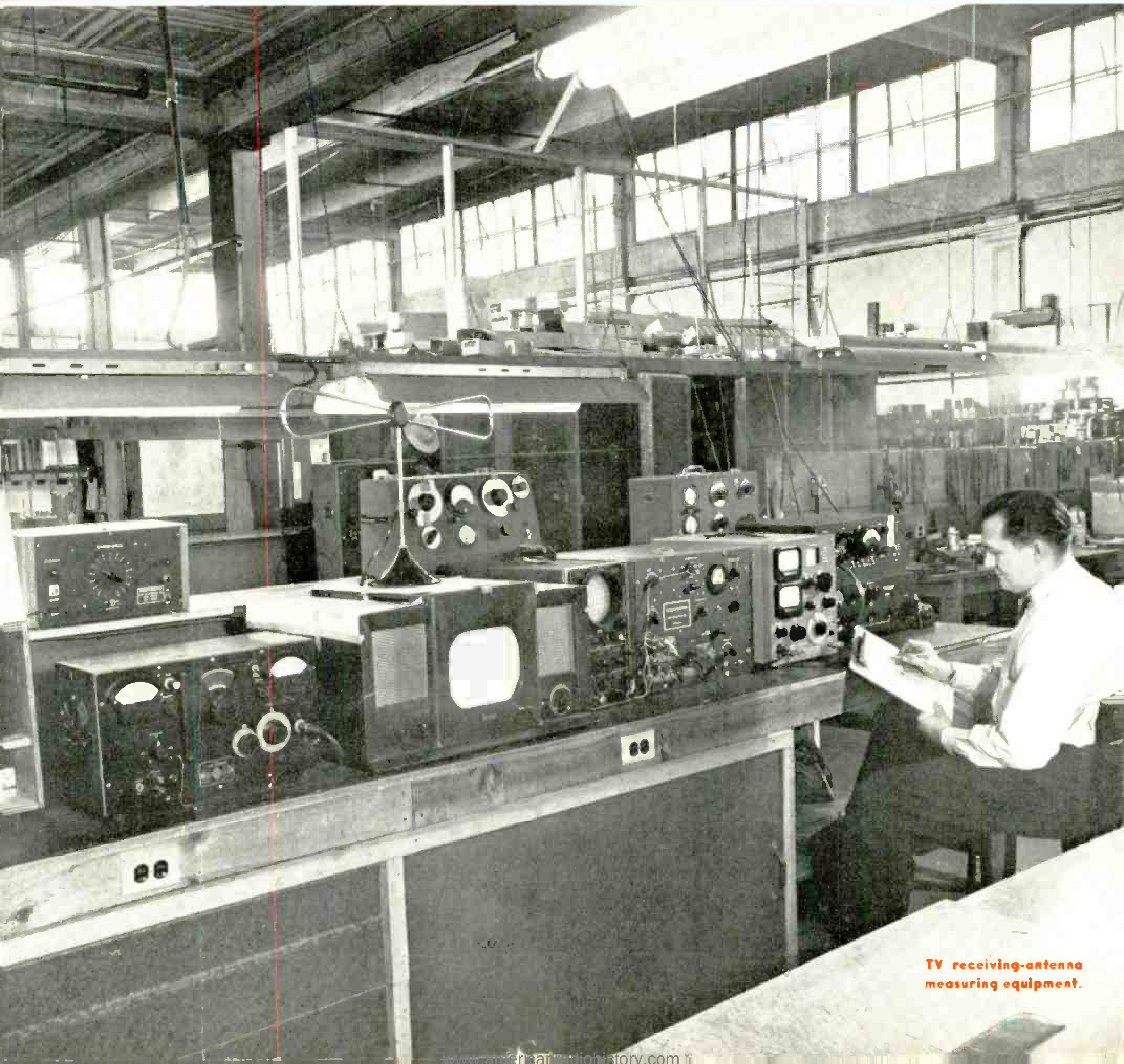
# TELE-VISION ENGINEERING

FEBRUARY, 1951

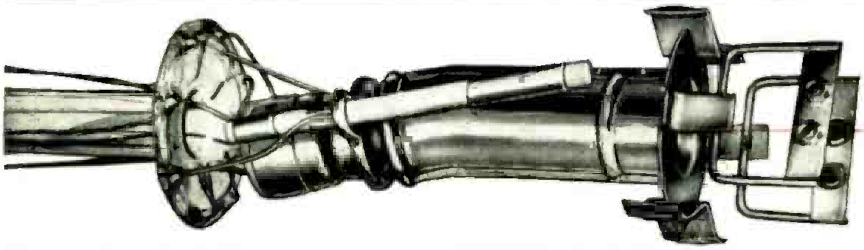


TV receiving-antenna measuring equipment.

# fine overall focus starts with the

# Du Mont

# BENT-GUN



In big-picture tubes, more than ever, fine-line focus — clear across the screen — is an important function of the electron gun.

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# TELE-VISION ENGINEERING

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*Research . . . Design . . . Production . . . Instrumentation . . . Operation*

**VOLUME 2** **FEBRUARY, 1951** **NUMBER 2**



## *MONTHLY FEATURES*



## *Cover Illustration*

Measuring equipment setup for TV receiving antennas, featuring use of signal generators, field intensity meters, impedance matching units, etc. See page 8, this issue, for complete analysis. (Courtesy Radiart)

**Editor: *LEWIS WINNER***

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TELE-VISION ENGINEERING

LEWIS WINNER, Editor

*February, 1951*

### *Human Engineering**

A NEW SCIENCE, *human engineering*, offering striking evaluation concepts, has appeared on the industrial horizon. Concerned with quantitative measures of human capabilities and limitations and their application to machine design, the approach offers an exciting media for the probing of the faculties of perception, action, reaction and decision.

Commenting on the machine and human-being relationship, in a foreword to a recent encyclopedic report on the subject, Admiral Luis de Florez said that since our machines must be manned by the average human being, their operation must be governed by his capabilities under the influence of mental stress, fatigue and sudden change, and accordingly, these capabilities must be analyzed, measured and made available to the designer and engineers to make good our progress from now on.

In the field of vision, there appears an excellent example of the challenging problem. For instance, we all know that vision is extremely important and that those who can see more things more of the time are certainly better off than those who can't. Nevertheless, thousands of man-hours of engineering time have been spent on the development of a variety of devices that are really not as effective as they might be simply because the visual display is not what it might be.

Analyzing the foregoing factor, the report states that when we set about to see visible radiation, or light, the eye responds to the total effect regardless of the wavelength or any other property of the physical makeup of the stimulus[1]. Therefore, when radiation of a continuous spectrum, such as daylight reaches the eye, a sensation of white light is produced rather than discrete sensations of all the colors of the solar spectrum. Accordingly, says the report, we have a phenomenon which poses a challenging problem to an experimenter, for he must measure a light stimulus in relation to the subjective sensations produced in the eye, and yet make his measurements in terms of some physical objective standard.

Brightness discrimination poses another interesting human-engineering problem. For instance, when a designer develops the performance characteristics of a picture-pickup camera, he can be aided in his work by a knowledge of the limitations imposed on his design by the contrast threshold of the human eye. According to the report, an attempt at a quantative determination of these limitations has revealed that the performance of the eye can be represented by the performance of an ideal pickup system with a quantum efficiency of five per cent at low brightness and .5 per cent at high brightness. Incidentally, the performance of an optimal TV system has been defined as the performance limited by random fluctuation in the absorption of light quanta in the primary photo-process.

Visual acuity represents another pertinent facet which can be explored in a study of human engineering. Acuity, which refers specifically to the ability of the human eye to perceive the shape of objects, is commonly checked with letters on a chart and circles and squares. A major difficulty in evaluating acuity has been the absence of an absolute criterion of performance. In studying the problem, it has been found that there are four factors that can be measured by the usually-used tests. According to the study, these are retinal resolution, lens accommodation, form or letter perception and resistance to interference. In a series of tests it was learned that wall charts measure four different factors, only one of which (retinal resolution) is common to all the tests. Three common factors were found: brightness discrimination, form perception (in all letter tests) and simple form perception, the latter in triangle and square-discrimination tests.

Color constancy has also been found to be an extremely intriguing probe object in human-engineering activities. The report disclosed that the actual colors we perceive are not constant under all conditions, results depending to a great extent on how long the eye has been exposed to them, whatever the colors may be in the surrounding area, and what color has been previously fixated. The effect of one color upon the other is quite a problem. The characteristic stems from the principle of color adaptation, the general effect being to lessen the sensitivity of the retina to the stimulating color. For instance, long exposure to a color stimulus induces the sensation of a color that is usually the complementary of the inducing color. This induction increases with a decrease of gray and corresponding increase in saturation in the inducing color. The induction has found to be greatest when there is no sharply defined boundary between background field and induction field, when both fields are in the same plane, and in the boundary region between fields. Therefore, the inducing effect of red, yellow, blue and green is greater when there is no brightness contrast. Here are factors which require explicit consideration in developing, designing and producing equipment for not only color pickup, but monochrome cameras as well.

There are a number of other characteristics of vision whose end effects can be altered by the relationship of the machine and the human being. For instance, we have light sensitivity, depth perception, color vision, perception of motion, all of which are directly associated with the production of a better picture.

Human engineering offers the planner and designer a forceful means of learning more about the probable characteristics of those who will man the machines of the future to provide those ideal results, always anticipated, but often never quite fulfilled.—L.W.

[1]The report defines vision as the sense whose receptor organ is the eye and whose adequate stimulus is electromagnetic radiation within a limited range of 400 to 800 millimicrons in wavelength.

* Based, in part, on information appearing in the *Handbook of Human Engineering Data for Design Engineers*, prepared by Handbook Staff, Tufts College, in cooperation with the Technical Publications Div. of Jackson and Moreland; released by OTS of the Department of Commerce.

# TVE-grams....

## *The Management Front*

**Small Business Orders Mount:** A recent report to President Truman by the Department of Defense revealed that out of 1,736,882 purchases of supplies, services, and construction by the military departments in the year ending June 30, '50, 1,267,000, or 73%, were transactions with small business firms. In dollar value, these companies received $1,310,615,000, or 24.5% of the $5,355,396,000 defense orders. On contracts of less than $5,000 each, 71% of the dollar value went to firms employing fewer than 500 persons. And currently, the orders to the small businessman in numbers and income appear to be outdistancing the '50 record.

**The DO Digits:** The term *DO*, or Defense Order, followed by two digits, employed by NPA and the Department of Defense, to identify the group into which a defense procurement item falls, has been confused with priorities. There is no priority or preference between program code numbers; *DO*-05 does not take precedence over *DO*-06 or any other *DO* program code.

Manufacturers or suppliers who receive an order bearing one of the ratings *DO*-01 through *DO*-22 inclusive, or *DO*-99, may extend the rating on their own purchase orders to obtain production materials to be physically incorporated in the procurement items or to replace inventories expended for that purpose. The extension is accomplished by entering the following certification on purchase orders:

"Certified under NPA Regulation 2, *DO*– (insert two digit program code number appearing on purchase order you receive from your customer)."

There is also a *DO*-98 private-contractor rating, which can not be used on purchase orders to procure specified items of production equipment *unless* its use has been approved by the military departments as necessary for production on military orders. Application for authority to use the *DO*-98 rating must be made to the contracting officer of the military department having the principal interest in the rated order production of the contractor or subcontractor.

For electronics and communications equipment the *DO* rating is 07.

**Production Stepup Plans:** In one of several moves to cushion the impact of conversion to defense production, Secretary Marshall has directed that contracts be spread across industry as much as possible, making use of negotiation methods of purchasing rather than the time-consuming bid procedure, wherever possible.

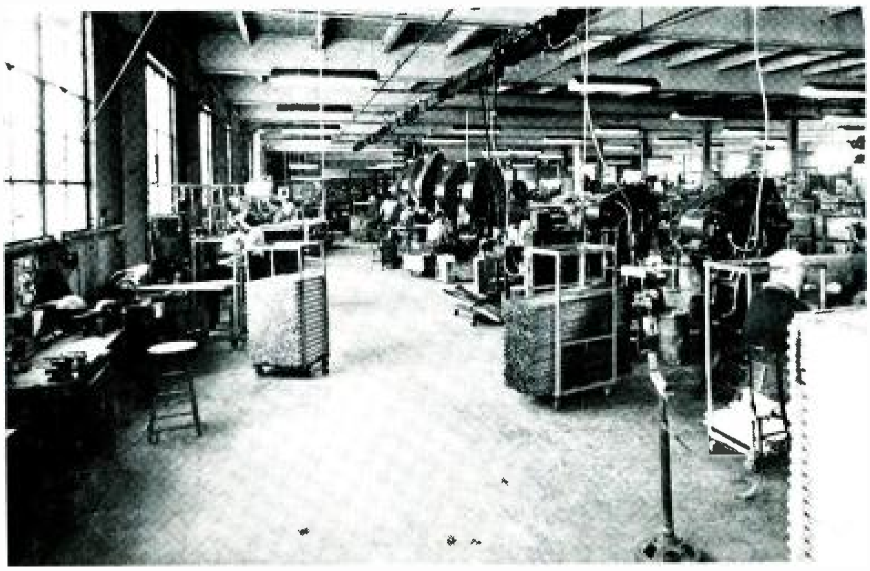
The guaranteed-loan program represents another example of the efforts being made to prevent, or at least to reduce to a minimum, work-stoppages during the conversion period, and to help civilian contractors. The guaranteed, or *V* type loan, to finance defense contracts, designed to expedite production and deliveries is similar to the RFC project of World War II.

In still another speed-up plan, John D. Small, Munitions Board chairman, has urged the Army, the Navy and the Air Force to hurry along contracts, especially for those major items which require a long time to produce. Items which can be made faster will be scheduled so as to keep pace but not outrun the others. Small pointed out that a build-up of huge stocks in advance of needs would create unnecessary shortages and interfere with the production of more urgently needed materiel.

Contracting officers have also been asked to cut the time consumed between the availability of funds and the award of contracts.

**Aluminum for TV Antennas:** In an amended NPA ruling prohibiting the use of aluminum for over 200 items, TV antennas were fortunately omitted. In addition, the ruling stated that producers or fabricators will not be required to accept rated orders for any aluminum products, for shipment in any one month, in excess of the following percentages of average monthly shipments during the first eight months of '50: Sheet (coiled and flat), plate, circle and blanks 40%; extrusions and tubing 45%; rolled shapes 30%; rod, bar, wire and cable 35%; forgings and pressings 60%; castings 40%; secondary ingots 45%; and all other mill products, each 40%.

**Right: TV receiving-antenna production facilities at Taco. (See pages 8, 9 and 10 for complete report on antenna desgin and production.) Below: Long-range camera, with a 3-meter focal length, developed by the Signal Corps. View shows 2/25 optics extended in operating position. Camera is expected to be on view during forthcoming IRE exhibition at Grand Central Palace.**



# Reports and Reviews of Current TV News

**Military Contract Information:** Names of contractors awarded Army, Navy, and Air Force contracts of $25,000 or more are available on a weekly basis through the Department of Commerce and Armed Forces field offices and all Army, Navy, and Air Force purchasing offices. This service in effect since July, '50, provides to businessmen a weekly synopsis of unclassified contracts, whether negotiated or formally advertised, through more than 1,200 information outlets. A similar arrangement funnels information from the purchasing offices of the General Services Administration and other government agencies to the same outlets. This service is especially useful as a guide for subcontractors. Generally, there is no need for a businessman to go farther than the nearest procurement information field office to handle defense contracts.

## Research

**HF Measurement Conference:** Over five hundred attending a recent conference on *hf* measurements in Washington, D. C., jointly sponsored by the AIEE, IRE and the National Bureau of Standards, heard quite an assortment of papers covering measurement of frequency and time, impedance, power and attenuation, and transmission and reception.

Describing a *vswr* measuring set, S. F. Kaisel of RCA Labs and J. W. Kearney of Airborne Instruments Lab, revealed that on a 'scope, it's possible to see a quantitative picture of the *vswr* looking into a wave guide or coax-line element over a 2600 to 4000-mc frequency range. It was reported that standing waves of 1.5:1 or greater can be measured. The complete unit consisted of a mechanically-swept reflex kylstron *rf* oscillator, continuously tunable from 2200 to 4600 mc, fed to a waveguide *magic tee* used as the measuring element.

