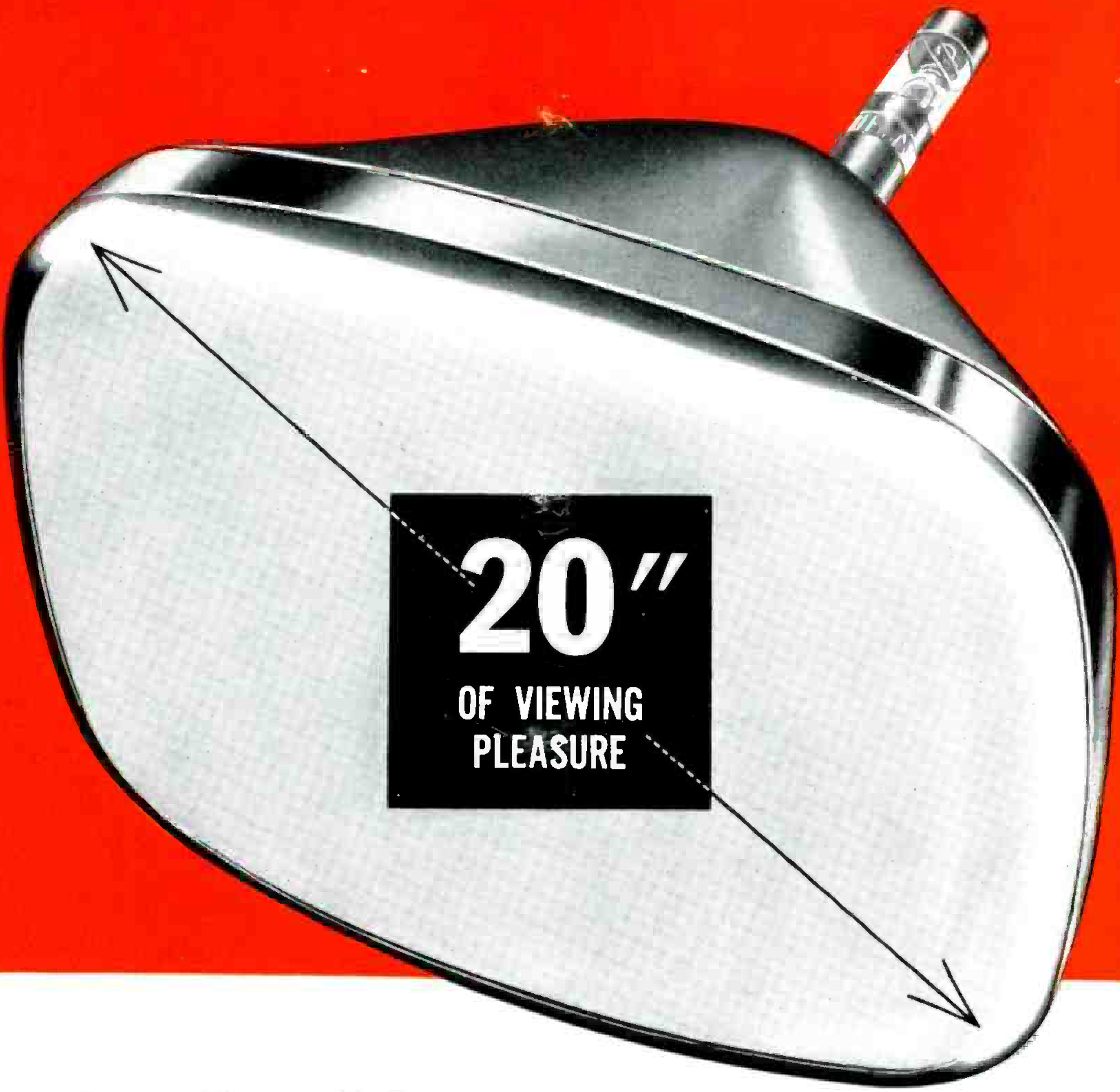
TELE-VISION ENGINEERING

APRIL, 1951

The News-Engineering Journal of The TV Industry

Surveying long-distance scattering on the veryhighs with a yagi system



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

VOLUME 2 — APRIL, 1951 — NUMBER 4

MONTHLY FEATURES

Cover Illustration

Dr. Henry G. Booker, Associate of The School of Electrical Engineering, Cornell University, studying long-distance scattering effects on the veryhighs, with a yagi-antenna system. (*Courtesy LaPointe-Plascomold Corp.*)

