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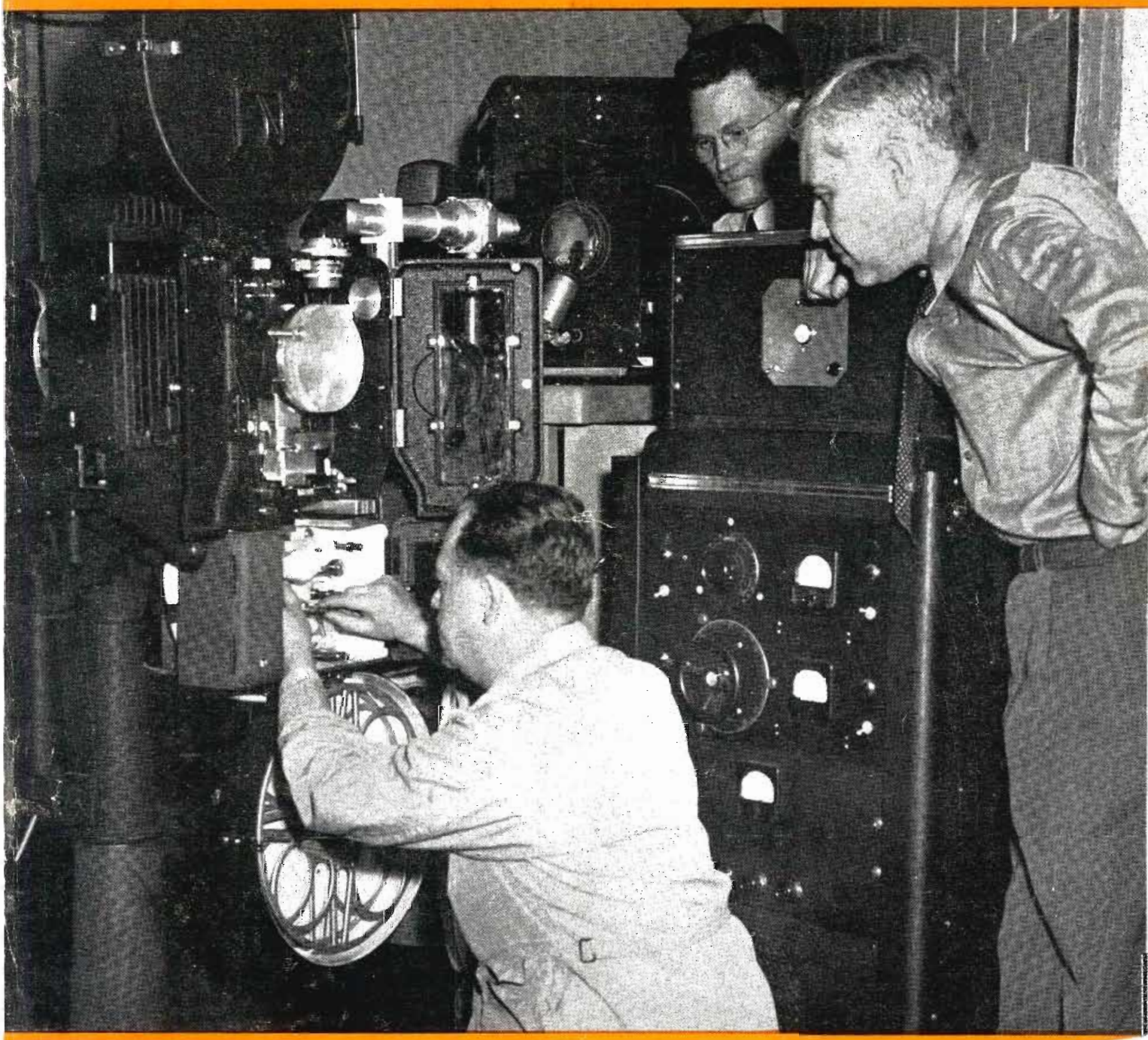

Threading new "shutterless" film projector for TV broadcast stations

Audio Quality Depends on Magnetic Tape • New TV Tube Minimizes "Glare" • Broadbanding Ring Type FM Antennas

July • 1949 CALDWELL-CLEMENTS, INC.

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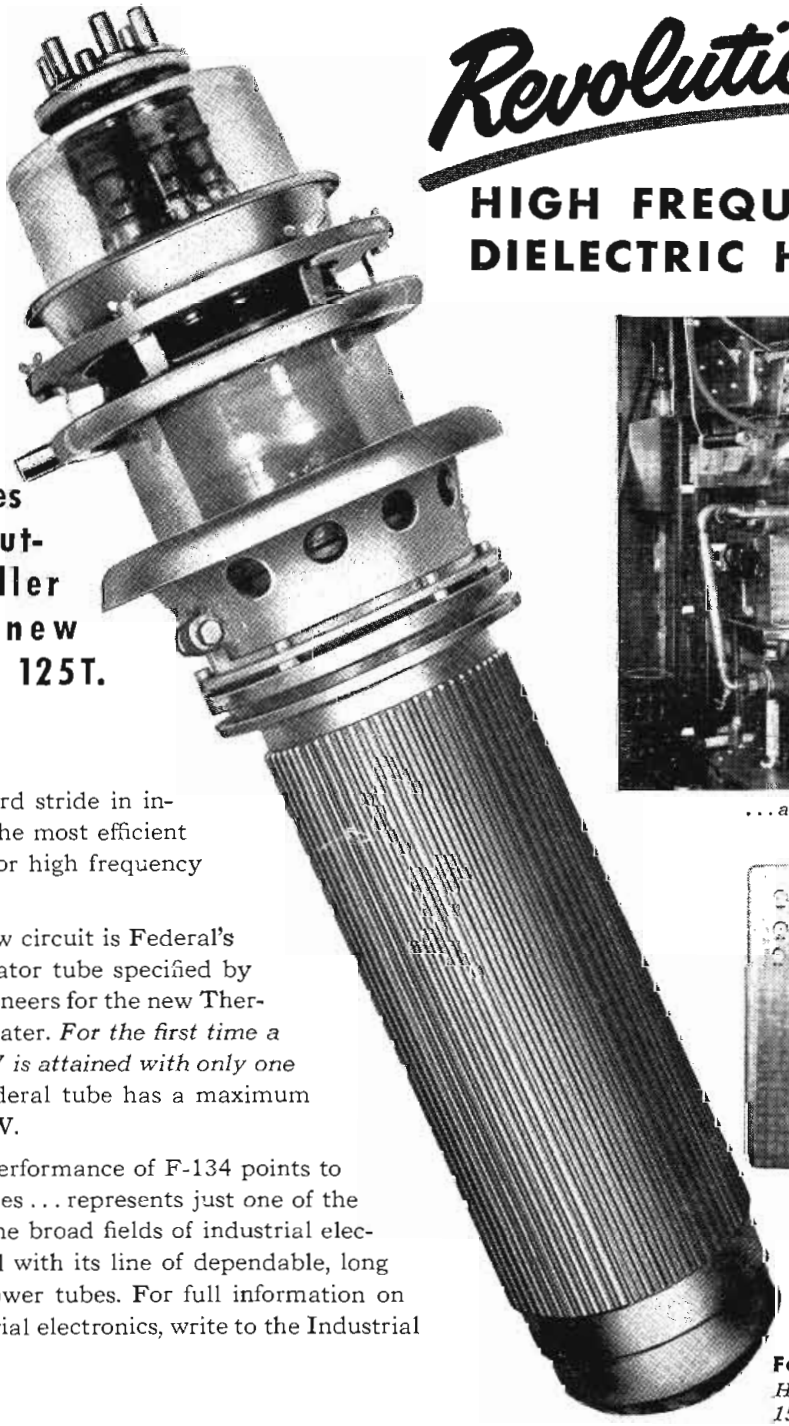
FEDERAL'S F-134

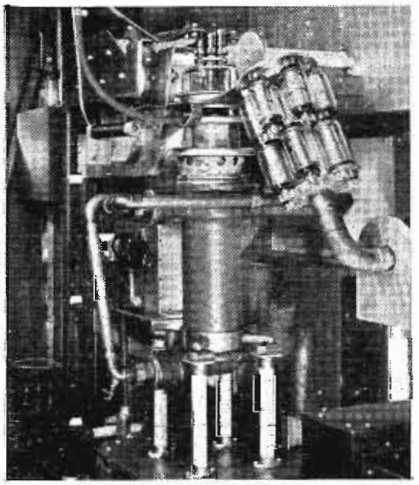
Revolutionizes

HIGH FREQUENCY DIELECTRIC HEATING!

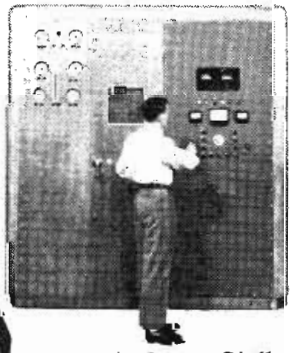


For the First Time

only one oscillator tube provides 150 KW power output in The Girdler Corporation's new Thermex Model 125T.



. . . as installed . . .



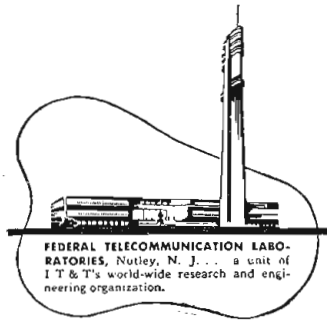
. . . in the new Girdler Thermex 125T.

HERE'S A GREAT forward stride in industrial electronics . . . the most efficient circuit ever developed for high frequency dielectric heating.

Stout heart of this new circuit is Federal's F-134—the single oscillator tube specified by Girdler Corporation engineers for the new Thermex 125T Dielectric Heater. *For the first time a power output of 150 KW is attained with only one oscillator tube.* This Federal tube has a maximum power output of 200 KW.

This record-making performance of F-134 points to new production economies . . . represents just one of the many contributions to the broad fields of industrial electronics made by Federal with its line of dependable, long life, advanced design power tubes. For full information on Federal tubes for industrial electronics, write to the Industrial Tube Sales Department.

Federal Type F-134
High Frequency Oscillator, 150 KW Plate Dissipation.



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JULY, 1949

COVER: THE 35mm TELECINE "SHUTTERLESS" PROJECTOR (extreme left) is shown with dissector tube and projector controls. The projector is being threaded by F. Ehrenhaft and the dissector tube is being adjusted by C. Larson. M. Cawein is looking on. See page 18.

Editorial Contents

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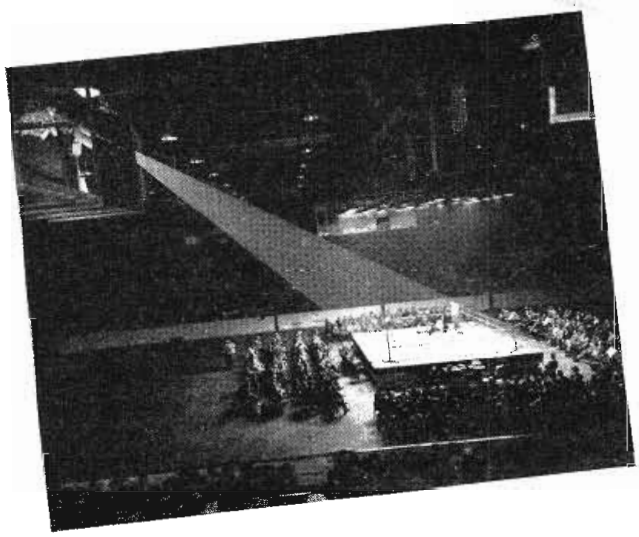
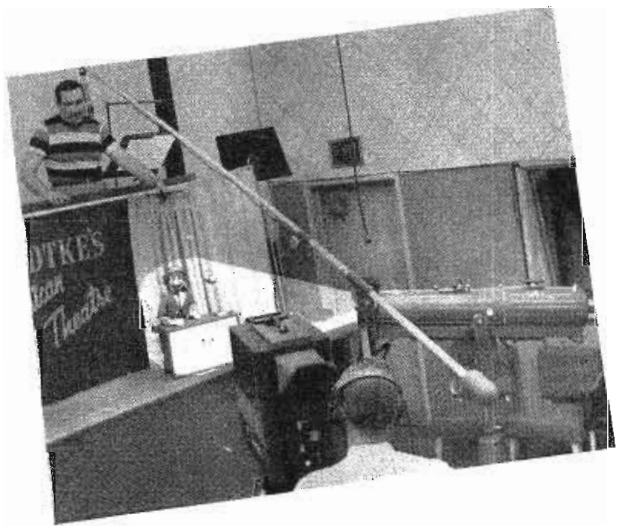
A NEW SPOTLAMP FOR TV STUDIOS

The STRONG TROUPER

Portable High Intensity A. C. CARBON ARC SPOTLIGHT

Permits better showmanship — and better lighting.





Produces snow white uniformly illuminated spot, with crisp edges, far surpassing in brilliancy any incandescent or vertical arc type spotlights. Delivers light of a quality ideal for TV.

Easily operated. Start it and forget it. You'll appreciate the unattended operation.

A silvered glass reflector and two-element variable focal length lens system.

Draws only 10 amperes from any 110-volt A.C. convenience outlet. Adjustable, self-regulating transformer which is an integral part of the base for the first time makes possible a high intensity arc spotlight without the use of heavy rotating equipment.

Automatic arc control maintains constant arc gap and a steady light, free from hiss or flicker. The airborne hum level does not interfere with sound. A trim of carbons burns one hour and twenty minutes at 21 volts and 45 amperes.

Horizontal masking control. Can be angled at 45 degrees in each direction.

Mounted on casters. Easily transported to remotes.

THE STRONG ELECTRIC CORPORATION

"The World's Largest Manufacturer of Projection Arc Lamps"

3 City Park Avenue Toledo 2, Ohio

Please send free literature, prices and name of the nearest dealer in Strong Spotlights.

NAME .....

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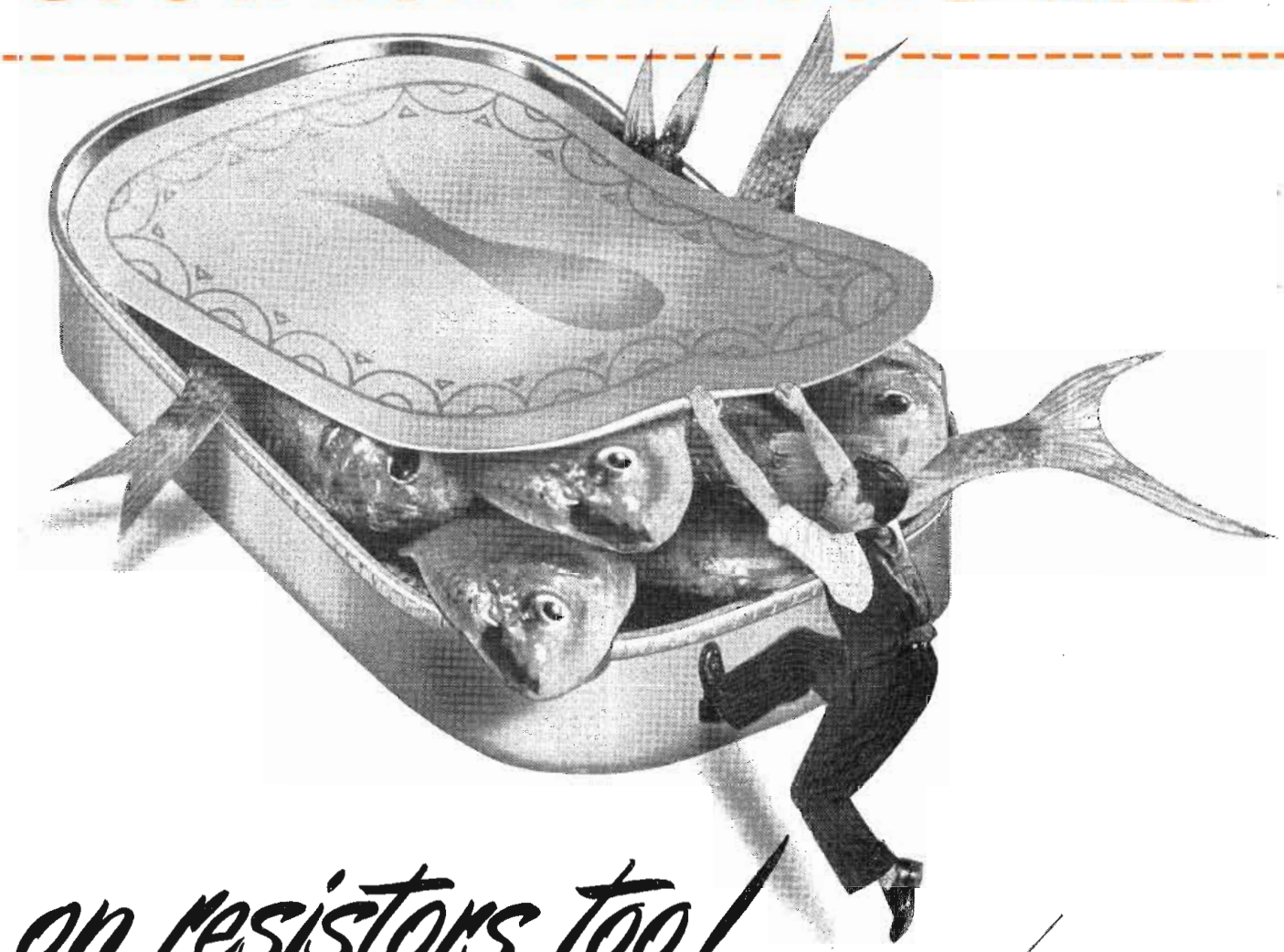
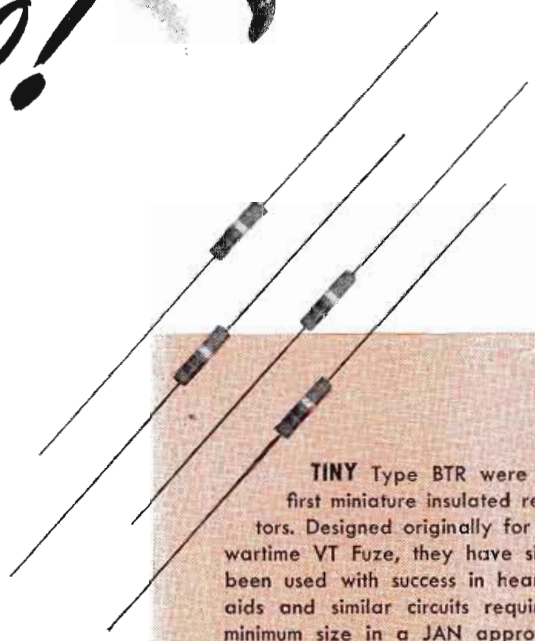
Crowded chassis are



on resistors too!

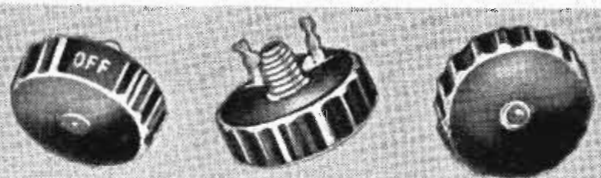
The smaller you make your electrical or electronic instruments and equipment, the bigger your problems grow. But when you specify miniature IRC resistors you conserve space without sacrificing efficiency, and miniaturization creates no bottlenecks.

Because of our years of experience in the manufacture of resistors, IRC long ago foresaw the trend to miniaturization—and prepared for it. With the widest line of resistor types in the industry, we are able now to supply miniature components for most resistor applications.

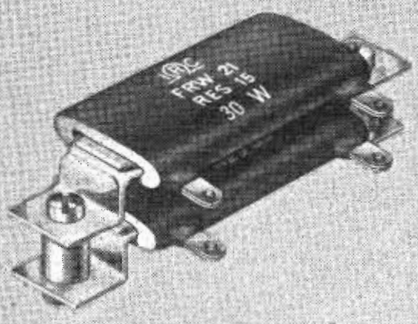


TINY Type BTR were the first miniature insulated resistors. Designed originally for the wartime VT Fuze, they have since been used with success in hearing aids and similar circuits requiring minimum size in a JAN approved resistor. ⅓ watt rating in RMA ranges up to 22 megohms. The convenient coupon brings you full details.

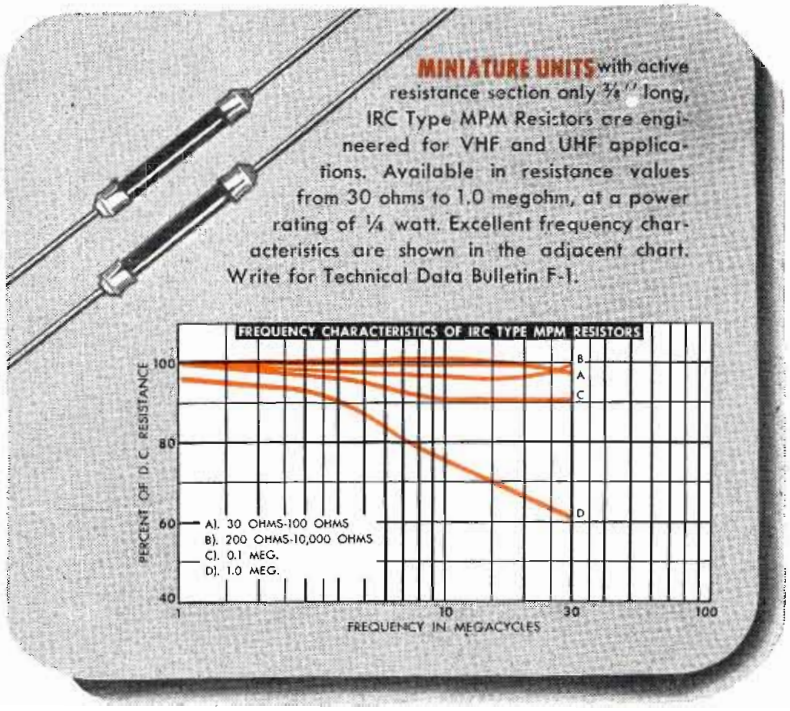
tough



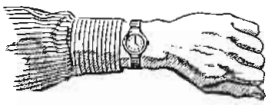
THIN AS A WAFER and no bigger than a nickel, IRC Type HB Fingertip Control features a quiet element, simplified construction and a unique rotating cover and contactor which permit ready resistance adjustment. It entirely eliminates the shaft, bushing and bulky knob of conventional-type controls. Four point switch of similar design is also available. Fully described in IRC Catalog Bulletin A-1.



FLAT POWER WIRE WOUND RESISTORS provide a higher space-power ratio than tubular types. Designed to satisfy requirements of high wattage dissipation in limited space applications, they can be mounted vertically or horizontally, singly or in stacks. The lightweight construction of these flat units includes non-magnetic mounting brackets which permit easy installation and transfer of heat to chassis. Flat FRW's are manufactured in fixed and adjustable types. Bulletin C-1 gives characteristics and specifications.



MINIATURE UNITS with active resistance section only ⅜" long, IRC Type MPM Resistors are engineered for VHF and UHF applications. Available in resistance values from 30 ohms to 1.0 megohm, at a power rating of ¼ watt. Excellent frequency characteristics are shown in the adjacent chart. Write for Technical Data Bulletin F-1.



When you are cramped for standard resistors in a hurry, IRC's Industrial Service Plan gives you the speedy service you need. For small orders of standard resistors for experimental work, pilot runs, maintenance, simply call your local IRC Distributor. We'll gladly send you his name and address.

IRC — *Wherever the Circuit Says* →

Power Resistors • Precisions
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Send me additional data on the items checked below:

- ☐ BTR Resistors
- ☐ Fingertip Controls
- ☐ Flat FRW Resistors
- ☐ MPM Resistors
- ☐ Name and address of local IRC Distributor

NAME.....

TITLE.....

COMPANY.....

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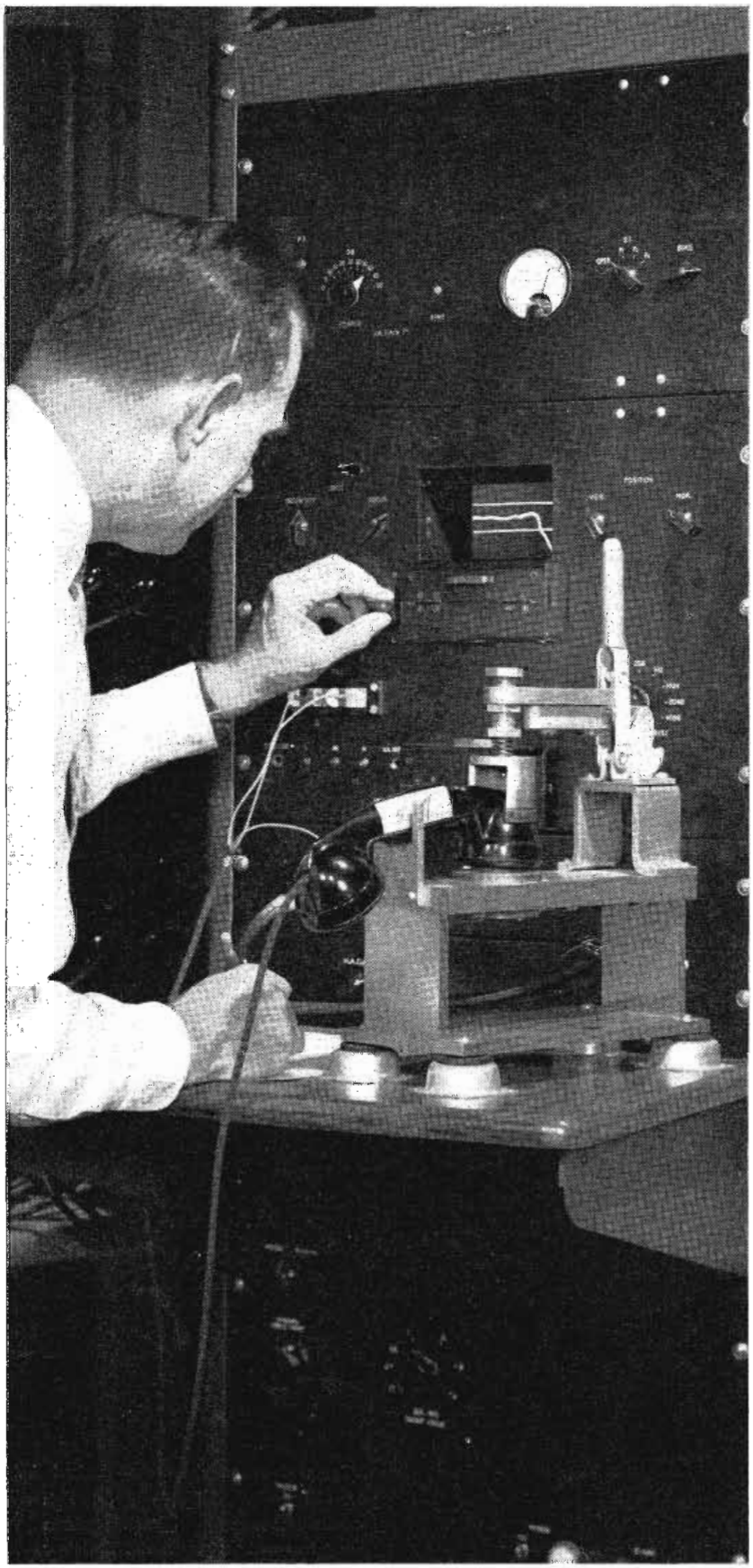

Your telephone receiver should treat each tone in the voice alike; that is important to you, because proper balance makes pleasant listening and easy understanding. Naturalness in receiver performance is pictured in a matter of seconds by the apparatus shown at left.

The receiver is clamped in place and an oscillator feeds into it frequencies representing all talking tones. Then a bright spot darts across an oscilloscope screen leaving behind it a luminous line which shows instantly the receiver's response at each frequency. It is precise; and it is many times faster than the old method of measuring receiver performance point-by-point and then plotting a curve.

It listens so YOU can hear better

At Bell Laboratories, development of techniques to save *time* parallels the search for better *methods.* For each time an operation is made faster, men are freed to turn to other phases of the Laboratories' continuing job—making your telephone system better and easier for you to use each year.

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EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.

Avoid "TELE-TENSION" Complaints!

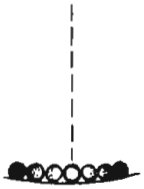
Eye-Saver

CORRECTED SCREEN PICTURE TUBE

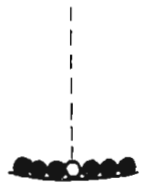
NOW AVAILABLE FOR TV MANUFACTURERS!

There's a BIG Difference in EYE-SAVER Picture Tubes!

EYE-SAVER tubes have a CORRECTED SCREEN to overcome the obvious objections of standard television picture tubes and at the same time increase the detail and contrast definition.



The picture screens on ordinary video tubes consist of a uniform group of phosphorescent particles. The light from one particle disperses and lights up others nearby . . . causing undesirable luminescenr halation. What should be only a pin point of light becomes a larger, brighter area to cause eye-fatigue and loss of detail. (This effecr is readily apparent when noticing the area immediately adjacent to the raster on a TV receiver. While it should be completely black, it becomes more and more gray as the raster brilliancy is increased. The only way it will ever look black then is to increase the whites enough to fatigue the eye into an optical illusion of contrast.)



EYE-SAVER picture tubes overcome this objectionable halation with an opaque agent between the phosphorescent particles. This reduces the "inter-action" of light and reduces the gray glare so that blacks and whites appear only where they are supposed to. Thus, a good contrast without halation or loss of detail is obtained.

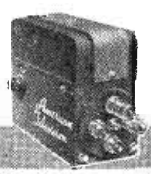
In addition, the total amount of light needed for this greater definition is only a fraction of that necessary for an uncorrected screen. By lowering the brilliancy level formerly needed for apparent contrast and detail, EYE-SAVER tubes eliminate the cause of squinting and eye strain that has plagued so many Television viewers.

Your customers know what they want . . . and they know just as strongly they DON'T want television that will tire their eyes or give them that "Tele-Tension" feeling. They're more and more conscious of the irritation, eye strain, and headaches of most of today's spotlight bright TV receivers . . . and they want their television set to be enjoyable, relaxing and safe for their children's eyes even when viewed for hours at a time.

There's good reason for their concern, for the trend until now has been toward even more brilliant and eye tiring picture tubes. Other video tubes *need* extreme brilliance so their dull gray background will appear black in comparison. But in fatiguing the eye into this optical illusion of contrast, those same brilliant whites also lose detail and cause the eye strain that is the basis of most complaints against television today.

American Television's EYE-SAVER tubes are the answer to that problem of customer satisfaction. By starting out at a blacker level — instead of a gray-white — and by decreasing the cause of the brilliant halations, EYE-SAVER tubes can get a clearer, more detailed picture with good contrast definition at a much lower brilliance level . . . thus eliminating the tiresome gray glare and spotlight effect of older type picture tubes.

EYE-SAVER picture tubes are being proved by exhaustive tests in private and independent laboratories throughout the country, and more and more TV customers are insisting on EYE-SAVER picture tubes every day. They're available in all sizes for new sets as well as replacements . . . and they cost no more than ordinary picture tubes.



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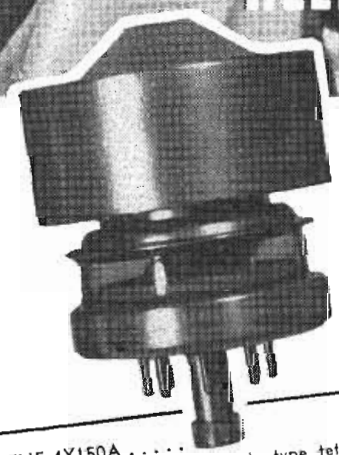


ABOUT THE 4X150A . . . .

This extremely compact external anode type tetrode is capable of relatively high-output power at low plate voltage. It is intended for use as an r-f amplifier or oscillator. The 4X150A is used extensively as a wide-band amplifier for video and in single or multi-tube high-power ultra-high-frequency equipment. Good operational characteristics are maintained up to 950-Mc.

ELECTRICAL CHARACTERISTICS

Cathode: Coated Unipotential		
Heater Voltage	6.0	volts
Heater Current	2.6	amperes
Screen-Grid Amplification Factor (Average)	5.0	
Direct Interelectrode Capacitances (Average)		
Grid-Plate (without shielding)	0.02	uuf.
Input	16.1	uuf.
Output	4.7	uuf.
Transconductance (i_b = 250 ma., e_b = 500 v., E_{c2} = 250v.)	12,000	umhos.

CLASS-C TELEGRAPHY OR FM TELEPHONY

Maximum Ratings; (Frequencies up to 500 Mc.)

D-C Plate Voltage	1250 Max. Volts
D-C Screen Voltage	300 Max. Volts
D-C Grid Voltage	—250 Max. Volts
D-C Plate Current	250 Max. Ma.
Plate Dissipation	150 Max. Watts
Screen Dissipation	15 Max. Watts
Grid Dissipation	2 Max. Watts

Complete data available on request.

Skill in the form of old fashioned individual dexterity, teamed with modern manufacturing techniques, plays a very important part in the manufacture of better vacuum tubes . . . Eimac tubes.

Craftsmanship of Eimac employees is the result of years of training at one specific art . . . vacuum tube assembly . . . and the degree of proficiency they have attained is manifest in the quality of the product they produce.

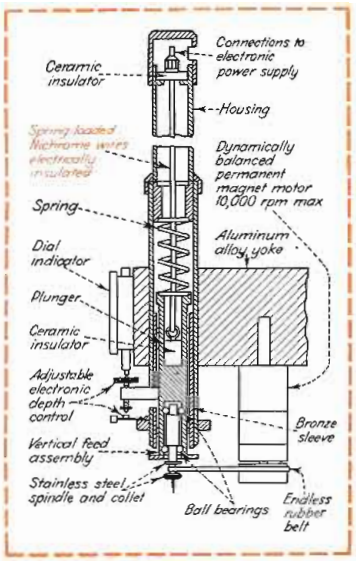
Illustrated is the screen-grid assembly operation of the Eimac 4X150A tetrode. Precise geometric alignment of these parts provides the excellent electron beam action in the 4X150A. This operation is but one of over a hundred similar operations in the construction of this tube requiring the painstaking abilities of the Eimac craftsman.

EITEL-McCULLOUGH, INC.

728 San Mateo Ave., San Bruno, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

a Revolutionary method of drilling microscopic holes that depends on NICHROME*



High coefficient of linear expansion of Nichrome V permits maximum vertical movement of spindle with shortest possible length of wire.

High tensile strength of Nichrome V permits use of a spring large enough to furnish sufficient force to drive spindle down.

High heat-resistance of Nichrome V permits heating wire to 1700°F. without permanent elongation—affording substantial drill feed range.

High specific resistance of Nichrome V minimizes heating current required.

Until now, precision drilling of extremely small diameter holes (such as .0016″ dia.) has been manually controlled. Even with highly skilled operators, however, drill breakage has been frequent—resulting in waste of time and effort, and damage to work and equipment.

But now comes the revolutionary Microdrill. Relying on sensitive electronic circuits, instead of the human senses of feeling and sight, it operates infallibly and precisely by means of remote electric controls.

