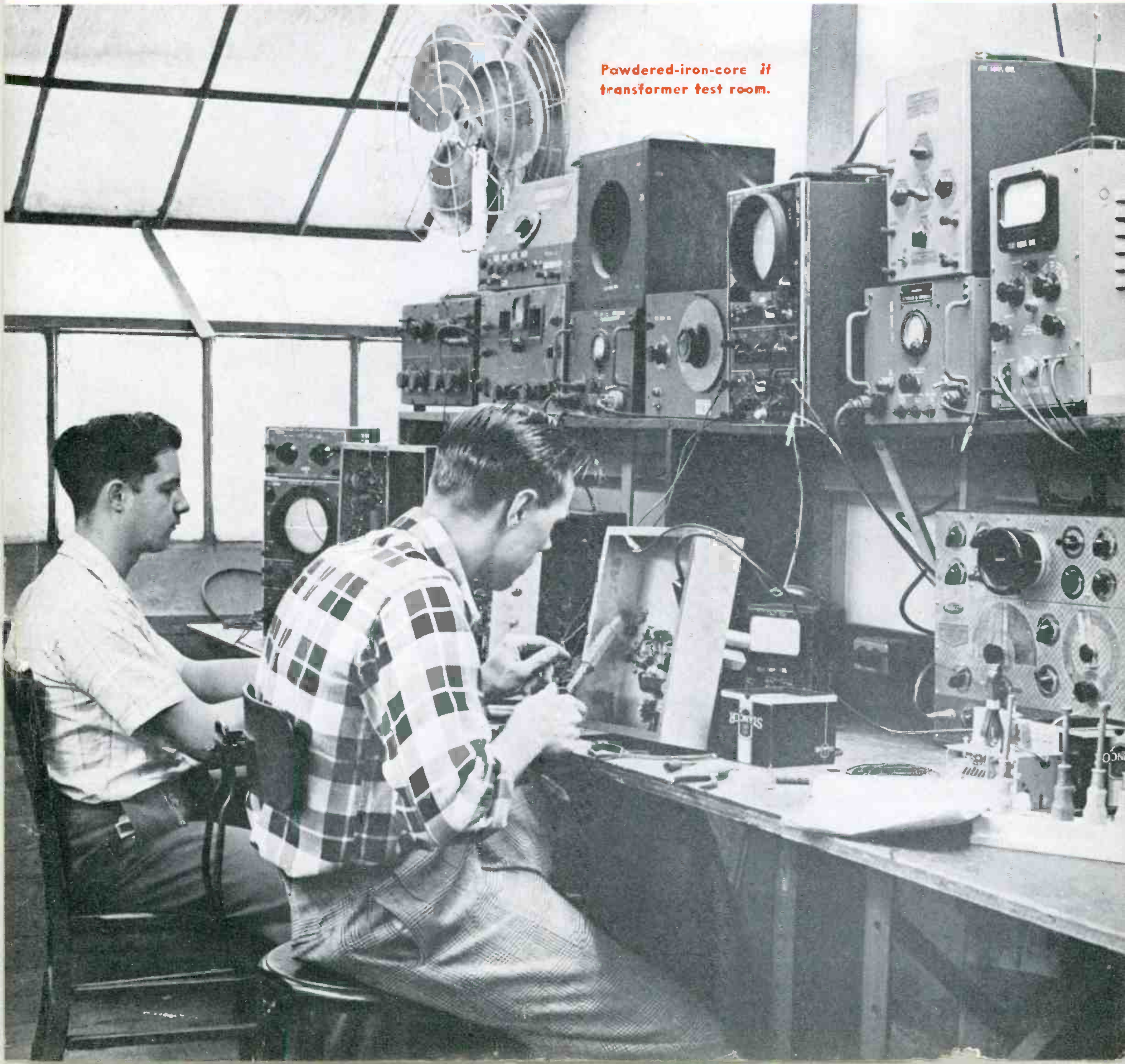
TELE-VISION ENGINEERING

NOVEMBER, 1951

The News-Engineering Journal of VHF-UHF TV, Radar and Allied Industries



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- MAXIMUM EFFICIENCY, UTMOST ADAPTABILITY, LOWEST COST
- AVAILABLE MOLDED TO PRACTICALLY ANY SHAPE OR SIZE WITH OR WITHOUT METAL ELECTRODES OR INSERTS

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Power factor, 1 megacycle	0.0015
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Loss factor, 1 megacycle	0.014
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Arc resistance, seconds	250
Impact strength, Izod, ft.—lb/in. of notch	0.7
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Maximum safe operating temperature, °F	650
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Coefficient of linear expansion, °C	11×10^{-6}
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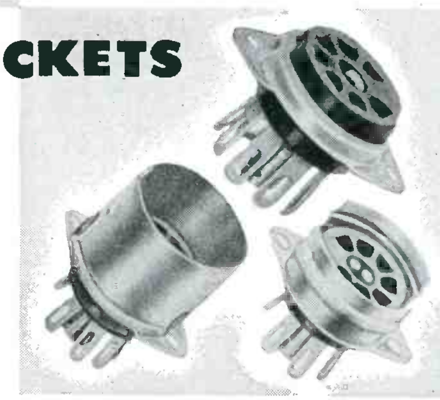
Write for Tube Socket Data Sheets



MYCALEX 410 is priced comparable to mica-filled phenolics. Loss factor is only .015 1 mc., insulation resistance 10,000 megohms. Fully approved as Grade L-4B under N.M.E.S. JAN-1-10 "Insulating Materials Ceramic, Radio, Class L."

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MONTHLY FEATURES

Cover Illustration

Corner of test-construction maintenance shop, where production *if*-transformer test equipment is assembled.
(Courtesy Automatic Manufacturing Corp.)

Editor: LEWIS WINNER

ABC

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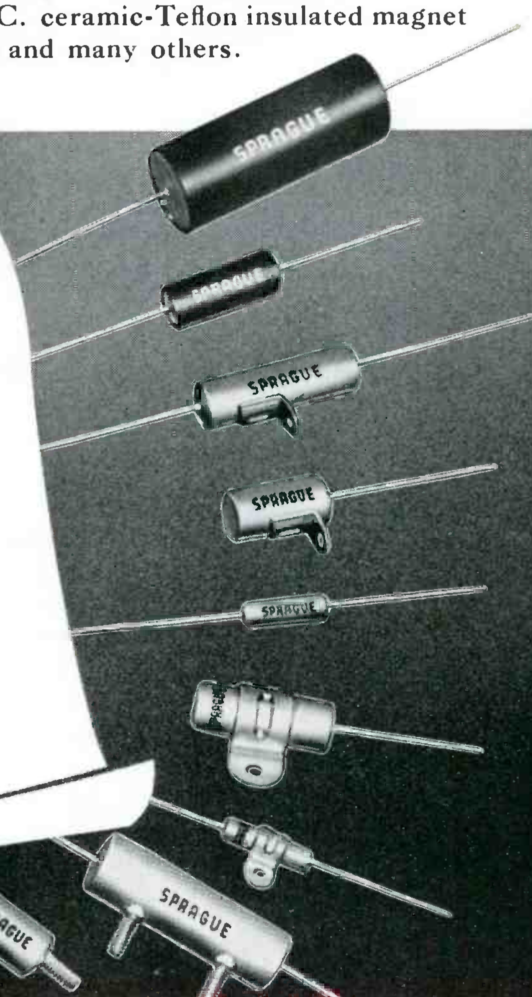


SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASSACHUSETTS

TELE-VISION ENGINEERING
LEWIS WINNER, Editor

November, 1951

The Freeze Lift and NPA—The TV ice age, which was supposed to have vanished in the late spring, then the late fall, has now been cast for a disappearance role next spring. This time, though, it appears as if the removal will really take place, since the paper hearings will have been completed and processing well on its way. According to Curt Plummer, FCC's chief of the broadcast bureau, the freeze might be lifted in April, '52, and about 80 construction permits granted for veryhigh and ultrahigh stations by early summer. Most of these permits are expected to go to relatively uncomplicated applications, involving uncontested applicants in new areas with single stations in cities of about 100,000 and under. And, about 50 per cent of the grants will be for *vhf*, and 50 per cent for *uhf*.

Reviewing this possibility and its effect on the defense program, during a recent RTMA symposium on electronics in '52, in Washington, Ed Morris, NPA's director of electronics, said that it might be necessary to consider material availability between the July and December '52 period.

Analyzing the amount of controlled materials involved in building an average TV station, including the antenna system and supporting tower, assuming the manufacture of equipment sufficient for 40 complete stations for the last half of '52, Morris pointed out that it is estimated that the requirements will be 2000 tons of structural steel, 3400 tons of other steel, 400,000 pounds of copper, and 85,000 pounds of aluminum per quarter, beginning with the third quarter of '52.

It was noted that the first 80 markets to be opened during the initial half of '53 are expected to result in a potential market for about 600,000 receivers a year. The production of these sets will probably start to materialize during the fourth quarter of '52.

In a forecast of *vhf* receiver production for '52, Morris predicted that between 3½ and 4-million chassis will be made; quite a revealing prophesy considering the expanded and increasing military program now under way.

In an effort to prepare for the projected freeze lift and possible shortages, RTMA has directed a task force to probe and police the situation carefully. According to many industry representatives, it is generally agreed that should the freeze be lifted in early '52, there will be sufficient transmitters under construction or already completed and warehoused to satisfy the demand through '52.

Sound and Television—While sightcasting is certainly a prime factor in the TV system, sound has a prominent role, too, a role which many have described as nearly as important as the camera-pickup link.

In an enlightening report on the subject in the EBU, Geneva, bulletin, BBC's sound engineer, L. G. Sutton, noted that there are so many problems confronting the sound engineer in a TV station that it is usually impossible to get the results required, netting a compromise which often means inferior sound. While it is common to employ a number of microphones to pick up sound from all parts of the acting areas, so many microphones are required that cumbersome techniques are often needed to mount and set the pickups. In some productions where many sets are required, it has been found impractical to use too many mikes, because the number of mike channels are not available; thus again, a compromise is effected and a dip in the result pattern is noted, the BBC expert declared.

For maximum pickup, BBC uses three types of mikes: unidirectional, bidirectional, and small omnidirectional moving-coil units. The directional mike, generally used on the boom, was noted as having an advantage in that it can be worked farther from the artist than an omnidirectional type, and there is also less danger of the mike or its shadow appearing in the picture. Also used at BBC are crystal mikes and sound concentrators, which were noted as providing inferior output, but very useful in special locations where it is impossible to use a normal mike.

While the mikes now in use provide a satisfactory service, they are far from the ideal. According to Sutton, a need exists for highly directional and small unobstructive mikes, which can be used in the picture without becoming a major part of the picture content. Unfortunately, he said, such mikes generally have disadvantages, and no entirely satisfactory solution seems to be available now.

Reviewing the problems faced by the sound engineer, the BBC specialist declared that such an engineer must not only be familiar with the electronic aspects of the system, but he must appreciate the mood and tempo of the production and be able to transfer this in the sound reproductions. It's also necessary for the engineer to assist actively the producer and the scenic designer during the planning, rehearsal and final transmission of the scene.

In Sutton's opinion, in spite of the decade and half of experience, it seems that the art of TV sound reproduction must still be regarded as in its infancy. There are a long list of requirements still to be determined, together with the technique of meeting them.

Clouds and Sunshine—The year '52 will undoubtedly be replete with problems. It will be difficult in some instances to get material. It will be difficult, too, for many to align their production facilities to accommodate defense requirements. For, in some plants, there may not be sufficient material around to operate the civilian production line, and not enough military business at hand to operate the entire plant. However, there were graver problems during the emergency days of '40-'45. Comparing the problems encountered then and today, Fred Lack of Western Electric pointed out, during a recent industry meeting, that troubles are nothing new to the industry. Somehow or other, he said, the boys have always found a solution through a grand display of resourcefulness.

Regardless of the trying moments that are here and might be ahead, industry will certainly find a way to overcome them, as it did in the past. Such was the forecast of Fred Lack. And there is no doubt that these views are shared by all in this enterprising industry.—L. W.

TVE-grams . . .

The Military Impact: Billion-dollar spending for armed forces gear will continue in '52, with peak billing expected during the first quarter, after which the production curve is expected to level off and remain more or less constant. This was the view of Colonel Clifford A. Poutre, chief of the office of electronics programs in the Munitions Board, during a recent review of the situation at an industry meeting in Washington. . . . In his opinion, by the middle of '52 the industry will have expanded in all of its areas to a point where it can fully support the military program, and still maintain a high level of civilian production. . . . The small businessman was described as having played, and expected to continue to play, a key role in hurdling production problems.

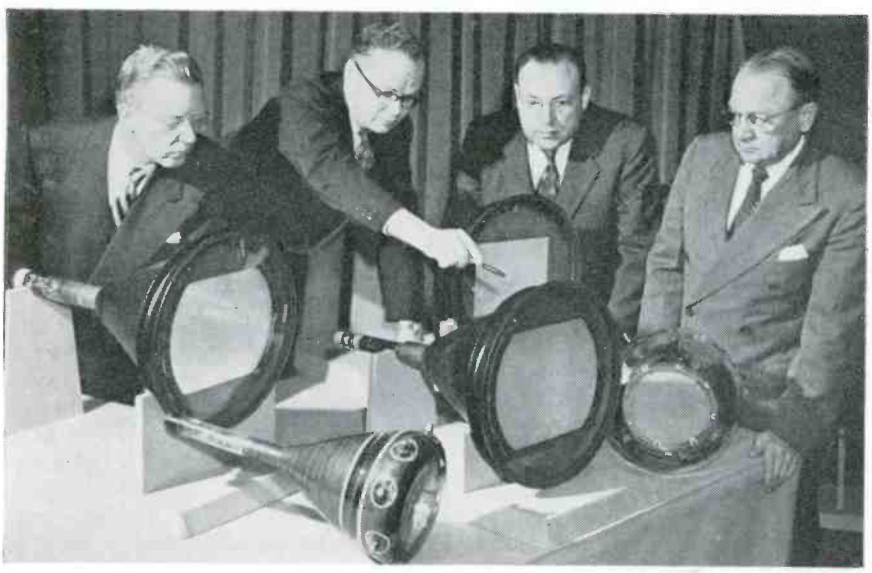
Material Substitution: Two elements appear to be destined for widespread applications as substitutes during the coming months—boron and magnesium. According to Washington, boron may prove to be the ace in the hole that will help pull the country through a critical shortage of some alloying material used in making steel. . . . As a hardening agent, boron, in amounts less than a few thousandths of a per cent, is said to be able to replace several hundred times its weight of manganese, chromium, molybdenum, and nickel. Boron, containing steel, has been found easier to process by machining, forging or cold working, than the higher-alloy steel which it can replace. The only negative property of boron is in its inability to impart better resistance to corrosion, wear, or high temperatures, for which many alloy steels are designed. . . . Magnesium, which weighs only two thirds that of aluminum, and only one fourth that of steel, is rapidly becoming a factor on many production lines using forged, extruded, cast or rolled-sheet supply. Rolled magnesium sheet does require high-rolling presses, which are not too plentiful currently. The present rolling capacity is rated at 5-million pounds, but this production is expected to rise to 30-million pounds, as a result of a giant rolling mill now being built in the middle west.

Aluminum Production Prospects Bright for '52: High aluminum outut by the end of '52 has been forecast in Washington. With new production lines whipping up to peak activity in the northwest, the supply prospects are much better than those of copper or steel. Rolling facilities are now plentiful for quarter-inch aluminum sheets, according to NPA, and by the middle of '52 aluminum rod and bars are expected to be available in greater quantities.

Reflectometer Keyed for Test Work: Radar sets and TV links will soon be tested with recording broadband microwave reflectometers, which can provide an automatically-drawn curve, disclosing how the reflection coefficient changes with frequency. According to A. L. Witten of Sperry, who described the equipment at a recent NEC meeting in Chicago, the instrument accomplishes in one minute, measurements which previously took a trained technician hours and sometimes days to perform.

Magnetic Amplifiers Rising in Popularity: Magnetic amplifiers, used briefly during World War II, may soon become a very popular substitute for tubes in equiment where ruggedness and reliability are essential, revealed Ed Weir of Magnetics, during an NEC talk. . . . Described as a rising star in electronics, the navy recently reported that the magnetic amplifier is truly a serious competitor to the tube, and is here to stay. In the early days, the device was ignored and called an imposter, too slow, cumbersome and inefficient to be taken seriously, navy authorities declared. Today, engineers have recognized its virtues to control frequency, voltage, servo mechanisms, radar and sonar equipment, pulse forming, sweep multivibrator circuits, etc. . . . So impressed is the navy with its possibilities, that they compiled a comprehensive analysis on the amplifiers for the military and civilian industries.

TV Degrees Now Official: It will soon be possible to receive an academic degree of Bachelor of Science in TV. The University of Southern California will begin courses leading to that degree in '52 in the College of Letters, Arts and Sciences. Highlighted during the course will be an on-the-scene training program with lectures given in a completely equipped studio, which it is expected will cost over $100,000.



Left: Reviewing five tricolor TV picture tubes, on display during a recent color report session in New York: (left to right) E. W. Herold; Dr. E. W. Engstrom, vice president in charge of RCA Labs division; H. B. Law, and Dr. V. K. Zworykin, vice president and technical consultant of the division. In the rear row are a 3-*gun shadow mask tube* (left) and a *line-screen* picture tube. In the foreground are (left to right) *grid-controlled, one-gun shadow mask*, and 45-*degree reflection-type* color tubes.

Right: Sarkes Tarzian and a recently developed vhf tuner, which not only provides for 12-channel coverage, but uhf too, through the medium of a pretuned or tunable unit, which converts tuner for ultrahigh *if* amplification. Tuner features use of a 6X8.

