequencies, respectively. Assuming that the frequency assigned to the vertical is at the edge of the intermediate frequency band, and that the tuned circuits have a Q of 100, the ratio of wanted to unwanted signal is about 4-to-1 for a frequency difference of one half of a megacycle. The damping constant of the tuned circuits, for a Q of 100, will be 3.75×10^5 . Then, in the time interval represented by a half line duration, 3.75×10^6 second, the transient response of the vertical impulse circuit due to a horizontal signal will be reduced to $e^{-34.0}$, or 0.001 per cent of its peak response. Thus,

in the vertical impulse circuit, there will be no hangover of the horizontal response. Then, if a biased detector is used, so that the 25 per cent amplitude of the unwanted horizontal signal is not detected, a clean separation of the vertical impulse is effected without the necessity of equalizing impulses.

In summary, we have discussed the possibility of transmitting television in present channel widths by means of frequency modulation. Due to the channel restriction, it has been necessary to consider the frequency modulation equivalent of selective sideband amplitude modulation. Fortunately, the frequency to amplitude converter, if it is of the type where operation is confined to one side of a resonance curve, fits naturally into the selective sideband scheme. Using a system of this sort, it has been found that the detail at any point in the final picture will depend on the brightness at that point, so that the brighter portions of the picture will show greater detail than the darker portions. At this point, further theoretical analysis of the problem becomes uneconomical, and recourse should be made to experiment to determine the best overall frequency characteristic and deviation width.

Assuming a deviation width of one half of the radio frequency channel, the signal-to-noise ratio of the frequency modulation receiver may be doubled over existing amplitude modulation receivers by operating the present amplitude modulated transmitters at their peak power levels. Multiple image effects due to reflection will be reduced by at least fifty per cent or more.

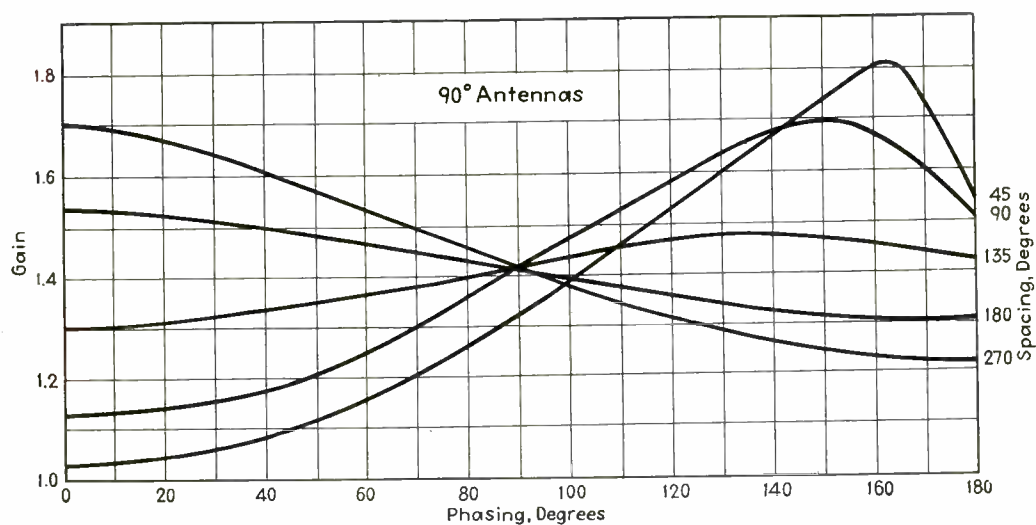
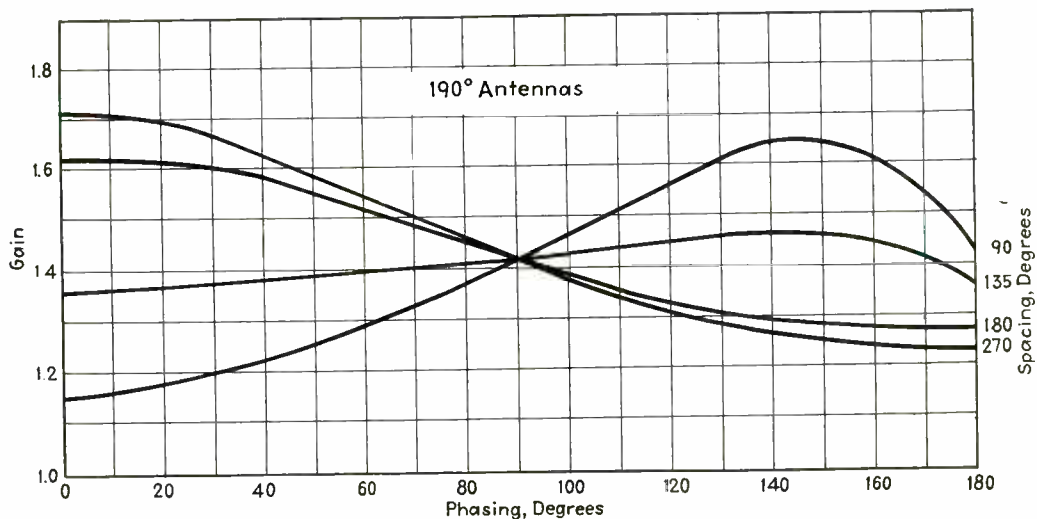
At the transmitter, the production of a large amount of video modulating power, and the necessity of a sideband filter in the output stage, may be avoided by low level frequency modulation. Cleaner separation on a frequency basis of the synchronizing pulses at the receiver should make a simpler synchronizing signal possible, with consequent elimination at the transmitter of much of the present complex signal generating equipment.

BIBLIOGRAPHY

- ¹ Roder, Hans, *Proc. I.R.E.*, 25, 1617, December, 1937.
- ² Crosby, M. G., *Proc. I.R.E.*, 25, 472, April, 1937.
- ³ Bingley, F. J., *Proc. I.R.E.*, 26, November, 1938.

DIRECTIONAL ANTENNA CHART

By WILLIAM S. DUTTERA
National Broadcasting Company



These charts show the voltage gain that may be derived from a two antenna array when the antennas carry equal currents and are both 90 degrees (one quarter wave length) or are both 190 degrees high. The voltage gain is the ratio of the maximum directional ground signal intensity to the non-directional ground signal

intensity from a similar antenna. The voltage gain is shown as a function of the phasing for various spacings. The approximate gain for other spacings may be found by interpolation or may be computed. The actual gain obtained will of course depend upon the loss in the system and allowance must be made for this loss.

TUBES AT WORK

A new method of photographing the solar corona, using television circuits, a profile integrator using a phototube, a universal ultraviolet meter, and a thyratron "reactrol" control

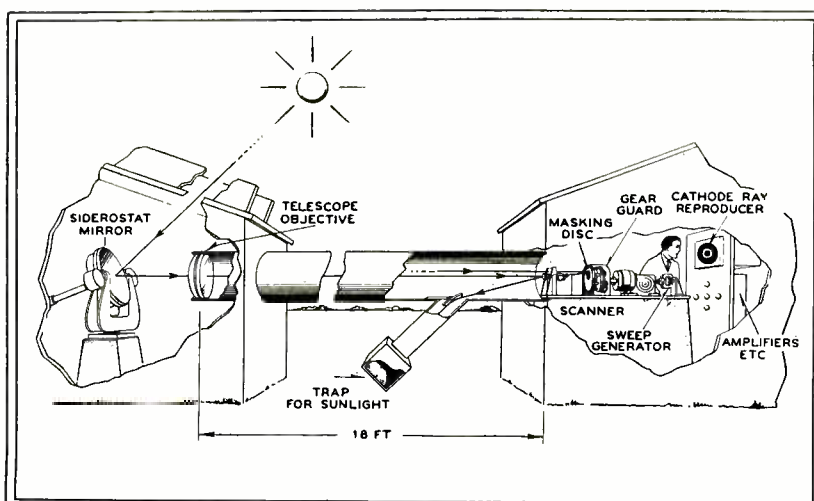
Television Technique Adopted In Photographing Sun's Corona

THE IMPORTANCE of the solar prominences (gas flames in the sun's corona) in correlating sunspot activity, and the dependent science of predicting radio propagation effects, are well appreciated. But the difficulty of photographing these prominences in the full light of the sun's disc has been so great that virtually the only time during which they can be photographed occurs during a total eclipse. Recently, however, a new technique for photographing solar prominences has been developed by Dr. A. M. Skellett of the Bell Telephone Laboratories, who reported it recently before the National Academy of Sciences. Briefly, the new technique consists in scanning an image of the sun, utilizing a spiral scanning path which explores the image just outside the disc of the sun. The method used is very similar to that used in the older systems of mechanical scanning in television. The scanner directs the light to a phototube where a corresponding current is produced. The d-c component of this current is produced by the light from the sky, and by general scattering of light from the sun's disc. The a-c component of the signal is derived from the light of the solar prominences. By passing the signal through a capacitively-coupled amplifier it is possible to eliminate the d-c component and to amplify the a-c component until it is of sufficient magnitude to control the grid of a cathode-ray picture tube, such as is used in television. The picture tube is scanned in a spiral pattern similar to, and in synchronism with, the scanning motion used to explore the sun's image. The image on the picture tube, thereby produced, is a reproduction of the solar prominences present on the sun. The image may be examined visually, and any changes in the prominences noted directly, or photographs may be made of the image for more extended study.

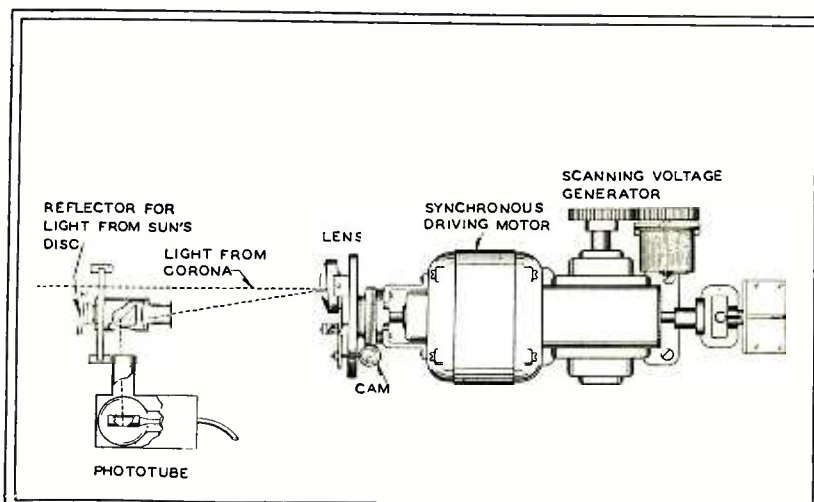
The details of the scanning setup are shown in the accompanying drawings. The image of the sun is formed, optically, by a concave mirror which directs it toward a horizontal telescope. The image of the sun's disc is intercepted by a small mirror at the other end of the horizontal telescope, and this mirror reflects this undesired light to a side arm of the telescope which traps

the light by absorption. The light which comes from the region around the sun's disc passes the mirror to a masking disc and thence to the scanning mechanism. The scanning system consists of a lens and mirror rotated by a synchronous motor. The mirror is rotated, and at the same time displaced along a radius of its circular motion, by means of a cam and lever arrangement. The combination of ro-

Solar prominences photographed with the "coronaviser" developed by A. M. Skellett. Note the scanning lines surrounding central black disc which represents the sun



The complete set-up of the coronaviser. The sun's image is reflected to a horizontal telescope, and the light due to the solar disc is intercepted. The light from the corona is passed to a spiral scanner and phototube which develops a video signal whose d-c component is then removed



The optical and scanning system of the coronaviser. The synchronous motor drives a mirror-lens which reflects the light from the corona into the phototube. Geared to the motor shaft is a potentiometer which develops scanning voltages. These voltages drive the scanning spot of a cathode ray tube on which the corona image is viewed

THEY LIGHT ON THESE...

CINCH DIAL LIGHT SOCKETS!

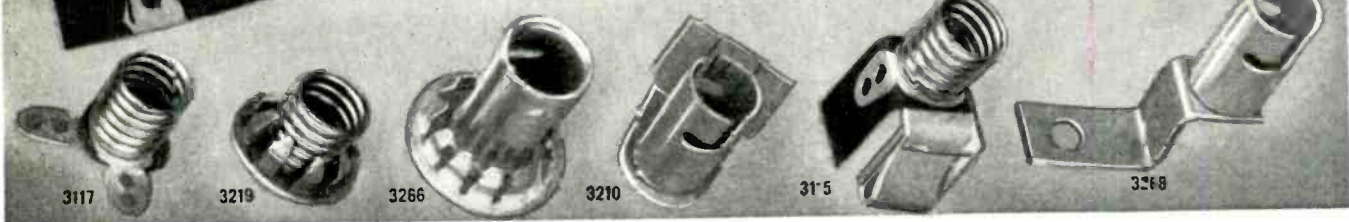
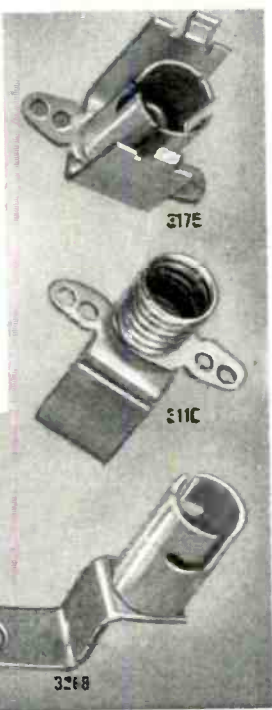
Wide variety to choose from—great numbers in use... Cinch dial light sockets assure mechanical and electrical perfection under any set specification or construction.

Radio engineers, technicians—agree that for dependability, certain performance... given a choice, they "light on Cinch".

Cinch and Dial Radio Sockets are licensed under H. S. Eby secret patents

SUBSIDIARY OF UNITED CARB FASTENER CORP., CAMBRIDGE, MASS.

CINCH MANUFACTURING CORPORATION
2335 WEST VAN BUREN STREET CHICAGO, ILLINOIS



AMERICAN AIRLINES USE EIMAC TUBES in their radio ground stations



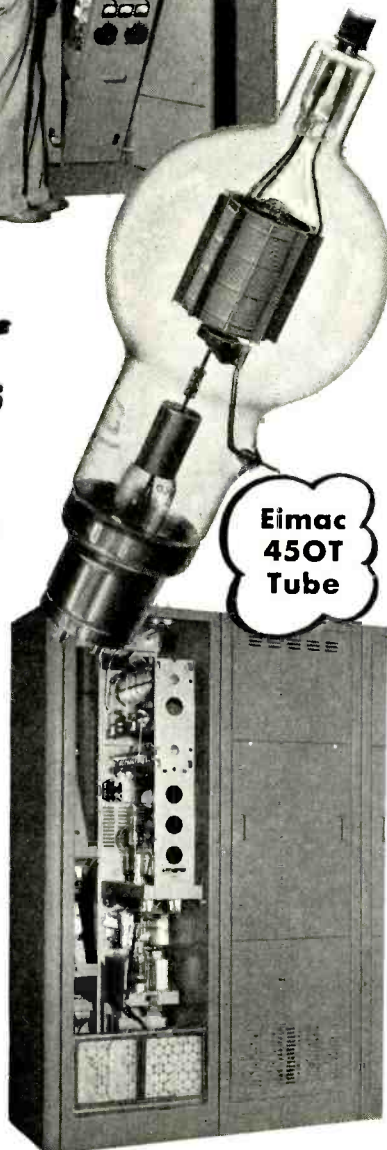
New ground stations for American Airlines manufactured by COLLINS RADIO COMPANY. Another important endorsement of the superior quality and outstanding capabilities of

Eimac
TUBES

One after another, leaders in the field of radio communications are turning to Eimac for vacuum tubes. Practically every major Airline in the USA is now using these superior tubes for the important jobs in their vital radio communication systems.

This new multifrequency transmitter was designed and produced by one of the nation's leading radio equipment manufacturers for one of the world's leading air transportation companies. Eimac 450TL tubes are used in the power amplifier, operating at an anode potential of 4kv, drawing 1 amp. anode current. Another pair of Eimac 450TL's are the class B modulators. Driving power is extremely low considering the available output delivered by either stage. Complete details can be obtained by writing direct to the equipment manufacturers or to the makers of Eimac tubes.

EITEL-McCULLOUGH, INC., San Bruno, Calif.



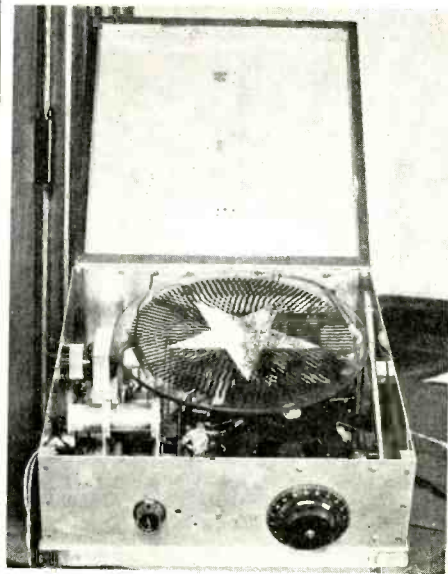
tational and radial motion produces spiral scanning. Light from the mirror-lens is reflected to a small telescope which directs the light to a conventional phototube.

The signal produced in the phototube circuit is passed through the capacitive connection to remove the d-c component, and amplified before being applied to the picture tube. The synchronous motor of the mechanical scanner is coupled to a generating system which develops a scanning voltage used to scan the picture tube in synchronism with the mechanical scanner. Tests with the equipment (known as a "coronaviser") have proved that the corona prominences may be photographed readily, but it is apparent that for the best results the equipment should be placed at a high altitude where freedom from dust and other sources of scattered light may be obtained, and further, the optical system of the telescope must be built to minimise scattered light and diffraction patterns. When these improvements have been made, it seems likely that the coronaviser will become a new astronomical tool of considerable importance.

• • •

Integrator for Irregular Plane Surfaces

TO INCREASE the accuracy and convenience of measuring the areas of irregular plane surfaces, the Stockton Profile Gauge Corporation, Lowell, Mass., has recently developed a polar integrator based on the use of a light source, reflector and photocell in a compact cabinet. Above the light source and at right angles to the light beam is a rotating disc of transparent material, preferably glass. On this disc and in concentric circles are



Photoelectric profile gauge



ITS A BOY STOP

BOTH DOING WELL

STOP LOVE

MESSAGES of hope and fear wing their way over telegraph circuits . . . safeguarded at many points by Synthane Bakelite-laminated parts.

Important to telegraph equipment manufacturers are Synthane's high dielectric strength, easy machinability and mechanical properties. For the same reasons, and others which follow, Synthane may favorably influence the design, production, performance or salability of your own product.

Synthane is a dense, hard, uniform technical plastic with a combination of properties a yard long. It is light in weight—about half the weight of aluminum—structurally strong and non-hygroscopic. It resists the corrosive effects

of many acids, salts, gases, solvents, petroleum products and water.

Synthane combines these and many other desirable properties to a degree seldom found combined in any other single material.

Synthane is easily machined. You can fabricate it yourself or we'll do it for you just as we did for the three widely different manufacturers whose products are pictured below.

For your own satisfaction, protection and economy, investigate all the combined advantages of Synthane. Your request for information, samples or engineering assistance will be answered promptly.

SYNTHANE CORPORATION, OAKS, PENNSYLVANIA

SYNTHANE TECHNICAL PLASTICS

SYNTHANE

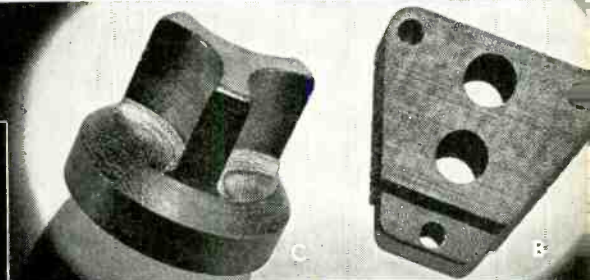
Bakelite- laminated

PRODUCTS OF THE MONTH

A—Sawed, milled and drilled Bread Slicing Guide.

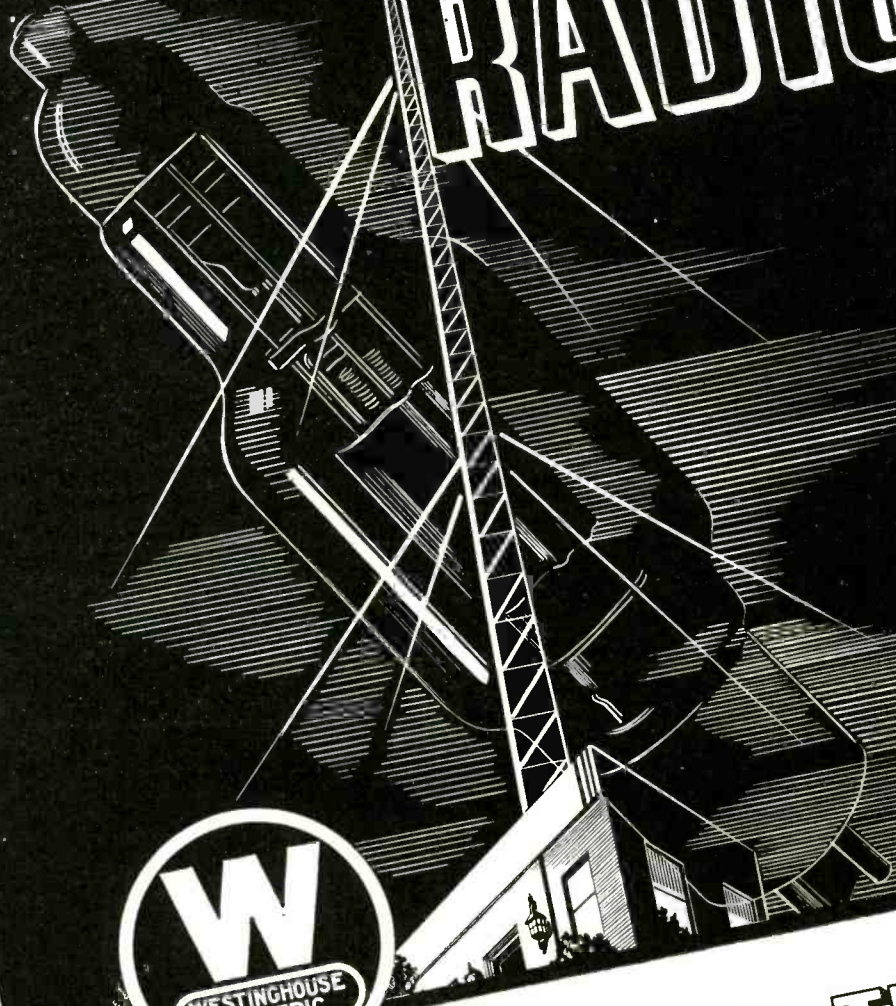
B—Sawed, shaved, milled and drilled Cabin Roller Filler for Airplanes.

C—Turned and milled Pump Valve.



SHEETS . RODS . TUBES . FABRICATED PARTS . SILENT STABILIZED GEAR MATERIAL

Westinghouse RADIO



TRANSMITTING TUBES



Westinghouse

To you who know radio inside out...

who perhaps were in it from the very start, as we were, Westinghouse Radio Tubes need no introduction.

From the same production line that has been producing Radio Tubes continuously since the first broadcast, Westinghouse makes available a complete line of transmitting tubes for broadcasting and other uses.

These Westinghouse Radio Transmitting Tubes reflect in quality and performance the accumulated experience of the oldest name in commercial radio broadcasting.

Westinghouse pledges the resources of its great research and engineering laboratories to the continued advancement and prestige of the radio industry.

Write for descriptive bulletin TD-92, Westinghouse Special Products Division, Bloomfield, N. J.

Westinghouse Broadcast Equipment

KDKA's new Westinghouse 50,000 watt transmitter, recently installed, brings to radio a new standard of equipment for both improved performance and economy of operation.

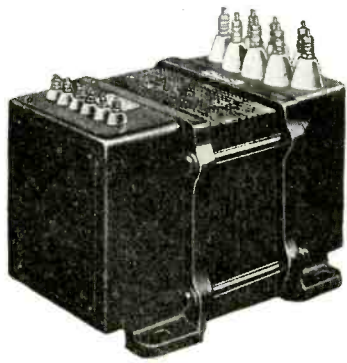
This result is possible because of the great experience of Westinghouse in the operation of many broadcasting stations, dating

from the very first broadcast twenty years ago. And this experience is backed up by equally great resources in research, engineering and manufacturing.

Call the nearest Westinghouse District Office for additional information on radio transmitting apparatus.

Tune in "Musical Americana," NBC Blue Network, Thursday, 8 P. M., E. S. T., 7 P. M.,
C. S. T., 9:30 P. M., M. S. T., 8:30 P. M., P. S. T.

Radio Tubes



Left: AmerTran Type W air-cooled plate transformer, sizes to 5 Kva. at 17.5 Kv.

Right: AmerTran Type H air-cooled filament transformer, sizes to 300 Va.



Transformer Components For all Requirements in Electronic Tube Circuits

HAVE you been designing electronic tube equipment, such as rectifiers, radio transmitters, amplifiers, etc., around specifications of standard transformer and reactor components? With the large assortment available, this is possible in many cases, but the practise frequently leaves something to be desired from the viewpoint of either performance or efficiency.

AmerTran engineers are open minded on this question and will gladly discuss problems of this nature with you as they come up. We manufacture both standard and special transformers of all types used in electronic tube circuits and will recommend the particular equipment best suited for your needs. Furthermore, our set-up is such that, if special units are desirable, they can be produced economically in either small or large quantities and in mountings similar to standard parts.

Let us have data on your transformer requirements so that we can submit complete information on AmerTran Transformers.

AMERICAN TRANSFORMER CO.

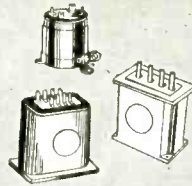
178 Emmet St.



Newark, N. J.

AMERTRAN

AMERTRAN ELECTRONIC PRODUCTS



AUDIO FREQUENCY
COMPONENTS



AIR INSULATED
RECTIFIER COMPONENTS



MANUALLY OPERATED
VOLTAGE REGULATORS



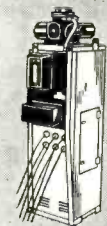
LINE EQUALIZERS



OIL IMMERSED
TRANSFORMERS



RECTIFIERS



AUTOMATIC
VOLTAGE REGULATORS

alternate opaque and transparent sections, each section being calibrated to equal 0.1 square inch. A small motor drives a shaft holding this disc at a predetermined rate of speed. When the cover of the cabinet is closed it acts as a reflector for the light beam which is transmitted through the transparent section of the disc to the photocell. Connected in circuit with the photocell are an amplifier and thyatron tube, with a ratchet motor for operating a counter. The counter revolves once for each operation of the ratchet motor.

To obtain a measurement of the desired regular or irregular surface, the operator places the plane surface to be measured on the disc, closes the cabinet cover and closes a switch which starts the disc revolution. After the disc has made one complete revolution the light source and photocell mounted on the shaft below operated by a coil spring is permitted to recede one notch toward the center and the second concentric circle is scanned. This procedure continues until the whole disc has been scanned with the exception of the small portion in the center of known area, and which is covered by the surface to be measured.