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TELE-VISION ENGINEERING
LEWIS WINNER, Editor

April, 1951

Wanted . . . More Engineers — Industry today is plagued by a shortage of materials, but its most critical shortage may well turn out to be that of engineers and scientists. It has been reported that industry has absorbed the last two graduating classes of nearly 50,000 men each, and is now contending in a highly competitive manner for the 30,000 who will graduate in '50. Many of these, who are in ROTC programs, will have to go into the armed forces, and others who have draft deferments will be subject to later call. It has been estimated that the number of graduates in engineering will decline from 30,000 in '51 to 17,000 in '54, unless something is done at once to provide a solution. Scott Helt of DuMont has suggested as one step in the solution, the establishment of a Reserve Specialist Training Corps, such as the Students Army Training Corps of World War I. In his opinion, it would also be well to encourage more women to enter engineering. There is no reason why qualified women engineers cannot undertake jobs which require little physical exertion. . . . Reporting on this problem recently, H. N. Muller, Jr., of Westinghouse, declared that industry can ease the situation by providing a flexible program of orientation and training for its young engineers, and by making sure that its engineers are really involved in engineering work.

The Partial Freeze-Lift Plan — With FCC geared to allocate either 65 or 70 channels in the ultrahighs, assign 52 of these new channels to augment the present 12 for national coverage on a new separation basis to prevent interference, and most believing that the plan has many redeeming features, the prospects for an early resumption of building and installing appear to be really promising, for the first time in three years. Specifically, when we might have a curtain raising will depend on the results of the round-the-clock hearings soon to begin, when many are expected to decry the suggested plan, and many more will applaud the proposal, loudly. The controlled-materials plan, which will go into effect on July 1, is also expected to play a key role in the opening up of more sight lanes soon. Indications are that the NPA is fully aware of the importance of telecasting on an expanded scale, and that accordingly every effort will be made to allot substantial quantities of materials for production and construction.

TV Revenue Leaps—Regarded by some, a short while ago, as just a vapid infant whose potentialities were still quite remote, television proved in '50 that these sour prognosticators were really wrong. For it was a really bouncing baby during this period accounting for striking net profits not only in manufacturing, but broadcasting, too, with fifty-four of the nation's stations reporting profitable operations and better than one-half of these reporting incomes of $100,000 or more. Eight stations reported earnings in excess of $400,000. . . . On the manufacturing front, Philco reported an increase of 300 per cent on sales over '49. A gain of 130 percent in sales, and 175 percent in income, was reported by Olympic Radio. According to Stromberg-Carlson, production of receivers in '50 increased 50 percent over the previous year.

Industrial TV Becomes a Factor — Wired sight and sound, often described as just an experiment, has been found by many to be more than a lab project. In the steel industry, for instance, wired TV is now being used in numerous operations. In one case, it's serving to control quality in the continuous casting of steel billets. According to the steel experts, the pouring operation is a very critical one. To get good sound billets without spongy spots or air inclusion, the mold must always be kept full to a certain exact level. Formerly, it was necessary to station a man directly at the mold top to watch the pouring and be prepared to signal an operator fifty feet away. There was always the possibility of a misunderstanding, the hazard was very high and the discomfort from radiant heat became unbearable. TV has solved this problem with a camera featuring a long focus lens suspended above the molten surface in the mold, providing an exact, instantaneous and continuous picture of the molten metal level to a viewing screen some distance away.

TV Engineers Win Applause—Replying to the recent biting criticism of industry's engineers by FCC member Robert F. Jones, RTMA's board chairman, Robert Sprague, declared recently that their record for more than a quarter of a century speaks for itself. He pointed out that it is true that engineers recognize economic factors and hesitate to spend money recklessly, whether it comes from the ultimate consumer or their employer, and that also they are sometimes brutally frank in expressing opinions, whether they speak as individuals or representatives of industry or engineering groups. However, he declared: "Any fair-minded person must concede that they are honest and fair in their ultimate judgments." A tribute well earned by the boys in the lab, plant and field.—L. W.

The Ultrahigh Proposal

Receiver Design and the UHFs: With the arrival of the FCC plan providing for up to 2000 more stations, through the activation of most of the 470 to 890-mc band, there appeared some revealing data on what ultrahigh-receiver designs may be expected to feature.

