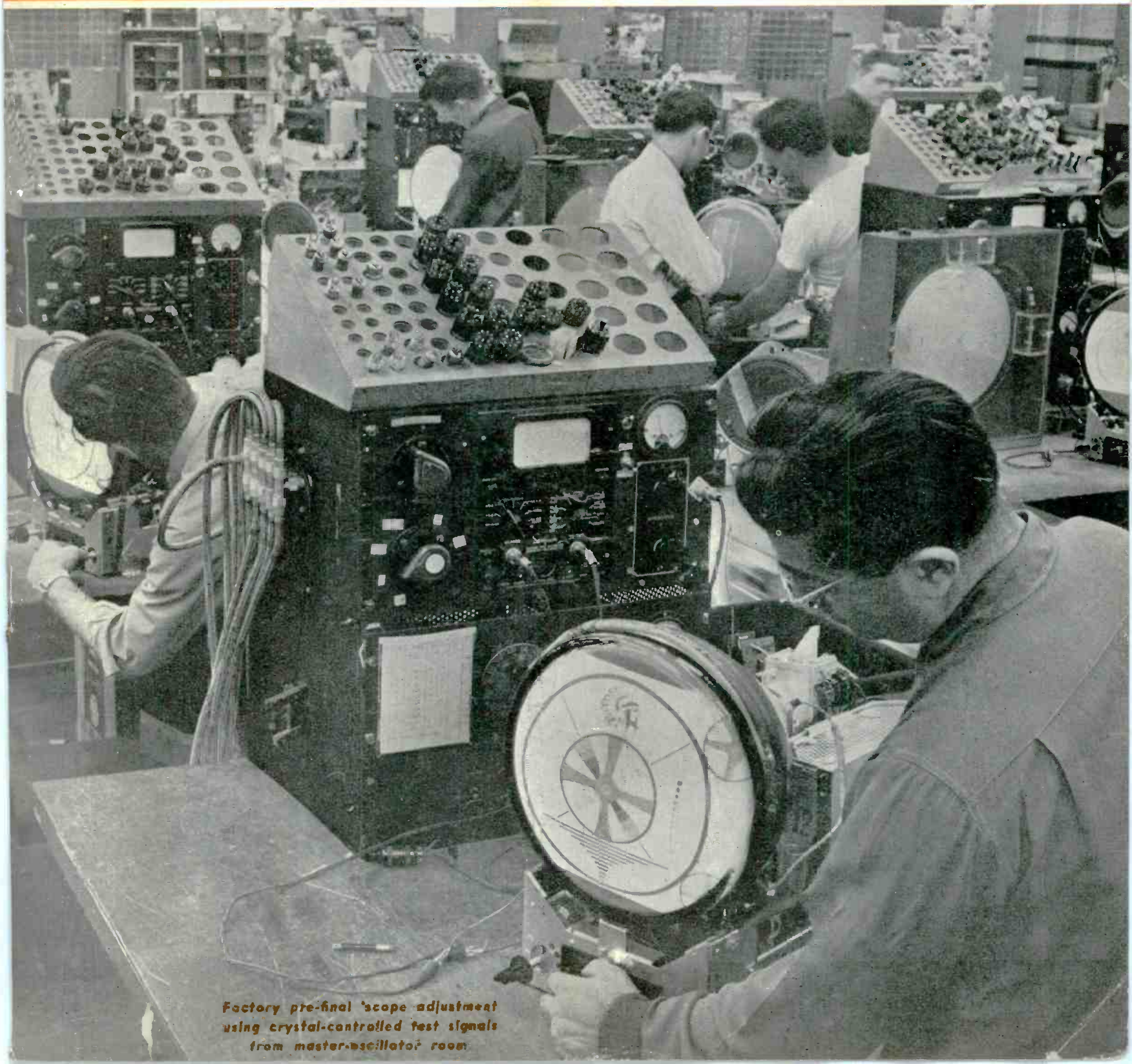
TELE-VISION ENGINEERING

MARCH, 1950



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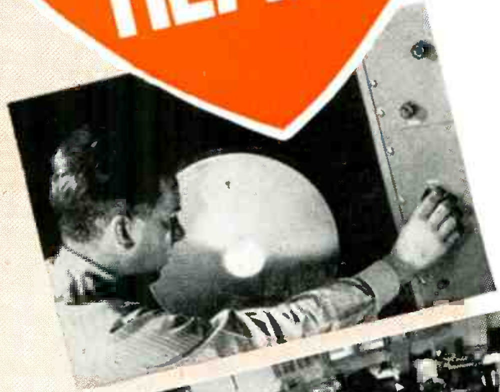

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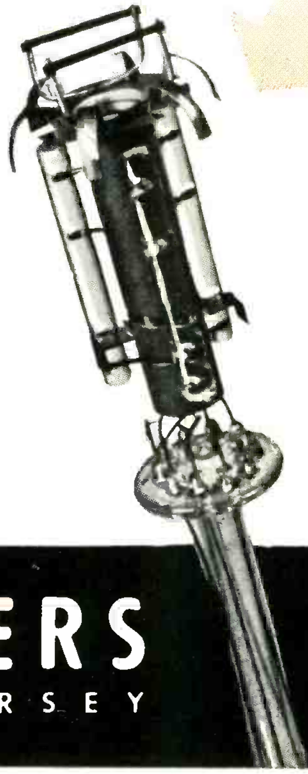

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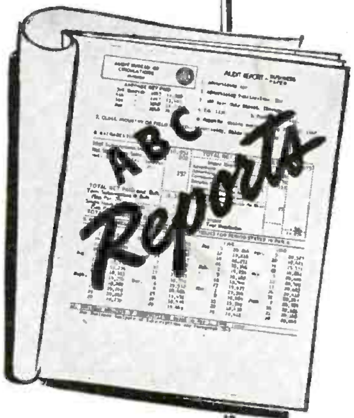

TELEVISION ENGINEERING

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VOLUME 1 — MARCH, 1950 — NUMBER 3

MONTHLY FEATURES

Cover Illustration

Pre-final TV receiver test setup at G.E. plant in Electronics Park, Syracuse, New York, involving checks on video and audio sensitivity, vertical sync, oscillator tuning range, horizontal sync, picture centering, centering of focus detail and resolution, and manual control functions.

***Editor:* LEWIS WINNER**

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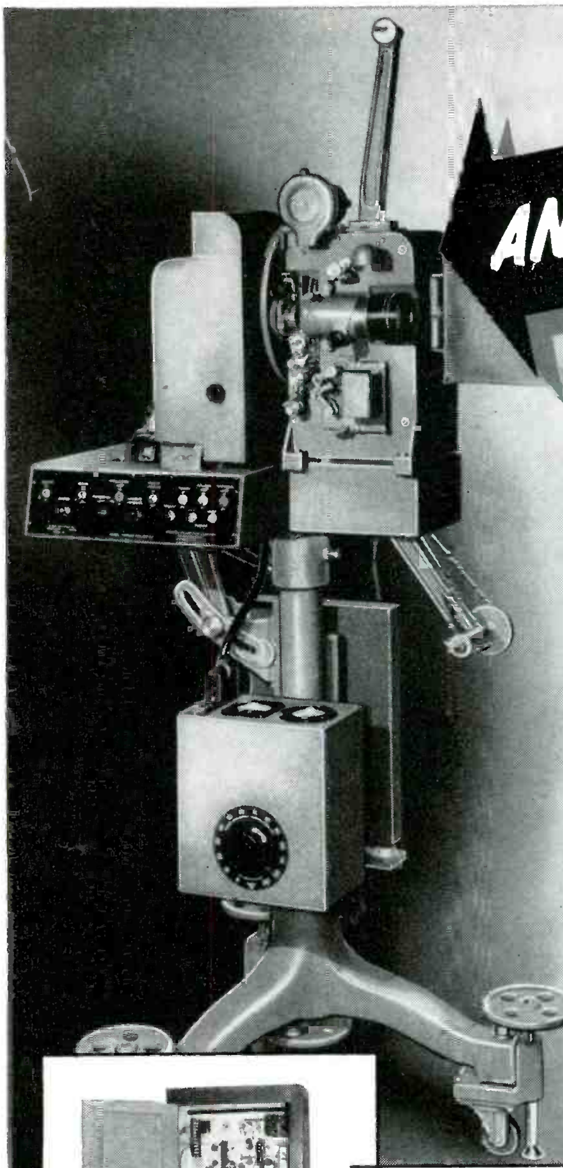

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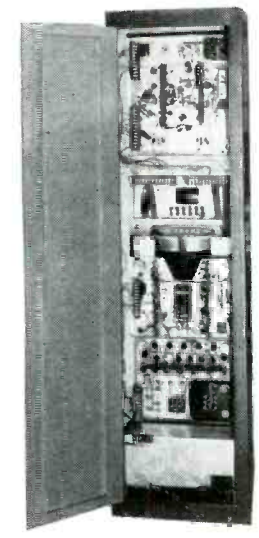

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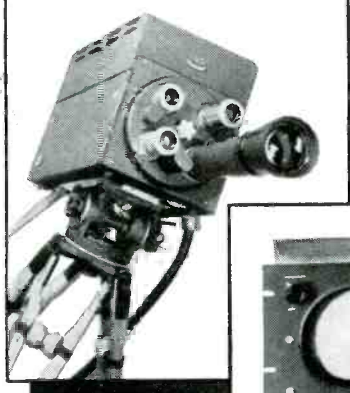

IMAGE ORTHICON PICKUP HEAD

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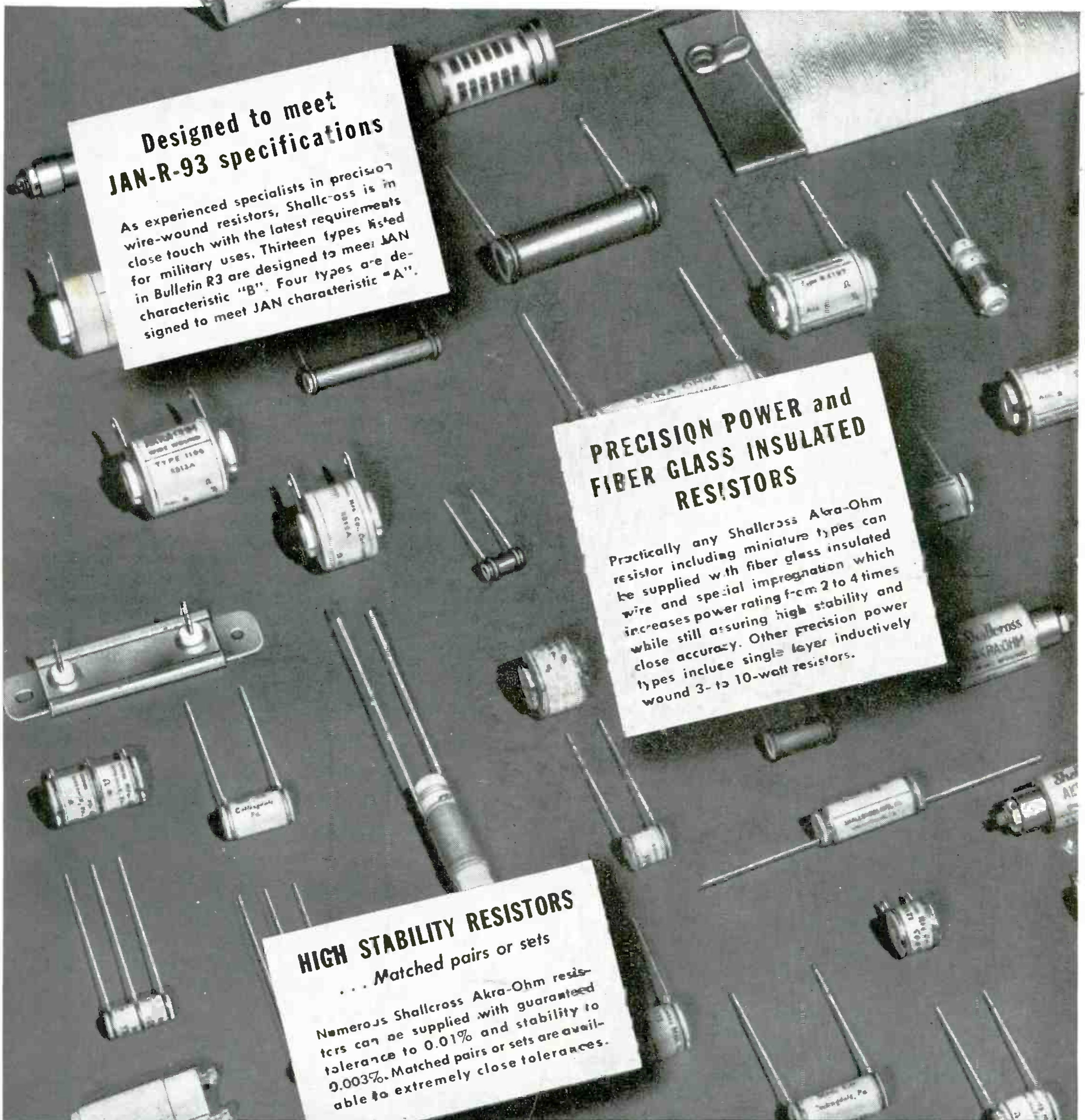

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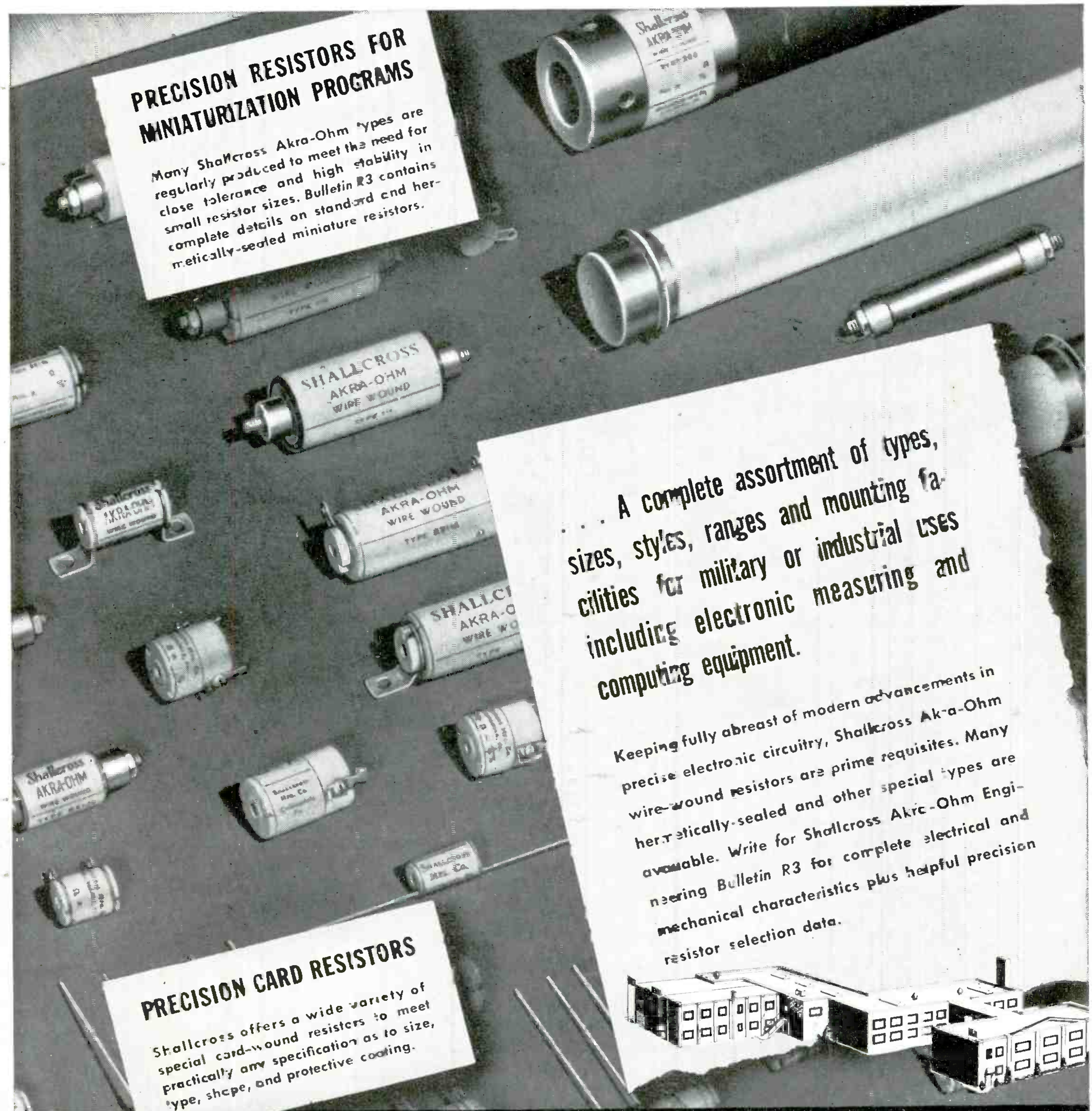

COMPANY TE-30 **Collingdale, Pennsylvania**

The Newspaper that the "Savannah" delivered

The first steamship to cross the Atlantic, it is said, brought back a newspaper containing the report of a famous European scientist "proving" that practical marine propulsion by steam was impossible.

That, of course, was in the knee-pants days of the Scientific Age. Today, it would be a rash scientist who would apply any such label to a proposed development. "Unknown" or "yet to be proved" perhaps, but not "impossible." Imagination is as much a part of modern research and engineering background as physics or mathematics.

In electronics alone, a generation of progress was crowded into a few hectic war years. Products not known — for jobs that had never been done—became commonplace. Yet all of this represents only a fresh beginning . . . not an end. As in the past, Sprague research continues on the assumption that even the best of today's components are only test models for tomorrow's even more difficult assignments.

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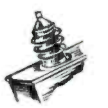

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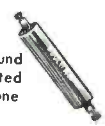


* T. M. REG.

HPB-348

TELE-VISION ENGINEERING
LEWIS WINNER, Editor

March, 1950

As Coy Sees It

THE COLOR ISSUE and its relation to the freeze, received quite a candid governmental review a few weeks ago, disclosing for the first time why the FCC has been unable to make up its mind.

The review, in the form of an address before the Oklahoma University, came from FCC chief, Wayne Coy. Commenting on one of the problems, that of interference, which we indicated last month had been solved, Coy said: "An engineering committee, comprised of representatives of industry and employees of the Commission, have reviewed all the data available on tropospheric propagation. These engineers spent months at this task and came up with a report on which the Commission has based a new allocation plan, which calls for approximately 220 miles between co-channel stations and 110 miles between adjacent channel stations in the veryhigh bands, and 200 and 100 miles, respectively, in the ultrahighs. *I'm rather confident that with these separations between stations we can expect a very high quality of TV service.*"

In probing the freeze, the FCC headman said: "When the Commission stopped processing TV applications in September, '48, it did so because of two problems (very-high and ultrahigh nationwide-system coverage). They were big problems. These two problems could have been solved several months ago, had it not been for the realization that in using up such a large part of the ultrahigh band, there will be no place left for a color TV service in the future."

Then the Commissioner went on to say that, until the FCC can determine whether it should permit use of the wheel system, which has undergone the longest test period but which might be limited in reproduction possibilities, or the use of other new systems only recently developed and still under improvement, or perhaps multiple standards for all systems, there must be a careful evaluation of all the factors, a study that takes time and unfortunately affects the freeze lift. He indicated that it was hoped that the answers might become available before the year is out.

The before-the-year-is-out opinion was also voiced by none other than former FCC Commissioner E. K. Jett, during an association meeting in Baltimore. Jett predicted that the Commission would lift its freeze next fall.

With such hopeful statements, from two conservative gentlemen, on the horizon, it does appear as if there might be a very welcomed thaw before '51 comes around the corner.

Closed Circuit TV

WIRED TELECASTING, in color and high-fidelity black and white, over broad-band circuits, unveiled at the recent IRE National meeting in New York, introduced a striking new trend with glowing possibilities.