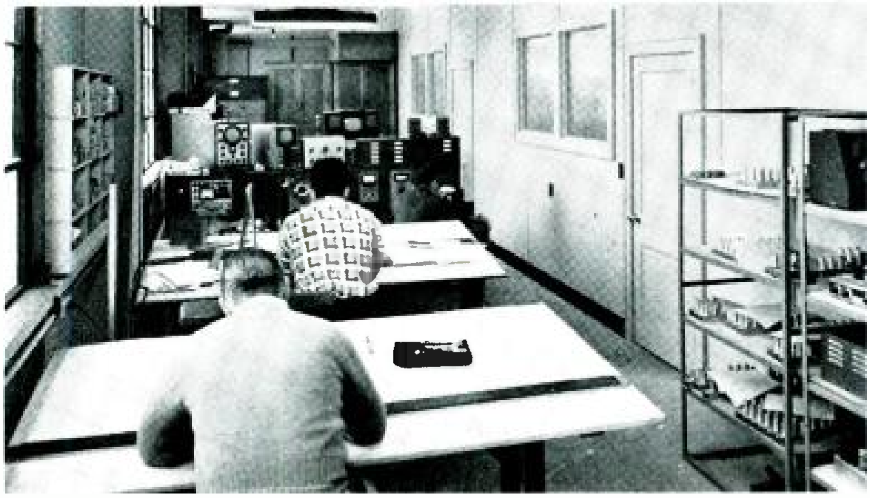
A system for measuring waveguide and coax-line impedances with a circular waveguide, was disclosed by A. E. Laemmel of Polytechnic Institute of Brooklyn. It was pointed out that the rotary variation of voltage, induced in a pickup loop rotated in a circular waveguide jointed to the waveguide or coaxial line containing the unknown impedance, can be used to measure impedance in the same way as is the linear variation of voltage picked up by the probe of a slotted section. Both patterns were said to be the same under suitable conditions.

Recent extensions of crystal-controlled frequencies into the microwave region by harmonic generation, and the extension of the frequency range of crystal units in filter networks, have called for more accurate measurements of the electrical elements of the equivalent network of the crystal unit. Work of this nature being conducted at Bell Labs was reported by L. F. Koerner. Studies have revealed that the agreement of frequency measurements of a crystal unit in various test circuits is a function of its *Q*, and the ratio *r* of its shunt capacitance to the capacitance in the series branch of the equivalent network. The measurements of the resonance frequency of the series branch in various circuits may vary by 100 x *r* 20%, and the spread between the frequency of zero phase angle and the frequency of minimum impedance of the equivalent network may be double this value.

**Square-Law Tube:** At the forthcoming annual IRE exhibition at Grand Central Palace, Aaron S. Soltes of the Air Force Cambridge Research Labs, will present a square-law-tube display. On view will be the parabolic static characteristics (output current versus input voltage) of a beam-deflection square-law tube as displayed on a 'scope. This type of square-law tube has been used to perform squaring operations on signals ranging in frequency from zero (*dc*) to 40 mc and higher.

During the course of the IRE Convention and Exhibit, Soltes will present a paper on this tube entitled *Squaring Amplifier*.

A section of the Taco electrical engineering lab where new antennas are tested electrically as prototypes, pilot-run models, and again as production-run models.



Below: Lead-calcium storage batteries developed by Bell Telephone Labs. The batteries are said to be less subject to corrosion than the types now in use, and will serve for many months without the addition of water. A major new feature is the use of calcium instead of antimony as a hardening agent for the lead alloy in the grids and other metallic parts of the battery.

# TVE-grams . . .

**On-the-Spot Camera:** A camera using invisible electrical images which can produce on-the-spot pictures, even in active atomic radiation areas without being fogged, has been announced by the Signal Corps Engineering Labs.

The camera, dubbed *Two-minute Minnie*, produces a finished 4 x 5-inch picture two minutes after the shutter is snapped. Its plates, which need no chemicals for processing, can be used over and over again merely by wiping off the image.

The picture has tones similar to that of an ordinary black and white photograph and can be printed on paper, wood, cloth, glass, plastics, or ceramic materials. It can be made into a transparency from which enlargements can be produced.

The camera employs a newly discovered electrostatic, electrophotographic process in which light is recorded on a selenium-coated metal plate that has been sensitized by an electrical charge.

Where the light hits the charged plate, the electricity leaks off the sensitized material in proportion to the amount of light received and is grounded on the plate. What is left is an invisible electrical image.

Finely ground charcoal or anthracite coal powder is then blown across the face of the plate. Wherever there is electricity on the plate the dust sticks; the more the electricity, the more powder remains.

The powdered image in then transferred to ordinary paper or other material coated with an adhesive layer such as rubber cement. To protect the surface and fix the print a clear transparent plastic film is pressed against the picture.

There is no need for a darkroom, the entire process being done in the back of the camera within two minutes. Edward K. Kaprelian, chief of the photographic branch of the Signal Corps Labs, has predicted that this time will be cut to a minute or less within a year.

The camera uses an ordinary lens and shutter. Its light source is the same as for an ordinary camera; sun or reflected light, photofloods, flash bulbs, or ordinary light bulbs.

The speed of the sensitive plate is about the same as the ordinary orthochromatic black and white film.

Development of the camera was under sponsorship of the Signal Corps which aided the Haloic Company, Rochester, New York, and the Battelle Memorial Institute, Columbus, Ohio, in the research and design leading to production of a model.

**RF Capacitor:** An experimental *rf* capacitor with a constant total capacitance and an adjustable temperature coefficient (*TC*), which is claimed to be adaptable to commercial air-capacitor production methods, has been developed by engineers at the Naval Research Lab.

In the NRL design, four capacitors are connected in series-parallel. One element in each series leg is a variable air-dielectric capacitor. These are mechanically coupled so that, when they vary with each other in accordance with a predetermined law, the equivalent capacitance of the four-element combination remains constant. Fixed ceramic capacitors are used for the other series element in each leg, one having a positive *TC* value, the other a negative one. Air-dielectric capacitors were selected for the adjustable element to avoid the difficulties encountered with the ceramic-dielectric type. The total capacitance per unit volume for a capacitor of this type is about one-fourth that of a conventional air-dielectric capacitor.

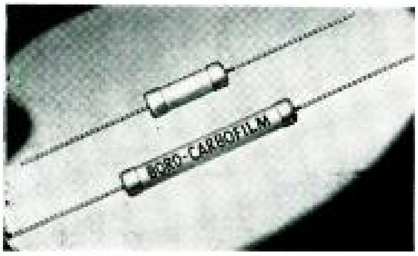
Although the size of the experimental capacitor was cited as a disadvantage by NRL, it was noted that the versatility and stability of such a circuit element may contribute to its effective application. Such a device, for example, might be used in a critically stabilized *lc* oscillator where minor aging effects are to be compensated to allow a high degree of long-term stability. Such a capacitor might also be used as a secondary standard of *TC* values for interlaboratory correlation or for checking quality control measurements at a capacitor manufacturer's plant. In addition, such a circuit might serve as the heart of a test set which would allow rapid and accurate *TC* measurements. This latter need is particularly interesting when it is realized that current practices allow the production of a fixed ceramic capacitor for only a few cents, although the accurate determination of its TC value may cost several dollars.

## *The Production Line*

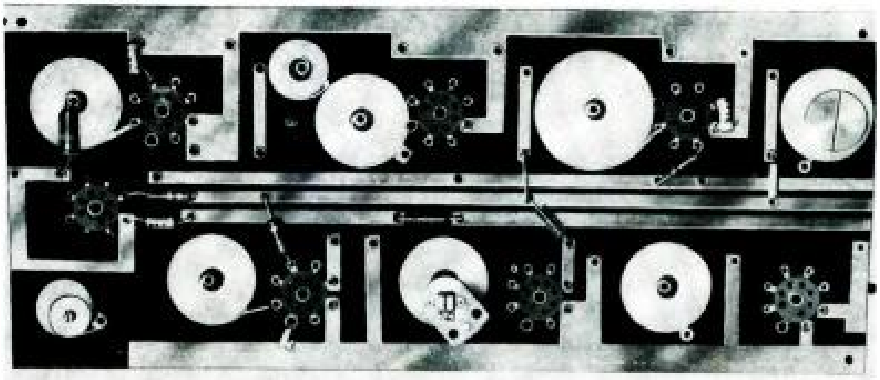
**Thermal Shunt:** A thermal shunt can be used to prevent overheating of miniature electronic components during soldering according to a British Telecommunications Research Establishment report, now available from the Department of Commerce Office of Technical Services.

The shunt, which is simply a crocodile-type clip to which heavy copper jaws have been added, was developed after

Borocarbofilm resistors now available in 1/4, 1/3, 1/2, 1 and 2-watt sizes. They are being manufactured under license arrangement with Western Electric. (*Wilkor Products, Inc., 2882 Detroit Ave., Cleveland 13, Ohio*)




Section of TV receiver, featuring stamped capacitors, inductances and wiring. (*Courtesy Franklin Airloop*)



research revealed that the brief overheating resulting from soldering operations during the assembly of miniature electronic equipment permanently changed the value of carbon composition resistors as much as 20%.

By attaching the thermal shunt to the component lead wire during soldering, and leaving it in place for about 15 seconds after the soldering is completed, the change in value was reportedly held within 1%.

The shunt dissipates heat that normally reaches the resistor by conduction along the terminating leads. Any heat-dissipating mechanism will assist in this purpose, and, particularly in tight places, use of a pair of long-nosed steel pliers is reasonably satisfactory. The copper-jawed clip, for which the report provides a blueprint, was found most efficient and its premature removal is not as likely as with a pair of pliers.

Use of the shunt is recommended for the protection of all types of miniature components, including small capacitors, chokes molded in polythene, wire-ended germanium crystals, etc. The report points out that heat-damage problems can be minimized through careful planning of a miniature electronic layout, usually by grouping small components around the outer surfaces of larger ones.

**Noise Figure Standards:** The noise figure, a fundamental measure of the quality of linear electrical networks, is of basic importance in TV, radar, etc. In these systems some of the limitations on reliability, sensitivity, and distance are set by the type and magnitude of noise in the device as well as by the noise produced ahead of the network input terminals. To assist laboratories and industry in the evaluation of this important factor, the Bureau of Standards has inaugurated a calibration service for the noise figure in the frequency range of 500 kc to 30 mc. Standards for this purpose have been developed by M. Solow, I. W. Hammer, and P. H. Hass of the Bureau's Central Radio Propagation Laboratory.

The noise figure of a linear network is the ratio of the available noise power at the output (the total network and source noise) to the available noise power at the output source alone. Noise power in an electrical network (i.e., a receiver) is generated by the network resistance (Johnson noise) and its vacuum tubes (shot noise). The noise figure is a function of frequency and of the network and source impedance; both are measurable to a high degree of accuracy by various independent techniques. With these important parameters of a unit accurately evaluated, calibration can now be made. The Bureau's calibration method involves five components: a temperature-limited noise diode, a two-terminal source network, a four-terminal network under calibration, an attenuator, and a sensitive voltmeter.

The equivalent noise resistance used in evaluating the technique utilizes the concept that the noise power from the network can be represented by the Johnson noise of this resistance. Experimental verification of this theory was made with eleven different values of test impedance and at frequencies of 0.5, 4.3, 12, and 30 mc. Measurements made with the temperature-limited diode conclusively proved that the equivalent noise resistance was constant for all the values of test network impedance at each frequency. The evaluation has shown that the Bureau's calibration method will yield precise noise figures. It was also proved that this method of calibrating noise figures is valid for a matched or unmatched condition of input impedance. In addition this method may be successfully applied to measuring the impedance of two-terminal networks.

Calibrations can be made for high gain, linear, four-terminal networks such as receivers and amplifiers (10 to 150 ohms) source impedances to ± 0.2 db and at frequencies up to 30 mc. Work is in progress to extend noise figure standards to 300 mc.

## *Trends*

**Bent Antennas for '51:** In a reply to ye editor, inquiring about the receiving antenna design characteristics which may prevail during '51, Radiart's antenna engineer, R. W. Cronshey, declared that the high-low separate dipoles may disappear, and be replaced by antennas employing driven elements which bend forward in a V position such as the biconicals and VV's now in use. The forwardly-bent angle, he added, allows higher harmonic operation with the major lobe still pointing forward, so that the element acts as a combination high-low antenna all in one.

Thanks, RWC, for your prophetic views.—L. W.

Left: Installing an adaptor plug from the decoder unit of a subscriber-vision picture unscrambler, into the sync socket of a TV chassis. Below: Calibrated 0 to 100,000-ohm linear potentiometer for use as a resistance substitute for service or laboratory work, which is said to provide a rapid means for determining the values of burned-out resistors when substituted in the circuits. (*Courtesy Chicago Industrial Instrument Co.*)

# TV

Figure 1
Field telephone, position indicator and measuring equipment used to study pilot model antenna. Field strength meter is in the foreground and adjacent to it is the signal generator. At the steering wheel is Raymond W. Cronshey, Radiart antenna engineer.

*A Report on Lab, Measurement and Fabrication Techniques Employed in Plants in the East and Middle West.*

IN THE MANUFACTURE OF TV receiving antennas, it is often assumed that the project is quite a simple affair, involving in the main nothing more than the mechanics of bending. Actually, forming is but one of many operations in the modern mass-production plant, where a combination of research, design and carefully evolved electronic and mechanical production techniques are employed to provide an assortment of efficient pickup elements.

In research and design, a variety of intriguing procedures are used. In one plant*, for instance, in the blueprint to finished-product study, polar field patterns are carefully evaluated for every model. For it is this curve plotted on polar coordinate paper which reveals the relative amplitudes of the pickup of the antenna for different angles of azimuth. From such a graph the shape of the *beam* can be determined and the angular separation between .707 voltage (1/2 power) points obtained; this angle is usually referred to as the *angular beam width*. This, together with the existence or non-existence of spurious *lobes* help a prospective buyer to determine which type of antenna will be best suited to a particular location, etc. Since the shape of the horizontal field pattern is different for each of the 12 channels, the plotting of the field patterns consumes a large amount of lab time.

While some prefer to work with scale models inside of the lab, the field patterns taken at this plant are made on actual full-size antennas. Because of this, the antennas cannot be measured inside of the lab where the proximity of various metallic objects, etc., would give rise to spurious and misleading readings.

To get around this problem, all measurements are taken in the open, above the roof of the lab. A rotatable shaft, protruding through the lab roof, to which is attached a hand-steering wheel and a pointer assembly calibrated in degrees of azimuth, provides the antenna control. On the roof a raised platform allows access to the antenna under test. A field telephone is connected between the lab and the antenna platform so that changes or adjustments can rapidly be made.

If desired, local television channels can be used as the signal source. However, readings can be taken on any channel desired. To accomplish this a transmitting antenna is located on a distant corner of the building roof and beamed at the test antenna. A local

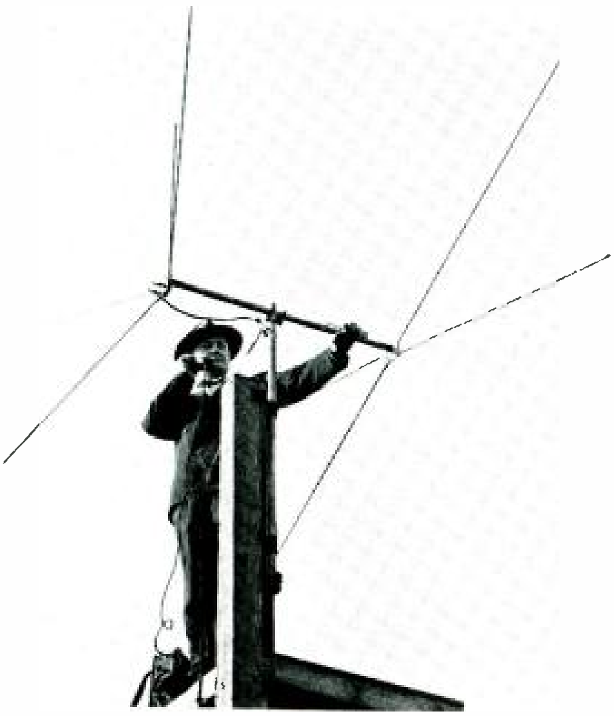


Figure 2
A test antenna above the lab roof, undergoing investigation. At the field telephone is William Petras of Radiart making final adjustments.

*Radiart, Cleveland.

# RECEIVING ANTENNA
# Research, Design and Production

by RALPH G. PETERS

transmitter consisting of a signal generator[1] is connected by coax cable to the transmitting antenna; thus any desired frequency may be transmitted.

For reception a field-intensity/noise meter[2] is used. Calibrated down to ½ microvolt, accurate readings on nulls as well as on lobe maximums are possible. A 300-ohm line connects the antenna to the receiver. However, so complete is the shielding of the transmitter and receiver that no interaction is noticable, and the transmitter can thus be placed directly along side of the receiver with practically no *spillover*. This is a convenient feature when switching frequency. From the antenna *steering* position the field-intensity meter can easily be read and, if desired, the readings plotted on the convenient clip board which holds the blank polar coordinate graph forms. If desired, a recording-pattern plotting machine can be switched in to make a permanent field pattern record.