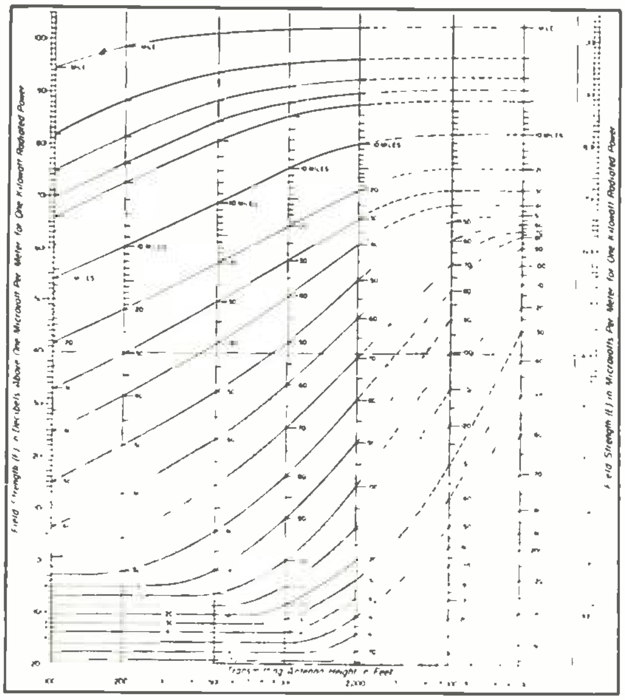
In a commentary on upstairs interference, caused by oscillator radiation, the report said that there was general agreement that the problem is certainly likely to be more severe on the higher than on the present bands, not only because of the difficulties in suppression, but because of the wide span of the new band which makes it impossible to place the oscillator outside of the range and still employ an *if* which is practical in the present state of art. Proposed higher *ifs*, such as 111 mc, were declared to be impractical because existing tubes and those available in the foreseeable future will not permit adequate amplification with a reasonable number of *if* stages. In addition, the use of a higher *if* would reduce adjacent channel selectivity. The suggestion that one-half of the band be set up as a repository for oscillator radiation was termed not feasible, either, for it eliminates any incentive for receiver makers to reduce the radiation nuisance. The solution may be found in part, the Commissioners declared, in the use of the 41.25 mc *if* suggested by RTMA and in the allocation plan which will require stations seven channels apart to have their transmitters separated by a minimum of 60 miles. This separation will, it is expected, afford the same protection as co-channel separation.

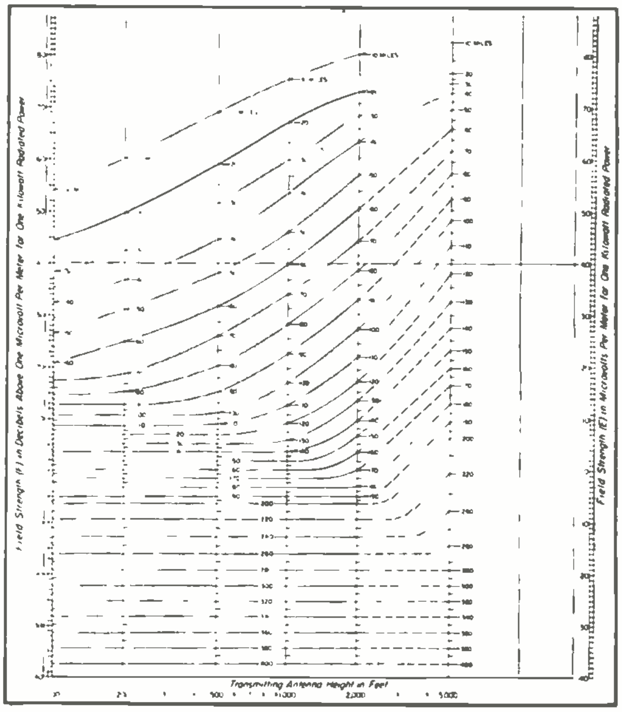
Image interference, picture and sound, was also cited as quite a problem. On the veryhighs, such interference has not been common, since signals from stations removed from the desired channel by twice the *if* do not normally fall into another channel. However, on the ultrahighs, there are a large number of contiguous channels and interference can occur. Two solutions have been proposed. First, receivers should have an image rejection of 30 to 40 db, which it has been found is not too difficult to provide, and second, station separation must be provided. Specifically, a minimum separation of 75 miles has been suggested between transmitters, where the stations are separated by fifteen channels to provide against picture-image interference, and a minimum separation of 60 miles is proposed between transmitters where the stations are separated by fourteen channels, to avoid sound-image interference.