Heart of the drill press is a spring-loaded Nichrome V wire which, when heated electrically, expands, thereby lowering the drill spindle. Conversely, when heating current is decreased, it contracts and raises the spindle. Electronic control of the heating current effects extremely smooth vertical travel, the drill being raised or lowered at a precisely adjustable rate.

Holes as small as .0016″ in diameter are drilled with utmost ease—drill breakage reduced to a negligible minimum. Time is saved. Costs are cut.

Says the manufacturer, Teletronics Laboratory, Inc., Westbury, N.Y.: "The wire used in the Microdrill must have a high coefficient of linear expansion, high tensile strength, high specific resistance—and must be able to retain its physical and electrical properties at high temperatures. We know of no other wire as suitable for our purpose as Nichrome V."

If you, too, have a product-performance problem, why not consult with us. In addition to Nichrome and Nichrome V, we make over 80 alloys for the electronic and electrical industries. One or more of these may be what you are looking for.

50TH YEAR — SPECIAL PURPOSE ALLOYS SINCE 1899 — DH — TRADE MARK REG. U. S. PAT. OFF. — 1899 - 1949

*Nichrome is manufactured only by

Driver-Harris Company

HARRISON, NEW JERSEY

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Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*T.M. Reg. U. S. Pat. Off.

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and its

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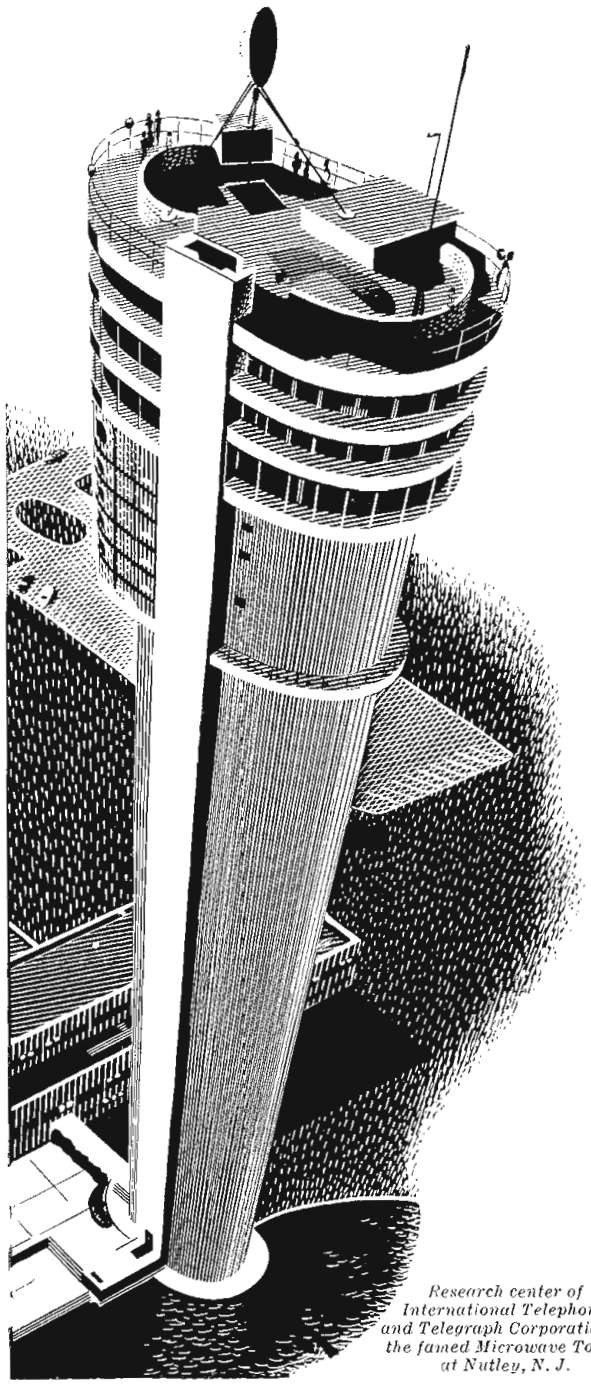

Research center of International Telephone and Telegraph Corporation—the famed Microwave Tower at Nutley, N. J.

A NEW DAY dawns for Capehart-Farnsworth Corporation and its organization of dealers and distributors, under the sponsorship of the International Telephone and Telegraph Corporation. Together, we will share in the development and production of "better television for more people."

Capehart and Farnsworth are pioneer names . . . names of world-wide distinction. This new association means that these great names . . . and all they stand for . . . will be backed by I T & T resources and strengthened by I T & T leadership.

Already known for its complete line of radio broadcasting equipment and important contributions in the television field—I T & T now joins forces with Capehart-Farnsworth Corporation in manufacturing and marketing home television receivers. I T & T's world-known research laboratories are now linked to the manufacturing facilities and merchandising organization of the new Capehart-Farnsworth Corporation.

For full details on the Capehart line of television, AM-FM radio and record changer combinations—present and soon to be forthcoming—write to Capehart-Farnsworth Corporation, Fort Wayne, Indiana. Ask about a Capehart franchise. A few choice territories are available.

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INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

67 Broad Street, New York 4, N.Y.

TELE-TIPS

2300-FT. TOWER will be dynamic Houston's business-section landmark, including offices, hotel, and AM, FM, and TV antennas thus topping Empire State Building by over 1000 ft. Texans have already built 560-ft. stone monument to Sam Houston overreaching Washington Monument by 5 ft. and are ready to tackle anything.

MULTI-VISION TV—In Dr. A. B. Du Mont's beautiful private laboratory in the middle of 60 acres of forest, on top of a New Jersey mountain overlooking New York City, there are many interesting experiments underway. But especially appealing, during our last visit, was a bank of seven large TV receivers each tuned to a different New York station, so that in a single teeming eye-full, one could follow all the current TV programs simultaneously, switching on the sound for any picture especially interesting at the moment! An hour in front of this six-ring circus strikingly revealed the varying techniques, levels and picture quality being delivered by each of the New York stations.

FOR A SUPER DE LUXE RECEIVER, (the above suggests) why not provide, just below the big main screen, a bank of six small "pilot" picture tubes on which all the other stations could be simultaneously and continuously glimpsed. Thus at will the rabid TV enthusiast could always see "what else" is on the air. Or if these marginal pilot pictures proved too diverting, they could be switched off and attention centered on the main screen.

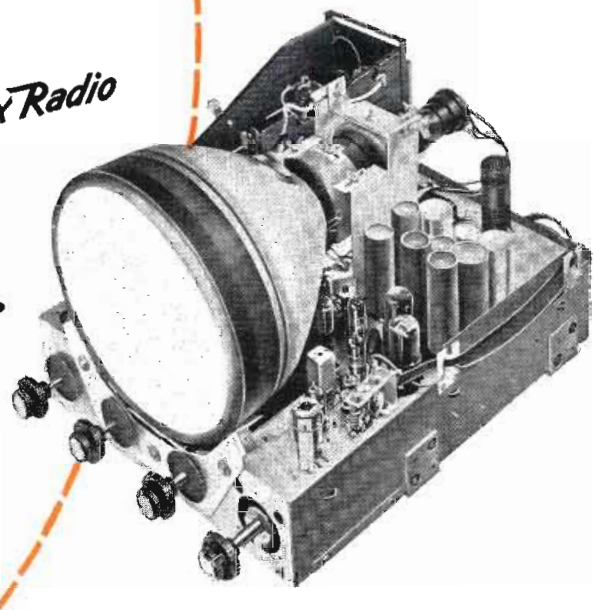
SIX-RING CIRCUS—For our own home viewing needs, we could settle for nothing less than a bank of seven full-sized screens stacked up at the end of our living room, so that each member of the family could (without internecine argument) independently watch the program he or she found most appealing at the moment, meanwhile noting out of the corners of his eye what's coming up on the other stations! Headphone switches at each chair would enable each viewer to turn on, in his own ear, the sound of the program he wanted to follow.

HI-Q COMPONENTS *Specified by*

The Leaders in Radio-TV & Communications

Emerson
FADA
Bendix Radio
Motorola
RAYTHEON BELMONT
Admiral
RCA VICTOR
Packard-Bell
Magnavox
Farnsworth
CROSLEY
Andrea
Tele-tone
DUMONT

—and many others too numerous to list in this limited space.



Chassis of the popular EMERSON Model 611 Television set. **HI-Q** components contribute their part to dependable operation.

Look at the leaders in Radio, Television and Communications, and you'll find *they* look to **HI-Q** for quality components.

HI-Q engineers have worked closely with many of these companies in the development of electronic components demanded by the ever changing circuits of modern electronics.

These same engineers with their wide experience are available to your company for confidential consultation. Write—wire—or phone. Three (3) plants exclusively devoted to the manufacture of ceramic capacitors, resistors and choke coils assure prompt delivery of your orders.

HI-Q COMPONENTS BETTER 4 WAYS

PRECISION Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.

UNIFORMITY Constancy of quality is maintained over entire production through continuous manufacturing controls.

DEPENDABILITY Interpret this factor in terms of your customers' satisfaction . . . Year after year of trouble-free performance. Our Hi-Q makes your product better.

MINIATURIZATION The smallest BIG VALUE components in the business make possible space saving factors which reduce your production costs . . . increase your profits.

HI-Q **Electrical Reactance Corp.**
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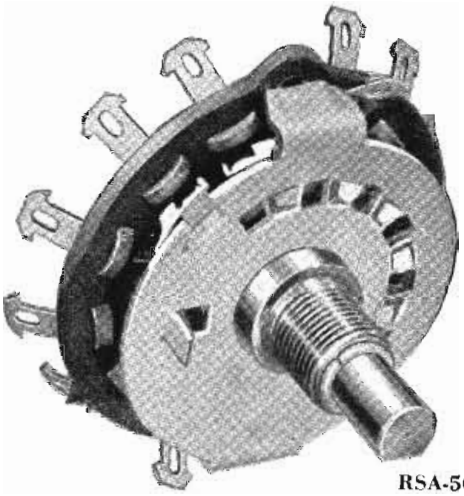
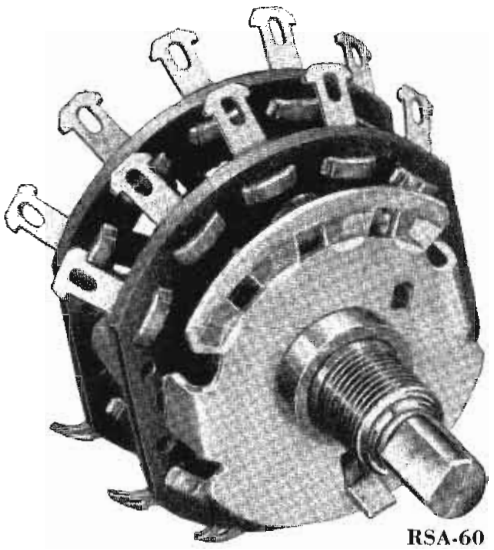
Plants: FRANKLINVILLE, N. Y.—JESSUP, PA.—MYRTLE BEACH, S. C.
Sales Offices: NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES

Two Single or Double Section Switches...



RSA-50



RSA-60

...of Space Saving Design and Mallory Precision Quality

Where space is a factor—dependability essential—the Mallory RSA-50 and RSA-60 switches fill the bill!

These circuit selector switches, with section and terminal design identical to that of the famous Mallory RS-50 and RS-60 switches, are designed for band and tone control switching in radio receivers and other electronic applications where medium and low torque indexing action is desired.

The index assembly is of durable design and constructed with a minimum of parts—affording dependable service life with low torque and positive indexing action.

Note these many features, inherent in all the Mallory RS series, which contribute to their dependability and quality:

- **Insulation of high-grade, low-loss laminated phenolic.**
- **Terminals and contacts of special Mallory spring alloy, heavily silver-plated to insure long life at low contact resistance.**
- **Terminals held securely by exclusive Mallory two-point fastening—heavy staples prevent loosening or twisting.**
- **Double wiping action on contacts with an inherent flexing feature—insures good electrical contact with the rotor shoes throughout rotation.**
- **Six rotor supports on the stator—insure accurate alignment.**
- **Brass rotor shoes, heavily silver-plated—insure low contact resistance.**
- **All shoes held flat and securely to phenolic rotor by rivets—prevents stubbing—insures smooth rotation—*minimum of noise in critical circuits.***

The RSA-50 and RSA-60 are both available in one or two section construction. The RSA-50 accommodates up to twelve terminals on either side of the section and provides from 2 to 6 positions. The RSA-60 accommodates up to ten terminals on either side of the section and provides from 2 to 5 positions. The RSA-60 has the narrow section design—ideal for under chassis mounting, where space saving is paramount.

ENGINEERING DATA SHEET

Send for the Mallory Engineering Data Sheet on the RSA-50 and RSA-60. It contains complete specifications for available circuit combinations with respective terminal locations, dimensional drawings—everything the engineer needs to adapt the RSA-50 or RSA-60 switch to a particular circuit.

SPECIFICATION SHEETS

Specification sheets for the RSA-50 and RSA-60 switches have also been prepared. These sheets are printed on thin paper to permit blueprinting. The sectional drawings indicate standard and optional dimensions—make it easy for you to order production samples built to your requirements.

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TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

COSTLY FUSSINESS—More of the petty practices that set up obstacles to efficient radio-electronic manufacturing for the Armed Forces, are coming to light. The matter of name-plates is especially exasperating, for each branch of the Forces has its own detailed requirements for nameplate data. Thus, identical radio apparatus going to Army, Navy and Air, has to have three widely differing nameplates! Settling on the details of these nameplates may take weeks of correspondence back and forth, delaying delivery long after the essential device itself has been completed. We ran across one instance where nameplates are still holding up delivery and payment, nearly a year after much-needed apparatus had been finished and ready for shipment. Meanwhile the manufacturer's investment dollars in material and labor are being needlessly tied up.

PACKING HEADACHES—The military people have their own ideas about the proper packing of radio-electronic apparatus, and once such a requirement gets into the specifications, the unlucky radio-electronic manufacturer may expect to have his money tied up in a long-term freeze until he can meet what may be absurd requirements or until the packing specs can be officially relaxed. This becomes especially irksome and delaying in the rapidly-changing radio-electronic field where through new designs, earlier requirements may be needless or impractical, as in the case of the requirement of sealed cans applied to bulky transformer equipment! Such packing and shipping absurdities can hold up deliveries for months, while defense projects wait and the patriotic electronic manufacturer is tearing his financial hair.

DEAFENING DIMESWORTH—With lightning flashes playing around our radio and TV towers this month and next, it is heartening to recall that only about 20 coulombs or four kilowatt-hours are involved in the average lightning stroke. (At our home rate of 2 to 3 cents per kw-hour, this makes the average flash worth about ten cents). Of course the potentials developed are prodigious—50 to 100 million volts. And the currents average 20,000 amperes, ranging from a couple of thousand up to 200,000 amp. It is the briefness of time that brings these huge electrical dimensions down to energy magnitudes of household size, for lightning is all over in five to ten millions of a second,—though some discharges continue as long as 40 microseconds—about four-fifths of a TV scanning line.

SURPLUS GRADUATES—The 1949 crop of college graduates is now out in the chilly world, and already it is evident there are not enough jobs to go round. Radio-electronic graduates will have to find berths in other fields. Next year this situation will be worse, for there will be over 70,000 electronic graduates with less than 30,000 positions available. And in 1951 there will be 20,000 graduates fighting it out for 10,000 appropriate jobs in the radio-communications field. Projecting such figures even further, we may face years when only one-quarter of the electronic graduates will find electronic jobs. The situation ahead is something which both the colleges and industry should face, with timely warnings to the youthful candidates as to the outlook ahead.

FISCAL=AUDIO CONFUSION!—We have always been intrigued with the possibilities of the CENT as it appears in the IRE standard definitions—a "cent" being 1/1200 octave. With it, frequency ranges of speakers and amplifiers can easily be evaluated! However, higher costs nowadays seem to have changed things everywhere and so hereafter we may have to transfer our thinking to the *BIT*. One *BIT* was recently defined by the IRE to equal 0.301 Hartleys, the latter being equal to the information content of one decimal decision. This may be somewhat harder to evaluate since there is so little real information available about many things, but all we can do is to try!

Coming Next Month

Supplement to August Issue

CHART OF FM AND AM COVERAGE OF U. S.

The complete picture of frequency-modulation listening throughout the United States, based on latest FCC, FMA and RMA data, brought up to date. Chart will show areas served for dependable and satisfactory listening on AM and on FM to 100-microvolt limits and to 15-microvolt limits. Contours reveal surprising usefulness of FM in areas remote from standard broadcast stations and subject to high-level natural static. Also complete data on growth of FM stations and FM audience, and summary of areas in which fine musical programs can be heard only on FM receivers

Trends & Technics in European

By JOHN H. BATTISON, *Member British Institution of Radio Engineers. Former engineer E. K. Cole Co., London, and British Air Ministry. R.A.F. Squadron Leader*

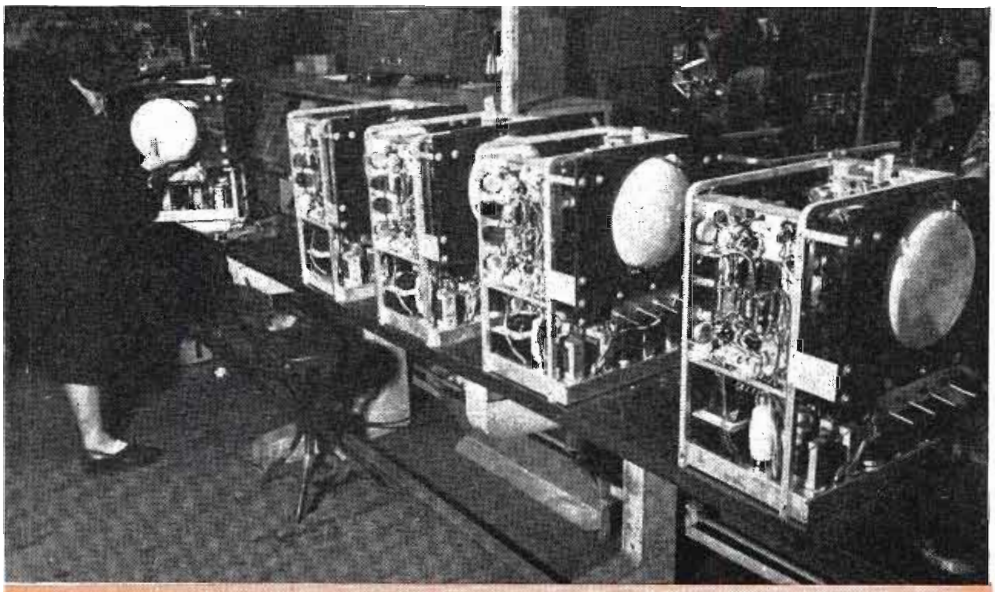


Fig. 1: Modern assembly line methods in production of EKCO television receivers, coupled with test and inspection checks at each vital stage, assure both quality and quantity

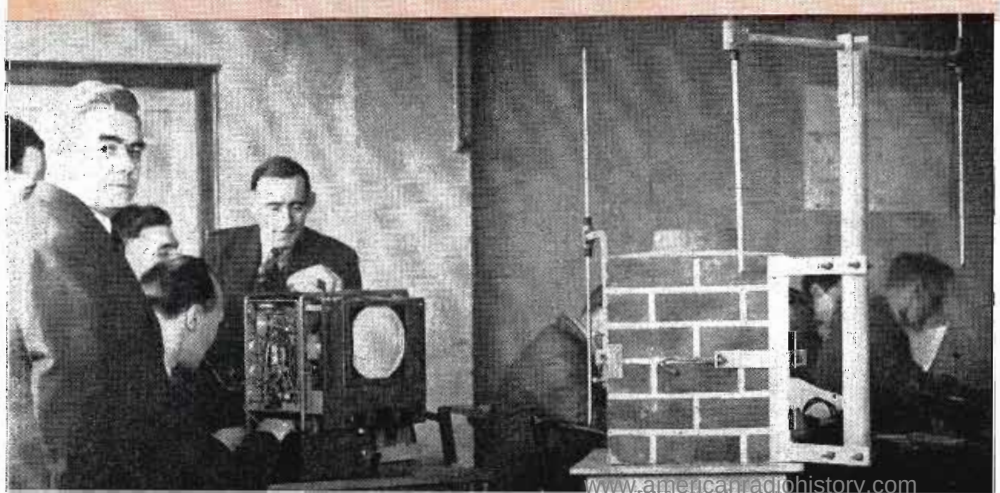
THE cessation of hostilities in Europe nearly four years ago did not bring the long-hoped-for millennium into the radio industry. Materials remained hard to get in most countries and industries. In many cases manpower, too, was scarce due to the desire of the military to hold on to what they had built into strong armies. Reconversion on the whole was not as rapid as had been expected and anticipated. But this semi-atrophy did not extend to men's minds, and the radio engineers continued to function, devising many new technics and utilizations in the radio field.

Without doubt the biggest thing in Europe today is television. France has just set up new standards of 819 lines and this standard will probably remain for many years to come unless some very new and revolutionary changes in transmitting systems are devised. One exclusive channel in the band 162 to 174 MC has been assigned together with three on a non-exclusive basis in the band 174 to 216 MC. It is claimed that operation on these frequencies with 819 lines will result in definition equal to that obtainable from 35mm film.

In England television is on everyone's tongue. The amount of program time per day would hardly seem enough to make the investment of several hundred dollars worthwhile. However, to judge by the way in which the lower priced sets have been selling it would seem that not many people share this view. The distribution of receivers is apparently a little different from that in the US, at least in New York City. In the latter place one finds as many TV antennas, if not more, in the lower income areas as in the well-to-do sections and generally disposed about the city without any apparent pattern. In London television antennas were somewhat noticeable by their absence in the poorer parts. In almost every observed instance the unfamiliar vertical dipoles and reflectors were in groups of two or three, giving the impression that one venturesome soul had bought a set, and then encouraged by his success his neighbors had done likewise. This is perhaps a slightly fanciful idea, but in all the areas of service around London it seemed to be the rule!

By courtesy of the BBC, I returned March 10, 1949, for a busy day at Alexander Park, the home of British Television. The equipment appeared to be much the same as it was before the war, with the exception of minor circuit changes. One point which was interesting was the economical use made of lines for blanking. Only 14 being used, compared with 7% (or 37 lines) in the US. This makes the definition from the 525 line system with a net value of 97 lines better than the 405 line system. Nine, ten and twelve inch cathode ray tubes are the most popular, with the twelves in great demand. Iconoscopes are still being used in the studio cameras, although two of the new field cameras use image orthicons and these are very well liked by both the engineers and the viewers. The use of iconoscopes renders

Fig. 2: Servicemen attending manufacturer's school at Southend, England. Dummy chimney, foreground, demonstrates proper method of mounting antenna. Note vertical polarization



Communications

Keenest interest displayed in television — FM, high frequency AM employed experimentally — US manufacturing methods sought

necessary a larger lens opening than is usual in the US. In fact an aperture of f3.5 is used, together with an optical view finder mechanically coupled to the lens to prevent parallax. Lighting technics vary considerably but all seem to result in the very effective style of lighting which usually characterizes British films.

The opportunity to watch television in the field did not present itself very often, but from the little that was seen one or two rather definite conclusions were drawn. The contrast ratio between black and white is much less than in the US system, due mainly to the different type of camera tube, and also to the color of the phosphor used in the cathode ray tubes. It also appeared that the tubes ran with lower final anode voltage. Turning up the contrast and brilliance controls did not make much of an improvement. The advantages of FM over AM were amply demonstrated when viewing at Southend, about 25 to 30 miles from the transmitter. Every car which passed drowned the sound and caused severe white noise on the screen (positive transmission).

FM in Experimental Stage

Frequency Modulation and High Frequency AM (HIFAM) are still very much in the experimental stage as far as broadcast service is concerned. Daily transmissions of both methods of modulation are made on a frequency around 90 MC. A high powered station is planned for Wroughtam in Kent, but whether it will employ FM or AM does not appear to be determined yet. Apparently there is a fairly strong effort afoot among the manufacturers in favor of AM, the theory being that the only advantage of FM over AM is the freedom from static and discrimination between interference signals. The [atmospheric] static level in England is quite low and this plus the argument that the use of FM would entail a lot of design work before new sets could be put on the market are the major reasons for the lack of interest.

UHF and VHF are not in the general thinking range of the average engineer for general broadcast use. Television may eventually necessitate consideration of these frequencies, but since the BBC is going ahead with plans for a total of six television stations to cover the whole of Great Britain, operating in the present band, it does not appear likely that there will be much

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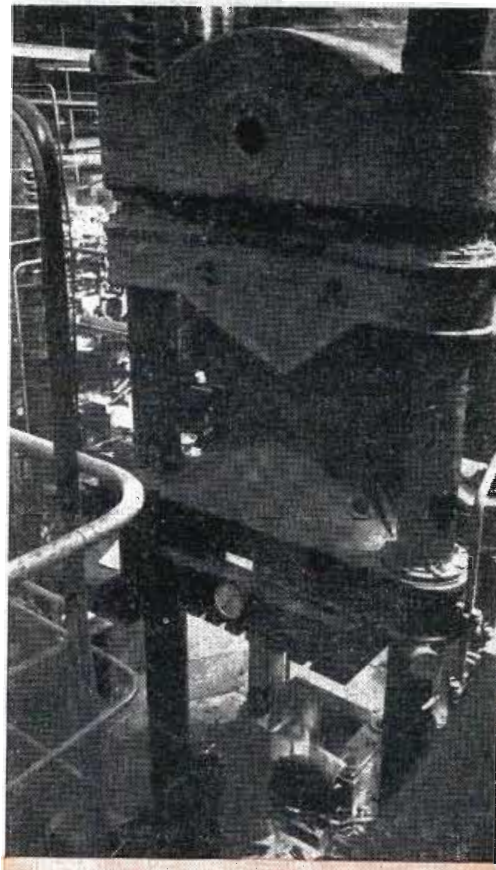


Fig. 3: Giant molding press in operation in the plastics division of E. K. Cole Co. Ltd.

Fig. 4: Close-up of molded plastic cabinet press in operation. First injection (thermoplastic) type cabinets in England were used to house one lightweight portable receiver

A New Telecine Channel

"Shutterless" projector, operating in conjunction with modified image dissector, "lap-dissolves" each film frame; requires no synchronization

By FRANZ EHRENHAFT, Consulting Engineer, 110 East 42nd Street, New York 11, N. Y.
and MADISON CAWEIN, Consulting Engineer, 3010½ South Calhoun Street, Fort Wayne 6, Ind.

IN translating the intelligence contained in standard motion pictures into television signals, the outstanding difficulty encountered is that motion pictures are exhibited at 24 frames per second while the television scanning rate is 30 frames (60 fields) per second. For television application two fundamentally different types of motion picture projection methods are employed: the intermittent motion type and the continuous type.

There are also two fundamentally different types of television pick-up tubes; the storage type (iconoscope, orthicon) and the non-storage type image dissector, phototube). With a storage type pick-up tube, an intermittent projector can be used for film scanning if its shutter is synchronized with the television system provided its mechanism is adapted for a two-three-rate pull-down, or, provided other means are available for converting the motion picture frame rate to the television-scanning rate.

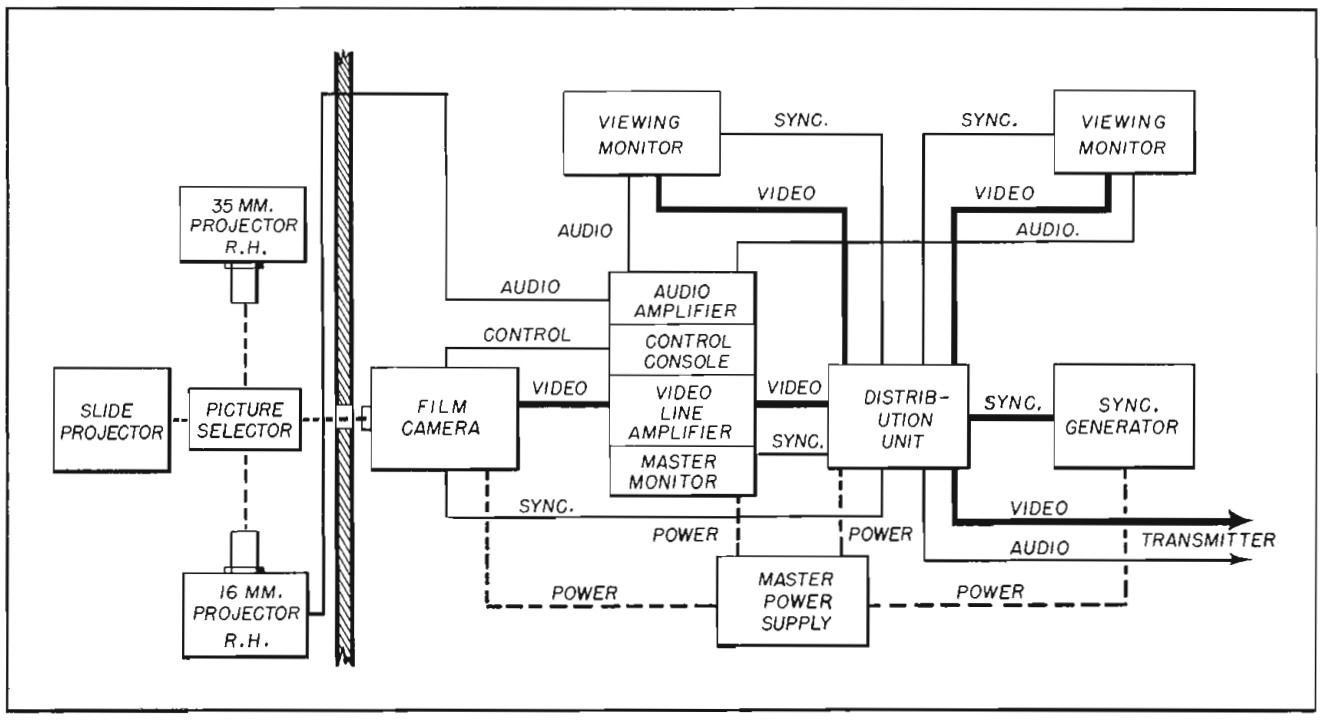
Frame Synchronization Unnecessary

Of the many different types of continuous projectors one type is particularly suitable as a television film scanner. In a projector where compensation for film motion is accomplished by a polygonal refraction prism, no shutter is used and this feature makes frame synchronization with the television system unnecessary. In the interlocked scanning systems for network television, where high-inertial frequency control of the synchronizing generators is used, it is necessary that the projector motor in the film studio is synchronously driven from the local 60-cycle-power source. When the prism projector is used this disadvantage does not exist.

The great advantage of the continuous projector lies in the fact that the 24 to 30 frame-ratio is no longer of any importance. When a projector of the prism-type is used, the image projected is continuous and the changes from one frame to the next are by means of a lap dissolve.

Two outstanding features—the independence from synchronization with the television system, and the independence of the film frame-scanning frame ratio—contribute to the flexibility of the continuous projector system and make it desirable

Fig. 1: Telecine Channel diagram shows equipment layout using 16mm, 35mm continuous-motion projectors and a slide projector



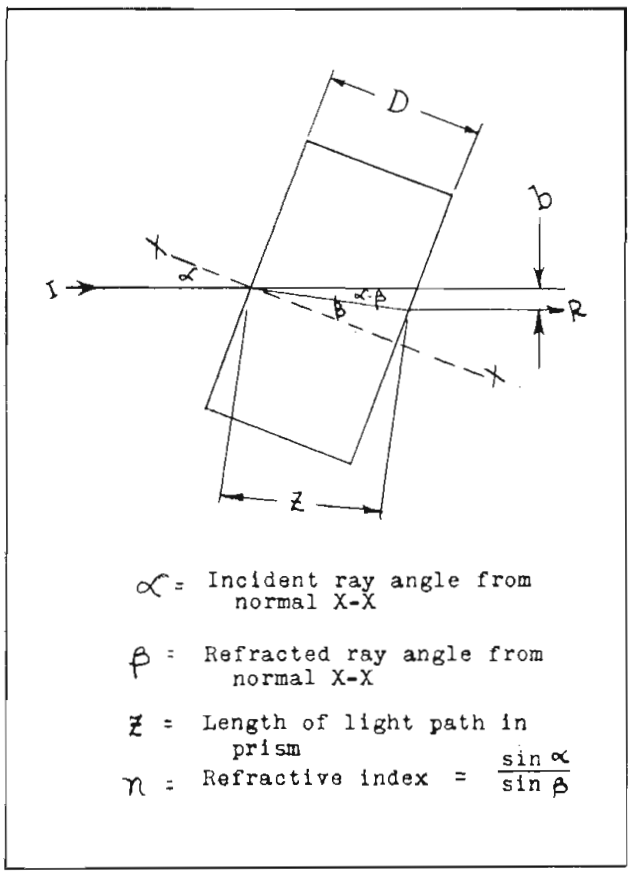


Fig. 2: Diagram showing displacement of light ray (I-incident, R-refracted) on entering parallel plane tilted glass plate

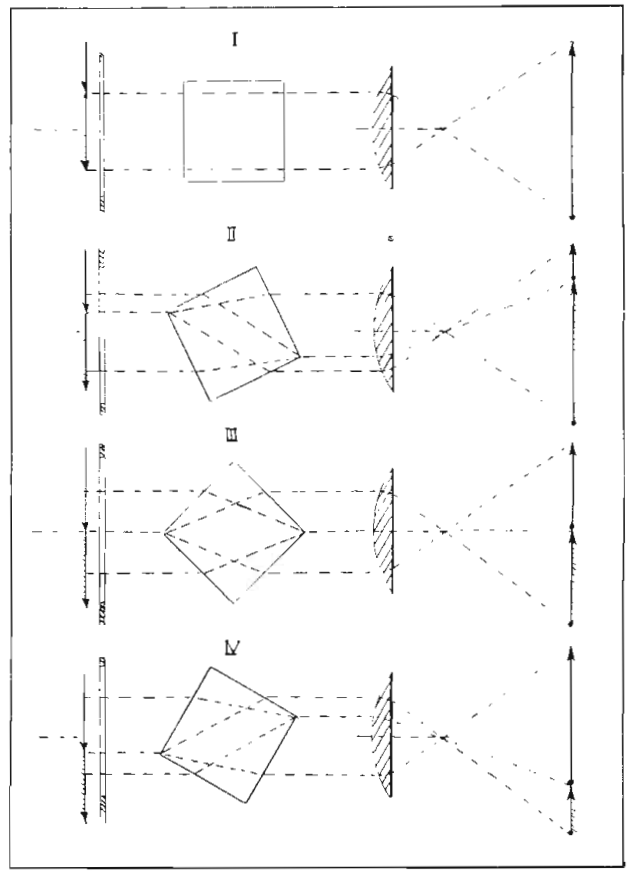


Fig. 3: Film Travel is compensated for by setting displacement equal to distance from one film frame line to the next

for use with any type of television pick-up tube. The application of a continuous projector with the non-storage type of photo-tube is, however, essential.