One of the problems associated with broad-band antennas is the amount of mismatch which they present to the transmission line as the exciting frequency is varied. This information can be obtained by measuring the individual reflection coefficients for each frequency or channel and then plotting them. However, this is a tedious procedure and accordingly a 'scope[3]-test instrument[4] has been adopted. In one sweep of the electron beam practically the entire low band or high band can be *scanned* and the reflection coefficient for each frequency displayed at a glance on the 'scope screen. A *uhf* signal generator[5] serves to provide a calibrated *pip* which is superimposed on the screen to identify any desired frequency or to calibrate the sweep of the beam. Thus, at once the entire standing-wave response can be observed for all frequencies within the limits of the scan.

### *Double Stacking Problems*

Where the requirements are essentially boardband or multi-channel in nature, antenna stacking often poses many problems. The interconnecting *phasing bars* or *Q-bars* are very frequency-sensitive and act as series line transformers. Their function should be to transform the input impedance and phase angle of each individual antenna into a different value, so that when all of the individual folded dipoles are connected in series or parallel they present a resistive terminal impedance of the proper value to match the transmission line used. Since these values vary with frequency, a more precise measurement of resistive and reactive components is required. For such purposes an *rf* bridge[6] is used. A separate balun for each channel is used to match the balanced line to the coaxial bridge.

After the electrical investigation is completed at this plant, the data are digested and evaluated in the light of practicality. Then it is possible to adopt an optimum electrical design which retains all or as many of the desirable characteristics. At the conclusion of this probe, the antenna is turned over to the mechanical engineering department where structural designs consistent with strength, ease of fabrica-

Figure 3

Fabrication of antenna crossarms. Operator in the foreground is taking a flattened (but not yet bent) tube from the barrel on the right and putting a right angle bend on it with the punch press. Then another operator (in the background) puts in additional indentations and bends to complete the fabrication. (Courtesy Radiart)

[1]Hewlett-Packard 608-A. [2]Stoddard Aircraft NMA-5.
[3]Du Mont. [4]Kay Electric Mega-Match.
[5]G-R 804-C
[6]Hewlett-Packard 803-A bridge; 608-A signal source; 417-A shielded detector.

Figure 4 (Right)

Final assembly line of crossarms for a biconical antenna. Starting at the rear, the bulk nuts, bolts and brackets, etc., are assembled together as sub-assemblies and passed on down the line. At the middle of the line the crossarms are fed to the line. As the arms travel down the line the various sub-assemblies are fastened to them and they emerge in the foreground all fabricated, inspected, and ready for packaging. (Courtesy Radiart)

Figure 5 (Left)

Antenna elements being flattened on one end in a compressed air cylinder press. After flattening, they are placed in barrel; see Figure 3. On extreme left are crated tubes not yet processed. (Courtesy Radiart)

Figure 6

Soldering connecting wires to the switch contacts in a partially-assembled antenna rotator. (Courtesy Radiart)

Figure 7

Final testing of antenna-rotator remote-control boxes. Control box is clamped into test fixture and made to control the rotator mounted on the short section of pipe in foreground. (Courtesy Radiart)

tion, and economy are added to the electrical design. At this point, the sales department enters the scene, suggesting ways to incorporate those features which the selling trends show to be popular, and to delete or modify features which it is felt might be stumbling blocks to the sales.

After this study, the engineering department then reduces the design to the final specification stage from whence it is turned over to the manufacturing division for fabrication.

In general, at this factory, the only purchased parts are the raw materials, such as aluminum and steel tubing, nuts and bolts, cartons, and moulded parts. Complete plating and fabrication of the various stampings, etc., are performed within the plant.

### *Use of SWR Gear*

In another plant[2] signal generators are employed to transmit signals for pickup by a full-size prototype antenna, located atop a building equipped with measurement gear. Here complete records are drawn up and after the antenna has been found to have the desirable characteristics, it is brought to a lab adjoining the test grounds. Then the antenna is analyzed by *swr* equipment to check any impedance mismatch.

After these tests are completed in the lab and the engineering reports show that the antenna has operational characteristics fitting the application requirements, the antenna is subjected to a series of tests by the mechanical engineering department. To be sure that the antennas can withstand changes in weather, such as windstorms, ice and snow, and extremes in temperature, an accelerated mechanical life test is employed with a vibration table.[1] In the matter of a few minutes, under constantly varying frequencies of vibration, all elements are subjected to years of installation punishment. Mechanical modifications are made as seen necessary as a result of this test.

The tooling operation, during which toolmakers make the necessary dies and punches required to convert the antenna to a production line item, is another important link in the manufacturing program. After the tools are made, and a pilot run of the antenna is completed, it is once again subjected to testing ground, electrical and mechanical laboratories for a recheck. If the antenna shows no marked changes from its prototype, it is sent out to the various test sites. If field reports bear out the engineering reports, the antenna is put into production, and turned over to the sales department.

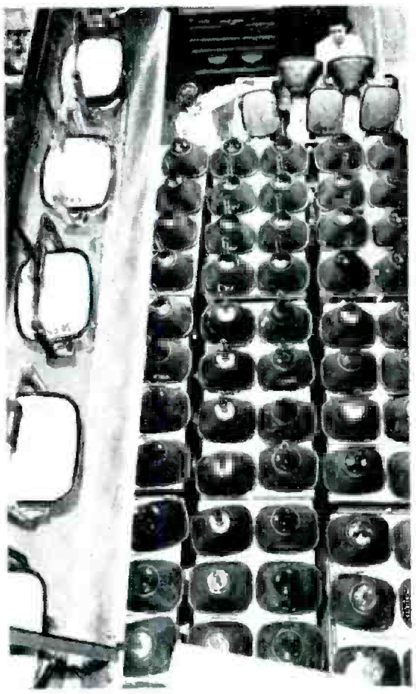
### *Credits*

The writer is extremely grateful to R. W. Cronshey, Radiart antenna engineer, and the Taco engineering staff, who supplied plant-facility data and illustrations for this report.

[2]Taco, Sherburne, N. Y.

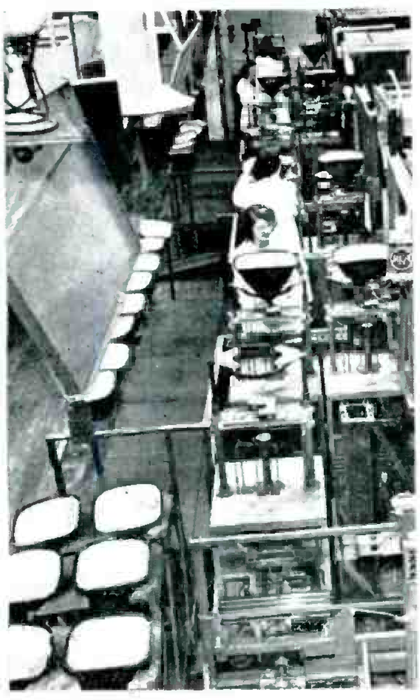
[1]Lippert, K.: TeleVision Engineering; August, 1950.

# 17″ Metal-Shell Rectangular Production



Above: Two-level production: rectangular metal picture tubes being racked in formation beneath an elevated conveyor belt.

Below: Rectangulars riding on trolley carts, each of which contains a complete exhaust system, enter and pass along an 80-foot length of the machine. Emerging at the far end, the tubes are automatically sealed, ready for the application of the tube base.



(Above views taken at RCA, Lancaster, Pa., plant.)

Quick drying method, in which tubes are placed in special drying racks (bottom of view). Process follows application of luminescent materials to the face plate of the tube.

(Views above and below, taken at RCA, Lancaster, Pa.)

Rectangulars entering giant bake oven. Passing through a 103-foot oven, the tubes are subjected to controlled heat which bakes on the fluorescent screen face. Oven is linked by conveyor belts to insure an uninterrupted flow of tubes from one machine to another.

Glass-to-metal vacuum-tight sealing, at RCA tube department's Marion, Ind., plant. Glass face plate and the metal shell are placed on the rotating turntable of the machine where multiple oxygen fires form an oxide on the metal rim. The edge of the glass face plate is then melted in contact with the oxide-coated rim, to form the seal. A similar technique is used to bond the glass neck section of the tube to the smaller end of the metal shell.

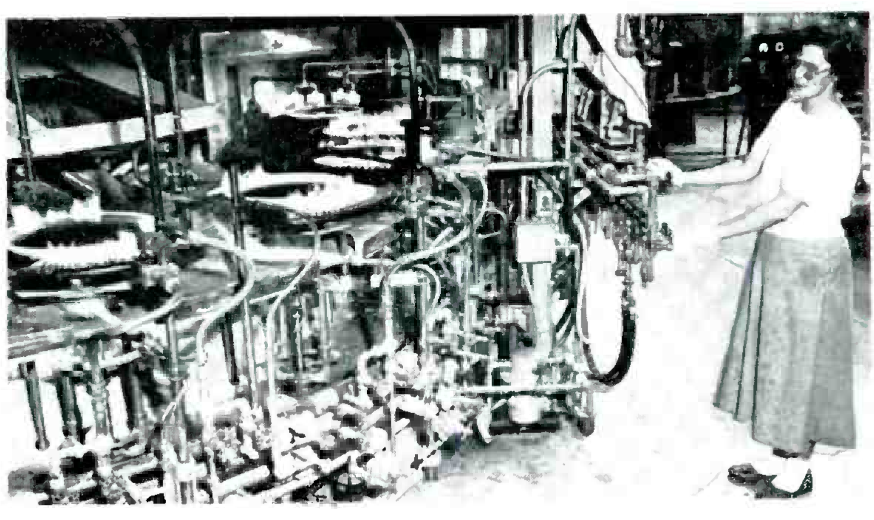
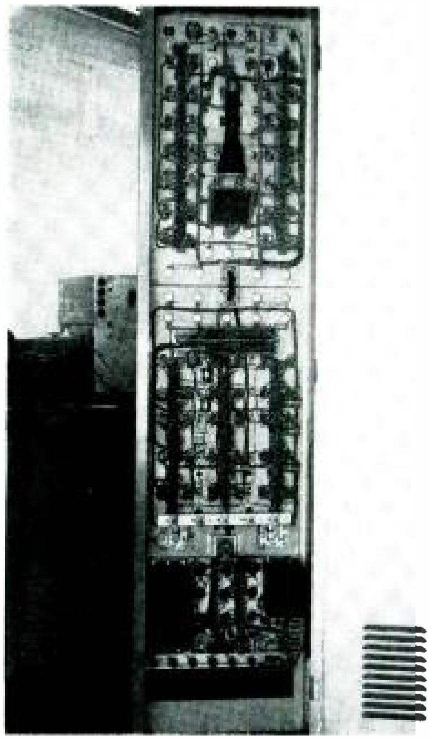


Figure 1
Studio sync generator prepared for waveform and voltage measurements, wiring and parts inspection. (Courtesy RCA.)



# TV Maintenance Procedures

by JOHN B. LEDBETTER, Engineer, WKRC-TV

***Use of Daily, Weekly, Monthly, Quarterly, Annual and Special Preventive Maintenance Test Schedules Found to Afford High-Efficiency Round-the-Clock Performance. Corrective Maintenance Programs Permit Operation During Emergencies, Providing Additional Operational Insurance.***

Efficiency in Television equipment maintenance depends not only on the time assigned to routine maintenance operations, but to the adoption of a well-rounded, logically planned schedule which encompasses preventive, corrective and emergency measures for each unit of equipment.

### *Planning the Schedule*

It is the responsibility of the chief engineer and technical supervisor to set up an efficient, workable maintenance schedule and to assign specific maintenance duties to such members of the engineering staff as are capable of carrying them out. In turn, it is the duty of each engineer to carry out all assignments to the best of his ability and to make any suggestions which might improve either the equipment operation or the efficiency of the maintenance schedule.

The time allotted to maintenance periods depends on such factors as economy, practicability, availability of manpower, available time, and limitations of the engineering operations budget. Although many stations will necessarily operate close to the minimum on some or all of these factors, it must be pointed out that such practice at best is only a measure of false economy. Let us consider, for example, a hypothetical maintenance schedule which allows sufficient time for routine daily maintenance and equipment adjustments, but makes no provision for emergencies. Such a schedule may work satisfactorily until a major breakdown occurs, but unless the maintenance schedule has been made flexible enough to cover the additional maintenance requirements, or unless the station has additional engineering personnel from which to draw, it will soon find itself hopelessly behind, not only in emergency maintenance facilities, but also in routine operation and adjustment.

Certain maintenance routines or methods are more efficient under certain conditions than others. All suggestions regarding new routines, improvements in scheduling, use of test equipment, etc., should be discussed in regular meetings of the engineering staff and adopted if worthwhile.

No maintenance schedule can be efficient unless permanent records are kept of equipment performance and operation. Data should include plate and grid *dc* voltages, waveforms, peak-to-peak voltages, and resistance measurements where practical. Periodic qualitative tests should be made of all equipment and the results compared with previous findings. It is also important that all cleaning, adjustments, modifications, parts and tube replacement, etc., be entered on the records. Such information not only prevents needless repetition of maintenance, but provides valuable information for emergency maintenance and makes stock inventory much easier.

In setting up a maintenance schedule for a station, it is suggested that first a list or outline of the most important or major points be made and then the schedule built around it, adding or eliminating certain features as individual conditions suggest.

### *Preliminary Analysis*

Utilization of senses (*sight, smell, touch*) represents the first step in the preliminary trouble-shooting program. In the *visual* routine, we have inspection for loose, broken connections, broken parts, defective insulation or wiring, evidence of overheating. The smell tests indicate overheated resistors, transformers, reactors. The final check, *touch*, reveals overheated parts, broken or loose connections, noisy or defective tubes, tube sockets, terminal boards; caution to be observed in touching, and danger involved in charged capacitors, overheated tubes.

### *Preventive Maintenance*

Five *daily tests* should be made to assure the success of a preventive maintenance program: (*1*) Notation of abnormal operating conditions; (2) analysis of 'scope and monitor indications; (*3*) preoperational adjustments and

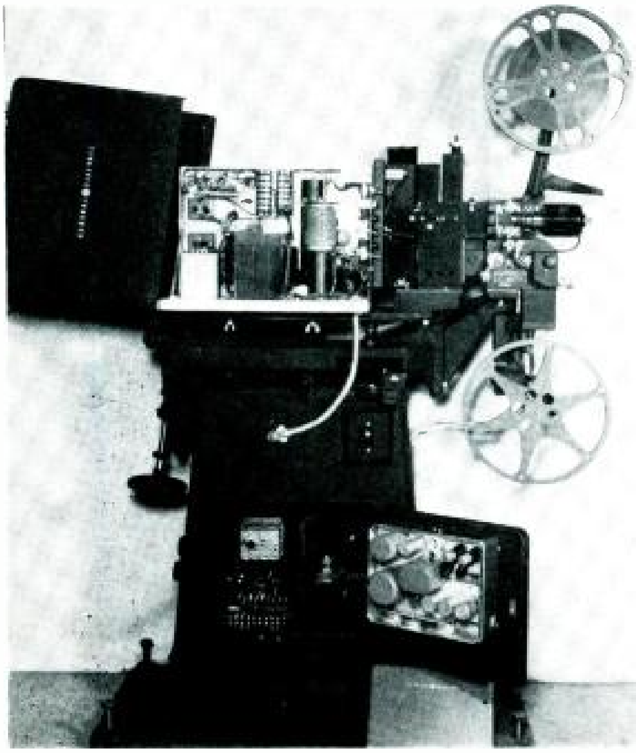


Figure 2
Pulsed light film projector, ready for maintenance. (Courtesy G. E.)

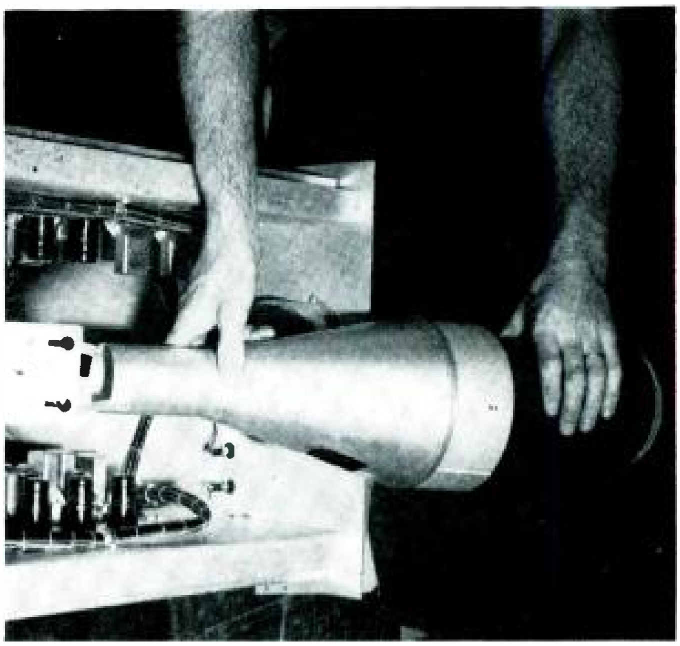


Figure 3
Removing a waveform monitor crt to wash face and safety glass, clean the socket and inspect other circuit components. (Courtesy G. E.)

checks: (*4*) general inspection after shut-down; (*5*) checking for indications of overload, excessive heating.