The *if* beat, posed as another design headache, could also be overcome, it was said, by channel separation. Where the 41.25 *if* is in use, beat signals may exist in channels separated by seven or eight channels from the desired station; the effect is similar to that of intermodulation. Accordingly, stations which are eight channels apart would be required to have a minimum separation of twenty miles; seven-channel separation has been provided for in oscillator radiation plan.

Not only were receiver factors probed in the proposal, but antenna installations, too. Noting that median field strengths of 68, 71 and 74 db might be required for the 2 to 6, 7 to 13 and 14 to 83 channels, respectively, to overcome local noise and interference under urban conditions, the allocation plan indicated that these strengths may have to be altered dependent on the use of indoor or outdoor antennas. If, it is assumed that an inside antenna will have an effective length equal to that a half-wave dipole and the transmission line loss is negligible, the instantaneous local field strength required might only have to be 46, 55 and 68 db above one microvolt per meter for the three channels.

In plot, at left, below, appears the expected field strength for channels 7 to 83, exceeded at 50 per cent of the potential receiver locations, for at last 50 per cent of the time at a receiving antenna height of 30 feet. In plot, at right, is the expected field strength for the 7 to 83 channels exceeded at 50 per cent of the potential receiver locations for a least 10 per cent of the time at a receiving antenna height of 30 feet.





High-Band Operation Procedures: Reviewing the types of transmission that will be required to assure best reception on the upper channels, the report declared that the offset carrier technique will be particularly important, with the exact offset carrier frequency to be used by each station to be specified by the Commission. In the veryhigh band, stations will be offset from each other, in the new plan, by plus or minus 10 kc and 1 kc. Similar requirements will be applied to the ultrahighs, with specific values to be determined later.

Directional antennas*, proposed during several sessions, are not likely to be used for awhile in the new range. It was found that if this type of antenna system is used, there is less flexibility in choosing an antenna site, prompting a possibility of conflict with air-navigation requirements, a situation which can become acute due to civil aviation demands in the current emergency. In addition, since directional antennas have to be located away from cities, there appear the problems of shadows and multi-path distortion. It was also reported that, in many instances, proposed sites for directional antennas were in highly artificial service areas, with a good part of the station's signal strength being directed out to sea. The antennas were also declared impractical because the service areas would be no larger than that of a community station, and such stations would be as expensive to construct and operate as metropolitan stations.

High Power on the Ultrahighs: That much sought high power for the higher bands, now appears to be many notches closer, thanks to the development of several new tubes, antennas, and circuit innovations. In one development, 1-kw base power has been achieved in a ceramic tube, and in another an antenna gain of 20 has been provided, making it possible to secure *erps* of 20 kw.

In the ceramic power tube appear such features as gold-over silver plating on all external metal parts to provide low-loss contacts. There's a concentric ring-seal construction which permits insertion or removal from a cavity housing.

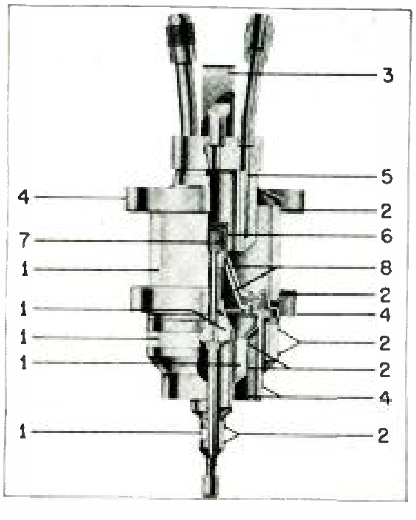
A 5-kw tube is a feature of another ultrahigh system, the unit being of velocity-modulation or klystron design. Describing this tube and a transmitter developed for it in a systems report, H. M. Crosby of General Electric said that the klystron, actually a multi-cavity affair, serving as visual power amplifier, operates as a broadband linear stage. Power gains in excess of 50 are said to be available in this stage, when adjusted for wideband response of 5 mc, flat within 1 db. A klystron is also used as the aural power amplifier, with no adjustments required for broadband response. A vestigial sideband filter is employed in the visual *rf* output stage to complete required attenuation of the lower sideband, although some of this attenuation is accomplished by selectivity of the preceding amplifier and driver cavity circuits. A slot-type diplexer is used for feeding a single transmission line with both visual and aural signals, without interaction between two sections of the transmitters.