New Posts—*Leonard F. Cramer*, formerly executive vice president of Allen B. DuMont Labs., has been appointed assistant general manager of the Crosley division, Avco Manufacturing Corp. . . . Hallicrafters has named *Michael D. Kelley*, TV sales manager; *William J. Halligan, Jr.*, radio sales manager; *William S. Wright*, operations manager; *Fred T. Page*, controller; *Randolph W. Westerfield*, member of the executive staff; and *J. C. Matthews*, chief purchasing agent. . . . *Raymond S. Perry* has been elected vice president and director of Federal Telephone and Radio Corp. . . . *Jerry Ciral*, formerly with RCA, Hollywood, has joined the staff of H. A. Kittleson, as a field engineer. . . . *Henry F. Argento*, formerly sales manager, has been elected an assistant vice president of Raytheon Manufacturing Co. He will also serve as assistant manager of the power-tube division. . . . *Joseph A. Abbott* has been appointed rep for Federal Telephone and Radio on the RTMA industrial relations committee for '51-'52. . . . *Mrs. Douglas Horton* has been elected to the RCA board of directors to succeed *Arthur E. Braun*, who has resigned. . . . *Harrison Johnston*, formerly of G.E., has been appointed manager of the product engineering division of the Ampex Electrical Corp. . . . *Sam Littlejohn* has been elected commercial vice president of G.E. . . . *Dale Cropsey* has joined the engineering staff of Potter and Brumfield as works manager. . . . *James C. P. Long*, formerly head of the material coordination section of the Bureau of Aeronautics, U. S. Navy department, has been appointed to the Washington, D. C. engineering statff of the Sprague Electric Co. . . . *Myer Fried* has been named a special advisor to P. B. Reed, vice president in charge of the government service division of RCA. . . . *Edwin R. Liberg* has been appointed supervisor of custom engineering for Audio and Video Products Corp. . . . *E. G. Shower*, formerly of Bell Telephone Labs, has joined Radio Receptor Co., Inc., as chief engineer of a newly formed germanium division. . . . *W. W. Wommack* has joined the molding compound sales force of the Plaskon Division, Libbey-Owens-Ford Glass Co. . . . *Rear-Admiral Stanley F. Patten*, USN (Ret.), has been elected vice president of Allen B. DuMont Labs. . . .*Martin L. Scher* has been appointed national sales manager of Emerson. . . . *Murray Weinstein* has joined the research department of Regal Electronics Corp. . . . *Dr. Louis N. Ridenour*, formerly chief scientist of the U.S. Air Force, has been appointed director of engineering of the International Telemeter Corp. . . . *W. D. Renner* has been named manager of sales engineering for Howard W. Sams and Co. . . . *Les A. Morrow*, Cleveland, Ohio, is now representing Thomas in Ohio, Kentucky, western Pennsylvania and West Virginia. . . . *William E. Boss*, formerly field sales representative in upstate New York for the RCA Victor home instrument department, has been appointed staff assistant to *J. B. Elliott*, vice president in charge of the company's consumer products. . . . *William F. E. Long*, Washington, D. C., has become the first director of statistics for the Radio-Television Manufacturers Association. . . . Tricraft Products has announced the appointment of *Lou Potashnik* as sales manager. . . . *William H. Hazlett* has been appointed eastern sales manager for the Audio and Video Products Corp. . . . *Colonel Walter Birdsall Brown*, former Signal Corps officer, is now sales manager of the Transmitter Equipment Manufacturing Company, Inc. . . . *Frederick T. Budelman* and *William Fingerle, Jr.* have formed, in association with French-Van Breems, Inc., Stamford, Conn., a manufacturing and engineering corporation for radio and electronic equipment, to be known as the Budelman Radio Corp. . . . *James L. Brown* has been named sales manager for receiving tubes and cathode-ray tubes for Westinghouse. . . . *Carl F. Miller*, inventor of the Locktal tube, has been named manager of Westinghouse receiving tube development and design engineering. . . . *Otto H. Schade* received the David Sarnoff Gold Medal Award for outstanding achievement in TV engineering at the recent SMPTE convention in Hollywood, Calif. . . . *Gerald R. Chinski* has been named chairman of the conference public relations committee, for the 4th southwestern IRE conference and radio engineering show which will be held in Houston on May 16 and 17, 1952, at the Rice Hotel. *Gerald L. K. Miller*, past chairman of the Houston section, is serving as conference manager. . . . *Marvin E. Nulsen*, Indianapolis, Ind., has been named sales rep for the picture-tube division of DuMont Labs. *Jack F. McKinney Sales Co.*, Dallas, Texas, have been named reps for the division in Texas, Oklahoma, Arkansas, Louisiana and Mississippi. . . . *Dr. David C. Miller* has been appointed assistant director of research of Philips Laboratories, Inc., Irvington-on-Hudson, N. Y. . . . *Robert A. Stang* has been named sales rep for Electronic Instrument Co. in Metropolitan New York, New Jersey, eastern Pennsylvania, Maryland, Delaware and the District of Columbia. . . . *Ray M. Rand* has been appointed sales rep for the Audio-Video Recording Co. . . . *George W. Henyan*, manager of the G.E. industrial and transmitting tube operations, has accepted a temporary appointment as chief of the components branch of the NPA electronics division, headquartering in Washington. . . . *Louis Martin*, formerly general sales manager of the Elizabeth and Sickles divisions of the General Instrument Corp., has been appointed general sales manager of Standard Coil Products Co., Inc. . . . *T. R. Meyer* has been named director of the quality control department for the Owens-Illinois Glass Co. Kimble glass division and the American Structural Products Co. . . . *T. Y. Henry*, formerly manager of materials section, division standardizing, of RCA Victor, has been appointed division manager of the Flexo Wire Co., a subsidiary of Copperweld Steel Co. . . . *John H. Nelson*, of RCA Communications, Inc., has received the first merit award of the Foundation for the Study of Cycles. . . . *Robert T. Pennoyer*, manager of the G.E. Buffalo tube works, has been appointed manager of the tube department advanced manufacturing section in Schenectady, N. Y. . . . *R. E. Nugent* has been named chief engineer of the Feedrail Corp. *W. R. Jewett* is assistant chief engineer, and *G. H. Baumann*, sales manager.

Murray Weinstein

Otto H. Schade

Col. W. B. Brown

Adm. Stanley F. Patten

James C. P. Long

TV Picture Tubes

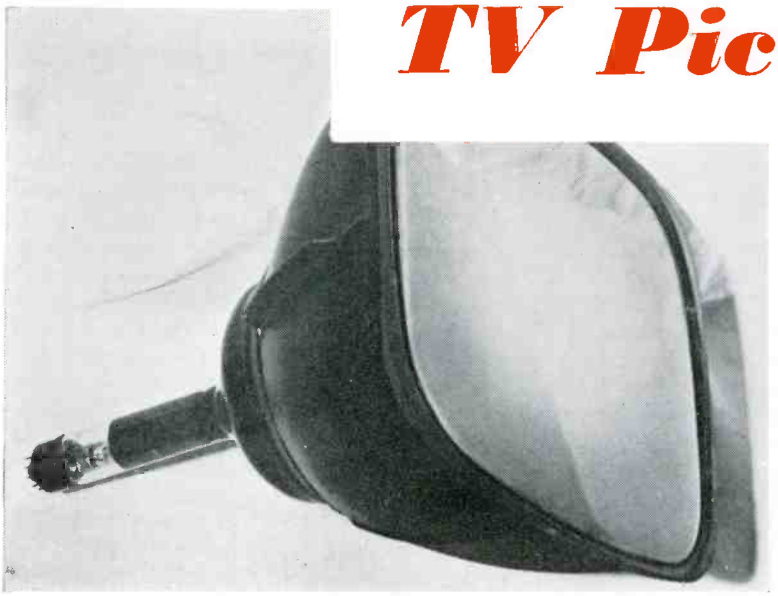


Figure 1

A 16-inch rectangular tube with chrome-iron sealing beads, the remainder of the envelope being 1010 steel.

In the production of receiving chassis, the eventual selling price has always been and will be a principal market consideration. In an analysis of the TV industry's progress in effecting price reduction of sets, there emerged the surprising fact that the largest single factor has been the reduction in the cost of only one component, namely, the picture tube. This cost reduction cycle began with the development of the metal-envelope picture tube. However, in addition to present economic conditions, there are cogent reasons why one can hardly expect this trend to continue. Longer viewing hours call for picture tubes with longer life, while increased screen sizes necessitating higher cathode loading and anode voltage has been found to demand more care in processing, resulting in higher cost. To these factors must be added increased costs attributable to the use of electrostatic focusing, the adoption of which has been spurred in the interest of material conservation. Only one avenue appears to be open to compensate for these added costs; once again, the envelope of the tube. The early metal-glass cathode-ray tubes employed stainless steel, a chrome-iron alloy containing 27% chromium with a base price of around 55 cents per pound. The chrome content was later reduced to 17% and the price of the alloy dropped to around 40 cents per pound. It has been found that large additional savings can be realized by the use of cold-rolled 1010 carbon steel which costs less than 10 cents per pound.

Extensive development work has been conducted on picture tubes with the 1010 steel envelopes. During the course of this development, a number of problems were presented. A faceplate glass having the correct thermal coefficient of expansion and, at the same time, susceptible to fabrication by mass production methods, was required. Thus the sealing process required modification. It was also found necessary to evalue another glass for the neck of the tube which would fulfill dielectric strength and resistivity requirements. Lastly, the glasses and the metal envelope had to be capable of withstanding the processing to which the cathode-ray tube is subjected.

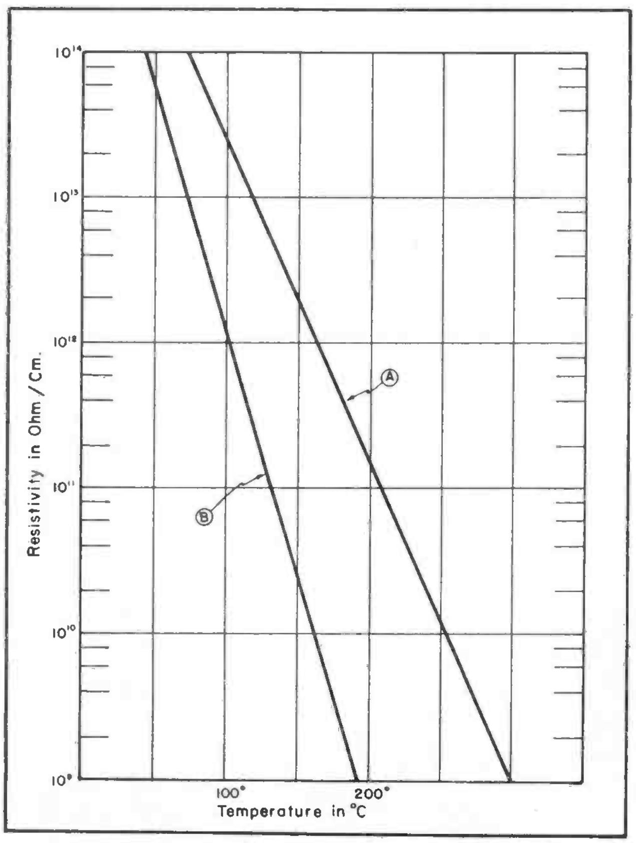


Figure 2

Resistivity curves of Lancaster Lens LL-117 (B) and G-12 glass (A).

Iron Envelope with Chrome-Iron Sealing Areas

As an intermediate solution, a chrome-iron ring was welded onto each end of an iron cone, to permit sealing a glass window and neck of the same composition as presently used in the metal-glass tubes made with modified 430 stainless steel. In Figure 1 appears a 16-inch rectangular tube constructed in this manner, with a 1010 steel middle part and chrome-iron sealing lands.* The drawback of this method was found to reside in the necessity for heliarc welding of the ring to obtain a vacuum-tight joint, representing an additional manufacturing step.

All Iron Cone—Faceplate Glass and Sealing Technique

The coefficients of thermal expansion of chrome-iron alloys and of the faceplate glass used in present-day picture

*Composite envelope, which was developed jointly with R. G. Olson and Ronfeldt Associates of Toledo, Ohio, has certain advantages. The envelope portion proper is made by ordinary metal stamping procedures in two half-sections which are then *heliarc* welded together. Savings of metal may be accomplished by using lighter gage material and strengthening beads.

With Iron Envelopes

by C. S. SZEGHO and R. G. POHL
The Rauland Corporation

Manufacturing Techniques Developed for Fabrication of Tubes Featuring Envelopes with Chrome-Iron Sealing Beads and All-Iron Cones.

Figure 3
A 16GB4 picture tube in an iron envelope.

tubes, compared with those of 1010 cold-rolled steel and of the glasses which can be successfully sealed to it, are detailed in table 1.

To increase the coefficient of thermal expansion of the glass its alkali content must be raised, but this lowers the viscosity of the glass. Consequently, the sheet glass must be drawn more slowly, thereby reducing the manufacturing efficiency and increasing the cost. The weathering qualities of the glass, as well as its resistance to the acid treatments to which the glass is subjected during picture tube processing, are also impaired. A satisfactory compromise has been reached. in one instance, in the production of a No. 3911** glass which is a suitable faceplate glass for the 1010 steel cones. While direct seals of this high-expansion glass to untreated 1010 steel cones were made, it was found that the glass usually cracked during processing. It has been found that whenever cold-rolled steel is heated above 1000° *C*, large amounts of occluded gases are released and pass up into the liquid glass, which upon solidifying leaves many bubbles and results in a weak seal. A further cause of breakage arises from heavy scaling of the iron during the heat treatment. The metallic oxide is wetted by the glass and forms an oxide-glass bond which is stronger than the bond of the iron to the oxide. This oxide then separates from the iron base. For this reason, it is necessary to protect the iron from excessive oxidation. This was first achieved by covering the sealing land with a low-melting point glass in the form of a frit. The sealing lip of the cone was covered with a paste of this glass frit suspended in water or amyl acetate; then the faceplate was placed on top of the lip and the seal made.

In a modification of this technique the cone was glazed by melting the frit in the oven first and completing the faceplate seal later. This practice, of course, is nothing other than that used in the conventional enameling of iron ware. The first step in the process of enameling consists of mixing a glass frit in water together with small amounts of clay and alkali salts to prevent precipitation and to provide the proper consistency. This mixture is sprayed onto the cone which is then baked at approximately 1500° *C* to melt the glass and glaze the metal. The coefficient of thermal expansion of the enamel used was approximately 117 x 10^{-7}/° *C* in the range from 30° C to

(*Continued on page* 26)

Metal	*Coefficient of Expansion*	*Glass of Faceplate*	*Coefficient of Expansion*	*Annealing Point*
Chrome-Iron; 27% Cr (Modified No. 446)	114x10^{-7}/° *C*	PPG 3590	102x10^{-7}/° *C*	527° *C*
Chrome-Iron; Telemetal (Modified No. 430)	117x10^{-7}/° *C*	PPG 3720 (Teleglas)	105x10^{-7}/° *C*	524° *C*
Iron (No. 1010)	144x10^{-7}/° *C*	PPG 3344	130x10^{-7}/° *C*	510° *C*
		PPG 3911	117x10^{-7}/° *C*	504° *C*

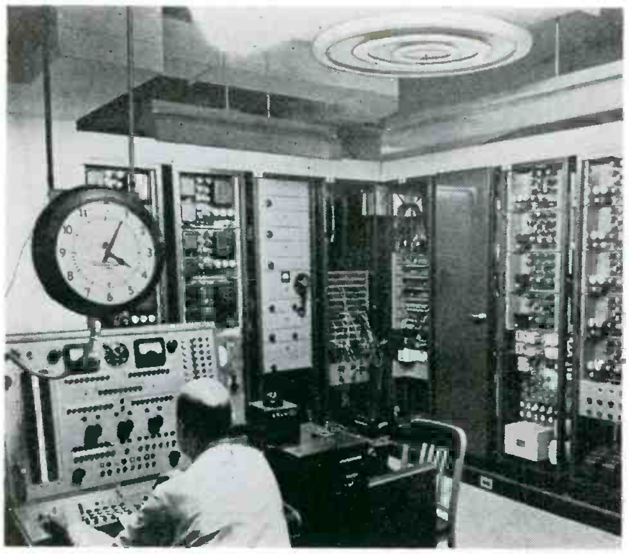
Table I

Metal	*Glass for Neck*	*Coefficient of Expansion*	*Annealing Point*	*Electrical Resistivity in 100° C*
Modified No. 446	G-12	89x10^{-7}/° *C*	433° *C*	2.4x10^{13} ohm cm
Modified No. 430	Lancaster Lens LEA-4	95x10^{-7}/° *C*	425° *C*	Same as G12
No. 1010 Iron or Ti-namel	Lancaster Lens LL-117	117x10^{-7}/° *C*	401° *C*	1.2x10^{12} ohm cm

Table II

**Pittsburgh Plate Glass Co.

TV Studio AIR



Below

Control room at WPTZ with a circular air unit.

Left

Flush ceiling mounted circular type air-distribution unit in TV studio master-control room at WCAU-TV.

Problems and Their Solutions in Rooms Used for Feature Shows, News, Master and Studio Control, Picture Recording and Processing, etc.

TELEVISION studio air conditioning has problems peculiar to the very unusual genus of this intriguing medium.

In typical studios, for instance, it has been found necessary to introduce large volumes of air, with db readings held to approximately 20. High air volume is necessary because of the tremendous light load natural to TV operations. Therefore, extra precautions are required to hold down noise levels. In one installation, all the return ducts and supply ducts were acoustically lined and provided with sections of flexible material, at intervals, to prevent sound transmission. In this same installation, the return ducts from the control room and studio were so close together, that a labyrinth sound absorber was needed to prevent sound transmission from control room into the studio.

Circular Recessed Outlets

In solving the problem, eight circular recessed ceiling outlets were installed, each handling 940 cfm with an average throw of seven feet. The ceiling and mounting height was twenty-four feet, with half of the return air removed at eight feet above the floor and the balance of the return air at floor level.

Studio Obstructions

Often there are obstructions in the studio that may interfere with proper air distribution.

Since scenery, properties, sound equipment, cameras, and other obstructions are characteristic of the busy TV studio atmosphere, any air distribution system considered must possess flexibility of air flow adjustment. Units are available on which air deflection can be altered from vertical to horizontal by a simple key adjustment. Certain circular outlets have an adjusting lever in outlet neck for setting of volume control, easily accessible yet hidden and tamperproof. These units can be obtained as supply outlets only or as combination supply and return.

Square Outlets

A more recent addition to air distribution technique is the square outlet, available in recessed type to match acoustical tile or surface type for plaster ceilings. These units are completely adjustable on the job and can be set at the factory or in the field to give one, two, three, or four-way discharge air pattern and clear obstructions encountered on the job.

Linear Ceiling Units

A linear ceiling outlet has received favorable consideration in many installations, because it offers little or no interference with the many ropes suspended from the ceiling to hold various equipment in place. This line-type unit also provides effective handling of large air volumes at low noise levels. One particular make of linear ceiling outlet is available with a fluorescent lighting fixture incorporated. This unit has been found to be ideal for many studio applications with the

				Size*	
Room	*Supply Air*	*Return Air*	*Units*	*Supply Diameter*	*Exhaust Diameter*
News	230 cfm	172 cfm	2	8″	5¼″
Shop	160 cfm	120 cfm	2	8″	5¼″
Master Control	1030 cfm	0 (Supply unit only)	1	24″	0
Studio Control	300 cfm	280 cfm	1	14″	9¼″
Telecine	560 cfm	420 cfm	1	14″	9¼″
Processing	840 cfm	620 cfm	2	17″	11¼″
Film Transciption	850 cfm	630 cfm	1	28″	18″

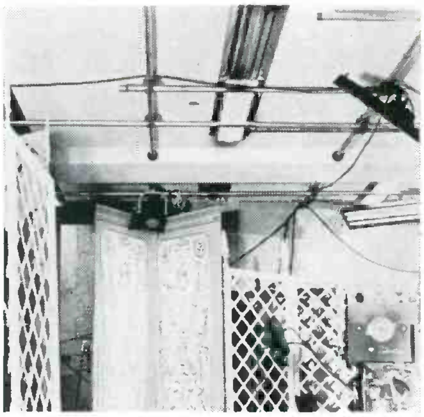
*These sizes are based on Barber-Colman Venturi-Flo air distribution units.