The operation permits the light source to count those sections on the disc not covered by the surface to be measured. In the model illustrated the known value of the disc is 190 square inches, and the counter is calibrated accordingly. Therefore, to obtain an accurate measurement, the counter is set at 100 and revolves backwards, giving at the end of the measuring cycle the measurement of that portion of the disc being covered by the surface being gone over. When the measuring cycle has been completed the power is automatically shut off. The cover of the cabinet can then be lifted and another surface measured. By refinement of the opaque and transparent sections on the measuring disc and by refinement of the light beam which is interrupted by these opaque sections, the accuracy of the device can be further increased.

In addition to applications in science and education, the device has a field in industries where irregular patterns are used to be laid out on irregular or regular material. Sets of shoe patterns, for example, could be measured, laid out for cutting and the waste also measured. It could then be determined by trial which layout of these irregular surfaces would give the best results with the minimum waste of material.

• • •

Mercury Used in G.E. Lamp

In the October issue of *Electronics* it was erroneously reported that the new high-pressure lamp, used as a source of illumination in the television studios of the General Electric Company in Schenectady, contained argon gas. The lamps contain mercury vapor at high pressure.

A UNIQUE "LOW-LOSS" INSULATING MATERIAL

Bakelite Polystyrene for High Frequency Circuits



BAKELITE Polystyrene plastics are unique in many respects, but nowhere do they serve to greater advantage than as low-loss insulation in high frequency circuits. With a power factor and dielectric constant superior to any other organic plastic material, Bakelite Polystyrene offers vast new possibilities for the improvement of radio and television parts. Its stable electrical properties and exceptional moisture resistance provide dielectric characteristics that remain nearly constant at varying temperatures.

The illustration features coil forms and standoff insulators made by the James Millen Mfg. Co., Inc. These are just two of the many low-loss electronic

parts that are now being molded successfully from Bakelite Polystyrene.

Investigate the unique combination of electrical properties inherent in Bakelite Polystyrene. Enlist the cooperation of our research and development laboratories to determine how these low-loss plastics can be most profitably adapted to your own requirements.

BAKELITE CORPORATION
Unit of Union Carbide and Carbon Corporation



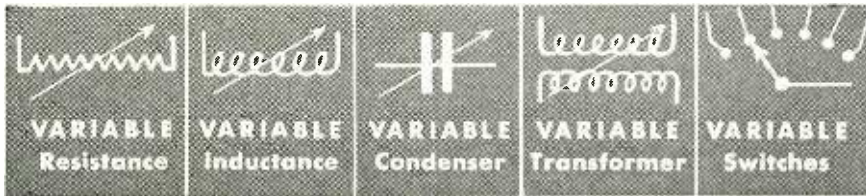
247 PARK AVENUE, NEW YORK

BAKELITE
The registered trade name of Bakelite Polystyrene, a trademark of Union Carbide and Carbon Corporation, Inc.

PLASTICS HEADQUARTERS

**Consider these advantages of
BAKELITE POLYSTYRENE
for high frequency equipment**

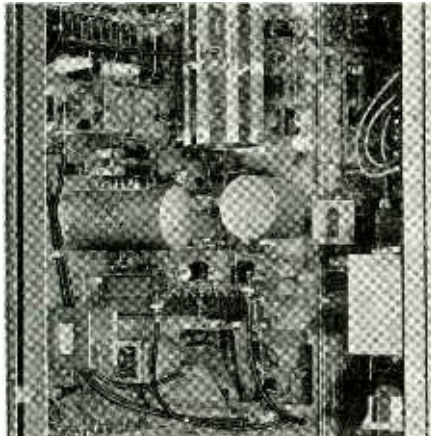
- POWER FACTOR**
(60 to 1,000,000 cycles)
.0001 to .0002
- DIELECTRIC CONSTANT**
(60 to 1,000,000 cycles)
2.60
- LOSS FACTOR** (60 to 1,000,000 cycles)
.00026 to .00052
- DIELECTRIC STRENGTH**
500 to 525 volt/mil
- RESISTIVITY**
Over 10^8 megohm cms.
- ARC RESISTANCE**
(proposed A.S.T.M. method)
120 to 130 secs.



WHEN THE CIRCUIT CALLS FOR *variable* UNITS...

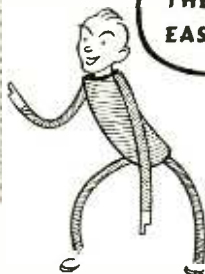


...YOU NEED FLEXIBLE SHAFTS



THEY LET YOU MOUNT THE UNITS WHERE CIRCUIT EFFICIENCY AND EASY ASSEMBLY SAY THEY SHOULD BE...

AND ALSO GROUP THE CONTROLS FOR EASY OPERATION



The "FLEXMEN" are right. Coupling with S. S. WHITE Remote Control Flexible Shafting will greatly simplify the design and construction of radio, television and all other electronic equipment in which there are units requiring adjustments from the outside. BULLETINS giving details about this shafting are yours for the asking. WRITE for them—today.



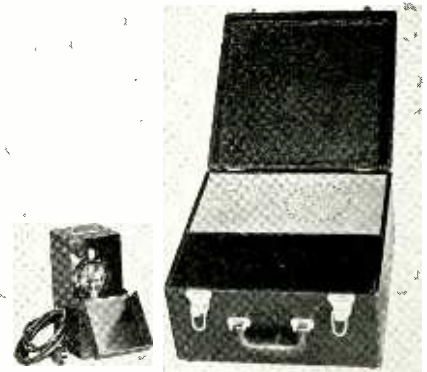
S. S. WHITE

The S. S. White Dental Mfg. Co.
INDUSTRIAL DIVISION
 Department E, 10 East 40th St., New York, N. Y.

FLEXIBLE SHAFTS for POWER DRIVES, REMOTE CONTROL and COUPLING

Three Phototubes Available for Ultraviolet Meter

A new meter for measuring the output of various sources of ultraviolet radiation has been developed in the Westinghouse Laboratories at Bloomfield, N. J. It is intended for use with any one of three ultraviolet sensitive phototubes: the tantalum phototube is used particularly for measuring the output of ultraviolet lamps; the titanium phototube for measuring the uv content of solar radiation, and the platinum phototube for radiation capable of producing ozone. In the new meter, the current passing through the phototube is integrated in a condenser charging circuit, and the condenser voltage is



Portable ultraviolet phototube meter

used to trip a counting circuit. The number of counts per second is a direct measure of the intensity of the uv radiation falling on the phototube. The trigger tube in the counting circuit is a grid-glow tube. A fullwave rectifier is also built into the unit to supply the necessary direct voltage to the phototube and counting circuit. The whole unit weighs about 30 pounds, is portable, and operates directly from a 115-volt 60-cps power source. The phototube is mounted in a separate housing so that it may be placed close to the radiation source. Among the uses of the device are the measuring of uv radiation in irradiation of food, sterilization, measuring of dosage in sun-lamp treatments, and the supervision of ozone sources in air conditioning and purifying equipment.

• • •

Tube and Reactance Combination for Control of Heating Equipment

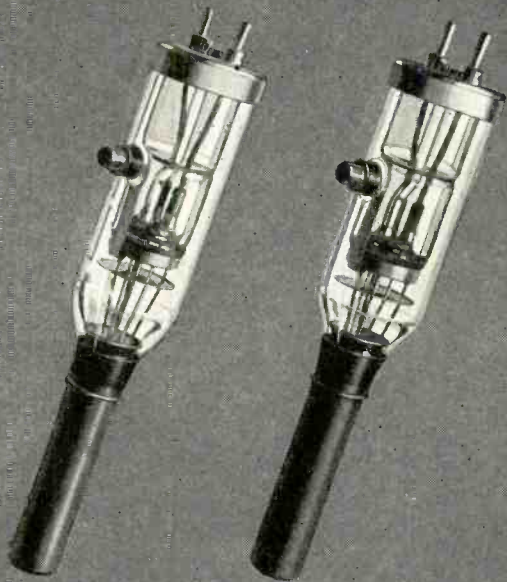
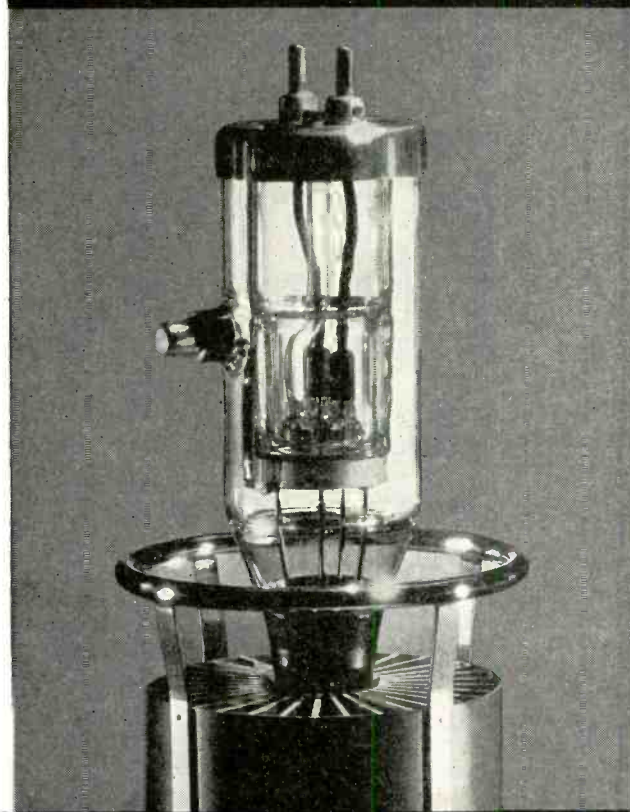
A new "Reactrol" system for controlling the current supplied to electrical heating equipment has recently been developed by General Electric. The device is capable of operating on the basis of pressure or temperature, depending on the type of basic measuring instrument used. If a temperature indicator is used, the current output of the indicator is caused to control the grid circuit of an amplifier, in the plate circuit of which a saturable-core

Take your choice of AIR BLAST or WATER COOLED TUBES

by

Western Electric

343AA—The remarkable new air blast cooled tube developed for use in the 405B (5 KW) Transmitter.



342A—water cooled—Developed for use in 406 (10 KW) and 7 and 306 type (50 KW) Transmitters.

343A—water cooled—Developed for use in the 405A (5 KW) Western Electric Transmitter, and as a replacement tube in earlier transmitters.

... Most economical and reliable tube hour service — minimum program loss!

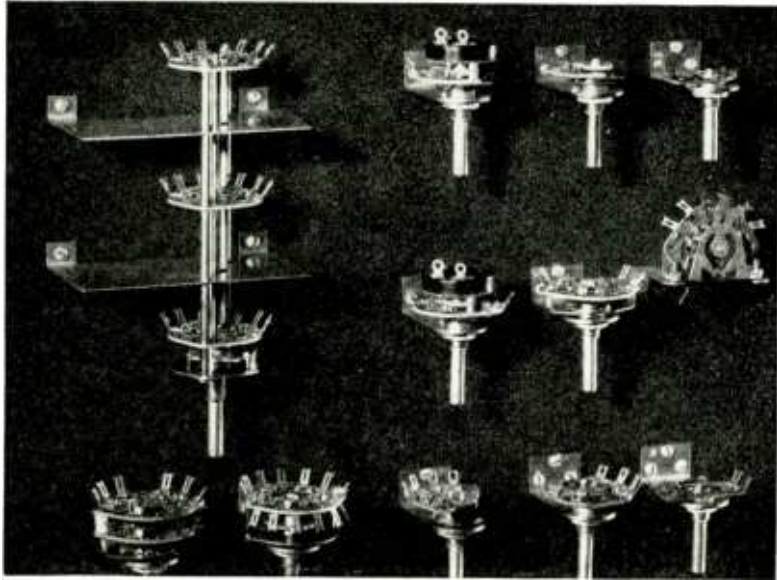
Such tubes as the 342A and 343A water cooled have proved their outstanding qualities through 2 years of laboratory and field life tests. Now the 343AA sets a new high standard for air blast cooled tubes.

You can count on these tubes for unusual operating economy because of such built-in features as: (1) larger filaments to allow greater tungsten evaporation; (2) Copper to glass seals throughout; (3) Greater safety factors in anode rating; (4) Molded glass construction for precision and strength; (5) Highest melting point insulators, completely shielded; (6) Grids swaged of proper materials for desired characteristics; (7) Separate air jacket with corona ring handle; (8) Internal radiant energy shields.

It will pay you to get full details on Western Electric tubes for every socket in your broadcast transmitter. Write Graybar today!

DISTRIBUTORS: In U. S. A.: Graybar Electric Company, New York. In Canada and Newfoundland: Northern Electric Co., Ltd. In other countries: International Standard Electric Corp.





BAND SWITCHES MANUFACTURED BY CENTRALAB, MILWAUKEE, WISC.

Band Switches

TEXTOLITE FULFILLS EXACTING MECHANICAL AND ELECTRICAL REQUIREMENTS

In all short-wave circuits, it is essential that, at all degrees of humidity, insulation losses be as small as possible. Equally necessary in modern band switches, with their ingenious designs, is a tough laminated material that can be punched into intricate forms.

To meet these requirements, General Electric offers Textolite No. 2008 which combines low losses with stability and the necessary toughness to stand the severest punching operations.

General Electric has recently reorganized its fabricating facilities to assure quick and uninterrupted service on fabricated parts. To take advantage of this improved service send inquiries and requests for prices direct to:

IN THE EAST—

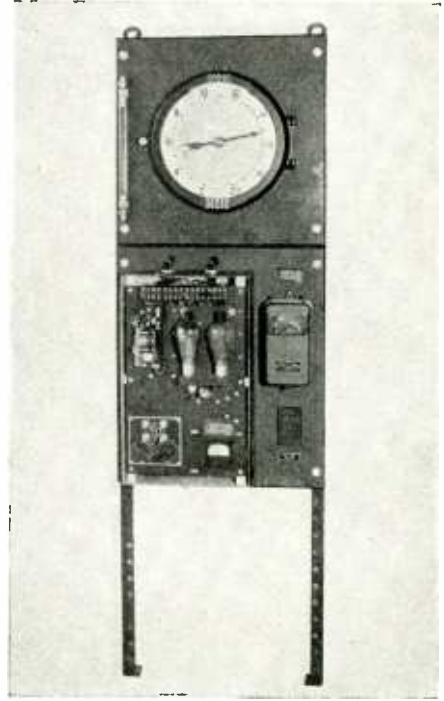
Plastics Department, General Electric Co., 44 Cambridge St., Meriden, Conn.

IN THE WEST—

General Laminated Products, Inc., 3112-23 Carroll Ave., Chicago, Ill.

GENERAL  ELECTRIC

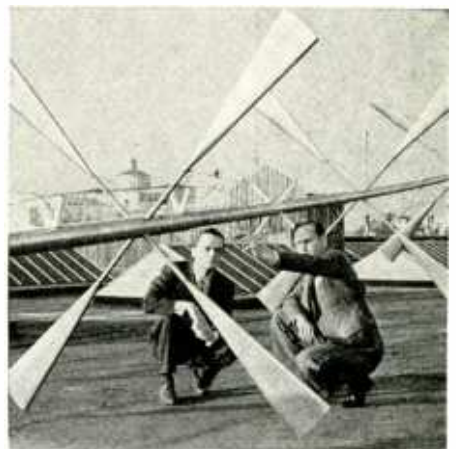
FD-203



Reactrol control equipment

reactor is connected. The rectified current passing through the control tube determines the amount of flux in the saturable core, and the alternating current, passed through a separate winding on the same core, is thereby regulated. Similarly, a pressure indicator may be used, or for that matter any indicating instrument capable of supplying the necessary control voltage to the grid circuit. Proper proportioning of the control characteristic of the reactor makes it possible to exercise close control over the measured quantity with practically no hunting or overshooting.

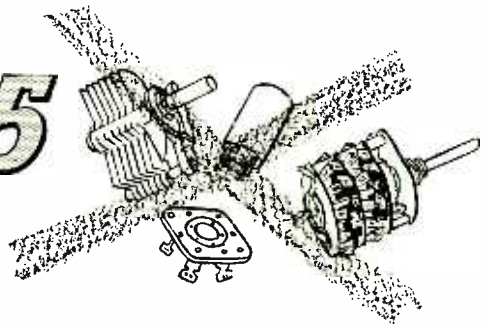
PADDLE ANTENNA



Paddle shaped radiators designed to give greater definition to television pictures are an unusual feature of this sixty foot vertically stacked antenna of four elements built in Hollywood for the Don Lee broadcasting station W6XOA. Left to right are Thomas S. Lee and Harry R. Lubke, designers

why

CHANGE 4 OR 5 COMPONENTS



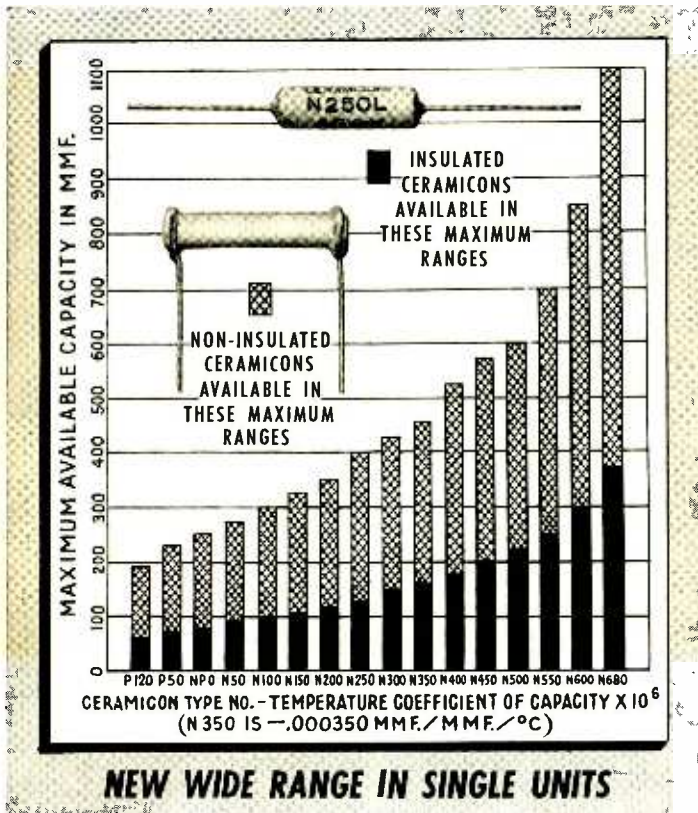
TO ELIMINATE FREQUENCY DRIFT

when 1 Erie Ceramicon

REG. U. S. PAT. OFF.

CERAMICON
N250L
40 MMF.

WILL COMPENSATE FOR IT?



Frequency drift due to temperature variations may be caused by changes in inter-terminal capacity in coil forms, tube sockets and band change switches or by dimensional changes in coil forms and condenser stator mountings.

To eliminate this drift you can track it down in these various components and replace them with better quality material—a long and expensive process. Fortunately this procedure is unnecessary for, in most cases, an Erie Ceramicon inserted in the oscillator circuit will efficiently compensate for the summation of all the individual drifts present.

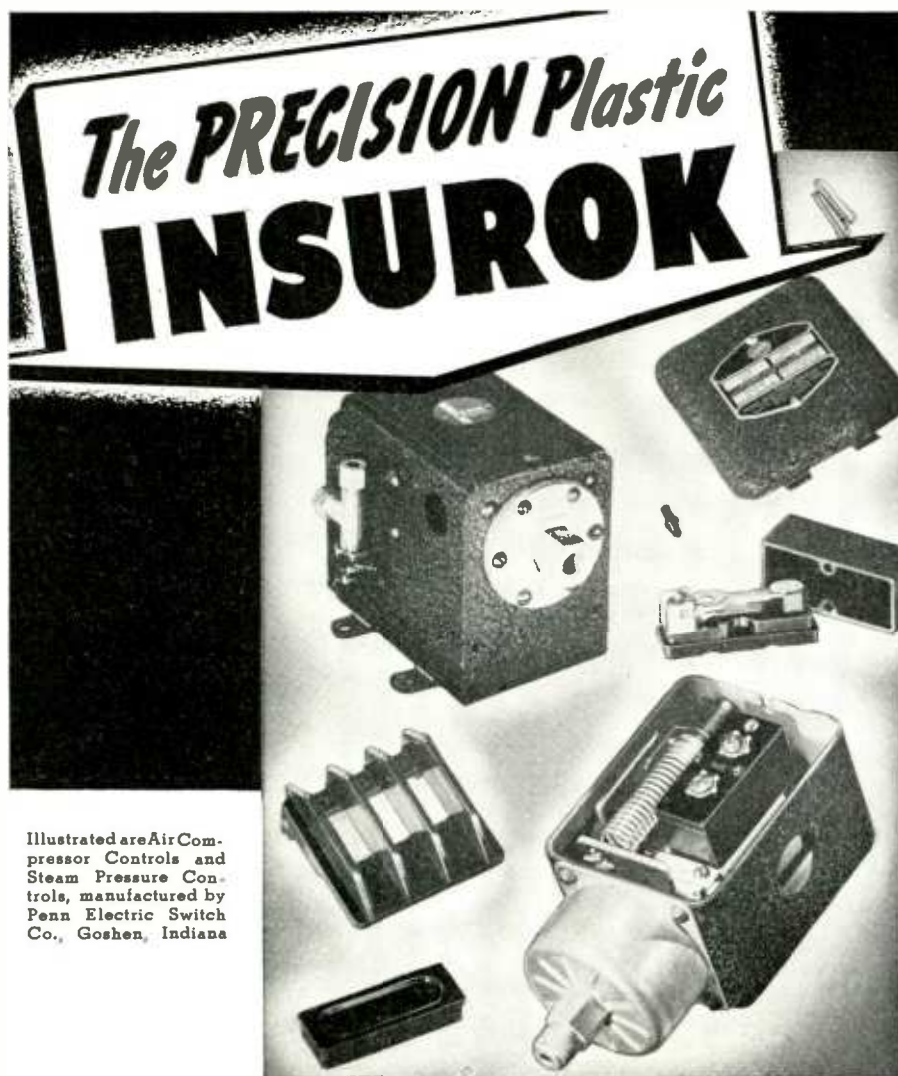
These ceramic-dielectric condensers have a definite and reproducible temperature coefficient that is unaffected by either temperature or humidity. Erie Ceramicons are available in insulated and non-insulated types in the ranges shown at the left. Our engineering department will be glad to work with any manufacturer in solving problems of this nature.

RESISTORS
SUPPRESSORS
CERAMICONS
SILVER-MICA
CONDENSERS

Erie

RESISTOR CORPORATION, ERIE, PA.

MOLDED BEZELS
PUSH BUTTONS
AND KNOBS
POLYSTYRENE
COIL FORMS



Illustrated are Air Compressor Controls and Steam Pressure Controls, manufactured by Penn Electric Switch Co., Goshen, Indiana

where EXACTNESS is essential

Among other things, The Richardson Company prides itself on the fact that precision molding to close tolerances is the normal mass production procedure . . . day in and day out performance . . . not reserved for the unusual or particular job. Users of plastics, therefore, who insist that their product be built up to the highest level of excellence, are not burdened with proportionate cost penalties when they entrust all their plastics requirements to Richardson. The facts will prove interesting—and profitable. Call the Richardson office nearest you.

The RICHARDSON COMPANY

Melrose Park, (Chicago) Ill. Founded 1858 Lockland, (Cincinnati) Ohio
 New Brunswick, N. J. Indianapolis, Ind.
 Detroit Office: 4-252 G. M. Building, Phone Madison 9386
 New York Office: 75 West Street, Phone Whitehall 4-4487

PATENTS

(Continued from page 13)

resistor patent No. 2,010,133.

The net sum and substance of the above remarks on the subject of claims is that they should be worded positively, should include nothing by inference and, if a whereby clause is used, it should be supported by sufficient structure in order that the function set forth in the clause follows as a matter of course.

It must be kept in mind that all *unnecessary* limitations should be omitted from claims when first presented. The inventor may leave it to the Patent Office to cite prior art which later will cause him to write in limitations in order to render the claims patentable. The greater the number of elements in a claim the greater the ease with which infringement may be avoided, since there is no infringement if an element of the claim is omitted in the alleged infringing device.

Method Claims

The courts have held that a true "method," which has for its object the making of a new composition of matter, the processing of an article, or the like, is independent of the apparatus disclosed and that, consequently, such apparatus should not be positively included in the claims.

If the application relates to an "art," such as a process for making a resistor the claims should be devoid of "apparatus" limitations. Following, are examples of good and bad method claims.

Bad: The method of making a resistor which comprises mixing ground glass and bakelite with a *spatula*, drying the mix in an *electric oven*, grinding the mix in a *ball mill*, coating the particles with carbon, thereafter using a *pill machine* to form rods from the coated particles, and baking the rods in a *muffle*.

Good: The method of manufacturing a resistor which comprises coating each of a plurality of particles of inert filler with polymerizable resin, superimposing a film of conducting material upon the resin coating, compressing the filmed particles into a coherent mass, and polymerizing the resin coating to lock the particles in place * * *. (From Claim 16, patent 2,010,133.)

General Considerations

Avoid the use of engineering slang. Use accepted terms and clear,

expressive and accurate language.

Avoid the use of long and involved sentences. When such sentences are employed, the grammatical construction is likely to be the chief concern of the reader. In general, long sentences are neither clear nor expressive.

Make short paragraphs. If the subject does not change, make paragraphs arbitrarily. Each page should be sub-divided into at least three paragraphs and preferably more.

A good specification contains a full and accurate description of the various features of the invention and of the details comprised in its embodiment. The specification should be written as if the reader knew little or nothing about the subject-matter of the invention, but it may be assumed that the reader is acquainted with the general art to which the invention appertains. Matters which have a bearing on the relation of the various parts to each other should not be left to inference.

A poor specification is usually subject to the following criticisms:

The description is meager; that is, the person preparing it has hit only the "high spots."

The language is vague and indefinite and "continuity" is lacking.

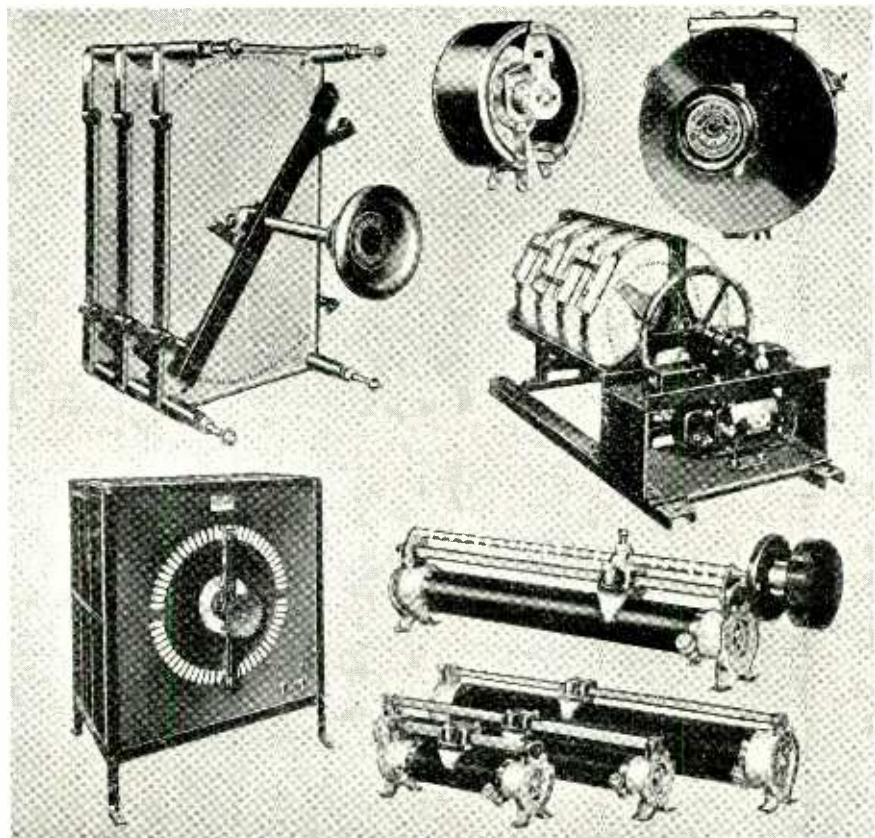
The description is insufficient to enable another to fully understand or to practice the invention set forth.