*Weekly tests* are also important: (*1*) Cleaning internal and external parts of equipment, and methods used; (*2*) inspection of cable connections, tightening adjustments . . . precautions, care in handling; (*3*) checking equipment control settings and adjustments; (*4*) extent of tests (linearity, video response, noise, distortion, alignment, etc.).

*Monthly tests* must also be made. These include: (*1*) Tube testing, notation or comparison of transconductance and quality readings . . . determining borderline tubes; (*2*) inspection and cleaning of all parts of equipment; (*3*) checking and recording cable socket voltages; (*4*) tightening coaxial connectors, fittings, terminations.

*Quarterly tests* should also be included: (*1*) Relay cleaning, adjusting . . . methods, precautions; (*2*) inspection of tube records.

In the *annual tests*, three steps must be followed: (*1*) Complete overhaul, inspection of equipment; (*2*) replacement of electrolytics; (*3*) modifications to equipment.

There are always special tests which must be included. These might include inspection of transmitting antenna, coax feed lines, antenna resistance measurements, field-strength measurements, investigation of reception complaints, phenomena, etc.

### *Corrective Maintenance*

*Operation During Emergencies:*

(*1*) *Correlation of personnel.* Importance of making definite assignments; efficiency and rapidity of emergency repairs. Need for well-defined system of operation. Obtaining full cooperation of the staff. Making full use of each engineer's technical ability.

(*2*) *Analysis of Trouble.* Importance of rapidity in determining source of trouble. Determination of operating conditions, source of trouble by waveform analysis. Point-by-point procedure for locating defective stages. Importance of holding regular engineering meetings for discussion of operation and analysis.

(*3*) *Emergency Circuit Changes.* List of possible equipment patching, substitution or re-wiring for temporary or emergency operation. Adjustments, operating procedures for prolonging life of equipment.

After every possible item has been listed, the chief engineer and technical supervisor should evaluate the importance of each item as it applies to individual or special station equipment. The maintenance schedule should then take on a form similar to the following:

### *Typical Maintenance Schedule*[1]

*Daily, Prior To Sign-On:*

(*1*) Make a visual inspection of all rack power supplies, tubes, and voltage settings.

(*2*) Check rack blower system for proper operation.

(*3*) Check all regulated power supplies; adjust if necessary.

(*4*) Check high-voltage power supply in film camera rack. Set high voltage and check interlock operation.

(*5*) Check regulated voltages in stabilizing amplifiers.

(*6*) Check timer count-down adjustments in sync generator. Set controls to mid-range positions.

*Daily, After Shut-Down:*

(*1*) Make a visual, feel, and smell test of all equipment. Check for evidence of overheating or improper operation.

### *Film Room Maintenance*

*Weekly:*

(*1*) Clean film projector and condenser lenses.

(*2*) Clean multiplexer mirrors.

(*3*) Clean slide projector lenses and mirror.

(*4*) Clean front surface of Balopticon

(*Continued on page 23*)

[1]This schedule is a composite representation of maintenance information supplied essentially by WMAR-TV and supplemented by RCA, G.E., DuMont, and WKRC-TV.

# TV PULSE

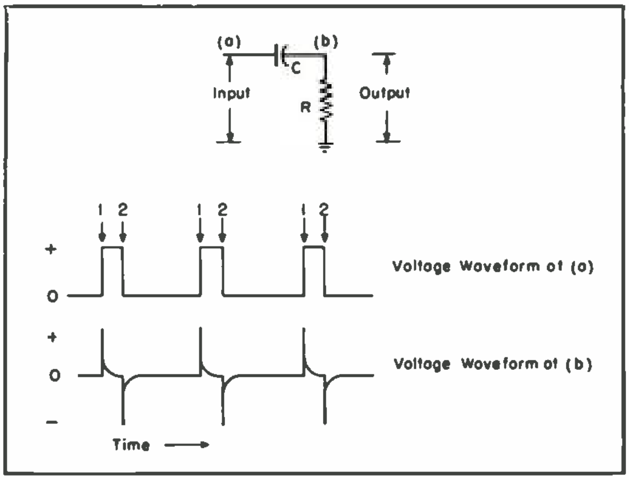



Figure 1
Common type of rc differentiator and its action.

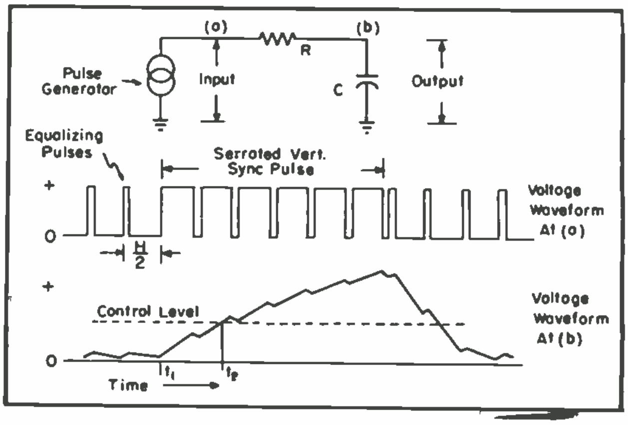



Figure 2
Simple integration circuit and its action.

FREQUENT USE OF DIFFERENTIATING circuits is made in the operation of television systems. Differentiation is the determination of the infinitesimal difference between two states of a variable quantity with respect to time. A familiar example is the relationship between distance (*s*), velocity (*v*) and time (*t*):

$$\frac{ds}{dt} = v$$

Simply, the above equation states that the rate of change in distance (*s*) per unit of time (*t*) is equal to the velocity (*v*) at the finite instant being considered; i.e., miles per hour equals velocity.

In Figure 1, a common *rc** type differentiator and its action are illustrated. The purpose of the circuit is to determine the rate of change of the voltage applied at (*a*) in the circuit corresponding to the instants labelled *1*. This is indicated by the sudden rise in voltage at (*b*) due to the surge of charging current through *R*. To obtain this effect, the *rc* time constant must be short compared to the interval of the pulse being differentiated. In a typical *rc* combination, used in the synchronization of a commercial thyratron horizontal sweep generator, we have values of 47,000 ohms and 50 mmfd, having a time constant of 2.35 microseconds, compared to a horizontal sync pulse interval of 5 microseconds.

The sudden positive voltage change at (*a*) produces a sharp pulse or pip at (*b*), falling off rapidly almost to zero before the end of the rectangular pulse. The output at (*b*) indicates that a sudden rise in voltage has occurred at (*a*). At *2*, a sudden fall in voltage occurs at (*a*) and is likewise differentiated at (*b*). Both or either of these pips may be required for synchronizing, etc. If these pips occur at the grid of a tube biased to cutoff, the negative pip will have no effect. In other applications either of the pulses may be eliminated by clipping.

### *Delayed Pips*

Where a delayed pip is required for some particular application, the pip occurring at *2* is used. Obviously, it is delayed with respect to the beginning of the rectangular pulse occurring at *1*. Any delay may be obtained in this way, simply by varying the duration of the rectangular pulse. Polarity of the resultant pip is not a factor, since phase inversion is obtainable in a single stage of amplification.

### *The Integrator*

We have observed that differentiation is the determination of the infinitesimal difference between two states of a variable quantity with respect to time. Integration, on the other hand, is the summation of successive differentials. In terms of the example relating distance (*s*), time (*t*) and velocity (*v*), the integral is the summation of all the finite changes in distance to arrive at the total distance traversed in a particular interval of time. Solving the equation:

$$\frac{ds}{dt} = v$$

$$ds = v\,dt$$

$$s = v \int dt = v\,(t_{stop} - t_{start})$$

Therefore, knowing the velocity of an automobile, for example, and knowing the difference in time between the start and stop of a journey, we can arrive at the total distance travelled by the simple process of integrating the differential equation.

The integration circuit is used in television to form the vertical sweep synchronizing pulse. In Figure 2 appears a simple integration circuit. The input at (*a*) is the RMA standard television signal occurring during the vertical blanking period. Only the equalizing and serrated vertical sync pulses are shown. Prior to the beginning of the serrated vertical sync pulse, the equalizing pulses cause the capacitor *C* to acquire a charge. This charge is reduced almost to zero before the next equalizing pulse has a chance to add to it. However, when the serrated pulse occurs, the charging interval is much greater than the discharging interval; thus each successive pulse adds to the charge on *C*. Therefore, the charge on *C* will reach the control level potential required to lock the vertical sweep oscillator in step with the transmitted signal.

### *Pulse Separation*

Pulse separation is required at the picture-tube chassis to accomplish two

*The *rl* circuits may also be used for differentiation in a similar fashion. However, it is more practical to apply the *rc* circuit.

# TECHNIQUES


**by C. J. AUDITORE**

TV Facilities Engineer, WOR-TV

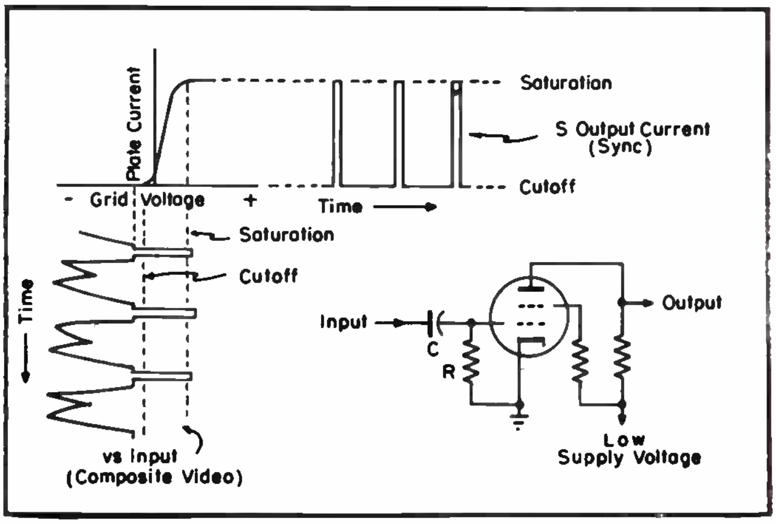




Figure 3
Sync separator action.

***First of a Series of Papers Based on Instruction Notes Prepared for WOR's TV Operating Engineers. Analyzed in This Installment Are the Differentiator, Integrator, Pulse Separator and Thyratron Sawtooth Generator.***

primary objectives: (*1*) Separate the mixed sync pulses in the blacker than black region from the picture signal, and (*2*) separate the mixed sync into horizontal and vertical synchronizing pulses.

The first of these objectives is accomplished in the sync separator. The operation of this circuit is shown in Figure 3. The composite video signal is applied to the tube circuit at *input*. The mixed sync portion of the applied signal is positive going and the picture portion is negative going. The *rc* coupling in the grid circuit has a relatively long time constant, producing grid-leak bias.

Grid-leak bias is produced in the following manner: The first positive-going pulses on the grid cause the grid to draw current, placing a negative charge in the grid side of the capacitor *C*. The negative bias is the result of this charge leaking off through the resistor, *R*. Furthermore, it will last over a relatively long period of applied signal, since the *rc* time constant is long. The charge on *C* is constantly replenished by subsequent positive-going signals, with no practical distortion of the signal, because the charging resistance presented by the grid-to-cathode circuit is relatively small.

The low-supply voltage and grid bias produce grid rectification, so that only the sync pulses will have sufficient amplitude to cause plate current to flow. The low plate and screen voltages will permit the sync pulses to drive the tube from cutoff to saturation. The overdrive into saturation will clip the sync pulse tips, providing a *clean* and uniform sync output. Such a circuit will provide a constant amplitude output for a wide variation of signal inputs.

### *Sync Separator Designs*

Sync separator circuits vary in design. The simple one-tube circuit may be expanded to provide separate tubes to cutoff the picture and clip the sync tips at a predetermined amplitude. The end result, however, is always the same.

The mixed sync must be further separated into horizontal and vertical sync pulses, the second objective of pulse separation. The circuit and voltage waveforms of Figure 4 show how this is accomplished. The voltage waveforms (*a'*) and (*a*) are the RMA standard television signals in the vicinity of the vertical blanking pulses between fields and frames, respectively.

The sync separator removes the picture component, and produces negative-going mixed sync pulses at (*b*). These are applied to the differentiator circuit consisting of $C_d$ and $R_d$. The differentiator circuit is responsive only to sudden voltage changes, resulting in the output voltage waveform shown at (*c*). The leading edge (occurring first in time—time shown from left to right) of the rectangular pulses contribute the negative pips, and the lagging edge contributes the positive pips. It is preferred to have horizontal synchronization coincident with the leading edge of the horizontal sync pulses. Therefore, a horizontal sync amplifier will be required after (*c*) to provide positive pips for synchronizing the horizontal sweep generator. The pips produced at the half-horizontal line frequency, because of the presence of equalizing pulses, are not effective, since the horizontal sweep generator is not susceptible to synchronization in the middle of its normal cycle.

### *Vertical Sync Amplifier*

The negative-going mixed sync at the output of the pulse separator (*b*) is coupled to the grid of $V_6$. The voltage waveform at (*b*) and (*c*) is identical. The vertical sync amplifier performs the following functions: (*1*) Serves to isolate the vertical integration circuit from the horizontal differentiation circuit: (*2*) converts the negative-going mixed sync to the positive-going pulses

# Perspective Distortion

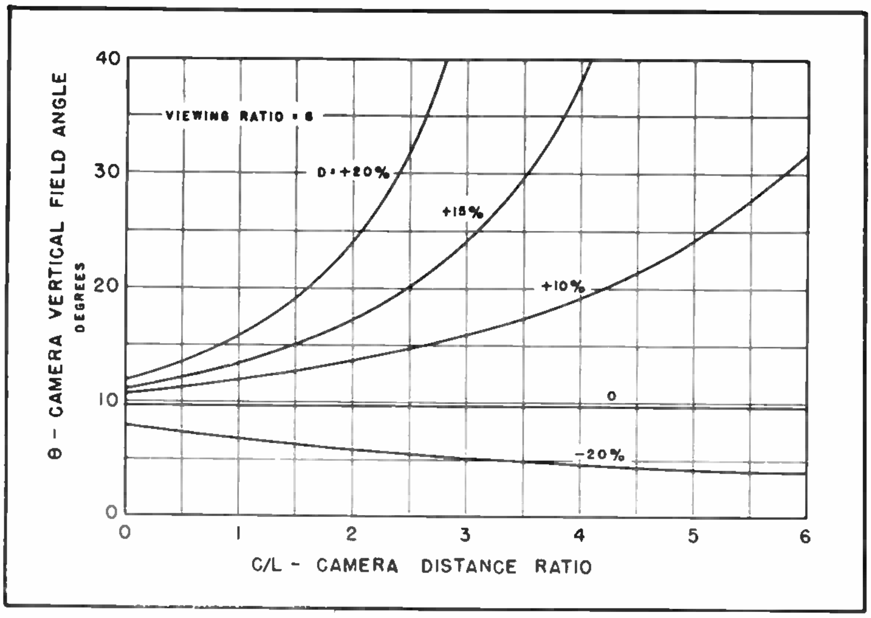



Figure 1
Curves showing limiting values of camera vertical field angle versus C L ratio for several values of distortion (See text for tentative values of C/L for different types of scenes.)

To KEEP perspective distortion within preassigned limits, a relationship must be maintained between the camera vertical field angle and the camera-distance ratio. This relationship is illustrated in Figure 1; it appears from these curves that for a maximum distortion of 20 per cent, a vertical field angle of 12° to 14° should be used for scenes of large depth and an angle as great as 25° used only for views of small depth.