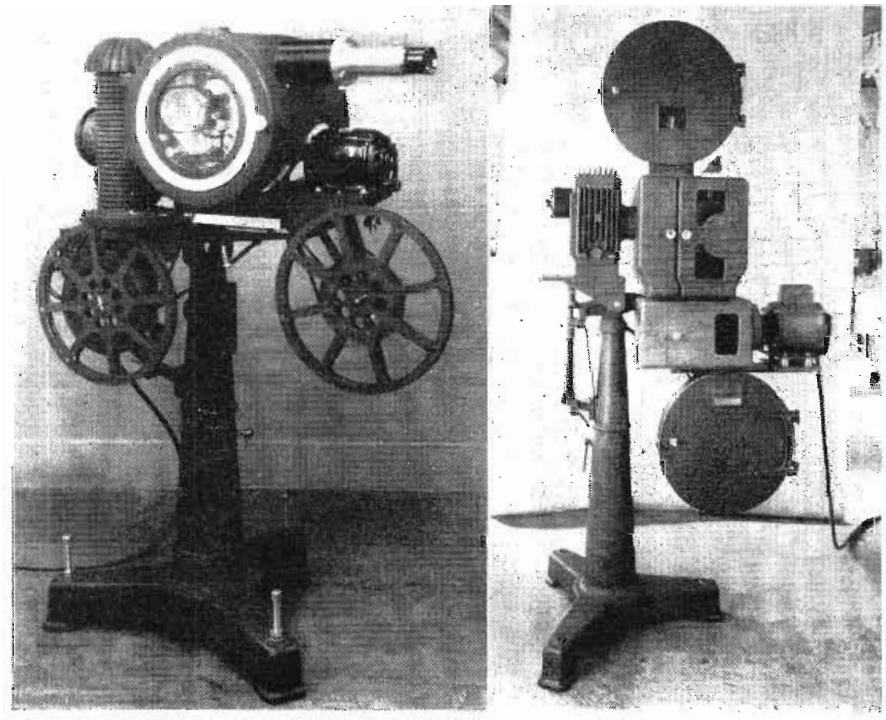
The development of picture scanning in connection with the flying-spot method shows considerable promise and is considered superior to the storage-tube intermittent-projector scanning method in many ways. The desirable advantages of this continuous motion system are freedom from shading, excellent contrast range, high picture-resolution and better linearity. The flying-spot source however introduces difficulties and distortions due to the decay period of the fluorescent spot. These difficulties have not been completely solved for use with film. An intermittent projector is ruled out with the non-storage type of photo-tube, since no pull-down time is available. The prism projector could be adapted for use with the flying spot system if the distortion-trailers, due to the phosphor decay-time and the continuous movement of the film, could be eliminated.

All of the advantages and none of the limitations of the flying-spot system are available in a combination of the dissector tube and the prism projector.

A block diagram of the Telecine Channel is shown in Fig. 1. In this arrangement both a 35 and a 16 mm continuous-motion projector (see Fig. 4) and a slide projector

(*Please turn to next page*)

Fig. 4: (Left) 16mm and (right) 35mm telecine shutterless projector equipments



are located in the projection room. A picture selector, having a suitable mirror arrangement, can be used to bring the picture from any of the three projectors into the film camera, which is placed in a separate room. Both rooms are connected by a glass window through which the image is projected.

The film camera employs a Farnsworth image dissector as pick-up tube, because of the superior qualities it possesses for film pick-up application. The film camera-channel employed is the result of developmental work at the Farnsworth Television and Radio Corporation during the past few years. The dissector tube itself is a modification of the original image dissector and employs a number of rings to minimize the distortion which is inherent in all extended-image devices, where an axial magnetic field is used to focus the electrons from the photo-cathode.[1]

Linear Geometrical Picture

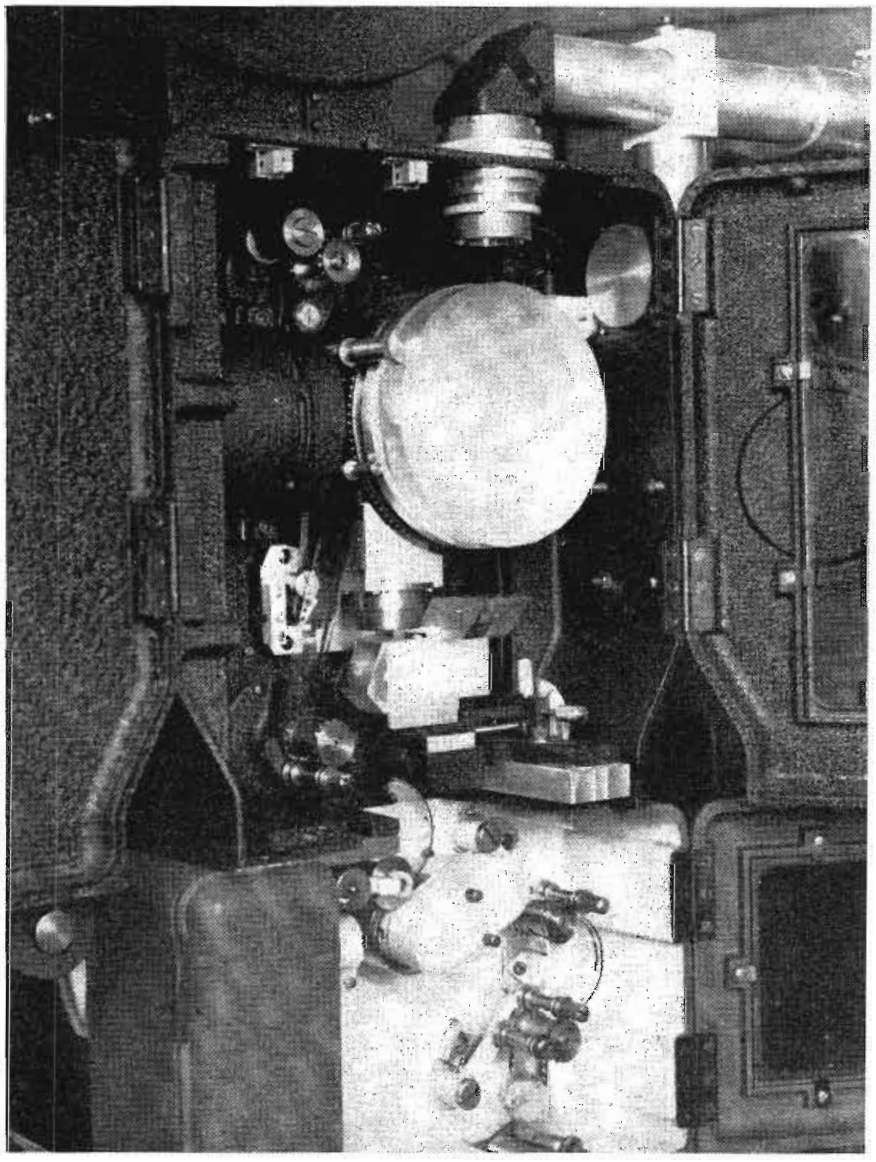
A combination of equi-potentials and specially arranged magnetic fields results in the attainment of a quite linear geometrical picture which is superior to those obtained generally in the industry today. The feature of instantaneous electron signal-current from the dissector results in sharp resolution and exact contrast variations, with complete freedom from electronic shading troubles. Sensitivity is somewhat less than that of storage-type tubes, however, and can be overcome by increasing the intensity of light from the projector, as by use of an arc.

Optical focus of the projectors can be set normally or by remote control. Electronic focus of the camera is set by remote control from the master monitor. Aspect ratio and linearity may be controlled also from the master monitor. The video output level of the camera is one volt peak-to-peak, on a low impedance, concentric line. Blanking and DC level are added to the video signal by circuits in the camera. A synchronizing signal level of one volt peak-to-peak is required by the camera.

The audio pick-up from the film is conventional. Both audio and video signals are supplied from line amplifiers to various viewing monitors as required in the studio. These signals can be made available at any reasonable level on low-impedance coaxial lines for modulating the transmitter. The video level is usually supplied at two volts peak-to-peak, and may be composite or without sync, as desired. Sync signals may be derived either from a local generator or from a master generator in the network, as desired, since there is no need for synchronizing the projectors.

Definition quality is 250 lines of television resolution for 16 mm pictures, and 400 lines for 35 mm. This quality can be improved by using an aperture smaller than the .015 in. which is standard in the Telecine dissector, or by aperture compensation. In the case of reduction of aperture size to improve resolution quality, it becomes necessary to increase the light falling on the dissector cathode by a proportional amount (proportional to area of apertures) in order to maintain a suitable signal-to-noise ratio. Contrast quality is superior to that achieved in storage-tube systems, and Gamma control may be provided if desired.

Fig. 5: Close-up view showing interior of film compartment in a 35 mm projector



Rotating Refraction Prism

The continuous projector[2], where the compensation for the film motion is effected by means of a rotating polygonal refraction prism, is based on the optical principle that a light ray penetrating a tilted plane parallel glass plate is displaced in a certain manner. The displacement is dependent upon the refraction in-

dex of the glass, the angle of incidence of the light ray, and the thickness of the glass plate. This is shown in Fig. 2.

In mathematical form the relationship between the different factors is represented as follows:

$$b = \overline{z} \sin(\alpha - \beta)$$

$$D = \overline{z} \cos\beta$$

$$b = \frac{D\sin(\alpha-\beta)}{\cos\beta} = D(\sin\alpha - \cos\alpha\tan\beta)$$

$$b = D\sin\alpha\left(1 - \frac{\cos\alpha}{\sqrt{n^2 - \sin^2\alpha}}\right)$$

which gives b as a function of D, α, and n. The rate of change of b with respect to α is given by:

$$\frac{db}{d\alpha} = D\left[\cos\alpha - \frac{\cos 2\alpha}{(n^2-\sin^2\alpha)^{\frac{1}{2}}} - \frac{\cos^2\alpha\sin^2\alpha}{(n^2-\sin^2\alpha)^{3/2}}\right]$$

As $\alpha \to 0$ (or for very small α)

$$\frac{db}{d\alpha} \approx \lim_{\alpha\to 0}\left[\cos\alpha - \frac{\cos 2\alpha}{(n^2-\sin^2\alpha)^{1/2}} - \frac{\cos^2\alpha\sin^2\alpha}{(n^2-\sin^2\alpha)^{3/2}}\right] =$$

$$\frac{db}{d\alpha} = D\left(1 - \frac{1}{n}\right)$$

Let 1/n=A and note that D and A are constants then:

$$\frac{db}{d\alpha} = D - DA = K$$

and $db = K\alpha$ so that db is a linear function of $d\alpha$ and the rate of change of b varies directly with the rate of change of α as long as α is comparatively small.

Accordingly, the light rays have to be limited to these small angles to prevent noticeable optical distortions. This makes the use of a great number of pairs of plane parallel faces necessary and prescribes the use of long focal projection optics and condensers. Practically, the problem was successfully solved for 16 mm and 35 mm films by the use of 24 sided glass prisms.

The film travel is compensated for by setting the displacement equal to the distance from one film frame line to the next. Fig. 3 shows how this compensation is accomplished by the use of a polygonal prism.

It can be seen that the projected image on the screen conforms to one full frame in one position only and that this position occurs when the prism has two parallel faces perpendicular to the optical axis. In any other position the projected image is composed of portions of two consecutive frames, continuously changing in ratio during the rotation of the prism. The frame to frame change is effectively a lap-dissolve and consequently makes the use of a shutter unnecessary.

Changes in film length by shrinkage are of great importance and must be taken into consideration. Because the distance between frame lines is reduced by shrinkage, the calculated size of the prism does not conform with actual sizes encountered from film to film. A lens system of small power, adjustable in its position between the film and the prism, is used to compensate for these differences. The adjusting device is calibrated and numbers are coordinated to a scale on a built-in shrinkage gage.

The uniformity of motion of the film and its synchronization with prism rotation is of utmost importance. Any amount of change in the relation between prism position and the film will make the image move vertically on the screen. For this reason no gear connection is used between the rotating prism and the film transporting sprocket.

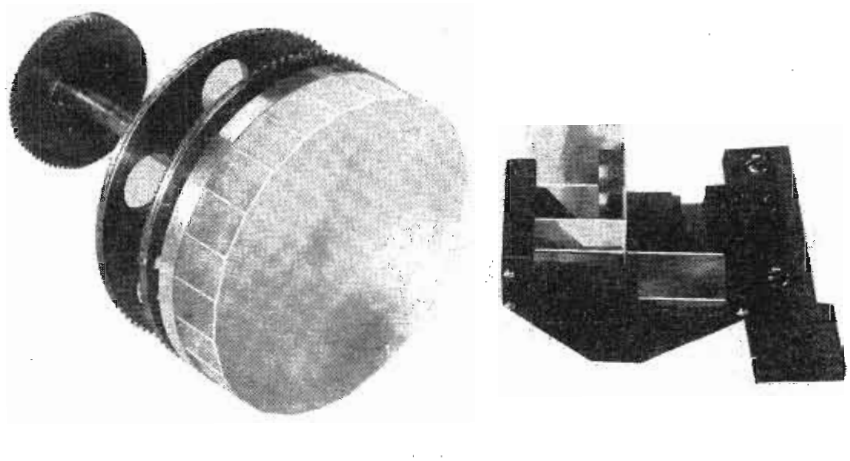


Fig. 6: (Left) 24 sided glass prism and film perforation engaging sprocket are mounted on a common shaft (Right) Photo showing the type of porro prisms used in this equipment

Porro Prisms

The prism and the sprocket engaging the film perforation are mounted on a common shaft, as shown in Fig. 6. Reflection of the light rays from one plane to a parallel one was satisfactorily solved by use of porro prisms. The type of porro prism used is also illustrated.

The use of a film gate very close to the engaging sprocket tooth did not completely eliminate relative motion between the film and the prism even though the sprocket and prism were coaxially mounted. In the model[3] illustrated in Figs. 5, 6, the sprocket itself is used as a film gate, with material improvement in steadiness. An incandescent lamp is used as a light source in this model but in order not to risk burn-outs during a television performance, the use of an arc-lamp is recommended.

Because of the fact that the projected image is composed of portions of two consecutive frames, and because the prism has to follow the moving film over an extended travel, the film aperture has to be elongated to allow for the illumination of approximately two frames. This larger opening of the film gate permits the projection lens to throw more than one image onto the screen. The undesirable additional image portions would cause internal reflections in the pick-up tube, and should be prevented. To accomplish the elimination of these undesirable images, a real image is produced by a special projection system, and this real image is then masked and projected by a second projection objective onto the pick-up tube.

The sound reproduction from film in television needs special care, particularly if 16 mm film is used. Standard methods of reproduction are not adequate because flutter must be kept to a minimum, and this can only be accomplished by arrangements similar to those used in rerecording equipment. Such a design is utilized in the Telecine projector with the result that the quality of sound reproduction is limited only by the film recording.

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[1] This development was an outgrowth of electron-optical research at the Bell Telephone Laboratories by Dr. Oliver.

[2] The prism projector was suggested for Television Scanning by John A. Maurer, 3707 31st St., Long Island City, N. Y., in 1939.

[3] This projectar was manufactured by Akeley Camera and Instrument Corp., 175 Varick St., New York, N. Y.

Broadbanding Ring-Type

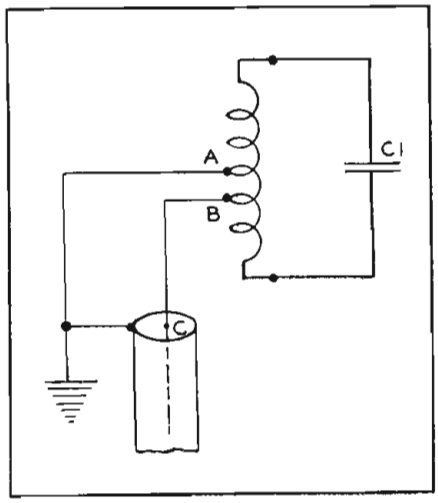
Addition of series resonant circuit in coaxial feed-line to counteract off-frequency antenna reactances increases response from 0.5 to as much as 8 MC

By B. E. PARKER, Chief Engineer, FM Dept., Gates Radio Co., Quincy, Ill.

BECAUSE of their relatively light weight and low wind resistance, ring or circular type antennas have enjoyed widespread popularity in FM broadcasting. Their use is frequently an economical advantage since often an existing AM tower can be used as the supporting structure. Further, the radiation pattern is basically omnidirectional.

While this type antenna exhibits many marked advantages, it does have one serious disadvantage in the narrow bandwidth that it affords. A single ring has a bandwidth on the order of 0.5 MC as measured between the two frequency points at which the VSWR (voltage standing wave ratio) exceeds 1:1.5. It would appear that with the antenna properly adjusted to operate at the center frequency this bandwidth would be considerably in excess of the requirements for FM Broadcasting use. Experience has shown, however, that because of factors external to the antenna this is not necessarily true. For economic reasons it has become the practice of industry to resonate the antenna to the center operating frequency by means of variable circular capacitor plates located at the open high impedance ends of the ring. The capacitor plates, of course, can be pre-tuned and set at the factory to a given operating frequency. Since the spacing of the capacitor tuning plates is critical to within 1/16-in., handling in shipping, reassembling, and mounting can easily disturb the tuning. The ring resonant frequency can also be disturbed by the structure on which the antenna is mounted through mutual inductances and capacitance. Rain collecting on the tuning capacitor plates serves to detune the ring due to effective change in spacing and/or change in dielectric constant, and ice and sleet are even more detrimental.

Fig. 1: Simplified diagram of shunt-fed antenna which exhibits an anti-resonant characteristic at its resonant frequency



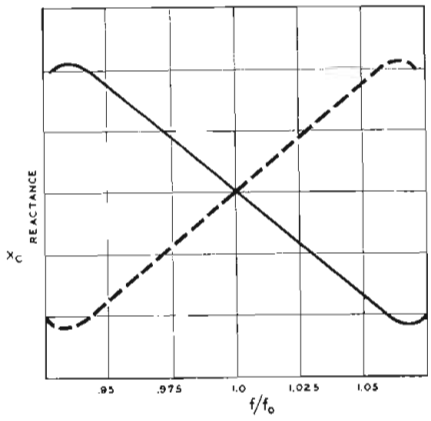


Fig. 2: Frequency-reactance characteristics of a series resonant circuit (dotted line) and a half-wave dipole antenna (solid line)

Detuning, for any of the reasons listed above, results in standing waves on the transmission line, and the attendant evils of SWR ratios are well known now in the FM broadcasting industry. While the use of de-icers and heaters to reduce detrimental climatic effects is helpful, it has not proved to be a complete solution to the problem, and operational experience with FM stations employing heavier broadband antennas indicated conclusively that bandwidth should be materially increased.

Developmental work was directed at obtaining a small light weight unit in order to meet the needs of the many low powered FM stations, and also, because of the new 10 watt campus FM stations, an inexpensive and uncomplicated design was dictated. The antenna in Fig. 5 is the final development and proves to have the simple mechanical properties of the ring antennas and the electrical characteristics of the heavier broadband type FM antennas.

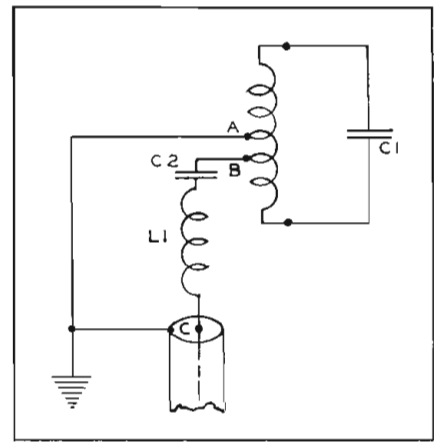


Fig. 3: Small ceramic capacitor and inductive length of feed-wire (C_2, L_1) comprise series resonant circuit connected to antenna

Method of Increasing Bandwidth

While the feedpoint resistance of a halfwave antenna does increase materially as the frequency is increased, the bandwidth (between the 1: 1.5 VSWR points) is largely

FM Antennas

dependant on the reactive component of the impedance. By eliminating or counter-acting this reactance it is possible to effect a large increase in bandwidth. This was the procedure followed in the design of the FM-11 antenna and its increase in bandwidth is approximately 12 times that of an uncompensated halfwave dipole.

A shunt fed antenna exhibits the properties of an anti-resonant circuit at the resonant frequency and may be represented in a simplified form as shown in Fig. 1. Point A is the midpoint of the dipole and point B represents a 1.5 ohm tap with respect to point A. As the frequency is varied around the resonant frequency of the dipole or ring, reactance will be present at point B as illustrated in Fig. 2. This is essentially the same as the familiar parallel resonant circuit reactance curve.

Since a series resonant circuit exhibits a reactance curve (Fig. 2—dotted) of opposite nature, this characteristic may be used advantageously in counteracting the reactance presented by the anti-resonance of the dipole or ring antenna.

At VHF the inductance present in even a short length of wire may become appreciable. This inductance, present in the length of feed wire between the 51.5 ohm point on the antenna and the coax con-

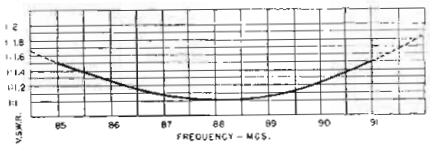


Fig. 4: Standing wave ratio curve at 88 MC

nection, is series resonated by means of a small ceramic capacitor. Represented in simplified form, the added series resonant circuit appears between points B and C in Fig. 3.

As the frequency is increased the capacitive reactance at point B will be counteracted by an opposite inductive reactance presented by the series resonant circuit. Consequently, at the termination point of the coax (point C) the load will still appear resistive as the reactance of the anti-resonant circuit and the eries resonant circuit tends to cancel.

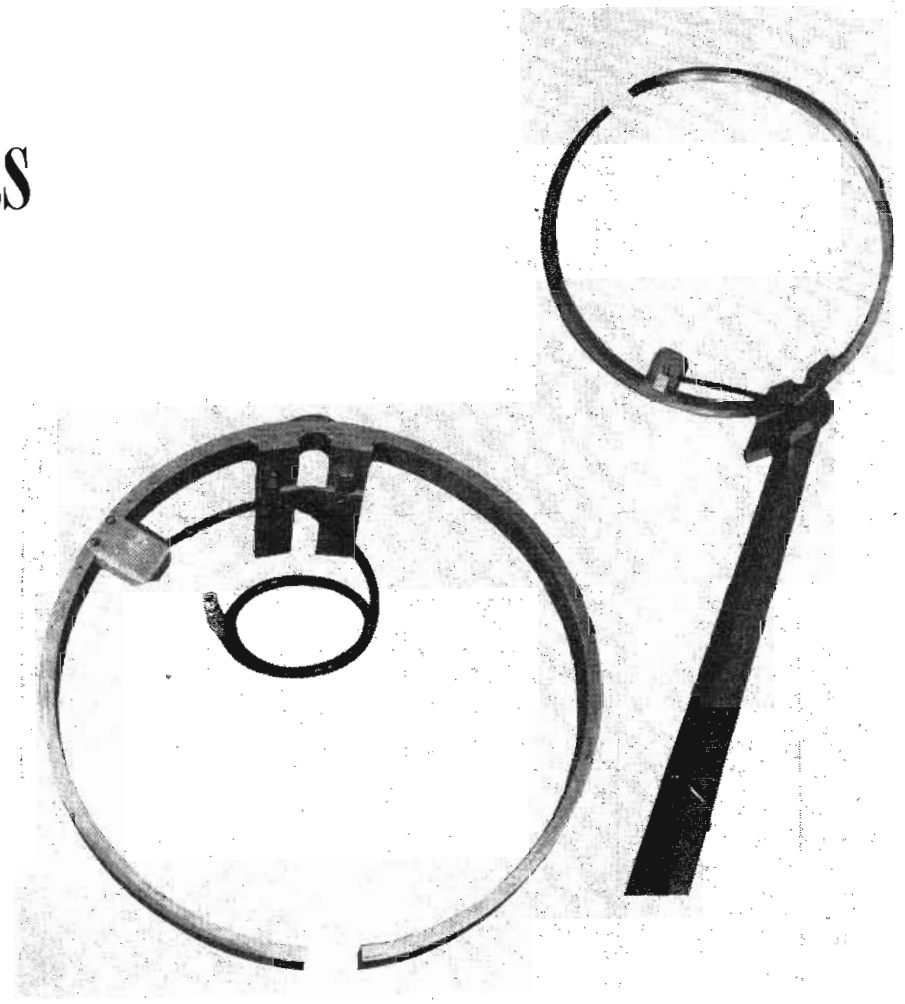


Fig. 5: Photographs show physical appearance of FM-11 ring type antenna. Besides its broad-band response, antenna features simplicity, light weight, freedom from adjustment

Results Obtained in Practice

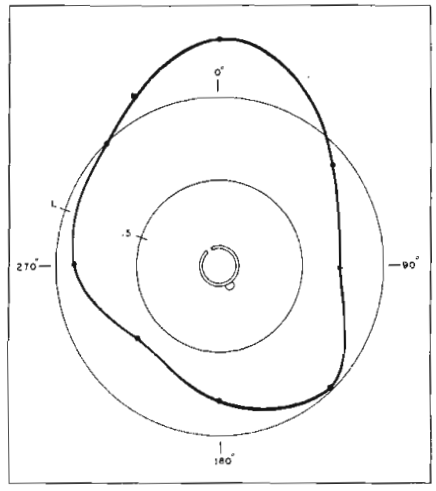
In applying the above principles it was found that a simple ring has a bandwidth of 0.5 MC could be increased to between 6 and 8 MC. Fig. 4 shows the measured bandwidth of a typical production antenna centered at 88 MC.

Due to the wide bandwidth, tuning or adjustment is not required at either the factory or upon installation in the field! For the same reason de-icing equipment is unnecessary. The lightning hazard is reduced because the antenna can be effectively grounded through the mounting clamp.

The measured radiated pattern is essentially omnidirectional as illustrated in Fig. 6. In most installations the additional gain provided by the bulge in the pattern may be used advantageously to provide a higher signal strength over a high noise "downtown" area. This is especially of value to low power FM stations.

Gain, as for all types of antennas, is dependent on the number of bays for a given height in spacing. A single ring has a power gain of 0.8. The impedance at the feed point was chosen as 51.5 ohms to match the impedance of coaxial cable types most often used at these frequencies. The same principles as discussed above can be applied to TV antennas since wide bandwidth is essential for these services also. In fact, one model tested at 96 MC showed a bandwidth in excess of 8 MC.

Fig. 6: Radiation pattern of FM-11 antenna



Television Photometry

A method for obtaining direct and precise light measurements for television studios

Television Studio LIGHTING — *Second of a Series*

IN the study of television lighting problems and the special effect of background projection, it has been necessary to re-examine thoroughly the basic concepts upon which the science of light measurement is based. Photometry involves a specialized set of quantities defining that portion of the electromagnetic spectrum which is visible to the human eye. It must therefore be remembered that the classical basis of photometry is the subjective effect of a radiation lying roughly in the 400 to 720 millimicron band on the eye. It is this latter statement which has led to such a divided opinion as to precisely what a given measurement indicates. To date, no practical or satisfactory means has been developed to measure the purely subjective case of sensation. The stimulus, however, may be directly and accurately evaluated and through experience, comparison, and statistical analysis be translated into a usable prediction of sensation.

For a given light stimulus, the response of the eye will vary with the viewer and will be practically undefinable. An image orthicon camera chain, on the other hand, can produce a measurable and invariable response with a fixed source of light. In addition, the spectral sensitivity of the television system will not be the same as that of the eye. These are well known facts, yet the measurement of studio lighting has been made with instruments not compensated for the system on hand. The use of the human eye as an intermediate comparitor interposes an arbitrary and perhaps inaccurate standard of reference. Although the eye cannot act in any sense as a light measuring device, it can, when properly trained, be a fair judge in comparing luminosities. Thus, an illuminometer of the Macbeth type may

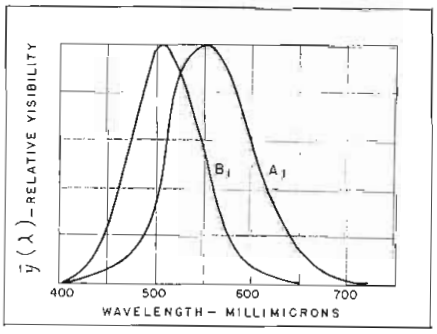


Fig. 1: Curves illustrating the average visual response at ordinary field luminance (A_1) and at the visual threshold (B_1)

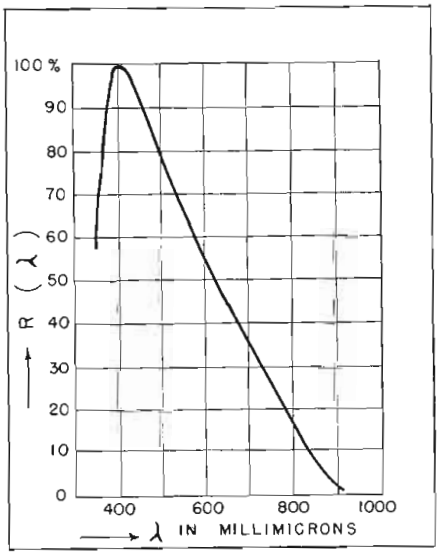


Fig. 2: Typical spectral response curve of the 2P23 type Image Orthicon tube

be used in determining the luminosity of a light source or the illuminance of an irradiated surface. There are two serious drawbacks, however, being:

1. Should the spectral composition of the light being compared differ from the reference, the possible measurement error may become prohibitive.

2. The eye cannot judge that part of the spectrum which lies without the visible region, but which may be contained within an image orthicon's spectral response curve.

Insofar as the first point is concerned, filters may be of help but generally serve to further complicate the measurement procedure. Obviously, it is advantageous to make a direct physical measurement based on the spectral response curve of the desired reference, in this case an image orthicon.

Factors Affecting Quality

If now the image created by a film projected on a translucent screen is added to the lighting consideration, it becomes increasingly important to evaluate the overall situation objectively with regard to the two important transducers in the system, film and camera chain. Before proceeding further, it will be useful to review some of the more important factors which may affect the quality of the background projection. Briefly, these are:

(a) Highlight luminance of the screen
(b) Range of luminance of the screen.
(c) Gradation of luminance, or gamma, of the screen
(d) Ambient illuminance
(e) Directivity of the translucent screen
(f) Flicker and synchronization when dealing with moving pictures.

Note the use of the word luminance instead of brightness to avoid confusion between the objective measurable concept and the subjective sensation in the human observer. Brightness will be applied only to the latter meaning. For a valid prediction of how the first four points mentioned above will affect an image orthicon, it is first necessary to develop a theoretical foun-

and Optical Background

By ***RUDOLPH L. KUEHN,*** *Development Engineer, National Broadcasting Co., Inc., RCA Building, New York City*

dation, and then devise a simple and rugged means of making measurements under operating conditions. It is possible to use the same analysis which has been applied to photometry and radiometry to establish a method of videophotometry. Instead of the standard luminosity or visibility curve as a reference, a new basis utilizing the spectral response curve of the pick-up system is used. In a studio application of perhaps three or four cameras on one program, all the pick-ups would necessarily be required to have similar spectral sensitivity characteristics for any common denominator of measurement.

Consider now a typical spectral curve of the 2P23 image orthicon. If the response is considered as unity or 100% at the peak of a curve, the ordinates of which are a function of wavelength, and if all other responses are evaluated with reference to this peak, then the result may be seen in Fig. 2. Thus, for equal values of luminous flux, a relative distribution is obtained with greatest response at approximately 420 millimicrons. This function is very similar to the visibility or standard luminosity function y (λ) except for its position and width on the lateral axis, and can therefore be used as a basis of measurement. Using now the concepts of radiation, from the nature of the above curve it can be said that $R_i = (H_o/H_i)R_o$ where R_i is the response at a wavelength λ_i; R_o = response at 420 millimicrons (unity or 100%); H_o = irradiance in watts/cm² at $\lambda = 420$ millimicrons; H_i = irradiance in watts/cm² at $\lambda = \lambda_i$. It is now necessary to assume a standard which would specify the luminous flux equivalent to one watt of monochromatic radiant flux of $\lambda = 420$ millimicrons. Call this φ lumens. For a line spectrum the illuminance is:

$$E = \varphi \sum_1^n R_i H_i \quad \text{lumens/cm}^2$$

being the summation of the illuminance of n lines at wavelength i. To obtain the result for a continuous spectrum it is only necessary to assume the differential element and integrate between limits of wavelength:

$$E = \varphi \int_{\lambda_1}^{\lambda_2} R(\lambda)\, H(\lambda)\, d\lambda \quad \text{lumen/cm}^2$$

The function E is one of the important measurable quantities in a photometric science. It may be applied to the illumination or illuminance of a surface as the amount of luminous flux falling on the surface per unit area (lumens/cm²). It may also be used as a measure of the luminous emittance or luminosity (L) of a source as luminous flux emitted per unit area (lumens/cm²). A translucent screen may be viewed as a luminous source bearing in mind however its special properties of directivity, absorption and reflection.

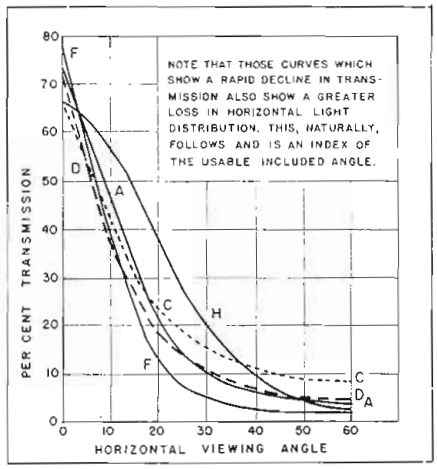


Fig. 3: Transmission % vs. horizontal viewing angle for various translucent screens

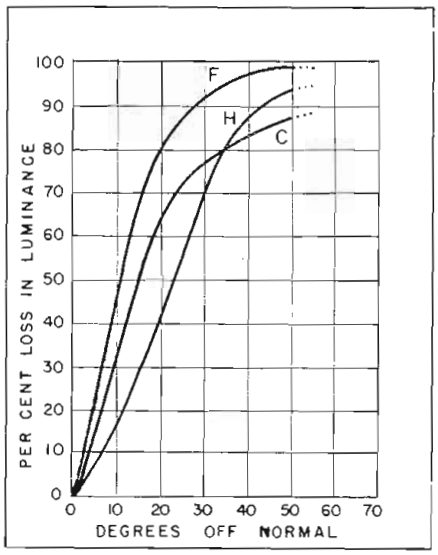


Fig. 4: Curves showing the horizontal light distribution of sample translucent screens

If the irradiation of a surface area S is uniform, the total radiant flux falling on it is P = SH watts and the corresponding quantity in luminous flux based on the characteristic R(λ) is:

$$F = SE = S\varphi \int_{\lambda_1}^{\lambda_2} R(\lambda)\, H(\lambda)\, d\lambda \quad \text{lumens}$$

$$\text{or} \quad F = \varphi \int_{\lambda_1}^{\lambda_2} P(\lambda)\, R(\lambda)\, d\lambda \quad \text{lumens}$$

Obviously, it is possible to measure the radiometric quantity and evaluate it with respect to the proper spectral response characteristic to obtain the corresponding photometric value. The ratio of any photometric quantity to the corresponding radiometric quantity is given by:

$$K = \varphi \frac{\int_{\lambda_1}^{\lambda_2} P(\lambda)\, R(\lambda)\, d\lambda}{\int_{\lambda_1}^{\lambda_2} P(\lambda)\, d\lambda} \quad \text{lumens/watt}$$

The latter is called the absolute luminosity, or luminous efficiency of the radiant energy. Strictly speaking it is not an efficiency but an expression of the relative effectiveness of a given radiant power in yielding luminous flux.