With the aid of a new antenna system, claimed to provide a gain of 20, an erp of 100 kw is said to be available. The antenna consists of a four-bay helical radiator of side-fire design. A tubular mast supporting the helical radiator forms the outer conductor of an incoming coax line. Only four feed points are required along the mast, one for each complete radiating bay.

According to Crosby, the exciter-driver unit used for the transmitter is actually a 100-watt transmitter, with one crystal oscillator used to control *both* the visual and aural carriers. Accordingly, the two carriers are essentially locked together with a fixed separation of 4.5 mc. Any frequency drift due to the crystal results in each of the carriers drifting in the same direction, while the two remain 4.5 mc apart. This single control arrangement has been found to be particularly desirable when using the intercarrier method of aural reception.

*A directional antenna has been defined as one having 3 db or more difference in *erp* in the azimuthal directions of minimum and maximum radiation.

Cross-sectional view of 1-kw ultrahigh coax tetrode featuring aligned screen and control grids. The grid wires (6) are made of platinum-clad molybdenum, grids being brazed into copper cones (8). Small spacing between cones is said to provide greater capacity and less inductance between grids. Both grids can be maintained at the same *rf* potential; external bypassing is necessary at lower frequencies. Other features of the tube are ceramic construction (1); ring-seal design (2); lifting handle (3); space for spring fingers (4); integral water jacket (5); and thoria-coated unipotential cathode (7). (*Courtesy G.E.*)



Section of helical uhf antenna developed by G.E. with a gain of 20. Antenna, designed for use with 5-kw uhf transmitter features four sections, of the type illustrated.

H. M. Crosby of G.E. adjusting uhf velocity-modulated tube around which has been built a five-kw transmitter. In transmitter, crystal output is multilpied in conventional manner to one-fourth of visual carrier frequency, which is then doubled twice in cavity-type circuits using 4X150A tetrodes. Signal then excites driver amplifier at output frequency. Driver amplifier, also a 4X150A, is grid modulated by visual signal through clamp-type visual modulator. This signal is then fed to power amplifier through a coax cable.

TVE-grams . . . ——IRE Annual Convention Report

TV Recording

Pickup and Reproduction Factors: Analyzing the problems involved in providing a video signal which should closely resemble the original *camera pickup* signal. *G. Edward Hamilton*, ABC eastern-division TV engineer. disclosed during a professional-group session. that there are six factors primarily affecting this requirement: (*1*) system resolution, (*2*) brightness range. (*3*) film characteristics. (*4*) film development process. (*5*) film printing process. and (*6*) Overall *gamma* of the system.

Before the two sciences (film and television techniques) are merged. it is essential that certain factors influencing each other be considered. the most important of which is the reproduction of light intensities or *grey scale*. Actually. the process of television recording and reproduction involves a number of grey scale transitions: Subject-to-light variation; camera response to the subject light variation (usually the image orthicon); recording picture-tube response to the input signal variation. and reproducing camera chain response to the input variation.

Gradation of greys in an object differs only with respect to the amount of light reflected from each element, i.e., the brightness of each element. It is. therefore. the brightness gradations in the subject that must be measured and compared. Measurement of these variations over a normal subject are of little value since the tones merge one into the other. Thus. it is desirable to use a *standard* grey scale from which the individual steps may be determined.

In TV recording there are two particularly important items, *latitude* and *contrast*, which contribute to quality. Latitude represents the range over which the response curve is a straight line. whereas contrast defines the exposure limits to which a film has been exposed. i.e., contrast range may fall inside or outside of the latitude limits.

According to Hamilton. a major consideration in negative and positive film steps in the recording process is the amount of light transmitted through the film. since it is these light variations which are ultimately converted into electrical impulses. The term usually employed to describe the transmission characteristics of tones in film is *density*; the logarithm of opacity. where opacity is the reciprocal of the transmission factor.

While all the grey steps in the negative (or positive) which fall in the straight portion of the curve progress uniformly in density. they may *not* produce the same light ratios as their corresponding exposure values. It is this characteristic which is defined by *gamma*, the exponent to which the exposure ratio must be raised to equal the reciprocal of the transmission ratio.

In considering the problems of grey-scale reproduction by television recording. it was pointed out that it is of foremost importance to note that the photographic process is only a means to an end; i.e.. the negative and positive images of the original are only intermediate steps in the process of rebroadcasting of an original sequence. There exists. however. such a close relation between the grey-scale reproduction in the negative. the positive print and the reproducers. that all three must be weighed separately and collectively.