The significance of the camera distance ratio $C/L$ may be illustrated by assigning tentative values of this quantity to typical television scenes. For outdoor scenes in which both distant and near objects appear, such as a view looking along a road or a general view of a baseball park, the length $L$ is large compared to the distance $C$ from the camera to the nearest object in view, and the ratio $C/L$ is much less than one. For a close view of a person, however, in which no significant objects appear either in front of or beyond the person the length $L$ is only the depth of the person along the camera axis, and the value of $C/L$ may vary from about four for a head view to about 15 for a full length view. Tentative values of the camera distance ratio for various scenes, using a vertical field angle of 25°, might thus be listed as follows:

General outdoor scenes..........*0-½*
Large objects such as buildings...*½-2*
Indoor scenes ..................*1-5*
Persons, furniture, etc.....*3 or greater*

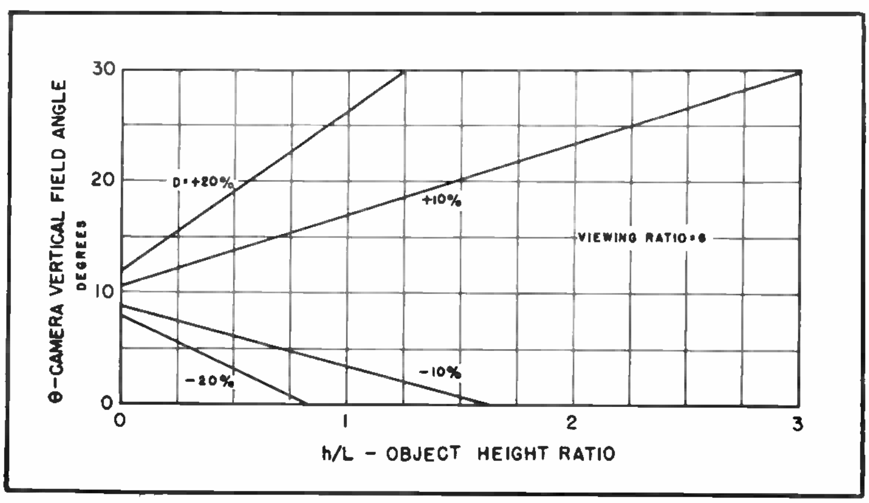
Use of these values with the curves shown last month and in Figure 1 of this installment shows that the greatest distortion occurs for outdoor scenes and for views of large objects. Less distortion is generally present with indoor scenes, and the distortion in views of persons and objects of small depth is usually not more than 20 per cent.†

It is frequently desired that the image of an object nearly fill the television screen in at least one direction. This may be considered a special case with reference to equation (4), since the camera vertical field angle becomes a function of the camera distance. For such cases equation (4) may be written, for given values of ρ and $D$, to give the camera vertical field angle as a function only of the object dimensions, rather than as a function of $C$ and $L$. If the image of the near part of the object just fills the screen in the vertical direction, $C = h/\theta$ where $h$ is the height of the near part of the object. Substituting this value for $C$ in equation (4) and solving for $\theta$,

$$\theta = \frac{1/\rho + D\,h/L}{1 - D} \qquad (5)$$

The fraction $h/L$ is termed the object

Figure 2
Curves showing limiting values of camera vertical field angle versus object height ratio required to keep perspective distortion within the plus and minus values indicated. The curves apply when the image just fills the screen in the vertical direction.




†Curves of θ versus C/L from equation (4) have been plotted in Figure 1 for several values of distortion:

$$\theta = \frac{1}{\rho}\,\frac{1}{(1 - D)(1 + C/L)} \qquad (4)$$

*A viewing ratio of six has been assumed since this value is representative of lower viewing ratios used for commercial television pictures, and is approximately the viewing ratio at which the eye just fails to resolve the picture structure of present 525-line pictures. It is apparent that with the greater viewing ratios generally required for a 405-line picture, either greater distortion is present, or for the same limiting values of distortion smaller camera field angles must be used. For pictures of higher definition, obtained for example with an 819-line picture, the opposite is true.*

# in TV PICTURES

by EDWARD C. LLOYD, Principal Marine Engineer, Bureau of Ships, Navy Department*

***Part II . . . Selecting Camera Field Angles Independently of Camera Distance to Minimize Distortion . . . Perspective Discontinuity in Composite Scenes . . . Criteria for Picture Definition.***

height ratio. Figure 2, plotted from equation (5), shows limiting values for $\theta$ required to keep the distortion between given plus and minus values. For many cases it may be possible to select $\theta$ for zero distortion, which from equation (5) is simply $\theta = 1/2$, corresponding to a camera distance $C = 2h$. Similar expressions may be obtained for cases where the object fills the screen in the horizontal direction, or where a given fraction of the screen height or width is filled. Equation (5) may be applied generally to all scenes if $h$ is taken as the height to be covered by the camera at the plane of the near portion of the object or object space. This use of equation (5) permits the choice of the camera field angle independently of the camera distance.

Figure 3 shows values of distortion as a function of $\theta$, obtained from equation (5), for several object height ratios. These curves illustrate that $\theta$ and the corresponding camera distance become more critical at near zero distortion as the object depth, $L$, increases.

Little information seems to be available that would permit a determination of acceptable values of distortion. For scenes involving close-ups of persons, it is interesting to note that for photographic portrait work the acceptable perspective distortion, as computed from minimum camera distances and lens focal lengths recommended by one writer,[2] is within the range of ±5 per cent. Hardy and Perrin[1] have stated that the improvement obtained by enlarging a photograph made with a small camera is very largely due to the improvement in perspective. The preference of most persons for enlarged photographs may be indicative of a preference for low perspective distortion.

The quantitative definition of perspective distortion may be usefully applied to studio scenes in which the background is provided by a screen on which still or motion pictures are projected. In such cases it is usually desired that the background scene appear to be a continuation of the studio scene. The background will not appear to be a realistic part of the studio scene, however, unless the perspective distortion of the background scene and that of the studio scene are in proper relationship to each other. When the proper relationship is not provided, a discontinuity of perspective, and a corresponding discontinuity of the scene, appears to the viewer to occur at the plane of the background picture. A familiar example of this type of discontinuity occurs in viewing objects through the surface of still water; objects partly below and partly above the surface appear to bend at the surface, and a series of equally spaced objects, such as the rungs of a ladder, appear to be spaced more closely below the surface than above it.

The perspective distortion of the background scene alone may be derived in a manner similar to that used for equation (2), and is found to be

$$D_b = \frac{1 - (P/A)(P_b/A_b)}{1 + C_b/L_b} \qquad (6)$$

where the subscript $b$ refers to the background scene. $A_b$ is thus the distance from the television camera to the background picture, and $C_b$ is the camera distance used in making the background picture.

If the background scene is to appear to be a continuation of the studio scene the depth of the studio scene will, in general, extend from the near plane of the studio scene to the plane of the background picture. Thus, $C = A_b - L$, and from equation (2) the distortion of the studio scene alone is

$$D = \frac{1 - P/A}{A_b/L} \qquad (7)$$

In order that no discontinuity appear at the plane of the background picture, lines common to both the studio scene and the background scene must appear to pass through the plane of the picture without a change in direction. Thus, any line passing through two scenes which extend an elemental depth, $dL$, on each side of the picture plane must, at the distance $dL$, appear to depart by the same distance, $dr$, from the positions it would have with no perspective distortion present. Since the proper image height, $r$, for the line is the same for both the adjacent scenes of elemental depth, and $dy$ is proportional to $dr$, the perspective distortion $dy/y$ must be the same for both scenes. From equations (6) and (7) this distortion is

$$dD_b = \frac{1 - (P/A)(P_b/A_b)}{P_b}\, dL$$

and

$$dD = \frac{1 - P/A}{A_b}\, dL$$

Equating these two expressions and simplifying gives the result $A_b = P_b$, which means, of course, that the television camera must be located at the proper viewing distance for the background picture if no discontinuity is to result. If the television camera is not so located a perspective discontinuity will result, and may be defined numerically by the expression

$$E = P_b\left(\frac{dD_b}{dL} - \frac{dD}{dL}\right)$$

from which

$$E = 1 - P_b/A_b \qquad (8)$$

It may be noted from this expression that positive values of discontinuity occur when the television camera is farther from the plane of the background picture than its proper viewing distance, and that negative discontinuity occurs when the television camera is closer than this distance. Positive discontinuity makes converging lines appear to converge more rapidly in the background scene than in the studio

*This paper is not related to the author's work for the Navy Department.

[1]Hardy and Perrin, *The Principles of Optics*, pp 465-469, McGraw Hill Book Co.; 1932.

[2]Swahn, H. C., *Portraiture with a Miniature Camera*, Popular Photography; Feb., 1949.

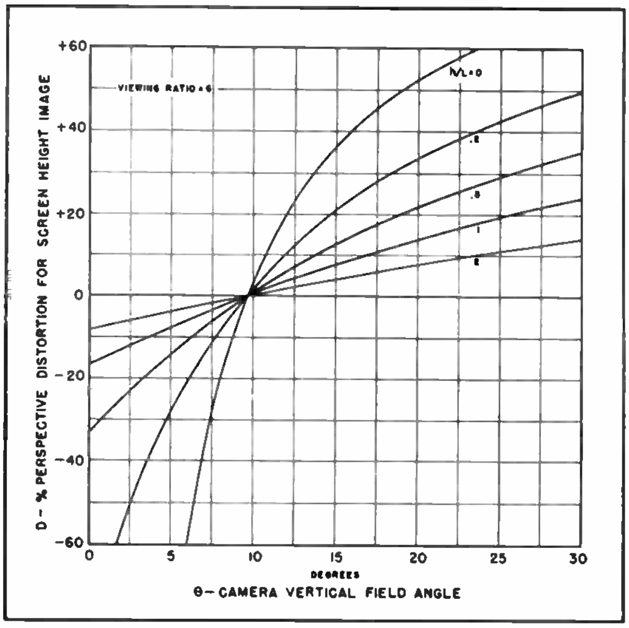



**Figure 3**
**Curves of perspective distortion as a function of camera vertical field angle for objects having different height to depth ratios. The field angle becomes more critical for objects or scenes of large relative depth.**

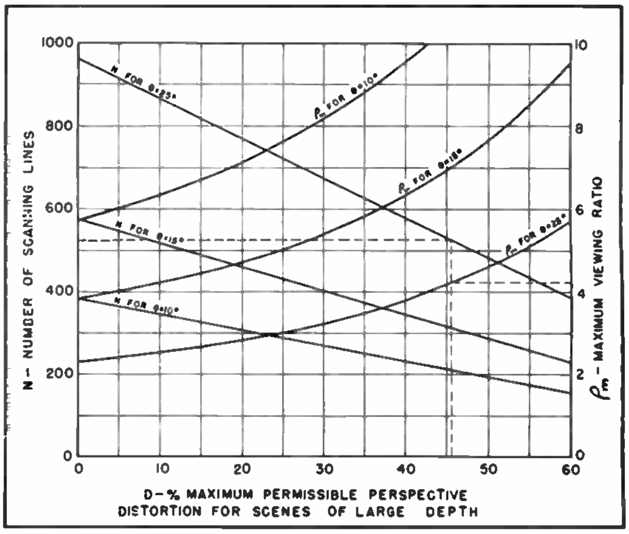



**Figure 4**
**Curves showing maximum permissible viewing ratio as a function of permissible perspective distortion, and the corresponding number of picture scanning lines required for satisfactory picture definition at the maximum viewing ratio. The curves for N are based on the assumption that two adjacent lines may subtend a maximum angle of 1.7 minutes of arc at the eye of the viewer. The dashed lines show the conditions existing for a 525-line picture.**

scene, and negative discontinuity has the opposite effect.

It is interesting to compute, from equation (8), the numerical value of discontinuity that occurs in viewing a scene extending through a water surface. For this case, equation (8) becomes

$$E = 1 - n_b/n$$

where $n_b$ and $n$ are the indices of refraction of the water and air respectively. This expression is exact only for small angles of view about a normal to the water surface, but applies with reasonable accuracy over angles of view that would be used. If the values of $n_b$ and $n$ are taken as 1.33 and 1.0 respectively, the value of $E$ is $-0.33$.

No data are available concerning values of $E$ that can be tolerated for television scenes; however, if the familiar effect obtained in viewing objects extending through a water surface is judged to be unsatisfactory, the acceptable values $E$ must lie between $-0.33$ and $+0.25$. The two values correspond to negative and positive discontinuities having the same effect.

Reference has been made to lines that are common to both the studio scene and the background scene. It is not necessary, however, that there actually be lines in one scene that extend continuously into the other in order for a discontinuity to appear; rather, any succession of objects, some of which are in one scene and some in the other, may appear to be separated by a discontinuity that is inferred by the viewer from the relative direction of lines in the two scenes.

### *Criteria for Picture Definition*

For established values of maximum perspective distortion and desired camera field angle, the corresponding maximum permissible viewing ratio may be computed from equations (3) or (5), dependent only upon the physical proportions of objects or scenes that are to be televised. The maximum viewing ratio, so determined, requires a picture definition such that the picture structure appears to have satisfactory continuity, and this in turn permits determination of the minimum number of scanning lines** and channel bandwidth.

From equation (5) the maximum viewing ratio is

$$\rho_m = \frac{1}{\theta(1-D) - D\,h/L} \qquad (9)$$

where $D$ is the greatest distortion permitted and $\theta$ is the desired camera vertical-field angle. Here, $h$ is the height to be covered by the camera at the plane of the nearest portion of the object or object space. In general, the permissible (positive) distortion varies for different scenes; that is, $D$ is a function of $h/L$ in equation (9). Lacking experimental data by which this function could be determined, it is assumed that the denominator of (9) is a maximum when $h/L = O$. It is probable that permissible values of distortion increase with scenes of increasing depth, but within limits of such additional distortion the assumption made is not affected. For commercial television pictures, scenes involving practically all values of $h/L$ are televised, and the determining value of $\rho_m$ then corresponds to $h/L = O$:

$$\rho_m = \frac{1}{\theta(1-D)} \qquad (10)$$

With the maximum viewing ratio determined from equations (9) or (10), the required number of scanning lines is $N = 1/k\,\alpha\,\rho_m$, where $\alpha$ is the maximum permissible angle, in radians, at the eye of the viewer subtended by two adjacent scanning lines. The factor $k$ has a value of 0.92 to 0.95, corresponding to the percentage of the total number of lines that form the picture.

The angle $\alpha$ is a measure of the apparent continuity of picture structure, and a determination of its optimum value for television pictures has been the subject of a number of investigations. It has been shown that, for the eye not to resolve adjacent picture elements, $\alpha$ must not exceed about one minute of arc.[3] This agrees with the accepted value of the limiting resolution of the eye for two adjacent points‡. For television pictures, however, it has been held that this condition need not be met under all viewing conditions. For example, Schade[4] found that at a

**Assuming that the relationship between horizontal and vertical definition is fixed.

[3]Engstrom, E. W., *A Study of Television Image Characteristics*, Part I, Proc. IRE; Dec., 1933.

[4]Schade, O. H., *Electro-Optical Characteristics of Television Systems*, Part I, RCA Rev.; Mar., 1948.

‡Ref. *1*; p. 19.

viewing ratio of four, apparent picture definition improved with pictures of up to 800 lines, corresponding to $\alpha = 1.1'$, but concluded that a 500-line picture, corresponding to $\alpha = 1.7'$, is acceptable. Engstrom[4] found that a value of approximately 1.5′ corresponded to an "ideal viewing distance," with a screen illumination of five to six foot-candles, but found that at 20 foot-candles illumination the viewing distance necessary for the same apparent picture continuity increased 30 to 40 per cent, corresponding to a value of $\alpha = 1.1'$. A viewing ratio of six, assumed earlier for a 525-line picture (490 active lines), corresponds to a value of $\alpha$ of 1.2 minutes of arc.

Goldmark[5,6] has indicated that a value of $\alpha$ of about 1.7 minutes of arc is acceptable, and gives the following expression for the "optimum viewing distance" as a function of the total number of lines N, where $\alpha$ is expressed in minutes:

$$\rho = \frac{10800}{0.92\,\pi\,\alpha}\,\frac{1}{N} \qquad (11)$$

Although use of values of $\alpha$ of less than 1.7 minutes may be desirable, this value is assumed for the purpose of determining the minimum number of scanning lines. Substituting the value 1.7 for $\alpha$ in equation (11) and combining with equation (9) gives, as the number of scanning lines required,

$$N = 38.4\,\theta\,(1 - D) - 2200\,D\,h/L \qquad (12)$$

where $\theta$ is expressed in degrees. From this expression it can be seen that a 960-line picture is required for zero perspective distortion with a 25° camera-field angle, regardless of the object dimensions.