A simple approach exists to one other useful concept of photometry. If a luminous source is placed at a distance D from a surface normal to the flux emanating from the source and measurements of E are taken at the surface with varying D, a curve will be obtained. It will be found that as D increases, the product ED^2 approaches a constant. Thus, the limiting value of ED^2 is used to define the strength of the source and is called the luminous intensity or candle power:

$$I = \lim_{D \to \infty} (ED^2) \text{ candles}$$

providing E is in lumens per unit area. From this results the familiar

(*Please turn to next page*)

inverse square law, $E = I/D^2$ which is applicable beyond certain distances from the source depending upon its size, shape, and the precision required. An approximate rule of thumb which may be used is that the error in using the law will be less than 1% if D is at least five times the greatest dimension of the source. If E is expressed in lumens per square foot, then I will be in terms of foot-candles. This can also be shown by the analysis of the radiation from a point source at the center of a sphere, but this introduces the concept of the nonexistent solid angle which can be dispensed with at present. By definition, one foot-candle is the illuminance on a surface normal to the luminous flux at the distance of one foot. If the surface is not normal to the source, then the flux falling on it is reduced by the factor cos θ where θ is the angle of deviation from normal and the inverse square law becomes: $E = (I/D^2) \cos \theta$.

Although in certain instances it will be found advantageous to calibrate instruments in terms of intensity units, apparently the more fundamental measurement is that of E or L in lumens per unit area. Returning once again to the translucent screen of background projection, it becomes exceedingly important to treat it as an extended source. For a given projector, projector distance, and projector lens, a plot may be made of the screen's luminosity as an extended source. If the screen is divided into a large number of unit areas and measurements of L are taken normal to each area, a polar diagram may be constructed connecting by lines all like values of L. Such a diagram would serve as means of evaluating the performance of the screen (under the given conditions) for normal pick-up, and is similar in appearance to the horizontal radiation patterns of antennas or loudspeakers. For angles other than normal, the values on the above diagram can be multiplied by a loss factor depending upon a light distribution curve of the particular screens. Such distribution curves have been made and found quite effective. If a nonselective dispersion is assumed for the screen, any means of measurement may be used for distribution. The transmission of the screen, however, and the spectrum of the projected light cannot be arbitrarily assumed continuous and equal. Here, then, is the necessity of utilizing physical, objective measuring devices, adjusted to the $R(\lambda)$ in question.

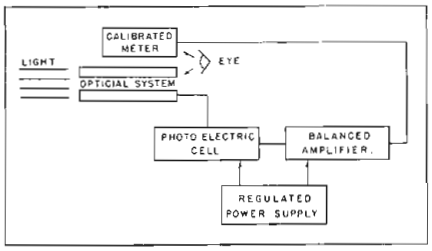


Fig. 5: Simplified diagram of proposed physical photometer which may be adjusted by optical filters or by PE cell response to match a television transfer characteristic

Of the various radiation sensitive means which may be used in the above measurements, two may possibly be utilized. These are the vacuum photocell and the barrier-layer cell. Both of these are subject to errors arising from temperature changes, fatigue, spectral response curves different from $R(\lambda)$ and deviation from the cosine law due to large included angles. The latter may be helped by an integrating sphere or a depolished diffusing glass. The other errors can be stabilized and compensations may be introduced. A vacuum photocell type of photometer with an optical system and field limiting apertures is worthy of consideration. Such a device has been proposed by D. W. Epstein[1] of the RCA Princeton Laboratories. For studio use, a calibration in lumens per square foot or foot-candles would be required.

When dealing with a moving picture projector other problems arise such as synchronization and the intermittent nature of the light. If possible, the shutter should be manually opened, the luminosity measured, and the average luminosity computed. Consider a shutter of the type shown in Fig. 6.

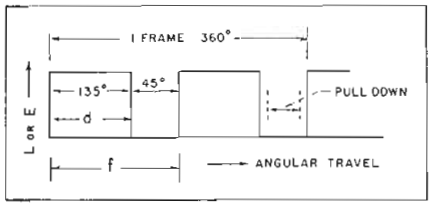


Fig. 6: Light output vs the angular displacement of a sample shutter (the rise and decay time periods are disregarded)

The average luminous emittance is then, $L_{av} = Ld/f = (135/180)L = 0.75L$. A larger ratio of shutter opening to shutter travel serves to utilize a higher percentage of the available luminosity, in this case 75%. If it is not convenient to measure L directly, it would be desirable to incorporate into the proposed photometer the ability to respond to average conditions. It must be realized that all these measurements are referred to a projector *without* film. With the introduction of a film slide or a 16mm film it becomes necessary to compare the H & D characteristic with the image orthicon transfer characteristic for proper response. Insofar as the actual reduction of luminosity of the screen due to film density is concerned, actual measurements may be taken, or computations be made based on the contrast and density of the particular film in use. At this point, however, the operating conditions should have been established on the previous basis, and final conditions may be set by observation in the control rooms.

The presence of ambient lighting for foreground material presents a special problem. Needless to say, spill lighting on the translucent screen, and shadows falling on it must be kept to a minimum. Such measurements or observations are readily made without a picture on the screen. It may be well to point out that an ambient overall spill illumination on the screen of value E_s lumens/ft^2 has the following effect on contrast: Assume a contrast $C = L_1/L_2$, where L_1 = maximum luminance of the picture and L_2 = minimum luminance of the picture. By definition $(L_1/L_2) > 1$, and hence $L_1 > L_2$. It follows then $(L_1 + E_s)/(L_2 + E_s) > 1$. The increase to both parts of the ratio is effectively a modification by the factor $(L_1 + E_s/L_1)/(L_2 + E_s/L_2)$; which may be written:

$$(1 + \frac{E_s}{L_1})/(1 + \frac{E_s}{L_2})$$

$$\text{However } \frac{E_s}{L_1} < \frac{E_s}{L_2} \text{ and } (1 + \frac{E_2}{L_1}) < (1 + \frac{E_s}{L_2})$$

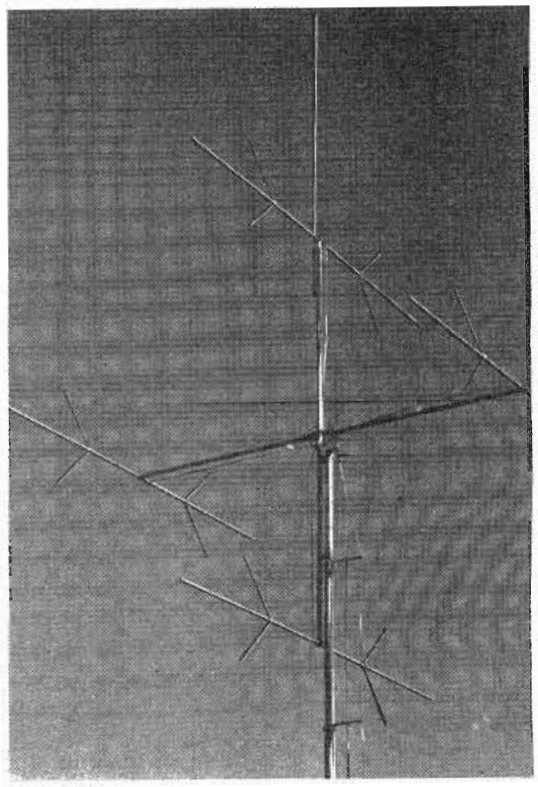
Therefore the factor modifying $L_1/L_2 = C$ is a fraction less than one, and the net effect is a reduction in contrast by the ratio

$$(1 + \frac{E_s}{L_1})/(1 + \frac{E_s}{L_2})$$

Naturally the extent of the reduction is also a function of the initial screen luminances. This reduction may be quite rapid as a numerical trial will show. A contrast ratio of 100/1 when receiving an evenly dis-

(*Continued on page* 50)

Reversible Beam TV Receiving Antenna



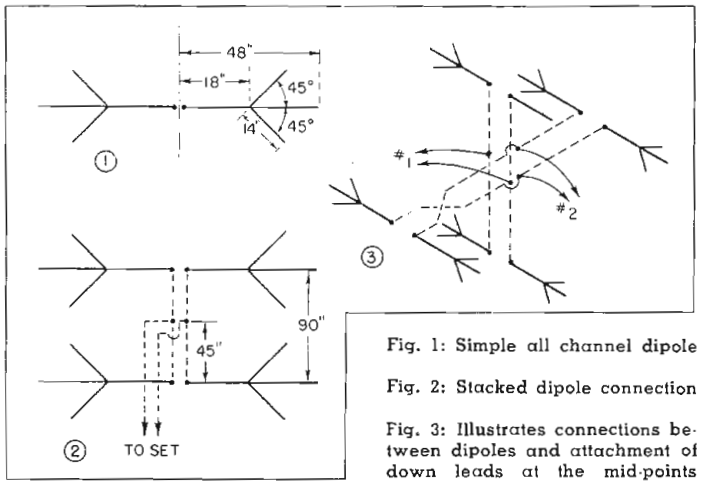


Fig. 1: Simple all channel dipole

Fig. 2: Stacked dipole connection

Fig. 3: Illustrates connections between dipoles and attachment of down leads at the mid-points

THE features of this antenna were first disclosed at the September 20, 1948 FCC Engineering Conference on television and later[1] became the topic of a paper at the IRE convention, New York City, in March 1949. Developed at the RCA Princeton laboratories, and currently known as the "Woodward"[2] antenna, it provides a uniform gain of about two over all 12 channels without switching, and obtains a figure-8 pattern with one lobe 20 times the other. The pattern can be reversed by the simple throw of a switch at the receiver. This antenna is reasonably easy to manufacture and it is understood that some companies will soon be retailing them for about $25.00.

Because many of our readers have expressed keen interest in this development, Tele-Tech presents herewith a step by step sequence that describes the construction of such an array.

Step 1. Take a simple dipole, cut for, say Channel 2. At a distance from its center equal to the length of a dipole for say, channel 10, attach V-shaped arms making an angle of 45° with the dipole. These form an electrical discontinuity, and as a result the high band (Chs. 7-13) frequencies tend not to flow beyond these points. The result is a simple ALL-CHANNEL dipole illustrated in Fig. 1.

Step 2. Stack two such dipoles, one above the other, on an antenna mast. Space them by a distance approximately equal to their overall length and connect them in parallel using standard 300-ohm lead-in wire. Down-lead (Fig. 2) No. 1 is taken from mid-point of this connector.

Step 3. Construct a second unit, as described in STEP 2 and mount it horizontally in the center of the STEP 2 unit, which we will consider as mounted vertically in the plane of the antenna mast. The result is best visualized from a perspective as in Fig. 3. The latter illustration shows that the connections between the horizontal dipoles are transposed once. No. 2 down-lead to the receiver is taken from this unit.

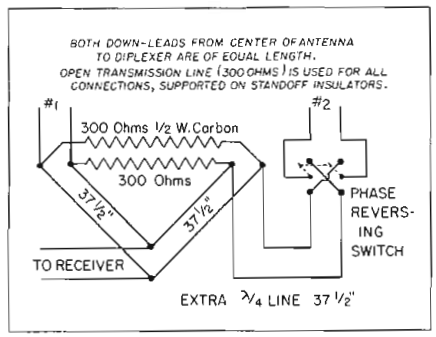


Fig. 4: Diplexer circuit used at receiver

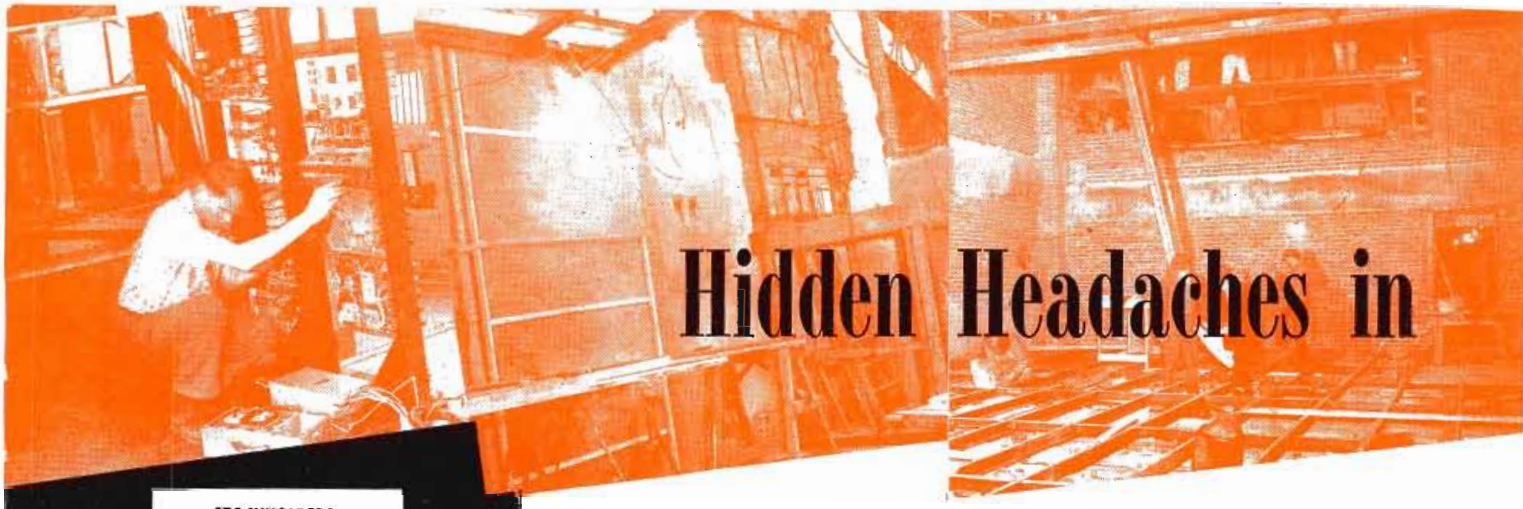
Step 4. At the receiver, a sort of "resistance diplexer" is employed to keep the standing wave ratio low and to afford a phasing network for the receiver connection. The loss of signal in this is about 10%. Note the position of a D.P.D.T. switch (ordinary H & H toggle) used for reversing the phase of the signal from one down-lead. The directivity of the array is reversed in this way. These connections are shown in Fig. 4.

The diplexer is made of the proper lengths of the same open transmission line (300 ohm) that is used for the down-leads. This line is wound back and forth on a suitable frame, mounted at the back of the television cabinet. If the receiving location is such that all stations are in one direction only, the rear pattern lobe will never be required and the reversing switch can be eliminated. The diplexer then can be mounted near the dipoles so that only a single down-lead is required.

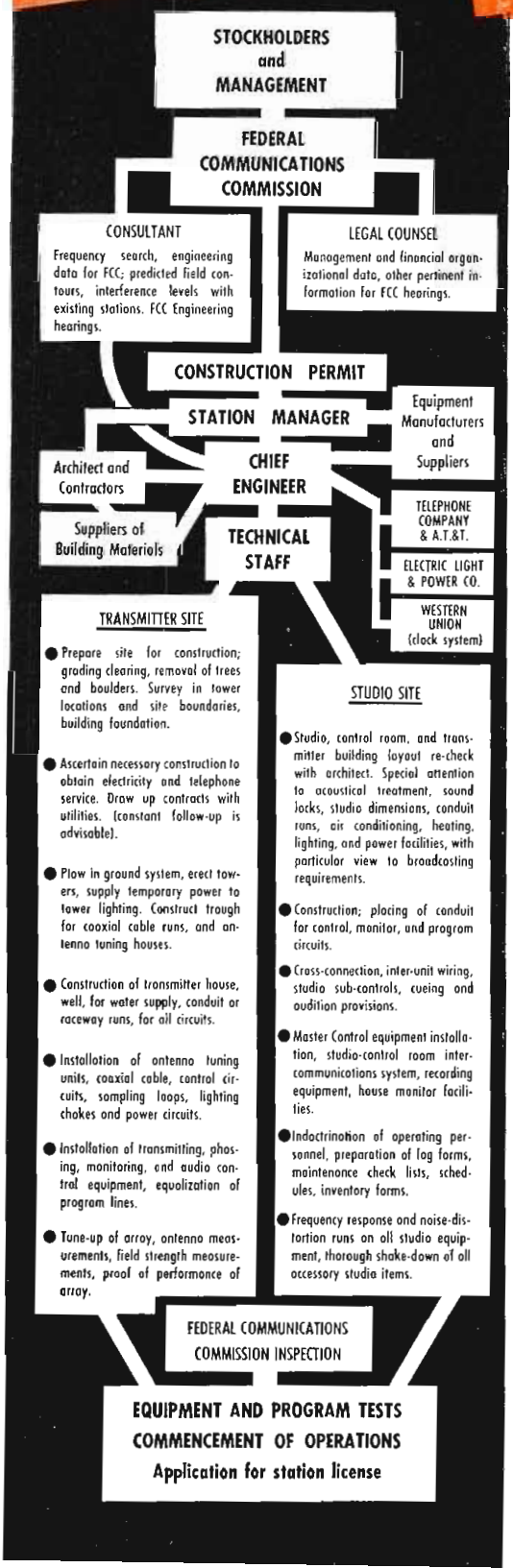
To those who have added a reflector to the usual dipole to suppress interference from the rear and still find the interference annoying, the RCA antenna should yield a very worth-while improvement.

[1] Trends in Television and Radio Receiver Design, R. R. Batcher, Tele-Tech Jan. 1949, p 22

[2] Reversible Beam Antenna for 12 Channel Television Reception, O. M. Woodward Jr., RCA Review, Vol. 10, No. 2, June 1949, Pages 224-240



Hidden Headaches in



You can't solve the human equation with a slide rule

THE technical problems of broadcast-station construction have long since been worked out, and are common knowledge among engineers.

Too often, however, the equally important non-technical factors are ignored by the broadcast engineer. Accustomed, as he is, to smooth efficiency, split-second timing, and the other stable characteristics of an established station, when he finds himself in the dynamic environment of construction, he is often lost.

An experienced chief engineer, returned from war service to build his second station, after three months of frustrating struggle and little progress, was referring to everyone connected with the job as "those d—— civilians." His engineering ability was above question, but the everyday headaches and imponderables had him licked, at that moment.

The variety of factors peculiar to the broadcasting industry today, and the tremendous number of construction permits being granted by the Federal Communications Commission, make an evaluation of these influences more important than ever. Until very recently, men with actual construction experience were a small minority. As a consequence the tendency has been to approach station construction with only the technical aspects in mind. Ignorance of the less concrete elements involved has resulted in delay, and loss of money.

The first situation with which the chief engineer of a station under construction has to deal is the terrific pressure brought to bear by the station owner. The management is understandably anxious to get on the air, and often cannot understand why the station cannot begin operations immediately upon the arrival of the basic components. In extreme cases, this can be a source of irritation to all concerned, and should be dealt with carefully. Otherwise, destruction of the confidence of the management in the ability of the engineer can bring about disastrous results.

Results of Hasty Construction

One engineer, confronted with this situation, solved it neatly by telling his employer that he could put him on the air within forty-eight hours, but couldn't guarantee how long he would stay on. Even more dangerous, however, is the tendency on the part of the technical personnel, in the rush to complete the job, to slight attention to sound constructional practices. An instance of this took place in a station which was so hastily assembled that the microphone, control, and power circuits were left indiscriminately tangled on the floor, not even cabled, let alone in conduit. Here, the owners were delighted with the rapidity with which the station went on the air, but the abruptness with which it later went off, was a recurring embarrassment. Added to this was a wondrous assortment of clicks, pops, howls, and hum, intermingled with the program material. That is an extreme example, of course, but the temptation to put off necessary tasks until "after we're on the air" can result in serious trouble.

The tremendous demand on the manufacturers for broadcast equipment introduces another problem directly affecting the time consumed in building. This can be particularly serious in installations involving

Building a Broadcast Station

the use of custom-built equipment, such as the phasing networks required for directional arrays. After the specifications have been sent to the manufacturer, a tactful, constant follow-up of the progress of its production is essential. Standard equipment is more readily obtainable, although the same conditions apply, and it is wise to remind the manufacturer continuously of the necessity for speed in the delivery of equipment. In no case can it arrive too soon, and the ideal situation would be one in which all of the components are on the scene, in storage, before the actual construction begins. Short of this impossible ideal, the best one can hope for is that the units will arrive in reasonably logical sequence, and that the supplier can be persuaded to cooperate. The reasons for this are obvious, and an intelligent adaptation of the construction schedule to the changing delivery dates of items of equipment, can make a great difference in the time required to do the job. The sequence is important.

Weather Conditions Important

For example, all out-door work can only be performed under good weather conditions, and depending upon the time of the year, and the climate, delay in the arrival of the coaxial cable, or wire for the radials has often resulted in the postponement of broadcasting for weeks or more. Such obvious details as the condition of the soil, prior to plowing in the ground system, can change overnight, to the detriment of the finished job. A good rule of thumb, in this respect, is to concentrate on work that has to be done outdoors, whenever availability of material and the weather make it possible. For these reasons, and an infinity of other variables, it is never wise to be committed to a final opening date until equipment tests are actually under way.

Close coordination of the activities of all the contractors taking part in the construction is imperative. Even where the architect and the contractors are thoroughly competent, there is bound to be confusion, due to lack of familiarity with the broadcaster's problems. Conduit runs should be worked out with extreme care, and reconciled with structural details not shown on many blueprints. Simple "boners" on the part of the architect should be guarded against, such as studio doors opening into busy corridors, without benefit of a sound lock. (This has actually happened, unbelievable though it may be.) The placement of air-conditioning ducts, the installation of the heating system, and the lighting must be studied closely, with broadcasting problems in mind, otherwise extremely unfortunate operating conditions can result. A classic example exists in one station where the beautiful, modernistic transmitter building depends upon panels of glass brick for its source of daylight. No old-fashioned windows were considered necessary. Little ventilation was provided for, and the men who have to stand watch over the multi-kilowatt transmitter find it quite uncomfortable in summer weather, not to mention the danger of seriously over-heating the equipment.

Wrong Number!

Inadequate fore-warning of the phone company resulted in a humorous incident out West not long ago. A regional station was in the middle of its program tests, when the music was over-ridden by a loud frying noise, coming from the studio-transmitter line. This was followed by ad-lib conversation between two telephone company employees;

"Hey, Mac, you got the wrong—loop!"

"——. I can't help it!!" The Strauss waltz in the background did little to sooth the nerves of station and company officials.

Studio Design Problems

Studio design, particularly with respect to acoustical treatment, is another special problem. Normally, a good architect will take care of this, but the engineer should assure himself to the best of his ability that this situation is being dealt with intelligently. The serious study of room acoustics is a field beyond the ken of most broadcast engineers, and even the experts have been known to slip.

Recently, a metropolitan network station staff called in the best brains they could find, to build a new main studio. Upon completion, the unanimous opinion was that it was far too "dead". In another case, a small local station was sent elaborate plans for the treatment of its studios, only to find that molded plywood polycylindrical diffusers and the other treatments recommended, were all far too expensive to undertake. The owner, having nobody to consult, and being uninformed, was on the point of abandoning his half-completed station. Fortunately, when his engineer joined the organization shortly afterward, he was able to re-work the acoustical treatment along more economical lines, using more ordinary materi-

(*Continued on page* 59)

Tape Characteristics for

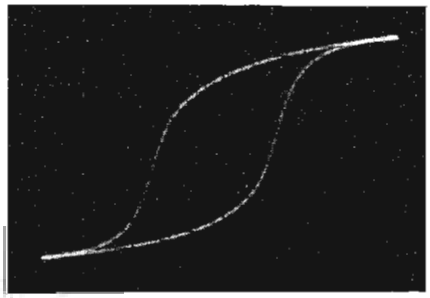
Careful control of variables during manufacture; proper operational, storage, and handling technics govern in obtaining uniform high quality recordings

By ***REYNOLDS MARCHANT****, Development Engineer, Minnesota Mining & Manufacturing Co., 900 Fauquier Ave., Saint Paul 6, Minn.*

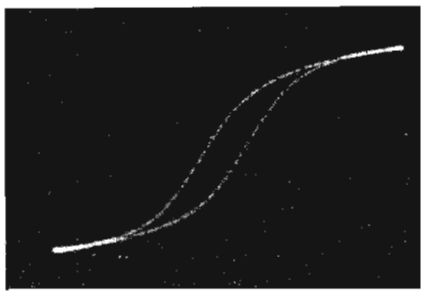
IN any measurement of the characteristics of magnetic materials, a hysteresis loop is perhaps the most universally used parameter. Instruments have been developed which will automatically trace, on a cathode ray oscilloscope, the hysteresis loop for a sample of ferro-magnetic material. Further improvements of this equipment have been made which permit testing relatively small quantities of magnetic material, such as are normally found on standard ¼-in. wide magnetic tapes. Such instruments make it possible to quickly measure the two fundamental properties of the magnetic material — coercive force and remanence.

Both coercive force and remanence must be held to specific production tolerances in order to insure consistent performance of the tape in a recording system. Since the coercive force is, to some degree, a measure of the tape's ability to retain a given magnetic flux, it bears a direct relation to the magnetizing force required to record or erase a signal. Magnetic tapes having very high coercive forces require large amounts of bias and erase current, which in turn introduces problems of heat dissipation in the erase head. Coercive force is also related, in a complex fashion, to the apparent frequency response of the recording system at different audio frequencies. It directly relates to the wave length of the recorded signal on the tape, and therefore is a factor which the recording equipment manufacturer must consider in determining the maximum frequency response of his equipment for a given tape speed. In general, higher coercive force materials may be recorded with less pre or post equalization of high frequencies to obtain an overall flat frequency response. It is therefore apparent that the coercive force should be some median value which is high enough to give satisfactory output at the high audio frequencies without posing problems of erasure.

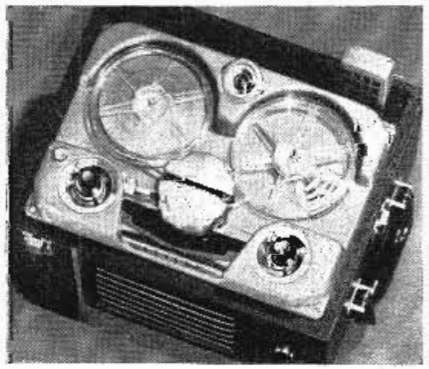
The German Megnetophone recorders operated at a basic tape speed of 77 centimeters or 30 in./sec.



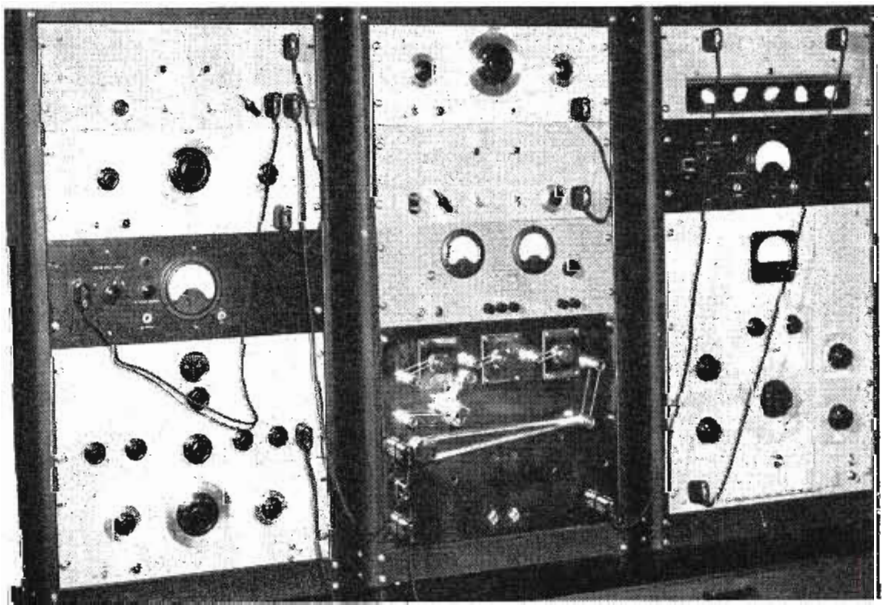
Hysteresis loops for high (above) and low (below) coercive force magnetic tapes can be automatically plotted on CR oscilloscope



Commercial magnetic tape recorder for home use. This machine (Revere) records two separate tracks on ¼-in. tape and with a playing speed of 3¾-in/sec permits one hour of recording on a 5-in. reel of tape



Loop testing equipment for measuring the output and frequency response of tape samples



Audio Quality

Professional tape recorder (Ampex), using low coercive force tape, operates at 30 in/sec

and had a frequency response flat to about 10 KC. The shortest wave length of the recorded signal was therefor .003-in. and tapes having fairly low coercive force in the region of 75 to 125 oersteds were capable of giving satisfactory performance. Similar tapes have been manufactured and used in this country.

It has been determined that such tape is not satisfactory for use with equipment meeting the present NAB standard of essentially flat response from 50 to 15,000 cps at a tape speed of 15 in./sec. For this application, magnetic tape having a coercive force of from 225 to 250 oersteds is most desirable, and a commercial tape having a coercive force of approximately 240 oersteds is being produced in considerable quantities for broadcast and professional use. It is obvious that recording at a 15 in./sec. tape speed has considerable advantage both economically and from the standpoint of tape storage. For home recording equipment, where economy dictates the lowest possible tape speed, tapes having a coercive force in the range from 300 to 350 oersteds have been used in systems operating at a tape speed as low as 3.75 in./sec. Such machines, operated on a dual track basis, are capable of recording one full hour on a 5-in. reel of tape with reasonable fidelity.

Remanence is a measure of the amount of magnetic flux left on the tape by a given recording signal. As a tape property, the value of remanence should be as high as possible consistent with low distortion, since greater remanence means more signal and therefor a better ratio of signal to system noise. For tape of a given coercive force, the remanence and the thickness of the coated magnetic layer are also related to the relative signal output at high and low audio frequencies. Quality control by one tape manufacturer utilizes a routine test procedure whereby the output at 500 cps is compared with that at 5000 cps at a tape speed of 7.5 in./sec. The absolute value of output at 500 cps is also used as a measure of the variation in output from lot to lot of tape. Control of the remanence value within established limits is necessary in order to avoid problems of changing level when two lots of tape are spliced into the same reel.

It should also be borne in mind that the problem of differences in recording level are problems of machine design, as well as tape design. If tapes recorded on several different machines are spliced together to make up a program, changes in level of the recorded signal may be expected unless all machines impress the same signal on the tape with the same VU meter reading. It is probable that machines made by the same manufacturer will record at the same level, but it is quite possible that tapes made on different machines will not be properly related to each other.

To Standardize Characteristics

A concerted effort is being made by the members of the NAB Magnetic Tape Committee to standardize the play-back characteristics of various commercial machines. Undoubtedly a standard recording level will be adopted. Preliminary reports indicate that several different machine manufacturers, all using the same type of magnetic tape, are already in very close agreement in play-back characteristics.

The dispersion character of the magnetic material on the coated tape and uniformity of particle size both affect the residual noise left on the tape in the recording process. Proper control of these factors assures a background noise from the tape which is comparable with the general system noise in a well designed play-back amplifier system. The surface of the magnetic coating must be smooth and flat so that intimate contact of the tape with the head is maintained at all times. Irregularities of the tape surface would tend to change the spacing of the head gap from the tape with a resulting amplitude flutter of the higher frequency components. Since in most recording equipment the recording and playback heads are cylindrical in shape, reliance is placed on tension of the tape to maintain contact with the head. It is important therefor, that the tape tension be carefully controlled so that uniform contact with the magnetic head is assured. Rapidly fluctuating tape tensions will produce not only objectionable amplitude modulation, but very serious frequency modulation of the recorded signal. Some average tension variation from beginning to end of a reel of tape is acceptable since good head conformity can be obtained over a 2 to 1 tension range.

The physical properties of a magnetic tape are also of considerable importance to the behavior of the recording system. Most of the magnetic tapes produced and used today are composed of a coating of the magnetizable material on a stable, non - metallic backing. Backings commercially used are made of organic materials and may be of a fibrous type such as paper or of a continuous film type, a typical example of which is cellulose acetate film. An ideal backing would be one which had infinitesimal thickness and an infinite modulus of elasticity. Such an ideal backing

(*Please turn to next page*)

TAPE CHARACTERISTICS (Continued)

would then have no stretch, but at the same time have a high degree of flexibility.

Since we must obviously deal with practical materials and since performance must be balanced against cost, for a commercial product, certain compromises with an ideal backing must be made. In this country the choice of cellulose acetate as a backing material appears quite logical and such material is used in the commercial production of magnetic tape for broadcast and professional work. Cellulose acetate has long been used as the "safety" base material for home movie film where its aging properties and its stability under varying conditions of temperature and humidity have been thoroughly evaluated. Since its performance has been studied over a period of years and since it has reasonable mechanical strength in the thickness desired for magnetic tape, it has found wide acceptance. Because magnetic tape must be subjected to a certain amount of tension during the recording operation, it must necessarily experience a certain degree of elongation. If this elongation is constant in the recording and play-back operations, the recorded signal will be reproduced without alteration with respect to time. Variations in tape thickness would cause corresponding variations in elongation of the tape at a given tension, and while such tape might give consistent performance when recorded and played on the same machine, recordings made on a machine of one type and played back on a machine of different type would be subject to appreciable frequency modulation due to the changing elongation.

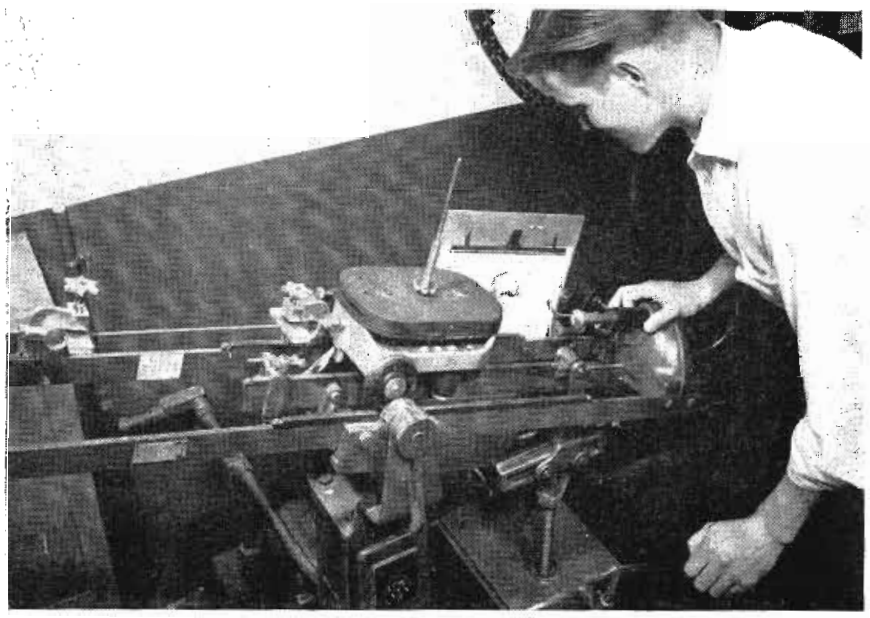
Tension of Tape

On most recording machines, the tape is dragged across several stationary surfaces including the erase, record and play-back heads. Because of this treatment, the coefficient of friction between the tape and the stationary surfaces should be reasonably low. If such is not the case, the tape will not have a uniform tension throughout its path of travel to the capstan as the tension will build up from friction point to friction point. An appreciable increase in tension may be produced by the time the tape reaches the play-back head (usually the last element in the head line-up) and this tension will cause the play-back head to wear at a rapid rate. A high degree of friction also results in a certain amount of chatter of the tape passing over the head. The chatter becomes audible, in some cases, as a squeal which may appear both as mechanical noise and as a modulation of the signal on the tape. This type of modulation can become very objectionable and can ruin an otherwise satisfactory recording. For this reason, the coefficient of friction should be held to as low a value as is possible consistent with adequate traction at the capstan. Satisfactory tape should have no appreciable tendency to stick to itself when wound up in a tight roll. Tentative NAB standards have been set up for this and other mechanical properties.