First evidence of the development of such a system appeared in the testimony of E. W. Engstrom, during the color hearings in Washington, when he described the key to the project, a 16-mm size camera, the vidicon, which in a three-unit setup would be used for color pickup at remote points.

At the IRE meeting, it was learned that the vidicon, which operates on the principle of photoconductivity, would be able to transmit pictures at normal lighting levels and attain a resolution of more than 500 lines. Commenting on its sensitivity, Dr. Paul K. Weimer of RCA Labs, said that theoretically it is possible to devise a photoconductive tube ten times as sensitive as the image orthicon. Describing the transmission possibiilties of the pickup tube, Richard C. Webb, also of the Labs, declared that a 500-foot coax line could be used at present.

Describing the future of this new mode of viewcasting, TV pioneer V. K. Zworykin said: "Whenever danger, discomfort, and remoteness militate against the presence of a human observer, the TV camera, compact, expendable and tolerant of wide variations in temperature and pressure, as well as chemical fumes and harmful radiation, provides a substitute. In education it may give every member of a student body intimate access to a delicate operation or a scientific demonstration. Conversely, information and widely separated sub-stations may be channeled by this type of television to a single central station, facilitating problems of surveillance and control. . . . In television development, itself, this new type of television system may serve as a testing laboratory for new methods. And since every link is a self-contained unit, it is not hampered by questions of frequency allocation and compatibility."

A paper by Honnell and Prince on a third dimensional TV system, using the velocity modulation principle (see page 12, this issue, for highlights of paper) gave evidence, too, of the magic which apparently is available with this new method of transmission.

In a third IRE closed-circuit TV presentation, an 18-mc, 180-field, 525-line color system using a scanning disk was displayed by DuMont. This system, it was learned, will work with cable lengths of a thousand feet. A 12½-inch receiver was used in the system, but it was learned that a drum is now being developed for use with a 19-inch direct-viewing tube, a demonstration of which was promised within the next sixty days.

Wired TV appears to have arrived and rung the fruitful bell.—L.W.

TV MICROWAVE-RELAY

Figure 2 (left)
Intermediate setup for two link relay of special telecast where a six-foot reflector, used with a 7000-mc receiver, served to pick up signals from a point of program origination 17 miles away, and a 2000-mc transmitter and four-foot reflector was used to direct signal to WMAL-TV 57 miles away. In this view appears a closeup of the special scaffolding and antennas used in setup.

Figure 3
WMAL-TV pyramidal horn antenna as mounted on 7000-mc microwave relay transmitter.

WITH REMOTE PICKUPS rapidly becoming a key factor in the TV broadcasting system, it has been found imperative to probe carefully the techniques involved in the installation and operation of the microwave links required for the service.

Since most pickups present special problems, where many variables must be considered, there is an urgent need for a maximum familiarity with the situations and their solutions, so that service can be established in the quickest and most reliable, yet economical manner.

For microwave-relay operation, the 2000, 7.000 and 13.000-mc bands have been made available, and may be used for inter-city, *stl* (studio-to-transmitter links) or mobile pickup. Exclusive assignment of the bands has been provided, in each area, in accordance with the TV broadcast channel allocation, as illustrated in Figure 1. In addition to the exclusive use of the frequencies shown, it is general practice at present to *pool* (i.e., make available to all stations in the area) any un-issued allocations. These *pool frequencies* are available for remote use only and cannot be set up on inter-city or *stl* service.

While three general types of equipment (i.e., 13000, 7000, and 2000 mc) are indicated by the allocations chart, actually only two are in general use. The first is the readily-portable, low-power 7000-mc apparatus, and the second is the high-power long-range 2000-mc equipment. TV stations with a large amount of special remote broadcast activity generally have one or more equipments of each type. The 13000-mc equipment has not been offered for general sale as yet. No doubt some will be produced in the future, for there is a definite need for an ultra-compact short-range system and this could probably be designed most readily for operation in this region.

The 7000-mc Equipment

The 7000-mc equipment[1] normally consists of a tripod mounted receiver and transmitter together with portable control units for each.

The transmitter circuitry is very straightforward. A two-stage video amplifier brings the input signal up to a sufficient level to be applied to the repeller of a 2K26 klystron. With full modulation the peak-to-peak deviation is about 10 to 12 mc. total. A *dc* restorer is provided which holds the sync tips to a constant frequency, independent of picture content. Regulated *dc* voltages are used throughout and the transmitter provides a nominal power output of 100 milliwatts. A factory-calibrated cylindrical wavemeter is coupled to the output waveguide and furnishes a frequency reference.

Figure 1
Microwave frequency allocations table.

TV Station Channel	*13000-mc Allocation*	*7000-mc Allocation*	*2000-mc Allocation*
2	13025-13050	6925-6950	1990-2008
3- 4	13050-13075	6950-6975	2008-2025
5- 6	13075-13100	6975-7000	2025-2042
7- 8	13100-13125	7000-7025	2042-2059
9-10	13125-13150	7025-7050	2059-2076
11-12	13150-13175	6875-6900	2076-2093
13	13175-13200	6900-6925	2093-2110

The receiver uses the same type of reflex klystron as a local oscillator in a superhet circuit, with a 117 mc *if* system having a bandwidth of about 18 mc. The amplified output of the *if* system splits and is fed to two discriminators.

The first is used for the demodulation of the output signal and has a conventional characteristic with a linear slope over the operating range. The second discriminator has a specially-shaped characteristic which crosses the zero axis at about 112 mc (about 5 mc below the crossover of the signal discriminator). The output of this discriminator is used to control an *afc* system and it functions in such a manner as to hold the frequency corresponding to the tip of sync at a point which keeps the video signal on the straight slope of the signal discriminator.

The equipment may be obtained with three different types of parabolic reflectors, to suit different applications; a tripod-mounting 4′ diameter reflector, a parapet-mounting 4′ reflector and a 6′ reflector. The first is standard equipment with the apparatus and is the best suited to portable operations. It has a

[1]RCA TTR-1A/TRR-1A: C. W. Hansell, *Development of Radio Relay Systems*, RCA Review; September, 1946.

Equipment Operation

Extensive Tests with 2,000 and 7,000 Mc Relay Systems, Designed to Bring in Special Telecasts from Remote Locations to the Studio or Main Transmitter of the TV Station, Reveals That Exacting Operational Procedures Are Required to Insure Optimum Performance. Operation of Portable Equipment from Continually Changing Locations Found to Impose More Operating Problems Than the Fixed Point-to-Point Service. Equipment Modifications and Specially-Constructed Accessories Also Found Necessary to Increase Control Flexibility.

by **EARL D. HILBURN,** Assistant Chief Engineer, WMAL, WMAL-FM, WMAL-TV

power gain of approximately 4000 (with respect to a dipole) and a beamwidth of about 3° (to the half-power points).

The parapet-mounting reflector is used with the standard 4′ reflecter waveguide-feed and is intended for semi-permanent installation at points where recurring broadcasts are scheduled. With either of these antennas, the system provides a satisfactory signal-to-noise ratio over a line-of-sight range of about 20 miles. The 6′ reflector (furnished by the manufacturer) is intended for use over longer courses. It may be tripod-mounted for portable use, or mounted in a gimble-ring assembly for fixed point-to-point service. Because of its weight (75 pounds) and difficulty in handling, it has not been used too widely. Furthermore, the beamwidth is so sharp (about 1¾°) that stability of the mounting is a considerable problem, turnbuckles or braces being required to keep any vibration of the reflector from causing a flutter in the signal at the receiver. The need for this type of antenna, at least for mobile work, has to a large extent been eliminated by the advent of higher powered 2000-mc equipment for the longer courses.

During our 7000-mc remote work, a need was found for a short-hop type of antenna. Accordingly, a pyramidal electromagnetic horn (Figure 3) was designed and constructed for use on short hops of up to about three miles. Proportions of the antenna were selected to provide a horizontal beamwidth of approximately 50° and a power gain of about 210, with respect to a dipole. It was constructed of silver-plated copper, and provided with a polystyrene faceplate to keep rain and snow out of the waveguide. Of small size and lightweight construction, it has been found to be a very convenient piece of equipment to have on those short courses where transmitter power is not an important factor.

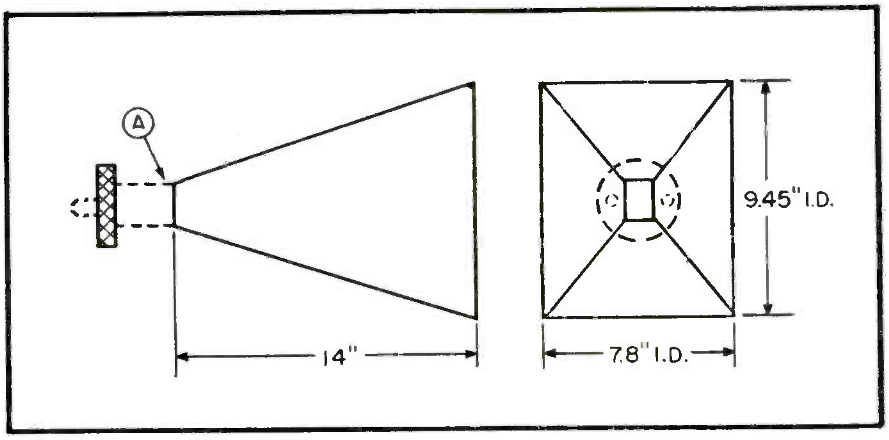
The 2000-mc System

Several 2000-mc systems are currently on the market, all featuring considerably more carrier output than the 7000-mc apparatus. This increased power means larger and heavier transmitter equipment and accordingly these relays are generally better suited to *stl* or other fixed service. The higher carrier power enables the 2000-mc equipment to be used to advantage in covering extremely long courses, and under certain conditions to cover short non-line-of-sight courses. This ability, to do jobs that could not be handled by a single 7000-mc relay, makes this type of system a desirable adjunct to any mobile television operation.

In our station, the 2000-mc transmitter[2] occupies a total of 44½″ of space

Figure 4.

Cross-sectional views of 7,000-mc horn for use with 1.375 H-plane and .625 E-plane waveguide system. The horn is constructed of 1/16″ sheet copper, silver plated after assembly is completed. The flair angles in the H-plane are 34° and in the E-plane, 28°. At A is the point of a braze (with a smooth inside transition) to short length of waveguide, using a two-pin connector and knurled ring.



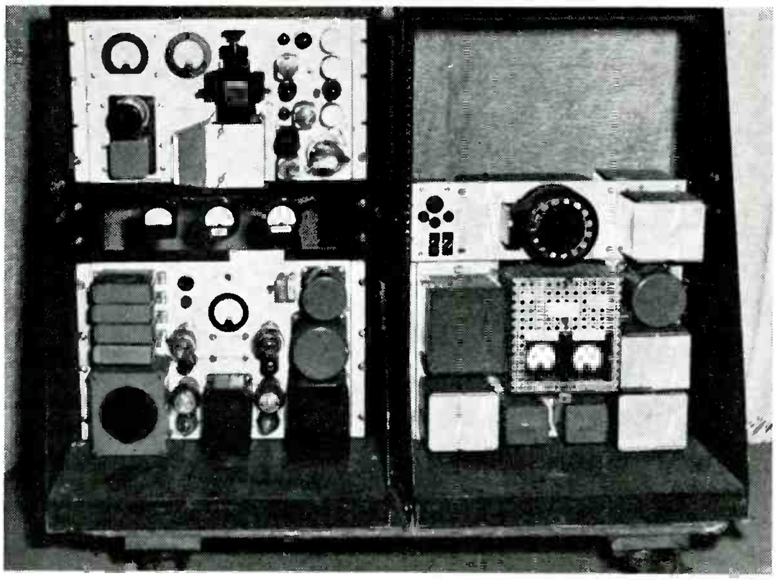


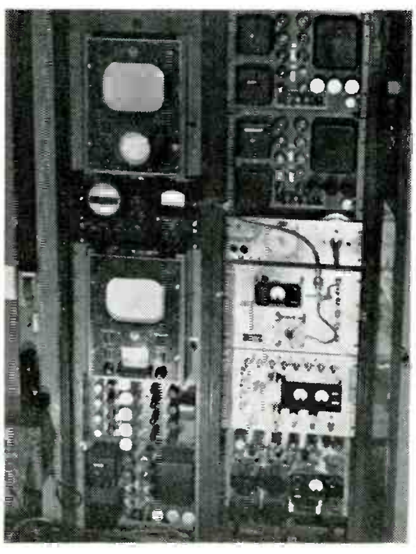
Figure 5
The 2,000-mc transmitter. Left rack contains magnetron-modulator unit, special meter panel, and modulator power supply. Right rack contains 2,000-volt regulated power supply for magnetron.

in two table-height relay racks, draws 1.5 kw of power from a single-phase 60-cycle 115-volt supply, and weighs approximately 200 pounds. In circuit, the transmitter lineup includes a multistage video amplifier terminating in a 4D32 power amplifier which applies the modulating signal to the halo of a QK-174-A package magnetron. This oscillator is frequency modulated to a swing of about 7.5 mc peak-to-peak, with full deviation, with a carrier output conservatively rated at 50 watts. Three power supplies furnish regulated plate power for all stages of the transmitter.

The companion receiver, shown in Figure 6, occupies 38″ of rack space and weighs just over 100 pounds. It employs a 2K28 klystron local oscillator, tuned crystal mixer assembly, and a 125-mc *if* amplifier with a passband of approximately 20 mc.

At present WMAL-TV is using three different antenna systems with this equipment. An 8′ diameter dipole and parabolic reflector is available for maximum system performance. This antennas has a gain of 1280 (with respect to a dipole) and a 4½° beamwidth (to the half-power points). The antenna is of screen construction to minimize wind-loading and lightweight alloys are used for all structural members. This antenna is intended primarily for use on fixed point-to-point service and is furnished with a flat mounting plate suitable for bolting to a tower or similar supporting structure. In Figure 7 appears a view of this antenna secured to a specially constructed rotating mount, which is controllable from the receiver-operating position. In spite of its bulk, this size antenna occasionally comes in very handy at the transmitting end in the field. Since it was not intended for portable use, mounting is a bit of a problem under these conditions. In one solution, shown in Figure 8, a special stand was constructed. Made of 4 x 4's, and held together with ½″ diameter bolts, this stand can be assembled from the completely knock-down condition by two men in about 30 minutes. It includes provision for *panning* the antenna through about 30° and *tilting* through about 5°, without shifting the position of the base of the stand.

Figure 6
The 2,000-mc receiver (lower half of right hand rack) including WMAL-TV constructed antenna-position control panel, local oscillator and mixer panel, if and video amplifiers, and regulated power supplies.



A 46″ diameter version of the 8′ reflector system is also available. This has a gain of 320 (with respect to a dipole) and a beamwidth of 9° (to the half-power points). This antenna has largely superseded a solid 4′ diameter parabolic reflector system, originally furnished with the equipment. The advantages of lighter weight and lower windloading make the screen reflector preferable to the solid paraboloid for portable operations.

In addition to a selection of antennas, the user has a choice of transmission lines; no equipment is actually mounted at the antennas and 52-ohm coax is used to connect these to the transmitter and receiver. For permanent installations, with considerable separation between the antenna and the operating equipment, rigid coax offers the advantage of reduced line losses. In the WMAL-TV installation, we have a 250′ run of 1⅝″, 2000-mc pressurized coax between the receiving antenna (Figure 7) and the receiver (Figure 6). More recent installations of this type have employed a ⅞″ rigid line. The loss in this latter line is reportedly about 2 db per 100′ at this operating frequency.

For temporary transmitter setups in the field RG-17/U (with 6.8 db attenuation per 100′), RG-14/U (9.5 db attenuation per 100′) and RG-8/U (14 db attenuation per 100′) flexible cable may be used. Constant impedance connectors and adapters are available for all of these, making it possible to use these interchangably or in combination. For convenience, the lighter weight cables have been used in those setups where transmission line losses are not a limiting factor in the performance of the system.

Prior Preparation Procedures

It is both costly and embarrassing to encounter difficulties when relaying a picture signal from the scene of a remote telecast to the TV transmitter. It is therefore essential that the engineering staff be certain that the relay can be successfully completed, before a special program commitment is made. The first step in establishing this link assurance is a survey. Actually this microwave survey is usually made at the same time that the other plans are made for the telecast. In operation, representatives of the program and engineering departments visit the scene of

[2]Raytheon RTR-1A. Current production is designated as type RTR-1B and embodies a number of minor modifications.

the pickup and determine such factors as: camera positions, lighting requirements, mobile unit parking, power availability, etc. The principal factors which must be evaluated in the microwave survey are the site for the antenna and the course-line to the link receiver.

The site for the antenna must be high enough to clear any local obstructions, but otherwise should be as close as possible to the mobile unit or point of video control. In those cases where an unusually great separation exists between a suitable antenna site and the video control point, an intermediate position must be determined for mounting of the microwave transmitter control. In these cases a video line must be run between the output of the camera switching unit and the input to the microwave transmitter. In any event, it will generally be necessary to have the transmitter or transmitter control unit within 200′ of the antenna site.

Having selected an accessible site for mounting the transmitting antenna, the course line must be checked carefully. If the distance to be spanned is comparatively short (5 miles or less), and the visibility is good, high-powered binoculars or a telescope can be used to determine whether or not a line-of-sight course is obtainable. Assuming the receiving point has been found to be unobstructed, it is a certainty that the microwave relay can perform to satisfaction. Before leaving the site it is a good idea to note the compass bearing to the receiving point, or make notes as to the approximate bearing in terms of landmarks in the immediate vicinity. Although good weather is very helpful at the time of the survey, bad weather or nighttime studies can be applied. Incidentally considerable time can be saved in orienting the dishes, if the transmitting antenna can be set to approximately the right bearing at the time the initial setup is made.

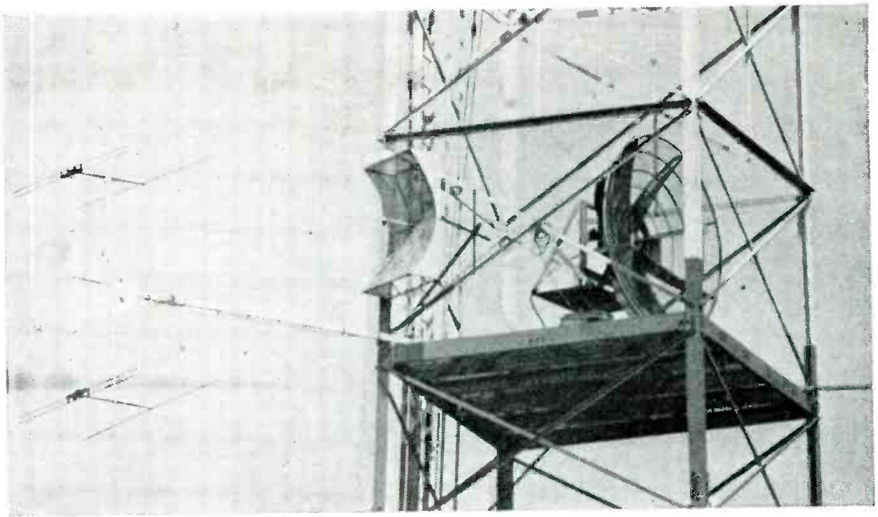


Figure 7

Telephoto view of 225′ level of WMAL-TV transmitter tower, showing eight-foot 2,000-mc receiving antenna on rotating mount. (Receiving antennas to left are used in direct off-the-air rebroadcast of Baltimore stations.)

If the weather is bad at the time of the survey and visibility is reduced to where the course cannot be checked visually, it is important then to note carefully any local landmarks in the immediate vicinity of the proposed transmitter location, and then check the course from the receiving point when the weather conditions are more favorable.

If the course-line is determined to be non-line-of-sight, the initial survey should include a study of the horizon from the operating site. Notes should be made as to several possible locations for intermediate equipment on a two-link relay. Each of these can be inspected later. The selected intermediate location should provide accommodations for the necessary equipment and clear paths to the terminal points of the circuit.