Reasons for the various occurrences are not stated and are not obvious in the device.

The considerations which enter into the invention are omitted, i.e. no background has been painted.

The writer has failed to grasp the full possibilities and breadth of the invention.

The reader, after carefully studying the Rules of Practice of the United States Patent Office, by following the suggestions contained herein should be able to write and file an application for patent that will "do in a pinch." The prosecution of the application subsequent to filing, however, is a highly technical procedure requiring extensive knowledge of patent law, patent practice and of decisions handed down by Patent Office tribunals and by the Courts. In most instances it is false economy for the inventor to prosecute his own application and if possible, he should secure the services of a patent attorney who has the required technical qualifications.



A RHEOSTAT LINE THAT IS COMPLETE



The bulletins describing the various Ward Leonard Rheostats are probably the most complete compilation of Rheostat data ever assembled by a single manufacturer. They cover a range from the tiny types for fractional horsepower motors to the mighty multiple units that control the rolling of steel. The subjects of

manual and motor drives, mountings and accessories are likewise completely covered. Ward Leonard is a quality line. Each item represents the "latest" in the field. Make your selection from the Ward Leonard data bulletins and be assured of a successful installation.

WARD LEONARD ELECTRIC COMPANY

Electric Control Devices Since 1892

Ward Leonard Electric Company, 32 South Street, Mount Vernon, N. Y.

Please send me complete set of your latest Rheostat Bulletins.

Name.....

Firm.....

Address.....

City..... State.....



TUBES

The topic of discussion this month is hum as caused by current leakage between the heater and cathode of a tube. The list of tubes registered by the R.M.A. Data Bureau during December as well as March and April 1939 is presented

Heater-Cathode Leakage as a Source of Hum

ELECTRICAL LEAKAGE between an a-c operated heater and cathode of a vacuum tube can introduce low frequency voltage into audio amplifier circuits and cause objectionable hum when considerable gain follows this part of the circuit. High frequency circuits are also subject to hum, if they allow the low frequency voltage to modulate the signal. It is through the courtesy of the Tung-Sol Lamp Works, Newark, N. J., that the following discussion is presented.

The principal cause of this hum is a minute leakage current which flows between heater and cathode. The flow of this current through the self-biasing resistor or the parallel combination of resistor and by-pass condenser applies a hum voltage between the grid and cathode of the tube.

It was found that heater-cathode leakage current is essentially a thermionic emission phenomenon and that the flow of current is due to the negative charges (electrons) and positive charges (positive ions) from the insulation coating on the heater to the cathode sleeve. The capacitance between heater and cathode, being of the order of $10 \mu\mu\text{f}$, is too small to constitute a leakage path.

If the heater varies in potential with respect to the other electrodes, the same phenomenon can cause hum, by emission of charges to these electrodes. Hum from this effect occurs most frequently in a-f amplifiers having a grid bias that is less than the highest voltage between heater and ground. The charges emitted to the grid flow through the grid coupling circuit to ground and the *IZ* drop in the grid circuit causes the hum voltage.

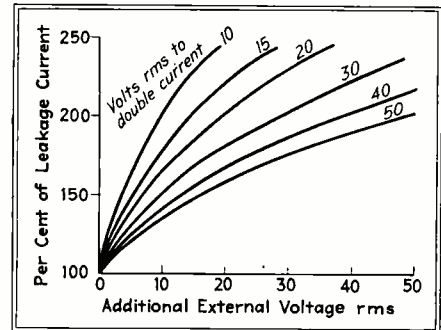
The heater-cathode leakage current is usually a very distorted wave when the applied voltage is a sine wave. This produces harmonics of the 60 cycle heater voltage at which the loud speaker is highly efficient. Under normal operating conditions, the impedance of the leakage circuit is much greater to dc than to ac. The ratio may be as much as 1000 to 1. This is a result of the fact that with a constant potential (dc) applied between heater

and cathode, the current decreases rapidly with time, and when the potential is reversed the current will start at some new high value and again decrease with time. In this discussion the term leakage current refers to the a-c component, unless otherwise specified.

The characteristics of the leakage vary greatly, as the current may consist of the emission of negative charges only, positive charges only or a combination of both. The leakage is usually unstable and will increase or decrease with use.

The impedance of the internal leakage circuit is always much greater than any external impedance across which hum voltage is developed. Therefore, in practical cases, the hum voltage varies directly with the impedance of the circuit through which the leakage current flows and can be calculated from the short circuit leakage current. The leakage current varies from 0 to about 3 microamperes (ac) for 6.3 volt heaters operated at normal voltage and no external voltage in the heater cathode circuit. The product

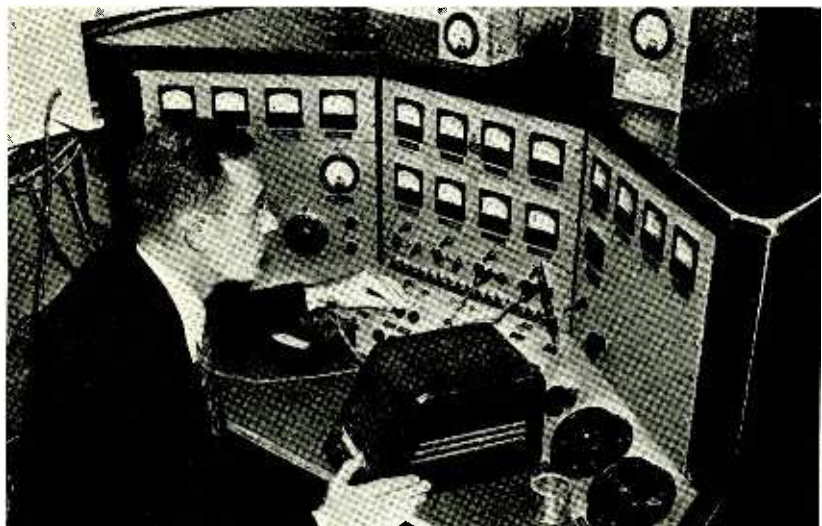
of this current multiplied by the 60 cycle impedance of the cathode biasing circuit is the hum voltage. As an example, assume the leakage current of a type 6F5 tube is 2 microamperes and it is operated as an amplifier with a 3000 ohm cathode bias resistor, by-passed with a $0.1 \mu\text{f}$ condenser. The 60 cycle impedance is nearly 3000 ohms and the *IZ* drop or hum is 6.0 millivolts. With a $5 \mu\text{f}$ by-pass condenser, the 60 cycle impedance is 520 ohms and the hum voltage is then 1.0 millivolt. If the full input signal to the tube is 0.1 volt, the leakage hum in the latter case is 40 db down. The hum will be down 60 db if the leakage current is 0.2 microamperes.



Effect of additional alternating voltage between heater and ground

The effect, on hum, of additional alternating voltage between heater and ground is determined by the use of the diagram. The leakage current varies as the cube root of the entire voltage in the circuit. Part of this voltage is internal, depending on heater voltage and leakage characteristics and the remainder is the alternating voltage between heater and cathode. The internal voltage varies between tubes and to properly rate the leakage of a tube it is necessary to give the leak-

CONTROL PANEL FOR WORLD'S LARGEST ATOM SMASHER



Robert Cornog, working in the radiation laboratory of the University of California, is shown at the control panel of the 220-ton cyclotron. By means of the speaker at Cornog's right hand, he is able to communicate over the public address system with observers working with the cyclotron in another room of the laboratory

age current without external alternating voltage as well as the additional external alternating voltage necessary to cause the current to double. Each curve of the diagram is labeled for the voltage that will double the current. The average for most tubes is 25 volts. Taking this value to apply to the 6F5 in the above example, the increase of hum by raising the heater 3 times or 18.9 volts above ground, is determined from the diagram. Interpolate between the 20 and 30 volts at the 18.9 point on the "Additional External Voltage" scale. Reading the "% Leakage Current" scale, the hum is found to be 185% of its previous value.

The leakage current increases rapidly with temperature, as does all thermionic emission phenomena. A 6 per cent increase in heater voltage approximately doubles hum, or a 1 per cent change in heater voltage causes the hum to change about 1 db when the hum in the amplifier is due entirely to heater cathode leakage.

The instantaneous leakage current, measured with continuous voltage, saturates as the potential between heater and cathode increases. This characteristic makes it possible to reduce the hum in any tube to a very small value by biasing the heater with respect to the cathode so that the net potential between the two never reverses. Hum reaches a maximum with a small bias (sometimes positive, sometimes negative) between cathode and heater.

Operating Conditions to Minimize Heater-Cathode Hum

Heaters should not be operated above rated voltage, as hum doubles with a 6 per cent increase in heater voltage.

If self-biasing circuits are used, the 60 cycle impedance should be as low as possible. This is attained by the use of low cathode resistance and high capacity by-pass condensers and is particularly important in the early stages of a high gain a-f amplifier. Use of fixed-bias avoids this source of hum.

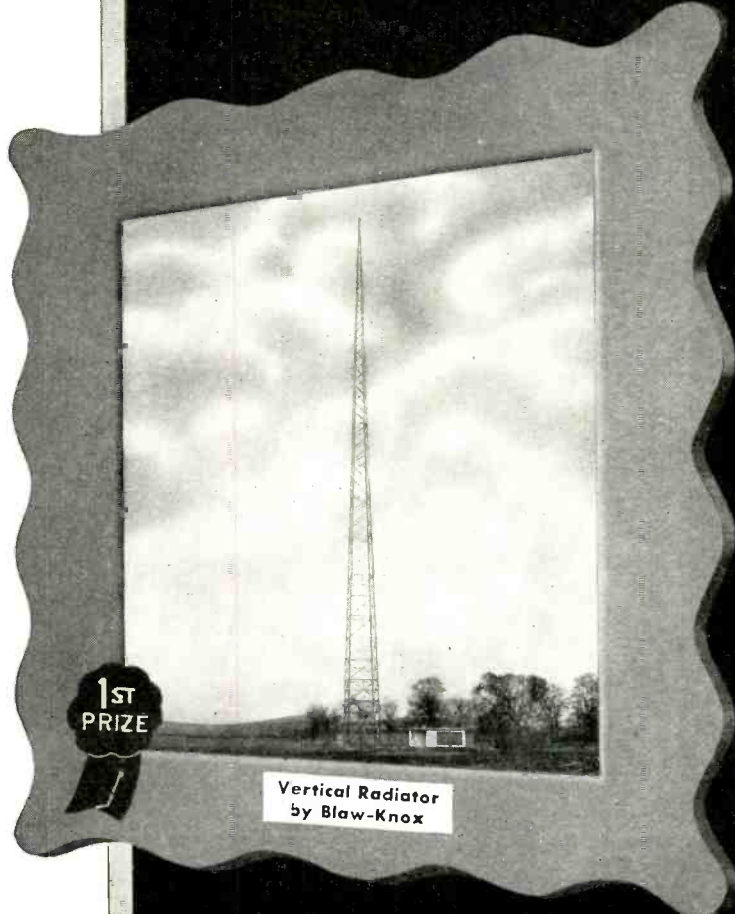
Tubes having comparatively small leakage, used as biased detectors, frequently hum as the cathode resistor is necessarily high and practical conditions require a small by-pass condenser. The most satisfactory method of avoiding this difficulty is to arrange the circuit to ground the cathode of the detector.

In series heater operation, the tube most critical to hum should be placed nearest ground. This is usually the detector tube in a-c d-c receivers. The next tube to be given the preferred position near ground is the converter, as this avoids modulation hum (not caused by heater-cathode leakage).

When a transformer is used, hum will be reduced by grounding the center of the heater winding.

Hum can be reduced to a negligible value by use of sufficient bias between heater and cathode to prevent the net voltage reversing. This condition occurs in infinite impedance detectors

Appearance counts too!



Clean-cut in appearance as well as performance, Blaw-Knox Vertical Radiators give stations a double reason for being proud of them. The features that distinguish Blaw-Knox Radiators—eye-value, greater broadcast coverage, extremely low maintenance cost—are due to one thing . . . *better engineering.* All Blaw-Knox radiators are designed for specific requirements; all reflect an experience covering the entire history of broadcasting. Let us discuss your radiator requirements with you.

BLAW-KNOX DIVISION
of Blaw-Knox Company
2038 FARMERS BANK BLDG., PITTSBURGH, PA.

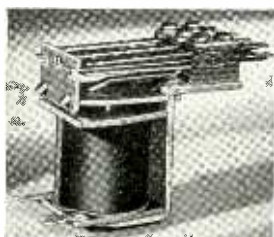
OFFICES IN PRINCIPAL CITIES
NOTE—Blaw-Knox Directional Radio Beacons are used exclusively to guide all air transport service in the United States and Canada.

DISTRIBUTORS
Graybar
ELECTRIC COMPANY

NEW TYPE RELAY NOW AVAILABLE

A Sturdy and Sensitive Design at Low Cost

This new relay, just perfected, costs less because it has fewer parts. Its brand new design affords greater sensitivity, too. So you can save money and get a better relay by switching to this new model. Investigate today.



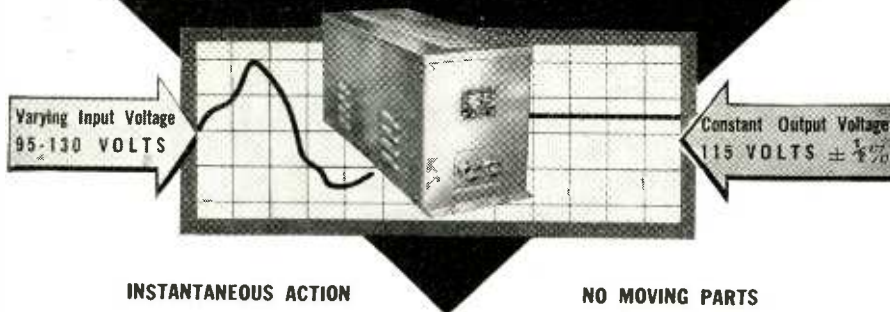
Details and prices on a wide range of contact combinations given in illustrated circular

just released. Write for copy to American Automatic Electric Sales Company, 1033 W. Van Buren Street, Chicago.

AUTOMATIC ELECTRIC

MAKERS OF TELEPHONE AND SIGNALING APPARATUS
ELECTRICAL ENGINEERS, DESIGNERS, & CONSULTANTS

STABILIZED A. C. VOLTAGE UP TO 25 KVA



When a precision electrical device or a critical process is powered from an AC line, a Raytheon Voltage Stabilizer will permanently eliminate all of the detrimental effects caused by AC line voltage fluctuations. Made for all commercial voltages and frequencies, single or three phase.

Raytheon's twelve years of experience in successfully applying the Stabilizer to hundreds of perplexing voltage fluctuation problems is at your service. It will pay you to take advantage of our engineering skill.

Write for Bulletin DL48-71 JE describing Raytheon Stabilizers.

RAYTHEON MANUFACTURING CO.
100 Willow Street, WALTHAM, Massachusetts

and certain cathode loaded circuits.

Hum, resulting from emission of charges from the heater to other electrodes, is reduced by decreasing heater temperature, by keeping the impedance of the electrode circuits low and by keeping the electrodes constantly biased with respect to the heater.

Balancing or bucking hum in a radio receiver is sometimes resorted to in minimizing total hum. Heater cathode leakage should not be given a part in hum balancing systems as it is too variable.

The two following test methods have been found useful in checking sources of hum:

To test for leakage hum use a 30 μ f condenser or a battery whose voltage is equal to the cathode bias. Connect the condenser or battery across the cathode biasing circuit, making the cathode positive, and note the effect on hum. A noticeable reduction of hum indicates the source is heater-cathode leakage.

To test for hum caused by emission from heater to grid, first disconnect the coupling from the previous tube. If hum is not diminished, continue the test by grounding the grid. Disappearance of hum indicates emission from heater to grid.

Tube Registry

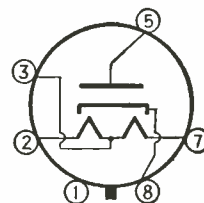
Tube Types Registered by R.M.A. Data Bureau During December 1939

40Z5/45Z5 (GT)

Identical with 45Z5 (GT)

BALLAST-RECTIFIER; heater type; (T-9) glass envelope; seated height 2 $\frac{3}{4}$ inches (max); 7 pin octal base.

$E_h = 45$ v
 $I_h = 0.150$ amp
 $E_{cc} = 125$ v (max)
 $I_{dc} = 100$ ma (max)
 $I_{peak} = 600$ ma
 $E_{drop} @ 200$ ma = 16 v
Basing 6-AD

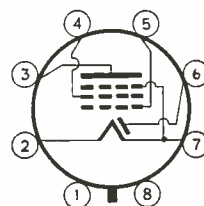


Tube Types Registered by R.M.A. Data Bureau During March and April 1939

Type 1N6 (G)

DIODE; power amplifier pentode; filament type; glass envelope; (T-9) octal base, 8 pins.

$E_f = 1.4$ v
 $I_f = .05$ amps
 $E_p = 90$ v
 $E_{c1} = 90$ v
 $E_{c2} = -4.5$
 $I_p = 3.1$ ma
 $I_{c1} = 0.6$ ma
 $I_{c2} = 800$ μ mos
 $g_m = 25,000$ ohms
 $P_o = .10$ watts
Basing 7-AM

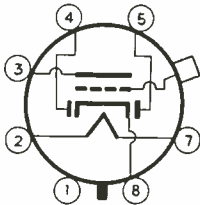


Type 12G7 (G)

Prototype 12G7 (GT)

DOUBLE diode, triode; heater type; (ST-12) glass envelope; 7 pin octal base.

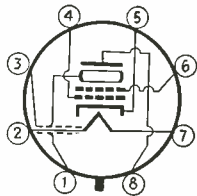
$E_h = 12.5$ v
 $I_h = 0.15$ amps
 $e_p = 250$ v
 $e_c = -3$ v
 $\mu_m = 1200$ micromhos
 $\mu = 70$
 $R_p = 58,000$ ohms
 Basing 7-V



Type 6AG7 (M)

VIDEO beam amplifier; heater type; (T-9) metal envelope; 8 pin octal base.

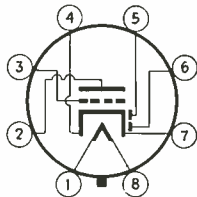
$E_h = 6.3$ v
 $I_h = 0.65$ amps
 $e_p = 300$ v
 $e_c = -10.5$ v
 $\mu_m = 7700$ micromhos
 $\mu = 770$
 $R_p = .1$ megohms
 Basing 8-Y



Type 7E6 (GL)

DOUBLE diode; medium mu triode; heater type; glass base-envelope; lok-tal base, 8 pins.

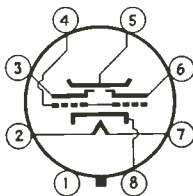
$E_h = 7.0$ v
 $I_h = .32$ amps
 $E_p = 250$ v (max)
 $E_c = -9$ v
 $I_p = 9.5$ ma
 $\mu_m = 1900$ μ hms
 $R_p = 8500$ ohms
 $\mu = 16$
 Basing 8-W



Type 6AF7 (G)

TWIN tuning indicator; heater type; (T-9) glass envelope; 8 pin, octal base.

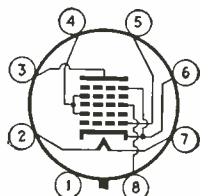
$E_h = 6.3$ v
 $I_h = 0.3$ amps
 Basing 8-A(G)



Type 12SA7 (GT)

PENTAGRID converter; heater type; bantam glass; octal base, 8 pins.

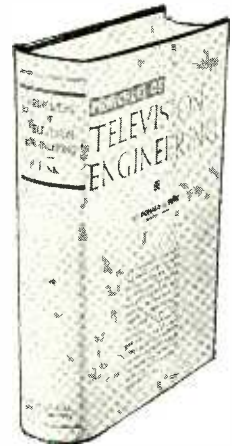
$E_h = 12.6$ v
 $I_h = .15$ amp
 $E_p = 250$ v
 $E_{c2,4} = 100$ v
 $E_{c3} = -2$ v
 $I_p = 3.4$ ma
 $I_{c2,4} = 8$ ma
 $\mu_c = 425$ μ hms
 $r_p = 0.8$ megohms
 Basing 8-AD



Just out!

Complete engineering information on television

Ten data-packed chapters cover the whole field of television design, operation, and maintenance. This new book, published in 1940, is a manual of all the up-to-the-minute information. It is a book to enable the technical man to make the transition from familiarity with radio engineering to familiarity with television engineering.



Principles of Television Engineering

By DONALD G. FINK

Managing Editor, *Electronics*

541 pages, 6 x 9, 313 illustrations, \$5.00

LOOK AT THESE CHAPTER HEADINGS

1. Television Methods and Equipment
2. Image Analysis
3. Fundamentals of Television Camera Action
4. Formation, Deflection, and Synchronization of Scanning Beams
5. The Video Signal
6. Video Amplification
7. Carrier Transmission of Video Signals
8. Image Reproduction
9. Television Broadcast Practice
10. Television Receiver Practice

Appendix: Transmission Standards, Recommended Practices, Definitions, and Names of Controls Adopted by the Radio Manufacturers Association

Here is a book that brings together conveniently for the radio engineer and radio amateur the basic principles on which Television rests, and illustrates the application of these principles in the standards of transmission and in practical equipment now being used.

It gives the reader an understanding of the functions of television equipment and provides the data on which design and operation of equipment depends. Traces the complete television process from the studio camera to the receiver screen.

EXAMINE IT 10 DAYS—MAIL THE COUPON

McGraw-Hill Book Co., Inc., 330 W. 42nd St., N. Y. C.

Send me Fink—Principles of Television Engineering for 10 days' examination on approval. In 10 days I will send \$5.00, plus few cents postage, or return book postpaid. (We pay postage on orders accompanied by remittance.)

Name

Address Position

City and State Company

(Books sent on approval in U. S. and Canada only.)

L2-40

LET US DESIGN YOUR RADIO CABINET



Our merchandising and engineering staffs will design for you, or cooperate with your engineers in developing a Plastic Molded Radio Cabinet that will have strong sales appeal and low production costs.

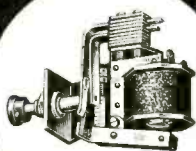
We have, perhaps, developed and molded more radio cabinets than any other custom molder, and this broad experience is at your service.

Write us regarding your 1940 problem, addressing Radio Design Department.

CHICAGO MOLDED PRODUCTS CORP.
1029 NORTH KOLMAR AVENUE, CHICAGO, ILLINOIS

For Synchronized

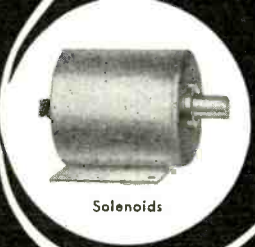
Control



Relays
AC-DC



Stepping
Switches



Solenoids

RELAYS by GUARDIAN

The experience, research and practice of a trained staff specializing in the design and development of unique control units is at your disposal. May we suggest how Controls by Guardian fulfill every need—singly—or in truly reciprocal arrangement? Write

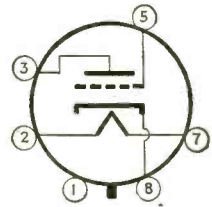
Guardian
ELECTRIC

1625 West Walnut Street • Chicago • Illinois

Type 6AF5 (G)

TRIODE; voltage amplifier; heater type; glass envelope; (ST-12) octal base, 6 pins.

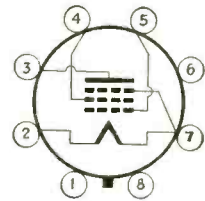
$E_A = 6.3 \text{ v}$
 $I_A = 3 \text{ amps}$
 $E_P = 180 \text{ v (max)}$
 $E_C = -18 \text{ v}$
 $I_P = 7 \text{ ma}$
 $\mu_m = 1500 \text{ } \mu\text{mhos}$
 $R_P = 4900 \text{ ohms}$
 $\mu = 7.4$
Basing 6-Q



Type 1A5 (GT)

POWER amplifier pentode; filament type; (T-9) glass envelope; octal base, 7 pins.

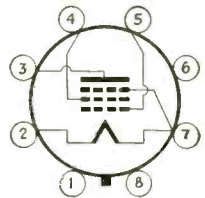
$E_f = 1.4 \text{ v}$
 $I_f = 0.05 \text{ amps}$
 $E_P = 85 \text{ v}$
 $E_{c2} = 85 \text{ v}$
 $E_C = -4.5 \text{ v}$
 $I_P = 3.5 \text{ ma}$
 $I_{c2} = 0.7 \text{ ma}$
 $\mu_m = 800 \text{ } \mu\text{mhos}$
 $R_i = 25,000 \text{ ohms}$
 $P_o = 0.1 \text{ watts (10\%)}$
Basing 6-X



Type 1C5 (GT)

POWER amplifier pentode; filament type; (T-9) glass envelope; octal base, 7 pins.

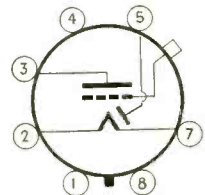
$E_f = 1.4 \text{ v}$
 $I_f = 0.10 \text{ amps}$
 $E_P = 90 \text{ v}$
 $E_{c2} = 90 \text{ v}$
 $E_C = -7.5 \text{ v}$
 $I_P = 7.5 \text{ ma}$
 $I_{c2} = 1.6 \text{ ma}$
 $\mu_m = 1550 \text{ } \mu\text{mhos}$
 $R_i = 8000 \text{ ohms}$
 $P_o = 0.24 \text{ watts (10\%)}$
Basing 6-X



Type 1H5 (GT)

DIODE-TRIODE; filament type; (T-9) glass envelope; octal base, 8 pins.

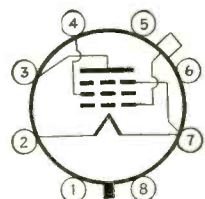
$E_f = 1.4 \text{ v}$
 $I_f = 0.05 \text{ amps}$
 $E_P = 90 \text{ v}$
 $E_{c2} = 90 \text{ v}$
 $E_C = 0 \text{ v}$
 $I_P = 0.15 \text{ ma}$
 $\mu_m = 275 \text{ } \mu\text{mhos}$
 $R_P = 0.24 \text{ megohms}$
Basing 5-Z



Type 1N5 (GT)

R-f pentode; filament type; (T-9) glass envelope; octal base, 8 pins.

$E_f = 1.4 \text{ v}$
 $I_f = 0.05 \text{ amps}$
 $E_P = 90 \text{ v}$
 $E_{c2} = 90 \text{ v}$
 $E_C = 0 \text{ v}$
 $I_P = 1.2 \text{ ma}$
 $I_{c2} = 0.3 \text{ ma}$
 $\mu_m = 750 \text{ } \mu\text{mhos}$
 $R_P = 1.5 \text{ megohms}$
Basing 5-Y





LOW DISTORTION—less than 1% for distortion measurements on high quality audio equipment and broadcast transmitters.

EXCELLENT STABILITY—saves time because NO ZERO SETTING necessary.

WIDE FREQUENCY RANGE—models available from 5 cps. to 200,000 cps.