Referring again to the recording equipment as a part of the entire system, it must be recognized that the recorder design should be correlated with the mechanical properties of the tape. Recording equipment designed to permit rapid forward or rewind motion of the tape should be capable of accelerating to a running speed or breaking the reels to a quick stop without subjecting the tape to momentary stresses of high value, since such stresses may produce elongation of a permanent nature. Rewinding of plastic back magnetic tape is preferably done at constant torque so that the tape tension decreases as the reel becomes larger, however, some compromise between constant torque and constant tension will usually give satisfactory results. Most of the tape recorder manufacturers, making equipment for broadcast station use, have designed mechanisms to drive the tape at either the standard NAB speed of 15 in./sec. or the secondary speed of 7.5 in./sec. permitting flexibility of operation and maximum economy in use of tape. The NAB Magnetic Tape Committee has recently recommended use of a standard hub for magnetic tape reels. Tape would be supplied by the manufacturer on this standard hub and suitable flange, or flanges, can be attached to permit use of the tape on any professional recording equipment. Tape made on one recorder can thus be readily adapted to use on another type of machine. The Committee is presently engaged in further standardization work of this nature with the object of recommending use of a single standard flange type which would fit any recorder.

On a magnetic recorder, the play-back head must be very carefully aligned with the magnetic image produced by the record head in order to insure proper reproduction. The recorded magnetic image on the tape must also be oriented exactly perpendicular to the direction of tape travel if tapes are to be interchangeably recorded and played on different machines. A small degree of misalignment of the play-back head with the recorded signal

Sample of magnetic tape being checked on Scott inclined plane tensile tester which automatically plots a curve of stress vs strain and accurately records breaking point



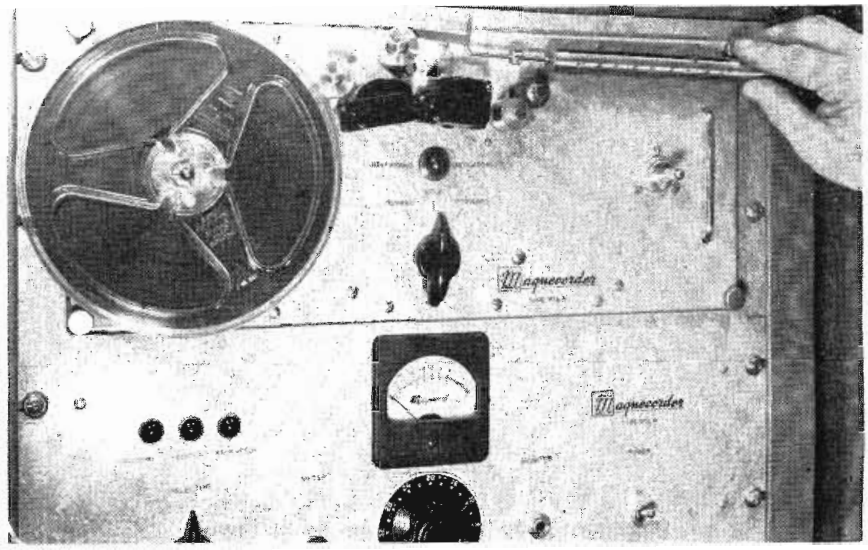
will cause a serious reduction in output at the higher frequencies. Recorders are usually furnished by the manufacturer with the record and play-back heads properly aligned, both with respect to each other and with respect to the tape travel. Provision is made, however, on all machines for adjustment of the heads in the field.

A large tape manufacturer has made available to the trade a standard head alignment tape which will enable adjustment of the heads to be made to within ±1½ minutes of arc at a wave length of .001-in. which corresponds to 15 KC at 15 in./sec. A head misalignment of 10 minutes of arc will cause a 6DB reduction in output at the 15 KC point. This effect is less serious at lower frequencies amounting to about 4 DB at 10 KC under the above conditions.

It is recommended that regular checks using a standard head alignment tape be made as part of the station routine checking procedure. It is particularly important that portable equipment be checked in this manner. All of the professional recorders produced in this country are driven by synchronous motors so that the speed of the tape should be independent of line voltage fluctuations. If, however, the recorder has been designed to use the full rated power of the drive motor at rated voltage, serious speed variations may occur at lower line voltages since some types of synchronous motors may then lose synchronism and run as straight induction motors.

Effects of Voltage Variations

Large variations in line voltage may have even more serious effects on the performance on the rest of the system. Optimum recorder design utilizes voltage regulator tubes to stabilize the voltage supply to the amplifier and bias oscillator tubes. Such regulator tubes usually have a fairly critical regulating range and abnormally low line voltages will often result in their loss of control and a serious reduction in supply voltage to the bias oscillator. Line voltages varying from 95 to 125 volts are commonly encountered and can produce a bias current change greater than 2 to 1. A bias change of this magnitude can produce a serious alteration in high frequency response and may have a marked influence on the amount of harmonic distortion produced. In studio work it is recommended that an adjustable voltage transformer be used to correct normally high or low line voltages to the value recommended by the recording equipment manufacturer. For use in the field, an adjustable voltage source such as a Variac, together with a suitable meter will insure against loss of quality due to line voltage abnormalties.



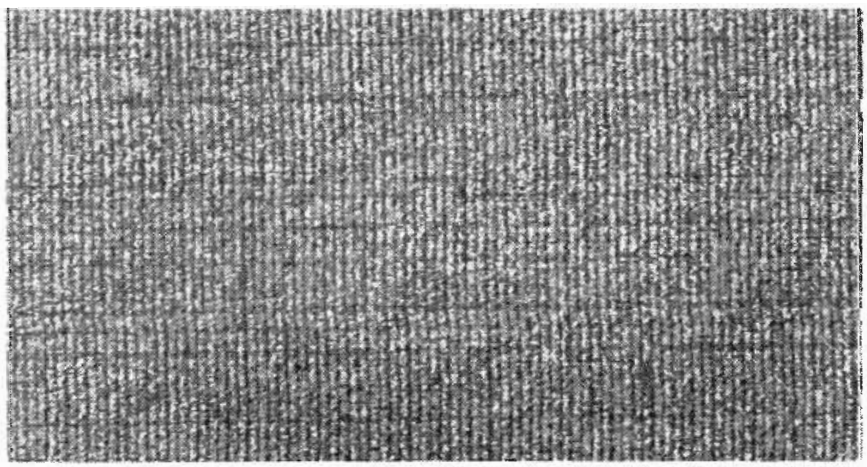
Checking for proper tape tension from stock spool by the use of a small spring scale

Recorders which employ slipping friction clutches to control the tape tension are subject to variations in performance due to wear or contamination of the friction surfaces. Satisfactory checks of such equipment can usually be made with a small spring scale which can be tied to the free end of tape on a full tape reel. A suitable spring scale having a maximum capacity of 16-oz. can be obtained from a scientific equipment supplier at nominal cost. In use, the reel can be placed on a friction driven winder spindle and the stalled tension thus measured. Tape can be pulled off the reel at a slow rate by means of the spring scale when the reel is placed on a stationary unwind spindle. Data on the proper tape tensions can be obtained from the machine manufacturer.

Wear on both the record and play-back heads may be expected, although most recorders are designed so that a minimum life of several hundred hours is obtained. The effects of wear on a record head are rather complex. One effect is to reduce the cross-sectional area of the magnetic material at the pole tips so that saturation results. Such saturation may have two secondary effects; that of spreading the recording flux over a wider

(*Continued on page* 56)

Magnified section of the magnetic track recorded on a tape sample. This track, made visible by the carbonyl iron technic reveals distortion of the laminations of the recording head. The distance between successive lines is approximately 0.001-in.



Using "G" Curves

New technic provides for determining dynamic operating characteristics of vacuum tube circuits directly and simplifies evaluation of distortion figures. Application to various amplifier and oscillator circuits discussed

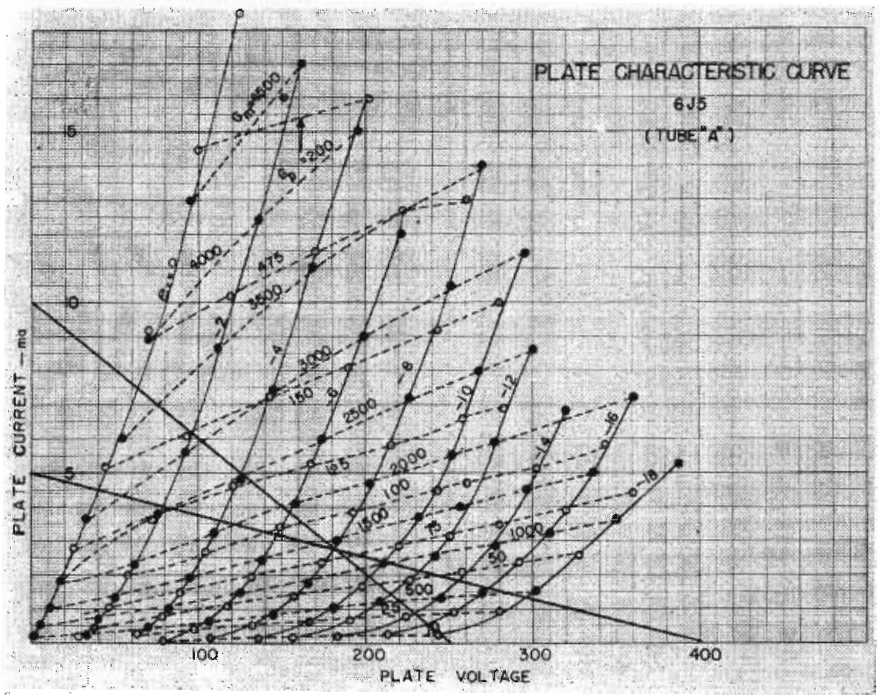
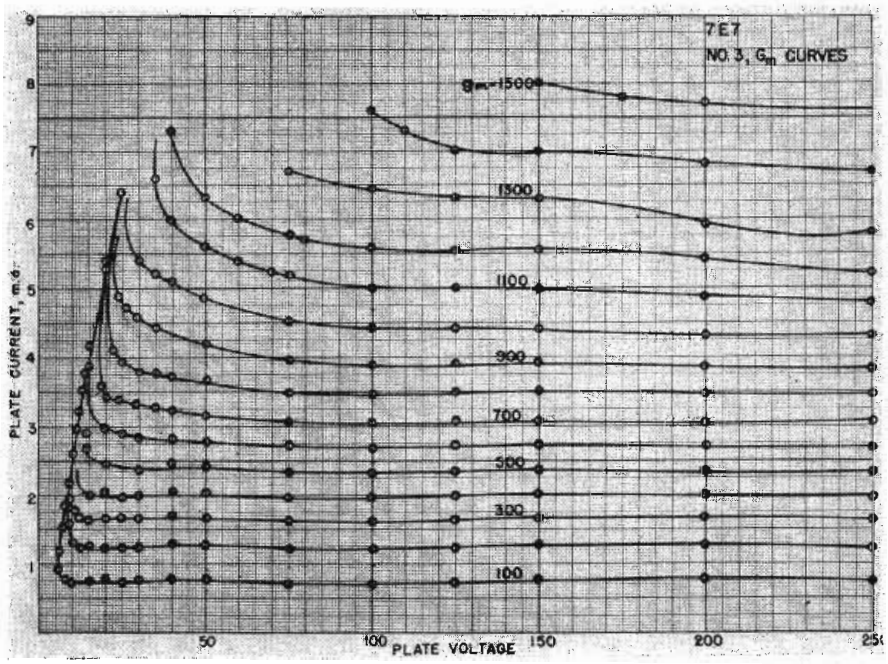


Fig. 1: Plate characteristic of 6J5 showing g_m and g_p as constant magnitude parameters

Fig. 2: In the 7E7 tube type (pentode) the g_m contours appear to be almost horizontal



FOR many years the design of tube circuits has been predominantly experimental and empirical. This condition is a result of, first, lack of adequate methods of simple and rapid calculations, and, second, lack of data required to facilitate satisfactory use of the methods. As a result, determination of distortion in amplifiers and choice of the best means of getting required circuit characteristics has been blind trial and error procedures. In addition, the original study of tube operation by existing methods requires use of different approaches for different types of tubes. Consequently, the study of basic properties is rendered complicated and disordered. The purpose of this paper is to present a unified approach to the study of circuits containing non-linear elements showing properties similar to vacuum tubes.

Physics of the Tube

Since the radio tube consists of a source of electric current and a series of controlling electrodes or grids, use is made of Equation 1 expressing this condition:

$$i_p = \sum_{j=1}^{n} g_{mj}\, e_{cj} + g_p\, e_p \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where i_p is the plate current increment; g_{mj} is the transconductance of grid j at given point; g_p is the plate conductance at given point; e_{cj} is the grid j to cathode potential increment; and e_p is the plate to cathode potential increment. The grid-cathode potential increment is zero for any grid maintained at cathode alternating potential. Hence, all such terms in the summation vanish. Then the expression carries only the number of terms representing the variable electrodes.

Although with more than one grid input, this equation is difficult to use with large signal conditions, it will be shown that with a single variable grid input large signals offer no difficulty.

For multiple signal grid circuits,

in Tube Circuit Design

Part One of Two Parts

By KEATS A. PULLEN, *Ordnance Dept., Ballastic Research Laboratories, Aberdeen Proving Grounds, Md.*

several factors must be considered. First, with signal grids separated by screens, as in usual practice, the maximum available number of electrons is determined by the first pair of grids. The second control grid varies the number of the available electrons permitted to penetrate to the plate. Consequently, $i_p = f(e_{c_1}, e_{c_2}, \text{etc.})$, and intermodulation terms will be present. Calculation of this condition in the structure becomes even more complex than theoretical calculation of a simple triode. Yet even the triode solution apparently has only been approximated.

Derivation of operation equations from Equation 1 requires substitution of the proper values for e_{c_j} and e_p. For the ordinary triode, tetrode, or pentode amplifier, $e_{c_1} = e_{in}$, $e_{c_j} = 0$ $(j \neq 1)$ and $e_p = -e_L = -i_p Z_L$. Substitution and solution gives Equation 2:

$$VA = \frac{-g_m Z_L}{1 + g_p Z_L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$VA = \frac{g_m Z_k}{1 + (g_m + g_p) Z_k} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$VA = \frac{-g_m Z_L}{1 + (g_m + g_p) Z_k + g_p Z_L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Relations (3) and (4) following a similar technic give amplification expressions for the cathode follower and cathode degenerated amplifier. Note that the grid to cathode voltages in both (3) and (4) differ from the input voltage.

One interesting observation with respect to equations 2, 3, and 4 is that they resemble very closely the formula for a general amplifier having feedback. For this reason, the $g_p Z_L$ term in the denominator might be called the plate degeneration. Likewise the term $(g_m + g_p)Z_K$ is the cathode degeneration.

Basic Application Technics

The standard plate characteristics curves of vacuum tubes as published carry only constant bias contours. Since a vacuum tube is operated by varying potentials about a fixed point on a curve, rate of change data are those pertinent to use. Examination of the available parameters, namely g_m, g_p, and μ, shows each to have variations too large to be neglected. Simplicity of application seems to favor use of g_m and g_p, particularly because of their use in the basic tube current equation (1).

Since all of these parameters are functions of at least two variables, namely e_{c_j} and e_p, contours of parameter constant magnitude would seem preferable. A set of curves of a 6J5 tube prepared in this manner may be seen in Fig. 1. Neither of the contour sets is horizontal, although the g_p contours are nearly so. The appearance of the g_m curves on a 7E7 pentode may be seen from Fig. 2. The plate characteristics have been omitted for simplicity.

Use of these curves is best seen from Fig. 1. Two load lines have been drawn on this set of curves, one representing a plate load of 25,000 ohms and supply of 250 volts, and the other 80,000 ohms with a 400 volt supply. Values of g_m and g_p for successive bias contour intersections with the load line should be tabulated. Substitution of these values in the appropriate operating equation gives point by point the voltage amplification of the circuit. Table 1 shows the results for a 6J5 amplifier, using the load lines of Fig. 1. For the same load with cathode degeneration, Table 2 tabulates the amplification data. For cathode follower use, Table 3 gives typical data.

Table 1

6J5 Amplifier

R_L = 25,000 ohms				R_L = 80,000 ohms			
Bias	Amp	Bias	Amp	Bias	Amp	Bias	Amp
0	17.6	−6	13.4	0	20.7	−6	15.8
−2	16.3	−8	11.7	−2	18.3	−8	15.3
−4	15.0	−10	9.7	−4	17.2	−10	14.1

Table 2

6J5 Degenerated Amplifier

Load Resistance	25,000 ohms		80,000 ohms	
Cathode Resistance	400	1000	1000	2500
Bias	Amp	Amp	Amp	Amp
0	13.7	10.3	16.3	12.4
−2	12.8	9.7	14.7	11.4
−4	12.0	9.2	14.0	11.0
−6	11.0	8.6	13.1	10.4
−8	9.9	7.9	12.8	10.2
−10	8.3	6.9	11.9	9.2

Table 3

6J5 Cathode Follower

R_K, ohms	1000	2500	5000	10,000	25,000
Bias	Amp	Amp	Amp	Amp	Amp
0	.810	.890	.924	.939	.947
−2	.800	.882	.918	.934	.942
−4	.783	.875	.910	.927	.936
−6	.757	.858	.895	.917	.929
−8	.709	.829	.881	.905	.924
−10	.621	.774	.841	.873	.907

Table 4

INPUT RELATION	$e_1 = K$	$e_1 = K\sqrt{Z_L}$	$e_1 = KZ_L$
FOR MAXIMUM VA	$Z_K = \sqrt{\frac{Z_{in}(1+G_pZ_L)}{G_M+G_p}}$	$Z_K = \frac{1+G_pZ_L}{G_M+G_p}$	$Z_M = \frac{1+G_pZ_L}{G_M+G_p}$
MAXIMUM VA	$\frac{(G_M+G_p)Z_L}{1+G_pZ_L}$	$\frac{(G_M+G_p)Z_L}{4}$	$\frac{Z_L}{Z_K\left(1+\frac{G_pZ_L}{(G_M+G_p)Z_K}\right)}$

For single ended stages, the amplification is approximately the zero signal amplification. In this case, distortion may be shown to be approximately

$$\% \text{ distortion} = 25\frac{A_1 - A_2}{A_1 + A_2} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

Where A_1 is the small signal amplification for maximum positive bias and A_2 is for maximum negative bias.

In the case of push-pull amplifiers, similar conditions apply. The total amplification here is the average of the amplifications of each tube alone. The average overall amplification is somewhat less than the zero signal amplification, and the distortion is

$$\% \text{ distortion} = 4\frac{A_1 + A_2 - 2A_0}{A_0} \quad \ldots\ldots\ldots\ldots\ldots (6)$$

where A_0 is the zero signal amplifications and other factors are as written above.

Amplification Values

The values of amplification obtained by these formulae represent the actual amplification at the respective conditions. This is a sharp contrast from values obtained by standard technics. The table gives small signal amplifications at each successive set of conditions. As a result, evaluation of distortion and average amplification is simplified. This follows since distortion is the result of variation of the computed small signal amplification.

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USE OF "G" CURVES (Continued)

In use of the "G" curve technic it must be remembered that the tube is cognizant only of the voltage difference between its electrodes. Hence, application of g_m and g_p data must be made on basis of inter-electrode voltages. The discussions following will build on the basic procedures of amplifier design already mentioned.

The formula for voltage amplification has already been given for this tube. The best design procedure is to work from the grid-cathode potential. The sum of the plate and cathode impedances must be used as load for plotting the load line. Voltages developed in the plate circuit compared to cathode circuit can be approximated as the ratio of the plate impedance to the cathode impedance. In pentodes, if high accuracy is required, the ratio of plate to total current change must be used, and also the total effective space g_m. Ordinarily the grid to plate transconductance should be close enough.

From the grid to cathode voltage values, the effective voltage amplification to the cathode may be determined. The formulae for these are

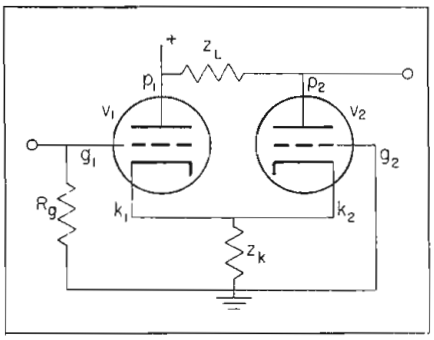

Fig. 3: Cathode coupled amplifier circuit

$$VA_{gk} = \frac{-g_{mp} Z_L}{g_{mT} Z_k} \quad \ldots\ldots (7)$$

$$VA_{gk} = \frac{g_{mT} Z_k}{1 + (g_{mT} + g_p) Z_k + g_p Z_L} \quad \ldots\ldots (8)$$

$$\text{where } \frac{g_{mp}}{g_{mT}} = \frac{\Delta i_p}{\Delta i_p + \Delta i_s} \quad \ldots\ldots (9)$$

Since the desired bias range can be chosen from these formulae, determination of maximum input and output signals can be made directly. This choice will be governed by the desired limits of distortion.

The principles discussed can also be applied bodily to the cathode follower. Note should be made that only the total space transconductance should be considered when using pentode tubes. Another similar application is the phase splitter. This circuit should be limited to triode tubes since g_{m_1} is not equal to g_{m_2}. In this case $Z_L = Z_K$, and the output consists of two voltages of equal magnitude and opposite phase.

Cathode Coupled Amplifier

This is a relatively complex arrangement (Fig. 3) requiring considerable care to make certain operating equations are correct. The exact equations are:

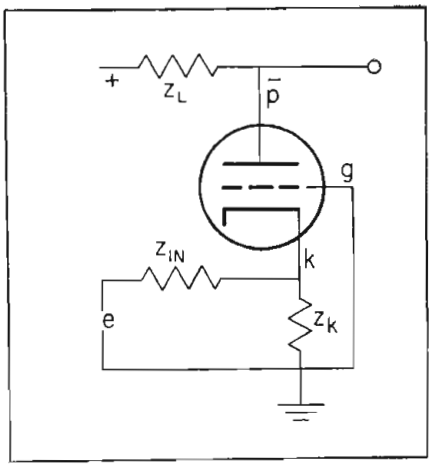

Fig. 4: Grounded grid type amplifier circuit

$$VA_{p2} = \frac{g_{m1} Z_L (g_{m2} + g_{p2}) Z_k}{[1 + Z_k (g_{m1} + g_{m2} + g_{p1} + g_{p2}) + g_{p2} Z_L + Z_k Z_L g_{p2} (g_{m1} + g_{p2})]} \quad \ldots\ldots (10)$$

$$VA_k = \frac{(1 + g_{p2} Z_L) g_{m1} Z_k}{[1 + Z_k (g_{m1} + g_{m2} + g_{p1} + g_{p2}) + g_{p2} Z_L + Z_k Z_L g_{p2} (g_{m1} + g_{p2})]} \quad \ldots\ldots (11)$$

For application to G curves, the ratio Eq. 12 is useful, as is the ratio of grid to cathode voltages on the two tubes, (13).

$$\frac{VA_{p2}}{VA_k} = \frac{(g_{m2} + g_{p2}) Z_L}{1 + g_{p2} Z_L} \quad \ldots\ldots (12)$$

$$\frac{E_1}{E_2} = \frac{(1 + g_{p2} Z_L) g_{m1} Z_k}{[1 + (g_{m2} + g_{p1} + g_{p2}) Z_k + g_{p2} Z_L + g_{p1} g_{p2} Z_k Z_L]} \quad \ldots\ldots (13)$$

Evaluation of this ratio permits determination of size of increments of E_1 for a chosen E_2. (E_1 is bias on tube 1, E_2 on tube 2). Use of these equations with G curve characteristics will permit a complete solution of the circuit.

In some cases, the following approximations are valid:

$$VA_{p2} = \frac{g_{m1} g_{m2} Z_k Z_L}{1 + (g_{m1} + g_{m2}) Z_k + g_{p2} Z_L + g_{m1} g_{p2} Z_k Z_L} \quad \ldots\ldots (14)$$

$$VA_k = \frac{(1 + g_{p2} Z_L) g_{m1} Z_k}{1 + (g_{m1} + g_{m2}) Z_k + g_{p2} Z_L + g_{m1} g_{p2} Z_k Z_L} \quad \ldots\ldots (15)$$

$$\frac{VA_p}{VA_k} = \frac{g_{m2} Z_L}{1 + g_{p2} Z_L} \quad \ldots\ldots (16)$$

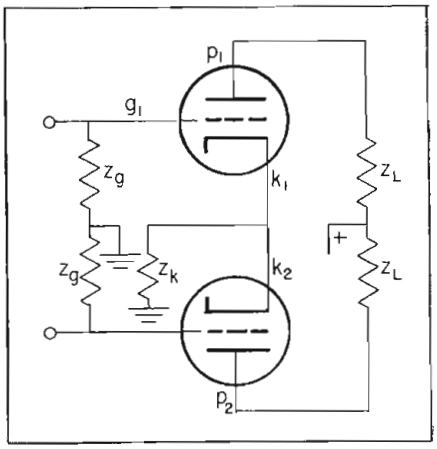

Fig. 5: Typical push-pull amplifier circuit

$$\frac{E_1}{E_2} = \frac{(1 + g_{p2} Z_L) g_{m1} Z_k}{1 + g_{m2} Z_k + g_{p2} Z_L} = \frac{g_{m1}}{g_{m2} + g_k} \quad \ldots\ldots (17)$$

Where Z_L is small, terms in g_{p2} may be neglected also.

Grounded Grid Amplifier

The equation of operation (Fig. 4) of the grounded grid amplifier is shown in (18) together with the grid-cathode voltage (19) and the input voltage in terms of the grid-cathode voltage (20). These equations may be used in a similar manner to those already discussed.

$$VA = \frac{(g_m + g_p) Z_L}{(1 + Z_{in}/Z_k)[1 + (g_m + g_p) Z_k + g_p Z_L]} \quad \ldots\ldots (18)$$

$$e_{gk} = \frac{e_{in} Z_k (1 + g_p Z_L)}{(Z_{in} + Z_k)[1 + (g_m + g_p) Z_k + g_p Z_L]} \quad \ldots\ldots (19)$$

$$e_{in} = \frac{e_{gk} (Z_{in} + Z_k)[1 + (g_m + g_p) Z_k + g_p Z_L]}{Z_k (1 + g_p Z_L)} \quad \ldots\ldots (20)$$

Conditions for maximum gain are also of interest and are listed in Table 4.

In the simplest case two ordinary amplifiers operated side by side will give typical operation (Fig. 5). In this case, the point by point average small signal amplification is one half the sum. A common practical circuit is a push-pull stage with a common unbypassed cathode resistor. The general equation is:

$$VA = \frac{Z_L}{2D}\left[g_{m1} + g_{m2} + 4 g_{m1} g_{m2} Z_k + (g_{m1} g_{p2} + g_{m2} g_{p1})(2Z_k \cdot Z_L)\right] \quad \ldots\ldots (21)$$

$$\text{where } D = [(1 + (g_{m1} + g_{p1}) Z_k + g_{p1} Z_L)(1 + (g_{m2} + g_{p2}) Z_k + g_{p2} Z_L) - (g_{m1} + g_{p1})(g_{m2} + g_{p2}) Z_k^2] \quad \ldots\ldots (22)$$

$$VA = \frac{1}{2} \frac{g_{m1} Z_L}{1 + g_{p2} Z_L} + \frac{g_{m2} Z_L}{1 + g_{p2} Z_L} \quad \ldots\ldots (23)$$

Here (23) refers to the Z_K (unbypassed) = 0.

Part Two will appear in the August issue.

DAYTON IRE AIRBORNE RADIO CONFERENCE

THE first technical conference on airborne electronics took place in Dayton, Ohio on June 3 and 4. It was sponsored by the Dayton Section of the Institute of Radio Engineers in response to the demand for exchange of information on this increasingly popular and vital subject.

Frederick R. Lack, vice-president of the Western Electric Company and president AFCA, traced the development of airborne electronics since World War I and urged as his two main points, "reliability" and "maintenance".

Mr. Lack pointed out that modern household radios and refrigerators, for example, have reliability and little or no maintenance. Even the complicated systems of long-distance telephones function with a high degree of reliability and a minimum of maintenance. He suggested that air navigation aids, radar, and various aviation electronic equipment should be built the same way.

Following Mr. Lack's address six significant technical papers were presented. John F. Byrne, Airborne Instruments Laboratory, 160 Old Country Road, Mineola, presented an analysis of the faired-in antenna development program for high speed aircraft. Omni-directional range reception was discussed in some detail and the results obtained with B-45 and F-90 aircraft was presented.

Much work on this subject has been in progress at Wright Field where, since 1943, three groups in the communications and navigation laboratories have spent full time building antennas into the skin of all aircraft. It has been found that the F-80 jet fighter for example, with only five outside antennas, loses 38.6 engine hp at 400 mph. At 500 mph, antenna drag cuts 176 hp from the ship and at 600 mph, the loss rises up to 418 hp.

In discussing air navigation and traffic control, Dr. Douglas H. Ewing of the Air Navigation Development Board pointed out that the increasing demands on the nation's air navigation and traffic flow facilities brought about by the war and the subsequent rise in air traffic have

Tracing the development of airborne radio since World War I, Frederick R. Lack, vice-president of the Western Electric Co. and president of the AFCA, urged concentration on "reliability" and "maintenance" features in new equipment design and manufacture

shown our existing facilities to be obsolescent. The problem of designing a new system has been studied by many groups, particularly the Radio Technical Commission for Aeronautics and the Research and Development Board. As a result of the study conducted by these two groups, the Air Navigation Development Board has been established by the Secretaries of Defense and Commerce. It is charged with the responsibility of developing an air navigation and traffic control system which will serve the needs of non-tactical military aviation as well as those of all civil users of airspace.

The discussion included a summary of the Board's research and development program and an evaluation of recent engineering effort in the field.

Dr. Henry G. Booker, Cornell University, discussed aspects of radio wave propagation. He stated that during the war it was found that radio refraction in the lower atmosphere often made it possible for radar receivers to see round the curved surface of the earth and to plot targets far below the geometrical horizon.

The phenomenon of super-refraction was associated with the occurrence of a radio duct, or wave guide, close to the surface of the earth. Any two points within such a duct are intervisible by refraction even though each is below the other's geometrical horizon. Field strength at one due to a transmitter at the other can therefore be of the same order of magnitude as would occur in complete free space, provided that the wavelength is sufficiently short and atmospheric attenuation is unimportant. With the increase of wavelength, however, the duct (being qualitatively similar to a wave guide in the form of a metallic pipe) ceases to be able to guide

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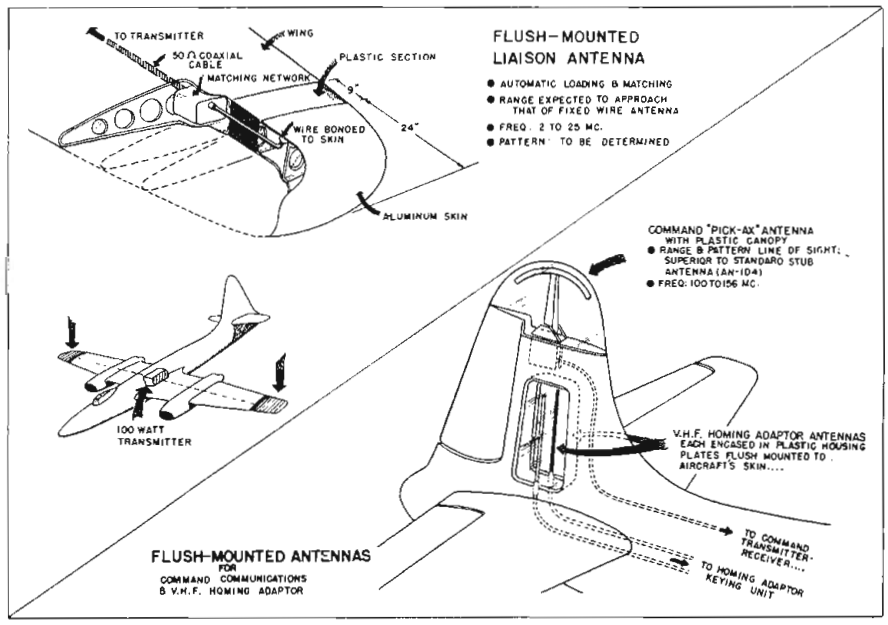
In airborne communications considerable interest is focused on the problem of building antennas into the skin of the aircraft. It has been found in the F-80 jet fighter, for example, with five outside antennas, 38 to 418 engine hp are lost between 400-600 mph



the waves efficiently: for sufficiently long wavelengths propagation takes place substantially as though no duct existed.

Dekametre and longer wavelengths are largely free from super-refraction because ducts extending from the earth's surface up to a height of the order of 100 feet are sufficient to guide them quite efficiently and are of frequent occurrence. In its most intense form, ducts extending from the surface up to heights of a few thousand feet, efficient guiding is possible, not merely for centimetre wavelengths, but also for decimetre and metre wavelengths. In its weak form, super-refraction merely causes a decrease in attenuation beyond the horizon, particularly at centimetre wavelengths.

For communication at metre wavelengths, and particularly for air-to-air communication, elevated ducts associated with subsidence-inversions are likely to be quite important and should be made the subject of special investigation.

Dr. Booker also pointed out that in recent years the scattering properties of the atmosphere, as distinct from its refractive properties, have come to attention. It appears that field-strength appreciably beyond the horizon is often due not to diffraction round the curved surface of the earth nor to refraction in the atmosphere but rather to scattering from the "illuminated" region of atmosphere above the horizon down into the "unilluminated" region below the horizon. This scattering arises from the statistical variations of the atmosphere which are also the primary cause of fading and of sound echoes from the atmosphere. Radio echoes from the atmosphere known as "angels" almost certainly have another explanation, however, such as birds and insects.