When a long distance is to be spanned, the course line should be determined by means of an accurate map showing ground elevations.* In general this operation consists of drawing the courseline on the contour map and then making a separate plot, on another sheet of paper, showing the ground elevation at frequent points along the course. The next step is to add to the profile section the height above ground level of the receiving and transmitting antennas. Allowance must also be made for buildings, groves of trees or other known obstructions along the course. Also, on very long courses or with low initial antenna elevations, due allowance must be made for the curvature of the earth.

If you are within the maximum working range of the equipment, and line-of-sight conditions are clearly shown to exist, either the 2000 or 7000-mc setup can be expected to cover the course. However, if grazing conditions are known to exist, or if the course is clearly below line-of-sight, it is doubtful that the 7000-mc equipment will provide an adequate signal. It is possible that the 2000-mc equipment may have power enough to provide a usable signal strength at the receiver, even under these conditions. The 2000-mc equipment will not *bore through* any intervening obstructions. On the other hand, diffraction of the wavefront will cause some signal to exist in what would otherwise be shadow areas. If the main beam signal strength is extremely high, there is a possibility that the greatly attenuated diffracted signal may be strong enough to operate the receiver in the normal manner.

(To Be Continued)

Figure 8

Mount being assembled for support of eight-foot 2,000-mc antenna system on scene of remote telecast.

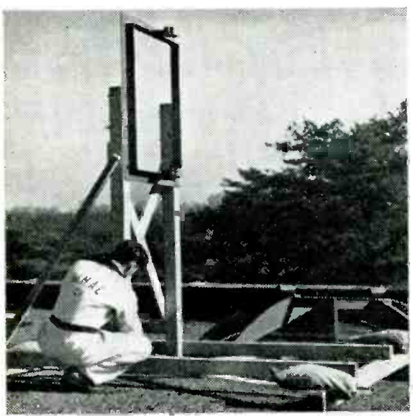
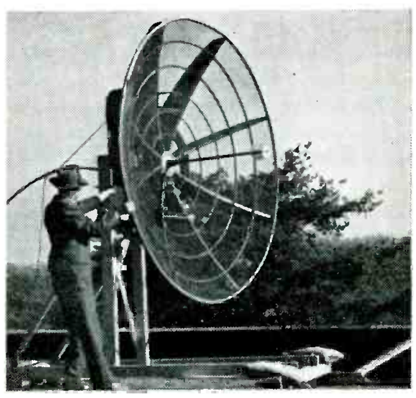


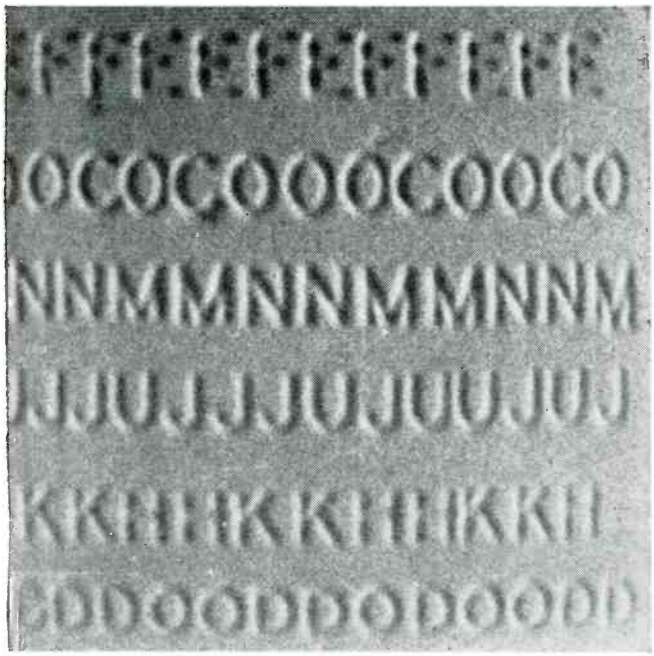
Figure 9

Mount assembled and antenna being adjusted.

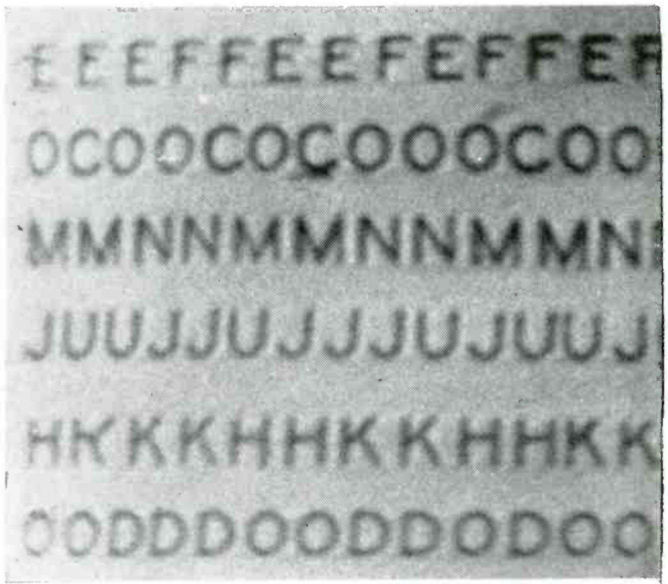


*Topographic maps may be obtained directly from the Department of Interior, Office of the Geodetic Survey, or in many instances from the local public library or the office of the county surveyor.

TV at the 1950



Below: Image of test chart using standard TV principle.



(Left): A vtr image of a test chart analyzed by Honnell and Prince in their TV-image reproduction paper. The images shown at left, and above and at right were televised over a video system which utilized sequential scanning of 350 lines per frame, 40 frames per second, and a video bandwidth of approximately 2.5 mc. These views were photographed from a 5" picture tube on 35-mm film. Some detail has been necessarily lost in the photographic and printing processes.

TV Image Reproduction by Use of VM Principles *

IN STANDARD TELEVISION SYSTEMS, pictures are reproduced on the picture tube by varying the brightness of a spot that is scanning the picture on the mosaic of the pickup tube. In a *velocity-modulation* system, which has received considerable attention in the past, the picture-tube beam current is maintained constant, and the change in brightness of the reproduced picture is achieved by varying the horizontal velocity of the spot in both the picture and camera tube in accordance with the brightness of the picture on the mosaic of the camera tube. Bright portions of the picture are reproduced by a low spot velocity and dark portions are reproduced by a high spot velocity.

To achieve *velocity television reproduction* the picture to be televised must be scanned with constant velocity and the video signal obtained in the usual manner, while at the receiver the image is reproduced by varying the horizontal velocity of the spot on the screen of the picture tube. This variation of deflection velocity is achieved by varying the horizontal velocity of the spot on the screen of the picture tube. No video signal is applied to the picture-tube grid so that the beam current is maintained constant.

A mathematical analysis of the response of this system shows that when the video signal has been added directly to the deflection voltage, the brightness of the reproduced picture element can be determined by the rate of change of brightness about the subject picture element along the mosaic scanning line. Further examination of the derived equations have disclosed that several different types of velocity television reproductions can be achieved, each of which possesses certain novel characteristics. To a first approximation it is possible to obtain a true reproduction of the televised picture through the use of suitable coupling networks, although contrast is poor under these conditions.

A consideration of the basic *vtr* principles indicate that when a certain critical value of injected signal is exceeded, the picture-tube writing spot will retrace a portion of the writing line, thus resulting in a segment of increased brightness. This characteristic of the system causes two-tone objects to be outlined by a light band on one side and a dark band on the other side. When a narrow bar is reproduced, the dark and bright bands lie very close together, thus giving maximum contrast and visibility. The relative positions of these bands depend upon the polarity of the injected video signal.

For these reasons, two-tone subject matter comprises an important class of material that can be reproduced with good detail by *vtr*. This category includes printed material, maps, line drawings, and circuit diagrams.

The investigation of *vtr* has revealed that there are several types of picture distortion which might arise in standard commercial video systems due to spurious coupling between the video and the deflection channels in television cameras or receivers. This spurious coupling will produce velocity modulation of the writing spot which results in a halo effect or in some other form

**From the 1950 IRE National Convention paper by M. A Honnell and M. D. Prince, Georgia Institute of Technology.*

Convention of the IRE

A Report on Papers Presented by Mertz, Fowler and Christopher, and Hornell and Prince Covering Quality Rating of TV Images and TV Image Reproduction by Use of Velocity-Modulation Principles.

of distortion which may be erroneously ascribed to excessive high-frequency peaking in the video stages or to ghost images caused by reflections.

The *vtr* system has been found capable of reproducing printed material and line drawings with a definition approaching that of a standard television system but with a loss of tonal values. Due to the three-dimensional appearance of the image presentation, *vtr* may offer some advantages for certain industrial television applications or radar 'scope displays. Furthermore, experiments to date indicate that velocity reproduction may be achieved with fewer electron tubes in the television system and with some reduction in circuit complexity.

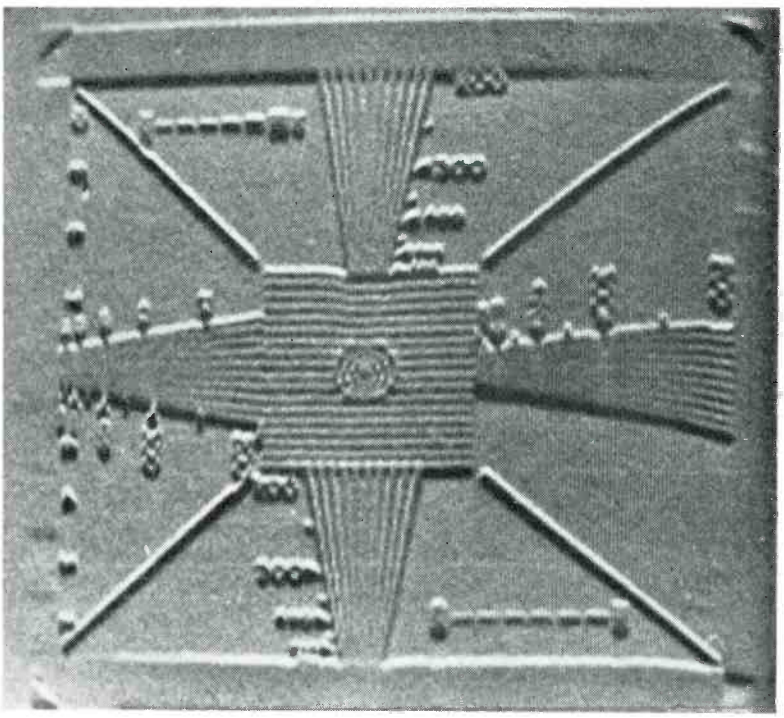
*Quality Rating of TV Images***

THE TRANSMISSION of television signals requires a frequency band much wider than other communication systems, and initial experience has shown that deviations from the ideal transmission medium assume great importance. Further the correction of such deviations is a relatively costly matter. Thus, it is important to have an accurate evaluation of the impairments resulting from such deviations. It is desirable to secure a quality rating which can be placed on as nearly a quantitative basis as possible, and that, as nearly as possible, the same scale be used for the various impairments. When considering transmission impairments this image is not sensed by the viewer as an original work of art, but as a reproduction of an original which may or may not be accessible. That is, the quality rating does not assume the burden of rating original artistic merit.

Two techniques have been explored for establishing such a rating of image quality. The first of these stems from procedures used in the older art of photography in studying film speeds and printing paper characteristics. It is simply based on presenting an observer with pairs of pictures, having slightly different but known physical characteristics, and asking him to vote his preference for each pair. This permits of determining optimum trends in the physical characteristics studied.

The technique has been applied to a rating of the subjective impairments from echoes as compared with reduction in sharpness (or bandwith) of the picture. In this approach, the television picture of a lantern slide with controlled amounts of echo, over a wide range, has been presented to an observer, side by side, with an optical projection of the same lantern slide,

A vtr image of a standard test pattern.



***From the 1950 IRE National Convention paper by P. Mertz, A. D. Fowler and H. N. Christopher of Bell Labs.*

The vidicon pickup tube camera and industrial-television monitor described by Weimer, Forgue and Goodrich of RCA Labs at the IRE meeting. The new pickup tube employs a photoconductive target which is sufficiently high in sensitivity to permit operation at moderate light levels without an electronic multiplier. In some experimental cases targets have exceeded 1,000 microamperes per lumen. The tube is 1" in diameter and 6" long.

projected out of focus by a controllable amount (using in principle the same projection optics as used by M. W. Baldwin in some prewar studies on the subjective appreciation of sharpness). In the test, the color was matched by projecting on to a blue screen, the blue requiring a careful choice. The contrast was approximately matched by reflecting and directing a controllable fraction of the light from the side of the projection lantern on to the whole screen.

Impairing Effect of Echo

By this procedure the impairing effect of the echo could be compared in subjective seriousness to that of a sharpness degradation, initially expressed in thousandths of an inch (or mils) off focus of the projection lens. Calibration of these results were made against frequency bandwidth for a conventional television system having a fairly perfect spot structure by a separate comparison with transparencies of the same subject matter transmitted by telephotograph through a known frequency band.

Picture Quality Rating

By analyzing the vote between the off-focus projections and the television pictures it has been possible to evaluate how much the preference amounts to in the case of any given pair. This follows a method developed by the psychologists, and was applied by Baldwin to measuring the subjective appreciation of sharpness in pictures. It can also be used as the basis of a system of rating picture quality.

Vote Analysis Technique

The vote analysis, in brief, consists merely of setting as one *limen* the difference between two pictures where 75 per cent of the observers prefer the one to the other. The vote distribution is found in practice to follow approximately the normal error law, so that the difference becomes two limens where the preference vote is about 91.1 per cent, and three limens where it is about 97.8 per cent. The image quality difference between two pictures of a pair in this system of rating is measured by the number of liminal units computed from the vote preference.

Alternate Method

The second technique, also derived (but with some changes) from the psychologists, consists in presenting to the observer a picture affected by differing and controlled amounts of the given impairment, in irregular sequence. The observer is given a list of comments, and asked to specify which comment most nearly characterizes his judgement regarding the impairment to the picture.

The comments which have been used are:

(*1*) Not perceptible
(*2*) Just perceptible
(*3*) Definitely perceptible, but only slight impairment to picture
(4) Impairment to picture but not objectionable
(*5*) Somewhat objectionable
(*6*) Definitely objectionable
(*7*) Not usable

Analysis Results

This technique has been applied to rating the seriousness of the effect of echoes and random noise on picture quality. The result, plotted as a curve, represents the median, i.e., 50 per cent of the observations are more tolerant of the impairment, and 50 per cent are less tolerant. From the distribution of the votes about the median it is also possible to set up a system of liminal difference ratings for the pictures.

System Evaluation

The two techniques, and the four different ratings, have been compared in the evaluation of echo impairments. The correlation among them is found to run from fair to extremely good. One liminal unit turns out to be about one comment number spacing more or less uniformly at all comment levels except the extreme ends of the scale.

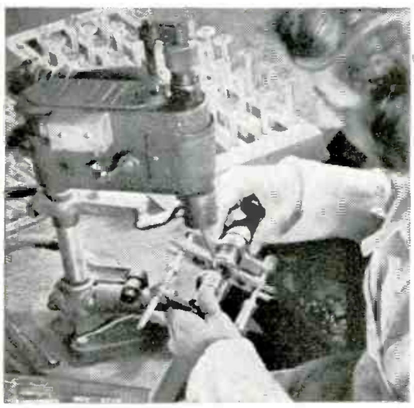
System Possibilities

The comparison technique is more difficult to set up and requires more observations to obtain a significant result than the comment technique. However, the observations are much simpler, requiring only an indication of picture preference, instead of an evaluation in terms of words. Also, in comparing a television picture with a projected picture, the results obtained are more absolute, to the extent that a projected picture is more reproducible, in the present state of the art, than a television picture.

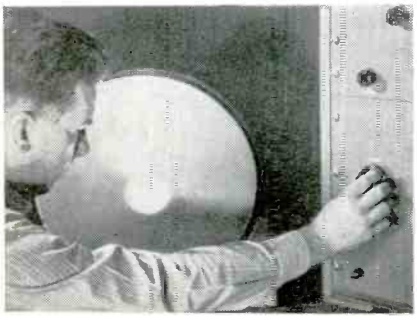
The comparison technique has also been used to compare sharpness as a quality parameter of the picture with highlight luminance and contrast ratio.

Electron-Gun Production Techniques*

(Above)
Electron-gun pinning operation, where pins are welded to parts. Pin location is checked on a 20:1 image by shadowgraph method. Gun construction is checked at this stage to assure correct spacing and alignment of completed gun mount.



(Below)
Cathode test-analysis setup. Bright spot in the center of the tube is a picture of the cathode emitting surface; this test discloses any break or dead spot which would affect the life of the tube, and at the same time the condition of the anode and second grid aperture can be observed.



Final assembly of gun mounts. Cleanliness, humidity and temperature control are closely watched at this stage of gun construction.

Specially-designed and constructed furnaces which are used for hydrogen-firing of all stainless-steel parts used in the electron guns.

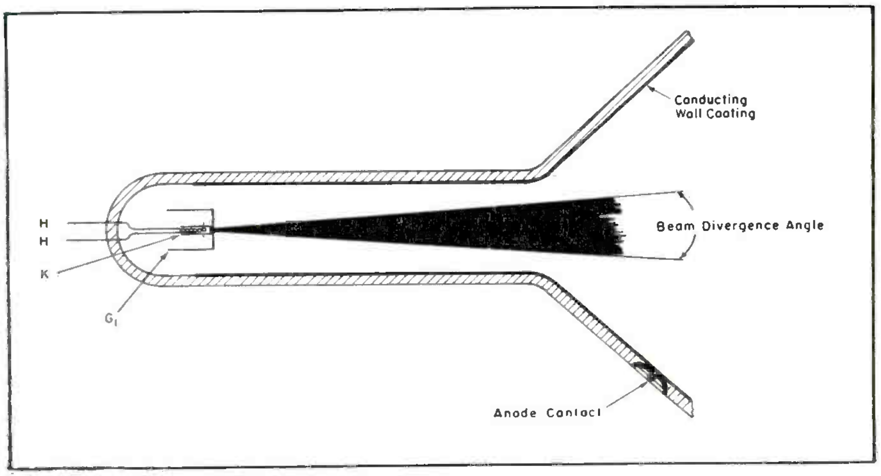
(Left)
Welding with thyratron-controlled equipment, which provides a strong weld with very little discoloration of the metal.

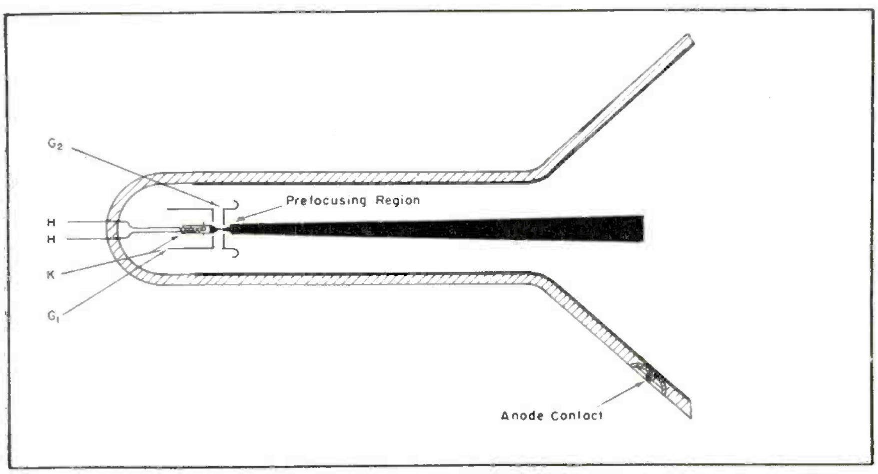
**Illustrations and data presented through the courtesy of Haydu Brothers.*

Annealing of the glass. One firesetter, assigned to each two machines, checks heat of glass. After annealing, the stems are inspected with particular emphasis placed on checking glass for any signs of strains or cracks.