HIGH OUTPUT—models available with 1 to 5 watts output.

INEXPENSIVE—the Model 200B, 20-20,000 cps., 1 watt output—only \$71.50 net f.o.b. Palo Alto, California.

Write for complete information about these and other instruments

HEWLETT-PACKARD CO.
367 Addison Avenue • Palo Alto, California

A CONTINUOUS WORLD'S PAIR:

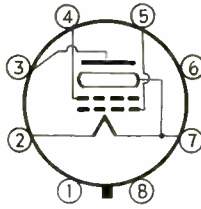
A 280 Tube and "Sylvaloy" Filament

WILBUR B. DRIVER CO.
NEWARK, NEW JERSEY

Type 1Q5 (GT)

BEAM power amplifier; filament type; (T-9) glass envelope; octal base, 7 pins.

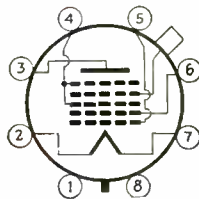
$E_f = 1.4$ v
 $I_f = 0.1$ amps
 $E_p = 90$ v
 $E_{c2} = 90$ v
 $E_c = -4.5$ v
 $I_p = 9.5$ ma
 $I_{c2} = 1.6$ ma
 $g_m = 2100$ μ mhos
 $R_1 = 8000$ ohms
 $P_o = 0.27$ watts
Basing 6-AF



Type 1A7 (GT)

PENTAGRID converter; filament type; (T-9) glass envelope; octal base, 8 pins.

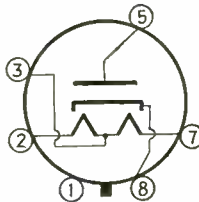
$E_A = 1.4$ v
 $I_f = 0.05$ amp
 $E_p = 90$ v
 $E_{c1,2} = 45$ v
 $E_{c3} = 90$ v
 $E_{c4} = 0$ v
 $I_p = 0.55$ ma
 $I_{c1,2} = 0.6$ ma
 $I_{c3} = 1.2$ ma
 $g_c = 250$ μ mhos
 $R_p = 0.6$ megohms
Basing 7-Z



Type 45Z5 (GT)

BALLAST-RECTIFIER; heater type; bantam glass; octal, 7 pins.

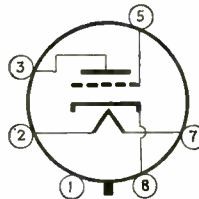
$E_A = 45$ v
 $I_A = .15$ amp
 $E_{ac} = 125$ v (max)
 $I_{dr} = 100$ ma (max)
Basing 6-AD



Type 12J5 (G)

TRIODE; heater type; glass; octal, 6 pins.

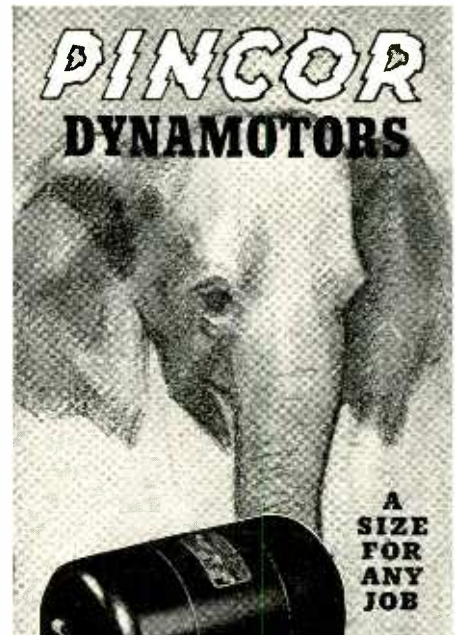
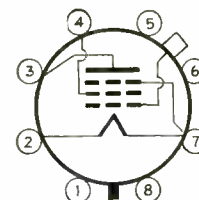
$E_A = 12.6$ v
 $I_A = .15$ amp
 $E_p = 250$ v (max)
 $E_c = -8$ v
 $I_p = 9$ ma
 $g_m = 2600$ μ mhos
 $R_p = 7700$ ohms
 $\mu = 20$
Basing 6-Q



Type 1P5 (G)

PENTODE; remote cutoff; filament type; glass; octal, 7 pins.

$E_f = 1.4$ v
 $I_f = .05$ amp
 $E_p = 90$ v
 $E_{c2} = 90$ v
 $E_{c3} = 0$ v
 $I_p = 2.3$ ma
 $I_{c2} = 0.7$ ma
 $g_m = 800$ μ mhos
 $R_p = .8$ megohms
Basing 5-Y



MADE TO "Take It"

Follow the lead of outstanding governmental and commercial radio engineers everywhere. Specify Pincor Dynamotors wherever a dependable "B" power supply is needed for air craft, marine and broadcast service, police units, auto radios and sound systems. They'll give you thousands of hours of trouble-free, smooth, quiet operation with highest efficiency and regulation.

Available in a wide range of frames, sizes and capacities to fit any particular requirement. 10 to 850 watts. Input, 6 to 110 volts; output, up to 1750 volts. With or without filter. Light weight, compact. Send coupon for catalog and data sheets.

ROTARY CONVERTERS

Complete line for converting 6, 12, 32, 110 or 220 volts D. C. to 110 or 220 volts A. C. 60 to 750 watts.

PIONEER GEN-E-MOTOR CORP.

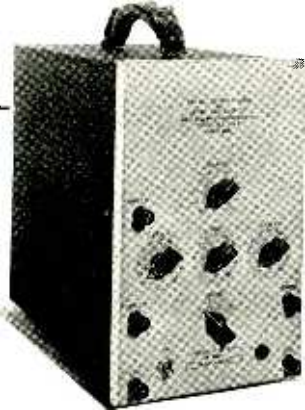
CHICAGO • ILLINOIS

Export Address: 25 Warren St., N. Y., N. Y.
Cable: Simontrice, New York

PIONEER GEN-E-MOTOR CORPORATION
Dept. R-4B, 466 W. Superior St., Chicago, Ill.
Please send information on Pincor Dynamotors
Motor Generators and special power supply
units.

Name _____
Address _____
City _____ State _____
 A'so send me Rotary Converter Catalog.

You need the ELECTRONIC SWITCH...



- Multiply several fold the usefulness of your cathode-ray oscillograph with the DuMont Type 185 Electronic Switch!

This handy, portable, moderate-cost instrument provides a switching-rate variable from 6 to 2000 times per second. Also operates as square-wave generator over frequency-range from 60 to 400 cycles per second. Here are typical uses:

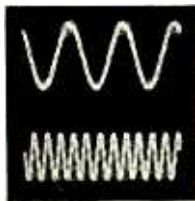
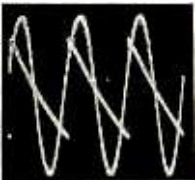


Photo showing comparison of two harmonically related signals on single oscillograph screen, using electronic switch. Patterns displaced for individual observation. Can be superimposed if preferred for very close comparison.



Independence and freedom from interaction of two channels shown in this photo. Illustrates ability of electronic switch to handle sawtooth and sinusoid at same time, and to make them appear as one oscillograph pattern.

Write for DATA . . .

- Literature describing DuMont Electronic Switch and DuMont Oscillographs, sent on request. Do not hesitate to submit your problems for our specialized engineering collaboration.



PASSAIC

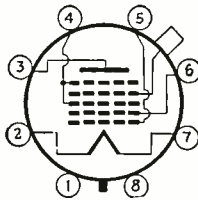
NEW JERSEY

Cable Address: Wespexlin, New York

Type 1B7 (G)

PENTAGRID converter; remote cutoff; filament type; glass; octal, 8 pins.

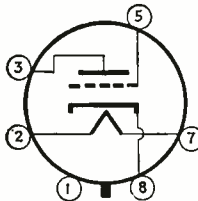
$E_f = 1.4 \text{ v}$
 $I_f = .10 \text{ amp}$
 $E_p = 90 \text{ v}$
 $E_{c1, s} = 45 \text{ v}$
 $E_{c2} = 90 \text{ v}$
 $E_c = 0 \text{ v}$
 $I_p = 1.5 \text{ ma}$
 $I_{c1, s} = 1.3 \text{ ma}$
 $\mu_c = 350 \text{ }\mu\text{hos}$
 $R_p = .35 \text{ megohms}$
 Basing 7-2



Type 6P5 (GT)

TRIODE; heater type; bantam glass; octal base, 6 pins.

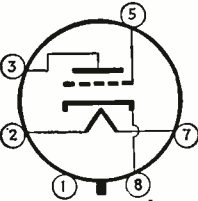
$E_h = 6.3 \text{ v}$
 $I_h = .3 \text{ amp}$
 $E_p = 250 \text{ v}$
 $E_c = -13.5 \text{ v}$
 $I_p = 5 \text{ ma}$
 $\mu_m = 1450 \text{ }\mu\text{hos}$
 $R_p = 9500 \text{ ohms}$
 Basing 6-Q



Type 6AC5 (GT)

POWER amplifier triode (positive grid); heater type; bantam glass; octal, 6 pins.

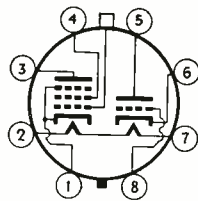
$E_h = 6.3 \text{ v}$
 $I_h = .4 \text{ amp}$
 $\mu_m = 3400 \text{ }\mu\text{hos}$
 $R_1 = 2 (5000) \text{ ohms}$
 $P_o = 8 \text{ watts (10\%)}$
 Basing 6-Q



Type 25B8 (GT)

PENTODE; triode; heater type; bantam glass; octal base, 8 pins.

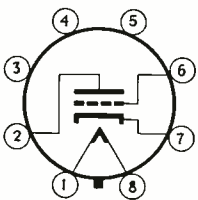
$E_h = 25 \text{ v}$
 $I_h = .150 \text{ amp}$
 TRIODE
 $\mu_m = 1500 \text{ }\mu\text{hos}$
 $\mu = 112$
 $R_p = 75,000 \text{ ohms}$
 PENTODE
 $\mu_m = 2000 \text{ }\mu\text{hos}$
 $\mu = 370$
 $R_p = 185,000 \text{ ohms}$
 Basing 8-T



Type 7A4 (GL)

TRIODE; heater type; glass envelope; loktal base, 8 pins.

$E_h = 7.0 \text{ v}$
 $I_h = .32 \text{ amps}$
 $E_p = 250 \text{ v (max)}$
 $E_c = -8 \text{ v}$
 $I_p = 9 \text{ ma}$
 $\mu_m = 2600 \text{ }\mu\text{hos}$
 $R_p = 7700$
 $\mu = 20$
 Basing 5-AC



MIDGET "MEGGER" CIRCUIT TESTING OHMMETER



Independent of Battery Voltage
 Ranges—from .1 ohm up to 200,000 ohms

Quite different from a voltmeter calibrated in ohms, this direct-indicating "Megger" Ohmmeter requires no adjustment for the voltage of the battery that supplies current for the test. The instrument is a true ohmmeter of the "Megger" cross-coil type. For laboratory, shop and portable use for checking coils, resistors, contacts, windings, circuits, relays, etc., and even insulation resistance up to 200,000 ohms. Molded case, mottled green in color. Write for descriptive Bulletin 1495-E.

JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS
 1211-13 ARCH STREET PHILADELPHIA, PA.

HERE IS YOUR GUIDE TO BETTER RELAYS



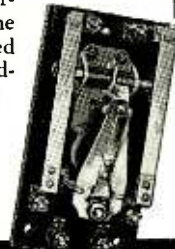
JUST OUT!

Fresh from the press comes the new Dunco Relay Book. Besides listing the full line of standard and many special Dunco relays, it contains a wealth of engineering and application information invaluable to all relay users.

YOURS FOR THE ASKING . . .

Write today for your copy. Have available at your fingertips full details of a line that, for years, has led the way to new standards of relay quality and dependability.

STRUTHERS DUNN, Inc.
 1326 CHERRY ST.,
 PHILADELPHIA, PA.



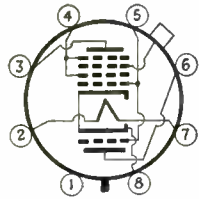
DUNCO RELAYS

Tailor-made for users who know that the sweetness of low prices never compensates for the bitterness of poor quality.

Type 6K8 (GT)

TRIODE-HEXODE; remote cutoff; heater type; bantam glass, octal base, 8 pins.

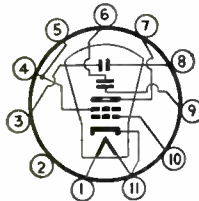
$E_A = 6.3$ v
 $I_A = .3$ amp
 $g_m = 350$ μ hos
 $R_p = .6$ megohms
 Basing 8-K



Type 5AP1

PICTURE tube; electrostatic focusing and deflection; soft glass; 11 pin, mag-nal base.

$E_A = 6.3$ v
 $I_A = .6$ amps
 $E_{a2} = 1500$ v
 D_1 and $D_2 = .23$ mm v
 D_3 and $D_4 = .28$ mm, v
 $E_{c2} = 2000$ v
 D_1 and $D_3 = .17$ mm v
 D_3 and $D_4 = .21$ mm, v
 Basing 10-A



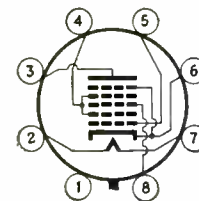
Type 5AP4

IDENTICAL with 5AP1 with exception of color as determined by phosphor.

Type 6SA7 (GT)

PENTAGRID converter; heater type; bantam glass; octal base, 8 pins.

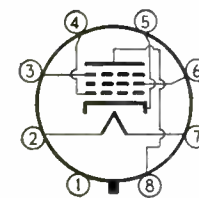
$E_A = 6.3$ v
 $I_A = .3$ amp
 $E_p = 250$ v
 $E_{c1,4} = 100$ v
 $E_{c3} = -2$ v
 $I_p = 3.4$ ma
 $I_{c3,4} = 8$ ma
 $g_m = 425$ μ hos
 $R_p = .8$ megohms
 Basing 8-AD



Type 6AC7 (M)

R-f pentode; sharp cutoff; heater type; metal octal, 8 pins.

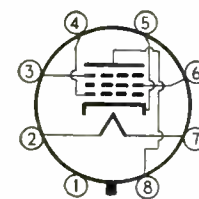
$E_A = 6.3$ v
 $I_A = .45$ amp
 $g_m = 9000$ μ hos
 $R_p = .75$ megohms
 $\mu = 6750$
 Basing 8-N



Type 6AB7 (M)

R-f pentode; remote cutoff; heater type; metal octal, 8 pins.

$E_A = 6.3$ v
 $I_A = .45$ amp
 $g_m = 5000$ μ hos
 $R_p = .7$ megs
 $\mu = 3500$
 Basing 8-N





**Complete PROTECTION
plus Outstanding
APPEARANCE!**

*There's a BUD CABINET
RACK to house EVERY
TYPE of ELECTRONIC
INSTALLATION*

Note these features:-

- Heavy Steel Construction.
- Furnished in either Grey or Black baked crackle finish.
- Made in 17 different styles and sizes.
- Panels fit flush with cabinet front.
- Hinged full-length rear door.
- Complete line of accessories available including Dollies, Interlock switches, Mounting angles, Panels, Chassis, etc.
- Interlock switch provisions included.
- Either or both sides available with or without louvres.

Additional information available upon request.



BUD RADIO, INC.
CLEVELAND, OHIO



CALLITE

FORMED PARTS



TUNGSTEN AND MOLYBDENUM

Add CALLITE Quality to the natural qualities of tungsten and molybdenum. Callite formed parts are CERTIFIED — that means uniform, tested and proved. Callite can serve you better, regardless of your requirements. Our entire staff of metallurgists and engineers are at your disposal . . . ready to bring to the solution of your particular problems a vast fund of specialized knowledge and experience. Formed parts in special shapes made accurately to your specifications. Consult Callite today. Catalog on request.

CALLITE PRODUCTS DIVISION

EISLER ELECTRIC CORP. • 544 39th ST. • UNION CITY, N. J.

NOW—A NEW

COMPLETELY ASSEMBLED
MULTI-PURPOSE, LOW-PRICED

PHOTO ELECTRIC (ELECTRIC-EYE)

And Capacity Relay

EXPERIMENTAL SET



Designed for Executives—Engineers and
Maintenance Departments

KEEN management adopts Photo Electric Equipment to protect premises and employees, improve manufacturing processes, increase production, reduce costs, and in advertising and sales promotion work.

Now you can use the amazing, new, inexpensive REHTRON Electric Eye Robot Experimental Set to help determine how and where photo electric equipment can be profitably employed in your business. The REHTRON Set is designed to demonstrate and duplicate nearly all applications of commercial photo electric equipment.

The REHTRON Set is NOT A TOY OR NOVELTY and may be actually used as an Invisible-Beam Electric Eye Burglar Alarm; Fire Alarm; Smoke Indicator and Control; Liquid Level and Turbidity Control; to operate a Magnetic Counter or Power Relay; and to simulate other industrial controls. Special Adapter furnished makes Robot a sensitive, wonder-working Capacity or Touch Relay for thermostatic, moisture content, flame or other Control application.

Complete Set consists of: 1. Robot Control Relay assembled in heavy gauge, black wrinkle finished metal housing. Sensitive, self-shielded, commercial type (caesium) Photo Cell and low wattage power tube included. Has rubber cord and plug for inserting into electrical outlet. Size 6 x 4 x 2 in.; 2. Signal-Switch Panel Board, 6 x 7³/₈ in. black ebony finish, parts for audible and visible signals assembled, wired and connected to Robot; 3. Light source Unit has transformer, cord and plug, bulb and socket, rotary switch, fixed-focus lens, removable Infra-Red filter, adjustable mounting base. Made of heavy gauge metal, black wrinkle finish, size 5 x 2³/₄ x 2 in. Light Source controls Robot up to 20 ft. with filter—30 ft. with white light; 4. Complete instructions, diagrams and suggestions for applications and experiments.

Set operates on 110-120V. 60 cycle A.C. Relay contacts deliver 6V. 1/2 amp. A.C., selective open or closed circuit. No batteries needed. Easily adjusts for sensitive, stable operation. **SATISFACTORY PERFORMANCE GUARANTEED.** Value far exceeds **LOW PRICE OF ONLY \$17.50 FOB Chicago.** Shipped open acc't. to rated firms. Exp. chgs. prepaid in U.S. when check or M.O. accompanies purchase order. Specify Cat. No. E-77. Literature and information on REHTRON commercial units on request.

REHTRON CORPORATION DEPT. E-2

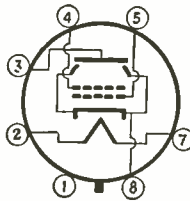
Mfrs. Rehtron Photo Electric Equipment
Burglar Alarms

2159 Magnolia Avenue, Chicago, Illinois

Type 50L6 (GT)

BEAM power amplifier; heater type; bantam glass; octal base, 7 pins.

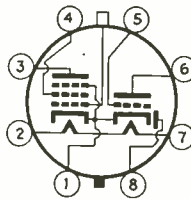
$E_h = 50$ v
 $I_h = .15$ amp
 $E_p = 110$ v (max)
 $E_{c2} = 110$ v (max)
 $E_c = -7.5$ v
 $I_p = 49$ ma
 $I_{c2} = 4$ ma
 $g_m = 6800$ μ mhos
 $\mu = 68$
 $R_i = 2000$ ohms
 $P_o = 1.75$ (10%)
Basing 7-AC



Type 25D8 (GT)

DIODE; triode; pentode; remote cutoff; heater type; bantam glass; octal base, 8 pins.

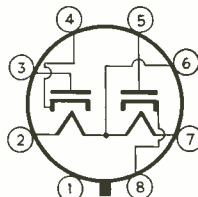
$E_h = 25$ v
 $I_h = .15$ amp
TRIODE
 $g_m = 1100$ μ mhos
 $R_p = 91,000$ ohms
PENTODE
 $g_m = 1900$ μ mhos
 $R_p = .2$ megohms
Basing 8-AF



Type 25X6 (GT)

FULLWAVE rectifier-doubler; vacuum; heater type; bantam glass; octal base, 7 pins.

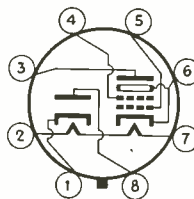
$E_h = 25$ v
 $I_h = .15$ amp
* $E_{ac} = 250$ v per plate (max)
 $I_{dc} = 60$ ma (max)
*With 100-ohm series resistors
Basing 7-Q



Type 70L7 (GT)

RECTIFIER-BEAM power amplifier; heater type; glass envelope; octal base, 8 pins.

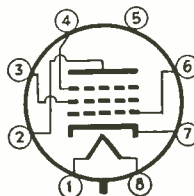
$E_h = 70$ v
 $I_h = .15$ amp
BEAM POWER AMPLIFIER
 $g_m = 7500$ μ mhos
 $R_i = 2000$ ohms
 $P_o = 1.8$ watts (9.5%)
RECTIFIER
 $E_{ac} = 125$ v (max)
 $I_{dc} = 70$ ma (max)
Basing 8-AA



Type 7C7 (GL)

R-f pentode; sharp cutoff; heater type; glass loktal envelope base, 8 pins.

$E_h = 7$ v
 $I_h = .16$ amp
 $E_p = 250$ v (max)
 $E_{c2} = 100$ v (max)
 $E_c = -3$ v
 $I_p = 2.0$ ma
 $I_{c2} = 0.5$ ma
 $g_m = 1300$ μ mhos
 $R_p = 2$ megohms
Basing 8-V



● The combination of high tensile strength that assures a lasting bond, and faster, cleaner work made possible by quick-acting flux of pure water white rosin, has given Gardiner Rosin-Core Solders an outstanding reputation for efficiency and economy on radio work by expert or amateur. Yet, due to modern production methods and big sales, Gardiner Solders cost less than even ordinary kinds. Made in various alloys and core sizes . . . and in gauges as small as 1/32 of an inch . . . in 1.5 and 20 lb. spools.



4889 S. Campbell Avenue Chicago, Ill.



SPEAKERS for all Applications

Speakers play such an important part in today's development of better radio receivers and kindred apparatus, that the selection of the proper type has become a specialized job. Our engineering and production facilities enable us to meet your most rigid requirements. Your specifications will have our immediate attention.



THE ELECTRON ART

Among the subjects from the technical press reported here are an ignitron welding timer, cutoff-frequency calculation of resistance-coupled amplifiers, Orthacoustic recording and antennas for duplex operation

Welding Timer Control

AN INTERESTING ARTICLE on welding timers appears in the December, 1939 issue of the *General Electric Review*. It is "Ignitron Contactor Control of Resistance Welding" by Warren C. Hutchins. The ignitron contactor is ideally suited for rapidly closing and opening primary circuits of resistance welders used for spot projection, and butt-welding or flash welding where the duration of current flow is short. Its advantages are quiet operation, low maintenance expense, freedom from shutdowns for repairs and dependability. Even in applications which do not require the precise control offered by synchronous timing, these contactors retain their inherent operating advantages.

The most undesirable instant for closing primary circuits of a resistant

welder is at the zero point of the voltage wave, for this will result in maximum transient current. With an ignitron contactor, the circuit cannot be closed at this point because the voltage must be above certain minimum value before the tube will pass current.

The three essential parts of the ignitron contactor are a mercury pool (cathode) a carbon anode and an igniter, all inclosed in a sealed metal container. When the timing contacts are closed current passes through the igniter and ionizes the mercury vapor in less than 0.000003 second. The welding circuit is now closed because the ionized vapor easily conducts the heavy welding current through the tube and on to the welding machine. When the timing contacts open, current to the igniter stops. When the wave of the alternating current reaches zero, the

vapor becomes deionized and the welding current stops until the timing mechanism again sends current to the igniter and repeats the cycle. In this way welding time as short as one-half cycle is possible. If the timing mechanism is set for longer welding, the prescribed cycle is repeated over and over. Throughout the operation the welding current is started and interrupted without noise and without moving parts. When used with an a-c supply, the ignitron tube will pass current in each half cycle that the voltage on the anode is positive. A second ignitron tube is inversely connected to pass current to the other half cycle.

Several available models of ignitron contactors are described and the ratings and water-cooling requirements are discussed.

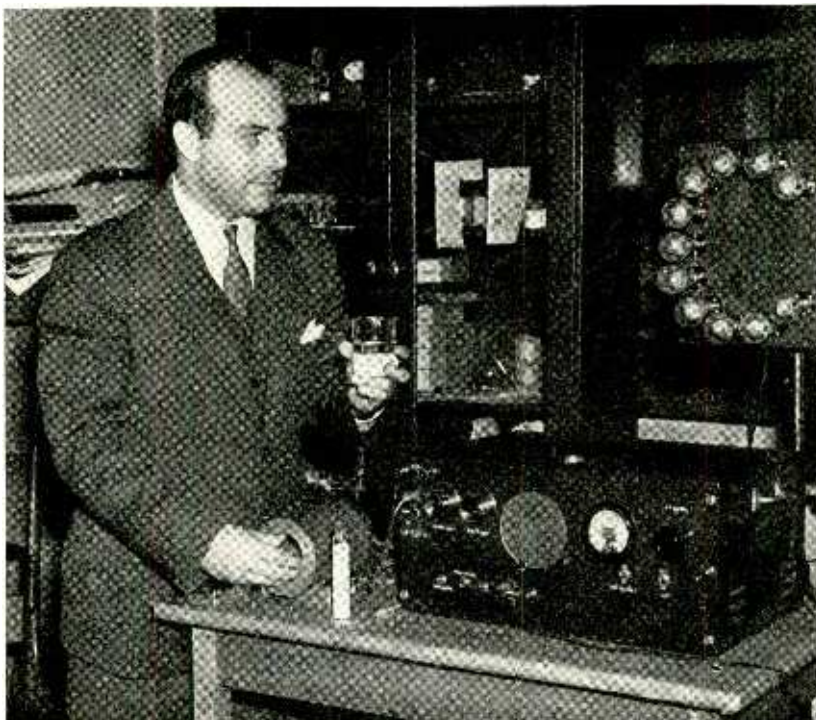
• • •

Calculation of the Low Frequency Cut-off of Resistance-Coupled Amplifiers

A SIMPLE AND STRAIGHTFORWARD treatment of the problem of low frequency limits of resistance-coupled amplifiers is contained in the July issue of *Fun-technische Monatshefte* in an article by Helmut Pitsch entitled, "The Calculation of the Low Frequency Limits of Resistance Coupled Amplifiers".

The method used depends on the relationship existing between the plate resistance and the coupling network of the following amplifying tube. The voltage u_a in Fig. 1 can be considered constant over the frequency range covered and not dependent on grid-input resistance. This voltage is fed into a resistance-capacitance network shown in Fig. 2 where the inherent 90° phase relationship of the voltages in

SHOWS HOW BODY MAY BECOME RADIOACTIVE



By means of the cyclotron a small amount of table salt was bombarded by neutrons until it was made artificially radioactive. By dissolving the salt in water and drinking the solution, Prof. John D. Dunning of Columbia University, was able to demonstrate that the radioactive solution could be traced through the human body.