For commercial television, where the limiting case probably occurs for scenes in which $h/L$ assumes values close to zero, equation (12) becomes,

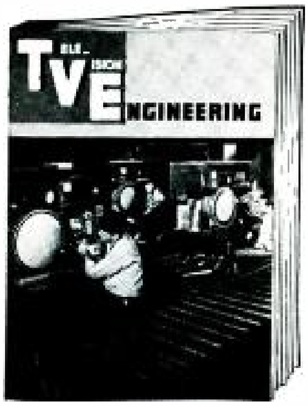
$$N = 38.4\,\theta\,(1 - D) \qquad (13)$$

Figure 4 shows curves obtained from equations (10) and (13) superimposed, and indicates at once the values of N and ρ, for given values of distortion and camera vertical field angle. The dashed lines indicate that at a distoron of 46 per cent, a 25° camera lens may be used with a 525-line picture viewd at 4.2 screen heights. To obtain a picter[e] of not more than 25 per cent distortio[n] at this angle, however, requires a view[-]ing ratio of three and a 720-line pic[-]ture; zero distortion requires a viewin[g]

(Continued on page 22)

[5] Goldmark, P. C., *Brightness and Contrast in Television*, Elec. Engineering; March, 194–
[6] Phillips, Donald, *The Status of Color TV as Viewed at the Current FCC Hearings*, TeleVision Engineering; April, 1950.

# Group Subscription Plan






## Perspective Distortion

(*Continued from page 21*)

ratio of 2.3 and a 960-line picture. The curves apply to scenes of large depth.*** For television systems in which scenes of large depth are not involved, similar curves may be plotted from equations (*9*) and (*12*).

In Figure 4, if values of $D$ selected are less than 42 per cent the viewing ratios required lie between 2.3 and 4.0 for a 25° field angle. It has been argued that the viewing distance should be at least great enough so that the viewer will not be required to move the head to view any part of the screen. The angle subtended at the eye by the screen diagonal, corresponding to this limitation, has been stated to be about 25°, and it seems to be primarily on this premise, together with the fact that the *average* viewing ratio in motion picture theaters is in the neighborhood of four, that a *minimum* viewing ratio of four has been proposed for television pictures. If, however, it is desired to view a television image in such a way as to produce an illusion of viewing the scene itself, the viewer must evidently train his view through nearly the same vertical and horizontal angles as those covered by the camera lens, just as if he viewed the actual scene from the camera position. In connection with practice in motion picture theaters, it is to be noted that viewing ratios between one and four are used, and that the objection to use of seats closest to the screen may be due, in part, to the fact that viewers in these seats must look upward at the screen—a condition that usually does not occur in viewing television.

In the determination of the necessary number of lines for a television system, the criteria of perspective distortion is, of course, only one of a considerable number of factors that may be considered. Usually opposed to the desirability of higher picture definition are the many factors related to channel bandwidth, simplicity of equipment, etc., that all dictate low picture definition. The desirability of reducing perspective distortion is a factor favoring higher picture definition. Further investigation is required, however, to determine acceptable values of perspective distortion for various types of television scenes.

### *Errata*

Equation (1), which appeared in Part I of this discussion, should have read: $D = 1 - y_v/y_p$.

In the seventh line below equation (7) $D'$ should have been $L'$.

***Part 1, Figure 3, TELEVISION ENGINEERING; January, 1951.

## Pulse Techniques

(*Continued from page 16*)

tor. If the value of *R* is made high enough, the tube cannot maintain its arc after the capacitor is discharged and it will extinguish. The cycle then repeats itself. The supply voltage, *E*, should be approximately five times the firing potential at the plate of $V_1$ for linear output. The firing potential at the plate of $V_1$ is set by the value of grid bias selected.

### *Output Waveform*

The output waveform at (*b*) consists of the sweep or *go-time* (*1-2*) and the sweep return or *flyback time* (*2-3*). The period from *1-1* corresponds to the free-running sweep output. However, when a positive sync pulse is applied to the grid just prior to the end of the free-running period, $V_1$ will fire ahead of the time and at the regular intervals set by the sync pulse period. The sweep *go-time* is determined primarily by the *rc* time constant and to a lesser extent by the values of the firing potential of $V_1$ and the supply voltage, *E*. The *flyback time* is determined by the resistance of $V_1$ in the fired condition for a given value of *C*, and it is short enough at horizontal and vertical sweep frequencies, presenting no problem.

### *Sawtooth Voltage Waveform Generator*

The sawtooth voltage waveform generator is satisfactory for electrostatic sweeps. This same circuit may be modified quite simply to render it useful for magnetic sweeps with the insertion of an appropriate resistance at the points marked *x-x* in Figure 5. The linear sawtooth-voltage charging and discharging cycle of the capacitor *C* is accomplished by a constant current flow, as shown previously. The constant current flow produces a rectangular voltage waveform across the resistance inserted at *x-x*. The modified output at (*b*) is obtained by direct addition of the resistor and capacitor voltage waveforms. This electromagnetic sweep voltage waveform provides the rectangular voltage wave for the production of a sawtooth current in the sweep coil, and the sawtooth-voltage wave to compensate for voltage drop across the coil resistance produced by the rising current.



## TV Maintenance

(*Continued from page 13*)

lens; clean inside at monthly intervals.

(5) Check film camera linearity. Use grating generator and bar slide if necessary.

(6) Check linearity of film camera monitor.

(7) Recheck film projector alignment. Make certain that the film picture is square with the raster, that title letters do not slope uphill or downhill in picture.

(8) Recheck Balopticon and slide projector alignment.

*Monthly:*

(1) Check camera cable connections for tightness.

(2) Check and tighten coax fittings on junction boxes.

(3) Check coax connections on control console.

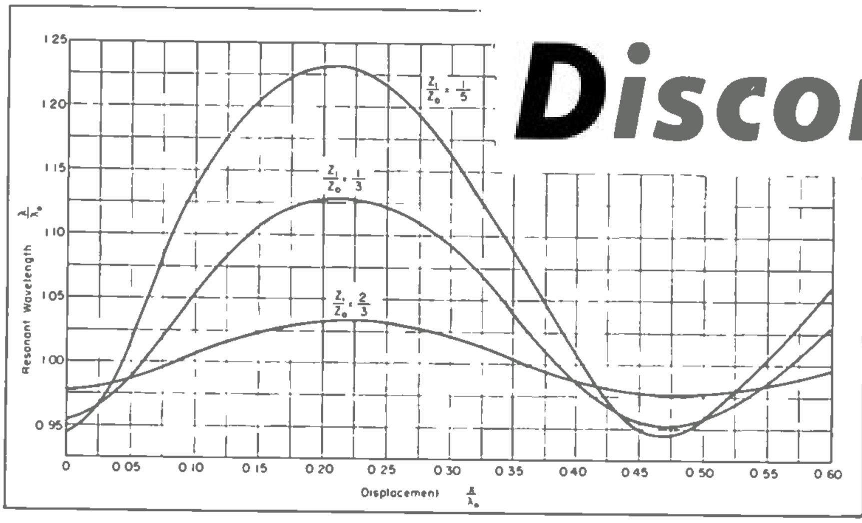
(4) Check and tighten coax fittings on relay and distribution amplifier panels.

(5) Clean control console chassis. Inspect for overheated components or other evidence of possible trouble. *Note:* Use compressed air for cleaning, making sure that excessive force is not applied in order to prevent damage to wiring or components.

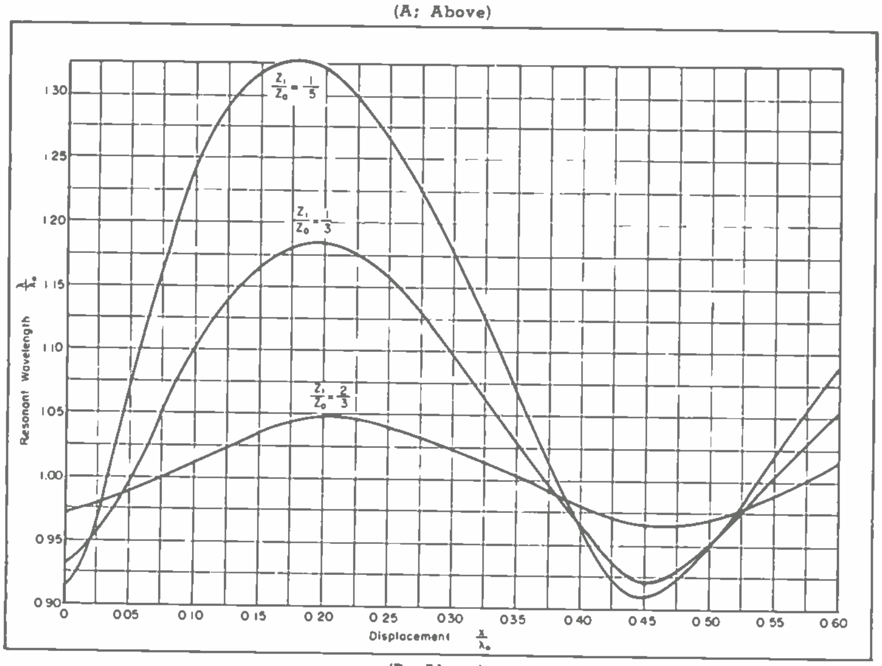
(6) Clean film camera chassis. Use compressed air.

[*To Be Continued*]

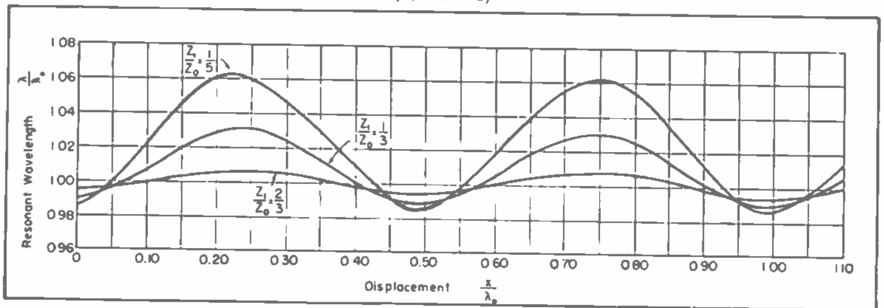
# Discontinuity



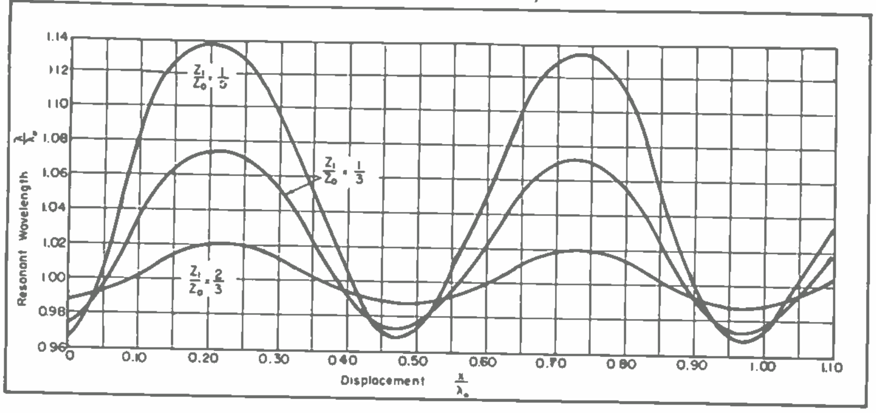

(A; Above)




(B; Above)




(C; Above. D; Below)




***Part II . . . Application of Charts. Typical Examples. Appendices With Characteristic Impedances of Sleeves.***

To illustrate the use of the charts or plots, developed to permit prediction of resonant coax-line tuning behavior, several examples have been evolved. Since the charts were derived on the basis of assumptions, cited in the initial installment*, they cannot be expected to predict results closer than about 10 per cent, even when a correction is made for discontinuity capacitance. The charts are helpful, however, in predicting, for specific cases, the approximate maximum tuning range obtainable, the linearity of tuning for various values of $x/\lambda_o$, and the effects of changes in the resonant *TEM* mode. Linear interpolation for values of $d/\lambda_o$ and $Z_o/Z_1$ provides results having sufficient accuracy for most engineering purposes.

#### *Example 1*

Let us suppose that the size and location of the sleeve of a $3\lambda/4$ mode coax resonator, are to be determined, the resonator having a characteristic impedance $Z_o = 50$ ohms which resonates a lumped capacitance, $C_o = 1.9$ mmfd. This resonant circuit is to be tuned from 24 to 21.4 cm, with 1.5 cm total linear motion of a metallic sleeve inside the cavity.

Choosing $d/\lambda_o = 0.08$, Figure 2 shows that the best linearity of tuning can be obtained at wavelengths longer than $\lambda_o$, and therefore we select $\lambda_o$ to be 21.4 cm. The normalized linear motion of the sleeve may be called $\Delta x/\lambda_o$ and is equal to 1.5/21.4 or about 0.07. The curve for $Z_1/Z_o = 1/5$ in Figure 2 shows that $\lambda/\lambda_o = 1.00$ at $x/\lambda_o = 0.383$. Subtracting 0.07 and going to $x/\lambda_o = 0.313$ on the curve, we find that $\lambda/\lambda_o$ has changed to 1.15 which exceeds the

*TeleVision Engineering, November, 1950.

(A)
Figure 1
Plot for the $3\lambda/4$ mode and $d/\lambda_o = .05$.

(B)
Figure 2
Plot for the $5\lambda/4$ mode and $d/\lambda_o = .08$.

(C)
Figure 3
Plot for the $5\lambda/4$ mode and $d/\lambda_o = .02$.

(D)
Figure 4
Plot for the $5\lambda/4$ mode and $d/\lambda_o = .05$.

# Tuning Charts for Resonant Coax Lines

by J. GREGG STEPHENSON, Receiver Section, Airborne Instruments Laboratory

desired limit of 1250 mc, where $\lambda/\lambda_o = 1.122$. It is, therefore, necessary to interpolate between values obtained from the curves for $Z_1/Z_o = 1/5$ and $Z_1/Z_o = 1/3$.

The results appear in Table I. The value of $Z_1 = 13.2$ ohms provides the required tuning range. The appropriate dimensions of the tuning sleeve can be calculated from this value of $Z_1$ and the appropriate equation in Figure 1*. Figure 2 reveals that frequency will increase with the dimension $x$ if $x/\lambda_o$ lies in the region between 0.30 and 0.40; in the region near $x/\lambda_o = 0.06$, the frequency would decrease with increasing values of x. Thus, the size and possible positions of the sleeve have been found.

| λ cm | $\lambda/\lambda_o$ | $x/\lambda_o$ | $d/\lambda_o$ | $Z_o/Z_1$ | x cm | d cm | $Z_1$ ohms |
|---|---|---|---|---|---|---|---|
| 21.1 | 1.00 | 0.383 | 0.08 | 0.20 | ... | 1.7 | 10 |
| | 1.15 | 0.313 | ... | ... | ... | ... | ... |
| 21.1 | 1.00 | 0.375 | ... | 0.33 | ... | ... | 18.3 |
| | 1.095 | 0.305 | ... | ... | ... | ... | ... |
| 21.1 | 1.00 | 0.380* | ... | 0.265* | 8.15 | ... | 13.2 |
| | 1.122 | 0.310* | ... | ... | 6.65 | ... | ... |

*Values obtained by linear interpolation

Table I. Results of interpolation for example I: $\lambda_o$ = 21.4 cm and $Z_o$ = 50 ohms

| Mode | $\lambda_{max}/\lambda_o$ From Curves | $\lambda_{max}/\lambda_o$ Corrected for $C_d$ | $\lambda_{min}/\lambda_o$ From Curves | $\lambda_{min}/\lambda_o$ Corrected for $C_d$ | Final Corrected Values max mc | Final Corrected Values min mc |
|---|---|---|---|---|---|---|
| λ/4 | 1.35 | 1.40 | 0.80 | 0.805 | 1117 | 643 |
| 3λ/4 | 1.188 | 1.23 | 0.92 | 0.926 | 974 | 732 |
| 5λ/4 | 1.109 | 1.15 | 0.96 | 0.967 | 919 | 783 |

Table II. Results from charts for example II: $\frac{d}{\lambda_o}$ = 0.08 and $\frac{Z_1}{Z_o}$ = ⅓

| $Z_1/Z_o$ | $\lambda/\lambda_o$ | $x/\lambda_o$ | $\Delta x/\lambda_o$ | x cm |
|---|---|---|---|---|
| 0.333 | 1.00 | 0.550 | 0.030 | ... |
| .... | 1.024 | 0.580 | .... | ... |
| 0.667 | 1.00 | 0.570 | 0.110 | ... |
| .... | 1.021 | 0.680 | .... | ... |
| 0.567 | 1.00 | 0.563 | 0.087 | 5.63 |
| .... | 1.024 | 0.650 | .... | 6.50 |

Table III. Results from charts for example III: $d/\lambda_o$ = 0.08

### *Example II*

Let us now suppose it is desired to find the maximum tuning range near 900 mc (33.3 cm) on various modes for a coaxial line of $Z_o = 77$ ohms, using a movable metallic sleeve of length $d/\lambda_o = 0.08$ and $Z_1/Z_o = 1/3$. At 900 mc, $\lambda_o = 33.3$ cm and $d = (0.08)(33.3) = 2.66$ cm. The correction factor for discontinuity capacitance $C_d$ should be used in this example, because we are interested in maximum, rather than incremental tuning ranges. Calculating $C_d$, the answer is 0.9 mmfd for a sharp-edged tuning sleeve having a $Z_1/Z_o$ ratio of 1/3, following methods described by Whinnery and Jamieson[3*]. Using the data in Figures 4*, 2 and 5 for the λ/4, 3λ/4 and 5λ/4 modes, and the correction factors from Figure 6*, the results of Table II are obtained.