There is an additional factor in film processing that exerts an important influence on the end product. that is. noted Hamilton. the lamp intensity used in printing the positive. To maintain control of the negative and positive time developments. plus the correct printer light. it is desirable that IIb sensitometer strips be printed on the negative and positive films.

Picture-Tube Design

90°-Deflection Picture Tubes: In the development of large screen picture tubes. particular attention has been focused on the tube's length. Since the neck length is fixed by the amount of space required for deflection. focus and ion trap components, a reduction in tube length for a given screen diameter requires that a larger deflection angle be used. In a probe of this design problem for 30-inch tubes. it was found that a 90° deflection angle might be an answer. Describing this wide angle at the Institute's meeting. *H. Grossbohlin* of DuMont said that to minimize the increase in deflection power required. the design of the neck contour was made as closely as possible to the ideal. It was necessary to use a neck diameter large enough to accommodate the electron gun structure. and a neck wall thickness of sufficient strength.

Having thus fixed the outside diameter of the tube's neck. it was noted, that the most efficient deflection yoke and wall contour design is then one where the yoke will fit as closely as possible to the neck wall, and where the wall contour is such as to permit the front edge of the yoke to come as closely to the beam as possible.

Reviewing electron gun design. the DuMont specialist said that an increase in deflection angle permits changes in the gun design which can minimize the attendant spot distortions. The use of electron optical laws indicates that the same apparent center resolution can be achieved on a 90° tube with a substantially reduced beam diameter, over that required for a tube of smaller deflection angle. This smaller beam diameter, it was said, can be achieved by the use of electrostatic prefocussing in the electron gun which also tends to reduce the focus current requirements. Since the spot deflection distortions are a function of beam diameter. these distortions can be minimized by choosing a value of center resolution for the tube which is not excessively high. In a gun design used a center resolution value of approximately 500 lines was achieved.

Left: Portable camera-transmitter back-pack described by L. E. Flory (at right) of RCA Labs. Research and development of the unit was carried out by Flory, W. S. Pike, Jr., J. E. Dilley and J. M. Morgan, of the labs, under the direction of Dr. V. K. Zworykin.

Receiver Design

UHF Tuner: In the design of a tuner for the proposed *uhf* TV bands, the general circuit arrangement is fairly well dictated by the present state of the art. Since low noise tubes for *rf* amplification in the 470-890 mc region are not yet available commercially, designers must pick the lowest noise mixer device available. These considerations dictate a crystal mixer (either silicon or germanium), some form of preselection between antenna and mixer, a local oscillator, and a low noise *if* amplifier. In the case of combination *uhf/vhf* receivers, this *if* amplifier may be designed in such a way that the *uhf* and *vhf* tuners have the same noise-factor-gain product.

Having determined these basics, it becomes possible to select an appropriate *if* for the system. At the New York conclave, *M. W. Slate, I. P. Van Duyne* and *E. G. Mannerberg* of DuMont discussed a tuner with an *if* of 114 mc, with the *uhf* local oscillator on the low frequency side of the desired *uhf* channel. This arrangement was described as representing a simple means of adding *uhf* to the functions of an existing TV receiver of the continuous or semi-continuous tuned type. The gain requirements of the *if* amplifier were noted as modest, since it was only necessary to provide enough gain to permit the *uhf* tuner noise figure to control the overall receiver noise figure. The so-called *driven grounded grid* circuit was selected for the *if* amplifier in the interests of a low-noise figure, combined with ease of gain control.

Although the *if* factor is important, it is also necessary to affect solutions for such problems as effective wide band coupling between antenna and mixer device, together with adequate *rf* selectivity; oscillator mixer coupling for optimum and *uniform* injection; tracking of mixer and oscillator tuned circuits; dial and dial drive; and adequate shielding and filtering to reduce oscillator radiation to a low value.

It was revealed that the coupling problem can be attacked only after the tuning element has been decided upon. With a modified semi-butterfly unit, a desirable means is to tap down on the capacitive branch of the anti-resonant circuit. This can be done quite effectively and allows direct connection to a 300-ohm balanced line, or with suitable balanced to unbalanced converters, to a coaxial line.