Table I

CONDITIONING

by W. W. KENNEDY

Chief Engineer
Air Distribution Development, Barber-Colman Company



Above
Partial view of line-type air distribution installation in studio at KTTV.

lighting used for directing sets and locating equipment.

Avoiding Drafts

Despite tremendous heat and consequently high air volume requirement, it is also often necessary to provide cooling satisfaction without annoying drafts. Performer and technician comfort is essential to fine performance. One manner of minimizing discomfort, due to excess heat generated by ceiling lights, is to introduce the air at a low level to secure the benefit of evaporative cooling due to slight air motion over the body. Heat from lamp fixtures would be drawn off at the ceiling through exhaust grilles and return air grilles would be located near the floor.

High-Ceiling Installation

In one main studio, satisfactory air distribution was obtained with a ceiling and mounting height of twenty-two feet. Four circular ceiling units were used, each handling 2,500 cfm with a throw of ten to fourteen feet. In a smaller studio with a twelve-foot mounting height, four ceiling outlets were required, each handling 1,700 cfm, throwing six to seven feet.

Typical Requirements

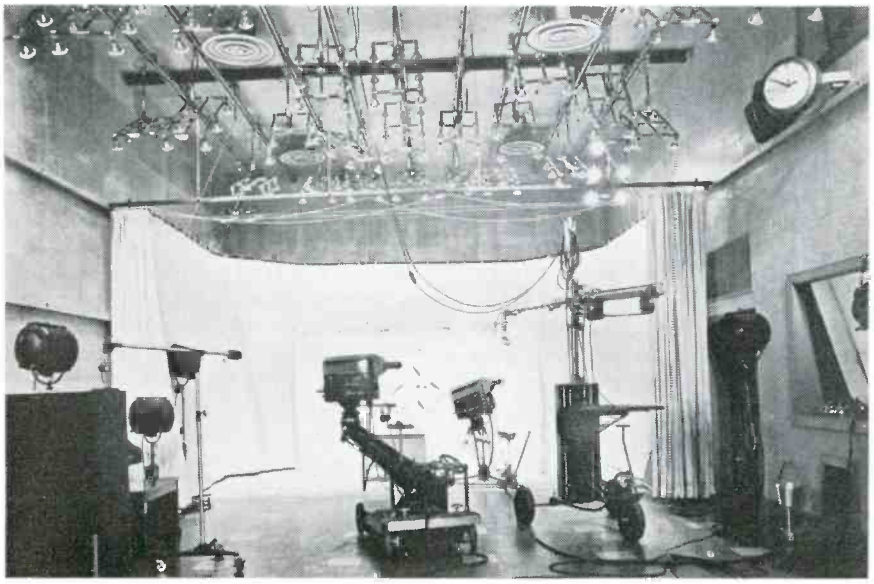
Requirements of a typical overall television station installation showing air quantity and size of outlets used, appears in table I. In this particular installation the units were combination supply and exhaust unless otherwise indicated; supply air temperature for cooling was 45° with a controlled room temperature of 75°.

Announcer Booth Setup

A pair of announcers' booths, with a supply requirement of 80 cfm and a return of 60 cfm, were each equipped with a line-type unit incorporating a lighting fixture. The studio required a supply of 5,500 cfm and a return of 5,500 cfm. Twenty-one line-type units with lights and twenty-one regular line units were used. Those used as supply outlets had dampers.

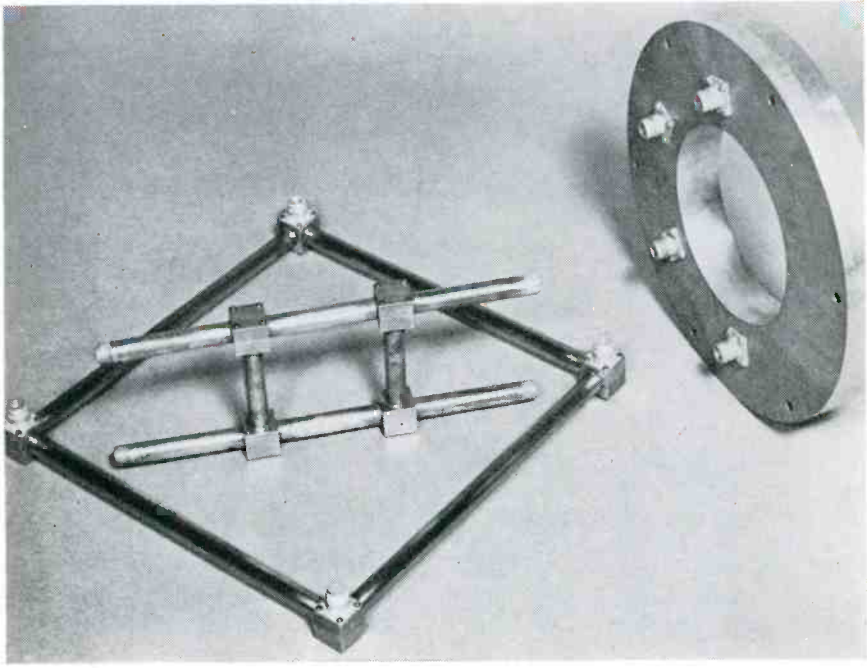
Future of Air Distribution

Manufacturers of air distribution products have thus far managed to come up with sound, practical answers to the many and varied requirements of TV studio air conditioning. And as television expands its demands for effective air distribution will become manifold. There is no doubt that air distribution systems will be ready to do their part effectively.



Left
Four circular-type air-distribution units in main TV studio at WFIL-TV.

UHF Transmission Line Problems



by BERT M. ELY

(Left)
Coax and guide junctions.

Highlights of Transmission-Line Project Discussed by J. M. DeBell Jr., of DuMont at Recent IRE UHF Symposium* Which Disclosed That Ultrahigh Problems Present Interesting Challenge. . . . To Lead Manufacturers to Provide Required Highly-Efficient Coax and Waveguide Lines. . . . To Engineers Who Will Have to Improve Line Circuitry and . . . To Broadcasters Who Will Have to Orient Themselves to the New Situation to Insure Maximum Equipment Proficiency.

On the ultrahighs, there have appeared many unusual problems, not only in the actual basic equipment, but in the allied items, such as transmission lines. It has been found, for instance, that currently available commercial TV lines will have to be improved before runs of any length can be used for *uhf*.

Analyzing this situation at the recent *uhf symposium*,* J. M. De Bell, Jr., of Du Mont, said that in general transmission line design, there are two fundamental problems: *line losses*, which must be minimized and *reflections*, which it is desirable to keep out of the system between the transmitter and antenna. If these goals are attained, it should be possible to maximize the power output of the system, since expensive *rf* power will not be wasted in heating conductors, and the full incident power will be permitted to leave the system instead of being partially reflected back to the transmitter, which may cause transmitter tuning difficulties.

It has been found that two unwanted effects occur if power is reflected. In the first place, it was pointed out, a voltage standing wave is introduced in the line. This results in the reduction of the safe power handling capacity of the transmission line. In the second instance, of more immediate concern to TV operators, according to past performances, reflected energy can give rise to the transmission of a second TV picture, if this reflected energy is not absorbed by the transmitter, but is reflected again from the transmitter, which is usually the case. This condition will cause the second picture to show up at the receiver in the form of a ghost if the transmission line is long enough, or simply a noticeable reduction in picture definition if the transmission line is short. Often, it was noted, one can compute where the reflection is coming from in the transmission line by noting how far a ghost signal is displaced from the original signal at the receiver and then going through a simple series of computations. Of course, all ghosts aren't due to transmission line reflection.

Probing loss problems, De Bell stated that the difficulty has been found to be complicated by skin effect. It is well known that the higher the operating frequency, the more *rf* currents flow nearer the conductor surface, resulting in less cross-sectional area of conduction. This, in turn, results in more transmission line resistance and, therefore, higher attenuation. Because of this peculiarity, cable makers have rated the lines for lower power handling capacities at the higher frequencies. Since, as power is dissipated in transmission line copper loss, the conductors become heated, it has become a practice to establish a safe operating temperature rise for the line and then define power rating so that the line will not exceed the assigned operating temperature. According to the Du Mont expert, conservative ratings for lines at *uhf* are: 1⅝″ for 4.5 kw; 3⅛″ for 16 kw; and 6⅛″ for 75 kw.

Generally, he said, the power handling capacity of transmision lines at *uhf* is about one-half the *vhf* rating.

Reviewing transmission lines for receivers, De Bell noted that a good home installation will have to accept any-

*Sponsored by the IRE Professional Group on Broadcasting Transmission Systems: general report on meeting appeared in TELEVISION ENGINEERING, October, 1951.

where from 2 to 10 db of attenuation in the line running from antenna to receiver. The twinlead types have been found to have least attenuation, but are most susceptible to increase of attenuation with rain and sleet conditions. In addition, they are more susceptible to man-made interference, and there also exists the possibility that the entire twinlead line will act as an antenna to spread local oscillator radiation around the landscape. Tests have indicated that shielded RG8 or 9, or tubular twinlead should yield optimum results in an average TV receiver installation.

If 6⅛" line is used, at *uhf*, particularly at the top 100 mc of the band, there may be problems for the broadcaster, the symposium lecturer noted, since here the line is approaching a point where it can operate as a waveguide. Explaining this result, De Bell said that power in the first unwanted higher mode (TE_{11}) of operation could conceivably flow into the radiating system without causing trouble, but it is more likely that the unwanted mode will: (*a*) be uncoupled to the radiating system because of its configuration and so result in a *vswr* because power is reflected, or (*b*) the unwanted mode could combine with the desired coax mode of transmission to yield partial cancellation and, hence, reflection. The problem of mode suppression has been receiving consideration, but there is no doubt that considerable work will have to be done before reflectionless mode suppressors can be constructed. It was noted, however, that perhaps by the time high-powered *uhf* transmitters become available to exceed the 3⅛" transmission line ratings, there may be some other salvation than mode filters.

In a summarization of the foregoing problems, it was pointed out that the center conductor of a transmission line appears to cause a large part of the loss in a coax system. Describing the offect of beads, De Bell declared that plain beads will cause reflections, and undercut beads, while they may yield a satisfactory line, make the line much more expensive to manufacture. Any deviation of the center conductor from concentricity will cause a change in line impedance and, therefore, a reflection. While beads may be considered as distributed capacitances at broadcast frequencies, it was noted, they must be looked on as lumped elements at *uhf*, and design steps must be taken to eliminate their less desirable effects. In view of this peculiar defect, it was said, it appeared as if elimination of the center conductor, or the use of a waveguide, would save everyone a lot of trouble.

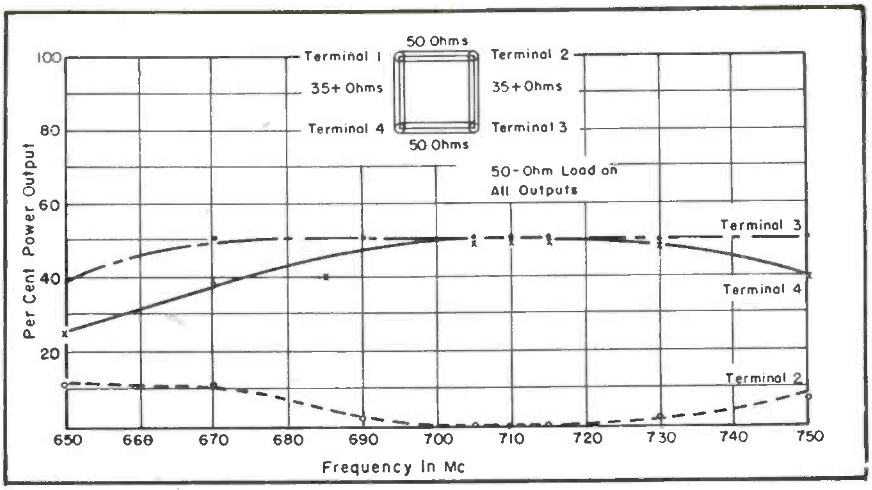
Currently, RTMA has established three commercial sizes of guide to be used for *uhf*: 7½" x 15" for 470 to 750 mc; 5¾" x 11½" for 640 to 960 mc; and 4⅞" x 9¾" for 750 to 1,120 mc.

Discussing new uses for transmission lines, De Bell said that at Du Mont there have been used waveguide transmission lines with slots located in the waveguide wall, and excited by probes.

A commentary on the possible use of transmission lines to diplex aural and visual transmitters into a single antenna, revealed that there are two types

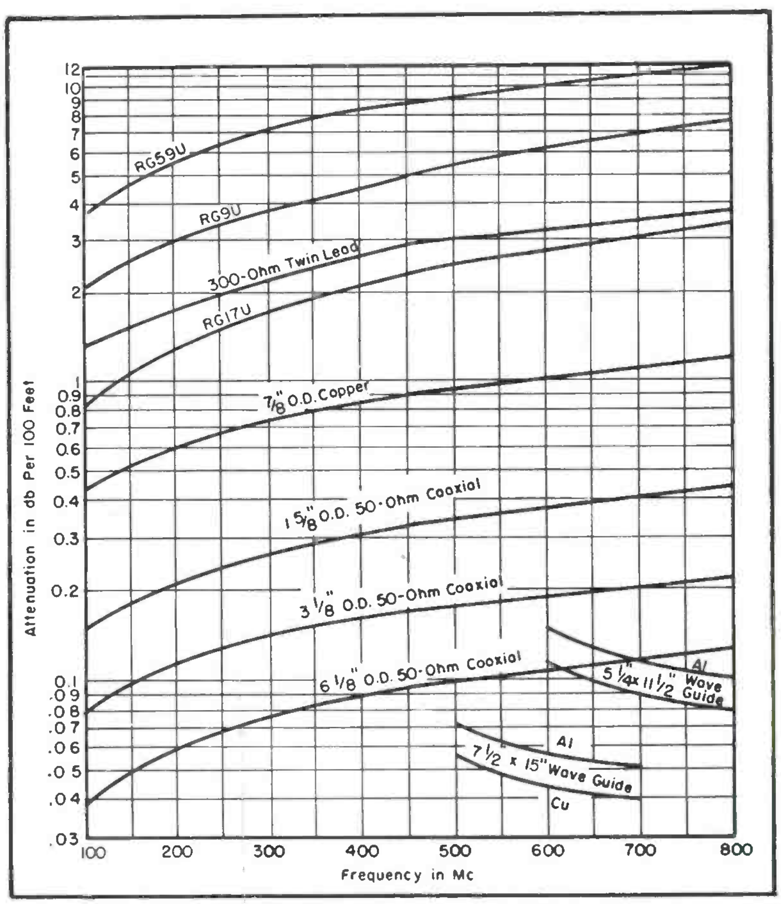
(*Continued on page* 27)

‡All the papers offered at the symposium are scheduled to appear soon in a special professional group report volume which will be available for approximately $2.00. *Complete publishing details will be announced shortly.*

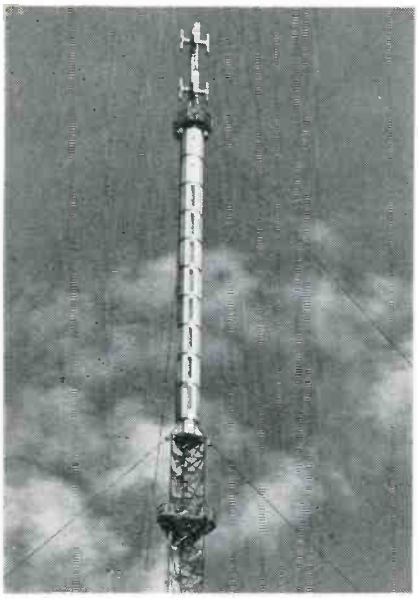


Schematic and power behavior plot of ¼ wavelength square hybrid ring.

Chart showing relative attenuation for different types of transmission line. The y-axis values are in db per 100'.



The 45-Kw TV Station



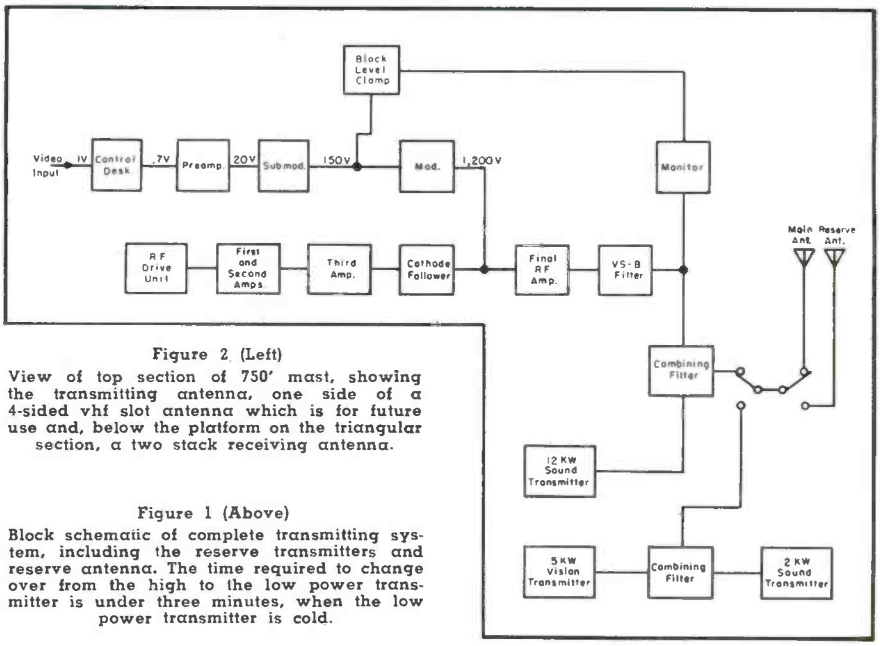


Figure 2 (Left)
View of top section of 750′ mast, showing the transmitting antenna, one side of a 4-sided vhf slot antenna which is for future use and, below the platform on the triangular section, a two stack receiving antenna.

Figure 1 (Above)
Block schematic of complete transmitting system, including the reserve transmitters and reserve antenna. The time required to change over from the high to the low power transmitter is under three minutes, when the low power transmitter is cold.

IN PLANNING transmisson systems capable of providing service to an extremely large audience, running into the millions living not only within an undulating terrain, but in industrial areas with many man-made interference problems, it is necessary to consider particularly two factors; power and antenna height. In England, this situation arose in the development of a station which could cover densely populated districts lying in valleys, and large industrial towns like Manchester, Huddersfield, Sheffield and Leeds. After surveying the coverage problems, it was decided to use a 5-kw transmitter* with a 45-kw peak white-power output and an antenna, 2,500 feet above sea level, all located at Holme Moss, in the northern part of the country, seventeen miles east of Manchester.

*Transmitting equipment and associated test gear supplied and installed by Marconi's Wireless Telegraph Co., Ltd., to BBC specifications, which were: Time of rise of output pulse, 0.14 microsecond; overshoot or undershoot, less than 5%; deviation from linearity of modulation characteristic, less than 4%; variation of black level under all conditions, less than 2%; 50 cps noise level in output signal, 48 db; 300 cps noise level in output signal, 56 db; total power consumption with all white picture, 180 and 120 kw.