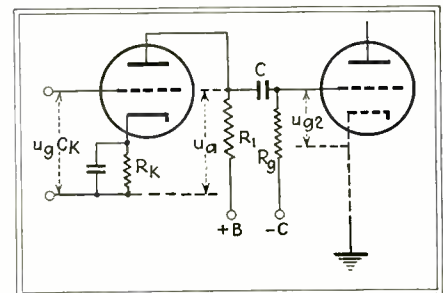
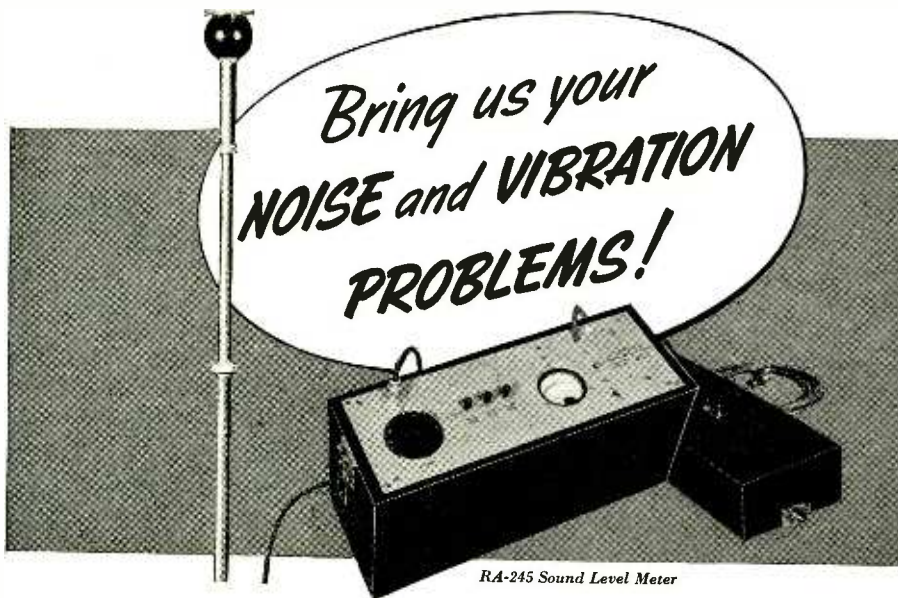


Fig. 1—Circuit diagram of the amplifier used in the calculation of the cutoff frequency

the respective elements is shown by the diagram. The corresponding vector diagram is shown in Fig. 3.

The point P moves along the arc of a semicircle, its position depending on the frequency imposed on C and its corresponding reactance at this given frequency. If the lowest frequency passed by the amplifier is limited to an attenuation of 30 per cent, the dotted vectors in Fig. 3 representing the lowest frequency passed are equal to 0.7 u_a . When the applied frequency is



RA-245 Sound Level Meter

IF YOUR PROBLEM is one of noise control in aircraft—refrigerators—automobiles—blowers—typewriters—anti-friction bearings—electric motors or other products, Electrical Research Products, Inc., can help you.
We offer you Acoustic Noise and Vibration Testing Equipment for laboratory work and production testing.

For example:
Sound Level Meters—AC and battery operated; Sound Frequency Analyzers—indicating and recording; Filter Sets—band-pass, high-pass, low-pass; Industrial Noise Analyzers—for production testing; Vibration Pick-Ups—moving coil type.
Let us show you how to apply our instruments to your needs.

Electrical Research Products Inc.

SUBSIDIARY OF
Western Electric Company
195 BROADWAY, NEW YORK, N. Y.

Send for this Bulletin!

S.S. White
MOLDED
RESISTORS
The All-Weather Resistors
1000 OHMS TO
1,000,000 MEGOHMS

Standard Range and High Value Resistors that have won favor by their *noiseless operation, durability, and retention of values and characteristics* under extremes of temperature, humidity and rapid climatic changes. Widely used in commercial, industrial and scientific equipment. Write today for a copy with Price List. Ask for RESISTOR BULLETIN 37.

S. S. WHITE

The S. S. White Dental Mfg. Co.
INDUSTRIAL DIVISION
Department R, 10 East 40th St., New York, N. Y.

double the lowest frequency, the capacitive reactance is one-half the resistive value and the corresponding values of voltages u_c and u_{g2} are shown by the solid lines in Fig. 3. Under these conditions u_{g2} is $0.9 u_a$.

At the low frequency limit of the amplifier, denoted by f_u ,

$$R_g = 10^{12}/2 \pi f_u C$$

and

$$f_u = 10^{12}/2 \pi C R_g$$

For an input resistor of one megohm and a coupling condenser of $5000 \mu\mu\text{f}$;
 $f_u = 10^{12}/2 \pi 5000 \times 10^6 = 32 \text{ cps}$.

If it is desired that the limiting frequency strength be 0.9 instead of 0.7 of

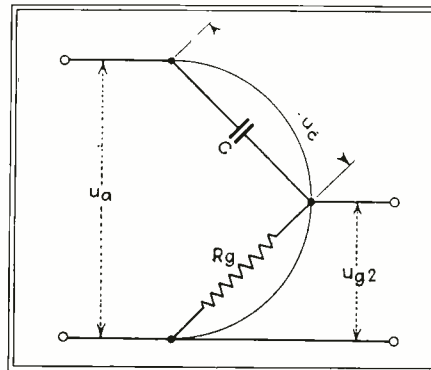


Fig. 2—Resistance-capacitance network with the inherent 90° phase relationship of the voltages in the various elements indicated

the input voltage, i.e. the attenuation be reduced, then the coupling condenser must be doubled in value or $10,000 \mu\mu\text{f}$.

The author proves the generality of his method by demonstrating that the anode resistance and internal resistance of the tube have a negligible effect on

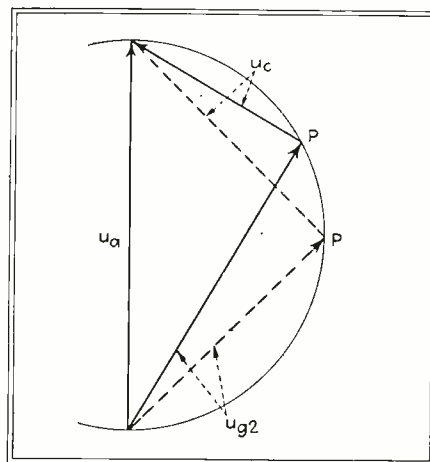
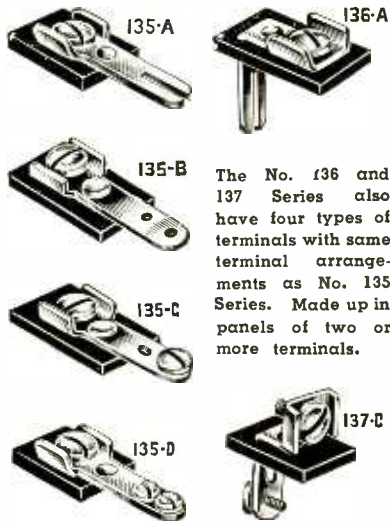


Fig. 3—Vector diagram of the network shown in Fig. 2

the results. He points out their effect is in general beneficial because they give rise to a somewhat smaller theoretical frequency range than is actually attainable from the equipment.

It is important to note that the cathode bypass network influences the lowest-frequency value and that in a

NEW TERMINALS With Wide Range Utility



The No. 136 and 137 Series also have four types of terminals with same terminal arrangements as No. 135 Series. Made up in panels of two or more terminals.

Our line of standard parts is constantly being increased to give you the most complete service for Terminal Panels, Terminals, Plugs, Sockets, etc. Specials also made to your blue print. Write for new catalog today. Address Dept. 10.

HOWARD B. JONES
2300 WABANSIA AVENUE,
CHICAGO ILLINOIS



LIKE A GOOD detective story?

You do? But you never can find time to read? Then send for our catalog—the book that has everything in radio. And make time for yourself by ordering at home! You'll be surprised at the saving—not merely in hours, but in dollars. Here's a source book for everything you need. All the products of all the national advertisers in radio. And a shipping service that delivers the goods inside of 24 hours! Ask for catalog No. 78.

Radio Wire Television Inc.

LAFAYETTE RADIO

NEW YORK 100 Sixth Avenue
CHICAGO 901 W. Jackson Blvd.
ATLANTA 283 Peachtree St.
BOSTON 118 Federal St.
NEWARK 24 Central Ave.
JAMAICA, L. I. 44-93 199th St.
BRONX, N. Y. 543 E. Fordham Rd.

pentode it is necessary to have a sufficiently large condenser as a bypass from screen-grid to ground. If this is not done, an opposing voltage is developed on the screen-grid which increases with the screen-grid resistance and inversely with the capacity. If the condenser is omitted, this voltage will exist for all frequencies.

• • •

Orthacoustic Recording

IN THE DECEMBER 1939 issue of the Association of Technical Employees' Journal, Robert M. Morris describes the new RCA-NBC Orthacoustic Recording System. Up to this time there has been no means of calibrating playback turntables, and the Orthacoustic recording system provides this in a standard method by which the maximum amount of quality may be obtained from a transcription. The recording characteristics of the Orthacoustic system are given in the diagram along with the characteristic of the reproducing unit to give the desired quality of reproduction. Consideration which enters into the development of these characteristics are: (1)

NEON SIGNS ON BLIMPS



Detail of the neon signs on the blimps which have flown over various cities on the Atlantic Coast last summer. Ten units are attached to the side of the ship, each unit of which can be lighted to form any letter or numeral. By means of a punched tape strip, prepared by the ground crew, any word of ten letters or less can be produced by the neon signs to spell out any desired message for advertising or publicity purposes. Here the individual letter panels are being attached to the side of the blimp by the ground crew

New 7-INCH PORTABLES with extra long scale



FOR LABORATORY, COMMERCIAL AND INDUSTRIAL TESTING



- 7-Inch Instrument with 6-Inch Scale.
- Standard and Special Ranges.
- Mirror Scale.
- Oak Carrying Case with Detachable Cover.
- Accurate to 1/2%. AC and DC Voltmeters—Ammeters with standard or special sensitivities.

MODELS 725-735 Portables may be obtained in standard and special ranges, including instruments of extreme sensitivity for laboratory use—as well as those for general commercial and industrial testing purposes. The large 7-inch instrument has a long six-inch mirror scale, maximum dial opening, and knife-edge pointer to assure quick accurate readings. Accuracy within 1% (1/2% for many ranges). Available in microammeters, milliammeters, ammeters, voltmeters, millivoltmeters, thermo-ammeters—multiple or single ranges. Case is quarter-sawed golden oak, 11" x 9" x 4", with handle and detachable cover. Black bakelite panel.

MODEL 1280

High Voltage (to 10 Kilovolts) Television Tester gives you a new testing procedure. Metal contacts and instrument parts are removed a minimum of one inch from sides of the case. The prods attached to the test leads are inserted through holes in the top panel to the contacts in the sub-panel beneath. Tests AC-DC Volts in steps of 2,500 and 10,000 (25,000 ohms per volt DC). DC Micro-amperes 0.50-500-5030.



WRITE FOR CATALOG
Section 232 Harmon Drive

THE TRIPLET ELECTRICAL INSTRUMENT CO.
Bluffton, Ohio

One Engineer Tells Another...

"The Lingo Radiator at this station is doing the biggest job of any radiator I know"



"The results we are obtaining are far superior to what we even anticipated", says another station. The amazing efficiency standards introduced by Lingo are now actual case records based on station operations under all conditions. Lingo "Tube" Radiators are designed, constructed and erected by an organization with over 40 years experience. Yet in design and performance this radiator is as new as tomorrow. In a few short years Lingo has "proven its way" into important consideration whenever new or modernized antenna systems are considered.

In addition to ever-increasing installations in the commercial field, exhaustive mechanical and electrical field tests on both the radiator and the fittings indicate the fine quality of the product and prove the high efficiency obtainable in actual broadcast service.

May we send you complete technical data?

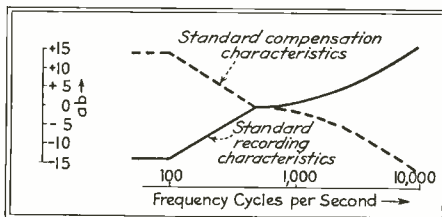
We will be pleased to send you detailed information without obligation. Please send location, power and frequency of station with your request.

JOHN E. LINGO & SON, INC.

Dept. E-2, CAMDEN, N. J.

LINGO
VERTICAL
TUBULAR STEEL
RADIATORS

Desire for a minimum background noise and maximum signal to noise ratio; (2) desire for a minimum of distortion particularly in the high frequency; (3) the necessity for recognizing previous standards; (4) a desire



Recording and reproducing (dotted line) characteristics of the Orthacoustic system

to achieve the recording and compensating characteristics as simply and economically as possible; (5) a desire to employ engineering information gathered in the development of other arts to the improvement of recording.

It is to be emphasized that the reproducer is as important to the quality of the results achieved as any other single element in the system. Accordingly, a reproducer of a quality in keeping with the rest of the broadcast station equipment is necessary if good results are to be achieved. A reproducer must therefore be light in pres-

DEMONSTRATE RADIO CONTROLLED SHIP



Howard Maroon demonstrates control by radio of the model of the motor ship North Star during a demonstration at the marine transportation section of the Franklin Institute. The five foot model is steered around the tank by the use of a telephone dial which sends short impulses to a selector mechanism whose purpose is to properly actuate the ship's operations

GOAT TUBE SHIELD FEATURES that simplify set manufacturing

TESTED 4-PERFORMANCE



● It's one thing to make a tube shield . . . and quite another to make one that improves set performance. Goat form-fitting shields are engineered to combine maximum performance values with maximum eye-value, dependability and economy. Let Goat Engineers help simplify your problems.

GOAT TUBE SHIELD FEATURES:

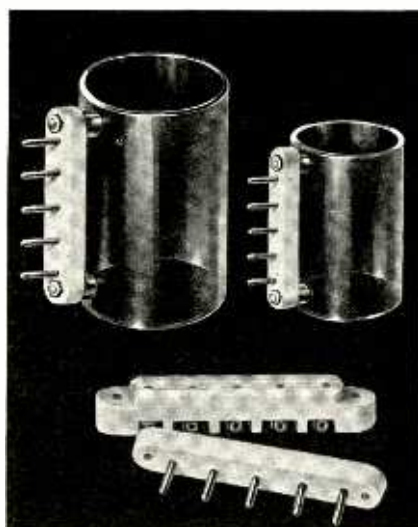
- | | |
|-----------------------|-------------------------|
| 1 Variety | 3 High Appearance Value |
| 2 Maximum Compactness | 4 Tested Performance |
| | 5 Quick Service |



Send for Bulletins

GOAT RADIO TUBE PARTS, INC.

(A DIVISION OF THE FRED GOAT CO., EST. 1912)
314 DEAN ST., BROOKLYN, N. Y.



POLYSTYRENE FORMS with STEATITE PLUGS

are but a few of the many newly designed component parts now available to the Electronics Industry.

Catalogue Upon Request

JAMES MILLEN MFG. CO. INC.
150 EXCHANGE ST. MALDEN, MASS.

sure on the disk (not exceeding 2 oz). Otherwise, the high frequencies will not be reproduced, especially near the center of the record. The frequency response of the reproducer should be flat to 7,000 or 8,000 cps. The mechanical impedance of the reproducer stylus must be low. An important factor in the life of the disk is pressure of the playback stylus. As previously mentioned the pressure should not exceed 2 oz and a desirable value is about 1.5 oz.

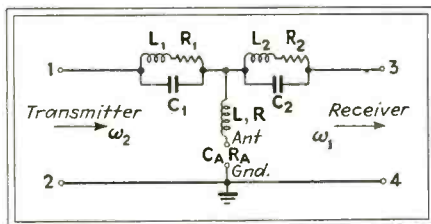
The author discusses filter circuits with which this characteristic may be obtained and how conventional transcription may be reproduced on the same equipment by simple switching.

• • •

Antennas for Duplex Operation

SIMULTANEOUS TRANSMISSION and reception of signals on a single antenna is described in an article by Geoffrey Builder, entitled "Duplex Operation on a Single Aerial," in the A.W.A. (Australia) Technical Review, Vol. 4, No. 3, which was issued on Nov. 17, 1939. Duplex operation on a single antenna is often useful, particularly in locations so limited that it is difficult or uneconomical to erect more than one satisfactory antenna. For example, an automobile fitted for duplex operation can rarely carry two satisfactory antennas for high frequency reception and transmission, especially in the frequency range from 1.5 to 5 megacycles.

The author gives the several requirements which must be fulfilled by a single duplex antenna system. They are as follows: (1) Adequate filtering



Basic circuit for the duplex operation of a single antenna

must be provided to prevent transmitter energy causing interference in the receiver. (2) Any considerable loss of transmitter power must be avoided. (3) A loss of received signal energy must be avoided as far as possible, or as far as may be necessary, to insure that the weakest received signals are sufficient to override interference and internal receiver noise.

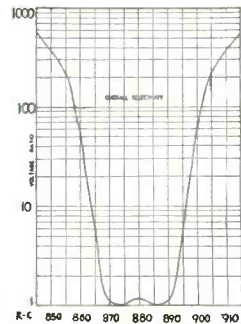
The circumstances requiring the use of a common antenna for transmission and reception also generally restrict the size of the antenna which can be used. Therefore, the author considers in some detail antennas which are very short compared with the operat-

OUTSTANDING! FOR 2 YEARS THE LEADING HIGH FIDELITY TUNER



- For MONITORING
- For AIR CHECKS
- For "OFF-THE-AIR" RECORDING
- For THE DISCRIMINATING BROADCAST LISTENER

- FEATURING . . .**
- INFINITE IMPEDANCE DETECTOR
 - BAND-PASS TUNED CIRCUITS
 - NEGATIVE MUTUAL COUPLING
 - 4 TUNED CIRCUITS
 - 20 KC BAND-WIDTH, FLAT-TOP
 - 100-TO-1 RATIO AT 40 KC
 - 10 KC AUDIO FILTER



FOUNDATION KIT No. 575 . . . NET PRICE \$20.32

Including: Coils, 4-gang tuning condenser, drawn chassis and bottom cover, 8 1/2 x 19 panel, slide-rule dial, engraved control knob plates, knobs, tie points, resistor mounting strip, tube shields, construction data.

IMMEDIATE DELIVERY . . . YOUR JOBBER HAS THEM

J. W. MILLER COMPANY 5917 SO. MAIN STREET
LOS ANGELES, CALIF.
100 S. Jefferson, CHICAGO • 11 Warren St., NEW YORK • 440 W. Peachtree, N. W., ATLANTA

3 REASONS

WHY YOU SHOULD CONSIDER GLOBAR BRAND CERAMIC RESISTORS

REG. U. S. PAT. OFF.

1 THREE TYPES

- TYPE A—Slight Negative Voltage and Temperature Coefficient
- TYPE B—Sharp Negative Voltage and Pronounced Temperature Coefficient
- TYPE Cx—Slight Negative Voltage Coefficient and Slight Positive Temperature Coefficient

2 WIDE RESISTANCE RANGE

- Type A—2 ohms to 1/4 megohm per inch of length
- Type B—5 ohms to 1 megohm per inch of length
- Type Cx—0.05 ohms to 100 ohms per inch of length

Resistance varies with diameter.

3 MANY SHAPES AND SIZES

- Custom made shapes to meet unique requirements in addition to standard round rods from 1/8" to 1" in diameter and 1/2" to 18" in length.

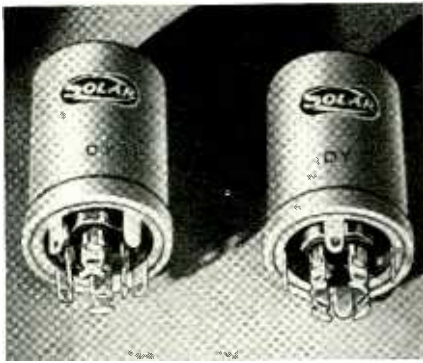
It will pay you to investigate Globar Brand Ceramic Resistors when confronted with resistance problems. Our Engineering Department is at your service. Send us the details of your requirements.

GLOBAR DIVISION
THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

REG. U. S. PAT. OFF.

Carborundum and Globar are registered trade-marks of The Carborundum Company

Globar CERAMIC RESISTORS



TYPE DY DRY

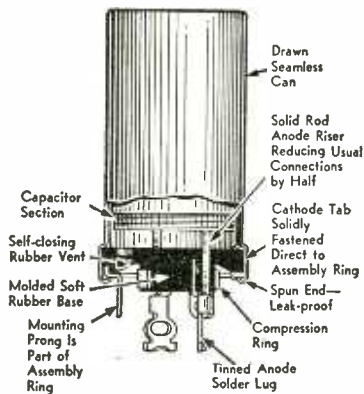
is an Electrolytic Capacitor incorporating
ADVANCED ENGINEERING



These units will operate under more severe conditions of voltage and temperature than have previously been considered standard. They exhibit improved r.f. characteristics. Sealing and venting follow time-proven wet electrolytic practice.



Solar internal construction, using high-gain etched foil, is acknowledged as superior because of stability under temperature variations. Unsurpassed for any radio sets. A necessity for all auto sets.



• Engineering data and samples are available upon letterhead request.

• The latest Solar Catalog No. 10, listing all types of Fixed Capacitors for Radio, should be in your files. Ask for it.

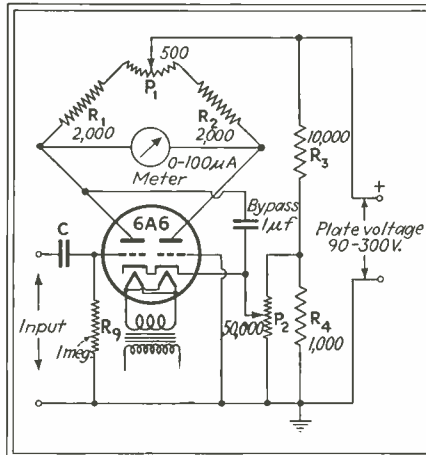


SOLAR MFG. CORP.
 Bayonne, New Jersey
CAPACITORS

ing wave length. The design data for the short antenna is generally applicable to longer antennas for which the design is generally simpler. The basic circuit for duplex operation on a single antenna is shown in the figure. The lefthand branch circuit $L_1C_1R_1$, LR and $C_A R_A$ is resonant at the transmitting frequency, the righthand branch $L_2C_2R_2$, $C_A R_A$ and LR is resonant at the receiving frequency, and the two circuits are anti-resonant to the receiving and transmitting frequencies ω_1 and ω_2 , respectively. The various factors involved in the design of such an antenna are discussed, together with the network losses and discrimination. The practical application and methods of adjusting such networks are also described.

Vacuum Tube Voltmeter

A BRIDGE TYPE OF VACUUM tube voltmeter employing two triodes in a Wheatstone bridge has several advantages over the single tube bridge voltmeter and the ordinary vacuum tube voltmeter. Such a device is described in "A Duo-Triode Bridge Voltmeter," by Richard E. Vollrath, in the Decem-



Circuit Diagram of the double-triode vacuum tube voltmeter

ber, 1939, issue of the *Review of Scientific Instruments*. As shown in the circuit diagram, the two triode units are connected to form two branches of a Wheatstone bridge, while the other two branches are formed by resistors. Because of variations in tube characteristics, the potentiometer P_1 is provided so that the resistance ratio of the upper branches of the bridge can be made equal to the ratio of the plate resistances of the corresponding triode elements. Grid bias is obtained from the voltage divider across the power supply. The calibration curve shown here was obtained with a voltage of 120 volts on the plate of the 6A6. The voltmeter was used for frequencies of 50 and 1,000 cps, for which the calibration curves were identical. While no tests were made at higher frequencies, there is no reason to suspect that this voltmeter should behave any differently than other vacuum tube voltmeters. No

**THERE'S
 ANOTHER
 MAN
 WAITING FOR
 YOUR JOB!**



• You can insure your future by spare-time training for a better job in

RADIO & TELEVISION ENGINEERING

Our own "coast to coast" network of CREI men in more than 300 broadcasting stations—is proof that CREI training pays. Chief engineers want men who possess modern technical training. The fact that more than 300 stations employ one or more CREI students and graduates is evidence of the opportunities that await the trained man. Just ask "any engineer" what he thinks of CREI Radio and Television Engineering courses. You'll be convinced that we have the very thing you need to get ahead. We'd like to send you details.

Write for Free Booklet:
 "The CREI Tested Plan"

48 interesting pages with scores of photographs and complete outline and description of CREI radio and television sparetime study courses.



**CAPITOL RADIO
 Engineering Institute**

Dept. E-2, 3224-16th St. N.W., WASH., D. C.

MODEL X-26



ASTATIC CRYSTAL RECORDING HEAD

Designed for use in recording on acetate coated blanks. Also used on wax master plates. Especially suitable for home recording equipment. Heavy die-cast cartridge assembly develops remarkable power sensitivity capable of recording a range of frequencies far greater than formerly possible. Due to constant amplitude characteristic, higher volume levels can be recorded without groove crossover.

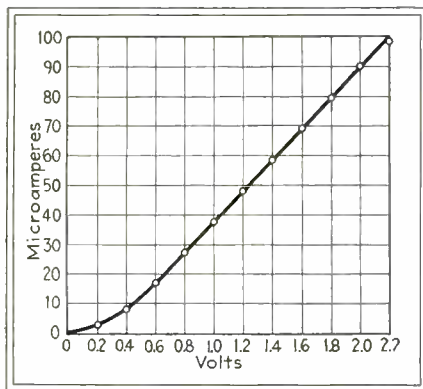
LIST PRICE NOW \$15.00
 (See Your Astatic Jobber)



Astatic Microphone Laboratory, Inc.

Youngstown, Ohio

Astatic Crystal Products Licensed Under Brush Development Co. Patents



Vacuum tube voltmeter calibration curve

significant change of calibration was noted after two months of constant use. If this instrument is to be used for direct voltages the condenser *C* at the input should be shorted out.

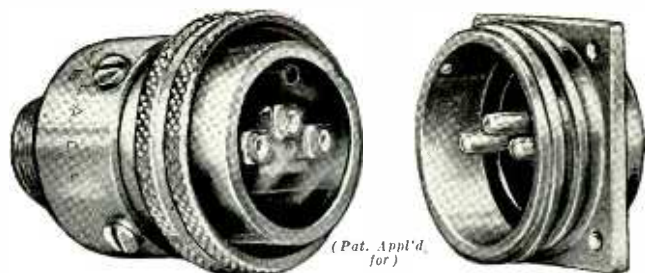
• • •

DuMont Proposals

(Continued from page 23)

number of lines is increased from, say, 441 to 735, is a change in the size of the picture which may be corrected by manual adjustment of the width and height controls. The type of synchronizing pulse proposed for this purpose is shown in the accompanying sketch. It consists of a number of 500 kc sine waves, from 160 to 240 waves being included during the vertical pulse. At the receiver, this 500-kc signal is separated from the rest of the wave by a sharply tuned circuit and the output of the circuit is integrated to form the vertical synchronizing pulse which is applied to control the vertical scanning generator. The horizontal synchronization impulses remain the same as those standardized by the R.M.A. and they are separated in the conventional manner.

It was shown at the demonstration that the proposed video signal shown in the diagram was capable of synchronizing a standard R.C.A. receiver designed for the R.M.A. signal, and this fact was offered as evidence that the proposed signal could be used in place of the R.M.A. signal without affecting the usefulness of the equipment now in the hands of the public. Further it was shown that standard receivers were capable of following changes in number of lines and number of frames per second, with the new signal, provided that the oscillation



Cat. No. SK-L3-21-3/8B

(Pat. Appl'd for)

Cat. No. SK-L3-3&S

Full-size Detail of CANNON Switching Receptacle and Plug with Automatic "Grounding" Device Housed in Receptacle, Face of Which is of Transparent Plastic Revealing the Mechanism.