Analyzing the oscillator-injection problem, the DuMont engineers said that it seemed evident that the best available oscillator tube which seemed likely to be manufactured for a reasonable price was a 7-pin miniature base version of the 6F4, and that a crystal mixer, using a commercially available germanium crystal, was the only practical mixer for the required frequency range.

When a semi-butterfly oscillator unit was built with a brass structure and polystyrene supports, it was found that a satisfactory range for a double-superhet unit, with the oscillator below the signal and a 112.75 mc *if* could be obtained with a .005" gap, if the conventional semi-butterfly structure were modified by the reduction of the width of the inductance loop portion in order to increase the inductance variation. This unit, though, had excessive thermal drift. To improve the drift situation, and to obtain a more readily producible design, it was decided to use a rotor and stator of a ceramic material, with conducting surfaces silvered on. Glass and steatite were considered excellent electrically and mechanically, but were not adaptable to economical fabrication in the desired shapes. A glass-bonded mica material was chosen as being readily molded, and having a coefficient of expansion approximating that of steel. A process of silvering the desired pattern, by applying an air-drying silver paint and subsequent electroplating, was evolved.

In oscillator units built, for both single-superhet and double-superhet operation, the former utilized a 41.25 mc sound *if*, with the local oscillator above the signal frequency, and the latter a 114-mc sound *if*, with the local oscillator below the signal. To obtain extremely high frequencies required for the single-superhet, it was necessary to clip the pins of the oscillator tube to about 3/32" from the base, to bring the tube base sufficiently close to the tuned circuit structure to minimize the lead inductance without having the pins project into the structure.

TV Cameras

Portable Camera Transmitter Back-Pack: A camera and a two-watt one-mile transmitting station, designed to operate in the field as a one-man back-pack unit, unveiled by L. E. Flory, of RCA Labs, at the IRE meeting, was described as a medium which could be used by reporters to flash pictures and commentary directly to editorial rooms.

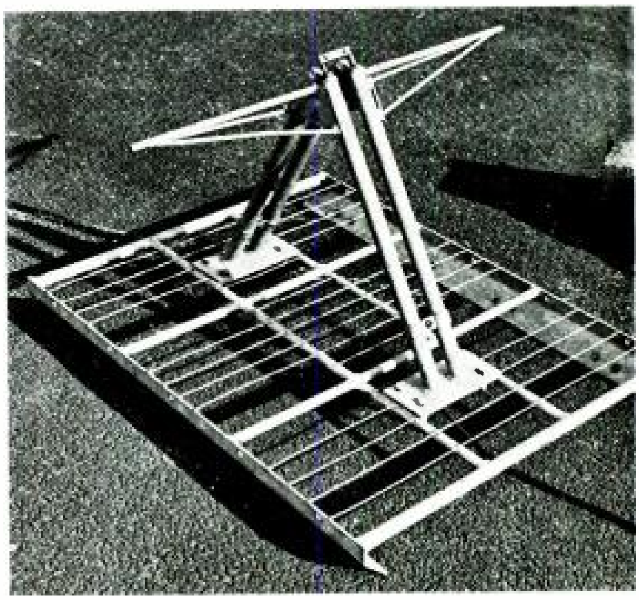
The back-pack, with forty-two tubes, carried in knapsack fashion, features two antennas which extend from the top of the pack, used respectively to transmit the picture signal to a base station and to receive voice and control signals from that same point.

The camera is an adaptation of the RCA industrial TV camera using the Vidicon tube. As an added feature, the camera includes a miniature picture tube which was said to serve as a view-finder for the cameraman.

Included in the unit are a battery-operated power supply, deflecting circuits, amplifiers, and a radio receiver for receiving instruction and other essential information from the control point. It was pointed out that a single battery could operate the portable station for about 1½ hours.

The narrator-cameraman's voice can be picked up and transmitted through the combination of a small microphone built into the camera case and a novel circuit which adds the voice signals to the picture signals as they are radiated to the control point.

View of single channel-7 supergain screen to be installed on the Empire State tower, disclosing details of dipole and feed system.



The Empire State Story

NBC and The Sky Tower: Few TV projects have been followed so closely as the multiple-station system evolved for the Empire State Building in New York City. Following the single-site pattern atop Mt. Wilson, the idea has travelled far from the talking stage of '49. Today, not only is a 222-foot supporting structure in place above the 102d floor of the building, and several stations already installing transmitting gear, but at least one of the tower licensees, WNBT, is planning to go on the air from the site in the early days of vacation time.