Current and future trends in the field of aviation communications equipment were discussed by John D. Woodward, Radio Corporation of America. General discussions included such items as: overall communication systems, selectivity problems, frequency generation, automatic antenna tuning, interphones, etc. Recordings were played to demonstrate some of the noise and acoustic problems associated with microphones.

In pointing out design trends in electronic components for airborne equipment, Frederick J. Given of Bell Telephone Laboratories centered attention on "miniaturization". During the war this word had particular significance, he said, for assemblies of components called "printed circuits" for use in ordnance devices. The success of achievements in this direction has acted as a trigger to stimulate widespread effort to obtain greatly reduced size in all electronic equipment including its accessories.

Guest of honor at the Airborne Electronics Conference was Brig. Gen. Tom C. Rives. Gen. Rives, as Chief of Electronic Subdivision, Air Materiel Command, announced his retirement effective June 30, thereby culminating 31 years of Military service. He will continue activities with the electronics field in basic research at University of Illinois

Much of this effort includes the unit packaging of small components which function together as a unit circuit such as an amplifier or oscillator. Unit packaging may involve the idea of printed wiring or it may involve alternative means of compacting components and their connecting wires.

Effort in this direction requires companion action in size and weight reduction of bulkier components even though their use may be less frequent. These include dynamotors, switches, transformers, high voltage capacitors, and variable air capacitors. Additional effort should be directed at the use of new or simplified circuitry such as may come about from the adoption of 400 or 800 cycle power supply frequency or the adoption of radically new circuit elements such as the transistor.

An unusual paper was presented by Dr. Paul M. Fitts of Air Materiel Command on psychological aspects in the operation of airborne electronic systems. Three general areas in which engineering psychology can contribute to the design and operation of airborne electronic systems are (1) improved detection of signals; (2) improved ability to interpret the significance of information; and (3) improved control and systems characteristics.

The visibility and legibility of visual radar displays are primarily a function of size, brightness, contrast, and pattern characteristics of the returns. Contrast should be maximized, but there is usually an optimum size for any display above and below which performance of a human operator decreases. Other factors are color, level of general illumination in the work-place, and psychological considerations in minimizing the effects of noise.

Adequate comprehension and interpretation of information depends on considerations different from those that determine visibility. Some of these factors, such as the coordinate systems used to represent spatial relationships, were reviewed in the presentation.

The efficient operation of airborne electronic systems depends also on adaptation of the system to utilize the output side of the human operator. Here we are concerned with discrete adjustment of various controls and switches, and also with situations in which the human is asked to function as a continuous, error-minimizing control system.

Exhibitors at the conference included the Aircraft Radio Corporation, Boonton, N. J.; American Phenolic Corporation, Chicago, Ill.; Collins Radio Company, Cedar Rapids, Iowa; Alfred Crossley & Associates, Chicago, Ill.; Dayton Aircraft Products, Inc., Dayton, Ohio; General Radio Company, Cambridge, Mass.; Radio Corporation of America, Camden, N. J.; SREPCO, Inc., Dayton, Ohio; The Superior Electric Company, Bristol, Conn.; Sylvania Electric Products, Inc., New York, N. Y.; and Western Electric Company, New York, N. Y.

Officers of the Dayton IRE Technical Conference were John E. Keto, President; Charles S. Helldoerfer, Vice President; Charles J. Marshall, Secretary; and Joseph General, Treasurer. The directors included G. H. Arenstein, H. E. Ruble, G. Rappaport, E. Berens, J. W. Heyd, W. H. Vance, Jr., L. B. Hallman, Jr., L. D. Killheffer, H. V. Noble, E. L. Adams, and L. P. Richmond.

Minimizing Internal Reflections in TV Tube

New luminescent screen manufacturing technic developed by Dr. Lee de Forest, U. A. Sanabria and associates also reduces halation effects

THE problem of securing adequate picture definition has usually been attacked by the perfection of the electrical circuits, with relatively little attention to the correction of other aberrations in the picture receiving tube system The main differences between the cathode-ray tube of 1949 and those of today have been the shortening of the overall tube length, simplifying the electron-gun structure and the metal-backed screen. Only the latter influences directly the character of the reproduced image. Of late. optical considerations have become of prime importance due to the fatigue developed in the optical muscular system associated with the viewer's eyes. While there has been marked progress in improving the definition obtainable in a television system, less improvement has been noted in the contrast ratio of the screen itself, an aspect that we are concerned with here.

The factors which control the con-

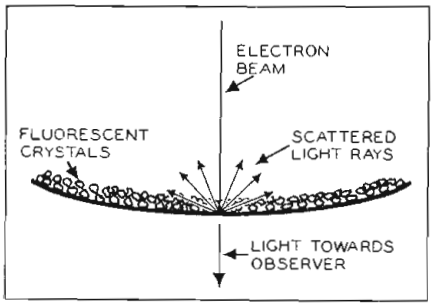


Fig. 1: Diagram showing scattering of light rays in screen of normal cathode ray tube

trast ratio limit obtainable from a cathode-ray tube screen are well-known and consist principally of halation due to total internal reflection at the screen, diffuse reflection and scattering in the screen material surrounding the illuminated spot, curvature of the screen, and reflections from the walls. These factors are listed in the order of their importance as they affect detail and field contrast, the first two being considerably detrimental to contrast.

The usual fluorescent screen is crystalline in structure. When a certain spot is excited light is uniformly emitted in all directions, Fig. 1. The light generated within the crystal does not come directly out, but may be internally reflected many times before escaping from the crystal. Much of the light either travels back into the tube or sideways toward the neighboring crystals,

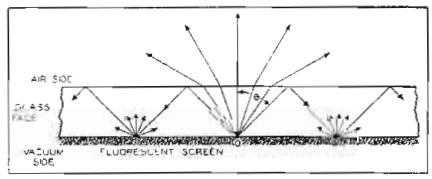


Fig. 2: Halation in a cathode ray tube

giving reflection and dispersion. Instead of a sharply defined spot on the screen, we see a bright blob of light, with the light intensity decreasing rapidly with distance in the immediate vicinity of the bombardment point and then slowly as the distance becomes relatively great. This extra halo washes out the black areas of the image.

An observer viewing an image on a conventional cathode-ray tube under normal ambient light conditions in the home finds that he can set the contrast control at a point which provides excessive illumination of the white portions of the image and achieve what he considers better contrast. Actually, the blacks do not become blacker by this action; and may even become more greyish due to a greater amount of scattered light. An illusion of deep black is achieved because eye fatigue caused by greater intensity of the whiter portions of the image. This illusion can be demonstrated when a test pattern containing definite black areas is viewed on a tube from which the cabinet mask has been removed but retaining the standard 4:3 aspect ratio: compare the intensity of such a black area with that of the unilluminated portions of the screen. It will appear that this segment is blacker than the screen background! Then block out all of the white shading surrounding the black segment of the pattern, and its blackness will then match the background shade of the unused portion of the screen, or be even less black than the screen background.

The methods for reducing hala-

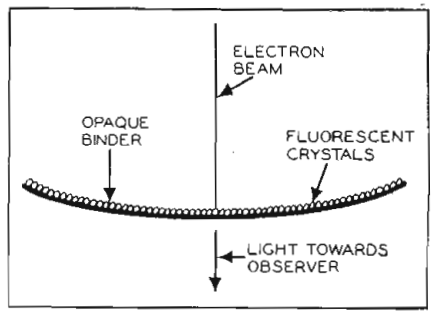


Fig. 3: Repression of scattered light rays in the corrected screen recently developed

tion have been explored and to the extent that they can be employed economically, have been adapted to present cathode-ray tubes. Research at the Tube Division of American Television, Inc. was directed toward reducing the undesirable effects of light scattering and diffuse reflection in the screen material surrounding the illuminated spot. The objective was to imprison and localize the light created by the electron beam on the luminescent screen so that side dispersion was eliminated. Investigation revealed that an opaque powder, such as managanese dioxide in combination with sodium metasilicate, dispersed between the fluorescent crystals in a satisfactory manner as long as the opaque powders used are not detrimental to the cathode-ray tube itself, i.e., do not give off gas or produce undesirable chemical formations with the luminescent powder. Opaque substance provides a barrier between the luminescent particles, and if the quantities and proportions are properly chosen, a screen of substantially single-crystal thickness is

(*Continued on page 57*)

TELE-TECH's NEWSCAST

TBA Requests Partial Lifting of TV "Freeze"

A letter signed by J. R. Poppele, president, the Television Broadcasters Association, Inc., 500 Fifth Ave., New York City, has requested the FCC to permit a partial unfreezing of applications for new television stations. It contends that in eleven market areas twenty-two channels could be assigned without complicating the tropospheric interference question. These markets are: Amarillo, Texas, five channels; Denver, Colo., one channel; El Paso, Tex., two channels; Sacramento, Calif., three channels; Salt Lake City, one channel; Corpus Christi, Tex.. three channels; San Diego, Calif., two channels; San Francisco, Calif., one channel; Stockton, Calif., two channels; Tacoma, Wash., one channel.

The request is based on the grounds that the continued application of the freeze is causing confusion and distress to manufacturers who are unable to make long range plans for transmitter and receiver production. It also asserts that the "unfreeze" would not only aid the manufacturers to avoid the jamming caused by the backlog of orders when the freeze is lifted, but would permit hearings to be held in those cities where the number of applications outnumbers the available channels. This would enable the successful applicants to place orders for equipment, thus keeping factories busy during this somewhat slack time and materially aiding the national economy.

68 TV Stations Now on the Air

Two more television stations began telecasting in June, bringing the national total to 68, an increase of 17 stations since January 1.

Latest entries are: WHAM-TV in Rochester, N. Y. and WKY-TV in Oklahoma City, reports TBA. TV box-score now reads:

Stations Operating (In 38 US market areas)	68
CP's Granted (Including 26 new markets)	50
Applications Pending	331

1949 Radio Fall Meeting

Formerly known as the Rochester Fall Meeting, the 1949 Radio Fall Meeting will be held October 31 through November 2 at the Hotel Syracuse, Syracuse, N. Y. under the sponsorship of the RMA for its members and members of the IRE. Officers of the Fall Meeting committee are: Virgil M. Graham, chairman; R. W. Ferrell of the General Electric Co., vice chairman and treasurer; and R. A. Hackbusch of Stromberg Carlson of Canada, Ltd., secretary.

Dr. Du Mont Honored by Brooklyn Polytech

Dr. Allen B. DuMont was honored June 15 with the degree of Doctor of Engineering during the 94th annual commencement of the Polytechnic Institute of Brooklyn, N. Y.

The citation read: "Allen Balcom Du Mont, inventive genius, able and creative engineer, courageous and resourceful industrialist, your achievements in the science, the art and the industrial management of television have been widely recognized by members of professional societies and trade associations, and by the ultimate beneficiaries of your genius, the American people."

WTCN-TV Joins CBS

The total number of CBS-TV affiliates has been brought to 41 with the addition of WTCN-TV, Minneapolis-St. Paul, on July 1. The new outlet has been assigned channel 4 and will operate with 17.9 KW visual power and 9.2 KW aural power.

TV TUBE PRODUCTION PASSES MILLION MARK

The one-millionth television picture tube produced at RCA's Lancaster plant is being inspected by Frank M. Folsom (left), president of RCA, and L. W. Teegarden (center), vice president in charge of technical products, after a special telecast marking the event over the NBC network. J. G. Wilson (right), executive vice president of RCA Victor Division looks on

Coming Events

August 19-20—Tenth Annual Seminar, IRE, Emporium Section, Emporium, Pa.

August 23-26—American Institute of Electrical Engineers, Pacific General Meeting, Fairmont Hotel, San Francisco.

August 29 - September 1 — Associated Police Communication Officers, National Conference, Hotel New Yorker, New York City.

August 30-September 2—1949 West Coast Convention, IRE, and West Coast Electronic Manufacturers Association 5th Annual Pacific Electronic Exhibit, Exposition Auditorium, Civic Center, San Francisco.

September 26-28—National Electronics Conference, Edgewater Beach Hotel, Chicago.

September 30-October 9—2nd Annual National Television & Electrical Living Show, Chicago Coliseum.

October 17-21—American Institute of Electrical Engineers, Midwest General Meeting, Netherland Plaza Hotel, Cincinnati, Ohio.

October 31-November 2—1949 Radio Fall Meeting (formerly Rochester Fall Meeting). sponsored by Engineering Dept., RMA; Hotel Syracuse, Syracuse, N. Y.

WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by Tele-Tech's Washington Bureau

CONSTRUCTIVE FCC TV BLUEPRINT PLAN—Assured that TV progress will continue on its present favorable upclimb and that televiewers need have no concern whatsoever about the usefulness and value of their present sets, the television industry and the FCC in the latter part of this summer will join in hearings that will be of tremendous importance to the future of the art of video. Consolidation of all the major television problems—the lifting of the present "freeze" on the 12 VHF channels; a plan to open up the lower half of the UHF-890 MC band for commercial **and color** telecasting; the need for a new VHF TV channel spacing plan: and experimentation in stratovision, polycasting and broad band mobile radiotelephone transmission—was determined by the FCC in its recent order.

A BROAD-GAUGED RULE-MAKING PROGRAM is called for and this now looms as probably a most constructive and progressive step for the video industry. Hearings will probably not occur until the latter part of August: with the filing of comments after the issuance of proposed rules and oral arguments consuming a month; and finally the issuance of the final rules. Thus it is not anticipated the final rules decision will be handed down by the Commission until November or December at the earliest, but more probably during early 1950.

TELEVIEWERS ASSURED OF RECEIVER UTILITY—Most important for the television industry was the firm position of the FCC that present television set owners need not fear for the future value and utility of their receivers. The Commission reaffirmed officially the plans of the television set manufacturing industry that use of the present VHF standards for operation on the UHF channels would be efficacious because the industry will furnish suitable and economical converters at a relatively low cost to the public. A week after the FCC plan was revealed, the Radio Manufacturers Association's leaders reiterated the industry's offer of simple and inexpensive converters.

GOVERNMENT-INDUSTRY COOPERATION IN MOBILE RADIO—Outstanding examples of government-industry cooperation are being given in the mobile radio telephone field—the Petroleum Industry and Power Utilities have recently established operational patterns and blueprints for frequency assignment and coordination which will be of great assistance to the FCC Engineering Staff. Latter government agency with a relatively few technical staff engineers could not possibly do a nationwide job of assigning and coordinating the frequencies. Both industries have established regional frequency coordination committees to formulate assignments in an orderly pattern with the least amount of interference within their own mobile radio services and to other services.

STRIDES FOR FREQUENCY SAVING — Great strides in improvement of mobile radio telephone equipment operations which have been recently made have attracted attention of the FCC and the users of these services. Motorola and RCA have just tested successfully base station-mobile unit functioning through new apparatus on adjacent channels without interference so that the existing channels' usage can be doubled. Federal Telephone & Radio has announced a new low-cost and lightweight small-packaged mobile transmitter-receiver unit with great potentialities for radio-equipped vehicles.

MORE RESEARCH NEEDED IN AVIATION ELECTRONICS-RADIO—Aviation electronics and radio, especially in air navigation control, is becoming more and more a major potential for the radio industry's manufacturing and research companies. Civil Aeronautics Administrator D. W. Rentzel, former president of Aeronautical Radio Inc., emphasized in his recent address before the joint meeting of the Royal Aeronautical Society and the U. S. Institute of Aeronautical Sciences in Washington that to achieve the ultimate $1.3 billion program of the Special Committee 31 of the Radio Technical Commission for Aeronautics intensive research must begin at once. He cited that the principles on which the ultimate system will operate are known today "but many of the needed devices have not yet been developed."

THE OMNIRANGE PROGRAM will be in fairly wide operational use by 1950 and by 1954 will probably become the air navigation standard, Mr. Rentzel foresees; DME and course line computers are slated for final development both ground and airborne in 1950 with operational use coming soon thereafter; and very high frequency air-ground communications is being adopted widely by commercial, military and private aviation.

MISCELLANY—Senator McFarland of Arizona, chairman of Senate Interstate Commerce communications-radio subcommittee, sponsors bill with hearings staged in mid-June which divides FCC into divisions to take care of major workloads and authorizes badly-needed increase to $15,000 for Commissioners.

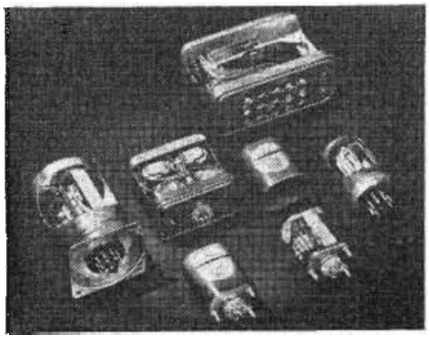
National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

New Parts for Design Engineers

Hermetically Sealed Relays

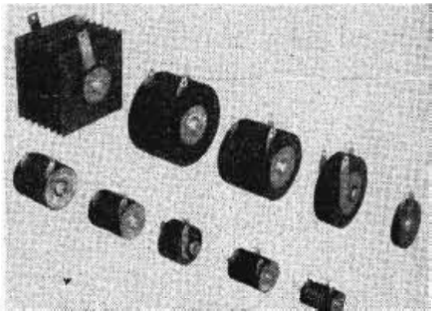
Sealed in a controlled atmosphere of dry, inert gas, this new line of relays is completely protected from the harmful effects of



moisture, ice, dust, fungi, salt and varying air pressure. Because they are enclosed in a metal housing, the relays are also tamperproof. Requirements of temperature, humidity and immersion tests as described in current armed forces specifications are satisfied. Relays will accommodate operating potentials from a fraction of a volt to several hundred volts, and contact ratings vary from a few milliwatts to several hundred watts.—**Automatic Electric Sales Corp., 1033 Van Buren St., Chicago 7, Ill.**

Selenium Rectifiers

A new line of high voltage selenium rectifiers has been developed in which the voltage per cell is twice that of the company's



previous design. The new rectifiers are designed for a DC voltage of 24 volts per cell with an RMS AC voltage of 33 per cell for single phase bridge circuits. They are available in 6 round sizes from 1 to 4⅜-in. and in 5 x 5 square and 4¼ x 6-in. sizes.—**Westinghouse Electric Corp., Metallic Rectifier Section, East Pittsburgh, Pa.**

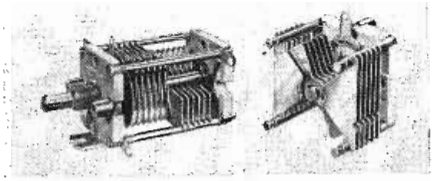
Relay

The magnetic circuit elements of the model SM super midget relay all perform multiple functions which permit drastic reduction in

size without loss of operating efficiency. Dimensions of the open relay are ⅝ in. diameter by 1 5/16 in. long over-all; weight is less than ½ oz. and volume is less than ¼ cu. in. Windings are available up to 3400 ohms permitting operation to 75 volts DC with minimum sensitivity of 5 MA at 80 milliwatts. The contacts are pure coined silver, conservatively rated at 2.5 amps for 100 operations, 1 amp for 50,000 operations or .25 amp for continuous operation on 115-volt, 60-cycle non-inductive load.—**Potter & Brumfield, 549 West Washington Blvd., Chicago 6, Ill.**

Variable Capacitors

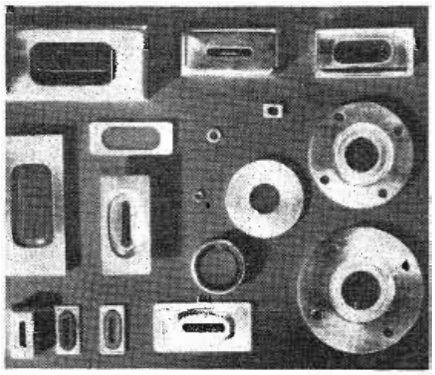
The ceramic band on the Johnson 167 variable capacitors is stronger than the rugged steatite and plates themselves. There are no



eyelets, nuts or screws to work loose and cause stator wobble and capacity fluctations. Stator terminals mounting posts and rotor bearings are ceramic soldered. Two sets of stator contacts are provided for connecting components to either side of the capacitors without appreciably increasing lead inductance of the circuit.—**E. F. Johnson Co., Waseca, Minn.**

Waveguide Windows

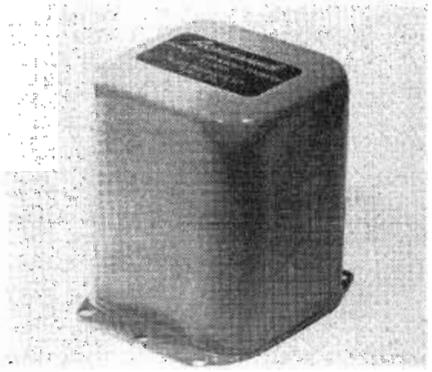
Glass stress is eliminated at the relatively high temperature differentials required for silver soldering with new glass waveguide



windows, now available in a wide range of window shapes and outside contours. Designed to operate in micro-waveguide systems ranging from 3,000 to 40,000 MC, the window-units have power losses from .02 to .1 DB. Those which are engineered for frequencies above 2500 MC will withstand pressures up to 65 psi absolute.—**Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.**

Input Transformer

A simple and positive method of connecting a reluctance type phonograph cartridge to high impedance input channels of receivers



and amplifiers is provided by the TI-100 input transformer. Its high step-up ratio supplies the voltage necessary to energize crystal input channels in which the wide range, better quality crystal cartridges have been used. 15 DB of bass boost starts from a turnover point of close to 350 cps and rises at a rate of approximately 6 DB per octave. High frequency response extends to 10 KC with gradual rolloff based on average recording pre-emphasis. A greater or lesser degree of high frequency response can be readily obtained by increasing or decreasing the resistance terminating the transformer.—**Acro Products Co., 5328-30 Baltimore Ave., Philadelphia 43, Pa.**

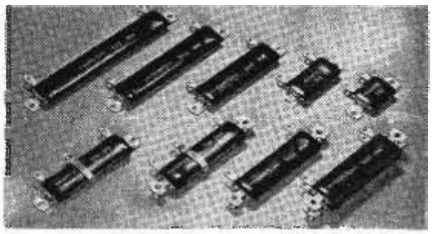
Isolation Transformers

Three isolation transformers with 50, 150, and 250-VA capacities have been designed for two purposes: adjustment of high or low

voltages for operation on normal 115 volts; and to promote safer, more efficient servicing or experimental work on electronic gear by isolating chassis grounds from line grounds. Beside providing 115 volts, the secondaries of these transformers will also supply 125 or 105 volts to facilitate the location of faulty set components.—**Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.**

Wire Wound Resistors

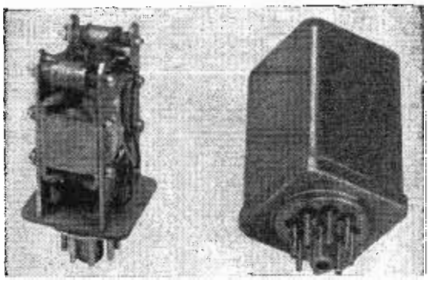
Wire-wound, vitreons-enameled (Thin-Type) resistors provide higher wattage per unit of space and are particularly useful



when space is limited. These resistors can be supplied in a single unit mounting bracket which allows the resistor to be mounted close to the mounting surface; or with a stud bracket which provides for the stacking of 2 or more units. The brackets, extending the entire length of the resistor core, tend to spread developed heat evenly throughout the resistor and quickly conduct heat to the air and mounting surfaces. Lengths vary from 1½ in. for the 30-watt size to 6 in. for the 75-watt size.—**Ohmite Mfg. Co., 4835 Flournoy Ave., Chicago, Ill.**

Polarized Relay

Developed under a Signal Corps contract specifying miniaturization and improvement of existing types of high speed telegraph key-

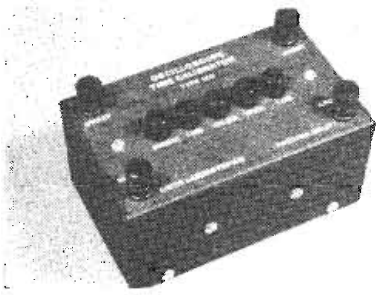


ing relays, the Sigma type 7 JOZ is a sensitive SPDT polarized relay measuring 1⅝ x 1⅝ x 2⅝ in. It is hermetically sealed and fits a standard octal tube socket. Contacting time is essentially bounce-free and characteristic distortion is entirely absent except at the very highest speeds. Although designed to handle 50 to 150 WPM, the relay is servicable up to 250 WPM. Transfer time is dependent on driving circuit but is less than 1 millisecond.—**Sigma Instruments, Inc., 70 Ceylon St., Boston, Mass.**

New Lab and Test Equipment

Oscilloscope Time Calibrator

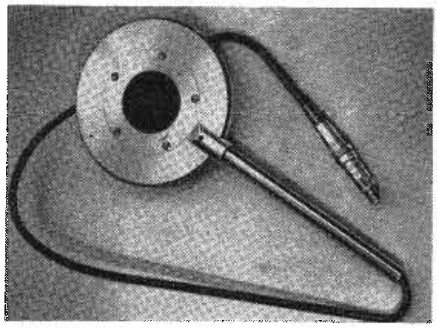
Measurements of elapsed time between any 2 points on an oscilloscope trace can be easily and conveniently made with the type



160 time calibrator. This unit is inserted in the lead from signal source to oscilloscope input, and at the touch of a button allows either the desired signal to be observed, or places time markers along the horizontal sweep. These markers appear as the crests of a damped sine wave, having a frequency of 1, 10, or 100 KC, or 1 MC. While the 160 requires no AC or DC power supply, a single connection is made to the oscilloscope sweep sawtooth voltage.—**Owen Laboratories, 9130 Orion St., San Fernando, Calif.**

Piezoelectric Gauge

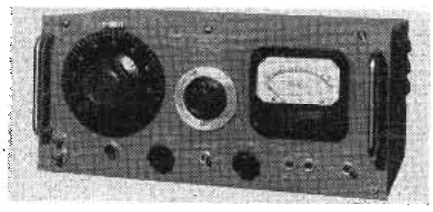
For those who need to measure pressures of "instantaneous" or "explosive" nature, a new model piezoelectric gauge is available



which will give faithful measurements of transient pressures varying from a few pounds to 30,000 psi. The gauge works on the principle that when certain types of crystals are placed under sudden compressive stress, an electric charge is generated which is proportional to the stress. Usefulness of piezoelectric gauges lies in their ability to measure shocks of high magnitude when transmitted through liquids, gases, and in some cases, through solids.—**Cambridge Thermionic Corp., 439 Concord Ave., Cambridge 38, Mass.**

Carrier Frequency Voltmeter

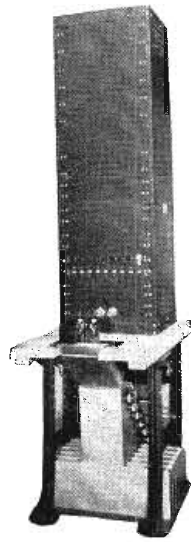
Tunable over the carrier-frequency spectrum from 3 to 40 KC the model 103 Voltmeter measures levels from 77 microvolts to 77



volts or —80 to +40 DBM (zero DBM: 1 milliwatt in 600 ohms). These levels are read on a 4-in. indicating meter calibrated in DB. Selectivity is such that a signal is 10 DB down 1 KC off resonance, 21 DB at 2, and 50 at 4. Indicated as being particularly useful in checking carrier telephone and telegraph systems, the unit consumes 80 volt-amperes operating from 105 to 125 volts on 60-cycle power mains through a built-in regulated power supply.—**Sierra Electronic Corp., 1210 Old County Rd., Belmont, Calif.**

Auto-Bridge

The Auto-Bridge tests and sorts resistors, capacitors or other impedances into as many as 8 groups according to standards prede-



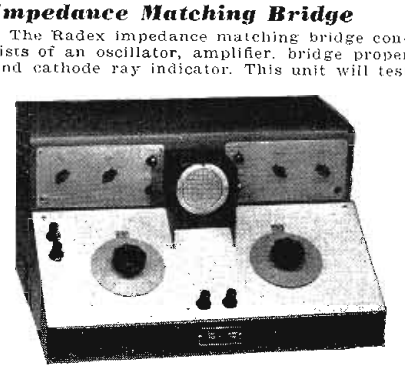
termined by plug-in ratio-coils. Standards and jig fixtures are available to meet any specific requirements. The operator holds the test piece against the jig and the testing and sorting mechanism is activated. A chute with electrically-operated trap-doors automatically routes the piece to the proper bin.—**Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.**

DC Amplifier

Model EDA is a high gain DC amplifier designed to be used with an oscilloscope for viewing phenomena having components ranging from DC to 30 KC. The amplifier and its power supply are separate units and are mounted in a relay rack type of cabinet. Power consumption is 250 watts, 115 volts, 60 cps. Frequency response is rated from DC to 10 KC ±5%; DC to 30 KC ±20%; DC to 45 KC ±30%. Drift is less than equivalent of .5 millivolt input in 5 minute period. Maximum output voltage is 400 peak-to-peak.—**Electronic Tube Corp., 1200 East Mermaid Lane, Philadelphia 18, Pa.**

Impedance Matching Bridge

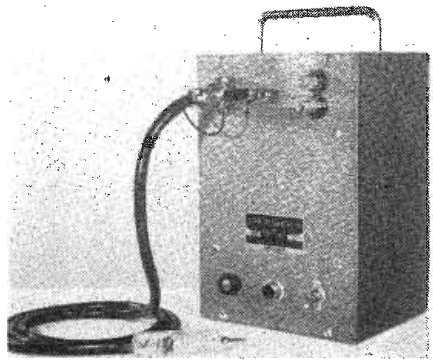
The Radex impedance matching bridge consists of an oscillator, amplifier, bridge proper and cathode ray indicator. This unit will test



all coils having inductances of .002 to 60 mh; condensers having capacities between 2 μf and 50 μμf and resistors ranging between one and 30,000 ohms. The percentage of accuracy may be adjusted from 3% to less than .015%. Balance indicator is a 3-in. cathode ray tube. Balance is indicated by observing the position of the trace which can be brought to a straight line from circular or elliptical shape by use of the resistance bridge arm. The straight line can then be made to rotate to ±45° by variation of the reactance bridge arm setting.—**Radex Corp., 2076 Elston Ave., Chicago 14, Ill.**

Bridger

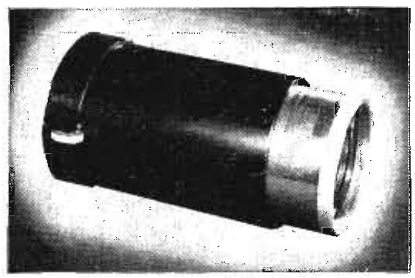
The model 100 bridger provides a means for bridging a vacuum tube voltmeter, distortion meter and/or oscilloscope across any part of



an audio frequency circuit through a well shielded cable without imposing a load on the circuit. Input impedance is 100 megohms in parallel with 8 μμf when using 3-ft. shielded input cable. Output impedance is 200 ohms with one side grounded. The model 100 uses an advanced design of cathode follower (with output/input ratio practically unity) and a new development in double-shielded cable. The cable capacity is almost completely balanced out by the circuit configuration.—**Audio Instrument Co., 1947 Broadway, New York 23, N. Y.**

Oscillograph Lens

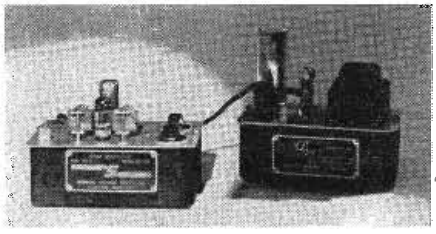
Type 2542 oscillographic projection lens is a 2-element, symmetrical, objective lens having a relative aperture of f/3.3 and a focal



length of 7.7 in. The lens projects an oscillographic pattern having an area up to 3 sq. in. to distances from 8 to 30 ft. from the screen of the cathode ray tube. This results in a picture that may be as large as 12 sq. ft. Axial light transmission of the system is approximately 85%. Mounting of the lens is accomplished with a bezel (type 2501) which may be obtained as a separate item.—**Allen B. Du Mont Laboratories, Inc., 1000 Main Ave., Clifton, N. J.**

Noise Generator

Providing a random noise with equal power in equal bands throughout the audio frequency spectrum and a substantial RF output if

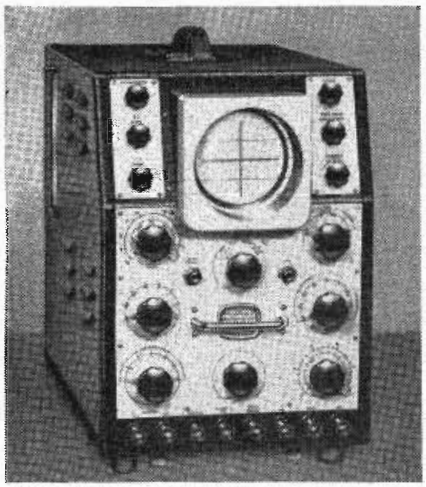


desired, the 810-A noise generator has been designed for use in research engineering and production testing. Conveniently operated with the type 20-A supply, this generator incorporates one 6C4 and one 6D4 tube and has an audio-frequency output voltage from 0 to 0.2 volts. Frequency range is 30 cps. to 500 KC in the RF range and 30 to 20,000 cps. in the AF range. — **Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass.**

New Lab and Test Equipment

Oscilloscope

Featuring DC amplification, the model 1049 shows 2 traces with independent vertical amplifiers. Precision, direct reading, dial



calibration of time intervals and amplitude for all gain and sweep positions and triggered sweep and 10 MC bandwidth are provided. Instruments are supplied with actinic blue, visual green or long persistence screens.—**Beam Instrument Corp., 55 West 42nd St., New York 18, N. Y.**

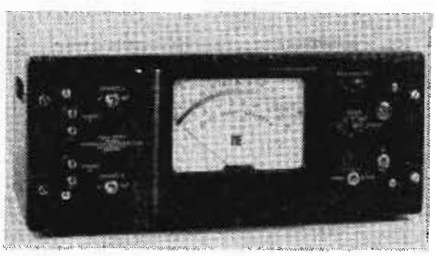
Grid Dip Meter

Compact and completely self-coutained, model 90651 grid dip meter has a transformer type AC power supply. The instrument's drum

dial has 7 calibrated uniform seale lengths from 1.5 MC to 270 MC with generous overlaps, plus an arbitrary scale for use with special application inductors. Internal terminal strip permits battery operation for antenna measurement.—**James Millen Mfg. Co., 150 Exchange St., Malden 48, Mass.**

Phase Meter

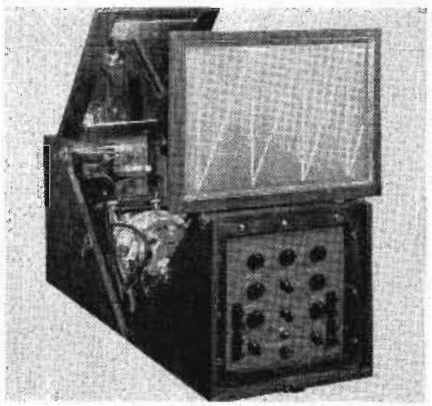
The type 320-A phase meter is a completely electronic instrument for the direct measurement of the phase difference between 2 volt-



ages. Direct readings of phase angles without ambiguity are indicated on a large meter which has 4 full scale ranges of 360°, 180°, 90°, and 36°. In addition, 180° phase reversing switches are provided. The instrument is designed for operation at audio and supersonic frequencies and, with some sacrifice of accuracy, may be used at sub-audio frequencies. Its operation is essentially independent of applied voltage, wave shape and frequency, and no adjustments, balances or corrections are involved. List $475.—**Technology Instrument Corp., 1058 Main St., Waltham 54, Mass.**