"GROUNDING" PLUG AIDS AIRCRAFT SAFETY

WITH thousands of "flying hours" in actual service to its credit, the CANNON automatic "grounding" Plug for aircraft service has established itself as an absolutely indispensable safety factor. At the insistence of major aircraft manufacturers, this safety device was developed for the protection of ground crews working near propellers. It is a cable connector designed to insure automatic "grounding" of the magneto circuit of each motor when the plug is removed from the socket. Thus, it is impossible to start the motor by inadvertent movement of the propeller, with consequent disastrous results to anyone in its path of travel. "Grounding" of the magneto is accompanied by the positive action of an ingenious internal mechanism of the Plug assembly, which operates automatically when the plug is removed from the socket.

The development of this "grounding" Connector illustrates the highly specialized service available to Cannon clients. In the transmission of electrical energy—electronic or otherwise—wherever cables are used—problems of efficient connection and quick disconnection are solved by CANNON Plugs. They are pre-eminent in the fields of Sound, Aeronautics, Geophysical Research, Instrument-Control on Ships and Laboratory Panels. Over 1,000 standard fittings always available.

Illustrated Bulletins contain valuable information that may assist in solving your "plug problems". Ask for your copy, specifying your particular requirements.

CANNON ELECTRIC DEVELOPMENT CO.

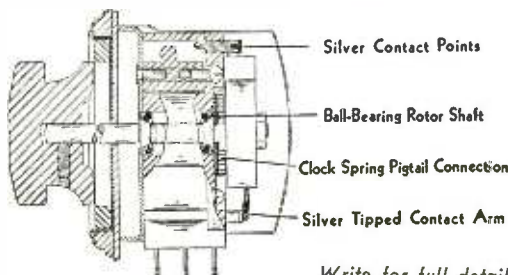
- ★ 420 West Avenue 33, Los Angeles, California
- ★ EASTERN SALES OFFICE, 220 Fifth Ave., New York, N.Y.

CANNON PLUGS



Mix with **REMLER** Silver Tap ATTENUATORS

Enjoy the feel of self-cleaning pure silver on silver, ball bearings front and rear, precision machined in every detail. It's smooth. And those are the factors that make the REMLER silver attenuator QUIET—so quiet you can operate it in a low-level circuit in perfect ease and comfort. Standard impedances. Special values to order.



Write for full details.

REMLER COMPANY, Ltd. • 19th at Bryant • SAN FRANCISCO



As business paper publishers for over fifty years, McGraw-Hill is uniquely equipped to offer complete, authoritative direct mail coverage of industry's major markets. Extreme accuracy is maintained (guaranteed to 98%) and through careful analysis of markets, complete classification of companies and personnel, etc., the widest possible selections are available. Send for handy reference folder, "Hundreds of Thousands of Reasons Why" which describes how McGraw-Hill Lists are built and maintained.

What Fields Do You Want to Reach?

- Aviation
- Bus & Electric Railways
- Civil Engineering and Construction
- Administrative Executives
- Electrical Dealers & Wholesalers
- Mill Supply Houses
- Power Services
- Product Engineering & Design
- Production and Maintenance
- Radio Dealers & Wholesalers
- Radio Engineering & Design

For further details, selections from above basic classifications, counts, prices, etc., or estimates on special lists . . . ask any representative or write to



Complete Lists Covering Industry's Major Markets

For Theatre and Public Address — Uniform Response over Full Frequency Range with the LANSING SPEAKER SYSTEM

For your public address, auditorium or theatre use investigate the many advantages of the LANSING SPEAKER SYSTEM. Use of a multicellular horn in conjunction with a wide range metal diaphragm unit provides uniform coverage over wide areas, eliminating high-frequency beam effect had from single speakers and horns. Absence of peaks throughout entire range of LANSING SPEAKER SYSTEM permits higher sound level at feedback point. Two way speaker system provides for Public Address and Auditorium reproduction of a quality before attainable only in the bigger theatres.

For your own use you will get in the LANSING SOUND SYSTEM years of high fidelity reproduction from perfectly engineered and carefully assembled equipment. If you are a jobber or contractor the LANSING SPEAKER SYSTEM, made by Lansing, is the perfect equipment for high quality installations.

For Auditoriums and Theatres seating less than 2000, Lansing recommends a system composed of following units:

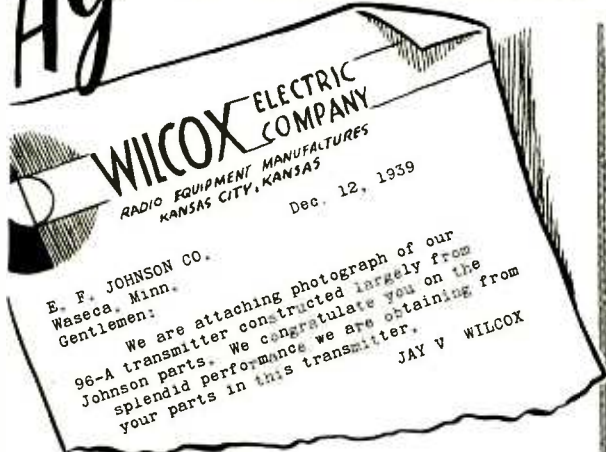
- | | | |
|-----------------------------------|---|--|
| 2 Model 415 Low Frequency Drivers | 1 Low Frequency Horn, folded type | 1 Set Wings and Cellular Horn Mounting |
| 1 400 Cycle Dividing Network | 1 Multicellular Horn (type depends on individual locations) | 1 Throat fit for Multicellular Horn |
| 1 Model 285 H.F. Driver | | 1 Type 500 Field Supply |

SPECIFICATIONS. FREQUENCY RESPONSE: Response uniform within 2db, 40 to 9,000 cycles. Measurements taken on axis of horn system at 25 feet. At 8,000 cycles uniform response within 2db over solid angle covered by cellular horn, as defined in specifications of said horns. Range from 40 to 400 cycles covered by 15XS low frequency speakers mounted on large folded single horn. Range from 400 to 9,000 cycles covered by No. 285 high frequency unit on multicellular horn. **DIVIDING NETWORK:** The Lansing standard 400 cycle network. **FIELD REQUIREMENTS:** Full field excitation requires 80-105 watts; we recommend our model 500 field supply, specially designed to furnish all power for this system. Permanent Magnet Units also available. **MEASUREMENTS:** Complete assembly, 100 inches wide by 114 inches high by 33 inches deep.

See Your Distributor or Write Today for Complete Details and Prices.

LANSING MANUFACTURING CO. 6900 McKinley Ave.,
Los Angeles, California

Again IT'S JOHNSON PARTS! BECAUSE OF Better PERFORMANCE



Every month brings news of more and more broadcast stations and manufacturers who have adopted Johnson equipment because it does the job right. Just one example is Wilcox Electric of Kansas City with their newest 3KW High Frequency Transmitter shown here — every part possible a JOHNSON part! Tuning Condensers, Neutralizing Condensers, Inductors, Tube Sockets, even Insulators and Couplings are JOHNSON because JOHNSON passed the rigid tests required by Wilcox. They can do the same for you.

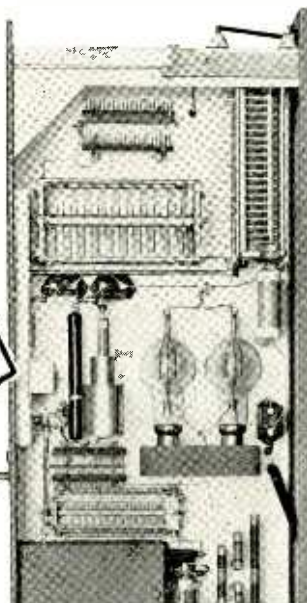
Write for Johnson Commercial Catalog 301D and General Catalog 966D.



E. F. JOHNSON CO
WASECA, MINNESOTA

EXPORT: 25 WARREN ST., NEW YORK, N. Y.

"MANUFACTURERS OF RADIO TRANSMITTING EQUIPMENT"



Like the Wilcox transmitter above, many other manufacturers of precision equipment as well as broadcast stations are now adopting JOHNSON parts.

range of the scanning generators was sufficiently wide to accommodate the new frequencies. The demonstration showed that considerably more flexibility might be obtained in transmission standards than had formerly been generally admitted. The question remaining was the degree to which such flexibility might properly be made a part of a public service. This matter, it was agreed, is one requiring considerable study and test before judgment on the proposal may be passed.

The demonstration was one of the most complete ever offered in the television field, and it was attended by practically all of the engineers who have an executive capacity in television development at present. The N.B.C. transmitter in the Empire State Building cooperated by sending images on the standard R.M.A. system so that they might be compared directly with the same subject transmitted on 625 lines at 15 frames per second. A 20-inch cathode ray tube, producing a picture about 12 by 16 inches in size was demonstrated using the standard R.M.A. system, to show the desirability of having a larger number of lines in large pictures. A film short subject was broadcast by N.B.C. and shown on a 8-by-10 inch screen, next to which the same film was projected at the same size directly from a motion picture projector. This direct comparison of the original and the televised reproduction showed the loss of detail, and it showed also a considerable degradation in the contrast range of the television image, which seemed equally important. Many of the spectators expressed the feeling, however, that the television system was doing a remarkably good job when subjected to such a critical test. The demonstration concluded with a field test of the proposed system, using the DuMont transmitter W2XVT and receiver located at Mr. DuMont's home, some 6 miles distant. These tests showed that the laboratory demonstration could be duplicated readily under service conditions.

What action may be taken in regard to the proposals has not yet been indicated by the F.C.C., presumably because no definite report has yet been rendered by the Committee which viewed the demonstration—D.G.F.

THE INDUSTRY IN REVIEW

Automatic Curve Tracer

Fig. 1—Circuit diagram of the automatic curve tracer. The rectified input and output of the amplifier are fed into the deflecting plates of an oscilloscope

THE frequency response characteristics of audio amplifiers and the effects of various amplifier circuit adjustments may now be more easily and conveniently observed through the use of an automatic curve tracer developed by the Photophone Service Division of the RCA Mfg., Co., Camden, N. J. When used in conjunction with an audio oscillator or other signal generating device, this instrument traces the response curve of the amplifier under test on the screen of an RCA 910 cathode ray tube. The intensity and duration of the visible trace are sufficient to permit several curves to be superimposed on the screen for comparison or photographing.

The source of audio signal is fed into a discriminating network, shown in Fig. 1 as C1, C2, C3, R4, R5, and R6. The characteristics of this network are such, that with a constant voltage E1 impressed across the network, the voltage developed across R6 varies directly as the logarithm of the frequency impressed. This is shown in the small curve in Fig. 1. The voltage E6 is impressed across the diode section of the 6H6 tube and is rectified. This rectified signal is amplified and impressed across the horizontal plates of the RCA 910 cathode ray tube. The

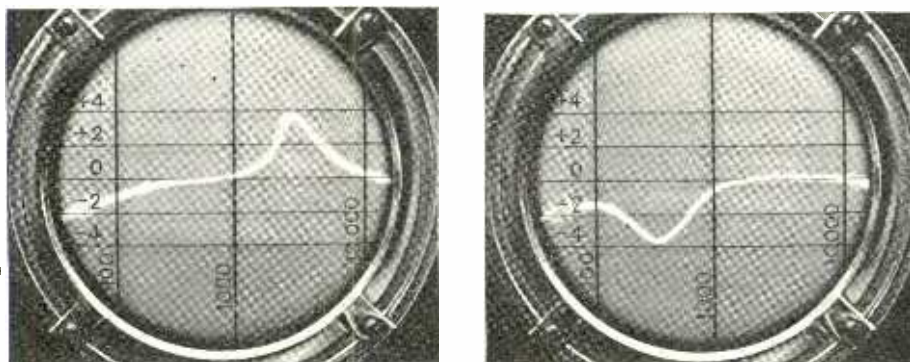
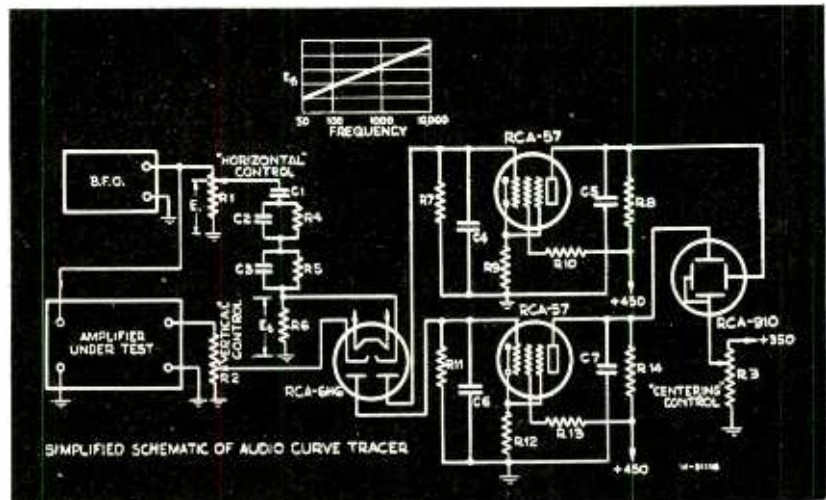
effect of this voltage on the electron beam is to move the beam from left to right across the screen as the frequency of the audio source is increased from zero upward thruout the audio range.

By rectifying and amplifying the output signal from the amplifier under test and impressing this d-c voltage across the vertical plates of the cathode ray tube, the beam is deflected vertically in accordance with the output level at the particular frequency under observation. The combination of the two deflection voltages results in the audio frequency curve of the amplifier being traced on the screen as the audio signal is varied thruout the audio range. Because of the long persistence characteristics of the 910 screen, the trace is held long

enough for observation or photographing. A two-stage amplifier is also incorporated in the instrument so that the low level output of a soundhead as used in theatre sound reproducing equipments can be amplified and used as the signal generator. A continuously variable frequency test film being run through the soundhead acts as a source of signal.

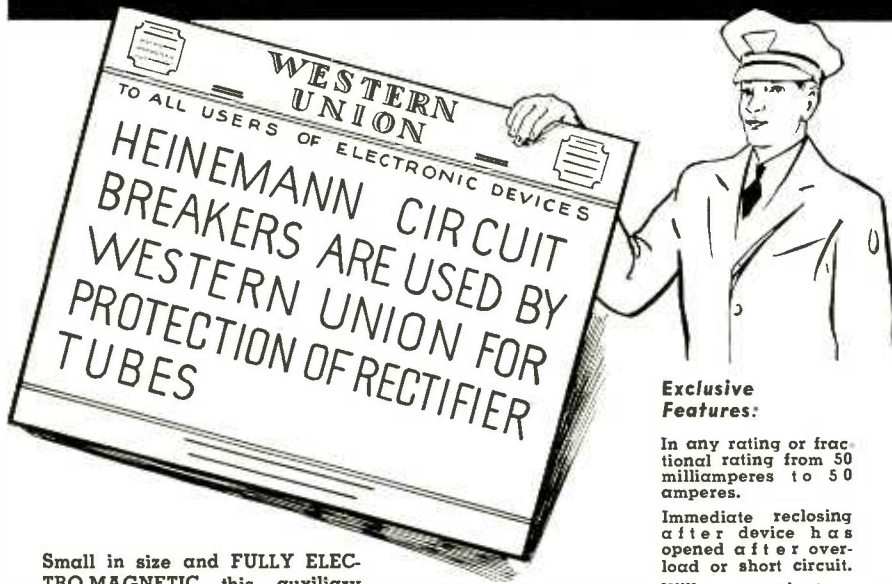
The instrument is completely a-c operated, portable, and self-contained. It is particularly useful in making production and service tests on audio frequency amplifiers.

A celluloid scale is used in front of the cathode-ray tube screen to indicate db level and frequency; the horizontal lines being in steps of 2 db, and the vertical lines 100, 1,000, and 10,000 cycles.



Figs. 2 and 3—Typical frequency response curves traced by this apparatus. The screen has a long persistence characteristic suitable for observation and photography

Vacuum Tube Protection



Small in size and FULLY ELECTRO-MAGNETIC this auxiliary breaker provides for economical and positive built-in protection against dangerous overloads and short circuits.

Exclusive Features:

In any rating or fractional rating from 50 milliamperes to 50 amperes.

Immediate reclosing after device has opened after overload or short circuit.

Will operate in temperatures from -40° F. to 240° F.

Increases life of tubes; reduces costly replacements.

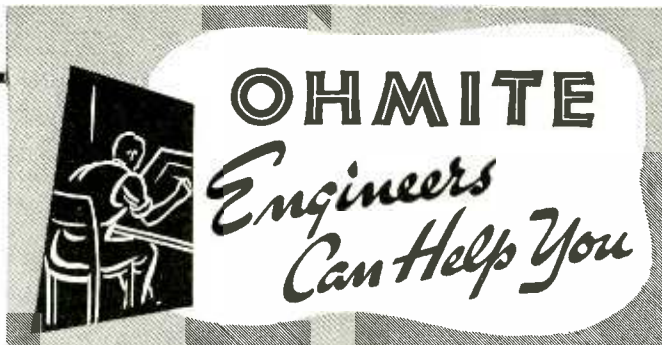
HEINEMANN CIRCUIT BREAKER CO.
97 PLUM ST. - - - - TRENTON, N. J.

News

★ Jensen Radio Mfg. Co., Chicago, Ill., announced several organizational changes. W. E. Maxson becomes President and General Manager. Hugh S. Knowles and Thomas A. White have been elected Vice-Presidents while continuing as Chief Engineer and Sales Manager, respectively. A. Leslie Oliver, is now Chairman of the Board of Directors. Peter L. Jensen, former President and Chairman has resigned the position. All of the men appointed to fill new positions have been with the corporation practically since its incep-

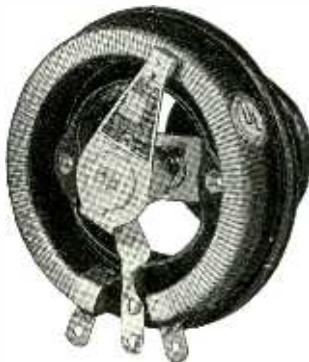


Thomas A. White, Vice President, Jensen Radio



SEND US YOUR "SPECS" TO GET THE RIGHT RHEOSTAT

Don't waste valuable time worrying about that Rheostat problem! Ohmite Engineers, with their wide, specialized experience, can help you solve it quickly, dependably, economically! Just send in your "specs"—often the right Rheostat can be found in the wide range of Ohmite stock types and sizes. Or, Rheostats can be made to order promptly to meet your exact requirements.



OHMITE MANUFACTURING COMPANY
4817 Flournoy Street, Chicago, U.S.A.

Write Today for Catalog 17

Be Right with **OHMITE**
RHEOSTATS • RESISTORS • TAP SWITCHES

tion . . . Tinnerman Stove & Range Co., Cleveland, Ohio, has found it necessary to discontinue the manufacture of stoves and ranges due to the growth of the Speed Nut Division of the company. Tinnerman Products, Inc., is now the new name of the company which will be devoted to the manufacture of Speed Nuts and Speed Clips . . . Heyer Products Co., Inc., manufacturers of battery chargers, testers, etc., are now located in their new plant at 471 Cortlandt St., Belleville, N. J. . . . The sale and manufacture of Cinaudagraph loud speakers have been transferred to a new company known as the United Teletone Corp., which is managed by I. A. Mitchell and S. L. Baraf of United Transformer Corp. . . . Transducer Laboratories announces that it has assumed all the manufacturing and experimental facilities of Transducer Corp. New experimental work will be done in the electro-acoustic and allied fields. Transducer Labs, under the direction of B. Eisenberg, are located at 42 West 48th St., New York City . . . Ansley Radio Corp., New York City, is now making its own radio chassis under a license from RCA and Hazeltine . . . Ernest J. Adams has recently been appointed Vice President and General Manager of Ansley Radio Corp. . . . William Brand and Company, 268 Fourth Ave., New York City, announced the establishment of its own manufacturing plant, located at Willimantic, Conn.

**SENSITIVE ELECTRONIC
AC VOLTMETER
MODEL 300**



10 to 100,000 cycles
Range .001 to 100 volts r.m.s.
Logarithmic voltage scale
A-C operation, 115 volts 60 cycles
Accurate and stable calibration
New principle of operation

Write for Bulletin 2G for complete data

Ballantine Laboratories, Inc.
BOONTON NEW JERSEY

**WALCO SAPPHIRE
CUTTING NEEDLES**

These needles were announced 15 months ago and we have since sold several thousand to broadcasting stations, studios, and recording engineers throughout the country *without a single complaint.*

NOW BETTER THAN EVER

During the past two months one of the largest research laboratories in the country has made an intensive study of these cutters. The result has been slight refinements which give longer life and lowest possible surface noise.

The needles now being shipped are considered to be as nearly perfect as possible, and far superior to all others.

Walco Sapphire Cutting Needles are guaranteed to be

ABSOLUTELY UNIFORM
List price: \$5.00 each

One-day resharpening service: \$1.40 net

STEEL CUTTING NEEDLES

We take pleasure in announcing the Walco Steel Cutting Needle

New, perfect in shape, hand-polished alloy-steel, they fill a long-felt need for a *really fine* low-priced cutter.

List price: 25c. each

10 to a package only

If your nearest jobber cannot supply you write direct to—

ELECTROVOX COMPANY
424 Madison Ave., New York City
PLaza 8-2740

The company will continue to manufacture saturated sleeving and flexible tubing known under the trade name of "Turbo" . . . Radio Club of America, founded in 1909, has elected officers for the year 1940 as follows: President, Keith Henney; Vice President, John L. Callahan; Recording Secretary, Carl Goudy; Corresponding Secretary, C. E. Dean; and Treasurer, J. J. Stantley . . . Finch Telecommunications, Inc., have leased, under a long time contract, a 3 story building at 4th and Virginia Sts., Passaic, N. J. for the manufacture of facsimile equipment for broadcasters, aviation, police, industrial and shipping use . . . George S. De Sousa, Treasurer of Radio Corp. of America, was recently elected Vice President and Treasurer . . . William Miller Corp., have moved to 362 W. Colorado St., Pasadena, Cal. . . . Dr. William A. Mudge has joined the staff of the Technical Service Div., of International Nickel Co., Inc., New York City . . . A competition for the design of an ideal building in which to house a 1,000 watt radio broadcasting transmitter has been launched by the Beaux Arts Institute of Design. It is open to students of all architectural schools and ateliers in the country. Announced purpose of the competition, which is sponsored by the Western Electric Company, is the stimulation



Hugh S. Knowles, Vice President,
Jensen Radio

of interest in the design of specialized structures for radio broadcasting purposes. By offering three cash prizes of \$250, \$100 and \$50, the sponsor hopes to attract the best undergraduate talent and plans to make the final designs available generally to the broadcasting industry. The competition opened on January 8th and the prize winners will be announced on May 15th. . . . Mr. George A. Scoville, Vice President and General Manager, of the Stromberg-Carlson Telephone Mfg. Co., died in Rochester, N. Y. recently. He was a member of the A.I.E.E. and of the Rochester Engineering Society and had been active in industry associations . . . C. R. Cox, formerly of Bell

Precision
**CRYSTALS
HOLDERS
OVENS**

FOR BROADCAST SERVICE

Both the compact BC46T temperature controlled variable air-gap mounting and the low-drift Bliley Crystal are approved by the F.C.C. Correct design and precision manufacture assure full dependability.



FOR GENERAL SERVICE



The VP4 steatite adjustable pressure holder, complete with Bliley Crystal, is widely employed in general frequency control applications throughout the range from 240kc. to 7.5mc.

FOR HIGH AND ULTRA-HIGH FREQUENCIES



The M02 unit, for crystal frequencies from 7.5mc. to 30mc., is designed to withstand the severe operating conditions encountered in portable and mobile services.

FOR FREQUENCY STANDARDS

Precision frequency control for primary or secondary standards is economically obtained with the SOC100 mounted 100kc. bar. The crystal is rigidly clamped between knife edges and is ground to have a temperature coefficient not exceeding 3 cycles/mc./°C.



Catalog G-11 contains complete information. Write for your copy.

BLILEY ELECTRIC CO.
UNION STATION BUILDING ERIE, PA.

Challenging Comparison... VALUE FOR THE MONEY



The test instrument line that leads the field in quality today scores another important first—in economy. They said it couldn't be done, but RCP has done it! Not here and there, but right down the line of 1940 RCP test instruments there is extra quality built in at no extra cost. That is why RCP can say.—Compare RCP test instruments with any line of your acquaintance. Compare features, performance, price. See if you don't agree with hundreds of engineers "from Missouri"—for the money. RCP outvalues them all!

HERE'S WHAT WE MEAN BY VALUE

Model 411
Universal
Supertester
\$16.25



MOST comprehensive tester ever devised. Provides measurements in ranges never before available in small instruments. 5 AC and 5 DC voltage ranges 0/10/100/250/1000/5000 volts. Six AC and DC ampere ranges to 25 amps. 4 ohmmeter ranges reading from 0.1 ohm to 4 megohms. DC milliamps 0/10/100. DC microamps from 0-200. AC milliamps 0-500. *It's 33 individual instruments in one!*

MODEL 413 POCKET MULTITESTER \$12.90

A POCKET-SIZE multitester with all the features and the quality of large, expensive testers, and none of the expense! Sensitivity of 2500 ohms per volt. A five range voltmeter 0/10/50/250/1000/5000 AC and DC. Three range ohmmeter 0/500/100,000/1,000,000. DC Microamps 0/400. DC Milliamps 0/10/100/1000. DC amps 0/10. Output meter same as AC volts.



Today send for your copy of FREE catalog, No. 121, describing the complete RCP dependable line of test equipment.

RADIO CITY
PRODUCTS CO., INC.
88 PARK PLACE, N. Y. C.

& Howell Co., Chicago, is now Chief Engineer with Victor J. Andrew Co. . . . W. A. Wolff has been appointed Information Manager of Western Electric Co. and its subsidiary Electrical Research Products, Inc. . . . Utah Radio Products, Chicago, announces the association of Peter L. Jensen as Vice-President of the company. Mr. Jensen is an old timer in loud speaker history and comes to Utah with a long background of engineering, sales and executive experience.

Literature

Television Receivers. Two recent issues of "Research Worker" are devoted to a description of television receivers by the Engineering Dept. of Aerovox Corp., New Bedford, Mass.

1939-40 Catalog. Condensers, dials, flexible couplings, tuned exciter tanks, coil forms, relays, transformers, antenna devices, etc., are described and illustrated in a catalog issued by James Millen Mfg. Co., Inc., 150 Exchange St., Malden, Mass.

Synchronous Motors. Catalog MI-5 contains diagrams and descriptions of Telechron self-starting synchronous motors and instrument movements. Available from Warren Telechron Co., Ashland, Mass.

Testing Instrument. "Vibrotest" insulation testing instrument, Model 201, a-c and d-c voltmeter, megohmmeter, ohmmeter, is described in a 6-page leaflet issued by Associated Research, Inc., 16 N. May St., Chicago.

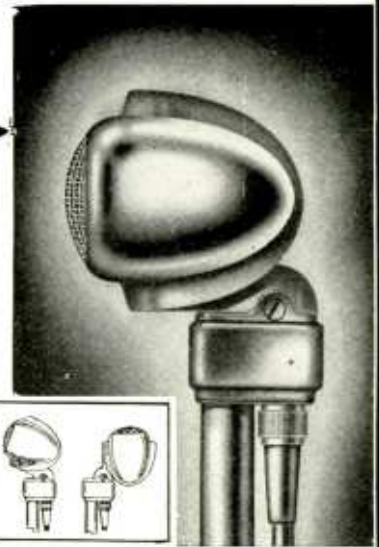
Coil Winder Driver. Model 210 coil winder driver is described in a bulletin available from Ideal Commutator Dresser Co., Sycamore, Ill.