The Design and Fabrication of

TV PICTURE TUBES





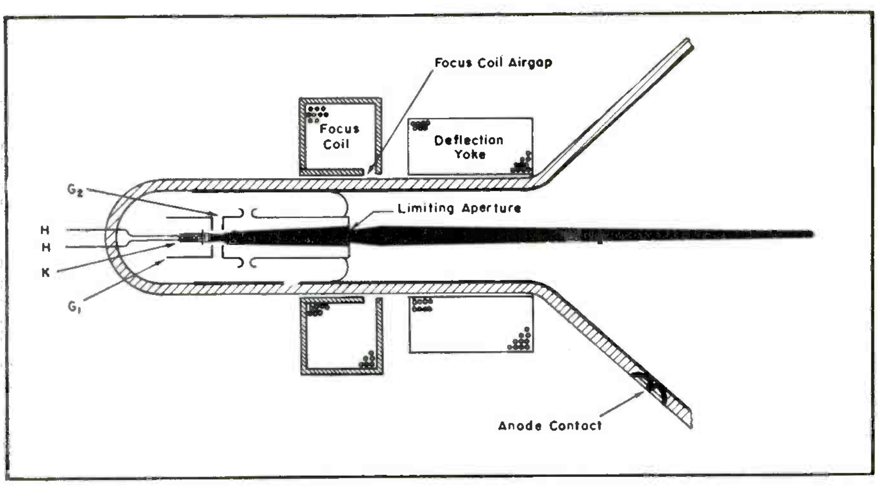


Figure 1 (left, top)
Simple electron gun structure.

Figure 2 (left, center)
Improvement of simple electron gun with an additional electrode, the second grid.

Figure 3 (left, bottom)
View of an electron gun with another refinement, a limiting aperture.

AT PRESENT there are over four dozen TV picture tubes, registered with RMA, which may be found in receivers manufactured within the last few years. The distinctions between types appear generally in the differences in physical characteristics such as screen diameter, deflection angle, overall length, and type of bulb used.

The function of a picture tube is to form and control a stream of electrons which may be focussed and deflected on a layer of fluorescent crystals to produce light at every point where the electrons strike the screen. The functions of beam forming and control are achieved by use of an electron gun.

In this electron gun, the heater, which is a coil of tungsten wire insulated with a ceramic coating, brings the cathode up to the temperature required for electron emission from the cathode coating. Immediately in front of the cathode surface (about .005″ separation) is the grid aperture, which is about .040″ in diameter and operated at negative voltage with respect to the cathode; hence no electrons flow from the cathode to the grid. The anode of our simple tube is a coating applied to the bulb and neck in which the gun is contained. This coating is operated at high positive potential with respect to the cathode. The electrostatic field produced by the anode wall potential penetrates into the grid aperture, inducing electrons to leave the cathode surface, and accelerating these elec-

Detailed Study of Direct-View Magnetic-Deflection and Focus Picture-Tube Processing Methods Discloses that Variety of Critical Factors Must Be Reviewed Carefully in Lab and on the Production Line to Satisfy Current Requirements: Light and Electron Optics, Beam Formation and Control, the Electron Gun, Prefocusing Action, Limiting Apertures, Beam-Deflection Techniques, Wide-Angle Applications, High-Vacuums, Ion-Spot Elimination, Slant Field and Bent-Gun Ion Traps, Metal and Glass Envelopes.

by K. A. HOAGLAND, Tube Engineering Department, Allen B. DuMont Laboratories, Inc.

trons to a high velocity. The electrons will continue their motion until they meet a retarding or negative electrostatic field, or until they strike some portion of the tube body which they are unable to penetrate. The electron beam consists of a bundle of individual electron paths; Figure 1. The beam is divergent, spreading outward as it travels further from the cathode and grid. To control the intensity of light produced, the grid voltage must be varied from beam cutoff to a maximum of zero bias. Beyond zero bias, the grid will collect electrons from the cathode and the tube behaves as a conventional diode, causing clipping of the video signal.

The simple gun described can actually be used in tubes for television purposes. For example, a gun with nearly this simplicity has been used in a projection tube, the 3" type 3NP4. Similar guns have been used in many of the television picture tubes manufactured in England. One disadvantage of this structure, however, is that the electron current in the beam is influenced not only by changes of control grid voltage, but also by variations in the anode voltage, which causes changes in the field intensity penetrating the control grid aperture.

An improvement of the simple electron gun is shown in Figure 2, with an additional electrode, a second grid, added to the basic structure. This grid consists of an aperture disc or cup close to the G_1 aperture, and is operated at a fixed positive potential of about 250 volts. This electrode serves as a shield-grid or screen-grid, similar in action to the screen grid of pentode type receiving tubes, helping to isolate the effect of anode voltage in influencing electron current flow from the cathode. In the usual type of *crt* using a second grid, the final anode voltage may be varied from 5 to 10 kv, with only a slight change in the available anode current for a given control grid voltage. A further action of the second grid, which is indicated by the shape of the beam in Figure 2, is that it tends to act as a convergent lens making the beam diverge less than it would for a gun which does not use a second grid. This lens action results from the manner in which the electrostatic field is

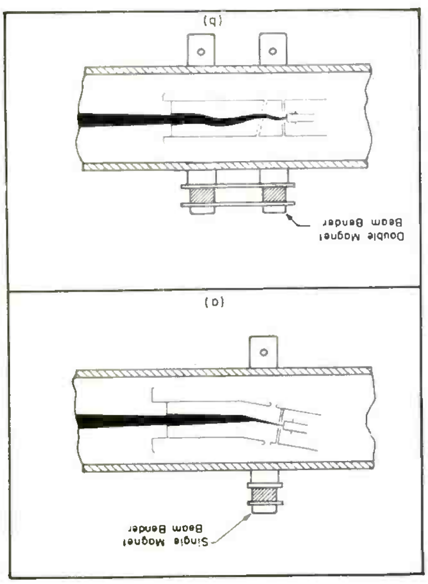


Figure 4 (left)
Slant-field ion-trap design (bottom) and bent-gun structure (top).

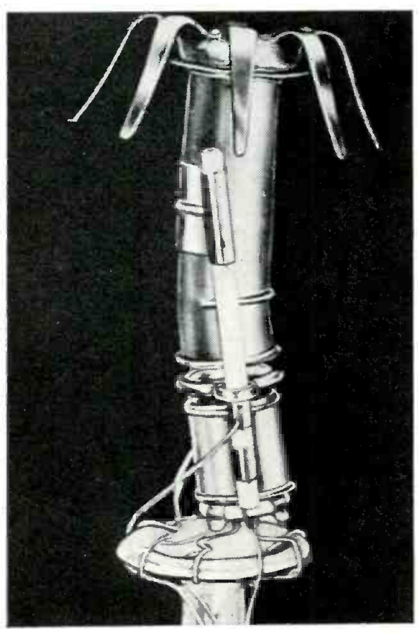
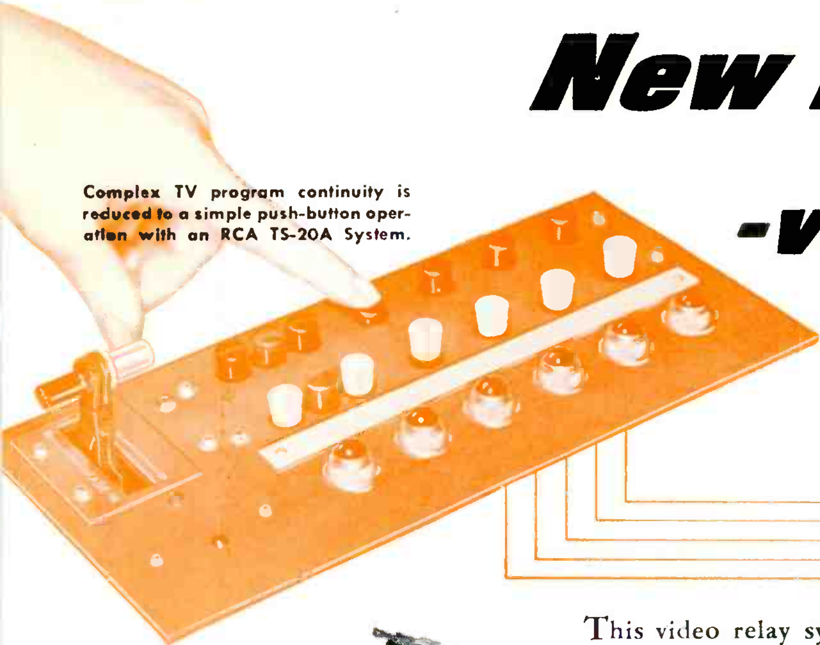


Figure 5
Bent-gun mount structure.

New Era in Video -via REMOTE



Complex TV program continuity is reduced to a simple push-button operation with an RCA TS-20A System.

This Relay Switching System does what RCA's Audio Relay Systems have

This video relay system removes all switching restrictions from equipment operations. It imposes no limitation on equipment installation—no matter where you set up your units. It provides unlimited flexibility—enables you to add facilities as your station grows, *without losing a penny's worth of your original equipment investment.*

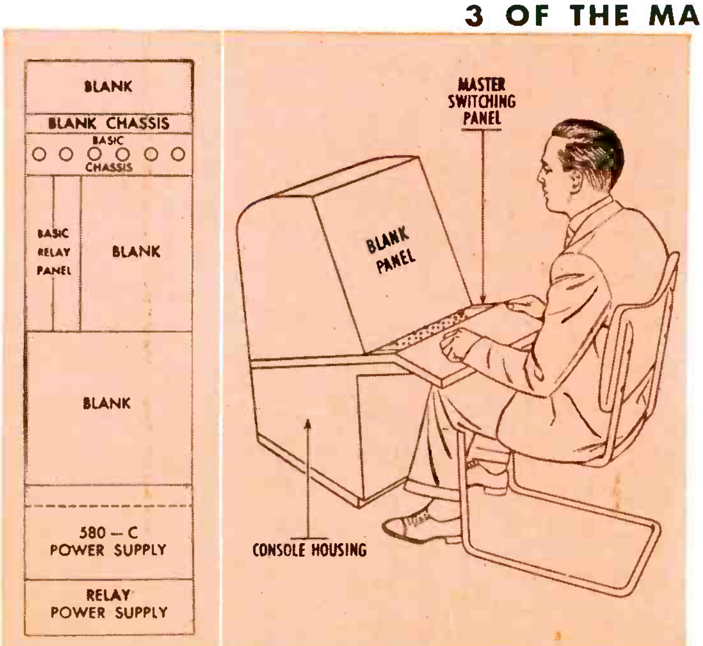
Actual switching in the RCA TS-20A system is done by d-c operated relays *located in the video line itself!* Designed by RCA for this special service, these relays are controlled by simple d-c lines from any point you choose. No expensive coaxial line required to and from control points. No extra cable connectors needed. You can rack-mount the relays wherever you want them. You can set up your control positions wherever you like. There are circuit provisions for sync interlocks and for tally lights.

The RCA TS-20 System provides complete master or studio facilities for program monitoring, production talk-back, and video switching between studio camera, film camera, remote pick-up and network programs. For example, you can fade or lap

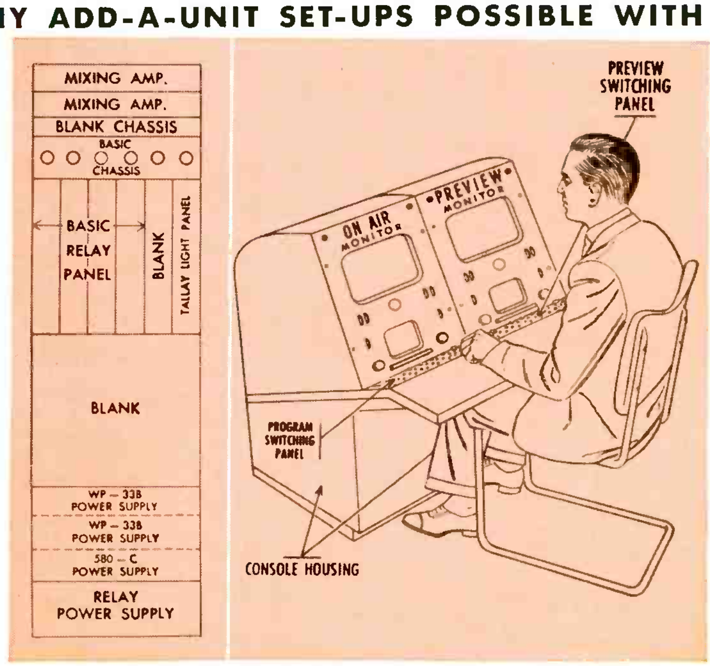
TELEVISION BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

3 OF THE MANY ADD-A-UNIT SET-UPS POSSIBLE WITH



1. Minimum Master Control arrangement. Combines simple operation with economy. Provides switching of 6 inputs to either of 2 outputs.



2. Simple Studio Control layout. Additional facilities include: Preview monitoring and line monitoring, fades, lap dissolves, and superimposition.

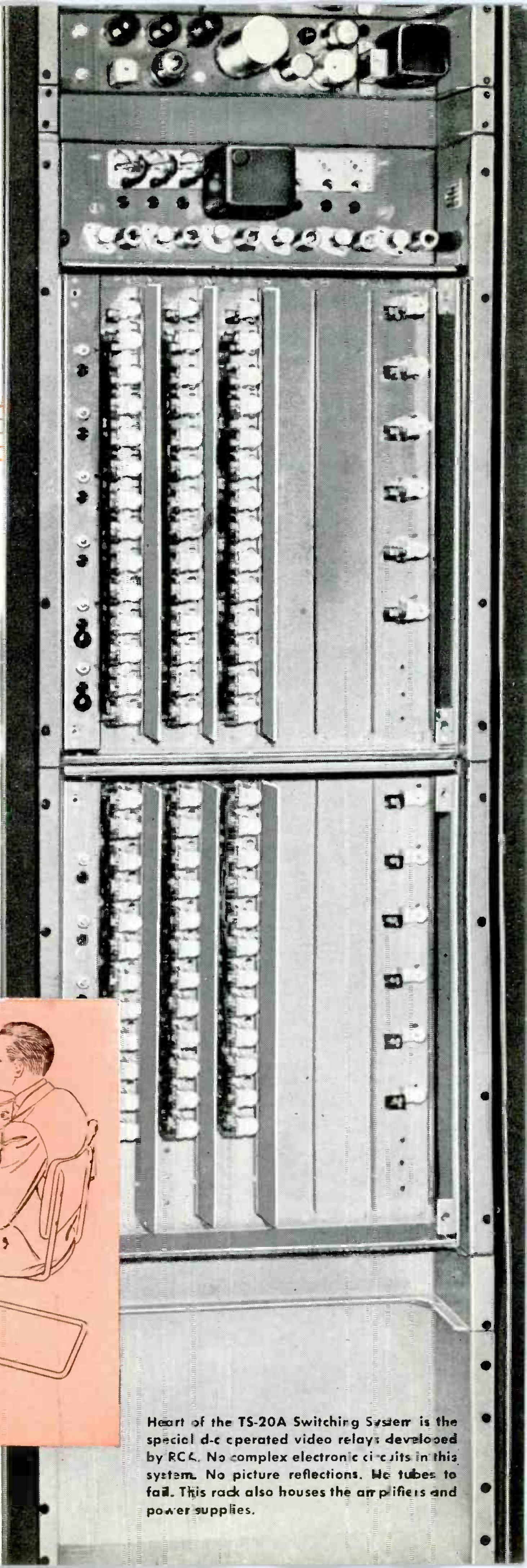
Switching RELAYS!

for TV master or studio control done for aural broadcasting.

dissolve between studios. You can set up for program previewing and other monitoring functions (up to 5 program monitors available). You can combine the TS-20A System with audio switching *and presetting,* so that the sound switches with the picture *automatically!*

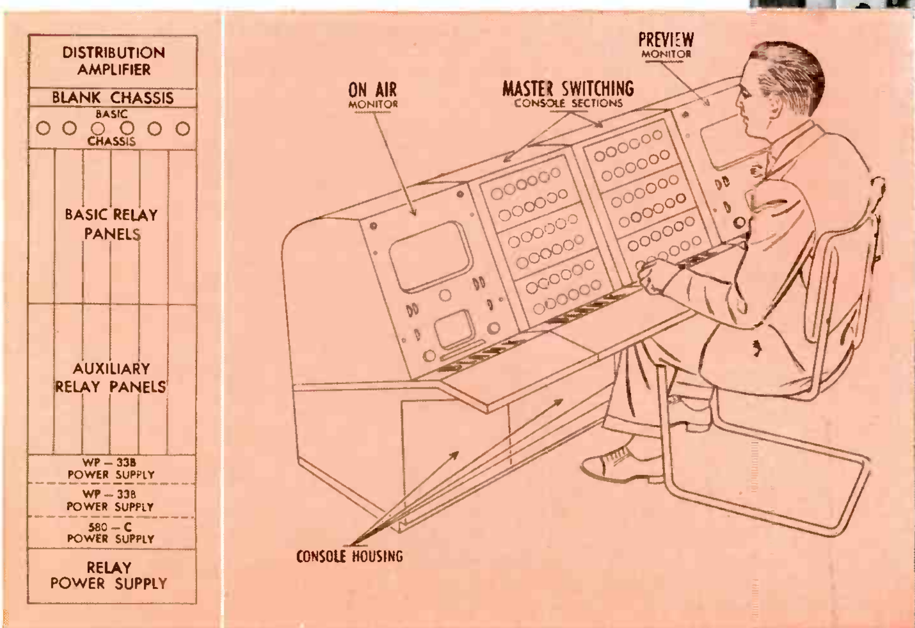
• • •

For long-range planning of your TV programming facilities, overlook none of the advantages of this revolutionary new relay switching system. Ask your RCA Broadcast Sales Engineer about it. Or write Dept. 23 C, RCA Engineering Products, Camden, N. J.



Heart of the TS-20A Switching System is the special d-c operated video relays developed by RCA. No complex electronic circuits in this system. No picture reflections. No tubes to fail. This rack also houses the amplifiers and power supplies.

RCA'S TS-20A SYSTEM.



3. A more elaborate master control room set-up than shown in No. 1. Switches any of 12 inputs to any of 5 outgoing lines. Includes preview and line monitoring.

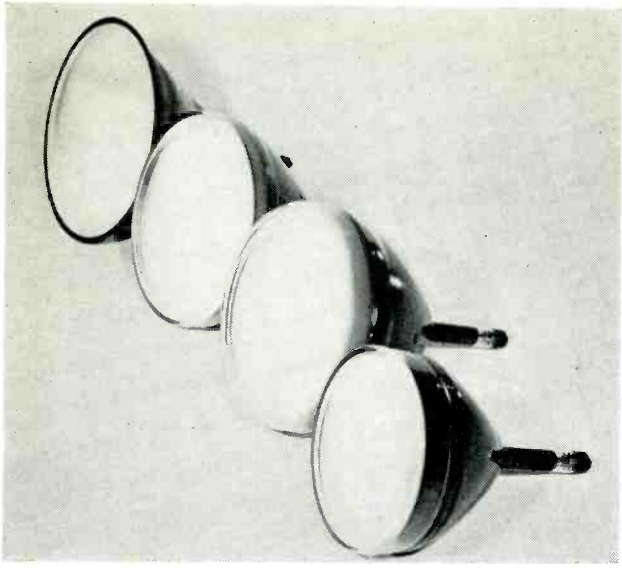


Figure 6
Four types of picture tubes used today: 19AP4, 16FP4, 15DP4 and 12QP4.