Modulator

The modulator was designed to provide a peak-to-peak output of 1,200 volts with an equivalent internal impedance of 5 ohms, and handle an *rf* stage grid current of 3 amperes.

The preamplifier was duplicated to minimize lost program time, if this complicated unit should develop a fault. Its functions are to provide: (*1*) Am-

Figure 3
Selective bridge combining circuit mounted on wall of transmitter hall. Reflectometer indicator panel below.

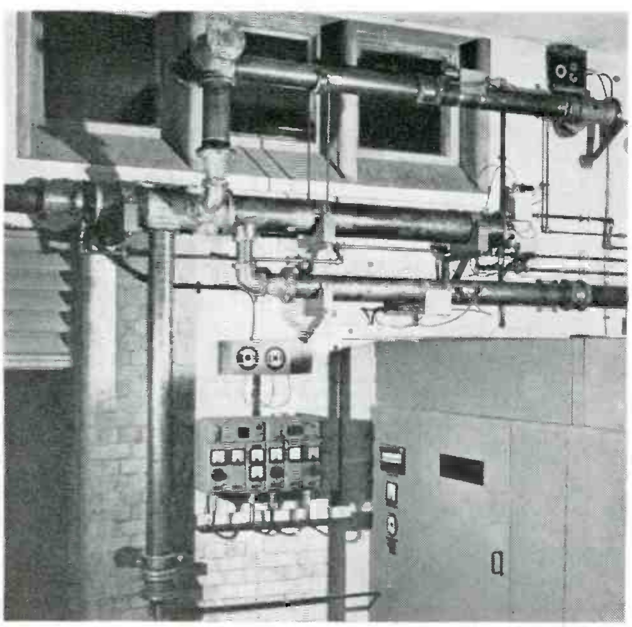
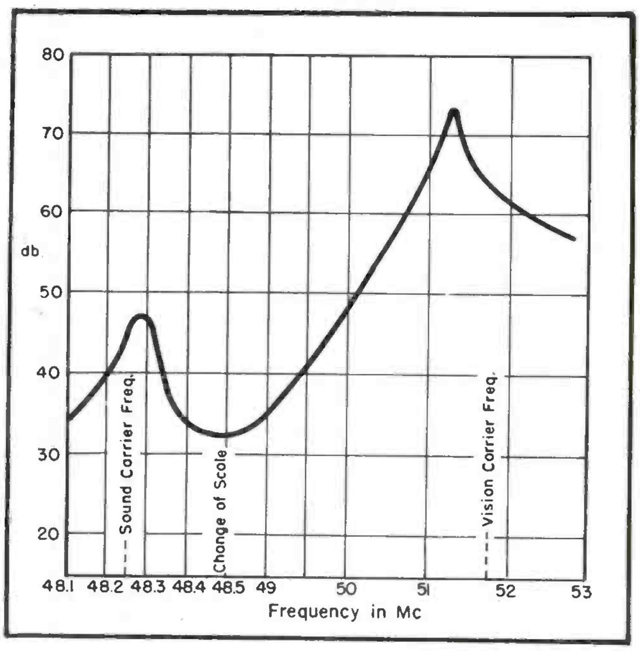


Figure 4
Insertion loss of combining circuit measured between video and sound input, the output being connected to the transmission line and antenna.



at Holme Moss, England

by F. D. BOLT and D. E. TODD

Planning and Installation Department, Engineering Division
British Broadcasting Corporation

Positive Picture Modulation Transmitter with Antenna 2500 Feet Above Sea Level Designed to Serve About 11-Million Potential Viewers Living Within .1-Millivolt Signal-Strength Contour, Which Includes Some of the Most Undulating Terrain in the British Isles.

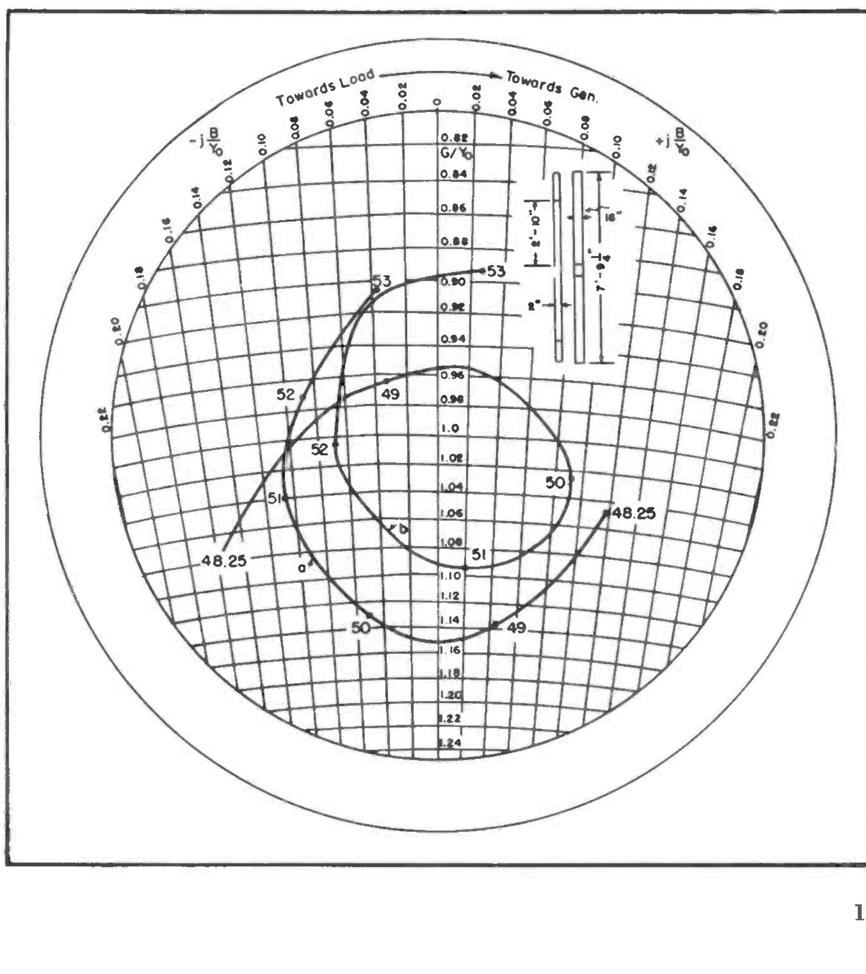
plification from 0.7 to 20 volts; (*2*) sync stretch to suit the modulated *rf* stage; (*3*) sync amplitude stabilization (radiated sync amplitude independent of incoming sync amplitude variations); (*4*) adjustable negative curvature of input/output amplitude characteristic to correct for later positive curvature of this characteristic by the modulated *rf* stage; and (*5*) clamping pulses for the black level clamp unit,

A *sub-modulator*, which consists of an amplifier, is followed by a cathode-follower, both of the shunt regulated type.[1] The amplification was found to be from 20 to 150 volts, and the equivalent output impedance approximately 30 ohms. In the shunt-regulated amplifier the anode load of the amplifier is formed by a second tube, which is excited by the voltage across a resistance connected between the cathode of the second tube and the anode of the first. The output voltage is taken from the cathode of the second tube. The output impedance of such an amplifier is much lower than that of a conventional amplifier, and consequently its bandwidth is greater. The shunt-regulated cathode-follower, similarly, uses a second tube as the cathode load of the cathode follower, the grid excitation of the second tube being obtained from a small resistance in the anode circuit of the cathode follower. The output is taken from the anode/cathode junction of the two tubes. The output impedance of a shunt-regulated cathode follower has been found to be much lower than that of a conventional cathode follower. The *dc* potentials of the grids of the regulator tubes can be adjusted by chains of series-connected neon stabilizer tubes which offer practically zero impedance to low frequency *ac*, but have a constant *dc* potential drop. Many of these neon chains are used throughout the modulator and are mounted in interchangeable plug-in units. The plugs in individual amplifiers or cathode followers were arranged to select the correct number of neons when a neon unit is inserted. The maximum *dc* potential handled by one of these chains is 3,400 volts.

In a black level clamp unit there is a shunt-regulated cathode follower in which the grid is *ac* coupled to the sub-modulator and the output is *dc* coupled to the modulator unit. The *dc* potential of this cathode-follower grid controls the black level radiated by the transmitter, three methods of control being available for selection by means of a switch: (*1*) Normal black level clamp controlled by a clamping pulse applied for a period during the 5 microseconds of black level which occur after the line sync pulse. . . . (2) controlled clamp, basically a negative feedback system which monitors the radiated black level line by line and ap-

Figure 5

Smith chart admittance curves for single dipole at feed point (a) and for one half of antenna measured at "T" junction (b). The admittance plot of the single dipole falls inside the 0.85/1 standing-wave circle over a 10% bandwidth, the point 1, 0 being equivalent to 248 ohms. At the common feed point of a dipole pair in antiphase, the admittance excursion is centered by the addition of parallel capacity, and at a selected point in the feeders nearer the generator further parallel capacity is added to limit the excursion to 0.9 swr circle as shown in (b).



[1]Cooper, V. J., *Shunt-Regulated Amplifiers*, Wireless Engineer; May, 1951.

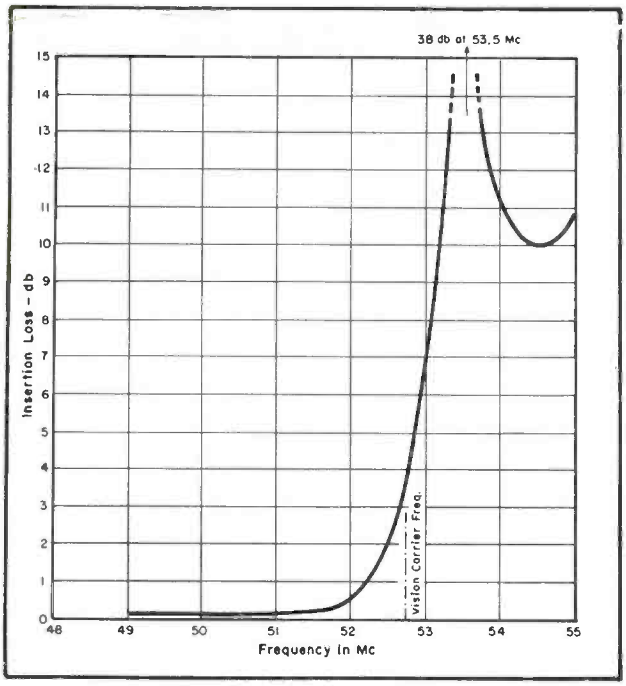


Figure 6
Insertion loss of vestigial sideband filter.

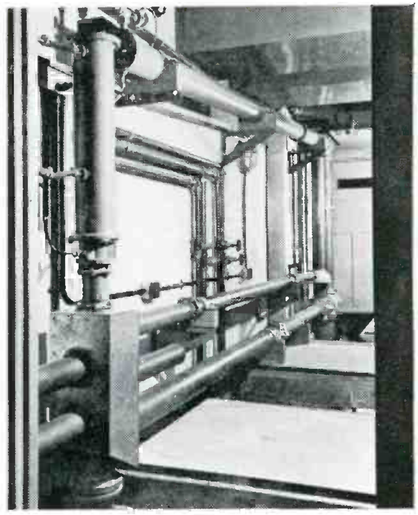


Figure 7
View of asymmetric sideband filter behind high-power video transmitter. Output from latter passes through the filter to a change-over switch and then either to feeder out to antenna or to a water-cooled test load. Filter permits lower sideband to be transmitted fully, but attenuates upper sideband increasingly for video frequencies above .75 mc.

plies any correction required to the clamp unit at line speed. (This is followed up by a slow-acting, or 1 cps or less, correcting voltage covering a wider range, the purpose being to compensate for line voltage variations and general drift of *dc* levels which could alter the radiated black level. The line speed control is able to correct for hum in the transmitter output and allows considerable economies in the power supplies to the later *rf* stages. These power supplies have to be built out to constant impedance from zero to 5 mc) . . . *(3)* sync-bottom restorer, a simple arrangement of diodes for use in the event of failure in the more complicated clamping circuits.

The modulator unit features a shunt-regulated amplifier using two forced-air cooled triodes[2], with indirectly heated oxide coated cathodes, followed by a shunt-regulated cathode follower with six of these triodes. The unit has a mutual conductance of about 25 milliamps per volt and a maximum anode dissipation of 2 kw.

For power to the modulator a single 3.5-kv 6-amp supply is used with both positive and negative terminals insulated. One stabilizer is provided to afford a source impedance of 0.5 ohm, an additional stabilizer being supplied to provide an impedance on one-sixth of an ohm between the negative supply terminal and ground.

Radio Frequency Stages

In the *rf* stages a cathode follower was installed to insure constancy of drive voltage at the grids of the final modulated stage. The two final stage tubes are water-cooled, thoriated-filament triodes.[3] An anode-supply voltage of 7 kv has been provided. The anode and output coupling circuits were designed for wide bandwidth. Particular care was taken with the neutralizing of this grounded cathode, balanced-bridge, circuit to assure maintenance of balance over the required frequency band; the balance obtained gives less than 2% of full output amplitude at the bottoms of syncs. The output of the final stage is 1.5 db down at ±2.7 mc from the carrier frequency.

Sound Transmitter

A conventional high-power class-*B* modulated unit was installed for sound to provide a carrier power of 12 kw at a frequency of 48.25 mc. A single air-cooled triode[4] was installed in a grounded-grid circuit for the final *rf* stage.

Birmingham to Holme Moss Link

Between Birmingham and the station, there is a 3-mc bandwidth 100-mile 3/8″ coax-cable circuit with repeaters every 6 miles. The overall variation in delay time between 150 kc and 2.9 mc has been found to be about 0.2 microsecond and the noise ratio between black and white picture and peak-to-peak noise 40 db. The rise time for steep input pulses is under 0.16 microsecond.

For standby purposes, pictures are available from a receiver tuned to the Sutton Coldfield television station, 70 miles away. The antenna for this receiver is 550 feet up on the main mast.

Antenna and Transmission Line System

The radiating system was designed to give an azimuthal radiation pattern circular to within ±1 db of the average gain of 4 db, compared with a single dipole. Since vertical polarization is used in Britain, the antenna is a vertical type, consisting of two vertically-spaced rings of four dipoles fed in phase rotation in the horizontal plane, the dipoles being colinear being in phase. The sound and video currents phase rotate in the same direction, the antenna being driven from a single transmission line carrying sound and video power.

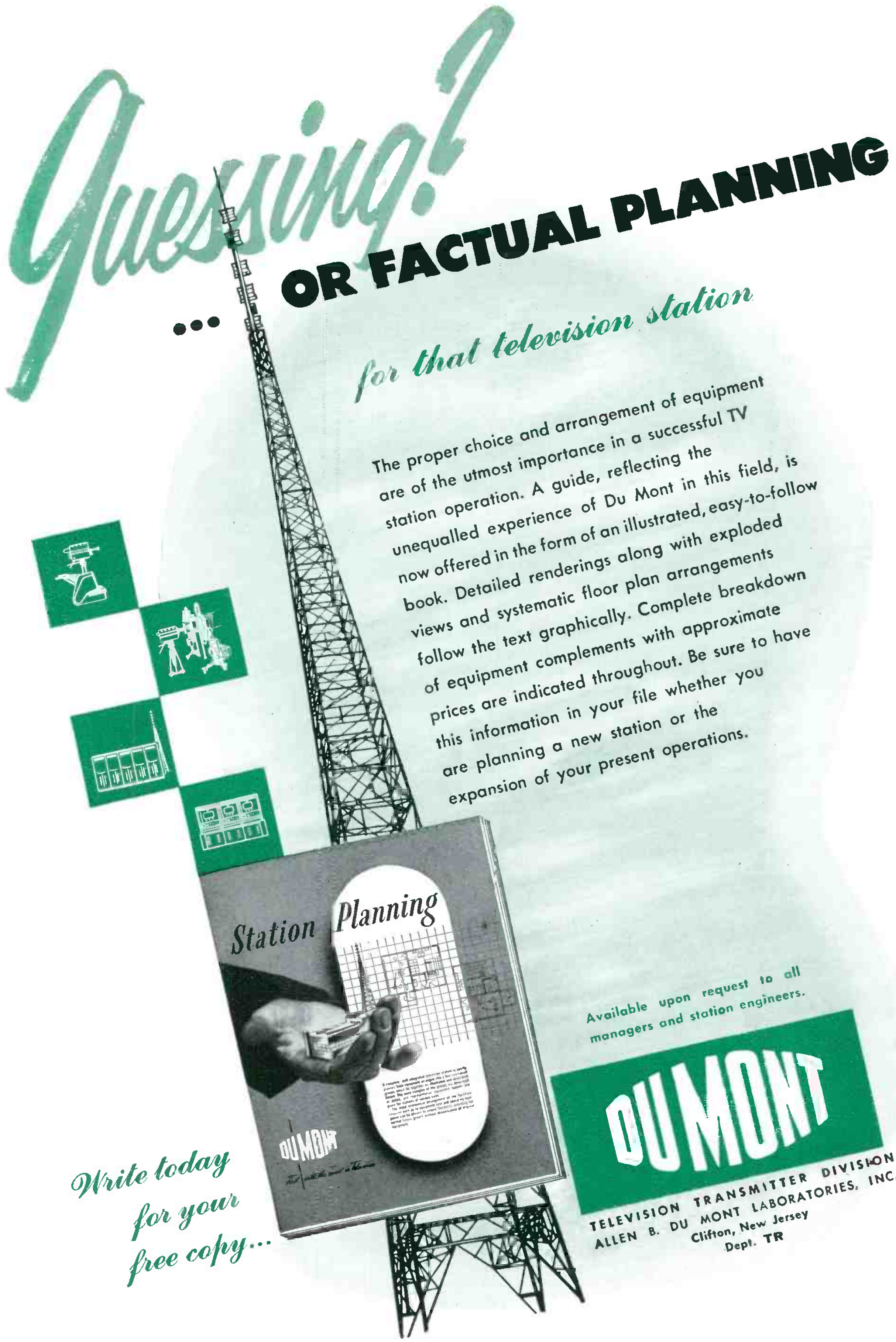
Each of the eight dipoles has been made with as wide a bandwidth as possible by closely folding a 16″ strip to obtain the best susceptance slope for the inherent loop.

By matching the two halves of the antenna to their branch feeders, it was found possible to share closely the power over the full video band of frequencies without the use of a bridge type equalizer and absorbing resistance mounted close to the antenna. Reflections which could be radiated after a noticeable time delay, are, of course, nearly completely eliminated by the 90° phase difference between the two halves of the antenna which, by careful construction have identical characteristics. Thus the *swr* in the main transmission line is always better than 0.96/1 and delayed, or ghost images are at least 35 db below the level of the

(*Continued on page* 28)

[2]Marconi ACM.3.

[3]English Electric BW. 165. [4]English Electric BR. 128.