From Table II it is apparent that the total tuning range decreases with the order of the *TEM* mode for a given discontinuity in the coaxial line.

### *Example III*

Our third example involves the determination of the motion of the sleeve

(*Continued on page 29*)

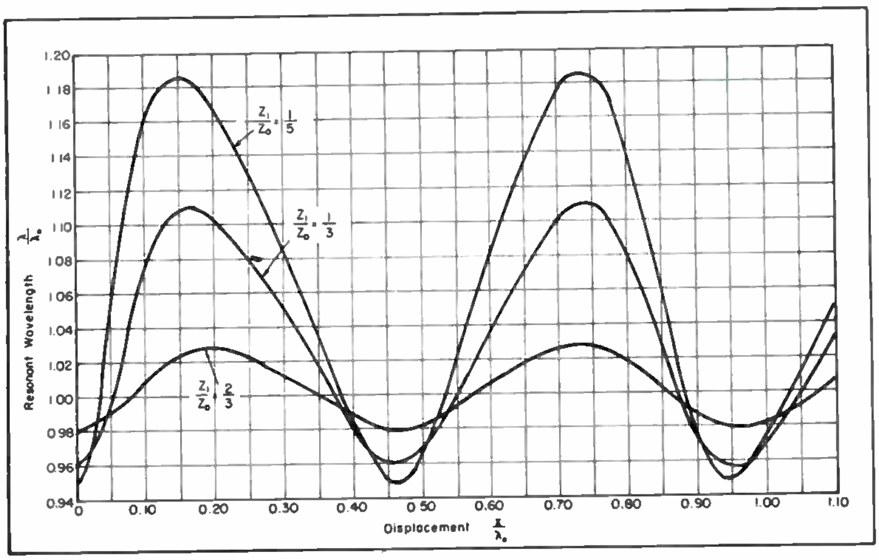



Figure 5
Plot for the 5λ/4 mode and $d/\lambda_o$ = .08.

# Instruments

# Production

# TV Parts

### *Portable Volt-Ohm-Mil-Ammeter*

A VOLT-OHM-MIL-AMMETER providing *ac-dc* voltage ranges from 0 to 5000, 1000 ohms/volt, is now available. Also provides *dc* to 10 amps and resistance range of 0-3000-300,000 ohms, and 3 megohms. Features direct connections, no cabling. Has a precalibrated rectifier.

Strap handle permits hanging the tester during work where both hands should be free. *Model 666-RL; The Triplett Electrical Instrument Co., Bluffton 2, Ohio.*

Triplett volt-ohm-mil-ammeter.

### *Microvolt Signal Generator*

A MICROVOLT SIGNAL GENERATOR that is said to have an accurately controlled output to .2 mv has been developed. Has double range of 125 kc to 110 mc and 150 to 220 mc, all on fundamentals. Crystal accuracy is available to .0025% for mobile bands of 30-50 and 152 to 162 mc.

Provides controlled modulated and unmodulated output from .2 to 100,000 microvolts through a 10 to 1 cast aluminum attenuator. May also be externally modulated from 15 to 10,000 cps.

AF output is 0-2 volts at 400 cycles. Contains a db meter to indicate reference level. *Model 292A; Hickok Electrical Instrument Co., 10521 Dupont Avenue, Cleveland 8, Ohio.*

### *Audio Oscillator*

AN AUDIO OSCILLATOR featuring an electronically-regulated power supply has been produced. Uses capacitors which are hermetically sealed in oil or mica. *Model TE 200K; El-Tronics, Inc., 2647 N. Howard St., Philadelphia 33, Penna.*

El-Tronics audio oscillator.

### *Molded Insulated Terminal Lugs*

MOLDED INSULATED MINIATURE TERMINAL lugs, stand-offs and feed-throughs are now being manufactured.

Stand-off types are offered with either molded LTSMG31 melamine or molded MTS-E1 phenolic to JAN P11 specifications. Use of the molded construction, instead of preformed tubular plastic, is said to eliminate internal air gaps which act as moisture traps. In addition, the method is claimed to provide more positive holding, units staying solid and tight under all normal heat and vibration conditions. *Series 1400; U. S. Engineering Co., 521 Commercial St., Glendale 3, Calif. Data available on request.*

### *TV Mask*

A TV MASK which is said to simplify the replacement of the 12JP4 and 12RP4 with the 12QP4A is now available.

Popularity of the 12QP4A as a replacement for the 12JP4 and 12RP4 is based on its close similarity to these older types, plus the features of a flatter face, and a gray filter face plate.

The greater radius of face curvature of the 12QP4A, which is the largest consideration in replacing the older types, is compensated for by the mask. When replacing the 12QP4 for the 12JP4 an ion-trap magnet must be added. *Cathode-Ray Tube Division, Allen B. Du Mont Laboratories, Inc. Direct all inquiries to Irving Rosenberg.*

### *Reversible Motors*

REVERSIBLE MOTORS which can be used as single-phase shaded-pole induction motors, as single-phase capacitor motors, or as two-phase motors, have been announced. The shading coil circuits of these motors can be designed for impedance or transformer coupling to the plate circuit of various tubes.

Two-phase motors are available with power ratings up to 1/50 horsepower for continuous-duty service. Motors supplied in four different frame sizes both with and without gear reductions. Both open and enclosed gear reductions are available in a wide range of gear ratios. All of the motors are said to feature high starting torque. *Barber-Colman Co., Small Motors Department, Rockford, Ill.*

### *Shock and Vibration Isolator*

AIR-DAMPED BARRYMOUNTS for vibration isolation are now available.

Unit mounts are 1" in diameter and have an overall height of 1" under minimum rated load. Load ratings range from .3 to 3 pounds per mount. Two mounting styles are available: Two hole mounting on 1.111" centers and four hole mounting on 1" centers. The center stud is tapped to a depth of ¼" with an 8-32 thread. *Series 6175 and 6695; The Barry Corp., 179-5 Sidney St., Cambridge 39, Mass.*

### *Resonant Paper Tubulars*

RESONANT CAPACITORS have been developed to meet increasingly critical *if* bypass functions.

Resonant capacitors can act as series resonant circuits, bypassing undesirable *if* signals and improve the filtering of *if* systems. Capacitors can be applied where it is necessary to bypass the *if* circuit to prevent *if* frequency currents or voltages (between 125 and 185 kc) from circulating in the system.

The capacitors are made by winding sections in such manner as to increase the inductance in same. By properly placing the tabs, the section inductance can be controlled so that the capacitor will be resonant in the *if* frequency band.

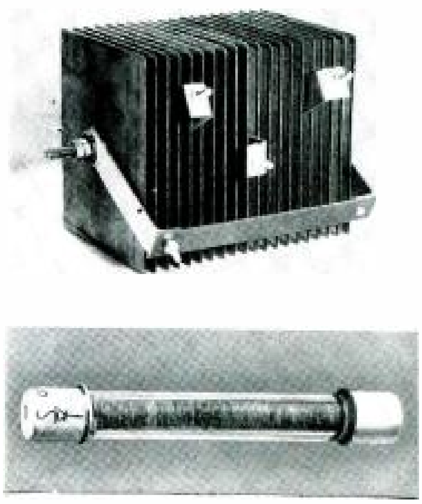
Capacitors are available in three standard ratings: .05, .1 and .2 mfd, 400 *wvdc*; measuring ½" d x 1⅛", ½" d x 1⅝", and 9/16" d x 1⅞", respectively. *Type RC; Aerovox Corp., New Bedford, Mass.*


Aerovox resonant capacitor.

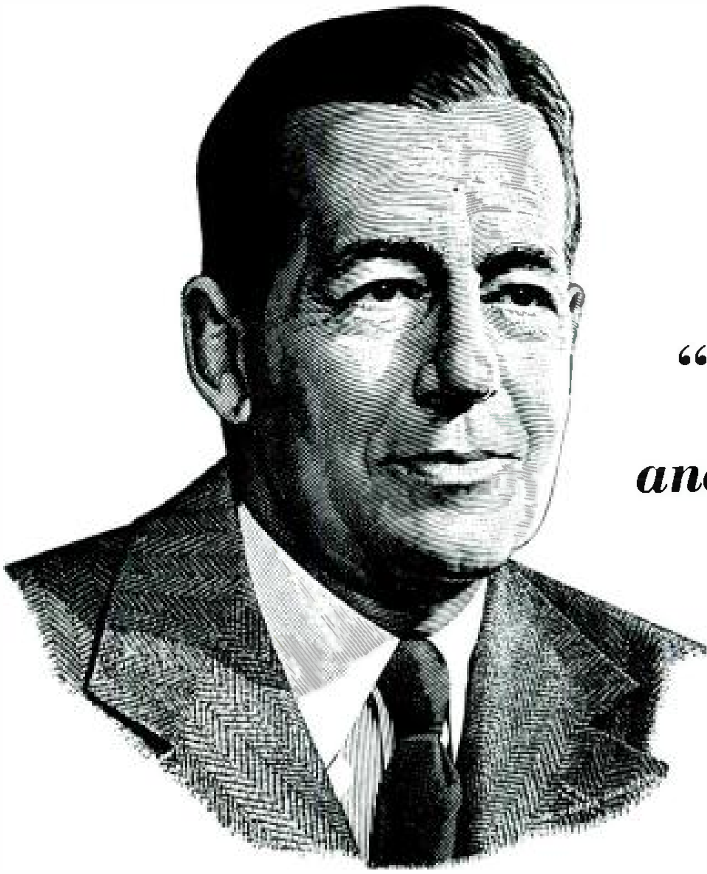
### *HV Selenium Rectifiers*

POWER RECTIFIER and enclosed high voltage selenium rectifiers have been announced.

Power rectifiers are available in 10 basic cell sizes. High-voltage selenium rectifiers have been produced in two cell sizes with inverse voltage ratings to 5000 and *dc* current ratings of 5 and 25 milliamperes in half-wave circuits and 10 and 50 milliamperes in full-wave circuits. *Centre-Kooled; Rectifier Division, Sarkes Tarzian Inc., 415 North College Avenue, Bloomington, Indiana.*



Sarkes Tarzian selenium rectifiers.



# VWOA News

### *The '51 Elections*

RETURNS OF the recent election showed that W. J. McGonigle was reelected prexy. Other elected officers included: A. J. Costigan, first vice president; H. L. Cornell, second vice president; W. C. Simon, secretary; R. J. Iversen, assistant secretary; and R. H. Pheysey, treasurer. . . . Named to serve on the board of directors were George H. Clark, A. J. Costigan, C. D. Guthrie, W. J. McGonigle, Captain Fred Muller, Jack R. Poppele, W. C. Simon and George E. Sterling.

### *Personals*

EDWARD E. FREEMAN, an oldtimer who recently became a VWOAer, began stirring up the ether as far back as April, '08, when he worked with Doc De Forest's group at 12 Broadway, N. Y. C., as well as vessels of the Merchants and Miners Line until '09. Activity on shore and ship stations followed: United Wireless Telegraph, Manhattan Beach *DF* and *Old Waldorf* WA. In '13 service began at the Telefunken Wireless Telegraph station at Sayville *SLL*, shifting over to *TWT* at 111 Broadway, N. Y. C., until '15. From there he moved to the *SORS* and sailed aboard several of their ships: the old Kilbourne and Clark ships. A five-year tenure, '16 to '21, followed with the U. S. N. at *NAH*, Brooklyn, where he served as a commissioned officer. In '21 he started with Marconi Wireless and RCA, and since that time has been in broadcasting at WJZ. . . . Ye secretary was a guest at the farewell dinner given to oldtimer Gene Cochrance upon his retirement from the FCC. Around 75 of Gene's friends and business associates were present. . . . The grapevine reports that congratulations are in order to VWOA member Max Ortelt upon his recent marriage. . . . Louis G. Pacent not only preaches radio, but he practices it on a broad scale and the whole family seems to be lending a hand, including Mrs. Pacent, who a short while ago served as Doc de Forest's secretary. The two Pacent boys are deep in radio. Louis G., Jr., is with Emerson as manager of the industrial development department, while Homer C. is a TV engineer with Hazeltine. . . . Joe Graham is with the FCC at the Millis, Mass., monitoring station. . . . T. M. Moss is now with Eastern Air Lines at the Municipal Airport in Atlanta, Ga., as ground station radio operator. . . . Capt. A. Begelman, who is head of the Maritime Coast Pilots Association, has sent his best wishes to Vic Villandre.

## Tuning Charts

(*Continued from page 25*)

necessary and the location of the sleeve in a $5\lambda/4$ mode resonant-coax system, where $C_o$ = 1.0 mmfd, $\lambda_o$ = 10 cm, $Z_o$ = 30 ohms, $Z_1$ = 17 ohms, and we want a total tuning range of 70 mc using a metallic sleeve of length $d/\lambda_o$ = 0.08.

From equation (6), in appendix 1, $x_o/Z_o = 50/30 = 1.67 = \tan 2\pi l_o/\lambda_o$. Therefore, $l_o/\lambda_o = 1.167$ and $l_o = 11.67$ cm. Because $Z_1/Z_o = 0.567$, it is necessary to interpolate from the curves in Figure 4. $\Delta f/f_o = \Delta\lambda/\lambda_o = 0.0235$. From Figure 4, it is apparent that good linearity of tuning can be obtained in various regions of $x/\lambda_o$; for example, for $x/\lambda_o$ = 0.52 to 0.65. The results from Figure 4 are presented in Table III. They show that a motion of about 0.9 cm (from $x$ = 5.63 to $x$ = 6.50) of the tuning sleeve is required to produce a frequency change of 70 mc.

### *Appendix*

*Characteristic Impedances of Sleeves:* Three types of tuning sleeve were illustrated in Figure 1*. The characteristic impedances are related to the various radii in the following equations:

*Characteristic impedance of main coax line*

$$Z_o = 138 \log_{10} \frac{\gamma_o}{\gamma_i} \text{ ohms} \qquad (3)$$

*Characteristic impedance of discontinuity on inner conductor*

$$Z_1 = 138 \log_{10} \frac{\gamma_o}{\gamma_2} \text{ ohms} \qquad (4)$$

*Characteristic impedance of discontinuity on outer conductor*

$$Z_1 = 138 \log_{10} \frac{\gamma_3}{\gamma_i} \text{ ohms} \qquad (5)$$

When a tuning sleeve is composed of a solid material of dielectric constant, $k$, an equivalent characteristic impedance $Z_1'$, and an equivalent length, $d'$, must be used in equation (2) and in referring to the tuning curves*.

*Equivalent characteristic impedance for dielectric sleeve on inner conductor*

$$Z_1 = 138 \sqrt{\frac{\log_{10}\frac{\gamma_o}{\gamma_1}\left(\log_{10}\frac{\gamma_s}{\gamma_1} + k \log_{10}\frac{\gamma_o}{\gamma_s}\right)}{k}} \text{ ohms} \qquad (6)$$

*Equivalent normalized length of dielectric sleeve*

$$\frac{d'}{\lambda_o} \approx \frac{d}{\lambda_o}\left(\frac{Z_1}{Z_1'}\right) \qquad (7)$$

Where: $d$ = actual length of sleeve
$d'$ = equivalent length of sleeve

Similar but more complicated expressions may be derived for composite sleeves made partly of metallic and partly of dielectric material.

## Personals

*Julius Haber* is now director of advertising and sales promotion of RCA Technical Products, RCA Victor Division.

Julius Haber

*Vice Admiral Edwin Dorsey Foster*, USN (Ret.), has joined the RCA Victor Division as director of the mobilization planning department. His department will serve to aid the company meet the government requirements for research, development, and manufacture of vital electronics equipment for the defense program.

*Everet S. Lee* is now editor of the *General Electric Review* succeeding Edward C. Sanders who has retired.

*Theodore A. Smith* has been appointed assistant general manager of the RCA Engineering Products Department, succeeding W. Walter Watts, now serving with Gen. Harrison of the NPA. *A. R. Hopkins* has become general sales manager, and *Barton Kreuzer* has been named general product manager of the department.