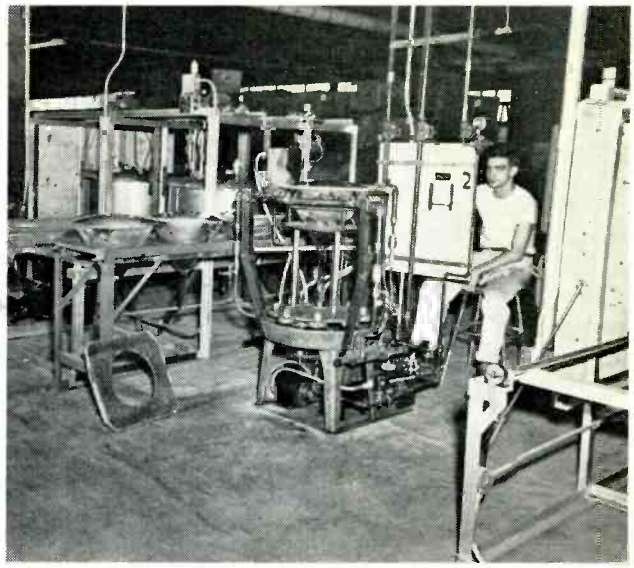


Figure 7
Face plate sealing and annealing of the 19AP4 type tube.

curved when penetrating into an aperture or cup; the convergent action on the electron beam is known as *pre-focusing*.

A further refinement of the simple electron gun structure appears in Figure 3. The beam formed by either of the structures illustrated in Figures 1 and 2 is not uniform in cross section; there are more electrons in the center of the beam than towards the edges, or more precisely, the current density is a maximum at the center of the beam and tapers off to negligible values at the edges. The ideal current distribution is one that is uniform over the entire beam cross section, since such a beam when focussed on the screen would produce a very sharply defined spot. To make the *crt* structure more closely approach the ideal, some of the electrons at the outer edge of the beam are trimmed off by an electrode known as the *limiting aperture*. Since this limiting aperture must be supported with the other gun parts, it is generally contained in a cylinder which is mounted close to the second grid. The use of this cylinder constitutes another refinement, since the shape of the final anode field can not be influenced by non-uniformity of the glass neck wall. Contact to the final anode and limiting aperture is made by a spider-like metal part which rests on the inner neck wall conductive coating. This coating extends up on the bulb body to a point close to the fluorescent screen.

Since the electron beam consists of diverging electron-ray paths, some form of lens must be employed to change the direction of the diverging rays, so that these rays will converge to a small spot on the cathode-ray tube screen. Either electrostatic or magnetic electron lenses may be used to perform this function. In either case, the lenses are similar to concave surface light lenses which focus light from an object point to an image point. In the electron lens for a picture tube, the object point is located very close to the control grid aperture and consists of a bundle of electrons of minimum cross-sectional area. It is the function of the lens to image this area on the fluorescent screen.

Light and Electron Optics

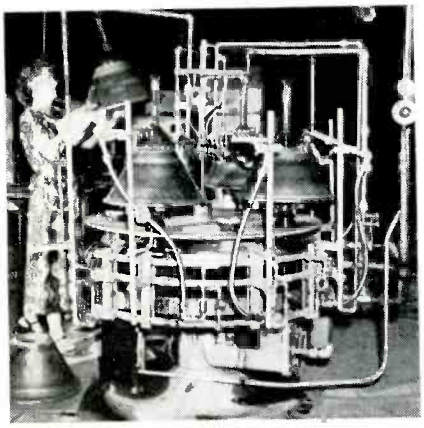
The relationship of light and electron optics is an especially important factor, particularly in considering what effects movement of the focus coil on the picture tube neck might have on spot size and the focus lens strength required. The law of lens magnification, one of the key rules of optics, must be carefully weighed in evaluating this problem. If an object is imaged at a very close distance from the lens relative to the object location, a greatly reduced image of the object will be obtained. Similarly, if the focus coil is moved further towards the tube face, a smaller spot size is attained at the screen, hence greater definition will result. This effect also indicates why tubes are capable of giving nearly the same resolution whether they are 3" in diameter or 19" in diameter. For example, a projection tube can produce full picture resolution in an area of say 3" x 4". An obvious question is why it is not possible to make picture-tube screens four times larger, hence get four times the picture resolution. However, if the deflection angle is to remain constant, the focus coil cannot be as close to the screen for the larger diameter tubes as for those of smaller diameter. Hence there is little gain in actual resolution by making a tube larger in diameter. Of course, there is a great advantage to the viewer, if he can inspect the picture on a large screen where he may sit at a comfortable viewing distance.

The light-optics analogy is also useful in predicting what focus lens strength is required. On most picture tubes, the magnetic focus lens is a magnifier; that is the image (the spot on the screen) is larger than the object. For any given tube type, moving the focus coil closer to the cathode means that we magnify the object greater and consequently increase the spot size at the screen. Also, since we have increased magnification, the strength of the lens has increased and more focus current will be required. (Magnetic focus coils must be located as close to the location recommended by the manufacturer. This point is generally immediately behind the deflecting yoke component.)

Deflection of the beam is accomplished by use of magnetic coils which form a magnetic field at right angles to the beam entering the yoke region. The interaction between the beam and the magnetic field is not unlike the effect which causes rotation in an electric motor. Since the beam is a flow of electrons, it behaves like a fine conductor, but with practically no mass or other mechanical resistance. In the deflecting yoke region, the beam is bent following a path which conforms very closely to the radius of a circle. In order that the deflected beam may leave

Figure 8

Funnel sealing of the 19AP4.



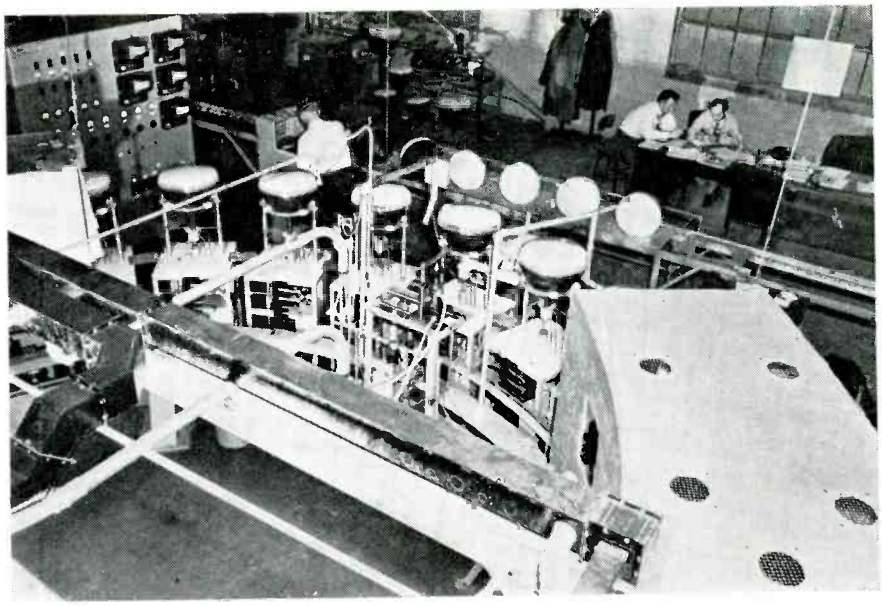


Figure 9

Picture-tube railroad exhaust system and baking ovens.

the neck region without intercepting the point where the neck and the bulb join, this radius must not be too large. This limits the length of the field used, and the deflecting component must be as close to the bulb body as possible. As the present trend towards increased deflection angle continues,[1] more and more yokes will appear utilizing means for getting around the neck corner without cutoff. One method used involves flaring the yoke ends so the coil may be moved further up on the bulb body than would be possible without such flaring. Another method is to shorten the yoke length, with consequent loss in yoke sensitivity.

The electron beam finally leaves the neck region as a focussed deflected and controlled writing pencil producing a light pattern in accordance with the electrical control signals applied. In the usual picture tube, the screen material on the inside of the face plate is a non-conductor. Like most substances, the screen material behaves as a secondary electron emitting surface, i.e., bombarding electrons of the incoming beam cause electrons to be emitted from the screen surface. These electrons are at a lower potential than those of the beam and thus will be attracted to the conductive inner bulb wall. In operation, secondary emission effects cause the screen to maintain a potential of from several hundred volts to one kilovolt below the actual anode-wall potential.

One of the requirements, in the manufacture of picture tubes, is that extremely high vacuums must be achieved to prevent excessive formation of ions, the heavy particles which do not behave like electrons in magnetic fields and which can cause screen damage. These ions are charged molecules, released from the cathode surface during operation, which are accelerated and aimed at the screen by the electron gun. The ions are approximately 2000 times heavier than electrons, and although they are accelerated to the same velocity in electrostatic fields, they are not changed in direction to any appreciable extent by the action of the magnetic fields which act on the electron beam. If a large number of ions are present, they are accelerated through the electron gun, out of the limiting aperture and eventually bombard the fluorescent screen at the center. This bombardment causes a deterioration of the ability of the screen to produce light. Hence, a darkened area, the ion spot, can result. If the picture tube runs at sufficiently high anode voltage, ion spotting is not a severe problem, since the electron beam can penetrate the screen material to a greater depth than the heavier and larger ion particles. For voltages below 10 kv, however, ion spotting can be serious.

Several methods of eliminating ion spots have been evolved: (*1*), a thin metal layer can be placed over the screen, permitting electrons to penetrate, but blocking ion penetration; (*2*), exhausting tubes to extremely low vacuums, hence reducing the concentration of ions; (*3*), utilizing the principle of ion-trapping in the electron gun. Methods (*1*) *and* (*2*) have been found to add considerably to the cost and consequently extensive use is now being made of the ion-trap electron gun. Two basic types are: (*1*), the slant-field ion trap structure requiring double field bending magnets for proper operation, and (*2*), the bent-gun structure which requires only a bending field; Figures 4 and 5.

In the slant-field type, the second grid electrode and the entrance edge of the final anode electrode are cut at an angle of about 11½°.

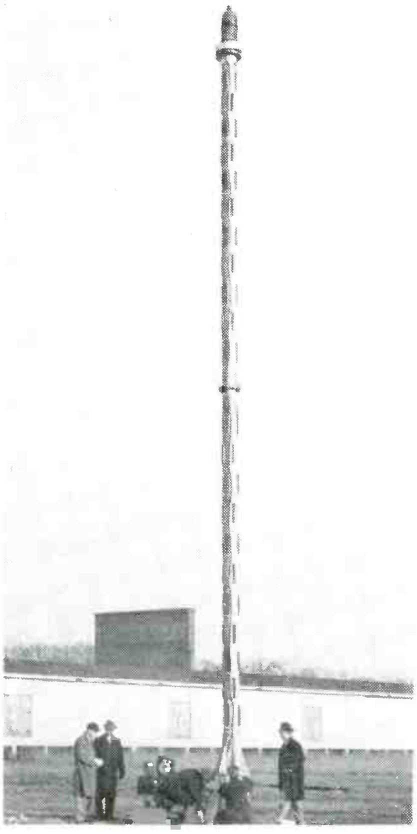
This produces a skewed electrical field which causes the electron beam and the ions coming from the cathode to deviate off the axis and aim at a point inside the anode barrel and limiting aperture electrode. By means of a magnetic field applied externally, the electron beam is bent in an opposite direction to that caused by the electrostatic forces, but the ions, since they are much heavier, are not deflected and are subsequently trapped and collected by the anode barrel structure. The resultant beam path crosses the gun axis at an angle. Hence, it cannot be returned to travel parallel and coincident to the tube and gun axis by the use of a single magnetic field. To correct this effect, a second magnetic field is used to make the electron beam return to a concentric location.

In the slant-field design, it has been found that an unsymmetrical electrostatic field is produced in the region between G_2 and anode. This effects the shape of the electron beam in such a way that the cross section may take the form of an elipse whose height is about 75% of the width. The effect of this distortion in the final writing spot is partly hidden by the deficiencies of our present television resolution standards. However, the elimination of this distortion is a desirable feature of any

(Continued on page 35)

[1]*TV Tube Developments*, TELEVISION ENGINEERING; February, 1950.

The Channel-24 (529-535 Mc)



The ultrahigh antenna, used at Bridgeport, during its development test stages.

WITH THE increasing demands for additional channels and the possibilities provided at the ultrahighs for such expansion, the 470 to 890-mc band has become a subject of intense study by many in the lab and in the field. In an effort to evaluate the situation in a metropolitan area, under typical operating conditions, tests have been conducted in New York City using transmitters operating at 67.25, 288, 510, and 910 mc, set up at WNBT, at the top of the Empire State Building. Extensive tests have also been conducted in the Washington, D. C., area with a transmitter operating at 505.25 mc installed at WNBW.

Shortly after these tests were completed, it was decided that an experimental ultrahigh transmitting station should be erected in a representative city at present not adequately served by a local *vhf* transmitter. It was felt that such a station should be a full scale custom built prototype of future commercial installations in the *uhf* band, so that the results obtained would be truly indicative of the practical possibilities of ultrahigh broadcasting in the type of community in which many of these stations would be operated.

It was felt that Bridgeport, Conn., represented a typical ultra high community, and plans were therefore set up to install a transmitter in that city. FCC granted permission to construct an ultrahigh system[1] which would operate in the 529 to 535 mc band, or channel 24.

Construction of the station, KC2XAK, was started on September 22, 1949, and transmissions began on December 29, 1949.

The system was set up to operate as a satellite of WNBT, with the visual and aural program signals picked up directly from New York, a distance of 55 miles. Thus, programs originating from WNBT on the present *vhf* band can be received, demodulated, processed, and retransmitted on the *uhf* band. Although provisions for local aural station identification have been included, none have been incorporated for local origination of test pattern or other video signal.

The transmitter[2], with power outputs of .5 kw and 1.0 kw (peak) for the aural and visual sections, respectively, was designed to operate in a standard 6-mc bandwidth, the visual carrier frequency being 530.25 and the aural carrier frequency, 534.75 mc.

The output of the visual section is fed through a coaxial vestigial sideband filter, and the visual and aural frequencies are then combined in a notch filter or diplexer and conducted to the antenna by means of a 3⅛″ coaxial transmission line. Employing a slot type antenna,[3] with a power gain of 17, and an antenna height, above average terrain, of 330′, a visual *erp* of approximately 11.5 kw has been provided.

To study receiving results, a number of television receivers and converters have been designed and manufactured,[4] and are now being installed in homes in and around the Bridgeport area. Field tests will include observations in homes throughout the service area in which *uhf* receivers have been installed, at distances and under conditions which will determine the extent of coverage of the station. Various types of receiving antenna will be tested, shadow areas and multipath problems investigated and extensive field intensity measurements will be made.

The Transmitter

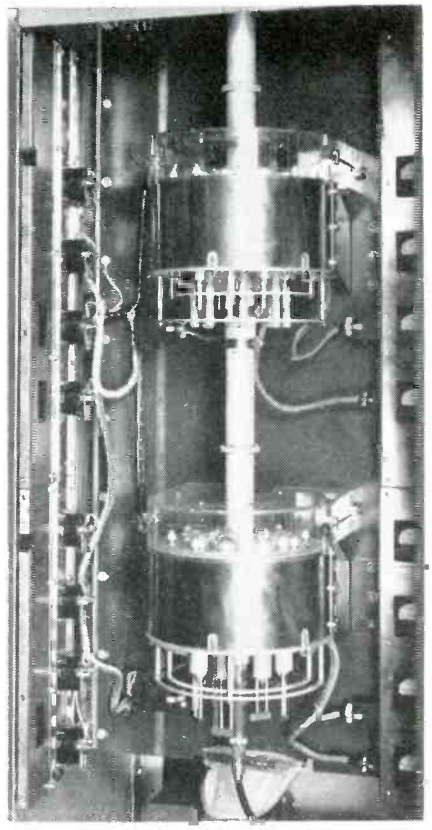
The transmitter,[5] housed in six racks each measuring approximately 25″ x 25″ x 84,″ employs a *vhf* transmitter which drives tripler stages consisting of eight 4X150A tetrodes operating in parallel in a single cavity. (The *vhf* portion of the unit provides *rf* power at 176.75 and 178.25 mc for the visual and aural channels, respectively.) This stage drives the grids of the final stage which also employs eight 4X150As in a single-cavity arrangement. The circuits are duplicated in the visual and aural channels. Modulation of the visual transmitter is accomplished by means of a cathode follower consisting of eight 6L6s connected in parallel. This stage drives the grids of the final stage. Separate excitation and bias adjustments are provided for the power amplifier tubes as well as separate meters and overload relays. Thus, the *pa* tubes can be adjusted to share the load equally. Modulation of the aural

**Based, in part, on papers presented by R. F. Guy and F. W. Smith of NBC, and T. M. Gluyas of RCA, before the 1950 IRE National Convention.*

[1]Transmitter, antenna, and auxiliaries were developed and manufactured by the RCA Victor Division. Station was designed and constructed by NBC which will also conduct the field surveys and propagation studies.
[2]RCA TTU-1A. [3]RCA TFU-20A. [4]RCA.

TV Station at Bridgeport, Conn.*

UHF Transmitter Capable of Delivering 1.4 Kw at Peak of Synchronizing Signal, Recently Installed to Provide Ultrahigh Transmitting and Receiving Allocation Statistics, Features Use of Eight-Tube Tripler System and Slot-Type Antenna With Gain of 17.



The tripler and pa stages; the tripler is in the lower cavity.

channel is accomplished in the conventional manner.

The 4X150A tubes, operated in parallel, are mounted in a cylindrical cavity and are symmetrically disposed about the axis. The plate and screen connections are made to the top and bottom walls of the cylinder. A coaxial transmission line is connected to the cavity at the center and serves to couple the resonate cavity to a useful load.

The amplifier load is varied by changing the impedance of a quarter wavelength section of transmission line. This is accomplished by rotating the outer conductor which changes the proximity of metal ribs within the coaxial section.

Design Problems and Experimental Techniques

Reduction of the circuit losses to reasonable proportions, was one of the major problems encountered during the design of the transmitter.

In developing a solution, the circuit Q of one of the cavities was measured with the normal load connected and with no load. From these measurements the circuit loss was deduced.

By successive measurements of unloaded Q, under varying conditions, it was possible to segregate the circuit losses contributed by vacuum tube seal losses, radiation losses, losses due to the addition of bypass capacitors, contact losses, and conductor losses. As a result of this arrangement, the circuit efficiency of the eight-tube ultrahigh amplifier was found to be 82%.

A directional coupler and a slotted line were used to measure grid-driving power, and a calorimeter load was employed to measure power output. A 4X150A at 530 mc developed 90% of the power calculated for low-frequency operation, but the *rf* grid voltage required slightly exceeded the calculated value.

In studying the neutralization problems, a small inductance was inserted common to the input and output circuits of the amplifier. This was achieved by adjusting the dimensions of the screen grid contacts. The added coupling neutralized the unavoidable coupling through the interelectrode capacitance of the tubes. The residual power coupled from the input circuit to the output was 0.1 watt.

To permit proper operation of television receivers employing the intercarrier sound principle, automatic control of the frequency difference between the aural and visual carriers has been provided at 4.5 mc at 450 cycles.

To achieve this control, a beat frequency is generated between the master oscillator of the aural transmitter and the crystal-controlled oscillator of the visual transmitter. This beat is compared to a crystal standard and an output is obtained which alters the frequency of the aural master oscillator until the beat frequency is identical to the crystal standard.

The Antenna

The antenna consists of a 10″ diameter conductor in which twenty-two groups of slots have been cut. These slots are one-half wavelength long and are separated vertically by an electrical length of one-half wavelength. The overall length of the antenna is approximately 40′. The slots are energized from a coaxial feed arranged to provide a balance in both power and phase between the upper and lower halves of the array. By this means, the horizontal pattern obtained is circular to within the accuracy of present measuring techniques. The vertical pattern has a beam width of approximately 2° between the half-power points.

[5]Styling similar to RCA TT-500-B 500-watt *vhf* transmitter, which is a basic part of the *uhf* system.

The Transmission Line

The transmission line to the antenna is standard 3⅛″ diameter coaxial line, with a measured attenuation of 0.222 db per 100′. The approximate line length is 250′. A waveguide is being investigated which may be used to replace part of the transmission line, and thus reduce transmission line loss.

Diplexing Unit

The diplexing unit consists of sharply resonant circuits arranged to provide high attenuation between the two transmitters and the antenna at the carrier frequency of the other transmitter. The unit is constructed from elements employing coaxial lines as resonant circuits.