Guessing?
... OR FACTUAL PLANNING
for that television station
The proper choice and arrangement of equipment are of the utmost importance in a successful TV station operation. A guide, reflecting the unequalled experience of Du Mont in this field, is now offered in the form of an illustrated, easy-to-follow book. Detailed renderings along with exploded views and systematic floor plan arrangements follow the text graphically. Complete breakdown of equipment complements with approximate prices are indicated throughout. Be sure to have this information in your file whether you are planning a new station or the expansion of your present operations.
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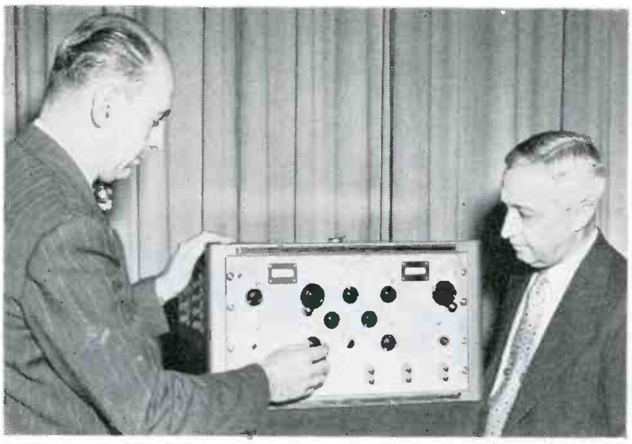


ULTRAHIGH

by RALPH G. PETERS

John F. Sterner (left), RCA tube department engineer, demonstrating to Milton J. Ackerman, manager of the company's test and measuring equipment engineering group, uhf sweep-marker generator which has a sweep frequency oscillator, marker oscillator, and crystal calibrator.

Equipment Now Available For the Lab to Permit the Design and Development of Tuners, Filters and Amplifiers, and for the Transmitter to Insure Quality Output.

In DEVELOPING experimental filters, tuners, and other components required for *uhf* operation, several basic types of test instruments are required. The sweep-marker generator has been found to be one of the key and extremely practical units which can serve a dual role; as a lab and factory instrument facilitating production of receivers and converters. One such unit,[1] recently announced, is a 3 in 1 unit with a sweep frequency oscillator, marker oscillator, and crystal calibrator. The generator also includes mixers and adders for superimposing markers upon the response curve after the signal has passed through the tuner under investigation.

The sweep-frequency oscillator uses a 5675 pencil trode in a modified cylinder circuit and is continuously tunable from 470 to 890 mc. It is frequency modulated by a vibrating device which varies the inductance of the cylinder to provide a linear frequency deviation up to 45 mc. The cavity is designed to have very low leakage, and a capacitance adjustment in the cavity is said to compensate for shifts in calibration when it is necessary to replace the oscillator tube. Blanking of the sweep oscillator is included to give a reference base line on a 'scope and to facilitate the checking of transmission line terminations. The blanking voltage is controlled by a pushbutton on the panel so that it may be removed for precise setting of the phasing control. The generator also includes a builtin detector with properly terminated load for directly monitoring the *rf* output voltage of the sweep oscillator. By utilizing the *rf* monitoring facilities, the generator can be used for making relative gain measurements of an *uhf* tuner or a similar piece of equipment.

The precision marker system included as a part of the instrument consists of a variable-frequency oscillator similar to the sweep oscillator and a crystal calibrator which provides 1-mc calibration pips throughout the *uhf* TV band. The crystal oscillator consists of a 10-mc crystal oscillator, a 1-mc locked-in oscillator, and a three-tube harmonic generator. A sensitive amplifier together with mixers and adders is used to superimpose the variable-frequency markers and the 1-mc markers on the response curve for observation on a 'scope.

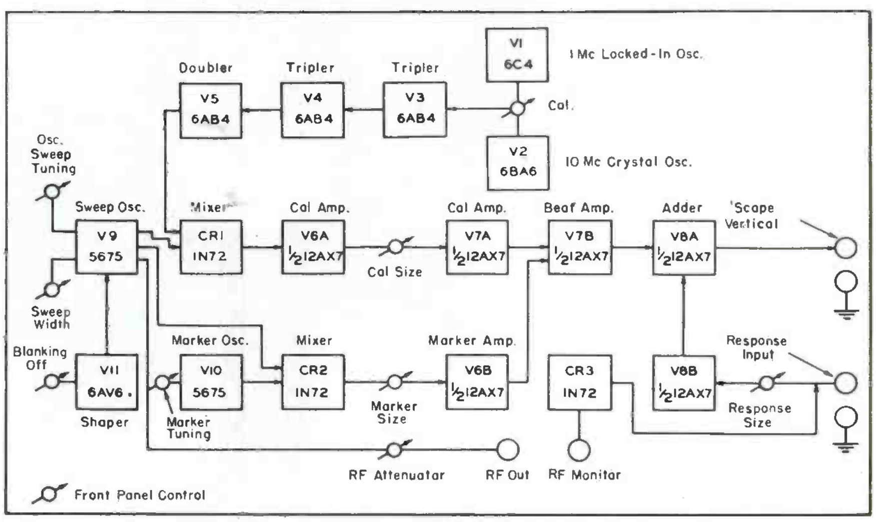
Operation

In use, the *rf* output of the generator is connected to the input of the tuner or circuit under test as illustrated in Figure 2. The demodulated *rf* output of the test circuit is then fed back to the demodulated voltage input terminals where the marker pips are added to the demodulated *rf* signal. The combined signal is then fed to the vertical input of the 'scope. The horizontal sweep frequency for the 'scope is also obtained from the front panel of the generator. Monitoring of the output signal is accomplished by transferring the *rf* output cable from the tuner input to the monitoring terminal on the sweep generator.

The sweep-marker generator features a waveguide-below-cutoff attenuator

**Based on copyrighted data appearing in the RCA TV Technical Training Manual and information presented during the recent week-long TV clinic sponsored by the RCA Engineering Products Department for broadcasters. The manual, a 444-page book, priced at $8.00, is available to TV broadcasters from Broadcast Equipment Sales, Engineering Products Department, RCA, Camden, N. J.*

Figure 1
Block diagram of uhf sweep-marker generator.



[1] RCA WR-40A, WR-41A (without marker oscillator and crystal calibrator) described at the recent NEC meeting by J. F. Sterner.

with a 100-db range. Variable marker oscillator accuracy after 10-minute warmup is said to be ± 0.3 per cent of dial scale reading. On the crystal calibrator the calibration points represent all harmonics of 1 and 10 mc within the 470 to 890-mc band, ± 0.005 per cent.

*Transmitting Test Gear**

At the transmitter one of the most important pieces of test equipment is the picture demodulator which is used continually to keep a running check on the quality of the transmitted picture.

The picture monitor must be capable of showing the picture as it will appear on a high quality home receiver. Inasmuch as the vestigial sideband system has inherent defects, the picture viewed on the monitor should show these same defects. The defects are a result of the phase distortion developed in the vestigial system and the wave-shape distortion due to the video pass band which is limited by the width of the TV channel assignment. The distortion appears as a leading white and trailing smear which accompanies the transmission of a vertical black line. A monitor which shows these defects provides the operator with an excellent means of observing the system operation, since any change in the appearance or magnitude of those defects indicates a change has occurred in the equipment.

Principle of Operation

A principal feature of the demodulator is the method of achieving a low-frequency response slope which must attenuate the carrier voltage 50% and must have an attenuation which is maximum at ¾ mc below carrier, and minimum at and above ¾ mc higher than visual carrier. In addition, a sound trap must be provided to avoid a 4.5 mc beat pattern on the picture viewing monitor. These exacting requirements may be attained through shaping circuits at either *rf* or *if* frequencies. In one unit, where the shaping is done at *rf*, there are coax line circuits which resemble those of the vestigial sideband filter. This design has been found to provide very stable performance, because the coax circuits can be preset during factory test and clamped in place so no tuning change can occur.

To accommodate both the *uhf* and *vhf* channels, a superhet type of circuit has been developed which also achieves the required stability.

The demodulators also contain equipment to measure the percentage modulation. In most designs, this consists of a relay which can be made to vibrate at a 60-cycle rate so that the video output is short-circuited 120 times per second. On the waveform monitor, the video trace provides a zero-output line which corresponds to zero *rf* output. The ratio between height of valleys of modulation compared to the peak of the trace provides a measure of the depth of modulation.

The video output of the demodulator also provides the waveform presentation when applied to the waveform 'scope.

Also featured in the demodulator is a diode unit which is used during adjustment of the transmitter to obtain the frequency response of the transmitter. The transmitter is modulated by a video sweep and the output waveform, as detected by the diode unit, is an indication of frequency response.

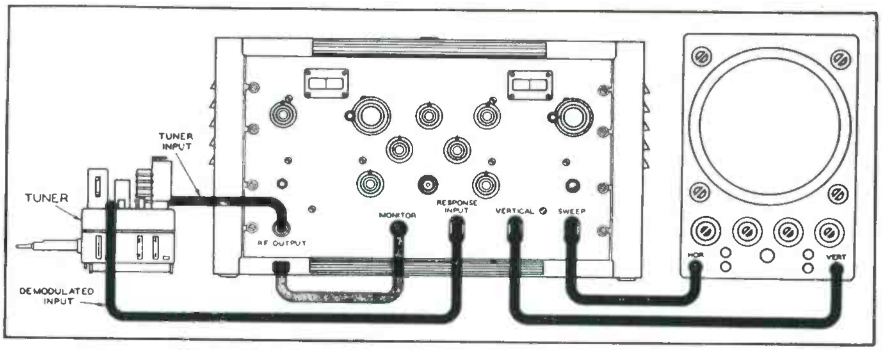


Figure 2
Typical connections for the sweep generator, a uhf tuner and 'scope.

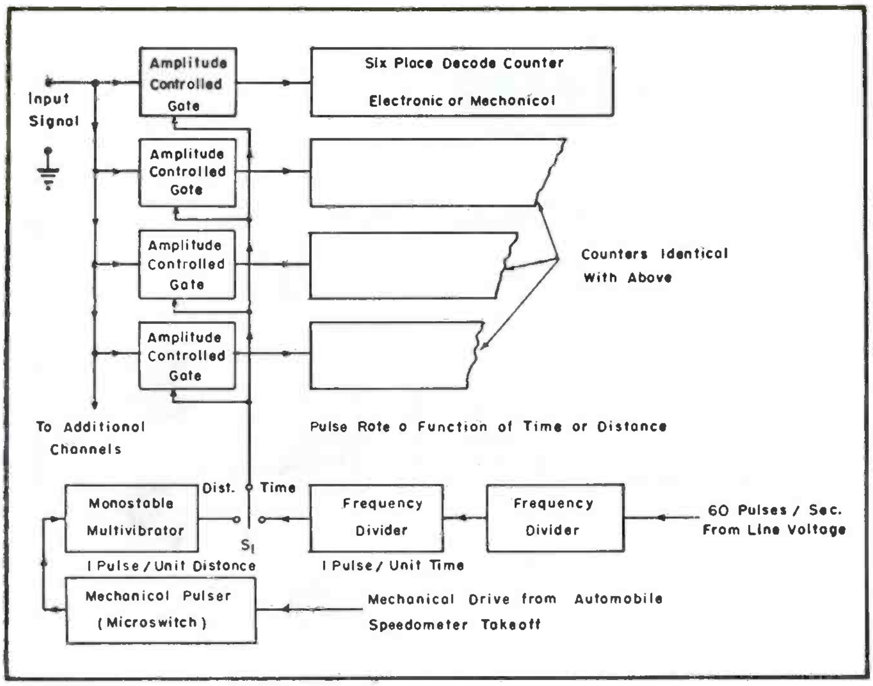
RF Load and Wattmeter

Also required at the transmitter are the *rf* load and wattmeter,** which provides a matched impedance dummy load termination for the transmitter, permitting tests on either the aural or visual sides to be made without radiating a signal from the antenna, and also providing a means of measuring the transmitter output power.

The equipment consists of a resistor element and a current indicating meter. A small *rf* voltage fed from a pickup probe within the load is fed to an internal crystal rectifier. Output from the rectifier is in turn coupled through a long time-constant filter network to the external meter which is calibrated to indicate average power directly in

Figure 3
In the transmitter room at Bridgeport during uhf seminar visit, Dr. Roy Marshall listening to a report on the operation of the console which permits viewing of picture on 530 or 850 mc output or direct. Monitor at right also provides view of picture direct from WNBT in New York.

**RCA MI-19024A, MI-19196 for *vhf* and *uhf*.



Block diagram of basic system used in field-strength analyzer described by Fred Smith during recent IRE uhf symposium held in Philadelphia, in which the signal to be analyzed is impressed on a series of electronic amplitude-controlled gate circuits. A series of pulses which are generated as a function of time or distance are fed to all the gate circuits. Each of the gates is designed to allow or prevent the passage of these pulses, depending on whether or not the amplitude of the applied signal is sufficiently large to exceed the threshold to which each gate is adjusted. The pulses permitted to pass by the gates are totalized in individual decade counters which may be ordinary electromechanical units for slow pulse rates, i.e. 1 to 15 per second or electronic, where the pulse rate is greater. Thus, the ratio of the count on a particular decade to the total number of pulses generated in an interval will be the percentage of the time or distance during which the present threshold level of the gate attached to the counter was exceeded. Individual systems are used to generate pulses as a function of time and distance and the position of a switch determines which type of pulse will be supplied to the gate circuits. The time pulses are obtained by counting down from the frequency (60 cps) 36 times.

watts. The time constant of the filter is such that meter indications are said to be accurate within ± 5 per cent.

Principle of Operation

The resistor unit consists of a coax line which ends with an inner conductor consisting of a cylindrical resistor and an outer conductor surrounding it having a conical taper which is nearly logarithmic. The shapes of the resistor and outer conductor are such that the line is correctly terminated over a wide band of frequencies. Inasmuch as the line is correctly terminated by the resistor, the voltage on the line will be proportional to the square root of the power, and independent of frequency. The voltage is measured on a meter which is calibrated in power. The meter is energized by a small amount of *dc* received from a germanium crystal and pickup probe through a low pass filter network.

Construction

In the low power ranges the load is convection cooled and is portable. In the higher ranges the units are water cooled by means of a heat exchanger coil immersed in the coolant. Usually these higher powered units are semi-permanently mounted. Since the water is used only to take the heat away, the rate of flow does not influence the calibration.

Application Notes

Two means are provided to check the accuracy of the units: A spare germanium crystal is mounted in the meter case; if the power reading is the same with either crystal, then the crystals are undamaged. The *dc* resistance of the load resistor can be measured with a *dc* bridge and checked against the value stamped on the name-plate. If the resistance has not varied more than a tenth ohm or so, the resistor is known to be all right. If the resistance has changed appreciably, the unit must be returned for repair. For transmitter adjustment purposes, the *rf* load and wattmeter is connected to either the transmitter or the vestigial sideband filter output. This is accomplished by disconnecting the transmission line at a convenient junction and connecting the input of the *rf* load. On models which are water cooled but not automatically controlled, the tap water supply must be turned on whenever the load is used. Transmitter adjustments may then be carried on since the transmitter is correctly terminated through the range of carrier and both sidebands. The readings on the indicating meter are average power and are correct to within five percent.

Another important use of the *rf* load is for emergency termination of one side of the diplexer on antennas having a two-line feed system. If one transmission line to the antenna, or one side of the antenna, should fail, the line corresponding to the faulty side can be disconnected from the diplexer and the *rf* load substituted. Half of the transmitted power will be absorbed, but the part that is transmitted will provide coverage over a reduced area.

*Frequency and Modulation Monitors****

Particularly important, too, at the transmitter are the facilities for monitoring the frequency and percentage modulation of the aural transmitter, and frequency of the visual transmitter. Provided for this service is an FM monitor, visual frequency monitor and frequency deviation meter.

The FM monitors contain the master-reference crystal oscillator. A multiplier chain supplies a harmonic of this crystal oscillator frequency which beats with the FM aural-transmitter signal to produce a 150-kc signal. This signal is amplified and limited, and is applied to a cycle-counter type of discriminator. The *dc* output of this discriminator operates the center-frequency indicator. The *ac* output, amplified and filtered, operates modulation indicators and is available for audio monitoring and distortion and noise measurements.

In the visual-transmitter frequency monitor, another multiplier chain excited from the FM monitor, supplies the same harmonic of the crystal reference oscillator to a mixer. A 4.35-mc beat frequency is heterodyned by a crystal oscillator to produce an *af* beat note. This beat note is supplied, through a filter which removes any residual synchronizing pulses, to a frequency meter.

This frequency meter, which receives a beat note from the monitor, incorporates a cycle-counter circuit used as a discriminator to drive the deviation-indicating meter, which indicates in cps, the deviation of actual transmitter operating frequency from assigned carrier frequency.

The frequency of the master-reference crystal oscillator can be adjusted from the front of the panel of the FM monitor. Both transmitters are monitored against this same crystal and an adjustment of the master-reference crystal oscillator therefore affects both monitor indicators equally.

***RCA *uhf* types BWU-6A, WF-50B and WF-49C.

Producing and Interpreting the PULSE-CROSS

by DONALD M. LAUNER, *Master Control Engineer, American Broadcasting Company*

Part II . . . Examination of the Vertical Interval . . . Analyzing Patterns by the Sequential Method.

IN EXAMINING the expanded vertical interval produced by the pulse-cross, it will be noted that immediately following the last active picture line, the video signal is brought to black level, in preparation for vertical retrace. The vertical blanking interval, which includes between 13 and 21 horizontal lines for each field (or 26 to 42 lines per frame as observed on the monitor) should include the following pulses and pulse-widths; pulse-widths may be measured as indicated for the horizontal interval:

(*1*) Vertical blanking *front porch* (vertical blanking before first equalizing pulse) 0.02 *H* to 1.02 *H* (1.27 to 64.77 microseconds).

(*2*) Six equalizing pulses before vertical sync, in line with horizontal sync, and with a nominal pulse width of .45 to .5 of horizontal sync width.*

(*3*) Six equalizing pulses before vertical sync at half-line position with a nominal pulse-width of .45 to .5 of horizontal sync width.*

(*4*) Six lines of vertical sync, with serrations occurring at half-line frequency. The rising edges of the serrations should be in line with the rising edges of the equalizing pulses, and the serrations have a width of 0.07 *H* to 0.01 *H* (4.445 to 0.635 microseconds).

(*5*) Six equalizing pulses after vertical sync, in line with horizontal sync, and with a nominal pulse width of .45 to .5 of horizontal sync width.*

(*6*) Six equalizing pulses after vertical sync at half-line position, with a nominal pulse-width of .45 to .5 of horizontal sync width.*

(*7*) Following the trailing equalizing pulses, normal horizontal sync

(*Continued on page* 29)

*Although the FCC standards stipulate that the equalizing pulses have an *area* of .45 to .5 that of the horizontal sync pulse, a linear measurement of .45 to .5 of horizontal sync *width* is a very close approximation.