Portable Projection Oscilloscope

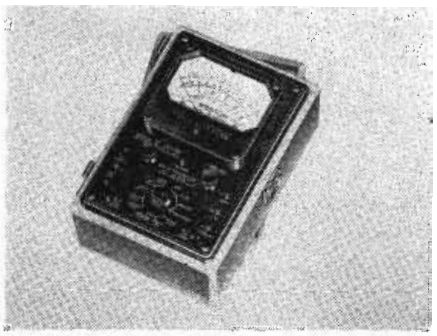
Model 701 portable projection oscilloscope produces an oscillogram approximately 16 in. wide by 12 in. high, a large-size picture capa-



ble of being viewed by large groups. The "Norelco" projection system is used and when folded up, the cabinet is approximately 13 x 16 x 19 in. Model 701 has all the controls of a conventional oscilloscope and provisions are also made for external, 60 cycle or internal sweep synchronization; 6.3 volts AC signal is available from binding posts The vertical deflection sensitivity is approximately 60 millivolts rms per in., or 0.6 volts for full scale deflection. Horizontal deflection sensitivity is approximately 0.65 volts rms per in. or 1 volt full scale. Vertical amplifier response is good to 50 KC and usable to 100 KC. Horizontal saw-tooth sweeps are good to 2 KC and usable to 5 KC.—**Beta Electric Corp., 1762 Third Ave., New York 29, N. Y.**

Speech Circuit Analyzer

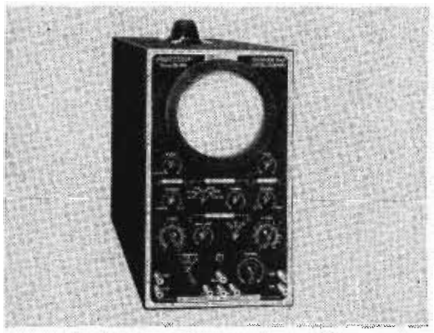
An analyzer designed specifically for communication system maintenance—telephone, carrier current, and transmission line measure-



ments—measures low level speech circuits with a minimum of disturbance. It is entirely self-contained, requiring no power line connection. Designed in cooperation with railway signal and telephone engineers, the new analyzer, known as the model 779 (Type 5), makes DBM readings at all audio and carrier current frequencies. AC response is essentially flat to 50 KC within 1 DB over the range—20 to +22 DBM, and is useful for comparative DB readings on all common carrier current frequencies above 50 KC. Complete ranges to 1,000 volts AC and DC, current from 100 microamps. to 10 amps., and resistance ranges from 1,000 ohms to 10 megohms, along with a transmission measuring instrument calibrated in ½-DB steps, make this new analyzer a general utility instrument for communications measurement work.—**Weston Electrical Instrument Corp., Frelinghuysen Ave., Newark, N. J.**

Oscillograph

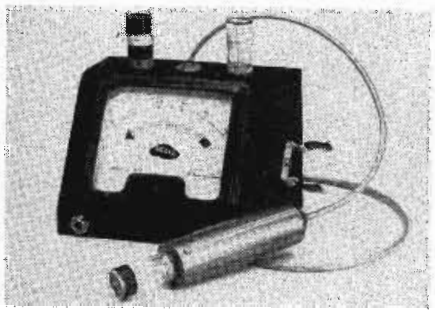
Series ES-500, 5-in. cathode ray oscillograph has been specifically engineered for the alignment and adjustment requirements



of modern laboratory electronic apparatus. The series ES-500 has an extended range vertical amplifier response to 1 MC and an input resistance of 2 megohms and an input capacity of approximately 20 μμf. Direct linear internal sweep coverage is provided from 10 cycles to 30 KC. Net $149.50.—**Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y.**

Resonance Indicator Converter

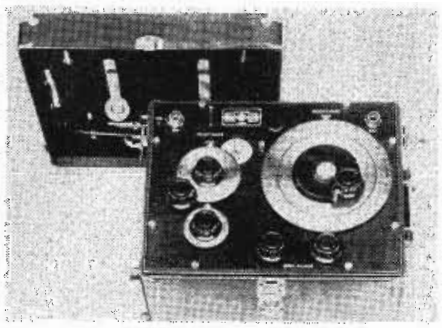
Any signal generator or test oscillator can be converted into a direct reading resonance indicator with the addition of model 915 test



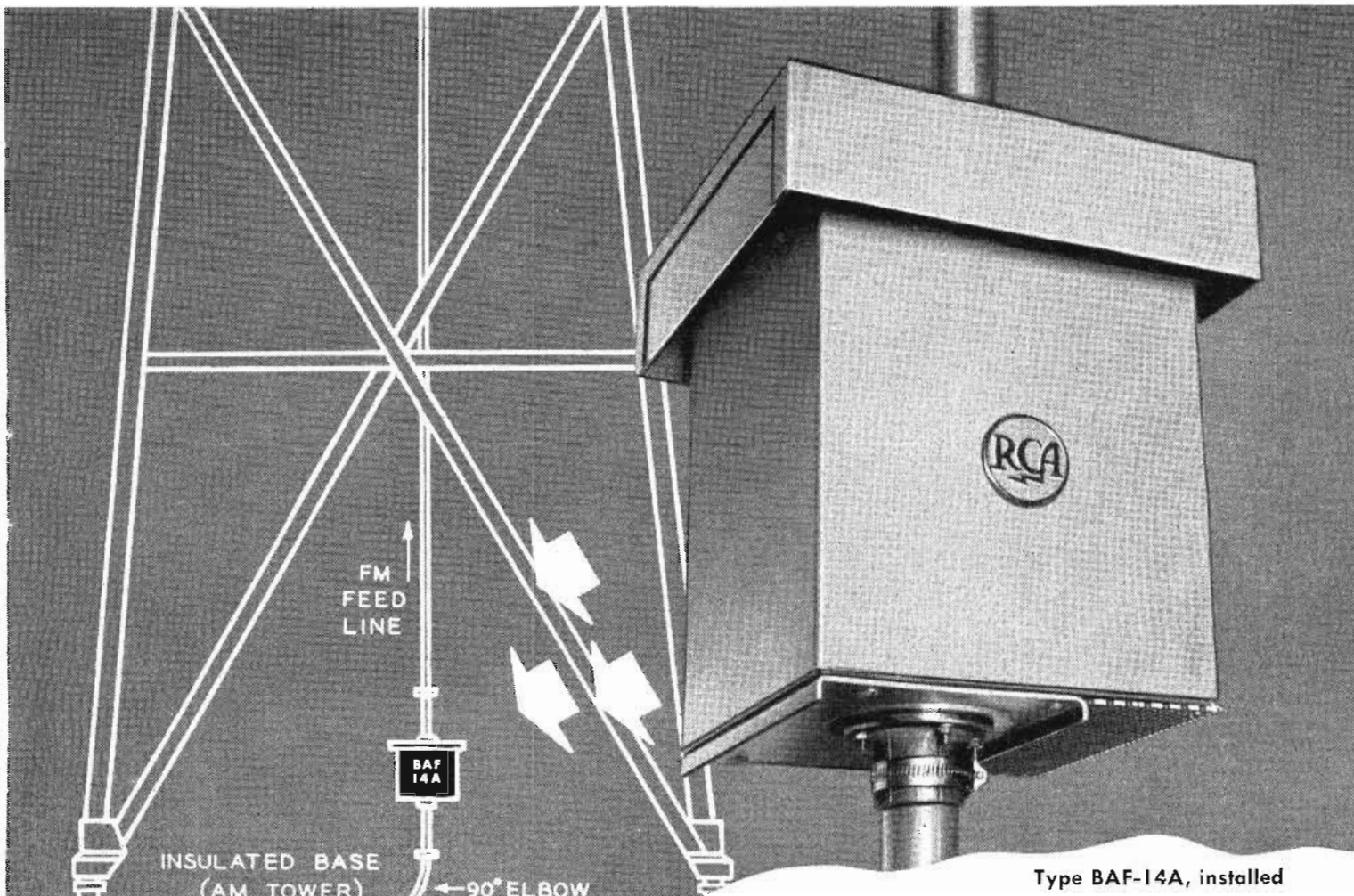
equipment unit. This instrument has a continuous frequency range of 100 KC through 300 MC when used with three specially designed probe coils.—**McMurdo Silver Co., Inc., 1240 Main St., Hartford 3, Conn.**

Impedance Bridge

Covering a normal frequency range of 50 KC to 5 MC, the 916-AL impedance bridge is a modification of the previously-developed



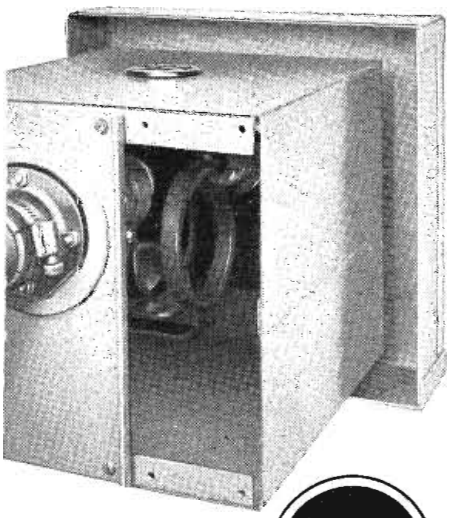
high frequency design and can be used at frequencies as low as 15 KC. The bridge reads directly in resistance at all frequencies, and directly in reactance at 100 KC. For other frequencies, reactance readings are divided by the frequency in hundreds of kilocycles. Resistance range is zero to 1,000 ohms. Reactance range at 100 KC is 11,000 ohms. The bridge will measure resistors, capacitors, inductors, lines, antennas and other networks. Its sensitivity in the standard broadcast band is considerably better than that of the higher-frequency model. List $450.—**General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**



Type BAF-14A, installed

...isolates the FM feed from your AM tower ...the easy way

Close-up view of the BAF-14A with the shield removed.



New design—New low price*

● The new RCA Type BAF-14A Isolation Unit enables you to transfer FM power effectively across the insulating zone of your AM tower . . . *and makes it possible to completely isolate the FM and AM signals from each other.* The unit maintains a low standing wave ratio on any FM channel and has minimum effect on AM tower impedance. Type BAF-14A will handle up to 10 kilowatts of FM power—with AM base insulator voltages up to 14 kv, peak!

In this Isolation Unit, two series-resonant circuit loops are coupled to each other in such a way as to provide excellent band-pass characteristics over the range of 88 to 108 Mc. Each circuit connects directly to its respective input or output transmission line—terminating in an end-seal. Provision is made to carry the gas pressure line across the unit.

It's a simple matter to connect up the BAF-14A . . . *because the input and output terminals are both equipped with special swivel flanges that eliminate expensive special coaxial fittings.*

Built in a weatherproof metal box, only 12" x 12", the BAF-14A Isolation Unit is delivered ready to go. No tuning or adjustments to go through after installation.

Ask your RCA Broadcast Sales Engineer how the BAF-14A can solve your tower coupling problem. Or write Dept. 87G, RCA Engineering Products, Camden, N. J.

*Ask your Broadcast Sales Engineer

BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

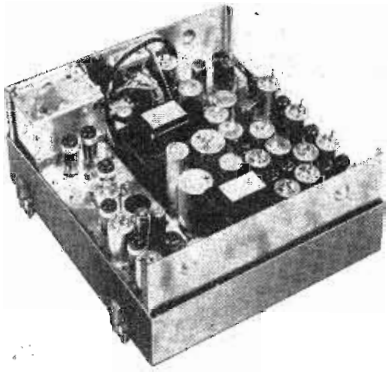
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

TV, Sound & Communications Components

Mobile Radiotelephone

A power output of 10 watts on any frequency in the 152-162 MC band is provided by the FT-145-10 mobile radiotelephone, a



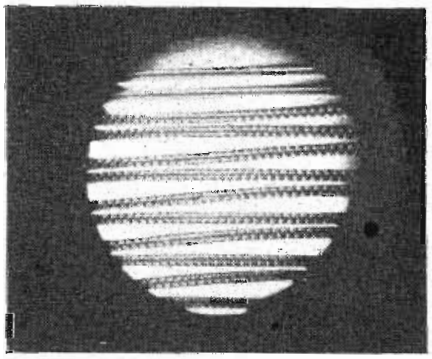
new unit which was designed for reliable operation over long periods of time under adverse weather and terrain conditions. Engineered to meet RMA test recommendations, the FT-145-10 draws only 7.3 amps. standby and 23.9 amps transmit, thereby allowing in many cases, the use of existing vehicle generators and batteries. Special vibration-proof RF coils to assure maximum stability and selectivity and a novel neon squelch to facilitate fingertip control of the squelch were included in the design of the unit. All tuning operations are performed from the top; "desk-drawer" accessibility plus plug-in connections permits replacement of equipment in a matter of minutes. Overall size is 5 5/16 in. high, 12 3/16 in. wide, and 14 1/8 in. deep. List $350. — **Federal Telephone & Radio Corp., 100 Kingsland Road, Clifton, N. J.**

Recording Wire

Super-Tone recording wire, precision-made of high-fidelity stainless steel, is the latest addition to the Recordisc line of home and professional recording blanks. The spools are made of aluminum and are available in packages which contain a handy, useful guide to help the wire recording enthusiast make better recordings.—**Recordisc Corp., 395 Broadway, New York, N. Y.**

Intermodulation Test Record

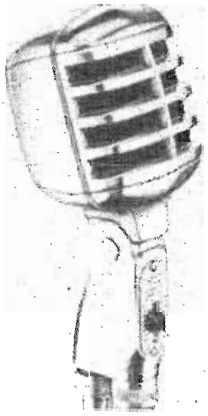
A high standard of production control of pressings assures frequencies flat within 1 DB to 20 KC at 9 cm/sec. and 100/7000



cycle intermodulation under 2% on each pressing of this clear vinyl tone record. Included are frequency runs for 500 and 350 cycle crossovers, LP spot-check frequencies, and a high amplitude sweep frequency run from 1,000 to 35 cps for checking arm resonance and tracking of pickups. Double utility is provided by the V shape of the groove, allowing playback of all bands with either LP or regular pickups.—**Cook Laboratories, 139 Gordon Blvd., Floral Park, N. Y.**

Crystal & Dynamic Microphones

Frequency response of 2 new low-cost, general-purpose crystal and dynamic microphones is substantially flat between 50 and



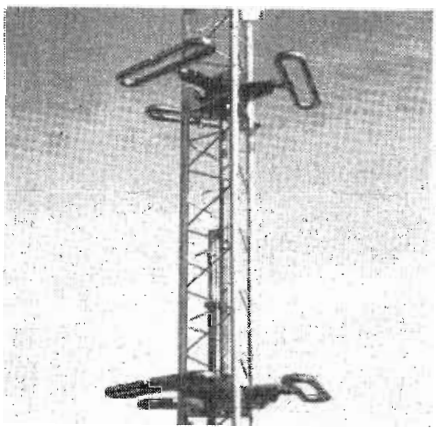
8000 cps. Output level is —48 DB for crystal model 911 and —53 DB for dynamic model 611. Model 911 uses a high capacity crystal, fully enclosed for greater moisture protection. The dynamic model is available in low and high impedances. List price, model 611-20 (with 20 ft. cable) $31.00; list price, model 911-20 (with 20 ft. cable) $24.00.—**Electro-Voice, Inc., Buchanan, Mich.**

Tape and Wire Indexer

Indexing and cataloging contents of a recorded reel of magnetic wire or tape is an operation performed by the E-Z-CUE, a patented device for critical wire or tape editing. The unit can be mounted on the chassis of any standard recorder and it may be connected to the supply or take-up spool with a flexible cable attached to a simple screw machine coupling made for every recorder. The cueing indicator counts each revolution of the wire or tape spool, and reverses when the wire or tape is rewound, automatically bringing the reading back to zero after the rewinding is completed. Average accuracy is within approximately one second of recording time on standard spools of wire or tape.—**Accessories Div., Amplifier Corp. of America, 396-7 Broadway, New York 13, N. Y.**

TV Transmitting Antenna

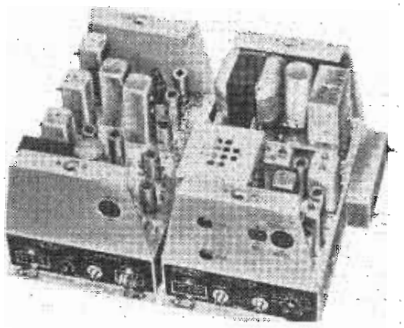
A television triangular loop antenna has been developed which is simple and highly effective electrically and at the same time



economical and mechanically sound. Efficiency is equal to, or higher than, any other television transmitting antenna of comparable size. Both picture and sound transmitters are coupled to all loops of the antenna stack so the full effectivity of the antenna is realized on both channels.—**Federal Telecommunication Laboratories, Inc., 500 Washington Ave., Nutley 10, N. J.**

Mobile Radiotelephone

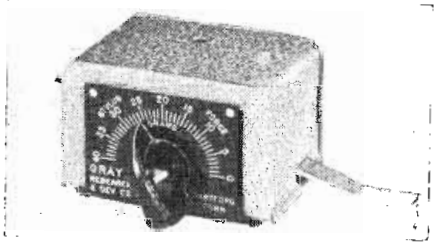
Mobile radio equipment for the 152-162 MC band has been developed with a lower standby battery drain than has ever been possible



with equipment of this type. The instant heating transmitter consumes no power from the battery during standby periods and the low-drain-receiver uses only 4 amps. Because of their exceptional battery economy, the FM-47X receiver and FM-177X, 15 watt, or FM-179X, 50 watt, transmitters are particularly adapted to 3-wheeled motorcycle use.—**Kaar Engineering Co., Palo Alto, Calif.**

Stylus Force Gauge

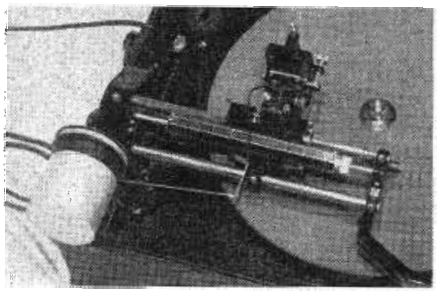
In order to assure correct stylus pressure and consequent high quality in the reproduction of recordings, a new stylus force



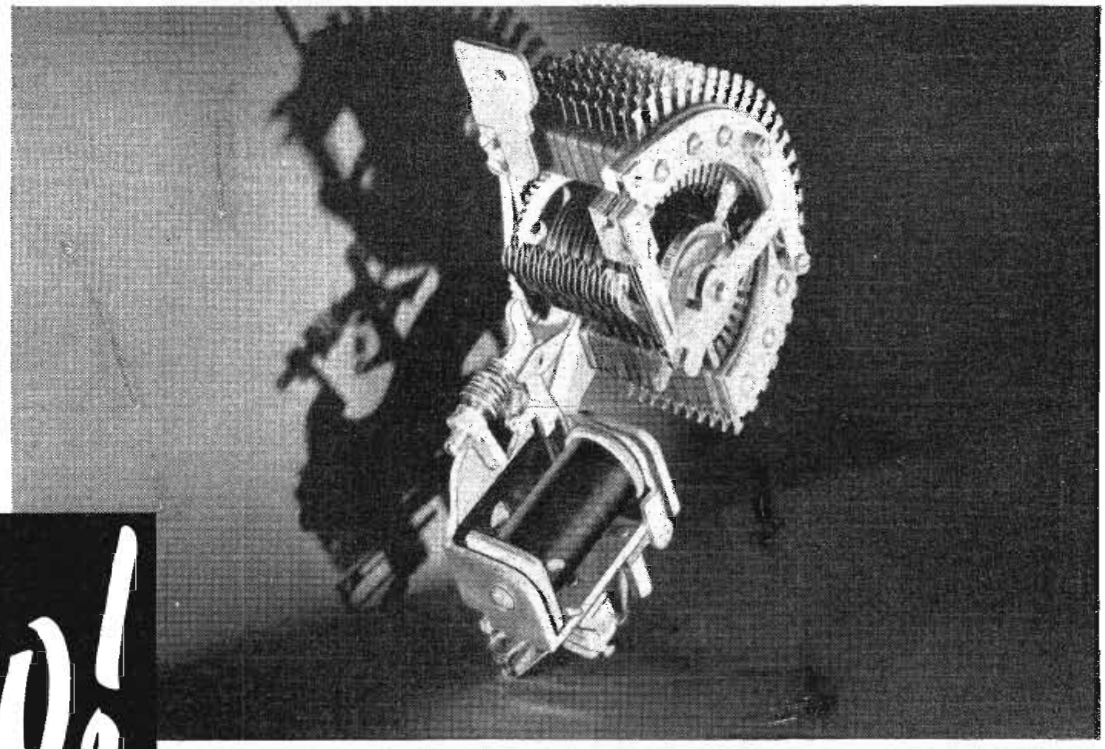
gauge has been developed. The gauge is easy to use and measures accurately and directly in grams.—**Gray Research & Development Co., Inc., 16 Arbor St., Hartford 1, Conn.**

Recording Diameter Equalizer

A new recording diameter equalizer (model 628) automatically applies the equalization necessary to compensate for the loss in high



frequency reproduction that occurs as a result of decreasing groove velocity while cutting at 33 1/3 RPM. No equalization is applied at diameters in excess of 12 in. When cutting inside a 12-in. diameter, the high frequencies are progressively boosted to a maximum of 8 DB at 10,000 cycles for a 5-in. diameter. This boost counteracts the average translation loss encountered in transcription work. Insertion loss of the diameter equalizer is 10 DB. The unit should not be inserted in a circuit where the average level exceeds 1 watt (+22 DB, ref. .006 watt).—**Fairchild Recording Equipment Corp., 154th St., & 7th Ave., Whitestone, N. Y.**



new! the Type 45 Rotary Switch

70 Steps a Second Speed
Up to 10 (or more) Bank Levels
Only 1 Field Adjustment

For *all* the features you want . . . in *any* remote-control application . . . look to Automatic Electric's Type 45 Rotary Switch!

SPEED . . . it's faster! It carries 10 wipers at 70 steps a second on 46 volts d.c. self-interrupted, or at 35 steps a second, externally interrupted.

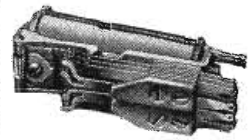
CAPACITY. . . it's greater! Ten or more 25-point bank levels can be accommodated on the same frame, and single ended wipers can be provided for 50-point operation.

ADJUSTMENT . . . it's simpler! A rare readjustment of the interrupter springs is all that's normally required.

OPERATION . . . it's smoother! With an even load on *all* contacts, the Type 45 runs without galloping; there's no chatter or bounce.

ADAPTABILITY. . . it's more useful! With more levels, faster speed and 25- or 50-point operation, it's suitable for a wider variety of control applications.

For complete information on this switch that's new and better, write for our new circular.



the Class "B" Relay

Here's a new relay, too, that can be used for ordinary relay service—opening, closing or switching circuits—and for extremely high-speed operation. Independently operating twin contacts assure perfect contact operation. Contact points are dome-shaped to maintain uniformly low contact resistance. They may be arranged in one or two pile-ups with a maximum of 16 contacts on 13 springs in each pile.

AUTOMATIC ELECTRIC

Distributors in U. S. and Possessions:
Automatic Electric Sales Corporation
1033 West Van Buren Street, Chicago 7, Illinois
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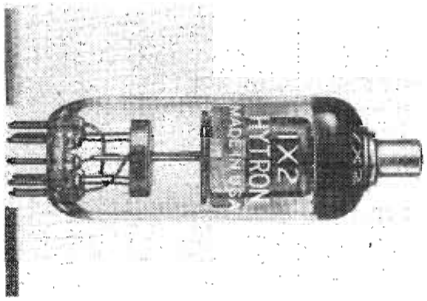
Tubes & Tube Accessories

TV Miniature Rectifier

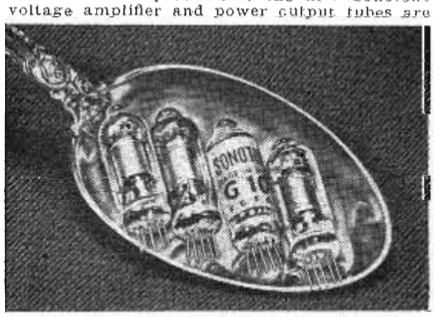
A special rectifier tube for low cost television receivers has been developed having a maximum rating of 15 KV inverse peak and



1 ma DC load current. Known as the 1X2, it is a compact, T 6½, 9-pin miniature, filamentary type, half-wave, high-voltage rectifier. Plate connection is to a skirted miniature top cap. A special feature of the new tube is the inclusion of 2 unconnected base pins offering tie points for filament dropping and high-voltage filter resistors. In new equipment applications, the 1X2 at its maximum rating, is a replacement for type 1B3GT/8016.—**Hytron Radio & Electronics Corp., Salem, Mass.**

Subminiature Tubes

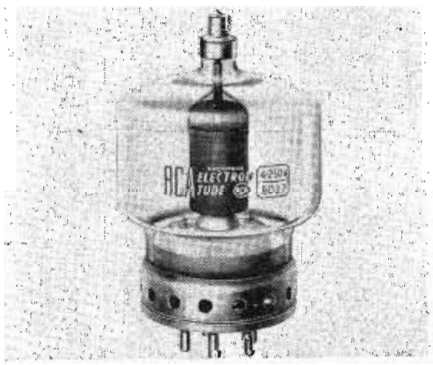
Believed to be the smallest vacuum tubes in commercial production, the new Sonotone voltage amplifier and power output tubes are



less than an inch long. Three of them in an amplifier circuit are capable of amplifying electric power 10 billion times. These tubes are produced in three current ratings; 10, 15 and 20 milliamperes. The voltage amplifier tube has a normal filament voltage 0.6 volts and a voltage gain per stage of about 75. The power tube delivers an output of 2 MW and has a normal filament voltage of 1.2.—**Sonotone Corp., Dept. T, Elmsford, N. Y.**

Power Tetrode

A forced-air-cooled power tetrode (4-250A/5D22) with a maximum plate dissipation of 250 watts has recently been added to the



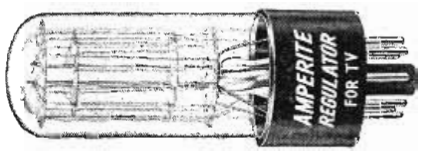
RCA line of power tubes. It can be used as an af power amplifier and modulator as well as an rf power amplifier and oscillator. Compact in size, it has low grid-plate capacitance and requires low driving power and may be operated with full ratings up to 75 mc, or with reduced ratings up to 120 mc.—**Tube Dept., Radio Corporation of America, Harrison, N. J.**

Miniature Triode

The 6AB4 is a new miniature triode which has been designed for use as a grounded-grid RF amplifier and local oscillator for television receivers. It is one triode section of the 12AT7, twin triode. A redesigned heater gives improved microphonic qualities and reduces hum-level. Mounted on a 7-pin, button base with a glass envelope, the 6AB4 has a maximum seated height of 1⅞ in.; an over-all height of 2¼ in.; and a diameter of ¾ in.—**Tube Division, General Electric Co., Schenectady, N. Y.**

TV Ballast Tube

Because the Amperite TV ballast tube is hermetically sealed and filled with helium, it will not overheat the cabinet and parts. Heat is dissipated evenly in all directions.



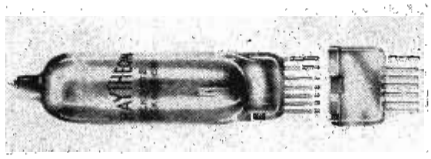
The tube is produced with as many as 5 separate controlling elements. Furthermore, to withstand the possible overload of TV receivers, some of the 2.5 watt elements are designed to withstand 40 watts, an overload of 2000%. Voltage breakdown between elements is 1,300 volts DC.—**Amperite Co., 561 Broadway, New York 12, N. Y.**

TV Tube

Developmental work has been completed on a new 16-in metal-glass television tube which is 2⅝ in. shorter than the 16AP4. The new tube has been tentatively identified as the type 16EP4. Because of its shorter length, the deflection angle is increased to 60°. The tube requires the use of an ion magnet and is available in quantity.—**Rauland Corp., 4241 North Knox Ave., Chicago 41, Ill.**

Subminiature Tube

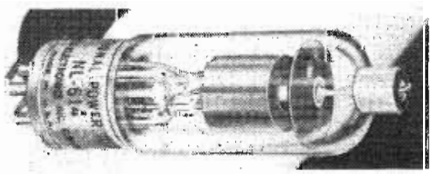
Electrically identical to the miniature 6AK5 except for a small difference in heater current, type CK5702/CK605CX subminiature tube



now is available and may be used in any circuits which have been designed for the 6AK5. Sockets are also available for the subminiature type.—**Raytheon Manufacturing Co., 60 East 42nd St., New York 17, N. Y.**

Rectifier

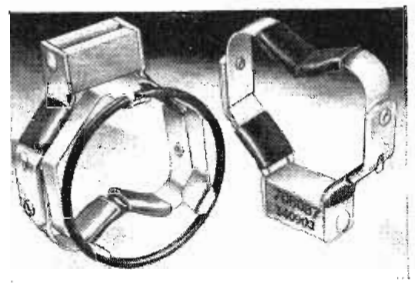
An inert gas-filled 2.5 amp. rectifier tube (NL-614) has been developed which may be used at any ambient temperatures between



−75° and +90° C. It is filled with xenon gas and is more compact than mercury vapor rectifier tubes of similar rating. The tube's characteristics are filament voltage, 2.5; filament amps., 8.5; DC amp. output, 2.5; peak current output, 15 amps.; peak inverse voltage, 900.—**National Electronics, Inc., Geneva, Ill.**

TV Tube Beam Benders

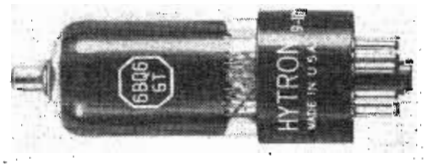
Television tube beam benders TV-2 and TV-3 slip over the neck of standard TV tubes and are designed to minimize burnt spots on



tube screens. The TV-2 features a single permanent bar magnet and is intended primarily for a 10-in. kinescope and 6BG6 tubes with flux densities across the magnetic poles of 33 ± 3G and 75 ± 10 G respectively. The more elaborate TV-3 incorporates 2 magnets; the bar magnet for the rear and the ring magnet for the front elements. This type is engineered for 12-in. and larger TV tubes, especially those of the bent-gun design. All parts except rubber sleeves and ring magnet are cadmium-plated.—**Clarostat Mfg. Co., Inc., Dover, N. H.**

Deflection Amplifier Tubes

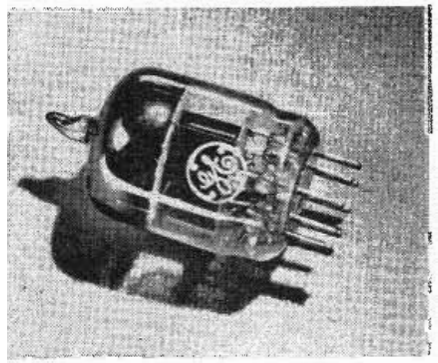
The 6BQ6GT and 25BQ6GT beam pentodes have been designed specifically for use as horizontal deflection amplifiers in lower cost



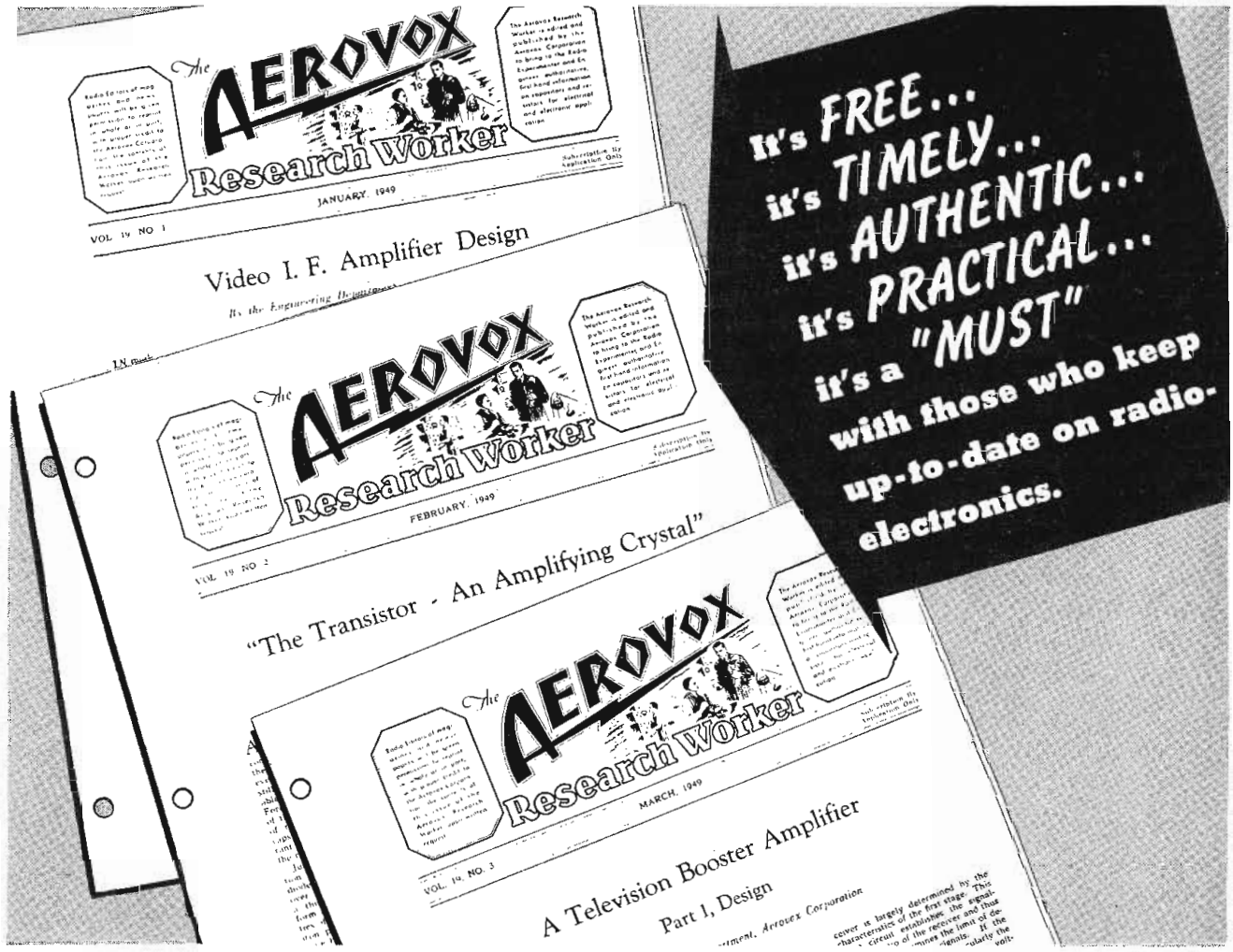
television receivers. Their construction and processing make them suitable for high peak inter-electrode voltages. The 6BQ6GT with its 6.3-volt heater is for use in transformer operated sets, while the 25BQ6GT with its 25-volt heater is suitable for use in sets employing series heater connections. The plate is brought out to a top cap for isolation of the high voltage and convenience in circuit layout.—**Hytron Radio & Electronics Corp., Salem, Mass.**

HF Twin Triode

Designed for sustained life under conditions of intermittent operation, the GL-5670 is a reliable, long-life miniature triode for mobile communication and aircraft radio



equipment. Its gold-plated grids and modified heater have been engineered to withstand a great number of on-off cycles. Heater voltage of the GL-5670 is 6.3 volts, AC or DC, while the heater current is 0.350 amps. Plate voltage maximum is 300 volts.—**General Electric Co., Tube Div., Schenectady, N. Y.**



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TV Photometry

(*Continued from page* 26)

tributed spill of 10 will be reduced to (100+10)/(10+1) = 110/11 = 10/1. On the other hand, a ratio of 200/1 will be reduced by a spill of 10 to (200+10)/(10+1) = 210/11 = 19.1/1. That the units employed here must be consistent is implicit.