An image orthicon, type 5655.
(Courtesy RCA)

TV CAMERA

Part III: Features of the Image Orthicon . . . How Manufacturer's Problems Encountered in Original Pickup-Tube Models Were Solved . . . Shock Effect Characteristics . . . The Image Isocon.

by ALLAN LYTEL, Temple University Technical Institute

CONTINUING OUR SURVEY of the improved types of camera tubes, we come to the *orthicon*, which is also a modification of the basic *iconoscope*. In this tube a combination of electrostatic and electromagnetic deflection is used to produce a scanning beam for the target. Light falls upon this target through the face of the tube from the lens system. The signal plate which faces the camera lens is a thin transparent section of metal, and an insulating layer lies between the signal plate and the photosensitive mosaic.

An image is formed by the lens system on the signal plate and since this element is transparent, the light image causes photoelectric emission from the light-sensitive mosaic. However, in this tube, a low velocity electron beam is used which produces a fundamental departure in the tube's operation. The electron beam from the gun scans the mosaic and returns to a collector anode where the electron beam itself becomes the signal current. Light on the mosaic causes an emission of electrons, and the scanning beam since it has a low velocity, actually is the signal. When the scanning beam approaches a picture element which does not receive any light, the electrons from the beam do not touch the mosaic, but they are slowed down and stopped, after which they are returned back away from the target and to the collector. Thus, the scanning beam approaches the unlighted picture element of the target but does not come in contact with it. In this manner the returning electron beam is unchanged. If the scanning beam approaches a picture element which has emitted electrons, that is, a portion of the mosaic which had light falling upon it, a sufficient number of electrons from the beam will actually land on the mosaic to replace electrons previously emitted. The electron beam returning to the collector anode from such a previously lighted area will have fewer electrons. In this manner the electron beam is modulated by the signal upon the mosaic.

Vertical deflection is produced by electromagnetic coils and horizontal deflection is obtained with a set of electrostatic deflection plates in conjunction with the axial magnetic field. The actual path of the electron beam is rather complex, being produced by both the electric and magnetic fields. It is important to note that the electron beam impinges upon the mosaic in a normal or perpendicular direction. Because of this perpendicular approach, there is no problem of keystoning and the precise area covered by the scanning beam may be exactly defined. The scanning electron beam actually has a helical motion, but in effect, the combination of methods of deflection sweeps the electron beam across the target mosaic and produces the standard scanning pattern without keystoning restrictions.

Spurious light spot signals are eliminated in the *orthicon* tube. A high degree of sensitivity and a much larger signal output are thus obtained than with the conventional iconoscope. Further modifications have made the *orthicon* the basic camera tube of today.

The Image Orthicon

The addition of electron multiplication by an electron image is used with the *orthicon* to produce an *image orthicon* type of camera tube.

The first or image section has a semitransparent photo-cathode and an accelerating grid. There is, in addition, a target consisting of a thin glass disk together with a fine mesh screen mounted very close to it on the photocathode side. Magnetic focusing is used by means of an external coil. Light is brought to focus by the external lens system on the photo cathode. Electrons

Tube Design

are emitted in direct relation to the intensity of light on any given area. This produces an electron image which is focused on the target by means of magnetic fields.

This electron image produces secondary emissions from the glass target surface. This glass target has a low front-to-back resistance but a high side-to-side resistance preventing the exchange of potential between any two elemental areas. The secondary electrons are then collected by the screen mesh which has a positive potential. Emission of the secondary electrons produces a potential on the photocathode side of the target. By means of front-to-back conduction these points of potential difference are transferred through the glass target.

In the developmental stage this tube involved new techniques of manufacture to produce the screen mesh and glass target. Various types of insulating targets were used having conducting plugs to carry the difference of potential from the front to the back of the target and allowing the elemental areas to be insulated from each other. As the tube is now produced a specially constructed glass target is used. This effectively performs the function of conducting plugs by allowing conduction from front to back, while preventing rapid conduction from side to side on the face of the target. The charges thus accumulated on the face of the glass are allowed to be neutralized at approximately 1/30 of a second. The mesh of the screen associated with the target also presented a considerable problem in manufacturing technique. Extremely small holes in the screen were required so that they would not interfere with the image production. A coarse mesh screen would produce lines or distortion by means of diffraction, thus interferring with the image. In its present manufactured state, this screen has between 500 and 1,000 meshes per square inch. With holes of such small size, there is no interference of the screen and image production is not affected in any adverse way.

Upon the face of the glass target nearest the scanning beam, a series of points of different potential, corresponding to the variations of light intensity on the original televised image, are produced by front-to-back conduction. The scanning beam functions in a manner similar to that of the basic *orthicon*. (Areas of positive potential, caused by secondary emission, attract electrons from the low velocity beam. Areas of negative potential, which result from no incident light, repel the scanning electron beam and cause it to return to the collector unmodulated.)

The intermediate section in this tube or the scanning section contains an electron gun with a cathode, control grid, and accelerating grid No. *2*. The scanning beam is brought to focus upon the target by means of an external focusing coil and the electrostatic field of grid No. *4*. Grid No. *5* or the decelerator produces an electrostatic field between grid No. *4* and the target to provide an overall uniform landing of electrons on the target area.

In this manner the scanning electrons cease their forward motion when they approach the surface of the glass and are turned back. There is a five-stage signal multiplier using the principle of secondary emission to increase the signal output many fold. Electrons travel from one dynode to the next of this five-stage electrostatically-focused multiplier. Electrons bounce from dynode to dynode, going from a lower to a higher potential, and constantly increase their number. Grid No. *3* is also used to assist this multiplying action. The output from dynode No. *5* is collected by the anode and used for the signal output. An amplification of the modulated electron beam of about 500 times is obtained in the multiplier section, which also increases the signal-to-noise ratio and permits operation of the camera with fewer amplifier tubes.

It should be remembered that as the beam goes from a less positive portion of the camera to a more positive portion, the output signal across the load resistor changes in a positive direction. In this manner, highlights in the original scene produce an output voltage of positive polarity which is applied to the amplifier tubes.

Several different versions of the *image orthicon* are currently being produced: one type[2] is designed for studio use and all other applications which require artificial illumination; another[3] may be used for both outdoor and studio pickup work, and a third[4] is recommended for outdoor pickup use. This tube provides operation over a wide range of illumination varying from bright sunlight (several thousand foot-candles) to the slight illumination of deep shadows (less than 1 foot-candle).

Shock Effect Problems

The *image orthicon* has a definite amount of noise sometimes called shock effect, because of fluctuations of current flow which may be found in any amplifier or camera tube. The following formula is useful in providing an approximate relation for this signal-to-noise ratio.

$$R = \frac{I}{I^{1/2} \times 10^{-6}}$$

$$R = I^{1/2} \times 10^{6}$$

Where: I = Current in amperes of scanning beam.
R = Signal-to-noise ratio.

This gain, of course, represents an optimum value which is never fully realized in operation of the tube in a commercial type camera. The useful gain for the *image orthicon* is between 20 and 200, depending upon the amount of light present in the picture. The overall gain of the multiplier and electron-image section is approximately 100 to 1,000 which is the factor by which this tube is more sensitive than the iconoscope.

The Image Isocon

There are inherent limitations in the function and output of the *image orthicon* camera tube. Shot noise occuring in the current of the returning scanning beam is added to the noise already present in the signal variations on the target. Since the *image orthicon* presents a maximum output signal for the darkest portions of the picture, the greatest amount of noise occurs in these same dark sections. The low percentage of modulation of this camera tube (somewhere between 20 and 30) is also a limiting factor in its use. These difficulties appear to have been overcome in a modification of the *image orthicon*, the *image isocon*.[5] Its operation depends upon the low velocity scanning beam falling upon the target and producing *scattered* electrons by

[1]Similar to the Farnsworth dissector tube.

[2]RCA 5655. [3]RCA 5769. [4]RCA 2P23. [5]RCA; RCA Review, p. 366; Sept. 1949.

Camera Tube Design

(Continued from page 25)

secondary emission. These electrons are greatest in the light portions of the original picture and if they can be utilized as the output signal, an inherent noise reduction will result. At the same time, a greater percentage of modulation will be obtained, which further reduces the noise present in the output of the tube.

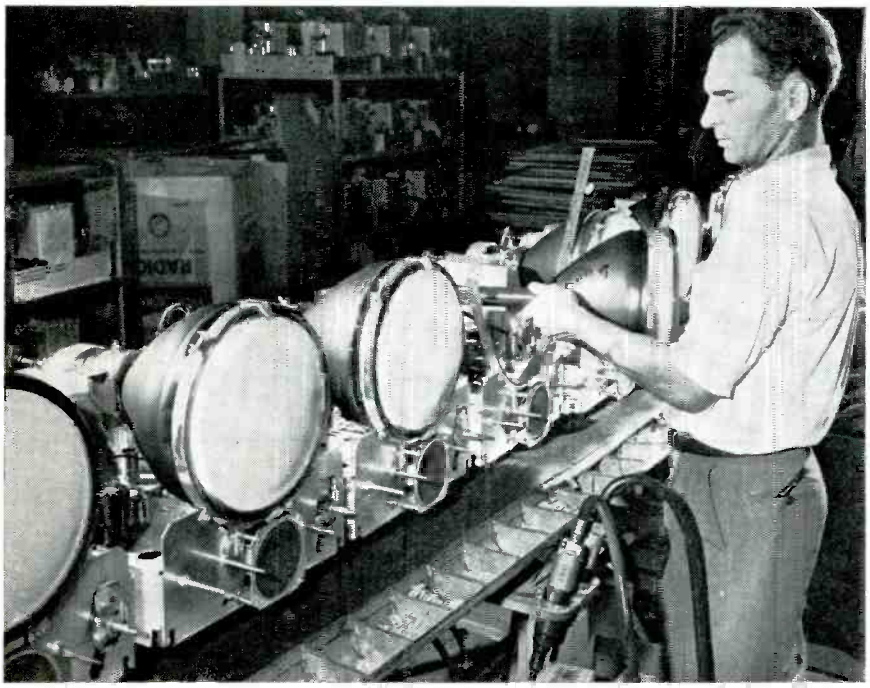
An electron beam which impinges on a conducting or non-conducting surface causes secondary emission whose ratio may be increased with the velocity of the electron stream. The electrons which are used for signal output in the *isocon* are those scattered electrons which are reflected at any angle, other than 90°, by the primary electron stream striking the target. These reflected electrons are maximum during the light portions of the picture and almost zero in the dark portions. By using only these reflected electrons as the signal which enters the multiplier section, the image *isocon* can function with a greatly reduced noise level.

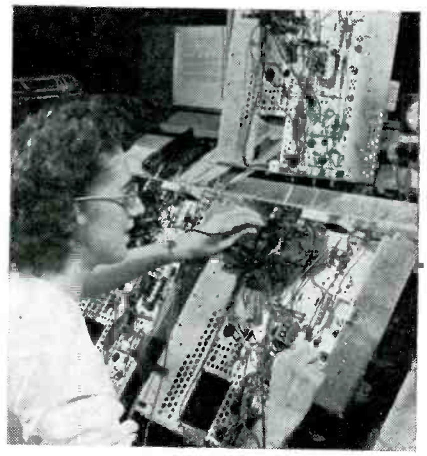
The original *image orthicon* produces a decrease in signal output during the light spots of the original picture. The *isocon* reverses the action and produces a maximum output during the light spots of the original picture. The principal problem is how to utilize these scattered electrons and not the original returning scanning beam.

This tube is still in the experimental stage and several methods have been developed to remove the scattered electron signal from the returning beam. The actual configuration of the electron stream as it goes from the gun to the target and returns is, of course, in the form of a helix, having several nodal points between the target and the electron gun. The electron stream, of course, focuses to a sharp point upon the target. It is found that scattered electrons may be removed by an aperture at the electron gun. However, this method is inefficient unless further modifications are used. It is possible by means of additional electrodes within the tube, to increase the helical motion of the electron stream on its way to the target which will increase the separation between the scattered electrons and the returning beam. These scattered electrons are then allowed to enter the multiplier section where they are used as the signal output. The original returning beam is intercepted by the edge of the multiplier aperture and hence this is not used.

There are several modified forms of this tube which have been developed. In one of the most promising types appears additional electrodes to increase the helical motion of the electron stream. It has been found that this tube provides less noise in the output especially in the dark portions of the picture. The ordinary *image orthicon*, on occasion, has been found to be unstable and develop noise spots after a short period of use. Where an *image orthicon* is used on first a bright picture and then a dark picture, its full range of sensitivity cannot be realized unless the beam current has been reduced. If this is not done a bright spot or comet will be noticed in the picture output. This is one point where the *image isocon* is definitely superior. There are, of course, limitations to any technical advance, and this new tube requires greater care in initial adjustment and operation. At the same time, slight misadjustments of the *image isocon* are much more noticeable than slight misadjustment of the *image orthicon*. It is difficult to evaluate or compare an experimental tube until all of the facts, including the results of long actual field operation, are evaluated. However, the *image isocon* does appear as a definite step forward in the long series of progressively better camera tubes.

On a TV Receiver Plant Line



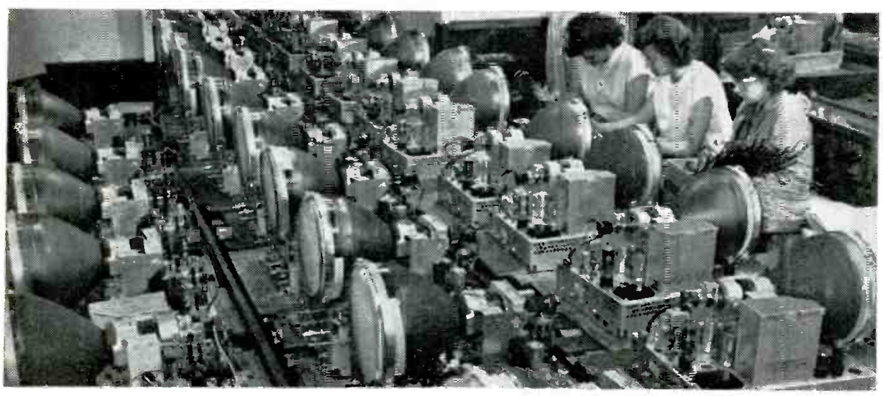


(Above)

Checking of chassis wiring, one of nineteen inspections and tests made, before picture tube is installed.

(Above)
Installing picture tubes.

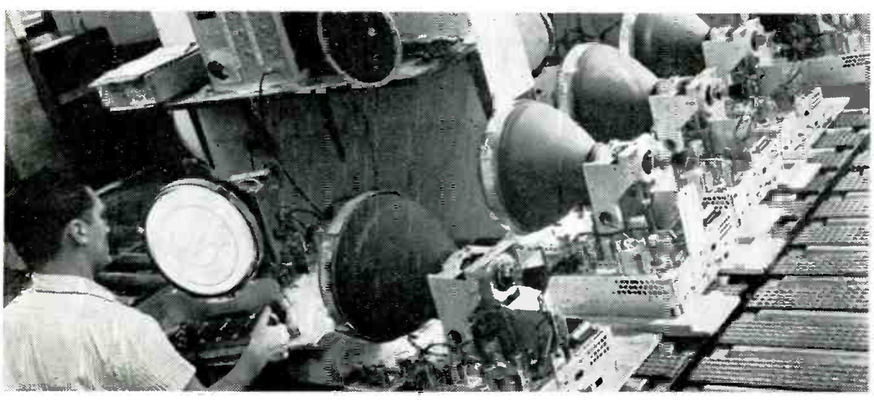
(Below)
Production-line checking of receivers.



(Receiver-production photos, illustrated on this page, were taken at the Sunbury plant of Westinghouse Electric Corp.)

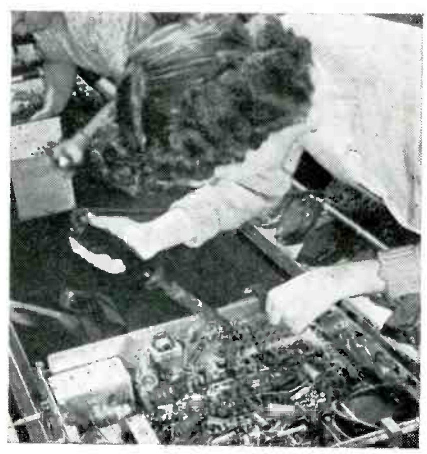
(Below)

Checking and adjusting TV receivers, a step which consumes approximately 1½ hours.



(Below)

Soldering-operation step, one of the 1,450-odd steps involved in producing a chassis.



Production Aids

Silver Printed Circuit Solder Alloys

TWO ALLOYS for use with all types of silver printed or plated conducting mediums, have been developed.

Solders are of two melting ranges: one type for the majority of applications where abnormally high temperatures are not encountered in service, and where the assemblies operate at temperatures above 350° F. Their special analysis is said to eliminate the danger of dissolving the silver conductors. They work equally well on ceramic, plastic, bakelite, and other base materials which have been coated with silver either by painting, spraying, dusting and firing or by plating.

Solders are produced in bar, solid wire, and rosin core shapes.—*Divco types 233 and 276; Dept. JT-9, Division Lead Co., 836 W. Kinzie St., Chicago 22, Ill.*

Pre-Built Screen Rooms

PREBUILT screen rooms have been developed for laboratory and production line use.

Screen rooms are available in *cell units.* Built to provide a minimum of 100 db attenuation from 0.15 to 1.000 mc. Of sectional, double-mesh construction, the units are said to require no soldering between sections.—*Ace Engineering and Machine Co., Inc., 3644 N. Lawrence St., Philadelphia 40, Penna.*

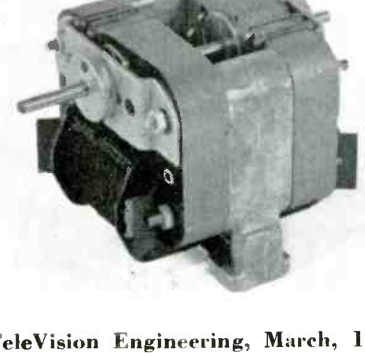
Tandem Motor

FOR WIRE RECORDERS, measuring instruments, remote tuning transmitters, and other applications requiring a reversible motor, a tandem reversible unit has been produced.

Said to have a high torque and good speed-torque characteristics. Maximum output is 0.004 *hp.* Features shaded-pole design with no brushes, which is said to eliminate radio noise. Centerless ground stainless steel shaft supported in wick type bearings. Has a molded plastic spool which will not absorb moisture and short the field coil.

Available with several shaft diameters and various extensions. Similar motors with 0.006 *hp* output are also available.—*Model Dyab, Barber-Colman Co., Rockford, Ill.*

Barker-Colman tandem reversible motor



Conduction-Type Soldering Unit

A SOLDERING UNIT, operating on the conduction principle, is now available for all types of soldering operations, including silver soldering and brazing.

Has a 24 heat selector.

With capacity said to be equal to a 450-watt electric iron, soldering is done with a handpiece weighing 5 ounces.

Upon immediate contact with work the tip of a copper jacketed carbon *pencil* on the unit glows red and flux-core solder flows when touched to the pieces being joined. When removed from the work carbon immediately cools. Power is used only when contact is maintained. Tips may be ground to varied shapes. No dressing or tinning is said to be required.

Complete unit weighs about 25 pounds and is 7"x7"x7", approximately.—*Glo-Melt; Wasserlein Mfg. Co., Inc., 7400 3rd Avenue, N., St. Petersburg 6, Florida.*

Lubricating Additive

A FRICTION-PROOF lubricating additive that is said to prolong the life and increase the efficiency of diesel, gasoline and electric motors and engines as well as pistons, gears, bearings, cutting tools, etc., has been developed.

Tests are said to indicate that oils strengthened with the lubricant can withstand pressures that would ordinarily break down an untreated lubricant and *freeze* all moving parts.—*Power-Ball Friction-Proof Oil; Power-Ball Oil Co., Inc., 911 Huger St., Columbia, S. C.*

Radial Miniature Ball Bearings

RADIAL MINIATURE BALL bearings with sizes starting at .0295" (.75 mm) bore and .1181" (3 mm) *od* are now available.