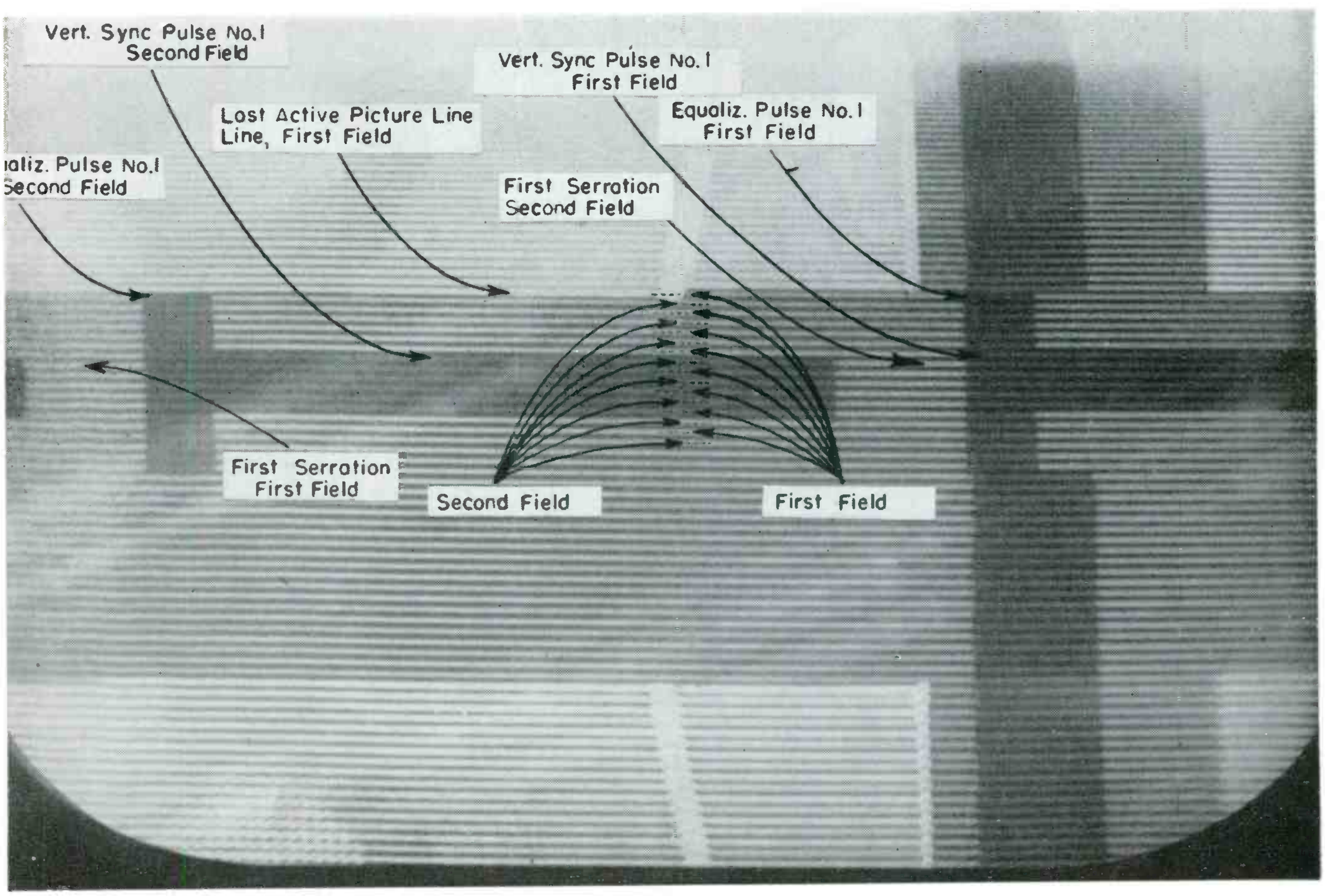


Figure 1
Sequential interpretation with respect to time.

FRINGE-AREA Performance Predictions

by E. A. SLUSSER

Part II. . . . Sample Calculations for Predicting DX Pickup Results

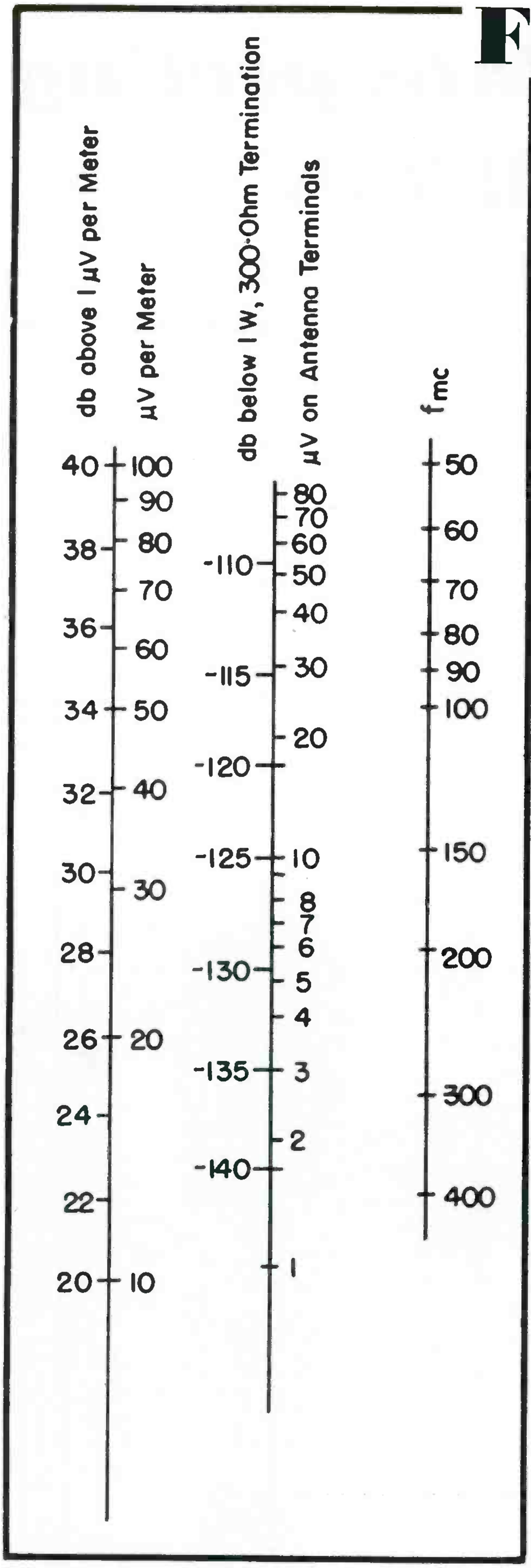


Figure 1

Nomogram designed to permit conversion of field intensity in microvolts per meter to microvolts on the receiver terminals for a half-wave antenna.

TV RECEIVER RESULTS, often measured in terms of DX pickup, can be predetermined not only by the receiver's design, but by the locale in which the set is to be used. As indicated in the first installment[1] of this discussion, there are four specific factors to consider: the effective transmitted power, propagation losses, receiving antenna and the gain of the chassis.

Different receivers vary in sensitivity and it might be assumed that the figures. detailed in last month's analysis, based on man-made noise to be practical limits of receiver sensitivity. In the case of a receiver and booster combination, the total receiver sensitivity would be the sum of the receiver and booster gains.

In terms of field intensity, it is generally considered that a city, business or factory area which has very high man-made noise level requires a median field intensity of 5,000 microvolts per meter, whereas excellent video can be obtained in residential and rural areas with a median field intensity of only 500 microvolts per meter. These figures are based on average levels of man-made noise, and it would be reasonable to expect good signals at levels as low as 50 microvolts per meter in low noise areas. For convenience a nomogram has been evolved (Figure 1) which converts the field intensity in microvolts per meter to microvolts appearing on the antenna terminals; most manufacturers express the sensitivity of a set in terms of input voltage. Signal power input into 300 ohms, expressed

[1]TELEVISION ENGINEERING; October, 1951.

in *db* below 1 watt has also been included.

Effective Transmitted Power

The effective radiated transmitter power, or the actual transmitter power corrected for the gain of the transmitting antenna, can be illustrated in a plot of the type shown in Figure 2, which expresses the effective radiated power in *db* using 1 kw as a reference. The correction in *db* can be taken from this graph and added to the predicted field intensity or the predicted receiver antenna terminal power.

Antenna Elevation

Corrections in *db* must be added to the predicted propagation figure for the actual elevations of the antennas. These corrections can be determined from Figure 3. They are expressed in *db* and are determined from the difference between the actual elevation of the antenna and the 40′ level on which the figures,* shown last month, were based. The new predicted propagation figures can then be used to predict fringe performance.

Sample Calculation

To illustrate the application of the maps, let us take the case of the profile, appearing in Figure 4 with the following conditions: $H = 400'$; $D = 35$ miles; $D_1 = 8.75$ miles; transmitter antenna elevation (H_t) = 500′; receiving antenna elevation (H_r) = 50′.

Let us assume that channel 5 is involved in our calculation. Figure 3* presented previously indicates that we can expect a field intensity of +15 *db* above one microvolt corresponding to −132 *db* below one watt at the receiver terminals. The effective radiated power of the transmitter, noted as 30 kw, is about 15 *db* above 1 kw, while the receiving antenna gain on channel 5 appears as approximately 4 *db*. The correction for the transmitting antenna elevation, taken from Figure 3, appears as about 21 *db* and the correction for the receiving antenna elevation about 2 *db*. (These are based on a 40′ level and represent the change in *db* from the 40′ elevation to the actual elevation.) Adding these figures to our propagation figure will indicate that there can be expected an antenna signal power of −90 *db* below one watt. If the receiver, located in a suburban area with a low man-made noise level, is used for consideration and the receiver manufacturer specifies

(*Continued on page* 29)

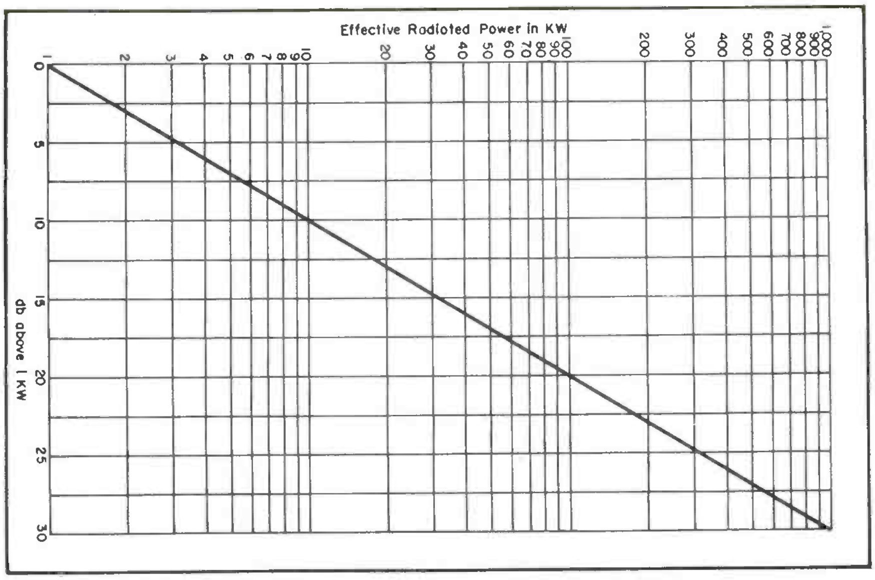


Figure 2

Plot illustrating effective radiated power in db, using 1 kw as a reference.

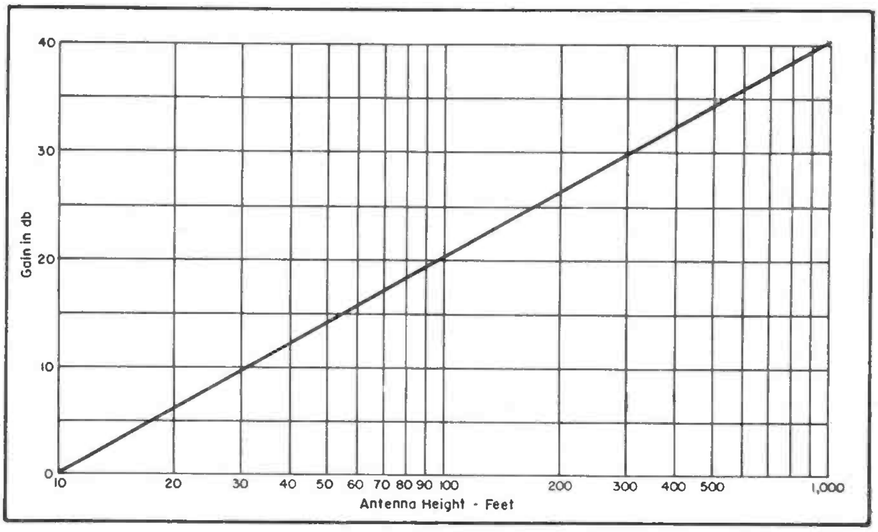
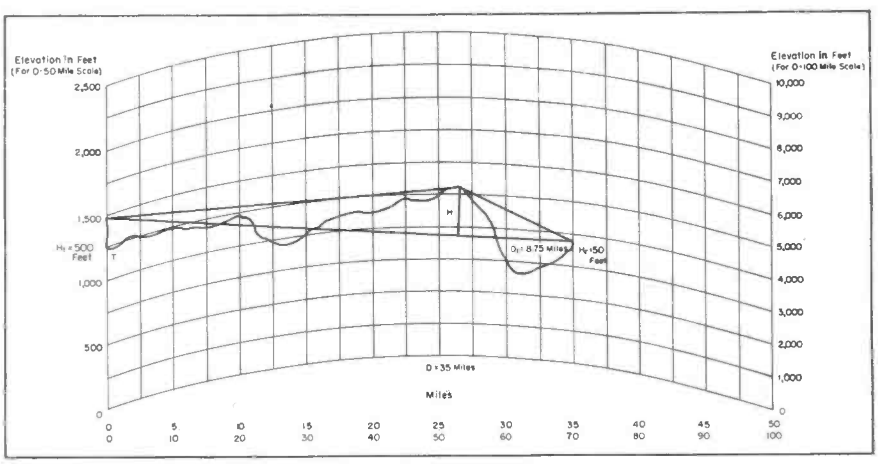


Figure 3

Plot noting correction in db for antenna elevation; effect of raising antenna elevation from a low level (10′). Response covers horizontal polarization.

Figure 4

Plot of surface-level profile between antennas.



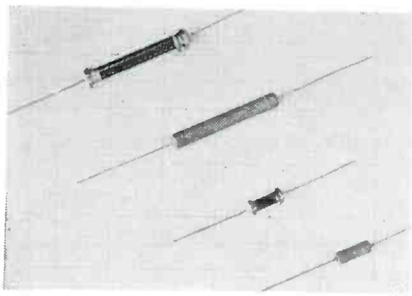
*Figures 3 and 4, TELEVISION ENGINEERING; October, 1951.

TV Parts & Accessory Review — Production

High-Frequency Resistor

A Resistor for high frequency applications, with power dissipations up to 2 watts, has been produced.

Resistors are available hermetically sealed in glass or in humidity-impervious casing, in a variety of mountings; axial lead, threaded stud or a tapped hole terminal. Wattage ratings range from ⅓ to 2 watts with a resistance range of 20 ohms to 200 megohms.—*Carb-ohm; Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.*

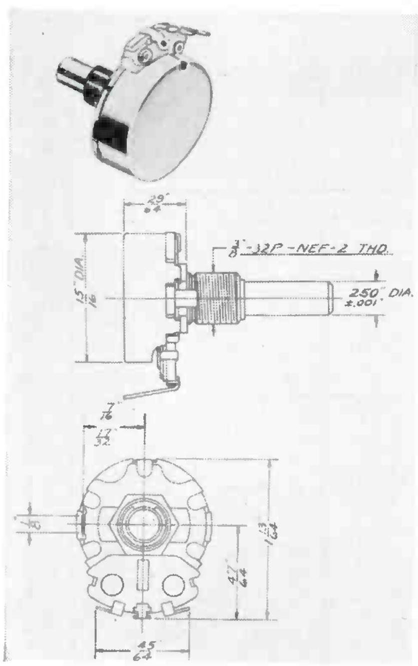


Phaostron Resistors

Variable Resistor

A Variable Resistor which is claimed to be usable from — 55° to + 150° C, has been introduced. Resistor has a 15/16″ diameter with a rating of 1 watt at 70° C with 500 *v* maximum across end terminals.

Available with locking bushing, high torque and water-sealed bearings and mounting. Straight tandem construction is available with panel and rear sections operating separately from concentric shafts, as well as concentric shaft tandem with panel and rear sections operating separately from concentric shafts.—*Type 90; Chicago Telephone Supply Corp., Elkhart, Ind.*



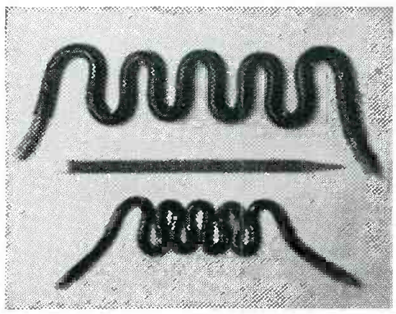
Chicago Telephone Supply Variable Resistor

50-Ohm Flexible Coax Cable

A 50-ohm Flexible Coax Cable which is said to be a simplified version of the RG-5/U, has been developed.

Inner conductor is No. 16 AWG copper; dielectric is polyethylene, .182″ od, and the braid is No. 34 AWG copper with 20 carriers, 6 ends, 11.5 picks/inch. Jacket is polyvinyl chloride .280 od. Capacitance is said to be 28.2 mmfd/foot; impedance, 52.5 ohms, and attenuation 2.6 db/100′ at 100 mc and 4.9 db/100′ at 300 mc.

Other types are available, with semi-solid polyethylene base dielectric, in the 50- and 70-ohm groups, corresponding to RG-58/U, RG-8/U, RG-59/U and RG-11/U cables.—*HH 5S; produced in Hannover, West Germany by Hackethal Wire and Cable Co., available through Columbia Technical Corp., 5 East 57th St., New York 22, N. Y.*



Flexible Coax Cable

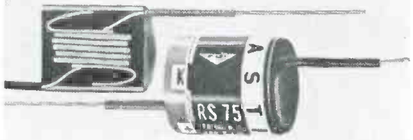
Subminiature Control

A subminiature control available as either a single or dual unit, has been introduced.