Technical Journal. Associated Electric Labs, Inc., 1033 W. Van Buren St., Chicago, issue a journal called "The Strowger Technical Journal". A recent issue contains the following articles: "Voice Frequency Dialing for Toll Circuits", "Transmission Characteristics of Types 40 and 50 Monophones", and "Automatic Network in Aquila Province". The journal is published in the interest of progress in communication engineering.

Disc Record Noise Reduction. "Brush Strokes", a house organ, of The Brush Development Co., 3322 Perkins Ave., Cleveland, devotes a complete issue on the subject of noise reduction in disc records through constant amplitude recording.

Weld Recorder. General Electric Co., (Schenectady, N. Y.) Bulletin GEA-3313 describes a weld recorder that records the character of the electrical input for every weld, as compared with allowable limits.

A PROFIT-BUILDER!



More Sales—Longer Profits—on the Trouble-Free **TURNER 22D Dynamic**

90° Tilting Head, 25 Ft. Removable Cable Set . . . **\$21.50**
Hi-Impedance List

Deduct \$1.50 for 8 Ft. Cable Set
Deduct \$1.50 for 50 ohm model
Available with switch \$2.00 extra

Here's a microphone that's rugged enough for the toughest P.A. job, yet ideal for the ham. Works well indoors or out, with amazingly low feed-back. Advanced engineering style. Full satin chrome finish. Gives professional results. Range 40-8,000 cycles. Level -34DB.

The TURNER CO.
910 17th St., N.E.
CEDAR RAPIDS, IOWA

TRANSFORMERS



Luminous Tube transformers are only one of many classes of transformers that Acme builds. Because of variances in installation and application, this type of transformer must be built to endure much abuse.

The Acme Voltrol, (panel mounting type illustrated) provides manual voltage control from 0 to 135 volts stepless regulation. A necessary instrument for every electrical testing laboratory.



Air-Cooled transformers up to 25 K.V.A. Acme's production facilities, design and engineering service by transformer specialists, are your assurance of better transformers for your special applications. Send specifications of your requirements.

THE ACME ELECTRIC & MFG. CO.
31 WATER ST. CUBA, N. Y.

Acme Electric
TRANSFORMERS

Capacitors. Catalog 10, a 33-page booklet, gives full information on capacitors for radio and television products manufactured from Solar Mfg. Corp., Bayonne, N. J.

Portable Vacuum Pumps. Bulletin 73 describes portable vacuum pumps for laboratory and test work. Beach Russ Co., 50 Church St., New York City.

Capacitor Manual. A 1939-40, Edition No. 1, of the Capacitor Manual for Radio Servicing is now available from Cornell-Dubilier Electric Corp., S. Plainfield, N. J. The manual is paper bound and contains 256 pages.

Vinylite Resins. An article on "Versatile Vinylite Resins" is contained in the recent issue of "Bakelite Review" a house organ of Bakelite Corp., 247 Park Ave., New York City.

GR Experimenter. Two recent issues contain the following articles of interest to our readers. "Network Testing with Square Waves", "A Broadcast Frequency Monitor for the 20-cycle Rule" and "One Cps from the Inverse Feedback Oscillator". General Radio Co., Cambridge A, Mass.

Resistance Handbook. A beautifully bound and well edited 108-page handbook of resistance alloys for engineers in radio, electrical, automotive, mechanical and chemical industries, is available from Wilbur B. Driver Co., Newark, N. J.

Transformer Encyclopedia. A new replacement transformer encyclopedia and service guide, No. 352-E, has been published by Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago.

Microphones. Three new handy accessories to make microphones easier to handle are described in a bulletin available from Shure Bros., 225 W. Huron St., Chicago.

Elastic Stop Nuts. Twelve new types of elastic stop nuts are described in sheets available from Elastic Stop Nut Corp., 1001 Newark Ave., Elizabeth, N. J.

Rheostats. Catalog R contains a description and illustrations of rheostats manufactured by Rex Rheostat Co., 37 West 20th St., New York City. Diagrams of connections are also included.

New Products

Photoelectric Relay

A NEW COMPACT photoelectric relay for counting, sorting, weighing, measuring, signalling, and other similar functions, has been announced by the Westinghouse E. & M. Co.

WHAT TO LOOK FOR in a recording turntable

• When you buy a recording turntable be sure it has these important features: 1) A simple, sturdy, trouble-free drive system that can be kept in perfecting operating condition without factory assistance. 2) A turntable so quiet in operation that "rumble" or "flutter" due to vibration is at least 50 db below the useful sound level. 3) A turntable that will record and playback a constant tone without a sign of waver or "wows". 4) A cutter feed mechanism that grooves perfectly every time. 5) A cutting head that enables you to actually playback a frequency range from 50 to 8,000 cycles. 6) A high grade magnetic pickup unaffected by temperature or moisture.



The Presto Model Y recorder has all these features. Send for bulletin explaining how this performance is made possible.

PRESTO RECORDING CORPORATION
242 West 55th Street, New York, N.Y.

Leach Antenna Transfer Relays CAPACITY AT MINIMUM—NO LEAKAGE

This new antenna transfer relay is designed to keep capacity to the minimum. It provides sufficient surface clearing to prevent leakage. Used to advantage on ultra high frequency circuits, it has pure silver contacts and solder terminal connections. Auxiliary center contacts are provided to handle light power circuits, or for grounding purposes.

Coils—2 to 125 Volts DC without requiring resistors.

Write TODAY for complete description.

Type 1437-S-9 List Price: \$11.00

LEACH RELAY COMPANY

5915 AVALON BOULEVARD, LOS ANGELES, CALIF.
15 E. 26th St., NEW YORK CITY Lawrence and Lamon Aves., CHICAGO



NEW SUPER HI-POWER GENEMOTOR for Heavy Duty Service



150 Watt, Weight 13½ lbs.
8½" Long, 4½" Wide, 3" High

Sets a new high standard for Power Units used on Marine, Police, and Aircraft Radio. The exceptional Hi Efficiency, small size, and light weight are the result of a new type, one piece field ring, and cmature design. Grease packed ball bearings require no oiling or attention. Double enamel and silk wire on armature insure trouble-free operation, end dust cover removable. Made in two sizes, 150 and 225 watt output, up to 1000 volts, input 5.5 volt and up.

There is a Carter Genemotor or Converter for every requirement. Write for further information

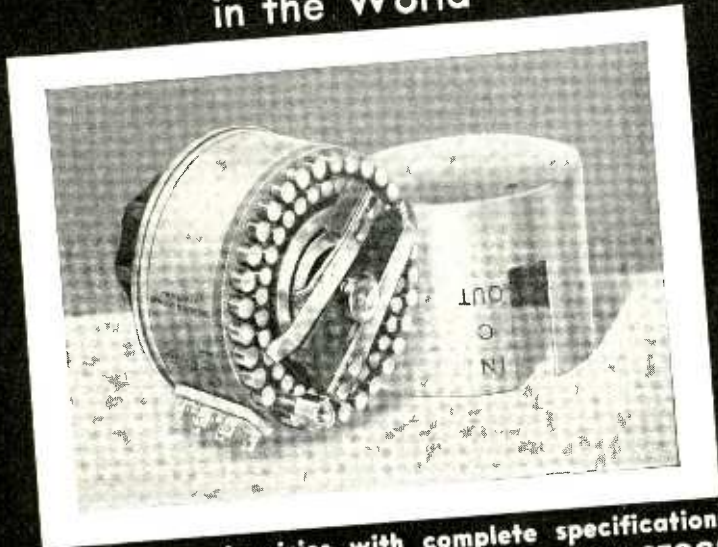
CARTER MOTOR CO.

1606 MILWAUKEE AVENUE

CHICAGO, ILLINOIS

DAVEN

The Most Complete Line of
Precision Attenuators
in the World



Send us your inquiries with complete specifications.
We can probably fill your requirements FROM STOCK.

THE DAVEN COMPANY
158 SUMMIT STREET NEWARK, NEW JERSEY



PERMANENT MAGNETS

ALL SHAPES — ALL SIZES
FOR ALL PURPOSES

Stamped, Formed, and Cast; Chrome, Tungsten, Cobalt and **ALNICO**** (cast or sintered) under G. E. license.

THOMAS & SKINNER
STEEL PRODUCTS COMPANY

1116 E. 23rd STREET INDIANAPOLIS, INDIANA

Laminations for Radio Transformers — Tools
Dies — Heat Treating — Stampings

38 YEARS EXPERIENCE

WAXES • COMPOUNDS for ELECTRICAL INSULATION

Zophar offers prompt service on Insulating Compounds for a wide variety of electrical applications, including:

... Insulation for CONDENSERS, TRANSFORMERS, COILS, power packs, pot heads, sockets, wiring devices, wet and dry batteries, etc. Also WAX SATURATORS for braided wire and tape. WAXES for radio parts.

Special compounds made to your order.

ZOPHAR MILLS INC.

130-26th St.

Brooklyn, N. Y.

FOUNDED 1846

This device (the RQ Photo-Troller) is especially designed for low operating expense, low initial cost, and ease of installation. It has two normally open and two normally closed contacts, each rated at 10 amps. on 115 volt a-c circuits. It operates on a change of 40 ft. candles, if not more than 15 ft. candles of extraneous



light is present. Increased sensitivity is obtainable by means of a condensing lens. The unit may be wall or bench mounted with open wiring, or with concealed or exposed conduit.

H-F Radio Chassis

THE ANSLEY RADIO CORP., 4377 Bronx Blvd., New York City, announces two new high fidelity radio chassis in their Dynaphone combinations. One covers the broadcast band only, while the other covers three wave bands. Both use variable selectivity to adapt the set to local conditions. Both are made in a-c or a-c and d-c types. The a-c amplifier uses triode tubes with 2A3's in push-pull in the output. A fixed bias arrangement gives approximately 15 watts output with low distortion. The a-c and d-c type uses four 25L6 tubes for an output of about 10 watts. A heavy high fidelity speaker is used.

VU Meter

FOR BROADCAST MONITORING and use with public address systems, General Electric, Schenectady, N. Y., has produced a new VU volume-level indicator, Type DO-61, which meets the electric, dynamic, and mechanical specifications formulated as a result of the combined efforts of the N. B. C., C. B. S., and the Bell Telephone Laboratories. The new VU instrument was developed to eliminate the confusion caused by the great variety of volume indicators



ANDREWS & PERILLO, Inc.

*announce their appointment
as distributors for*

**RCA INDUSTRIAL-CONTROL
AND TEST EQUIPMENT**



Our excellent plant and laboratory facilities together with extensive electronic experience makes it possible for us to offer you complete equipment for:

Inspection for defects and foreign substances

Remote control and indication

Vibration and pressure studies

Fatigue determination

Photo-electric control

X-ray Inspection

Cathode Ray Apparatus

and other specially designed apparatus.

We invite correspondence regarding your specific problems.

ANDREWS & PERILLO, Inc.

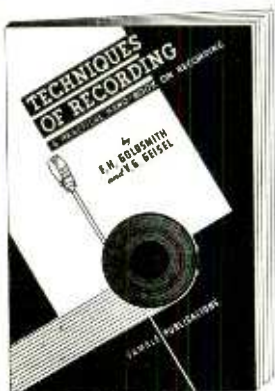
39-30 Crescent St.

LONG ISLAND CITY, N. Y.

At last!

The Answer to the
Question

**"When Will Someone Write
A Book On Recording?"**



**\$1.25
Post
Paid**

**A Guide for the Engineer
A Text for the layman**

GAMBLE PUBLICATIONS

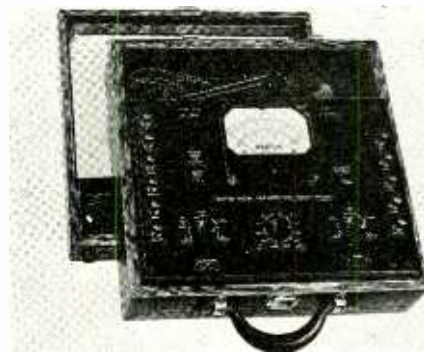
228 S. Wabash Ave., Chicago

in use throughout the communications industry. Previously, it was impossible to correlate the results from the various types of instruments since they differed in so many characteristics. For description of the VU and the background for this instrument see *Electronics*, February, 1939.

The instrument is available either with or without internal scale illumination, for semiflush mounting and may be had with or without antiglare glass.

Circuit Tester

A NEW CIRCUIT TESTER, for use in individual measurements on all types of control and signal equipment, and electronic apparatus, has been announced by Weston Electrical Instrument Co., Newark, N. J. Known as Model 785, this circuit tester has 27 complete ranges for voltage, current and resistance measurements. Some of its applications include measuring photocell currents, cathode ray tubes, PA systems, electronic circuit values, etc. The sensitivity of the instrument permits voltage, current and resistance measurements on oscilloscope circuits.



The Model 785 circuit tester provides d-c voltage measurements at a sensitivity of 20,000 ohms per volt in ranges of 0-1, 0-10, 0-50, 0-200, 0-500 and 0-1000 volts; a-c voltage measurements at a sensitivity of 1,000 ohms per volt in ranges of 0-5, 0-15, 0-30, 0-150, 0-300, and 0-500 volts; d-c current measurements in ranges of 0-50 microamperes; 0-1, 0-10, 0-100 ma.; 0-1, and 0-10 amps; a-c current measurements (available through a self-contained current transformer) in ranges of 0-0.5, 0-1, 0-5, and 0-10 amps; and resistance measurements in ranges of 0-3000, 0-30,000, and 0-300,000 ohms; 0-3,



Make T R & S Rivets Standard for Complete Satisfaction

In specifying rivets for your job, it is important to get the best. That's why you should insist upon T R & S rivets. T R & S quality means every rivet is of uniform preciseness, accurately gauged to drive smoothly and with non-brittle efficiency.

Insure complete satisfaction by making T R & S rivets the standard specification. We have solved the riveting problems of America's leading industrial concerns.



Many motorized models available in single stroke and multiple drive

Inquiries invited with samples of work you wish to do

TUBULAR RIVET & STUD CO.

World's Foremost Producers of Rivets


Wollaston

Massachusetts

CONTACTS

FOR THE FIELD OF ELECTRONICS

B-L RECTIFIERS



CHANGE AC TO DC WITHOUT MOVING PARTS, GLASS BULBS, LIQUIDS, OR SPARKING CONTACTS.

DRY—DURABLE
COMPACT—ECONOMICAL
SPECIAL RECTIFIERS AND COMPLETE ASSEMBLIES

THE BENWOOD LINZE CO.
ST. LOUIS, MO.
ELECTRICAL RECTIFIERS ENGINEERS

ELECTRON TUBE PARTS

QUALITY All Types EST. 18 YEARS

Seal Finish Tungsten Welds
Tungar Welds Coil Springs
Filament Hooks Gases
Spot Welders Caps
Stem Wire Cutting & Forming Machines

"The Engineering Co." of Newark, N.J., Inc.
Daniel Kondakjian, Pres.
59 Branford Street Newark, N. J.



UNIVERSAL

Recording Chassis
With or without motors for radio migs. and assemblers. Also cutting heads, arms, microphones, stands, accessories, etc. Attractive quality prices.

UNIVERSAL MICROPHONE CO. LTD.
424 Warren Lane Inglewood, Calif.

We manufacture a complete line of equipment

SPOT WELDERS, electric, from ¼ to 500 KVA	A.C. ARC WELDERS
TRANSFORMERS, special and standard types	From 100 to 400 Amps.
INCANDESCENT LAMP manufacturing equipment	
RADIO TUBES, ex-ray, cathode ray, photo cells	
ELECTRONIC EQUIPMENT, vacuum pumps, etc.	
TUNGSTEN SLUGS, rod and wire manufacturing equipment	
GENERAL GLASS working machines and burners	
COLLEGE GLASS working units for students and laboratory	

EISLER ENGINEERING COMPANY, CHAS. EISLER, Pres.
751 So. 13th St. (near Avon Ave.) Newark, New Jersey

We Manufacture PROTECTED AND UNPROTECTED



Slide-contact Rheostat

with self lubricating contact brushes in six different sizes, in 120 different ratings

Write for Catalog R to the
REX RHEOSTAT CO.
37 W. 20th ST. New York, N. Y.

VACUUM TUBES AND ELECTRONIC DEVICES

Design, Development and Construction of tubes and circuits.

VACUTRON, INC.
2819 12 St. South Arlington, Va.

FINE RIBBONS

of Tungsten, Molybdenum and Special Alloys

To your specifications
H. CROSS
15 BEEKMAN ST. NEW YORK

MICROMETER FREQUENCY METER

for checking transmitters, from 1.5 to 56 mc., within 0.01 per cent.

LAMPKIN LABORATORIES
— Bradenton, Fla., U. S. A. —

Transmitting Tubes Repaired and Guaranteed for Satisfactory Characteristics and Life

228A—\$100.00 204A—\$35.00 279A—\$175.00
Other prices on request

GARRETT W. LEWIS, Electronics
Route 3 Los Gatos, Calif.

ACTONE CUTTING STYLI

For recording direct on all coated aluminum or paper base discs. Individually lapped for a quiet, high quality cut.

H. W. ACTON CO., Inc., 370 7th Ave., New York

PILOT LIGHTS

UNDERWRITERS APPROVED MODEL 100



Write for DIALCO 1940 8-Page CATALOG

DIAL LIGHT CO. OF AMERICA, INC.
National Sales Agents
F. EDWIN SCHMITT SALES CO.
134 Liberty Street, New York, N. Y.



Universal Cinema Model

For Studio, Stage and Orchestra
Crystal or dynamic in any impedance, high or low. New swivel yoke. Gun metal or pol. chrome. Incl. 25 ft. rubber covered cable. Amazing value. Embodies 1940 tech. advances and beauty of design. List only \$22.50.

Universal Microphone Co., Ltd.
424 Warren Lane, Inglewood, Calif.

and 0-30 megonms. Resistance measurements are obtained in conjunction with self-contained stock batteries. The instrument accuracy on direct voltage and current measurements is within 2%, excluding the 1000 volt range, which has an accuracy of 3%. Because of the new temperature-compensated rectifier circuit employed, an accuracy of 3% on alternating voltage is attained.

New GR Generators

GENERAL RADIO Co., Cambridge, Mass., announce Type 804-A signal generator for use in testing radio receivers in the u-h-f range. The characteristics of the signal generator are: carrier frequencies from 7.5 to 320 Mc; output voltage range, 10 to 20 μ v; direct reading in both frequency and output voltage; internal 400 cycle modulation up to 60% is provided (external modulation can also be used); a voltage-regulated a-c power supply is included. Modulation percentage and carrier level are indicated directly on easily-read, fan-shaped meters on the panel.

Type 769-A square-wave generator can be used to determine the frequency response, particularly under transient conditions, of amplifiers and other networks. This generator is particularly useful for measuring the low-frequency response of television systems.

The output voltage can be obtained either unbalanced or balanced to ground. The plate-to-plate output voltage is 150 volts balanced, 75 volts unbalanced. Minimum output voltage is 10 microvolts. Output impedance is 500 ohms balanced, 250 ohms unbalanced. The impedance is independent of frequency down to d-c.

Square waves with fundamentals from 10 to 5000 cycles per second can be produced. The output circuit will pass frequencies between 0.1 cycle and 250,000 cycles.

The waveform is very close to a true rectangular shape. At low frequencies, the entire rise in voltage takes place in 0.001 cycle.

Reproducing Needle

PERMO PRODUCTS CORP., 6415 Ravenswood Ave., Chicago, offer an improved, high fidelity, transcription type, play-back phonograph needle. The Permo alloy forming the tip of

the needle is produced under 5000° heat, and after careful processing and inspection under microscopes throughout production, is made into pellets which are welded to specially drawn and tempered shank material. The shape of the conical tip section is compressed in rotary swage dies to give good transmission of h-f without adding mass. Special characteristics are: a lubricating action which does not wear nitrate or commercially pressed records and long life without distortion.

U-H-F Receiver

RADIO Manufacturing Engineers, Peoria, Ill., announce Model HF-30X which is an 11-tube superhet receiver providing precision reception of signals located in the u-h-f range 27.8 to 41.5 and 40.8 to 60.3 Mc. The unit is complete and compact. A 4-page descriptive folder which includes a circuit diagram is available.

Circuit Tester

A SAFE, CONVENIENT tester and polarity indicator for electrical and radio circuits from 80 to 550 volts, ac or dc, called "Safest" has been introduced by M. M. Fleron & Sons, Inc., of Trenton, N. J. This device makes obsolete the pigtail socket and lamp method of finding open or dead cir-



uits; and there is no need to change to higher voltage bulbs when testing up to 550 volts. The neon indicator bulb is enclosed in a Bakelite polystyrene housing, water-white in color, clear, and non-fragile. The test lead tips are fully insulated and the indicator bulb is protected against higher voltages with a special resistor.

Aerovox Products

BAKELITE-MOLDED mica condensers provided with handy meter-mounting brackets, for the purpose of r-f shunting of meter windings, are announced by Aerovox Corp., New Bedford, Mass. Long slots in the brackets permit attachment to the terminals of any of the standard panel-mounting meters.

TWO ACCESSORIES for the L-C checker are also available from Aerovox: mounting brackets which serve to mount the checker on the test panel of the service shop, and 0.001 μ fd mica condensers used in measuring inductance values with the L-C checker.

FOR PRECISION MEASUREMENT

in all high impedance circuits use

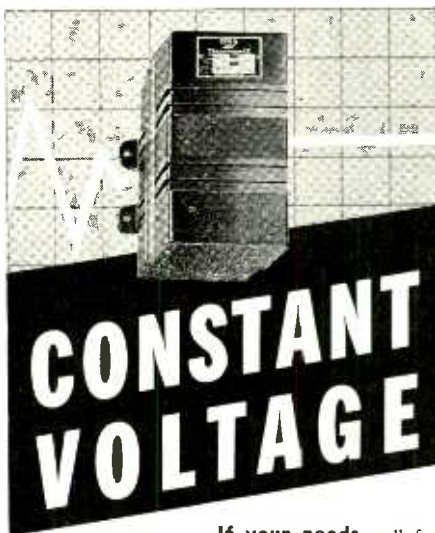
FERRANTI ELECTROSTATIC VOLTMETERS

Zero Current Consumption
Infinite Sensitivity
A.C. or D.C.
up to 3,500 Volts
Portable, Projecting or
Flush Types
Single, Dual and Triple Ranges



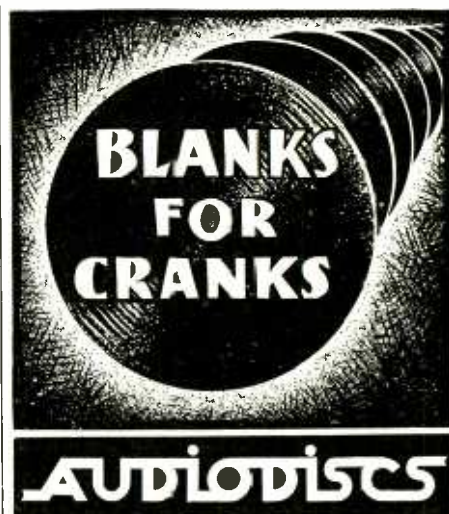
Reading up to 25,000 Volts
Self-Contained
Over-Voltage Protection
Magnetic Damping
Made, Guaranteed and
Serviced by

FERRANTI ELECTRIC, INC.
RCA BUILDING, NEW YORK, N. Y.



If your needs call for stable voltage at all times you can depend on SOLA CONSTANT VOLTAGE TRANSFORMERS

to deliver for you, even though the incoming line voltage varies as much as thirty percent. Practical, economical, trouble-free—they can replace non-regulating transformers or perform as auxiliaries to equipment now in use.

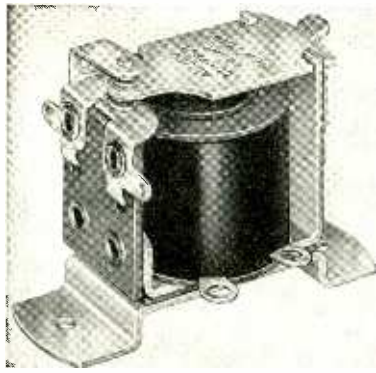


The superior properties of AUDIODISCS for both instantaneous recording and processing are made to order for the critical recordist who is really proud of his standards of sound quality.

- Smoother coated
- Quieter background
- Better frequency response
- Longer playing life
- Superior processing

All types and sizes. Also a complete line of recording accessories.





ALLIED RELAYS:

Type P.C.1—2500 Ohms—layer wound coil—adequately impregnated—yoke, armature and pole piece made of quality electrical iron—over-all dimensions 2 5/16" long, 1 1/2" high, 1 1/8" wide—designed for plate circuit of vacuum tubes.

Type P.C.2—Similar to above except coils available up to 5000 ohms.

Type P.C.3—6 volts AC; Type P.C.4—110 volts AC; Type P.C.6—6 volts DC; Type P.C.7—12 volts DC.

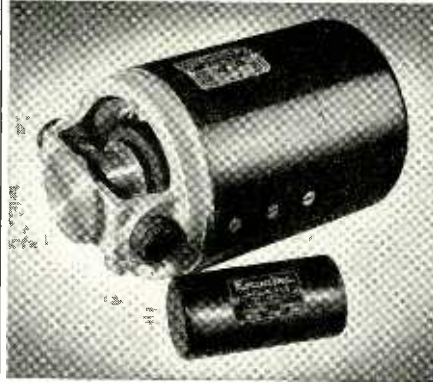
Also Type D relays for police, aircraft, and industrial uses.

Numerous uses as burglar alarms, light control, radio, call systems, teletype, etc. Because of quantity production, these relays are sold at extremely attractive prices.

Write for complete descriptive literature and prices.

ALLIED CONTROL CO., INC.
227 Fulton St. New York City

Export Dept.:
Pan Mar Corp., 1270 Broadway, New York City



EXPERTS USE EICOR DYNAMOTORS



They're precision-built for aircraft, police, marine and amateur transmitters and receivers—insure smooth, continuous, trouble-free performance and long operating life. Necessity for filtering is reduced to a minimum—AC ripple is practically eliminated. These new Eicor Dynamotors are the lightest in weight per watt output—and there is a size for every need, from the smallest of them all to the largest required.

Write for Data Today

EICOR INC.

517 S. Laflin Street, Chicago, U. S. A.

Export: AD AURIEMA, INC., 118 Broad Street
New York, N. Y. Cable: Auriema, New York

Mercury Switch

DURAKOOL METAL MERCURY Switch, and the "Double Reduction" are silent, unbreakable, and non-inflammable switches designed by Durakool, Inc., (Elkhart, Ind.) which use reducing agents to prevent deterioration of the



mercury and to increase efficiency and reliability in operation. The switches may be used for many applications from wall switching to motor starting or on devices requiring as many as 2400 contacts per minute.

Tube Tester

MODIFICATIONS IN THE Model 9000 dynamic conductance tube tester permit accurate testing of the new 117 volt tubes as well as the newest single-ended loktals. This counter or portable tester permits simple testing with easy-reading tube chart indicating tester settings. It compensates line variation for the spread between 90 and 130 volts. Consolidated Wire and Assoc. Corp., 520 S. Peoria St., Chicago, are the manufacturers.

F-M I-F Units

F. W. SICKLES Co., Springfield, Mass., has developed an intermediate frequency unit for frequency modulation receivers; and a circuit with a list of component parts is available from which one may construct a complete receiver. Methods for alignment are given in the bulletin. The receiver employs 7 tubes, not including the power supply, has one r-f stage, two i-f stages, a converter, a limiter, a discriminator and a 6F6 amplifier. The overall gain in the i-f system is roughly 2700 times; it delivers 4.2 peak volts to the limiter grid, the i-f peaking at 3000 kc.