Bearings are furnished with ball retainers. They have no filling slots and hence are suitable for both radial and thrust loads.—*RO Series; Landis & Gyr, Inc., 104 Fifth Ave., New York City.*

Solderless Type Terminal Blocks

SOLDERLESS TYPE molded terminal blocks provided with compression type solderless units, each capable of receiving wires from No. 16 to 6 *awg*, are now available. Typical combinations which may be accommodated by a single terminal are two No. 10, two No. 12 or two No. 14; one No. 12 with one No. 10, one No. 12 with one No. 14, etc. Attachment of wires to block is accomplished by tightening screws after insertion of stripped wires.

Blocks are rated at 35 amperes (600 volts), and are available in 4, 8 and 12 circuit sizes. Screw-on covers are available.—*Type Bepco; Buchanan Electrical Products Corp., 1290 Central Ave., Hillside, N. J.*

Plastic Mounting and Insulating Ring

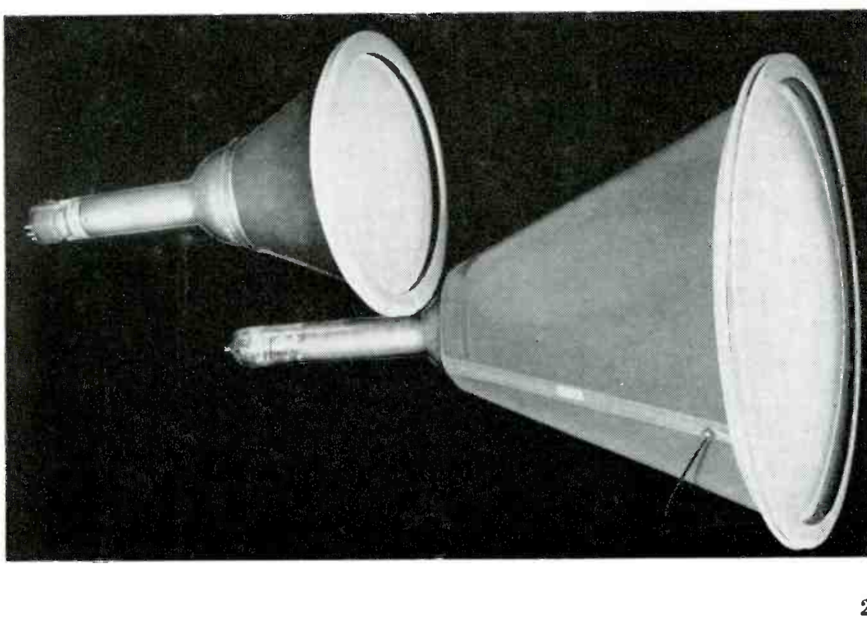
A POLYETHYLENE MOUNTING RING* has been designed to fit over the front rim of the metal tubes. This ring is said to contain various features: Due to the lap joint where the ring meets a fully formed insulating circle is created so that there is no leakage of electricity through the joint. Ribs on the surface of the ring provide for a full 2" creepage path, thus eliminating corona formation.

A *sleeve** of conical shape fits over the back portion of the tube; it is held in place by the ring which clamps the sleeve in position. By this means the entire metal part of the tube is completely insulated. On the sleeve a second anode contact is provided, together with a press-on lug, so that the lead wire can be easily attached. The ring serves to insulate the metal portion, and acts as the mounting base on which the tube rests. A rubber band is provided to act as an additional shock absorber.

Rings and sleeves are being manufactured for the 8½", 12½", 16", and 19" metal tubes.—*Anchor Plastics Co., 533-541 Canal St., N. Y. 13, N. Y.*

Anchor Plastics picture-tube mounting ring and sleeve assembly

* Pats. Pend.



Instrument News

RF Waveform Monitor

AN RF WAVEFORM monitor has been designed for use in TV broadcast installations to monitor the unrectified radio-frequency signal at the *rf* transmission line. The *crt* displays the *rf* carrier voltage on a linear time base at either field- or line-frequency. Further provision is made for measuring the relative amplitude of the various portions of the *rf* envelope within the accuracy limits prescribed by the FCC Standards of Good Engineering Practice. By adjusting the meter reading to full scale when a sync peak is positioned to reference line, the meter is calibrated to read any modulation level directly as *percentage of peak signal.*

Less than 10 watts of peak *rf* power are said to be required to produce a peak-to-peak deflection. Other features are: A gas-triode linear sweep circuit and band-pass circuits factory-adjusted to any one of the 12 commercial TV channels. The *on-screen* portion of the sweep is said to be expandable to approximately three times full-scale deflection without noticeable overload. Accuracy of any amplitude measurement with respect to the peak signal value is said to be within ±2% for peak-to-peak deflections of over 3" in the cathode-ray tube.

Designed for standard RMA rack mounting, the monitor measures 10½" h, 19" w, 20" d. Weighs 60 pounds.—*Type 5034; Television Transmitter Division, Allen B. DuMont Labs., Inc., 1000 Main Ave., Clifton, N. J.*

DuMont rf waveform monitor

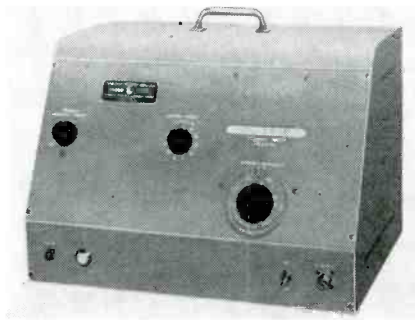
Coil Checker

A COIL CHECKER which combines a vacuum-tube voltmeter, calibrated variable capacitor and amplifier tube into a single instrument, has been designed. When coupled with any *rf* oscillator, the instrument is said to measure inductance, distributed capacity and the *Q* of any inductor, as well as the capacity of micas. (Described in bulletin 18-B.) —*Type 301A; Clough Brengle Company, 6014 Broadway, Chicago 40, Ill.*

Clough Brengle coil checker

UHF Sweep Frequency Oscillator

AN INSTRUMENT which generates frequency modulated *rf* signals throughout the 470 to 890 range with a maximum power output of at least two volts, has been developed for alignment and test of receivers and tuners operating within the ultrahigh band.—*Model 901; Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.*

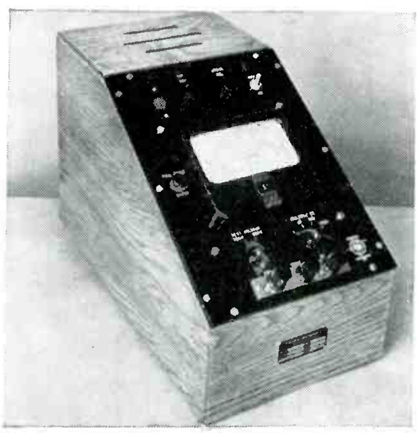


PRDC uhf sweep oscillator

Megohm Meter

TWO MEGOHM METERS featuring an internal circuit which is said to assure the user that the applied voltage is the specified voltage as long as the resistance of the piece under test is within the range of the meter, have been developed. In this manner tests may be conducted with a known voltage.

One model contains an internal 500-volt measuring source, as well as a 200-volt volt source, and the other has a continuously variable measuring source ranging from 100 to 600 volts *dc.* A voltmeter is provided for checking actual voltage being applied to test. With this model it is possible to test a piece for actual resistance changes as the voltage varies.—*Types L-4A and L-6A; Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.*



Industrial Instruments megohm meter

TV VTVM

A VOLT-OHM-CAPACITY MILLIAMMETER which employs a 9" meter scale is now available.

Measures resistance as low as 1/10 ohm and capacitance of 1 mmfd. Permits peak-to-peak voltage measurements and contains zero-center *dc* scale. Has an *ac* range of 1,200 volts. Said to feature flat frequency response to 300 mc.—*Model 209-A; The Hickok Electrical Instrument Co., 10529 Dupont Ave., Cleveland 8, Ohio.*

Frequency Deviation Monitor

A FREQUENCY-DEVIATION MONITOR has been produced to measure the relative strength of signals being transmitted, magnitude of frequency modulation, and the error displacement of the signal from its assigned center frequency.

Unit monitors up to five carrier frequencies in either the 25-50 mc or the 152-174 mc band. Additional frequencies may be monitored by the exchange of control crystals. These crystals, being temperature compensated, are said to introduce a negligible error of less than .00005%.

An integral part of the monitor is an AM receiver pre-tuned to WWV, by which the monitor may be accurately checked and calibrated. A built-in test circuit is said to allow exact gain setting of the monitor audio stages, insuring accurate overall calibration of the unit at all times.—*Motorola, Inc., 4545 Augusta Boulevard, Chicago 51, Ill.*

Motorola frequency deviation monitor

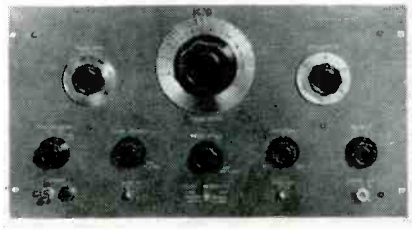
General Purpose Pulse Generator

A GENERAL-PURPOSE PULSE generator for testing *fast* circuits, as well as making everyday checks of other generators, *rf* circuits, peak-measuring equipment, etc., has been announced.

Instrument is said to have a pulse rise and decay time of .02 microsecond, 50-watt pulse, and a continuously variable pulse length, .07 to 10 microseconds. A low internal impedance of 50 ohms or less is said to insure a pulse shape virtually independent of load; low impedance also makes it possible to deliver accurate pulses at some distance from the instrument, if transmission lines are properly terminated.

The instrument has a repetition rate (frequency) continuously variable from 50 to 5,000 pulses per second, and pulse rate can be controlled internally, or from an external synchronizing source. Continuously variable synchronization pulses are available either in advance or following the main pulse. An amplifier-attenuator system is provided with low source impedance making possible either positive or negative pulses with continuously variable amplitude.—*Model 212-A; Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.*

H-P pulse generator



TV Parts and Accessory Review

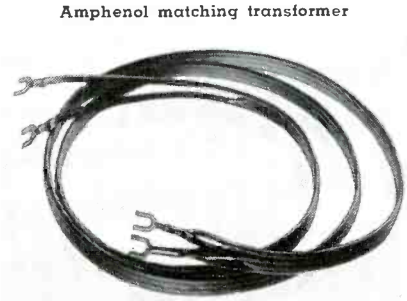
Polarized Relay

POLARIZED RELAYS, capable of repeating, with high accuracy, feeble signal impulses of varying time duration, and of maintaining this ability for long periods without attention, are now available.—*Carpenter Relays, made by the Telephone Manufacturing, Ltd., London, England, and distributed by C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Ill.*

Matching Transformer

A MATCHING TRANSFORMER, employing four-conductor twin lead specially connected to provide a transformation in impedance from 300 ohms down to 75 ohms, is now available. It is particularly useful in matching 300-ohm transmission line to 72- or 75-ohm input receivers or providing an efficient match between any 300-ohm antenna and a coaxial 75-ohm line such as might be used in an area of high noise level.—*American Phenolic Corp., Chicago 50, Ill.*

Amphenol matching transformer



Sealed Tubular Capacitors

A LINE of 600 *v dcw* tubulars, in capacities from .001 to .1, has been announced.

Capacitors feature an outer tube plastic impregnated, ends plastic sealed, light outer coat of high-tem wax, and leads anchored in solid plastic end.

Designed for 85° C operation.—*Type 85TOC Humidi-Seal; Pyramid Electric Company, 155 Oxford St., Paterson, N. J.*

Pyramid capacitor

Ceramic Capacitors

A LINE OF MINIATURE ceramic disc capacitors has been designed for bypass and coupling in TV and FM assemblies.

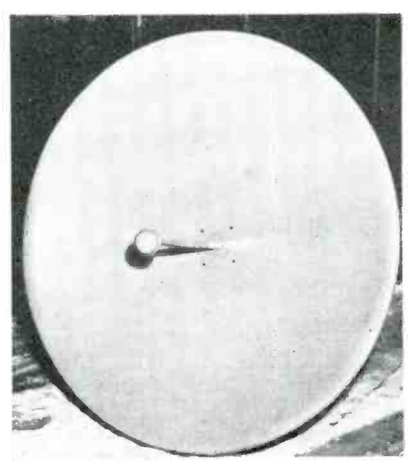
Capacitor is 19/32" in diameter and 5/32" thick. It now is being made in: (*1*) 500 *v dcw* at capacities of 50 to 500 mmfd at ±20 per cent; and (2) in 500 to 5,000 mmfd, guaranteed minimum capacity, within a temperature range of +10° C and +65° C. — *Cornell-Dubilier Electric Corp., South Plainfield, New Jersey.*

Parabolic Antennas

FIVE PARABOLIC ANTENNAS to cover the 5929-7125 mc band are now available.

Each parabola is available in two, four, six, and eight-foot diameters, and mounts are available for all types of installations. The antennas are said to have gains up to 44.9 db, and can be supplied with de-icing equipment and junction boxes.—*The Workshop Associates, Inc., 66 Needham Street, Newton Highlands, Mass.*

Workshop parabolic antenna



TV Tube News

Sylvania TV Tubes

AN 8½" ALL-GLASS, direct-view picture tube with electrostatic focus and deflection has been designed for 7"-type receivers.

The tube, type 8BP4, is interchangeable with the 7JP4.

Operating voltages include: 6,000 on No. *1* anode; 1,620 to 2,400 on No. *1* anode; and 0 to —72 to —168 volts on No. *1* grid.

A sixteen-inch, 22¼"-long, all-glass, direct-view tube, with an external conductive coating which acts as a filter capacitance when grounded, is now available.

The tube, type 16LP4, is supplied with neutral or clear face plates and employs an ion trap gun for use with external magnet. Deflection angle is approximately 52°, with magnetic focusing and deflection.

A sixteen-inch metal viewing tube, 16GP4, which is said to be five inches shorter than the 16AP4 also has been announced.

The tube is also said to be ¼" shorter than the standard 10" types. Deflection angle is 70°. Supplied with a neutral gray face plate.

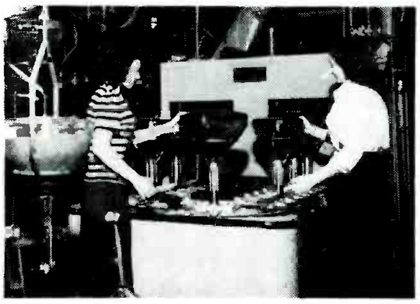
A miniature high-voltage half-wave rectifier, 1V2, has been designed for receiver pulse-rectifying systems and voltage doubler circuits for magnetically deflected 10" and 12" viewing tubes. Tube has a peak inverse-plate voltage of 7,500, peak plate current of 10 milliamperes, and an average plate current of .5 milliampere.

Now available also is a double-ended miniature high voltage-rectifier, type 1X2, designed for use with *rf*, fly-back, and 60-cycle types of power supply.

A high-perveance beam power amplifier, 6AU5GT, has been designed for use as a horizontal deflection amplifier in high-efficiency deflection circuits for receivers.

One 6AU5GT, in a suitable circuit, will fully deflect 10BP4, 12LP4, or other picture tubes having electron beam deflection up to 60° and operating with an anode voltage up to 12 kv. The tube has a 6.3 volt, 1.25 ampere heater. Under typical operating conditions, it will have transconductance of approximately 6,000 micromhos; mu of approximately 5.9. The maximum plate dissipation is 8 watts; peak positive pulse plate voltage is 4,500 volts; and maximum *dc* plate voltage is 450 volts.—*Radio Tube Division, Sylvania Electric Products, Inc., 500 Fifth Ave., N. Y. 18.*

AUTOMATIC TV TUBE WASHER

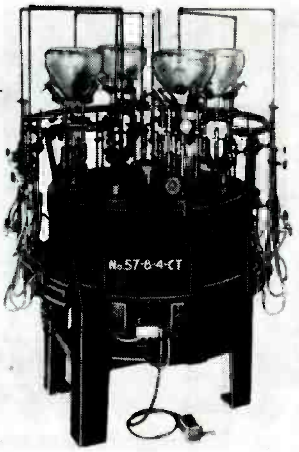


An automatic washing machine, in the Irvington, N. J., plant of Sheldon Electric Co., which washes the inside of the glass blanks with chemicals and then circulates several water rinses. (It uses so much water that under present water-shortage conditions, its operation might be hampered were it not for the unlimited supply of well water discovered recently in the Sheldon plant.)

Eisler Picture-Tube Sealing Unit

A FOUR-HEAD GENEVA gear-drive sealing-in machine adaptable for sealing the electron gun to the bulb of picture tubes is now available. Machines can handle up to 24" diameter tubes, with production in the range of 90 tubes per hour.

Machine is powered by two motors for adjusting independently the index head and the head drive. The motors are ½ and ¼ *hp* respectively, 1,720 *rpm*, with variable speed pulley. The machine is automatically operated by a reset timer which stops the turret from rotation for a predetermined time which ranges from 0 to 60 seconds. The indexing time can be manually controlled by a foot switch.—*Model 57-8-4-CTL; Eisler Engineering Co., Inc., 750 S. 13 St., Newark 3, N. J.*



Eisler sealing-in machine

G. E. TV Tubes

TWO SCANNING TUBES (6AV5GT and 25AV5GT) have been developed for magnetically deflected television sets.

Tubes, of beam-power amplifier design, can withstand high surge plate voltages for short periods of time. They are intended particularly for operation as horizontal deflection amplifiers in receivers employing either direct or transformer-coupled drive. Can operate from a power supply of 125 volts.

Three TV receiving tubes (6AS5, 6BQ6GT and 25BQ6GT) are now also available.

The 6AS5 is a beam-power amplifier of miniature construction, intended for use as the audio power-output tube. It is similar to the 35C5.

The 6BQ6GT and 25BQ6GT are beam-power amplifiers, designed to withstand high-surge plate voltages for short periods of time and are intended for use as horizontal-deflection amplifiers in receivers.

A new miniature receiving tube, type 6CB6, for use as a wideband amplifier in the *if* or *rf* stages of TV and FM receivers, has been announced.

The tube is a sharp cut-off pentode of miniature construction and is designed for use in applications where very high transconductance and low capacitance values are required.

Characteristics of the tube include a transconductance of 6,200 micromhos and a plate current of 9.5 milliamperes under typical operating conditions.—*Tube Divisions, General Electric Company, Schenectady, N. Y.*

TV Sound Activities

Microphone Floor Stand

A 3½-POUND microphone floor stand which can be disassembled into 7 pieces to fit into a speaker or amplifier case is now available.

Can be adjusted from 2' to 6'. Slipping of the telescopic sections is said to be prevented by the use of duraluminum C type washers under positive-locking knurled collars.—*Model MFS; Special Products Co., Silver Spring, Maryland.*

Magnetic Tape Recorder

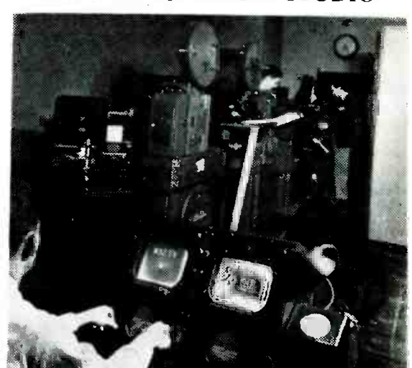
A MAGNETIC TAPE RECORDER featuring instantaneous monitoring from the tape while recording and separate heads for high frequency erase has been developed. Unit also has a forward and reverse high speed rewind, three dynamically balanced motors, record level indicator, instantaneous choice of 7.5" or 15" per second tape speed, independent azimuth adjustment for each head. Can play either standard 7" or NAB 10½" reels.—*Basic Recorder No. 401; Berlant Associates, 9215 Venice Boulevard, Los Angeles 34, Calif.*

Microgroove-Standard Record Pickup Arm

A PICKUP ARM, which has a low-as-possible vertical-to-lateral moment of inertia, is now available. Other features include: minimized vertical mass in order to track any record without imposing extra vertical load on grooves; absence of spurious arm resonance at any frequency; lower than 3-gram centimeter pivot friction; static balancing about the vertical axis to eliminate tendency to jump grooves when subjected to bumping or jarring; an offset head to reduce tracking error to less than ±2½°; protection of stylus point against contact with anything but the record grooves.