Measuring ⅝″ in diameter, the body depth of the single unit is 7/16″, while the double unit measures 53/64″. Bushing is ¼″ long, beyond which the shaft extends ½″. Shaft may be obtained as a flatted, or slotted tube. Standard shaft is ⅛″ round of soft metal. Available in either tapered, or linear resistances. Linear ranges are from 1000 ohms to 5 megohms. Tapered resistances run from 5000 ohms to 2.5 megohms.—*Series 48A; Clarostat Manufacturing Co., Dover, N. H.*

Molded-In Selenium Rectifiers

Miniature Selenium Rectifiers with outer case a spiral-wound phenolic tubing filled with wax which is rock hard at 100° C, has been developed. Rectifiers are manufactured with bare or insulated tin-copper leads. In ratings from 250 to 500 ma dc, the standard open plate construction is used.—*Plastisel rectifiers; Electronic Devices Inc., Precision Rectifier Division, 429 - 12th St., Brooklyn, N. Y.*

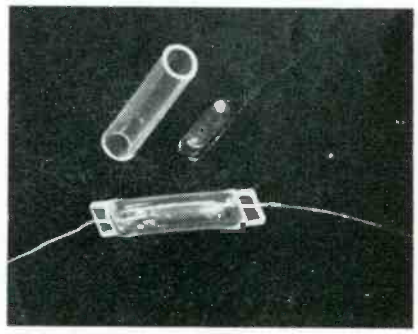


Electronic Devices Selenium Rectifier

Nylon Tubing

Nylon Tubing for use with thermistors has been developed. Tubing, with a diameter about the size of an ordinary lead pencil, is used to incase one type of glass enclosed bead thermistor used in time-delay circuits.

Connecting leads extend outside the casing. Tubing is said to provide mechanical protection of the glass bulb, electrical insulation (no metal end caps are required) and protect against straining the glass bulb through flexure of the connecting leads.—*Anchor Plastics Co., Inc., 533-541 Canal St., New York 13, N. Y.*



Anchor Nylon Tubing

Wire and Cable Kits

Miniature and Subminiature Wire and Cable Desk Kits, containing assorted types and sizes of wire and cable, has been announced.

Included in one kit are: No. 30, 26, 22 hookup wire; No. 29, 30 shielded wire; No. 30, 24 conductor cable; No. 30, 27 shielded conductor cable; No. 20 cotton covered twisted pair; and No. 27 shielded parallel pair.

A kit containing twelve 500-foot spools of No. 30 hook up wire in 12 different colors is also available.—*Tensolite Insulated Wire Co., Tarrytown, N. Y.*

Tensolite Wire Kit

Subminiature Slipring

A Subminiature Slipring, with diameters from .062″ to .250″, which features flexible leads, has been developed.

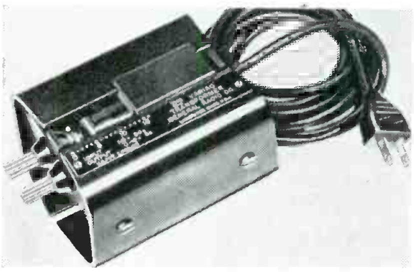
Unit is said to have an insulation which protects against breakdowns to 1000 volts, silver rings to reduce torque friction, and rhodium plate to reduce wear.—*Naer Corp., 631 S. Sepulveda Blvd., West Los Angeles 49, Calif.*

Instrument News

Low-Voltage Transformer

A TRANSFORMER that is said to provide an adjustable source of low-voltage 60-cycle power, has been announced. Secondary winding is isolated and the insulation between coils and to the core is claimed to withstand a 1250-volt breakdown test.

Continuous output current rating is 5 amps with an output voltage range from zero to 13. Mounting slot permits securing the unit to a wall or into equipment as a permanent component.—*Type 71-A Variac; General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*



G-R LV Transformer

Video Amplifier

A VIDEO AMPLIFIER that is said to have a flat amplitude response ± 1.5 db from below 10 cps to 20 mcps, has been announced.

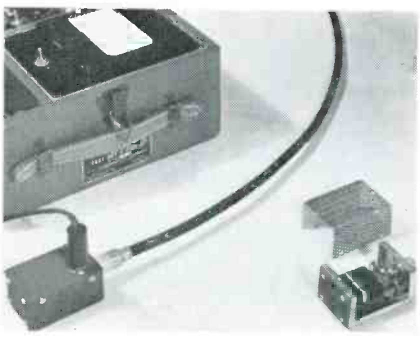
Designed for use as a 'scope deflection amplifier for the measurement and viewing of pulses of short duration and rise time, unit is claimed to pass 60-cycle square waves with less than 5 per cent tilt.—*Model V-2; Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.*

RF Wattmeters

RESISTIVE-LOAD RF WATTMETERS for use with 0-50 microammeters have been introduced.

Meters measure *rf* power output from 0-60 watts and 0-2 watts and are used for testing base stations and mobile-unit transmitters.

Output of the transmitter being tested is fed into the wattmeter load, and the suitable indicating device is connected to the jack provided. Calibration chart supplied is used to correlate the power dissipated in the load-unit and the meter readings. Hermetically sealed crystal diode and a 1% metalized multiplier resistor are incorporated in the unit.—*P7208, P7208-A; Motorola, 4545 W. Augusta Blvd., Chicago 51, Ill.*



Motorola Wattmeter

Multi-Frequency Crystal Oscillator

AN OSCILLATOR serving as a multi-frequency high-output signal generator has been introduced. Available in a crystal-controlled range of 4.5 to 50 mc.—*Model 50; Crest Laboratories, Whitehall Bldg., Far Rockaway, L. I., N. Y.*

Voltage Regulator

A VOLTAGE REGULATOR which it is claimed has an accuracy of .01 per cent over a load range of 1-1000 va, has been introduced.

Input is 95-130 *vac*, single phase, 55-65 cycles; output voltage is adjustable from 110-120 *vac*.—*Model 1001; Sorensen and Co., 375 Fairfield Ave., Stamford, Conn.*

Single-Sweep Accessory

A SINGLE-SWEEP ACCESSORY that is said to provide one pulse to trigger the single sweep of a 'scope at the start of any complex wave pattern has been developed.

Signal input required is approximately 0.1 v.—*Type 121; Sterling Instruments Co., 13331 Linwood Ave., Detroit 6, Mich.*

Sterling Instruments Single-Sweep

Impedance Bridge and Amplifier-Oscillator

A UNIVERSAL IMPEDANCE BRIDGE and an AMPLIFIER-OSCILLATOR have been announced.

Bridge-measurement ranges include: resistance, 1 milliohm to 11 megohms; capacitance, 1 mmfd to 11 mfd; inductance, 1 uh to 1100 h; Q, .02 to 1000.

Amplifier-oscillator converts the bridge to 115-volt *ac* and is said to provide a stable oscillator and a high-gain null amp, with plugin frequency selection and a precision balance of better than .02 per cent. —*Model 250-C and 855-A; Brown Electro-Measurement Corp., 4635 S.E. Hawthorne Blvd., Portland 15, Ore.*

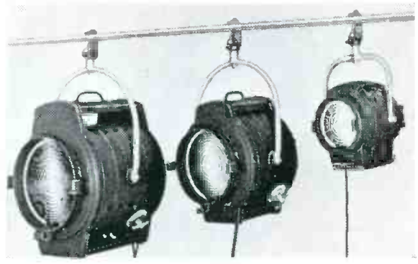
HF Attenuator Pad

A HIGH-FREQUENCY ATTENUATOR PAD for *dc* to 2500 mc, with an available attenuation range from 1 to 10 db in 1-db intervals, and 10 to 50 db in 10-db intervals has been introduced. Pads are provided with one female and one male type-N connector at opposite ends. It is said that a longitudinal pressure of over 20 pounds on either center pin is required before damage to the resistive element occurs.—*Model 50-L/p-1 to 50-L/p-50; Weinschel Engineering Co., 919 Jesup Blair Dr., Silver Spring, Md.*

Broadcast News

Television Spots

TV SPOTS for lighting of sets, objects or stage, have been introduced.—*Model 5000, Model 1000/2000, Model 500/750; Bardwell and McAlister, Inc., TV Division, 2950 Ontario St., Burbank, Calif.*



Bardwell and McAlister TV Spots

Studio Consolette

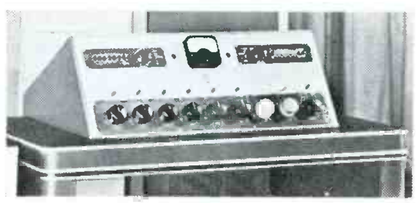
A STUDIO CONSOLETTE, providing a speech input system for AM, FM, and TV broadcast stations, has been announced.

Equipment offers control facilities for either one or two studios. In addition, it will serve an announce booth, a control room microphone, two turntables, a network, and five remote lines. Monitor amplifier may be used for auditioning, receiving and sending cues, talkback to studios, and as an emergency line amplifier. An override remote cue permits the remote operator to call in on any of the remote lines and over-ride the program on the control room speaker.

Consolette offers eight mixer positions. First four are high-level microphone channels with provisions for switching two additional microphones into the fourth channel. Positions five and six are assigned to turntables. Space and wiring are included for an additional twin preamp in the turntable circuits. Seventh mixer is used for network, and the eighth for remotes. Push-button switches select five line inputs to the remote mixer. Line transformer is included for isolation and impedance matching. Mixer circuit is of the series-parallel type. Both turntable mixers have built-in cueing switches which connect the turntable outputs to an external cueing amplifier when the mixer control is turned to the *off* position.

Frequency response from any input to the line output is said to be within ± 1.5 db from 30 to 15,000 cps; total *rms* harmonic distortion less than .5 per cent from 50 to 15,000 cps at a line-output level of 18 dbm.

Power supply is a separate unit, furnishing plate and heater power to the amplifiers and 24 volts *dc* to the relays. Requires an input power of 150 watts at 100-130 volts, 50-60 cycles, *ac*.—*BC-2B; RCA Engineering Dept., Camden, N. J.*



RCA Studio Consolette

Iron Envelope Picture Tubes

(*Continued from page 9*)

350° *C*, while its melting point was about 440° *C*. In usual commercial practice, a trace of titanium is added to the iron which is to be enameled; cones of this Ti-namel have also proved satisfactory as tube envelopes.

To seal the 3911 glass which softens around 700° *C*, it was found necessary to select a higher melting point enamel and modify somewhat the usual sealing technique. The faceplate was sealed to the iron cone in the same sealing machine utilized for conventional tubes of *Telemetal* and *Teleglas*.[1] One advantage of the enameled iron cone over the usual chrome-iron cone is that a lower sealing temperature is required, since the enameled iron needs only be hot enough to fuse the faceplate glass to the enamel rather than to form a good chrome-oxide on the bare metal. This permits lowering the sealing temperature by 150° *C*, thus reducing the probability of a phase transition of the iron from ferrite to austenite, with attendant irregularities in the coefficients of thermal expansion. After the face seal is completed, the tube must be annealed at 500° *C* for 6 minutes, removed from the oven, and allowed to cool in open air to room temperature. The previously mentioned problem of gas bubbling into the glass has not been encountered with enameled cones, apparently because the viscosity and surface tension of the enamel is greater than that of glass.

The enamel[2] must have a low fluorine content, because this element is detrimental to electron emission from BaO cathodes conventionally employed in picture tubes. Enameling the entire inside surface of the cone has the beneficial effect of eliminating rust flakes which would otherwise appear as blemishes on the fluorescent screen. Rust prevention by *parkerizing* or by nickel or chrome plating may prove equally suitable. Since acid leeches the enamel, a wash of soap was substituted for the customary acid wash in the first step in picture-tube manufacturing.

The high resistance through the enameled cone requires an additional modification in processing. The internal surface of the bulb must be coated with aquadag, as in the case of an all-glass tube, and a portion of the enamel must be ground off near the sealing rim to secure contact with the high-voltage supply. A decorative coating on the outside surface of the bulb is unnecessary as the enamel presents a pleasing finish.

Glass for Neck and Its Electrical Characteristics

Finding the proper glass for the neck was one of the most difficult problems encountered during the development of the iron-cone tube. High-expansion glasses usually have low electrical resistivity and are prone to electrolysis because of their high alkali content. Since the neck of a picture tube carries a high potential, around 15 kv, on the inside aquadag coating and is surrounded externally by parts at ground potential and, moreover, is heated by the deflection coil and the cathode heater, the glass of the neck must have low conductivity at temperatures around 100° *C*. The coefficients of thermal expansion and resistivities of the glasses used for the neck with cones constructed of various metals, are shown in table II; p. 9.

The press through which the lead wires to the electron gun pass is made with G12 for all present picture tubes. At first, a three-step graded-seal type of construction was visualized: a neck funnel consisting of the same composition as the faceplate glass, an intermediate glass tubing of high resistivity, and G12 glass to which the press is sealed. Though it is possible to reduce the mismatch between the three glasses to a sufficient degree to allow joining, tubes made with this intermediate seal punctured where the funnel joins the tubular section of the neck, showing that it is desirable to have the entire neck section of a single low conductivity glass. A glass (LL-117)[3] which contains approximately 49.9% silica, 27.7% lead and 17% alkali oxide,

[1]Bender, B. G., The Manufacturing of Round Glass-Metal Envelopes for Television Picture Tubes, *Ceramic Industries*; to be published.
[2]Enamel SL-12696 made by Chicago Vitreous Enamel Co., has proved suitable.
[3]Lancaster Lens Co., LL-117.

proved satisfactory. Presses were also made from this glass. The resistivity curves of this and the other glasses appear in Figure 2; p. 8. For the lead-in wires, it has been found advisable to use copper-clad iron instead of copper-clad nickel.

Tubes with enameled iron envelopes, faceplate glass of 3911, and neck section of LL-117 were successfully made and life-tested. It is hoped that picture tubes having iron envelopes may soon be manufactured in quantities.

Acknowledgment

The authors are indebted to E. Trantin and R. W. Armstrong, with whom the initial phases of the present work were done, and to H. H. Voelz for developing sealing procedures.

UHF Transmission Line

(*Continued from page* 13)

of diplexing systems currently in favor; one the balanced bridge type, which has two feed lines from the diplexer to antenna; the other a notch type, which results in a single feed system to the antenna.

Noting that by using two square hybrid rings and two cavity resonators, it is possible to devise a single output diplexer, De Bell said that in the double-ring notch-diplexer arrangement the resonant cavities are tuned and coupled to present a short circuit on the inter-ring connecting lines at only the aural carrier frequency. Phase relationships are such, he indicated, that the aural carrier power reflected from the cavity short circuit will proceed out at the ring antenna junction.

In an analysis of vestigial side band filters for *uhf* it was said that problem is serious, because of the extremely sharp cut-off required for lower side band attenuation. Cavity resonators are applicable to give a required attenuation rate, but their response is a spike over a very narrow frequency band.

To notch out the complete desired 3.25 mc, we were told, lower side band would require an unmanageably large number of cavities if connected in the brute force manner. Fortunately, it was pointed out, by using hybrid rings, it is possible to connect cavity resonators in lattice form, thereby borrowing a leaf from the pages of crystal lattice design, to attain a bandwidth proportional to the difference frequency of two resonant cavities. Four cavity resonators in stacked lattice arrangement were described as almost able to accomplish the prescribed side band-filter requirements.

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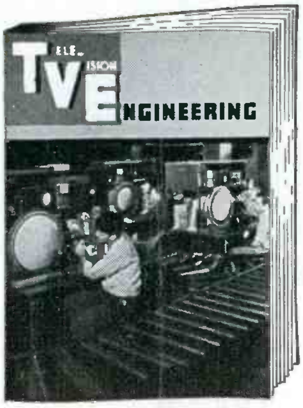

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45 Kw TV Station

(Continued from page 16)

main signal. Air-spaced coaxial lines with low-loss peg insulators have been used throughout, and random reflections due to non-uniformities are less than 1% along a 800′ main transmission line.

This transmission line, 5″ in diameter, carries the sound and video power with an efficiency of 87%, the two transmissions being combined in a selective bridge circuit. Both air and water are used to cool parts of this device.

The amplitude of the reflection coefficient is monitored continuously by built-in reflectometers at three points; at the output of each transmitter and at the output of the combining circuit, the associated meters also giving a direct indication of the forward power, high speed relays in the circuit of the reflected-wave indicator being arranged to bring either or both transmitters off power should serious mismatch occur.

As in all the new British television stations, vestigial sideband operation is featured and achieved by means of a pipe section filter. The same filter attenuates the second and third harmonics of the video carrier by some 45 db.

Since at Holme Moss severe winter weather is common with frequent icing conditions, 7½-kw heaters were built into the surface of each of the eight dipoles. All parts of the installation which could be damaged by ice falling from the mast or its guys have been protected and, in case the worst should happen, an emergency antenna is provided on a 150′ mast some distance from the 750′ mast. Matched change-over switches in the transmission line enable 20 kw of video and 5 kw sound power to be fed into this antenna through polyethylene-insulated cables.

Building

With the building on such an exposed site, special precautions have been taken to conserve heat and thus reduce the cost of building heating. The roof has been covered with a layer of heat-insulating material,[5] double windows fitted throughout, and the walls of cavity construction with an outer skin of natural stone. During program hours, the warm air which has been used for tube cooling is circulated round the building; at other times, thermostatically-controlled electric convector heaters are used. It is almost certain that the station staff will be isolated at times due to bad weather, and stocks of food and bedding have been provided to meet this emergency.

[5]Vermiculite.

Pulse-Cross

(*Continued from page* 21)

resumes, and blanking continues for 8 to 23 lines.

Let us now analyze, via the sequential method, the pattern shown in Figure 1, with the last active line at the bottom of the picture, which will be called our reference line. Progressing to the right on this line, the start of the vertical blanking interval appears and then further to the right the first equalizing pulse of the particular field under consideration, which will be arbitrarily called the first field. The next sequential line in the first field is the second line down from the reference line as viewed on the monitor; this is due to the interlaced alternate field. On this line there appears equalizing pulse *2* of the first field, and to the right on the same line, equalizing pulse *3*. Again a line is skipped and equalizing pulses *4* and *5* appear. After skipping another line we come to equalizing pulse *6*. Moving across this line brings us to the first vertical sync pulse of the first field. This same process, following alternate lines belonging to the first field, continues through vertical sync, trailing equalizing pulses, blanking and picture information until the completion of this field composed of 262½ lines, 1/60th of a second after its start. At this time we enter the vertical blanking interval again at the start of the second field. This field starts one line below our starting line for the previous field, and on this line we find that the first equalizing pulse for the second field occurs in the center of the *H* period. Continuing across the line we come to equalizing pulse *2* of the second field, which is in line with horizontal sync. Again a line is skipped and we come to equalizing pulse *3*, occurring in the center of the *H* period. This process repeats as for the first field, until the 525 lines comprising a full frame are completed.

By analyzing the pattern by the sequential method, and by understanding the order and sequence of all the pulses, it will be found that many of the confusing aspects of interlace will be more readily understood. Thus the pulse-cross pattern will be found to be an extremely useful tool for sync generator adjustment, servicing and measurement.

Credit

To G. Edward Hamilton, ABC eastern division TV engineer, the author is extremely grateful for his invaluable aid and assistance in the preparation of this paper.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 8, 1946 (Title 39, United States Code, Section 233)

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(*Signed*) LEWIS WINNER, *Editor*.

Sworn to and subscribed before me this 24th day of September, 1951.

(Seal) Catherine C. Pons, Notary Public.

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Fringe Area Prediction

(*Continued from page* 23)

that a minimum signal power input of –110 *db* below one watt is required for good video response, it can be assumed that reception would be satisfactory. The —90 *db* below one watt figure corresponds to +57 *db* above 1 microvolt per meter or about 750 microvolts per meter.