*Samuel Olchak* has been appointed assistant sales manager of Air King Products.

*Robert F. Field* has retired from the engineering department of the General Radio Co., after 21 years of service.

R. F. Field

*N. J. Peterson* has been named G. E. tube division sales manager, covering sales of products to the Federal government. *J. W. Duffield* has been appointed eastern regional sales manager of the tube division.

*Stanley P. Lovell*, president of Lovell Chemical Co., has been elected a director of Raytheon Mfg. Co.

*Robert L. Gibson* has been named general manager of the chemical department of General Electric Co., with headquarters in Pittsfield, Mass.

*L. D. Netter, Jr.*, has been appointed general sales manager of Altec Service Corp., 161 Sixth Ave., N. Y. 13.

*Gilbert C. Knoblock* has become general sales manager of the Standard Transformer Corp.

G. C. Knoblock

*John W. Belanger* has been named general manager of the large apparatus division, and *N. M. Dachemin*, general manager of the small apparatus division of G. E.

*Dr. Percy L. Spencer*, vice president in charge of the power tube division of Raytheon, has received priority of invention of basic magnetron strapping from the U.S. Patent Office.

*Donald B. Harris*, formerly executive assistant to the director of research of Collins Radio, has been named technical assistant to the president of Airborne Instruments Laboratory.

*John R. Howland*, formerly assistant to the president of Zenith Radio, has been appointed to head a newly created office of product research for Stewart-Warner.

*William Cranford* is now on the sales engineering staff of Cannon Electric.

# Industry Literature

*Automatic Electric Co.*, 1033 W. Van Buren St., Chicago 7, Ill., has released an 88-page catalog, *Relays and Switches for Industrial Control*, detailing telephone-type relays, stepping switches, mounting switches, general purpose relays and high-speed rotary-stepping switches.

*Sylvania Electric Products, Inc.*, Emporium, Penna., has released a 40-page tube substitution manual for substitute types of radio and television tubes. Nine sections provide text and charts on general tube classification, circuit modifications in which additional resistors are needed, substitute battery type tubes, substitute 150-ma and 300-ma tube types, substitute transformer and auto tube types, substitute TV receiving and picture tubes, and frequently needed change-over diagrams.

*Sarkes Tarzian, Inc., Rectifier Division*, 415 N. College Ave., Bloomington, Ind., has released a 64-page handbook covering power conversion and applications of selenium rectifiers. Handbook contains information on power rectifiers for high current applications, and high voltage enclosed rectifiers for low-current electronic applications. Booklet is priced at twenty-five cents.

*Lammert & Mann Co.*, 1753 Walnut St., Chicago 12, Ill., has issued a four-page bulletin, 501, covering impregnating equipment for sealing or bonding.

## ADVERTISERS IN THIS ISSUE



# Briefly Speaking . . .

STANDARDS which played so vital a role in World War II, have once more become a topic of the day. With scores of defense emergency problems beginning to pour on many desks, the striking possibilities offered by standardization, for conserving materials and simplifying procedures, are receiving particularly close attention. The unique features of standardization have been incorporated in a 12-page ASA booklet which reveals the significant part played by standards during the last war, and its potentialities in the present defense program. . . . Westinghouse Electric has announced the formation of an electronic tube division, and plans for three new plants to manufacture various types of tubes. E. W. Ritter has been appointed manager of the newly formed tube division. . . . A two-story addition is now being built by Sheldon Electric Co., at Irvington, N. J. . . . The Swedlow Plastics Co. has announced the opening of a manufacturing and fabricating plant at 333 N. Meridian Rd., Youngstown, Ohio. Fred Stefan has been appointed general manager of the new plant. . . . The spectacular Chicago fire which destroyed the huge warehouse located just outside of the Loop, burned out the entire showroom inventory and a large stock of tubes of Wells Sales. Fortunately the greater portion of the Wells inventory had been stored in three other warehouses, and business has been resumed at 833 W. Chicago Ave., Chicago 22, Ill. . . . Manpower problems were the subject of a special two-day conference of RTMA in Washington, recently. The meeting was highlighted by talks by John W. Craig of the Crosley Division of Avco, who is chairman of the RTMA industrial relations committee, Ewan Clague, Commissioner of Labor Statistics, U. S. Department of Labor, and George W. Taylor, professor of industry at the Wharton School, University of Pennsylvania.

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# Switches

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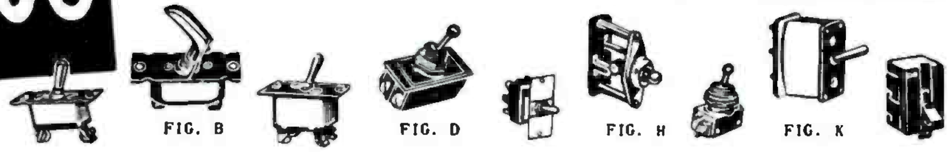
FIG. A FIG. B FIG. C FIG. D FIG. G FIG. H FIG. F FIG. K FIG. L

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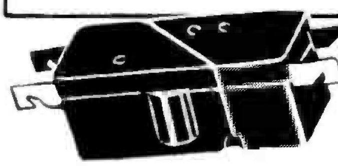
## TOGGLE SWITCHES

| STOCK NUMBER | FIG. | CONTACT ARRANGEMENT | MANUFACTURER & NUMBER | PRICE EACH |
|---|---|---|---|---|
| PH-500 | A | SPDT. | B18. | $0.35 |
| PH-503 | A | SPDT Center Off Mom Each Side. | B11. | .32 |
| PH-505A | A | SPDT Momentary. | B21. | .30 |
| PH-505 | A | SPST. | AN-3022-2B. | .30 |
| PH-506 | A | SPDT Center Off. | AN-3022-1. | .35 |
| PH-507 | A | SPDT Center Off Mom Each Side. | AN-3022-7B. | .32 |
| PH-513 | A | SPDT Center Off. | Cutler Hammer AN-3022-1B. | .38 |
| PH-514 | A | SPST. | Cutler Hammer B-5A. | .35 |
| PH-516 | A | SPST. | B5. | .35 |
| LT-104 | A | SPDT One Side Momentary. | Cutler Hammer 8905K568. | .35 |
| 309-168 | A | SPST. | 168553. | .30 |
| 309-178 | A | SPDT Momentary. | AN-3022-11B. | .35 |
| 309-181 | A | SPST Momentary. | Cutler Hammer 8211K6. | .35 |
| 305-172 | A Spcl. | SPST Momentary. | Cutler Hammer 8905K531. | .35 |
| 305-182 | A Spcl. | SPST Momentary. | Cutler Hammer 8905K630. | .45 |
| 370-14 | A | SPDT Center Off 1 Side Mom. | Cutler Hammer B-7A. | .30 |
| 370-4 | A | SPDT Center Off. | Cutler Hammer B-9A. | .35 |
| 370-25 | A | SPST Momentary. | Cutler Hammer B-6B. | .25 |
| 309-169 | B | SPST Momentary. | Cutler Hammer 8-19 | .35 |
| PH-509 | C | DPST. | AN-3023-2B. | .45 |
| PH-510 | C | DPDT Momentary. | Cutler Hammer 8715K2. | .50 |
| PH-511 | C | DPDT Momentary. | Cutler Hammer 8715K3. | .50 |
| PH-512 | C | DPST Center Off. | Cutler Hammer 8720K1. | .55 |
| 303-65 | C | DPST. | Cutler Hammer AN-3023-2. | .45 |
| 309-163 | C | DPDT Center Off Momentary. | Cutler Hammer C-11. | .55 |
| 309-162 | C | DPST. | Cutler Hammer C-1. | .45 |
| 309-164 | C | DPST Momentary. | Cutler Hammer 8711K3. | .40 |
| 305-87 | D | 1 Side DPST Mom, 1 Side SPST. | AH & H. | .95 |
| LT-100 | F | SPST. | Cutler Hammer. | .22 |
| LT-101 | F | SPST Momentary. | AH & H. W/Leads. | .20 |
| 301-51 | G | 4PDT Momentary. | Cutler Hammer 8905K12. | .75 |
| 305-140 | H | DT No Make Each Side. | Open Frame. | .25 |
| 309-161 | K | SPST. | Cutler Hammer 8781K3. | 1.95 |
| 309-170 | K | SPST. | Cutler Hammer 8905K656. | 2.25 |
| 301-41 | L | DPST. | AH & H | .75 |
| 305-76 | L | DPST. | AH & H—Open Frame. | .75 |
| 319-50 | L | SPST. | Allied Elec. Mfg. Corp. | .28 |
| 305-170 | Spcl. | SPST. | Cutler Hammer Type B13. | .40 |



## SWITCHETTES

| STOCK NUMBER | MANUFACTURER'S TYPE NUMBER | CONTACTS | TERMINAL LOCATION | UNIT PRICE |
|---|---|---|---|---|
| 303-20 | CR1070C103-A3 | N.C. | Side | $0.47 |
| 301-29 | CR1070C103-B3 | N.O. | End | .47 |
| 303-34 | CR1070C103-C3 | 1-N.O. 1-N.C. | End | .47 |
| 303-18 | CR1070C103-F3 | 1-N.O. 1-N.C. | Side | .47 |
| 303-19 | CR1070C103-E3 | N.O. | Side | .47 |
| 303-43 | CR1070C123-B3 | N.O. | End | .47 |
| 303-23 | CR1070C123-C3 | 1-N.O. 1-N.C. | End | .47 |
| 305-83 | CR1070C123-J2 | SPDT | End | .47 |
| 303-22 | CR1070C123-J4 | SPDT | End | .47 |
| 303-17 | CR1070C124-M4 | SPDT | Side | .47 |
| 303-16 | CR1070C12B-C3 | 1-N.O. 1-N.C. | End | .47 |

## LEAF SPRING SWITCHES

| STOCK NUMBER | CONTACT ARRANGEMENT | SPEC. INFORMATION | BACK OF PANEL DIM. | PRICE EACH |
|---|---|---|---|---|
| 303-96 | HPDT One Side. | . . . . . . . . . | 3¼x1¾x¾ | $1.65 |
| 311-58 | 1A Momentary & 1A. | W/Escutcheon Plate | 3¼x¾x¾ | 1.35 |
| 309-167 | 2C One Side. | . . . . . . . . . | 3x11/16x11/16 | 1.25 |
| 305-183 | 3A Momentary & 3A Momentary. | . . . . . . . . . | 3⅛x1⅛x¾ | 1.50 |
| 319-43 | DPDT Center Off. | Mossman. | 3⅞x2x1⅜ | .85 |
| 319-42 | 4PDT Center Off Mom One Side. | Mossman. | 3⅞x2x1⅜ | .95 |
| 309-159 | 3B. | Mossman. | 3⅞x2x1¼ | .85 |
| 309-158 | 2D. | Mossman. | 3⅞x2¼x1⅜ | .85 |
| 309-165 | 1A. | Mossman. | 3⅞x1 5/16x1¼ | .75 |
| 311-96 | 4PDT. | Bakelite Actuator. | 3 7/16x1⅜x⅞ | .85 |
| 305-164 | 3A. | . . . . . . . . . | 3⅛x11/16x11/16 | 1.25 |
| 319-43A | DPDT Center Off Mom Each Side. | Mossman. | 3⅞x1⅜x2 | .95 |
| 305-165 | 3A & 3A. | Switchboard Type. | 4¾x1½x¾ | .95 |

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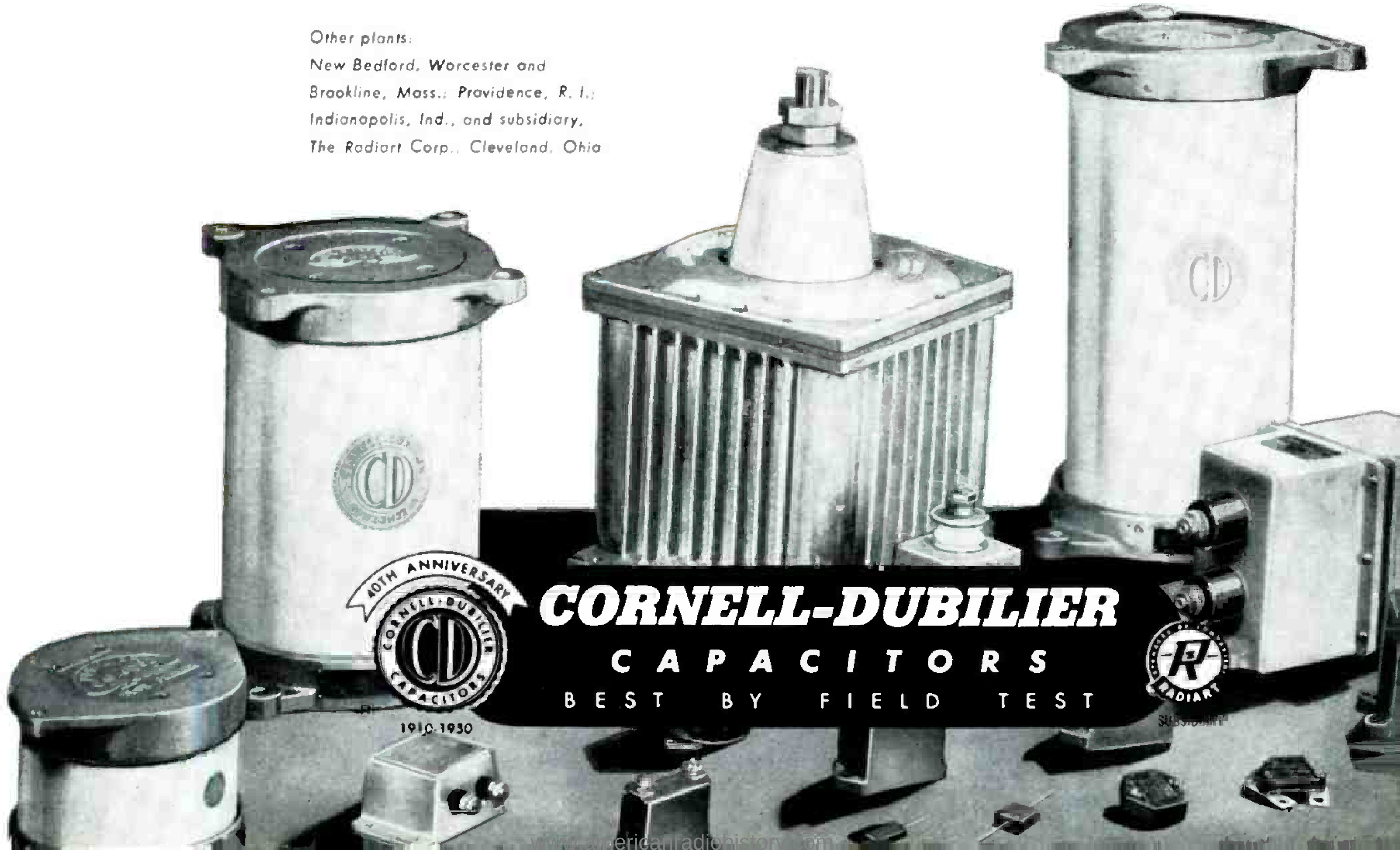

# New Towers in the Sky . . . .

**Thank you, Mr. Chairman, for a real Broadcasters Program!**

The IRE Professional Group for Broadcast Transmission Systems and its Chairman, have done a wonderful job in preparing a series of 14 technical sessions and symposia of vital interest to every broadcast engineer, at the IRE Convention.

Many of the papers have been organized into a single day so that the busy engineer who can spare only a day can enjoy a "feast" of the latest information. Tuesday, March 20, is "Broadcast Day" at the IRE National Convention, as you will see in the next column. On all four days are presented papers of interest to broadcast and television engineers.

The IRE Professional Group plan serves to focus concentrated attention to the specialized fields of interest in every department of radio science. The plan brings out the best of papers on each subject. Tremendous credit is due the Chairman, well known to this audience, for his planning for Broadcasters.

**Broadcast Day—Tuesday March 20, 1951**

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Morning—Symposium: "Broadcast Transmission Systems," with a general meeting of the Professional Group plus five technical papers.

Afternoon—Symposium: "The Empire State Story." For the first time the complete technical details of the world's tallest radio tower will be told by the engineers who built it and will use it; Dr. Frank G. Kear, Mr. O. B. Hanson, Mr. William L. Lamb, Mr. B. H. Richardson, and Mr. Herman E. Gihring. Over 200 slides will illustrate the building and testing of the tower.

Evening—Symposium: "Color Television," given by a panel of leading engineers from the companies engaged in color television research.

This truly will be a day no broadcast engineer can afford to miss—come and enjoy it.

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