In addition, arm includes adjustments for sensitive tracking force, height adjustment for turntables from ½" to 2" high, one-hole mounting and self-contained leveling screws, plug-in cartridge holder, magnetic arm rest and a visible stylus point for starting and cueing records.—*Model 190; Pickering & Company, Oceanside, N. Y.*

FILM PROJECTION STUDIO



Film projection studio at WBZ-TV which will be visited on April 15 by those engineers attending the New England IRE meeting in Boston: In foreground are two film camera controls, beyond which are two 35-mm projectors. At left is a Balloptican projector for slides, next to one of the strip-film projectors. At the rear are twin 16-mm projectors.

Industry Literature

Thomas Associates, 4607 Alger St., Los Angeles 39, Calif., have released a 32-page 1950 catalog covering cushioning materials: TA-70 conductive, TA-73-1 Skydrol resistant, TA-74 high temperature resistant, TA-75 fire resistant and an aromatic fuel resistant cushioning. In addition, fifteen clips, clamps and brackets are described.

Catalog gives detailed prints with material finishes, specifications and ranges of sizes offered in aluminum, steel and stainless steel. Installation sketches are included, showing suggested applications and special features.

Clapp & Poliak, Inc., 341 Madison Ave., N. Y. 17, have published a two-volume text, *Techniques of Plant Maintenance—1950*, covering the proceedings of the first *Plant Maintenance Conference* held recently in Cleveland, Ohio.

Subjects covered include maintenance organization and principles; maintenance costs and budgeting: selection and upkeep of lighting equipment; upkeep of motors, controls and distribution equipment; use of electrical instruments in maintenance, etc. The two volumes comprise 278 pages, 8½x11, and include 47 pages of tables, diagrams, illustrations, graphs and charts. Price for both, postpaid, is two dollars.

The Superior Electric Co., Bristol, Conn., have published a 12-page bulletin, No. 749, describing light dimming equipment. Bulletin displays dimmers from the small, 1,000-watt manually-operated single unit through heavy duty motor-driven *ganged* unit with an output up to 30,000 watts.

John F. Rider Publisher, Inc., 480 Canal Street, New York 13, has published Rider Manual Volume XX.

Manual offers coverage on AM-FM receivers, auto radios, record changers, and tuners, as of November, 1949. Data of 74 manufacturers comprises 1,776 pages. Priced at $18.00.

Electrical Reactance Corp., Franklinville, N. Y., have published a 32-page *datalog* describing HiQ capacitors, resistors and choke coils.

Electro Switch Corp., 167 King Ave., Weymouth 88, Mass., have issued a 12-page catalog (1950 P) of rotary (Esco type P) switches with information on the use of multi-pole, snap switches.

Pictorial circuit diagrams show how contact assemblies combine to provide single-handle control of complex circuits, that may be either independent or interconnected.

The Andrew Corp., 363 East 75th St., Chicago 19, Ill., have released bulletins describing tower lighting accessories, single and obstruction lights, code beacons, lighting filters for insulated towers, etc.

Insulation Manufacturers Corp., 565 W. Washington Boulevard, Chicago, Ill., have published a series of folders describing several types of cotton cloth electrical tapes.

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., have released a 4-page folder describing a line of ultra-high measuring equipment.

Personals

Curtis R. Hammond is now equipment sales manager of the receiving tube division of the Raytheon Manufacturing Company, Newton, Mass.

Hammond will be responsible for the sale of radio receiving tubes and picture tubes to equipment manufacturers.

George R. Sommers has been appointed assistant general sales manager of the radio tube division of Sylvania Electric Products Inc.

George R. Sommers

B. J. Edwards, technical director of Pye, Ltd., Cambridge, England, discussed *Television Development in Britain* during a recent meeting of The Radio Club of America.

Pinckney B. Reed has been named manager of the Industrial Equipment Section of the RCA Engineering Products Department. Reed replaces *George L. McKenna,* who has become assistant to W. W. Watts, vice president in charge of the department.

Harry R. Seelen is now manager of the Lancaster Engineering Section of the RCA Tube Department. Seelen succeeds Dr. Dayton Ulrey, who has retired and is now a consultant to the company.

Robert D. Hickok, president and founder of The Hickok Electrical Instrument Co., died recently.

R. D. Hickok, Jr., has been elected president of the company, and W. A. Weiss, vice president, in charge of engineering.

Edwin M. Martin has become president and chairman of the board of the Standard Electronics Corp., Providence, Rhode Island, which will design and manufacture radio and TV equipment that will be distributed by Graybar Electric Co. Robert F. Moyer is vice-president and treasurer.

Under the terms of an agreement, Standard will provide maintenance parts and service to all users of Western Electric equipment and Western will supply the necessary information to make this possible.

E. M. Martin

Jack McCullough and *Bill Eitel* recently received the U. S. Navy Distinguished Public Service Award for their contributions to the naval research and development program.

Veteran Wireless Operators Association News

The VWOA Elections

THE RESULTS of the recent election of officers and members of the board revealed that Wm. J. McGonigle was reelected prexy; William C. Simon, secretary; A. J. Costigan, first vice president; R. J. Iversen, assistant secretary; E. N. Pickerill, second vice president; and C. D. Guthrie, treasurer.

On the board of directors are George H. Clark, Fred Muller (U.S.N.R.), A. J. Costigan, Haraden Pratt, C. D. Guthrie, W. C. Simon, W. J. McGonigle and George Sterling.

The Twenty-Fifth Year

On the occasion of the twenty-fifth anniversary of VWOA, celebrated at the annual dinner-cruise in N. Y. City, prexy Bill McGonigle paid tribute, at the dinner and in the souvenir year book, to those who participated in VVOA activities during the twenty-five year span.

Bill pointed out that the original VWOA members—Peter Podell, Gilson Willets, Frank Orth, William Fitzpatrick, James Maresca, Sam Schneider, William Gill, A. Barbalate, George Clark, J. R. Poppele, Fred Muller, Fred Klingenschmitt, Hugo Gernsback, and James Maher deserve a special word of appreciation.

"To our past presidents—William Fitzpatrick, William Gill, James Maher J. B. Duffy, Fred Muller and George H. Clark," continued Bill, "we send our good wishes for their expert piloting of the good ship VWOA.

"To the other officers and directors, throughout the years, we are grateful, too, for their splendid cooperation," Bill added. "Several rate special mention—Bill Simon, presently secretary and director. For years treasurer and executive secretary, he has done a tremendous job of handling the detail work so necessary in every organization. George Clark, director, formerly vice president, president, secretary, executive secretary, and historian of VWOA and one of the original incorporators of our association, also merits applause. He continues to be just as active today as when we were founded a quarter century ago. To A. J. Costigan, Haraden Pratt, George W. Bailey, Charles D. Guthrie, Willard S. Wilson, F. P. Guthrie, H. H. Parker, Paul Trautwein, General Sarnoff, Arthur Lynch, A. F. Wallis, Henry Hayden, Charles Cooper, W. J. Halligan, E. H. Rietzke, Guy Entwistle, Lewis Winner, T. R. McElroy, Bryan Davis, Ludwig Arnson, Orrin E. Dunlap, Dr. Lee de Forest, and many many others. we are grateful, too, for their help."

Marconi Memorial Medal Awards

During the silver-anniversary dinner, the Marconi Memorial Medal of Honor was awarded to Commodore E. M. Webster . . . "In recognition of a lifetime of service to the radio art."

The Marconi Memorial Medal of Service was also awarded to FCC Commissioner George E. Sterling . . . "In recognition of over four decades of outstanding service in the field of radio."

The Marconi Memorial Wireless Pioneer's Medals were awarded to Hugo Gernsback . . . "Recognizing his outstanding pioneering achievements in the early days of wireless"; and to E. N. Pickerill. . . . "In tribute to his early efforts in wireless in aviation."

Elof Sandstrom is now chairman of the board of The Oak Manufacturing Co., Chicago, Ill. Robert A. O'Reilly has become president and William Bessey, vice president and secretary.

Edward B. Snyder has been appointed production manager of Bentley, Harris Manufacturing Co., Conshohocken, Pa.

Snyder was formerly associated with the Kimble Glass Division of Owens-Illinois Glass Company as technical director of the Conshohocken plant.

Charles M. Kay has been appointed division superintendent of steel works of American Steel & Wire Company's South Works in Worcester, Mass.

Paul H. Eckstein has rejoined The Hallicrafters Co., 4401 West Fifth Ave., Chicago 24, as television sales manager. Eckstein had previously been with Hallicrafters as sales manager of its home radio division.

TV Picture Tubes

(Continued from page 21)

electron gun. In the bent gun, the electrodes are arranged so the beam starts on its path at an angle of about 11° with respect to the axis of the picture-tube neck. The beam passes through the second grid and the entrance to the anode without distortion, and is bent back to the tube axis by the action of a single magnetic field. Spot distortions of the type normally encountered with slant-field guns do not occur since the fields in regions of greatest variation, such as from the low voltage, G_2, to the higher potential anode, are symmetrical. Symmetrical fields are obtained by locating the bend at a point on the anode barrel where the potential inside this electrode is nearly uniform, hence bending the barrel does not introduce serious field distortions. The use of a single bending field has also been found to affect a saving in neck length of from 1" to 1½", an important factor in determining cabinet sizes.

(To Be Continued)

ADVERTISERS IN THIS ISSUE

TeleVision Engineering

MARCH, 1950

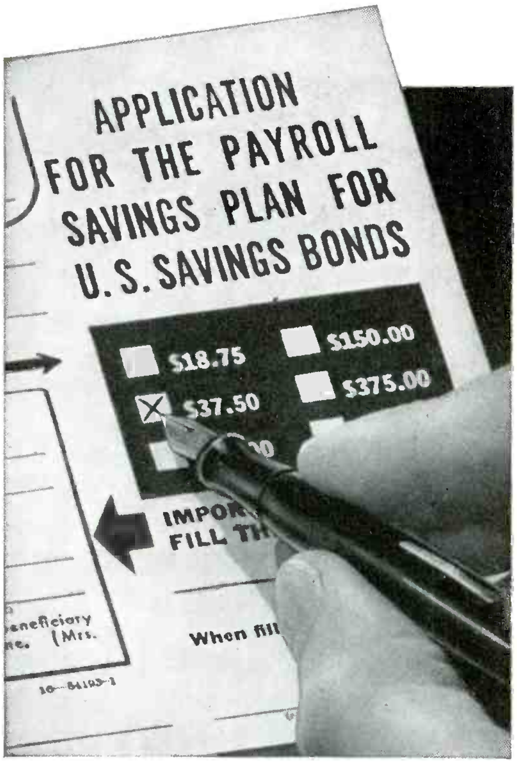
Briefly Speaking . . .

TV, which emerged as the spotlight feature of the 1950 IRE National Convention, won its golden ribbons not only in the quality and quantity of papers offered, but on the personal-award front, too. The cherished Morris Liebmann Memorial Prize was won by Otto H. Schade, RCA research engineer, for his outstanding work in TV optics. Fellow awards were won by many for their TV work: Alda V. Bedford, RCA Lab research engineer; Harley A. Iams, North American Aviation, Inc.; Harry B. Marvin, G.E. project engineer; Pierre Mertz, Bell Lab engineer; Jack R. Poppele, vice president and chief engineer of WOR-TV and president TBA, and Jerome R. Steen, director of quality control of Sylvania Electric. . . . There's been quite a trend to TV receiver simplification, which has prompted intense research in the procedures which might provide the best results. One of the leading exponents of the simplified idea has been W. B. Whalley of the Physics Laboratories of Sylvania, who, at a symposium on TV sponsored by the New York section of the IRE, pointed out that there are many functions of a receiver which can be studied for simplified design. These include: Channel selection and *rf* amplification; amplification at *if*; video detection; video amplification; *dc* level control; gain control; sound *if* system; discriminator; audio amplifier; synchronizing pulse amplification and separation; horizontal and vertical deflection, etc. . . . TV will be a highlight feature of the annual New England IRE meeting, which this year will be held in Boston and on April 15. Among those who will appear are Calvin Ellis of G.E., who will discuss a TV pulse generator; V. K. Zworykin, RCA Labs, who will cover industrial television; and M. W. P. Strandberg of MIT and Dale Pollack, consulting radio engineer, who will discuss coax noise diode termination. . . . Charles C. Carey and Arthur E. Thiessen are now directors of General Radio Co., replacing Melville Eastham and Henry S. Shaw, who are retiring. Eastham has been named honorary president and Shaw has become honorary chairman of the board. . . . Philips Labs has granted a license to Stackpole Carbon covering manufacture of magnetic ferrites. . . . A plant in Denville, New Jersey, which will cover 46,000 square feet, has been acquired by the Centralab Division of Globe-Union Inc. to manufacture a line of ceramic capacitors. . . . The new picture tube plant of RCA, at Marion, Indiana, was dedicated recently. At the ceremonies were Mayor Willard G. Blackman of Marion and Governor Henry F. Schricker of Indiana. . . . The Advance Electric and Relay Co. are now in a new plant at 2435 N. Naomi St., Burbank, California. . . . Emerson Radio and Phonograph Corp., will soon occupy an additional plant at Coles and 14th Street, Jersey City, N. J. It will be used for the manufacture of television and radio receivers. . . . The New York section of the IRE were hosts recently to four of industries' outstanding pioneers, who presented a review of developments through the past fifty years and predictions of future trends; Dr. A. N. Goldsmith, Lloyd Espenschied, John V. L. Hogan and William C. White. . . . WPIX, WABD and WCBS-TV will soon move to the Empire State Building, joining WNBT and WJZ-TV. Their antennas will be mounted atop a 199-foot tower.

It's EASY to install "Payroll Savings"

If you've put off installing the Payroll Savings Plan in your company because you feel it would be "a lot of work," then this advertisement is certainly for you! Because it's really very *simple* to give your employees the advantages of investing in U. S. Savings Bonds the easy, automatic "Payroll" way.

. . . and 20,000 companies' experience proves it pays!



HERE'S ALL YOU NEED TO DO

Appoint one of your top executives as Savings Bond Officer. Tell him to get in touch with your State Director, Savings Bonds Division, U. S. Treasury Department. Here's what happens . . .

The State Director will provide application cards for your employees to sign—plus as much promotional material and personal help as necessary to get the Plan rolling in your company.

Those employees who want Savings Bonds indicate on the applications: how much to save from their pay; what denomination of Bonds they want; and the inscription information to appear on the Bonds.

Your payroll department arranges to withhold the specified amounts, arranges to get the Bonds, and delivers them to the employees with their pay.

The Bonds may be obtained from almost any local bank or from the Federal Reserve Bank or may be issued by the company itself upon proper certification by the Federal Reserve Bank or Branch in the company's District.

THAT'S ALL THERE IS TO IT!

In case you're skeptical as to how many of your employees would like to have Payroll Savings, canvass your plant—and be prepared for a surprise. (Remember that pay-check withholdings for Bonds are *not* a "deduction"—the employee takes home his Bonds with his pay.) One leading manufacturer, who had professed little faith in the Plan, found his eyes opened when he asked the people in his plant whether they would like to obtain Bonds in this way. Within only six months after he installed the Plan, half his employees signed up. A prominent aircraft manufacturer, whose company had used the Plan for some time, was not aware of its potentialities until his personal sponsorship increased participation by 500% among his company's employees.

THE BENEFITS ARE BIG—FOR EVERYONE

The individual employees gain security—they know that the Bonds they hold will return $4 for every $3 at maturity. The company gains from the resultant increased stability and efficiency of its workers. The whole nation gains because Bond sales help stabilize our economy by spreading the national debt and by creating a huge backlog of purchasing power to boost business in the years ahead.

Is it *good policy* to deprive your company of Payroll Savings—even one more pay day? Better at least have a talk with your U. S. Savings Bonds State Director, get the answers to your questions, and *know for sure.*

The Treasury Department acknowledges with appreciation the publication of this message by

TELEVISION ENGINEERING

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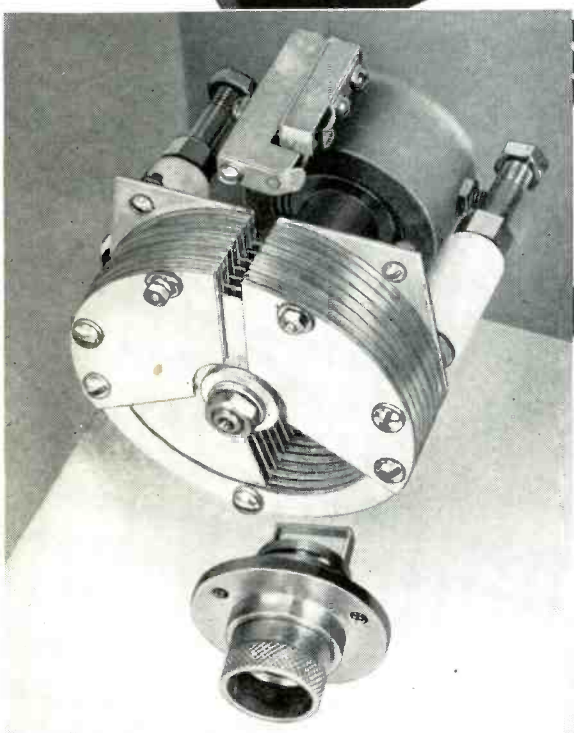
100 to 500 Mc OSCILLATOR



THIS oscillator, designed for use as a power source for general laboratory measurements and testing, covers the frequency range of 100 Mc to 500 Mc. With its associated power supply it is small, lightweight and compact. The entire range is covered with a single-dial frequency control with a slow-motion drive equipped with an auxiliary scale.

The tuned circuit of the Type 857-A Oscillator is our well-known Butterfly type. The difficulty of sliding contacts in any part of the oscillator circuit is avoided in this unique construction. The photograph above shows the output coupling loop and output jack. Coupling can be changed from maximum to almost zero by rotating the output jack.

FEATURES

- Dial calibrated directly in megacycles to an accuracy of ± 1%
- Vernier dial with 100 divisions, covering the oscillator range in ten turns
- Output through a coaxial jack with provision for varying coupling
- Output of ½-watt at 500 Mc
- Electron-ray tube in power supply to indicate grid current and furnish indication of oscillation
- Filament and plate power furnished by the Type 857-P1 Power Supply which is furnished with the oscillator

TYPE 857-A U-H-F OSCILLATOR (with power supply) . . **$285**

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

...the new, short metal-cone kinescope with "Filterglass" face plate

The new RCA-16GP4 offers special advantages to designers of large-screen television receivers:

Shorter—Nearly 5" shorter than the 16AP4, the new, wide-angle RCA-16GP4 permits reduction in depth of chassis and cabinet, and thus makes possible greater compactness in receiver styling. In addition, the 16GP4 permits economies in tube stocking, packaging, and shipping.

"Filterglass" Face Plate—Of high-quality glass and almost flat, the "Filterglass" face incorporates a neutral light-absorbing material to give improved contrast by minimizing ambient-light reflections and reflections within the face plate itself. The circular face plate provides a large picture with full scan.

Tilted Ion-Trap Gun—New tilted gun requires only a single-field, external magnet.

Duodecal 5-Pin Base—Permits use of lower-cost segment socket.

Less Weight—The RCA-16GP4 weighs substantially less than a comparable all-glass tube so that, with ordinary precautions, it can be safely shipped in the receiver.

RCA Application Engineers are ready to co-operate with you in applying the 16GP4 and associated components to your specific designs. For further information write RCA, Commercial Engineering, Section C58R, Harrison, N. J.

ANOTHER new RCA tube . . .

. . . the RCA-6CD6-G Horizontal-Deflection Amplifier for 16GP4 Systems. The RCA-6CD6-G makes possible the design of horizontal-deflection circuits in which the plate voltage for the tube is supplied in part by the circuit and in part by the low-voltage power supply. Ordinarily only one 6CD6-G is required for kinescopes with deflection angles up to 70° and operating at 14 kv.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

RADIO CORPORATION of AMERICA

ELECTRON TUBES HARRISON, N. J.