ADVERTISERS IN THIS ISSUE

TELEVISION ENGINEERING

NOVEMBER, 1951

VWOA News

OVER FORTY MEMBERS attended the recent fall gathering in N. Y. City. Guests of the evening were *Leslie Blasius* and *John Brescia* of the N. Y. Telephone Company, who discussed *radar* and *sonar*, and offered a film, *Echoes in the Sky and Water*, showing how both were used during the late war with Japan. In the audience were ye prexy *Bill McGonigle, Bob Howley, Benny Beckerman, Jess Holland, Henry Hayden, Jr., C. D. Guthrie, E.N. Pickerill, E. F. Duskis, Don McNicol, Vic Villandre, T. Jacobson, L. B. Victor, Frank Orth, Fred McDermott, G. P. Shandy* (from Cleveland), *Ed Dros, Leroy Bremmer, A. G. Cooly, Joe Savick, Harry Sadenwater, Tony Brizzolari, Sam Schneider.* Others at the dinner-meeting were *Fred Meinholtz, Arthur Costigan,* ye secretary *Bill Simon, George Clark, Fred Klingenschmitt, Steve Wallis, A. J. Anderson, George Mathers, Harold Koch, C. R. Shanholtzer, H. T. Williams, Gene Cochrane, Lawson Exley, Jess Holland, Stan Wolff, A. A. Hass, Fred Gommo,* and *Ralph Davis.* The gathering was preceded by a short meeting of the VWOA board of directors. . . . At the meeting *Leroy Bremmer* reported that he is now with Langevin as sales engineer. . . . *George Shecklin* was unable to attend because of a meeting at the National Maritime and Propeller Club. . . . *Art Ridley* telegraphed to say he could not make the meeting but sent regards to all. . . . *Pickerill* reported that upon his return from San Francisco in June, he spent the summer in New Hampshire. . . . *Fred Muller* sent in his regrets noting that he had been in the U. S. Naval Hospital for several weeks recuperating, and expected to be discharged shortly to return to his Jersey home and later to Florida. . . . We regret to announce the passing of *J. A. Balch,* an active member for many years, who resided at Virginia Beach. . . . Congratulations to *C. R. Shanholtzer* upon his recent marriage. . . . *T. M. Gardner* is back on the job as service manager for RMCA in Galveston, after several months of illness. . . . *Max Ortelt* has written in saying that in addition to filling his job at WBF in the plant, he likes to ham a little on his off days. Has two transmitters, working on four bands with 300 watts. He has worked 64 countries. *Roscoe Kent,* now in St. Petersburg, Fla., has been reinstated as a professional engineer and is busy serving as a manufacturers rep, handling technical equipment. . . . *Charlie Hodge* has written from his post in Saudi Arabia. . . . *Arthur J. Brizzolari* is engaged restoring an old historical colonial farm.

Industry Literature

Pyramid Instrument Corp., 49 Howard St., New York 13, N. Y., have published a 16-page manual, *504, Servicing with the Amprobe,* describing case histories of personnel using their voltammeter. Featured is a list of uses of the Amprobe.

Copperweld Steel Co., Glassport, Pa., has released an 8-page booklet, *Copperweld Wire for Electronic Applications,* detailing the uses of copper-covered steel wire in radio components, tubes, antennas and transmission lines, *rf* coils, flexing leads and insulated cords and connectors.

General Electric Co., Schenectady 5, N. Y., has published a 16-page booklet, *GEC-809,* describing the operation and application of fixed paper-dielectric capacitors, including charts showing the deratings for *ac* and *dc* applications.

Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill., has issued a 20-page product bulletin, *527A,* on builtup mica electrical insulation products. Included is a discussion on the processing, properties, types, grading and classifying of natural mica.

Tetrad Co., Inc., 4921 Exposition Blvd., Los Angeles 16, Calif., has released a bulletin, *951,* describing hermetically sealed miniature transformers, selenoids, radar deflection yokes, radar peaking coils, pulse transformers, universal windings and TV horizontal output transformers, focus coils, and radar tuning coils.

The Thomas and Betts Co., Inc., 82 Butler St., Elizabeth, N. J., has published a 56-page catalog, *66,* on pressure solderless connectors. A special section describes fittings approved by the Navy and a selection of bar fittings.

Oxford Electric Co., 3911 S. Michigan Ave., Chicago 15, Ill., has issued a catalog listing permanent-magnetic speakers, electrodynamic speakers, and speakers for TV replacement, auto-radio replacement, public address, intercoms and outdoor weatherproof applications, ranging from 2" to 15" units.

Octagon Process, Inc., 15 Bank St., Staten Island 1, N. Y., has released an 8-page brochure describing a paint-anchoring corrosion-resistant phosphate treatment for metals. Detailed are some common causes of paint failure and how they can be prevented.

Measurements Corp., Boonton, N. J., has published a 4-page catalog listing standard signal generators, square-wave generators, *uhf* radio noise and field strength meters, pulse generators, megacycle meters, *if* converters, vtvm, *uhf* oscillators, intermodulation meters and crystal calibrators.

The Television Transmitter Division of the Allen B. Du Mont Laboratories, Inc., 1000 Main Ave., Clifton, N. J., has published a *Station Planning* booklet which explains the facilities and function of all equipment necessary to the normal operation of a well-integrated television station. Equipment layouts are offered, with simplified renderings, exploded views and systematic floor plan arrangements.

Milo Radio and Electronics Corp., Dept. W.W., 200 Greenwich Street, New York 7, N. Y., have announced publication of an 1100-page general catalog, which contains a listing of over 75,000 items. Copy of book may be obtained free by writing on company letterhead.

Grant Pulley and Hardware Co., 31-85 Whitestone Pkway., Flushing, L. I., N. Y., has issued a 20-page booklet describing its history, operations, production facilities, products manufactured, potential and research and development procedures.

Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif., has released an issue of the *HP Journal* with an analysis of distortion measuring equipment.

Burlingame Associates, 103 Lafayette St., New York 13, N. Y., has published a 4-page brochure describing the H-P frequency counter.

American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill., has released an engineering news bulletin which describes the Jarvis potentiometer.

Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa., has published a 78-page *Technical Data* catalog, with the story of the AMP pressure crimp, augmented by test curves showing terminal performance under varying conditions of altitude, vibration, corrosion and low currents, audio and radio frequencies.

Briefly Speaking . . .

Voltage Fluctuations, which before the advent of television and other sensitive devices received little thought, is today a major factor receiving careful consideration in design, development, production and operation. According to J. G. Sola, prexy of Sola Electric, it has been found that in many areas the fluctuation is as much as 30 per cent, with the problem being spread throughout most of the country. "To complicate matters still more," he said, "in most places the variation is completely unpredictable." . . . Brush Development Co. has announced a headphone with a *metalseal crystal* element that is said to provide a new freedom from problems caused by high and low humidity. . . . A branch plant containing approximately 45,000 square feet of floor space and employing upwards of 100 people, for the manufacture of electronic components, has been opened in Kane, Pa., by the Stackpole Carbon Co. . . . WFMY-TV, Greensboro, N. C., is now on 5 kw, having switched from a DuMont Acorn transmitter of 500 watts to an Oak transmitter of 5 kw. . . . Seattle TV station KING-TV recently mourned the passing of an RCA-8D21, eldest tube member of the TV transmitter section, which was 9,254.8 hours old, said to be a new longevity record for this type of tube. . . . Arthur G. Jordan has replaced Joseph F. Cook at Clarostat in the scheduling and follow-up of all wire-wound fixed resistors, and Robert Levitre has become expediter in the production control department at the plant. . . . Crest Laboratories, Inc., Whitehall Bldg., Far Rockaway, L. I., N. Y., has increased its plant facilities and floor space to accommodate government order production. . . . James B. Tharpe, sales manager for the television transmitter division of DuMont, appeared as guest speaker at a recent joint meeting of the Instrument Society of America, Detroit section, and the IRE Professional Group on Instrumentation, and spoke on *Industrial Color TV applications*. . . . KNXT, formerly KTSL, on channel 2, Los Angeles, moved recently to Mt. Wilson and began operating on 25 kw erp. . . . Director Colonel J. Arismendi Trujillo Molina, president, treasurer and founder of radio station La Voz Dominicana at Cuidad Trujillo, has contracted to purchase an RCA 5 kw TV transmitter, associated studio and mobile equipment. Antenna of the new station will be located atop the Palacio Radial, in the capital city of Cuidad Trujillo. . . . Intex Co., Inc., 303 W. 42 St., New York 18, N. Y., are now export reps for Electronic Measurements Corp., 280 Lafayette St., New York 12. . . . Astron Corp., 255 Grant Ave., East Newark, N. J., has taken on additional space which will virtually double their production facilities. . . . Varian Associates, San Carlos, Calif., have leased approximately 10 acres of Stanford University land for construction of a million-dollar research and development lab which is expected to start early in '52 and be completed within one year.

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R-161	6	10	2B & 1A	1.10
R-518	85/125	6500	1C	3.60
R-633	180/350	10,000	1C & 5 Amps. Oct. Skt.	2.90
				2.45
R-667	6	.75	1B/10 Amps. 1A/3 Amps.	1.45
R-632	6	12	5A & 1C	1.25
R-154	6/12	200	1A	1.50
R-517	12	250	2A	1.50
R-116	85	3000	1B	3.05
R-631	100/125	3300	2A	1.90
R-545	110/250	7000	1C	2.45
R-124	300	12,000	1A	1.55
R-160	6	12	3C & 3A	1.30
R-155	12	100	4A & 4B	1.45
R-520	200/300	14,000	2C	3.45
R-159	6	50	2A	1.35
R-153	12	200	1C & 1A	1.55

SHORT TELEPHONE RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-635	12	100	1C & 1A	$1.35
R-826	12	150	2C, 1B	1.55
R-770	24	150	1A/10 Amps.	1.45
R-771	24	200	1A/10 Amps.	1.45
R-603	18/24	400	2A	1.55
R-575	24	500	2C	2.40
R-764	48	1000	2C & 2A	2.00
R-563	60/120	7500	1A	1.70
R-801	115*	——	None	1.45
R-213	5/8*	——	2A	3.10
R-589	12	125	2A	1.30
R-113	12	150	4A	1.55
R-689	12/24	255	1C	1.55
R-799	24	500	None	1.00
R-115	24	500	1C	1.70
R-110	24/32	3500	1C	1.70
R-121	150	5000	2A & 1C	2.05
R-634	150/250	6000	1A & 1B	2.45
R-800	12	150	2C & 1A	1.55
R-537	12/24	150	2C & 1B	2.00
R-750	24	400	1A	1.60

CONTACTORS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-650	24	100	1A/50 Amps.	$3.70
R-312	24	7	1A/200 Amps.	5.50
R-333	98/120	975	4A/Size 2	5.50
R-334	115	1200	3A/Size 2	5.50
R-338	6	7.5	1A/50 Amps.	3.45
R-353	65*	——	2A	3.95
R-358	18/29	200	1A/Dble. Brk.	2.00
R-445	14	12.5	1A/200 Amps.	4.05
R-446	12	18	1A/50 Amps.	3.90
R-447	12	18	1A/50 Amps.	3.90
R-448	24	67	1A/50 Amps.	3.90
R-449	28	160	1A/50 Amps.	3.90
R-450	24	75	1A/50 Amps.	3.90
R-188	24	200	1A/75 Amps.	3.70
R-183	24	60	1A/50 Amps.	3.45
R-187	24	100	1A/50 Amps.	3.70
R-554	24	85	2A/100 Amps.	5.90
R-788	100*	——	3B & 2A	5.45
R-682	115*	35	5A/10 Amps.	6.10
R-767	24*	20	2A/10 Amps.	4.95
R-180	12	25	1A/50 Amps.	4.05
R-265	24	60	1A/100 Amps.	3.45
R-535	24	70	1A/100 Amps.	4.80
R-556	24	70	1A/100 Amps.	4.80
R-557	24	100	1A/50 Amps.	3.85
R-178	24	100	1A/100 Amps.	4.80
R-608	24	125	1A/200 Amps.	2.80
R-184	28	50	1A/100 Amps.	4.90
R-719	24	10	1A/200 Amps.	4.95
R-182	28	80	1A/25 Amps.	2.40
R-244	75*	265	1A/20 Amps.	2.20
R-659	12	7.2	2A/20 Amps.	1.70
R-552	24	70	4A/50 Amps.	5.35
R-185	24	100	1A/50 Amps.	3.45
R-186	24	132	1A/50 Amps.	4.35

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-817	24	150	1A/50 Amps.	3.45
R-534	14	45	1A/30 Amps.	2.05
R-223	28	150	1A/40 Amps./48 VDC.	1.70
R-680	6	3	1A/50 Amps.	3.90
R-677	6	3.5	1A/50 Amps.	3.90
R-532	6	15	1A/50 Amps.	3.90
R-676	12	16	1A/50 Amps. 1AUX/25A	3.90

ROTARY RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-712	24	200	2B	2.05
R-711	24	200	2C & 1B	2.05
R-573	28	200	1C & 1B	2.05
R-766	24	230	12 Pos. 8 Deck	4.90
R-809	28	7	1B & 12 Pos.W/ 7" Shaft for Waters.	2.45

DIFFERENTIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-208	120	2000	2C/3 Amps.	$2.45
R-209	220/250	8000	1C/3 Amps.	3.10

SEALED RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-261	12/24	1900	1C/5 Pin Plug	3.75
R-673	48/150	7500	1C/5 Amps.	2.80

VOLTAGE REGULATORS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-745	6	2	1A/10 Amps.	$1.05
R-780	24	350	1C/6 Amps.	1.05
R-509	6/12	35	1B/2 Amps.	1.05

SPECIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-503	12/32	100	3A, 2C	$13.50
R-749	600	——	Max. 28 Amps.	7.45
R-804	550*	——	1B/38 Amps.	4.35
R-579	220*	——	1B	8.70
R-294	27.5	200	1B	5.35
R-686	115*	——	2C	6.10
R-246	115*	——	1B	11.20
R-246A	115*	——	1A	11.20
R-611	24*	——	1A/30 Amps.	5.35
R-283	12	125	1C/10 Amps.	4.35
R-614	18/24	60	1A/15 Amps.	4.35
R-245	12	25	4" Micalex Lever	3.20
R-527	6/12	50/50	In Series	1.20
R-544	12/24	60/60	1C	2.05
R-255	——	——	1A	3.50
R-669	75*	400 Cy.	1B, 1A	1.20
R-660	6	——	⅜" Stroke	1.20
R-651	24	100	Solenoid Valve	3.10
R-295	12	275	Annunciator Drop	2.70
R-230	5/8	2	2A, 1C	2.70
R-813	12	12	Wafer	5.35
R-275	12	750	1A, 1B, 1C	3.45
R-716	24	70	2A/5 Amps.	1.80
R-620	6/12	35	2C, 1A	1.30
R-629	9/14	40	1C/10 Amps.	1.55
R-720	24	50	2C Ceramic	1.70
R-500	12	10/10	2C/6 Amps.	3.55
R-816	12	10/15	2C/6 Amps.	3.55
R-524	24**	——	——	1.20
R-566	115*	Coil Only		1.00
R-710	——	150 Coil Only		.75

KEYING RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-714	9/14	65	2C/5 Amps.	$1.55
R-850	12	450	1A/1.5 Amps.	1.50
R-721	18/21	290	2C/5 Amps.	1.55
R-694	24	300	1A/5 Amps.	1.50
R-935	28	1000	1C/1.5 Amps.	1.65
R-949	2.4*	60 Cy.	1A/5 Amps.	1.95
R-704	2/6	.25	2B/5 Amps.	1.35
R-173	2/6	2	1A	3.00
R-280	6/8	77	1A Dble. Brk.	2.45
R-647	6/12	15	1B/20 Amps.	1.45
R-273	20	160	2A/15A Dble. Brk.	3.55
R-169	24	200	1A	2.45
R-570	24	230	1B Dble. Brk.	2.70

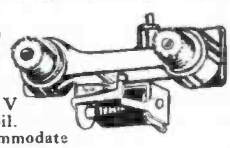
Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-960	24	230	3C/15 Amps.	2.95
R-529	24/48	1020	2C	3.10
R-715	24	——	2C Ceramic	3.70
R-584	6	20	1A Dble. Brk.	1.30
R-192	12	44	3C/10 Amps.	1.70
R-204	12	66	2A	1.45
R-224	12	85	1A	1.45
R-221	18/24	5000	1A	2 00
R-205	24	260	2C	1.55
R-891	24	475	1C/5 Amps.	1.45
R-536	27	230	2C	1.55
R-858	27.5	250	1A Dble. Brk.	1.45
R-833	6.5	1300	2C	3.05
R-220	75	5000	1C	1.50
R-828	6/8	42	1A	1.50
R-627	115*	——	1B Dble. Brk.	3.10
R-734	24	150	2C/10 Amps.	1.30
R-598	28	185	2C	1.30
R-622	20/30	200	3A & 2C/10 Amps.	1.45
R-274	24*	——	2A	1.55
R-855	110* 60 Cy.	160	1A Dble. Brk./15A	3.25
R-277	12	30	2C-D Break Cera	2.20

MIDGET RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-572	24	256	1C	$1.25
R-857	24	260	1 Make Before Make	1.75
R-912	4/5	20	3A-1C Ceramic	2.50
R-291	6	5	1A	1.25
R-921	6.7	18	1A Dbl.Brk.@ 10 Amp.	1.45
R-738	12	60	3A	1.20
R-922	12	75	1A Dbl.Brk.@ 10 Amp.	1.45
R-144	12	228	1A	1.45
R-145	18/24	250	2A Ceramic	1.45
R-298	21	300	1A	1.25
R-296	21	300	1A	1.25
R-586	21	300	1A & 1C	1.25
R-137	24	300	1C	1.45
R-142	24	400	2C	1.50
R-785	24	200	2C/10 Amps.	2.00
R-607	24*	——	1A	1.20
R-606	24*	——	1A & 1B	1.20
R-605	24*	——	3A	1.20
R-728	6	30	1A	1.25
R-149	6/8	45	1B	1.50
R-732	12	120	1A	1.45
R-281	12	126	2A	1.25
R-818	18/24	300	1B	1.30
R-135	24	250	1B	1.45
R-133	24	300	None	.75
R-138	24	300	1A	1.45
R-132	24	300	2C	1.50
R-731	24	300	2C	1.55
R-292	24	350	1C	1.25
R-626	24	400	1A/5 Amps.	1.55
R-786	60	1300	2C	2.00
R-588	90/125	6500	4C	2.70
R-755	24	300	1A	1.45
R-150	6	30	1A	1.50
R-893	14	150	1A, 1C	2.50
R-895	14	150	2A, 1B, 1C	2.50

*AC. **AC/DC.

SPECIAL!



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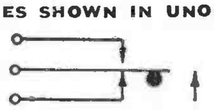
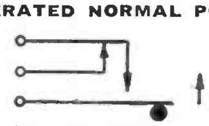
Form A—"Make" (Single Throw, Normally Open)

Form B—"Break" (Single-Throw, Normally Closed)



Form C—"Break-Make" (Double-Throw)



Form D—"Make-Before-Break"

Form E—"Break-Make-Before-Break"

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