Such analysis as has been herein presented is only a beginning. There is no lack of standards in nearly every phase of broadcasting and television, yet the extremely important situation of studio lighting measurement for a camera chain has remained a step-child or necessary evil which seemingly cannot be evaluated in precise terms. Such is not the case. The objective approach can yield results if used diligently.

REFERENCES

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"A Unified Approach to the Performance of Photographic Film, Television Pick-Up Tubes, and the Human Eye," Albert Rose, *Journal, Soc. Mot. Pic. Engr.,* Oct. 1946.
The Principles of Optics, Hardy & Perrin, McGraw-Hill.
"The Scientific Basis of Illuminating Engineering," Parry Moon, McGraw-Hill.

Radar Stations in Bahamas

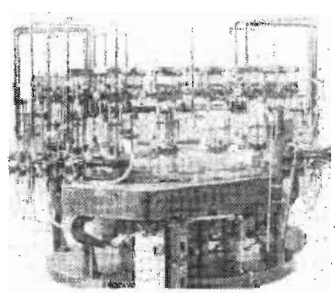
Permission to build radar tracking stations for guided missiles in the Bahamas Islands has been granted to the U. S. Armed Services by Great Britain and the Bahamas government. The project which will eventually cost $200 million will be part of the Florida-based 3,000-mile test range for guided missiles.

New RCA TV Plant

Installation of new equipment and conversion of other facilities marked the extension of television receiver production to a third RCA Victor Division plant at Bloomington, Ind. Approximately one-third of the 226,000 sq. ft. of manufacturing space in the modern one-story plant will be devoted to production of TV sets. This extension supplements operations in Camden and Indianapolis.

CR Tube Sealing Machine

Easily interchangeable adaptors on the Kahle cathode ray tube sealing machine enable it to seal either 12 tubes (up to 16-in.



size) or 16 tubes (up to 12½-in. size) per cycle of operation. Shrinkage is held to an absolute minimum because of the close tolerances to which the machine is built.—**Kahle Engineering Co., 1309 Seventh St., North Bergen, N. J.**

PERSONNEL

Harry F. Dart, Bloomfield, N. J., Westinghouse engineer who pioneered in radio, has been elected chairman of the New York section of the IRE. The section lists 5,000 members in metropolitan New York, including sub-sections in Long Island, Northern New Jersey and Monmouth County, N. J.

Madison Cawein, formerly affiliated with Farnsworth Radio & Television Corp., is now consulting engineer for Diamond Power in Detroit and P. R. Mallory in Indianapolis.

Arthur V. Loughren

Orville M. Dunning

Arthur V. Loughren and Orville M. Dunning have been elevated to the posts of vice president in charge of research and vice president in charge of engineering respectively, by the board of directors of Hazeltine Electronics Corp., Little Neck, N. Y.

Dr. Frank B. Hodgdon, for many years an engineer at the Hawthorne Works of the Western Electric Co. in Chicago, Ill., has accepted an appointment in the Research Department of the American Lava Corp., manufacturers of technical ceramics, at Chattanooga, Tenn.

The College of Wooster (Wooster, Ohio), at its 79th annual commencement, conferred the honorary degree of Doctor of Science on **Victor J. Andrew**. In 1936 he established Andrew Corporation and is now chairman of the board of directors of that corporation.

A. C. Sayland has been appointed chief engineer of the Motorola Consulting Service, with headquarters in Washington, D. C. He will assist in the mechanics of filing applications with the FCC for construction permits and station licenses by Motorola customers.

Arthur J. Rau has been elected a member of the board of directors of the Electrical Reactance Corp., Franklinville, N. Y. Electrical Reactance Corp. manufacturers ceramic condensers, choke coils and resistors.

Frank W. Guthrie has been appointed sales manager of the Rauland Corp., 4245 N. Knox Ave., Chicago 41, manufacturers of Visitron aluminized television picture tubes.

FCC's Plans for Future of TV

AT last the television industry has information on the trend of the collective thinking of the FCC on the subject of television broadcasting, according to the plans recently announced.

1. The lower portion of the present experimental band, 475-890 MC, will be divided into 32-35 channels, 6 MC wide, for commercial black-white (or color) television broadcasting.

2. These new UHF channels will be intermingled with the presently-used 12 VHF channels, which will be retained.

3. When an over-all allocation plan for both VHF and UHF stations has been worked out then the freeze will be lifted, sometime "in the fall".

4. The upper portion of the UHF band will be reserved for TV research, such as Stratovision, high-definition monochrome and color.

5. The Commission invites proposals for commercial broadcasting of color on VHF or UHF channels; PROVIDED it can be shown that: (a) the system can operate in a 6 MC channel; (b) it can be received on an ordinary TV receiver "with relatively minor modifications"; and (c) "sufficient receivers and parts are available to permit adapting monochrome receivers for color reception".

A notice of proposed rule-making will be issued in approximately six weeks from May 26. Revised allocation plans will take into consideration propagation studies in the Ad Hoc report. After these proposed regulations are issued 30 days will be allowed for comment. A hearing will follow within 10 to 14 days and oral argument will be heard within two weeks after the hearing. The final decision and the lifting of the freeze will be expected in the late fall. So much for the FCC announcement. What does it mean to the future of television?

Use of the UHF Band: It is believed that the opening of the UHF band to commercial television broadcasting was the only course that would take care of the large and growing demand for TV licenses. This new band is not as good as the VHF band from the broadcaster's view because of lack of high-power transmitters, the need of greater power for equal

coverage, reception problems due to terrain and the present lack of converters or suitable receivers in the hands of the public. Some of these disadvantages will be removed in time. The UHF band is the only place available to the late-comers in the TV broadcast field. They will have to be satisfied with it.

Frequency Space for Research: Television engineers are pleased that the FCC plans to retain the upper part of the UHF band for research. Had this not been done how could we expect improvement in this growing art of visual broadcasting? It would have ruled out high-definition pictures, leaving the French with their nominally superior 1000-line picture in the lead. It might have prevented us from ever having satisfactory pictures in color.

Intermingling: If this could have been avoided it might have simplified receiver merchandizing in the future. But it happens that the demand for more channels is great from those large cities where all of the available VHF channels are all ready assigned. Intermingling, which may mean that nearly all of us will have to have converters with our present receivers, can not be avoided.

The Commission correctly points out that the whole allocation problem is such that it has to be solved for the VHF and UHF at the same time. In this connection, it is believed that changing existing VHF assignments will not be feasible and that therefore all present and prospective owners of TV receivers should have NO fears of obsolescence.

Color: Apparently the FCC must think there is a workable 6 MC color system that will satisfy the army of TV observers. If so what system is it? The first guess would be that it is the modified CBS, sequential, medium-definition, rotating-disc, dim-picture system. The second guess is that a relatively unknown system, proposed by, but only partially demonstrated by, a West Coast inventor, details of which have not been released, may be a candidate. As far as is known the RCA simultaneous color system can not be squeezed into a 6 MC channel.

The reader should appreciate the fact that the FCC's surprising reference to color actually should not, in any way, *prolong the freeze*. The important thing is to make the best technical allocation of the VHF and UHF channels.

European Communications

(*Continued from page 17*)

drive in that direction at present. Of course this does not mean that VHF and UHF are neglected. Some of the best VHF radio and DF equipment seen is made in this country and there is great activity in the laboratories of the various companies working on UHF and microwave equipment. Production technics seem to have improved, possibly due to the US influence during the war. In many cases designs show the effect of mass production short life thinking, in place of the traditional English everlasting construction.

Interest is very great in US tubes, and the octal base is popular. The trend seems to be toward the 6 volt tube, although, of course, there is still a tremendous number of the earlier types made. Midget portable sets on the US style are appearing on the market, and many of them are beautiful pieces of workmanship. The "EKCO" Company puts out a very intriguing model under the name of the "Princess". This weighs four pounds with battery and covers the low and medium frequency bands. Being in two colors it is extremely attractive, although its price is a little high, $64.00. It must be remembered, however, that this includes $12.00 purchase tax. Plastic cabinets are very popular and just about every manufacturer uses them. The latest HMV television receivers use plastic cabinets. Incidentally, this receiver will probably revolutionize television prices in England. Selling for only $184.00, including almost $50.00 tax, it has a ten inch picture tube. The designer of this set said that it has only fourteen tubes, is a TRF, and has a sensitivity of 150 to 200 microvolts. It is designed for use in the metropolitan area where noise is not too high.

A day was spent inspecting the plant of the "EKCO" Company at Southend, and talking to the engineers in the research department. This is really one of the miracle companies of the radio age. Barely twenty years old, it has grown from two friends making battery eliminators in a back room to a multiple industry employing thousands, and active in all phases of the industry, from lighting fixtures to its own bakelite plant. Mention is made at length of this company because it is believed that it represents a better than average operation. Fig. 1 is

a view of the television assembly line. It is interesting to note the form of construction used in the sets. Although this particular mechanical construction may be more expensive than the somewhat more closely grouped layouts in the US, it pays off in ease of handling and servicing. The four controls on the front are on/off, volume, brilliance, contrast and sound tuning. Since only one channel is used there is no channel selector.

Mention of servicing brings up a somewhat unique school. The company runs a serviceman's school. Here dealers come for a short course on the company's products. The illustration, Fig. 2, is a view of the school, with a dummy chimney in the foreground demonstrating how to attach an antenna. The vertically polarized antenna is very obvious. Cabinet deliveries are never a bottleneck for this company. Their own presses, both injection and moulded types, supply not only their own needs but also those of other companies. The first injection (thermoplastic) cabinets in the country are made for the "Princess" portable. Figs. 3 and 4 are the moulded cabinet presses in operation. Interest in US radio, and particularly television, is very strong. In most of the discussions the writer found himself giving out information on US methods instead of learning about the English systems!

In general, radio engineering in England is much the same as in the US, with the exception that the drive to develop new equipment such as exists in the US is lacking. The system of broadcasting does not provide any incentive or particular urge to the manufacturer to develop new equipment for transmission since the market is so limited. It appears that in most respects much has been learned from contact with US methods during the war, and that apart from being a smaller industry numerically, it is working along parallel lines to its US counterpart.

Plastic Insulators for Smaller Metal TV Tubes

Because the application of their plastic insulating mounting rings and sleeves has proved so successful with 16-in. metal TV Tubes, Anchor Plastics Co., 533 Canal Street, New York, is now preparing to adapt this design for use with the new smaller metal tube types. According to reports received more than 25,000 of the 16-in. plastic mounting rings and sleeves are now in daily consumer use and 15 major television receiver manufacturers employ this item in their new equipment.

TAPE CHARACTERISTICS

(*Continued from page 33*)

area, or, the introduction of third harmonic distortion in the recorded signal. The net effect of spreading the recording flux would be to introduce a loss of signal at the higher frequencies.

Where appreciable wear can be visibly noted, a new record head should be installed and the worn head should then be returned to the manufacturer for examination or replacement.

Wear of the play-back head is most serious when such wear produces an increases in width of the air gap. Comparison of the gap of a new head with that of the worn head, when the two heads are observed under a medium power microscope, will reveal significant changes in gap width. A frequency response curve run on the recorder with new and old play-back heads is perhaps the simplest technique that can be employed by the station engineer to check play-back head wear.

Magnetic tapes produced several years ago in this country often showed a high degree of rub-off of the magnetic material. This material, removed from the tape, would accumulate on a record or play-back head to such a degree as to force the tape away from contact with the head. Improvement in tape manufacturing techniques have resulted in the production of tapes which are relatively free from this trouble. Periodic cleaning of the heads with a non-inflammable solvent such as carbon tetrachloride is still recommended as a routine procedure to remove lint, dirt or any other foreign matter which may accumulate on the head surfaces.

As previously mentioned, the remanent noise on a well erased tape is usually of the order of the amplifier system noise. Lack of symmetry in the bias oscillator wave form may cause a large increase in the apparent background noise of the tape. The introduction of relatively small amounts of even order harmonics in the bias or erase wave form will seriously affect the signal-to-noise ration of the system. Remanent magnetization of either the record or play-back head will also raise the background noise level to a high degree. If the signal-to-noise ratio in the magnetic recording system is less than that which could normally be expected, and the tape noise is appreciable greater than the amplifier system noise, the possibility of remanent magnetism in the heads should be investigated.

A procedure for demagnetizing the heads is usually described by the recorder manufacturer in his operating instructions for the equipment. Record and erase heads can usually be demagnetized by the momentary application of a 60-cycle current having a maximum value of from 2 to 3 times that of the bias current normally supplied to the head. The current should be applied and reduced gradually by an essentially stepless variable voltage transformer such as a Variac, the current being slowly raised from zero to the maximum value and returned to zero over a period of from 5 to 10 seconds. This same technique may be applied to the play-back head but care must be taken not to apply a current of such magnitude as to injure the winding.

In storing magnetic tape the same factors involved in the storage of safety base movie film generally apply. Extremes of temperature and humidity should be avoided. Ideal storage conditions would be in the temperature range of 60 to 70° F. at a relative humidity of 40 to 50%. For maximum life in long time storage, rapid and frequent changes in humidity and temperature are undesirable. Storage of plastic back tape in a basement in the summer time where the relative humidity may reach a value of 90 to 95% should be particularly avoided. Prolonged storage in areas where sunlight or heat radiators may hold the temperature above 110°F. will promote embrittlement of most plastic materials.

Since magnetic tape is a medium, whose state can be altered by a magnetic field, signals may be altered or impressed on the tape by strong fields existing outside of the recording equipment. Stray fields of this nature are usually held to a minimum in well designed broadcast station control rooms and studios. While it is highly improbable that stray magnetic fields may be encountered which would completely saturate magnetic tape, fields of lesser magnitude produced either by a large current in an electrical conductor or by permanent magnets may cause partial erasure of or impose an appreciable amount of background noise on a recorded tape.

A strong magnetic field may also cause transfer of a strong signal in one layer of tape to an unrecorded area in an adjacent tape layer. Instances have been reported of erasure of tape by the strong magnetic field of a street railway car or trolley bus when the tape was inadvertently placed near a hidden conductor in the wall of the vehicle. Relatively few instances of trouble of this kind have been reported, so from a practical standpoint it appears that the problem is not a serious one. Some measure of protection from stray magnetic fields is offered by shipping tape records in standard move films cans made of pressed steel. The added measure of protection afforded by such a container might well justify the extra shipping expense involved.

MINIMIZING REFLECTIONS

(*Continued from page* 39)

attained. Thus, the luminescent crystals remain exposed on the back for impingement of the electron beam and at the front for visibility. The opaque material acts to confine the light emission of each crystal to the crystal itself so that a white picture element has no tendency to lighten the grays or blacks. The optimum ratio of the barrier powder to the phosphor material depends on the intensity of the electron beam. A greater amount of dark powder can be employed at higher beam intensities with greater contrast gain.

Such screens do not require excessive illumination in order to give fidelity and contrast. All demonstrations have indicated the viewer has the ability to view the picture for long periods of time without the fatigue associated with common viewing practice.

While the opaque powder was intended primarily to eliminate light dispersion, it was also able to partially reduce the effects of halation produced when the light rays from a bombarded area travel into the glass face of the cathode-ray tube and are refracted. Those rays which make an angle greater than 0 (Fig. 2) do not leave the glass when they reach the outer surface, but are totally reflected back into the glass, scattering at each point where the reflected rays strike the fluorescent crystals. That portion of the scattered light which does not travel toward the observer is partially absorbed by the opaque binder, the amount of absorption increasing as the angle between the scattered light rays and a perpendicular to the screen increases. At 90°, when the scattered rays are parallel to the screen, and at greater angles, there is total absorption.

It has long been felt by many workers in the field that luminescent screens using aluminum backing were tending in an undesirable direction because they emphasize the contrast-destructive effects of light dispersion. The numerous screen filters available are a direct result of the overpowering intensity of the light generated in these tubes. The opaque powder system represents a more feasible approach to greater contrast by eliminating dispersion and reducing the brilliancy required rather than to overpower the observer with a light intensity high enough to create the illusuion of great contrast.

The American Television corrected screen, developed by U. A. Sanabria, Warren G. Taylor, and E. Browning, working under the direction of Dr. Lee de Forest, consists of a phosphorescent crystal buried in a light absorbing binder which completely surrounds the sides of the crystal but leaves the back and front faces exposed, Fig. 3. Further desirable effects can be obtained by the use of metal such as zirconium in the screen, which is a poor secondary emitter, opaque to light and yet a good gas getter, and which, under the influence of bombardment, picks up gas occluded in the rest of the cathode-ray tube. The combination of a getter within the screen powder and a light absorber is one of the features of this process. As a matter of fact, a highly reflecting substance, such as silver, which could be opaque to light and yet reflecting internally the light from the luminescent crystal, would be highly desirable. It might actually improve the light and, yet at the same time, discourage dispersion if the rear side thereof were covered with a dark substance, or the silver oxidized, in order to discourage reflection, but always leaving the crystal exposed, however, to the rearward.

IRE CONVENTION AT SAN FRANCISCO CIVIC CENTER

The 1949 West Coast Convention of the IRE and the 5th Annual Pacific Electronic Exhibit of the West Coast Electronics Manufacturers Association (WCEMA) will be held jointly in the Exposition Auditorium of San Francisco's Civic Center from August 30 to September 2.

Approximately 200 radio and television parts and component manufacturers will occupy 38,000 sq. ft. of exhibit space on the main floor of the auditorium. The IRE convention will be held in Larkin Hall and adjoining committee rooms on the main floor next to the exhibits. Following is a list of papers which will be presented:

Tuesday, August 30

Opening Session—Morning

Jonathan Edwards and T. J. Parker (USNEL) "An Application Of Frequency Selective Feedback"

Vincent Salmon (Stanford Research Inst.) "The Constant-Voltage Audio Distribution System"

Cledo Brunetti (Stanford Research Inst.) "The Future of Subminiaturization"

Vacuum Tubes—Afternoon

W. R. Baker, Q. A. Kerns, Jack Reidel, and R. F. Edwards (Univ. of Calif. Rad Lab) "High-Current High-Voltage Gas Discharge Tube"

Merrill H. Brown (Machlett Labs, Springdale, Conn.) "High Voltage Industrial Rectifier Tubes—Design Consideration for High Power Applications"

George D. O'Neill (Sylvania, Electric Products, Emporium, Pa.) "The Effect of Contact Potential Difference on Electron Tube Characteristics"

L. M. Field (Stanford University) "The Transverse Current Amplifier"

Circuitry—Evening

A. E. Harrison (Univ. of Wash.) "Graphical Analysis of Tuned Coupled Circuits"

D. A. Watkins (Los Alamos Scientific Lab), "Wideband Pulse Amplifiers"

Donald K. Reynolds and Milton B. Adams (Stanford Research Inst.) "Front-end Design in UHF Television Receivers"

Donald H. Preist (Eitel-McCullough San Bruno, Calif.), "Some Developments in UHF Power Oscillator Circuits"

Wednesday, August 31

Instrumentation—Morning

L. P. Robinson and R. L. Sink (Consolidated Engineering Corp.) "Multi-Channel Recording of Physical Phenomena" Charles E. Green (USNEL) "Frequency Control with Synthetic Crystals"

A. P. G. Peterson (General Radio Co., Cambridge, Mass.) "Measurement of Non-Linear Distortion"

E. R. Toporcek (Inyokern) "Use of Doppler Radar as a Test Range Instrumentation for Missiles"

Control Systems—Afternoon

J. R. Moore (North American Aviation) "Combination Open-Cycle, Closed-Cycle Systems"

Louis G. Walters (UCLA) "Electro-Mechanical Feedback and Recording Manometer"

Robert M. Osborn (North American Aviation) "Criteria Relating Steady-State Response to Transient Response of Closed-Loop Systems"

W. Ross Aiken and Dick A. Mack (Univ. of Calif. Rad Lab) "184-Inch Cyclotron Pulse Timing Circuit"

Microwave Technics and Applications—Evening

Harley Iams (Work done at RCA; Now Hughes Aircraft) "Use of Phase Front Plotter to Observe Propagation Effects"

William G. Sterns (Univ. of Calif. Antenna Lab) "Near-Zone Field Studies of Quasi-Optical Antennas"

L. E. Swarts (USNEL) "Absorbing Surfaces"

D. I. Cone (P.T.&T.) "Radio Circuits for

Telephone and Television Service—A Progress Report"

Thursday, September 1

Circuitry II—Morning

D. L. Trautman, Jr. (Stanford Univ.) "Unification of Basic Filter Viewpoints on the Complex Frequency Plane"

H. A. Rosen (Caltech) "Steady-State and Transient Response by means of a two-dimensional Potential Analogy"

T. H. Meisling and David H. Brown (Univ. of Calif. Computer Project) "Design of a Trigger Circuit" (To be retitled)

Theoretical Problems—Afternoon

Lotfi A. Zadeh (Columbia Univ., New York City) "Frequency Analysis of Variable Networks"

Samuel Silver and W. K. Saunders (Univ. of Calif. Div. of EE and Antenna Lab) "The External Field Produced by a Slot in an Infinite Circular Cylinder"

N. A. Begovich (Hughes Aircraft) "Slot Radiators"

Francis J. Zucker and Walter Rotman (Cambridge Field Station) "Microwave Guiding by Single Corrugated Surfaces"

Hidden Headaches

(*Continued from page* 29)

als. Extremes such as these can be easily avoided by study of data on the subject, compiled by the National Association of Broadcasters, and others.

The relationship between the consulting engineer and the broadcast engineer often has a direct bearing on the quality of the completed station. Only in the more complicated installations, however, does the consultant bother with the specific problems and details of equipment layout. Depending upon the capabilities of the station engineer, and the complexity of the job, the consultant's function is important to a greater or lesser degree. Sometimes, beyond preparing the paperwork necessary for the FCC, he has nothing to do with the building process, and may never even put in an appearance at the station. This is the exception, however, and usually he is an ever-present source of help. His attitude, and the necessity for the assistance he can give are factors of great importance to the engineer on the spot. Embarrassing things can happen, if his advice is ignored or mis-used.

There is a story, possibly apocryphal, about a certain chief engineer who was building a directional array consisting of several towers. After receiving specifications for self-supporting towers, guyed towers were ordered in their stead. The system wouldn't tune properly, since allowance for the change had not been made in the phasing and matching networks, nor were the sampling loops at the proper height, on the towers. Many weeks were wasted in attempting to arrive at the required pattern of radiation. True or not, this is illustrative of the necessity for close contact with the consultant.

On the other side of the ledger is the case of the management of an ordinary independent station, who presented the chief engineer with an imposing blueprint from the consultant, showing a block diagram of the entire station. This was obviously completely superfluous. Both the station and its engineer profit when the liaison with the consultant is cordial and close, and much wasted effort can be eliminated thereby.

In smaller stations particularly, the question of false economy has to be dealt with constantly. The engineering section is often expected to tackle odd jobs for which it is not trained, in the false belief that construction costs can be held down. Such tasks as assembly and erection of towers can be done by the staff ,but where time represents money, this is foolish. The same condition obtains with regard to installing conduit, and the many details requiring special tools and skills. If they are undertaken by the station personnel, it is usually at the expense of the technical aspects

(*Continued on page* 62)

BULLETINS

Transformers & Components

Standard Transformer Corp., Elston, Kedzie & Addison Sts., Chicago 18, Ill., has released its 1949 catalog on transformers and related components. A numerical index, price list, and classified index are included in the 22-page booklet. (Mention T-T)

Cameras for TV

"Motion Picture Equipment for Television Stations" is the title of a new brochure released by the Bell & Howell Co., 7100 McCormick Rd., Chicago 45, Ill. Prepared by the company's professional equipment division, the booklet illustrates and describes operation of the 70-DE and 70-H cameras as well as associated processing equipment. (Mention T-T)

Power Plant

Form 1349 catalog sheet on Katolight gas driven plants may be secured by writing to Kato Engineering Co., Mankato, Minn. Two units, the 600-watt Series 14 and the 500-watt Series 23, are illustrated and described. (Mention T-T)

Components

Catalog 300 is a comprehensive collection of specifications and diagrams of the electronic and electrical components of the Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass. Terminal lugs and boards, swagers, insulated units and coils and chokes are described. (Mention T-T)

Relays

Catalog No. 149 describing relays for 11 distinct applications has been issued by the Potter & Brumfield Sales Co., 549 Washington Blvd., Chicago 6, Ill. Details of PB's synchronons utility timers and signal indicator are also covered.

Bulletin 102 gives specifications and contact ratings of model SM, the Super Midget relay. Write to Chicago address. (Mention T-T)

Connector Desk Chart

Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Calif., has issued a new desk-size "Army-Navy Specifications" chart with the latest insert arrangements shown at half scale for use by aircraft, radio, communication engineers, designers, maintenance men, and purchasing agents. The chart measures 17 x 22 in. and contains 203 insert-layouts. (Mention T-T)

(*Continued from page* 59)

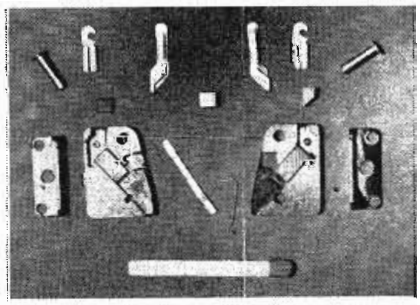
of the installation. Careful thought should precede any decision to employ technical manpower in any other capacity, in the interests of economy.

Technical manpower skilled in station construction is hard to find, with the result that evaluation of a prospective employee's experience and background assumes importance. There are any number of men who are competent in broadcast operation, with years of this type of experience behind them, but who somehow have never "gotten their hands dirty", delving into the equipment. Similarly, the younger generation, even though they may have just been through intensive schooling, are often deficient in the sort of ability needed. The most desirable characteristics are hard to define, but a general set of pre-requisites would include good formal training, broadcast operating experience, and preferably construction background. Lacking actual construction background, an innate love of the job is usually an acceptable substitute. As a general rule this type is found often in small stations. In the larger, established organizations, the tendency is toward over-specialization, and a consequent lack of familiarity with anything other than a particular segment of operation. Like the dinosaur, many of the personnel of big stations are specialized to the point of uselessness, when it comes to building.

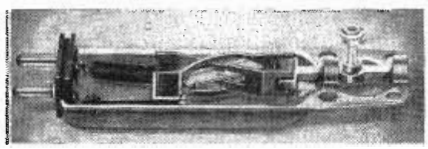
Engineering skill is important, in broadcast station construction, but it counts for little if the ability to evaluate intangibles and personalities under rapidly changing conditions is not present also. In dealing with the owner, the architect, the contractors, the consultant, and many others, coordination must be achieved. This requires more than the ability to think in technical terms. It demands flexibility, to cope with the unforeseen, and yet a balance must be struck and maintained, or the situation degenerates into chaos.

BARIUM TITANATES AS CIRCUIT ELEMENTS

A three part survey of these devices was completed in June Tele-Tech. In part III a change of one word, "whereupon" to "where" appearing in the June issue (Col. 3 line 29) inverted the meaning of the sentence. Actually ceramic elements have excellent characteristics in withstanding temperature and humidity effects. Fig. 30 shows a "Shure" ceramic pickup instead of a breakdown of the Astatic type as mentioned. Both types are shown below; with the Astatic pickup as the upper illustration.



Photograph showing the individual elements contained in "Astatic" type ceramic pick-up



Interior view of "Shure" type ceramic pick-up

Unprecedented requests for additional information relating to this series of articles causes us to include an additional list of references that did not appear with Part III. The ultrasonic applications were described in items (33) and (34) and the pickup details in (35) (36) and (37). The Roberts and Donley developments were described in greater detail in references (15a) and (17) in Part I of the series. Finally the method of fabrication of sheet material mentioned at the end of the article was described in greater detail in reference (40). Interested parties desiring a reprint of Part III with these references and changes complete should write to the Editorial Department of Tele-Tech for a copy.

Additional References

(33) Branson, Norman G., "Portable Ultrasonic Thickness Gage", **Electronics,** Jan. 1948.
(34) Batcher, R.R., "Ultrasonics—Aid to Industry" **Electronic Industries** pages 12-13, 32, July 1948.
(35) Hector, L.G. & Koren, H.W., "Ceramic Phonograph Pickup," **Electronics, 21,** pages 94-96, Dec. 1948.
(36) A trade name of the Gulton Mfg. Corp.
(37) Howatt, G.N., Crownover, J.W. & Dranetz, A., "New Synthetic Piezoelectric Material," **Electronics, 21,** pages 97-99, Dec. 1948.
(38) Time Magazine, **52,** No. 22, page 77 (1948)
(39) This name was suggested by the M.I.T. research group because of the similarity in function to the thermistor.
(40) Howatt, G. N., Breckenridge, R.G., & Brownlow, J.M., "Fabrication of Thin Ceramic Sheets for Capacitors," **J. of American Ceramic Soc., 30,** No. 8, pages 237-242, Aug. 1, 1947.

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While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

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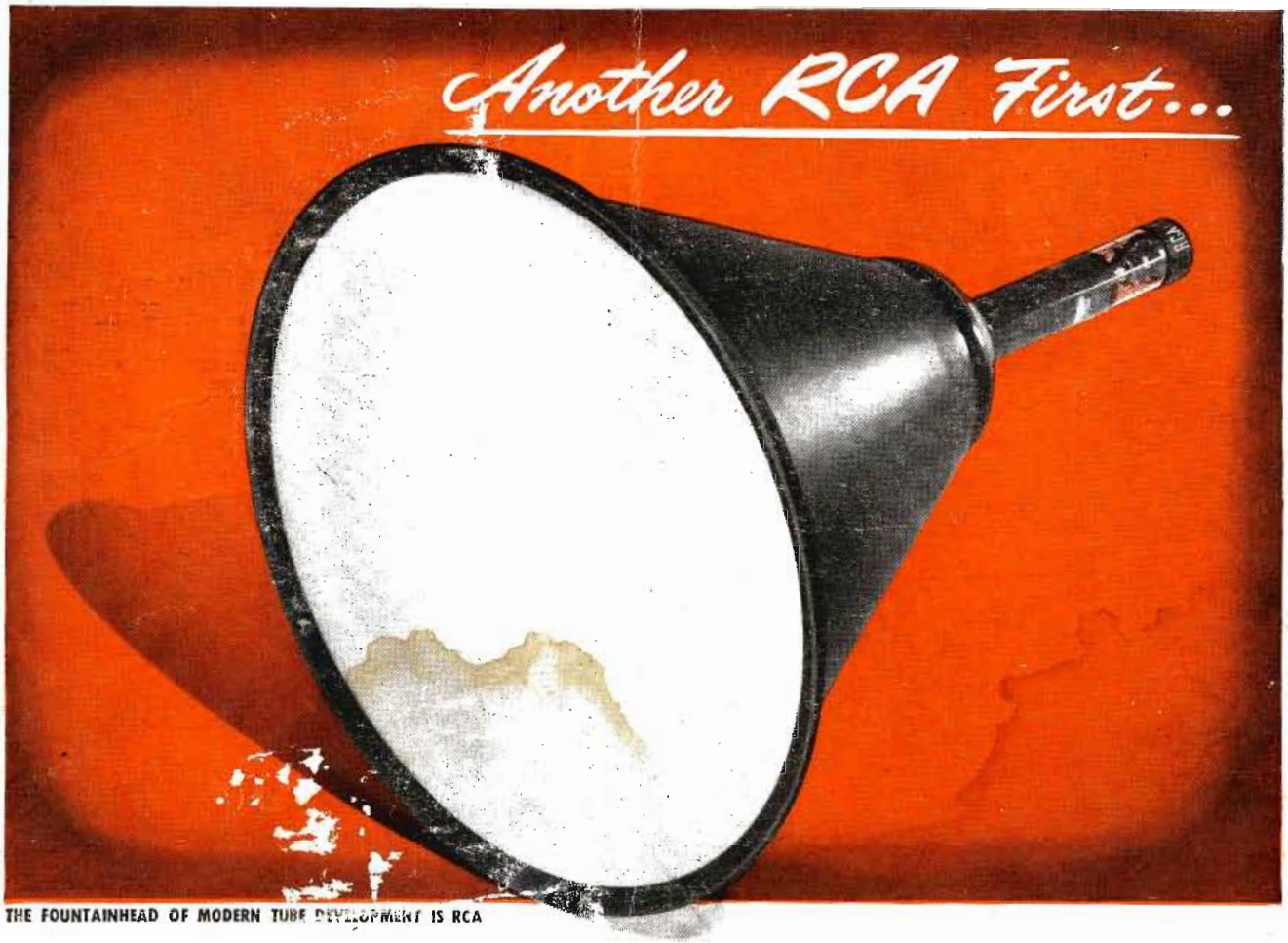


A new milestone in television progress

... the RCA 16-inch metal-cone television kinescope

● The RCA-16AP4—a 16-inch, directly viewed metal-cone kinescope—is RCA's newest contribution to the television industry. It is the outgrowth of a perfected process of sealing glass to large areas of metal.

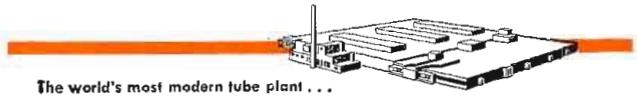
Use of the metal cone reduces weight substantially below that of a similar all-glass tube and provides greatly increased strength.

Other features of the 16AP4 include high picture brightness, good contrast even under high ambient light conditions, a high-quality face plate, and large useful screen area in relation to face area.

The RCA-16AP4 meets the growing demand for a picture size midway between that of the popular directly viewed RCA-10BP4 and the larger, projected picture provided by the RCA-5TP4.

The 16AP4 is currently being produced in quantity at the RCA Lancaster plant. Ground has been broken for a new large plant in Marion, Indiana, the entire production of which will be centered on the 16-inch metal tube.

RCA Application Engineers are ready to cooperate with you in applying the 16AP4 and associated components to your specific designs. For further information write RCA, Commercial Engineering, Section 57GR, Harrison, New Jersey.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