Condensers

TYPE J SILVER mica condensers are available from Erie Resistor Corp., Erie, Pa. These condensers measure 13/64 x 7/16 x 1 1/32 inch. Average temperature coefficient (20 to 80°) is +.000025 μμf/μμf/°C. Maximum power factor at 1000 kc is less than .04%. The construction of Type J is similar to the smaller Erie Type K unit. They are made with capacities of from 15 to 1000 μμf. Good stability of these condensers make them ideal

SEARCHLIGHT SECTION

(Classified Advertising)

EMPLOYMENT: "OPPORTUNITIES": EQUIPMENT
BUSINESS: USED OR RESALE

UNDISPLAYED — RATES — DISPLAYED

10 CENTS A WORD. MINIMUM CHARGE \$2.00
Positions Wanted (full or part time salaried employment only) 1/2 the above rates payable in advance.
Box Numbers—Care of publication New York, Chicago or San Francisco offices count as 10 words.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Individual Spaces with border rules for prominent display of advertisements. The advertising rate is \$6.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
An advertising inch is measured 7/8" vertically on a column—3 columns—30 inches to a page.

POSITION VACANT

RADIO SWITCH DESIGN Engineer for well established Eastern Radio Parts Manufacturer. Will consider only those with thorough general experience in the field. Reply must give full particulars of experience. P-227, Electronics, 330 W. 42nd St., New York, N. Y.

POSITIONS WANTED

VACUUM TECHNICIAN with long experience in developing and manufacturing of radio-transmitting, high pressure mercury arc and Glowlamps in U. S. and Europe, thoroughly familiar with all mech. work and pumping, wants position. PW-226, Electronics, 330 W. 42nd St., New York, N. Y.

GRADUATE EE: Experienced in allocation work. Field intensity and antenna resistance measurements, directional antenna design and installation, calculation of coverage and interference, etc. Also experienced as transmitter and studio operator. BS in EE and BS in Math. Present location, Washington, D. C. PW-228, Electronics, 330 W. 42nd St., New York, N. Y.

TECHNICAL GRADUATE Electrical-Radio. Age 30. Desires position as laboratory assistant or sales engineer. Experienced transformer, public address, interoffice communications assembly and inspection. Licensed amateur and radiotelephone first. PW-229, Electronics, 520 N. Michigan Ave., Chicago, Ill.

PATENT ATTORNEY

Patents—Personal attention ensures satisfactory results—Applications, searches, negotiations—Thad R. Goldsborough, Patent Attorney, 2714 Quarry Road, Northwest—Washington, D. C.

DEPENDABLE

Used

ELECTRONIC TUBE EQUIPMENT

A complete line of used equipment for the manufacture of Radio Tubes, Neon Tubes, Incandescent Lamps, etc.

Write for Bulletin showing savings from 25 to 75%

EISLER ELECTRIC CORP.
534 39th Street, Union City, N. J.

HIGH GRADE USED

ELECTRON TUBE MACHINERY

Huge Stock of Every Type and Variety

KAHLE ENGINEERING CORPORATION
Specialists in Equipment for the manufacture of Neon Tubes, Radio Tubes, Incandescent Lamps, Photo Cells, X-ray Tubes, etc.

900 DeMott St., North Bergen, N. J.

FOR SALE—USED

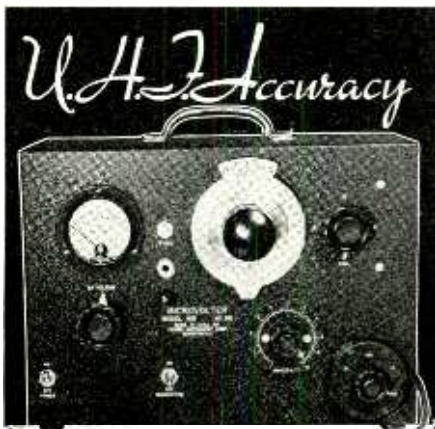
1 #650-A General Radio Co.
IMPEDANCE BRIDGE

In Good Condition

ELSBERT MFG. CO., INC.

353 W. Grand Ave. Chicago, Illinois

New advertisements must be received not later than January 29th for the February issue



FERRIS MODEL 18-B * MICROVOLT

- Combination of coils to cover the range of 4 to 150 megacycles
- Output up to 100,000 microvolts across fixed 14 ohms
- Ferris transmission line output system
- Write for bulletin E-18B for complete details
- Circulars on Signal Generators and Noise Meters are available on request

*Reg. U.S. Pat. Off.

FERRIS INSTRUMENT CORPORATION
BOONTON, NEW JERSEY

PROFESSIONAL SERVICES

(Rates on Application)

ELECTRICAL TESTING LABORATORIES

Characteristics
of Vacuum Tubes
Tests of photo cells, glow lamps, crater lamps.
Tests of electronic and optical devices
East End Avenue and 79th Street
New York, N. Y.
Phone: Butterfield 8-2600

INTERNATIONAL ELECTRONICS, INC.

DESIGN AND DEVELOPMENT
Radio Television
Sound Electronics
MANUFACTURING METHODS
Condensers Tubes Resistors
Vibrators Lamps Speakers
630 Fifth Avenue New York, N. Y.
Cable: Interengin, New York

HAROLD J. McCREARY

Mem. A.I.E.E. & W.S.E.
Consulting Engineer

Laboratory Facilities
Research Electronics
Development Television
Design Radio
Factory Practice Railroad Signaling
Patent Studies Telephony
105 W. Adams St. Phone STate 4003 Chicago, Ill.

F. H. SHEPARD, JR.

CONSULTING ENGINEER
ELECTRONIC APPLICATIONS

Specializing In:
Industrial Control Special Amplifier Design
Follow-Up Devices Photoelectric Applications
Radio and Carrier Operated Remote Control
6167 Cedar Ave., Merchantville, N. J.
Telephone Merchantville 1111

for use in tuned oscillator circuits where the LC product must be kept constant under all operating condition.

Cable-Type Transformer

A NEW HANDY, cable-type transformer to match 35-50 and 200-250 ohm low-impedance dynamic microphones (or lines) to a high impedance amplifier input is now offered by Shure Brothers, Chicago. This new A86A transformer may be located in any convenient place within 25 ft. of the amplifier.

Microphone

NEW HAND PHONES, known as Models 875 and 820, are replacing Fimer and Fimex microphones of Universal Microphone Co., Inglewood, Cal. These new models are just as adaptable for 5 meter transmitters and 5 meter receivers, and in addition are suitable for remote work, recording purposes, intercommunicating studios, and especially for amateurs who make car, boat or other mobile installations. Six ft. of 4 conductor cable accompanies each assembly.

Prefinished Bonded Metals

TWO NEW PRODUCTS, Nickel Aluminum and Chrome Aluminum, are being offered to the public for the first time by American Nickeloid Co., Peru, Ill. These two metals are formed by a surface of chromium or nickel bonded by an electrolytic process to an aluminum base metal, using the Krome Alume process patent. The two metals are available in sheets in sizes up to 36 x 96 ins., in a full range of tempers, and in gauges from 0.010 up to 0.064 ins. A choice of bright or satin finished and striped, crimped, or corrugated patterns adapts the new prefinished metals to many uses and designs.

High Current Tap Switch

MODEL 111, IS A new addition to the high current tap switches available from Ohmite Mfg. Co., 4835 Flourney St., Chicago. It is a multi-point, load-break, non-shorting, single-pole rotary selector particularly designed for a-c lines. Ratings are 5 amps at 120 volts and 3 amps at 240 volts. The switch has a maximum number of 11 taps.

Other New Products

RCA Mfg. Co., Camden, N. J., introduces a new "Long Life" needle capable of 1000 playings under normal conditions. It is packaged in a unique crystal-clear plastic package . . . A miniature instrument which combines the functions of an all-purpose meter with those of a trouble tracer, and yet requires little room in the kit, is the Model 456 of Radio City Products Co., 88 Park Place, New York City . . . Andrea Radio Corp., 48-20 48th Ave., Woodside, N. Y., has introduced a 12 inch tube television receiver with radio and with or without automatic phono-graph accommodation.



Oil

CAPACITORS

★ AEROVOX climaxes its conservative ratings policy in the HYVOL line of oil-filled high-voltage paper condensers. From more-than-generous proportioned paper sections to final details of sealing the metal containers against even slightest seepage, the HYVOL aim is to provide that extra safety factor so essential to builders of quality radio and electronic equipment.



Series -09 Rectangular HYVOLS are intended for heavy-duty continuous service at rated voltages, with ample margin for unexpected abuse. Heavy welded steel container; high-tension pillar terminals; adjustable mounting bracket permitting upright or inverted mounting at any height above or below chassis platform. 600 to 5000 v. D.C.W. 1 to 4 mfd. A quality product—at a popular price.

Series -05 Round-Can HYVOLS have long been the popular choice of amateurs. Conservative ratings for continuous, cool, troubleproof operation. Round aluminum can. Adjustable mounting ring. High-tension pillar terminals. 600 to 3000 v. D.C.W. 1 to 4 mfd.

Series -10 Inverted Screw Mounting. Same appearance and dimensions as usual metal-can electrolytic. Ideal for compact assemblies. 600, 1000 and 1500 v. D.C.W. .5 to 4 mfd.



Submit Your Problem . . .

★ Most likely you'll find the required capacitor in our exceptionally large line of standard types. But if not, do not hesitate to send along your problem for our engineering collaboration. Specifications, samples, quotations, cheerfully submitted.



The NEW "D-E" MICRODYNE



AUDAX engineers—constantly striving to still further raise the high standards of AUDAX instruments—now present a further development of the moving-inductor principle as used in MICRODYNE—with operating refinements which further elevate AUDAX performance to new heights of realism and consistency.

The new model D-E MICRODYNE has incredibly low "motional-inertia"—Needle-impedance is reduced practically to the disappearing point—Needle-point-pressure is brought down to the practical minimum—all to assure you the smoothest, most natural reproduction conceivable. AUDAX steps forward in maintaining its world-wide reputation as

**"The Standard by Which Others Are
Judged and Valued"**

MICRODYNE—regardless of climatic conditions—delivers consistently uniform response to 8,000 cycles and beyond, with sharp clean-cut definition of which only the "Moving-Inductor" principle is capable—yet for all its superlative qualities, COSTS NO MORE THAN THE ORDINARY PICKUP.

LIST PRICES FROM

\$12.50 to \$140.00

WRITE FOR LATEST LITERATURE ON PICKUPS AND CUTTERS

AUDAK COMPANY
500 Fifth Avenue New York City

*"Creators of High Grade Electrical and
Acoustical Apparatus Since 1915"*

INDEX TO ADVERTISERS

Acme Electric & Mfg. Co.	68
Acton Co., Inc., H. W.	72
Aerovox Corp.	75
Allied Control Co., Inc.	74
American Automatic Electric Sales Co.	50
American Screw Co.	7
American Transformer Co.	40
Amperex Electronic Products, Inc.	Inside Front Cover
Andrews & Perillo, Inc.	71
Astatic Microphone Laboratory, Inc.	62
Audak Company	76
Audio Devices, Inc.	73
Bakelite Corp.	41
Ballantine Laboratories, Inc.	67
Benwood-Linze Co.	72
Biddle Co., James G.	54
Blaw-Knox Co.	49
Bliley Electric Co.	67
Brand & Co., Wm.	3
Bud Radio, Inc.	55
Callite Products Division	55
Cannon Electric Development Co.	63
Capitol Radio Engineering Institute	62
Carborundum Co.	61
Carter Motor Co.	69
Centralab Div., Globe-Union, Inc.	2
Chicago Molded Products Corp.	52
Cinch Manufacturing Co.	35
Continental Screw Co.	7
Corbin Screw Corp.	7
Cross, H.	72
Daven Co.	70
Dial Light Co. of America	72
Driver Co., Wilbur B.	53
Du Mont Laboratories, Inc., Allen B.	54
Dunn, Inc., Struthers	54
Eicor, Inc.	74
Eisler Engineering Co.	72
Eitel-McCullough, Inc.	36
Electrical Research Products, Inc.	58
Electrovox Co.	67
Engineering Co. of Newark, N. J., The	72
Erie Resistor Corp.	45
Ferranti Electric, Inc.	73
Ferris Instrument Corp.	75
Gamble Publications	71
Gardiner Metal Co.	56
General Electric Co.	44
Goat Radio Tube Parts, Inc.	60
Guardian Electric Mfg. Co.	52
Heinemann Circuit Breaker Co.	66
Hewlett-Packard Co.	53
International Resistance Co.	Inside Back Cover
Johnson Co., E. F.	64
Jones, Howard B.	59
Lampkin Laboratories	72
Lamson & Sessions Co.	7
Lansing Mfg. Co.	64
Lapp Insulator Co.	5
Leach Relay Co.	69
Lenz Electric Mfg. Co.	6
Lewis, Garrett W.	72
Lingo & Son, Inc., John E.	60
Mallory & Sons, P. R.	8
McGraw-Hill Book Co., Inc.	51
Millen Mfg. Co., Inc., James	60
Miller Co., J. W.	61
National Screw & Mfg. Co.	7
Ohmite Mfg. Co.	66
Oxford-Tartak Radio Corp.	56
Parker-Kalon Corp.	7
Pheoll Mfg. Co.	7
Phillips Screws	7
Pioneer Gen-E-Motor Corp.	53
Presto Recording Corp.	69
Radio City Products Co.	68
Radio Wire Television, Inc.	59
RCA Mfg. Co.	Back Cover
Raytheon Mfg. Co.	50
Rehtron Corp.	56
Remler Co., Ltd.	63
Rex Rheostat Co.	72
Richardson Co.	46
Russell, Burdsall & Ward Bolt & Nut Co.	7
Scovill Mfg. Co.	7
Shakeproof Lock Washer Co.	7
Sola Electric Co.	73
Solar Mfg. Corp.	62
Superior Tube Co.	4
Synthane Corp.	37
Thomas & Skinner Steel Pds. Co.	70
Triplett Electrical Instrument Co.	59
Tubular Rivet & Stud Co.	71
Turner Co.	68
Universal Microphone Co., Ltd.	72
Vacutron, Inc.	72
Ward Leonard Electric Co.	47
Western Electric Co.	43
Westinghouse Electric & Mfg. Co.	38, 39
White Dental Mfg. Co., S. S.	42, 58
Zophar Mills, Inc.	70
Professional Services	75
SEARCHLIGHT SECTION (Classified Advertising)	
EMPLOYMENT	74
EQUIPMENT FOR SALE	
Eisler Electric Corp.	74
Elsbert Mfg. Co., Inc.	74
Kahle Engineering Corp.	74

DEPENDABILITY

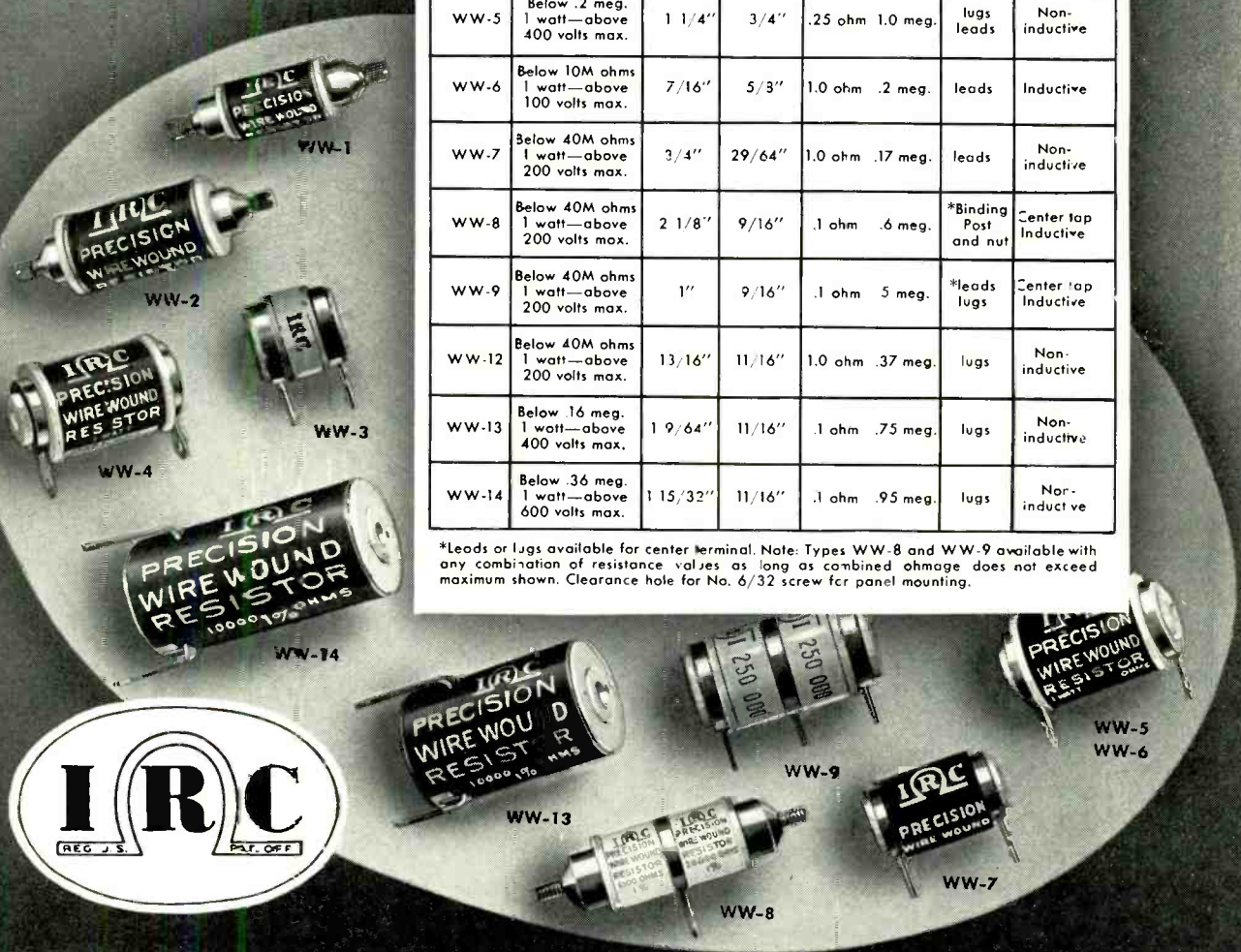
TO PROTECT YOUR EXPENSIVE EQUIPMENT

LEADING INSTRUMENT AND AMPLIFIER MANUFACTURERS specify IRC Precision Wire Wound Resistors for applications requiring complete dependability plus a high order of accuracy. Standard tolerance is $\pm 1\%$. Tolerances of $\pm 1/2\%$, $1/4\%$ and $1/10\%$ are available. Write for IRC Bulletin No. IV.

PRECISION WIRE WOUND RESISTOR SPECIFICATIONS

Type	Wattage	Length	Diameter	RANGE		Terminal	Winding
				Minimum	Maximum		
WW-1	Below .36 meg. 1 watt—above 600 volts max.	2 1/8"	9/16"	.1 ohm	600,000 ohms	Binding Post and nut	Non- inductive
WW-2	Below 1 meg. 1 watt—above 1,000 volts max.	2 15/16"	7/8"	.5 meg.	2.5 meg.	Binding Post and nut	Non- inductive
WW-3	Below 40M ohms 1 watt—above 200 volts max.	9/16"	9/16"	1.0 ohm	150,000 ohms	lugs leads	Non- inductive
WW-4	Below .16 meg. 1 watt—above 400 volts max.	1"	9/16"	.1 ohm	600,000 ohms	lugs leads	Non- inductive
WW-5	Below .2 meg. 1 watt—above 400 volts max.	1 1/4"	3/4"	.25 ohm	1.0 meg.	lugs leads	Non- inductive
WW-6	Below 10M ohms 1 watt—above 100 volts max.	7/16"	5/32"	1.0 ohm	.2 meg.	leads	Inductive
WW-7	Below 40M ohms 1 watt—above 200 volts max.	3/4"	29/64"	1.0 ohm	.17 meg.	leads	Non- inductive
WW-8	Below 40M ohms 1 watt—above 200 volts max.	2 1/8"	9/16"	.1 ohm	.6 meg.	*Binding Post and nut	Center tap Inductive
WW-9	Below 40M ohms 1 watt—above 200 volts max.	1"	9/16"	.1 ohm	5 meg.	*leads lugs	Center tap Inductive
WW-12	Below 40M ohms 1 watt—above 200 volts max.	13/16"	11/16"	1.0 ohm	.37 meg.	lugs	Non- inductive
WW-13	Below .16 meg. 1 watt—above 400 volts max.	1 9/64"	11/16"	.1 ohm	.75 meg.	lugs	Non- inductive
WW-14	Below .36 meg. 1 watt—above 600 volts max.	1 15/32"	11/16"	.1 ohm	.95 meg.	lugs	Non- inductive

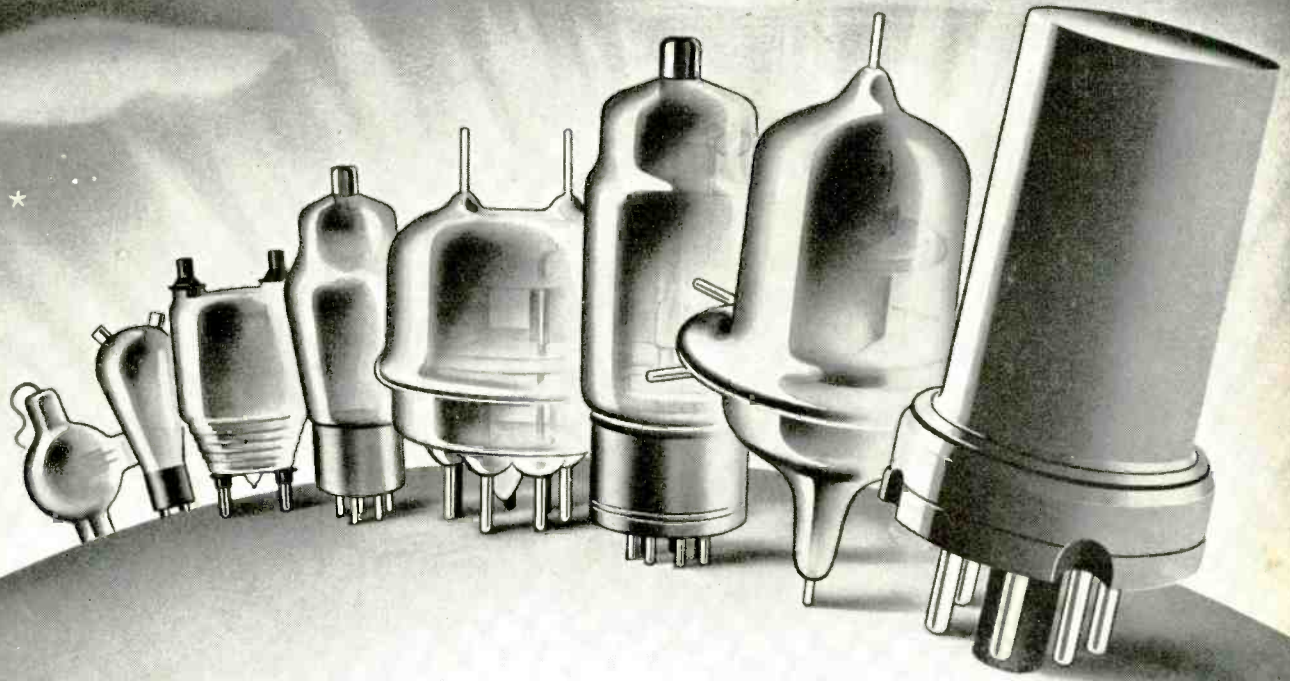
*Leads or lugs available for center terminal. Note: Types WW-8 and WW-9 available with any combination of resistance values as long as combined ohmage does not exceed maximum shown. Clearance hole for No. 6/32 screw for panel mounting.



PRECISION WIRE WOUND RESISTORS

INTERNATIONAL RESISTANCE COMPANY

403 NORTH BROAD ST. PHILADELPHIA, PENNA.



Pacing the Trend to UHF...

Since those early days of 15 years or more ago when the tremendous commercial possibilities of ultra-high frequencies first began to loom on the engineering horizon, RCA Tubes have continued to maintain unquestioned leadership in this field. Many existing RCA Tubes were such that they could be redesigned to step

up their performance at the higher frequencies. Where this could not be done, new tubes were developed, usually far ahead of any great demand. Today, from the small Acorn type, to the latest high-transconductance Television tube, RCA offers a complete, *time-tested* line for every UHF requirement.

TYPICAL EXAMPLES OF RCA LEADERSHIP IN UHF TUBE TYPES

Type No.	Date Announced	Description	Comments
954	March '35	Detector, Amplifier Pentode	Announced for experimental use five years ago, these popular Acorn types still maintain unchallenged leadership for receiving tube applications at frequencies in the order of 300 megacycles.
955	March '35	Amplifier, Detector, Oscillator Triode	
956	Sept. '36	Super-Control R-F Amplifier Pentode	
957	Dec. '38	Amplifier, Detector, Oscillator Triode	Essentially the same in construction as the above Acorn types, these tubes feature low filament current and pave the way for important developments in portable equipment designed for UHF.
958	Dec. '38	A-F and R-F Amplifier, Oscillator Triode	
959	Dec. '38	Detector, Amplifier Pentode	
1851	March '38	Amplifier Pentode	Three well-known RCA types representing an outstanding achievement in the production of high-transconductance tubes for use at high frequencies, and particularly for use in television video service.
6AC7	June '38	Amplifier Pentode (Single-ended Type)	
6AB7	June '38	Amplifier Pentode (Single-ended Type)	
800	Oct. '33	R-F Power Amplifier, Oscillator, Class B Modulator	Each tube in this group, especially popular among radio amateurs, features the ability to operate at full ratings at 60 megacycles. Although some of the units date back a number of years, they remain in widespread demand today thanks to the RCA program of constant improvement which has kept their performance fully abreast of today's exacting ultra-high-frequency requirements.
807	Oct. '36	Beam Power Amplifier	
809	Oct. '37	R-F Power Amplifier, Oscillator, Class B Modulator	
811	Sept. '39	Class B Modulator, R-F Power Amplifier	
812	Sept. '39	R-F Power Amplifier, Class B Modulator	
813	Oct. '38	Beam Power R-F Amplifier	Can be operated at full input up to 30 megacycles.
832	June '38	Push-Pull R-F Beam Power Amplifier	Can be operated at full input up to 150 megacycles.
833	Sept. '37	R-F Power Amplifier, Oscillator	Large air-cooled tube with an input rating of 1250 watts in class C telephony service up to 30 Mc.
834	Jan. '36	R-F Power Amplifier, Oscillator	Operates at full ratings up to 100 megacycles.
852	March '27	Oscillator, R-F Power Amplifier	A long-time leader because of its high-frequency capabilities—full ratings up to 30 Mc with 300 watts max. plate-input rating for class C telephony. These two RCA developments feature input rating of 1200 watts up to 300 megacycles.
887	May '37	UHF Power Amplifier, Oscillator (mu-10)	
888	May '37	UHF Power Amplifier, Oscillator (mu-30)	



Radio Tubes

RCA MANUFACTURING CO., INC., CAMDEN, N. J.
A Service of The Radio Corporation of America

FIRST IN METAL—FOREMOST IN GLASS—FINEST IN PERFORMANCE

www.americanradiohistory.com