In an effort to acquaint broadcasters with the variety of problems encountered during the planning era and the actual installation, and the solutions suggested and actually applied, all of the participants in the program were invited to discuss their roles during the first annual meeting of the IRE professional group on broadcast transmission systems during the convention in New York City. Among those who appeared were members of the primary committee charged with the responsibility of planning and supervising the tower's construction, architects for the building, the antenna designers and the chief engineers of the five stations who plan to use the tower: WNBT, WJZ-TV, WPIX, WABD and WCBS-TV. Representing the primary committee were *Dr. Frank G. Kear*, consultant, *O. B. Hanson*, NBC's vice president, in charge of engineering, and *Ray Guy*, NBC's radio and allocation engineering manager. Reviewing the original selection of the Empire State as a site for telecasting by NBC, members of the group pointed out that in '28 NBC and RCA had built and placed in operation at 411 Fifth Avenue, a 500-watt TV transmitter operating in the 2,000-kc region and utilizing mechanical scanning methods. It became apparent that this frequency was unsatisfactory for high quality TV and that it would be necessary to utilize higher channels. It appeared that antenna altitude would be extremely important for this operation and thus a high transmitter location would be necessary. The 1,250-foot Empire State Building was felt to be the ideal spot and in '31 NBC installed there a TV station of about 1,000 watts power, having separate picture and sound channels and utilizing individual vertical dipoles.

The early vertical dipoles were replaced, after a few years, by a triad-type horizontally-polarized antenna which simultaneously transmitted both picture and sound frequencies. The triad structure later was replaced by the famous *Indian club* TV antenna and its accompanying triad-type sound antenna. After World War II new NBC antennas were installed, comprising four sets of turnstile elements, especially developed for the new channel 4, and a double triad for the FM channel.

In the new installation, these turnstiles are being replaced by a superturnstile batwing. In addition to TV there will also be triplexed FM operation by NBC and separate FM operation by ABC and CBS. As a result there will be five TV picture channels, five TV sound channels and three FM channels, a total of thirteen individual carriers. By resorting to multiplexing of TV channels, it is believed that it will be possible to add two more TV stations, increasing the number of individual carriers to 17.

Since a consideration of the installation problems indicated that vertical mechanical displacement was most feasible for this system, it was pointed out that the desirable mechanical configuration for the steel supporting structure was obtained by using horizontal dipoles and screens in quadrature with the longest wavelength antenna at the bottom, where the screen width is greatest, the next longest wavelength immediately above it with correspondingly reduced screen widths, etc. This provided a tapered structural shape which is most efficient.

The completed structure was designed for a wind loading of 50 pounds per square foot, representing the maximum hurricane wind velocity ever recorded in the New York area.

Architectural and Constructional Aspects of Project: Early in the design of the Empire State building, the late John Raskob, who was the spark plug of the whole enterprise, conceived the idea of a mooring mast for dirigibles at the top of the building. Very exhaustive studies were made of the then-existing masts in various parts of the country, in consultation with experts of the Goodyear Company, and everything was provided to make possible the landing of a lighter-than-air craft, except the anchoring down of the tail of the ship. However, the mast was built and although it was never used for mooring, provision for the structure provided that vital constructional feature, sturdy support, required for the an-

Viewing the 14-foot scale model of the Empire State TV antenna tower, unveiled during the IRE Convention at the Waldorf-Astoria Hotel, left to right: FCC Commissioner George Sterling; Commander Mortimer W. Loewi, director of the DuMont TV network; FCC Commissioner Frieda Hennock; Lt. Gen. Hugh Drum, Empire State Building prexy; Brig. Gen. David Sarnoff, RCA board chairman; Philip B. Stephens, business manager of the Daily News, operator of WPIX; FCC Commissioner E. M. Webster; Kay Burke, Miss Empire State Building, and Edward J. Noble, ABC board chairman.

tenna tower. Describing this provision, *William F. Lamb* of the architectural firm of Shreve, Lamb and Harmon, the designers of the building, said that there was built into the structure, not only the mast itself, but all the way down to the foundations additional steel of sufficient strength to resist a horizontal pull of 50 tons, applied to the top of the mooring mast. This additional steel has made it possible, with a minimum of reinforcement, and that only at the extreme top, to erect a tall tower on top.

Discussing the procedures which are now involved in bringing materials, particularly the structural steel, to the upper tower, Lamb said that it is necessary to resort to a variety of operations. The pieces must be brought up in short lengths, mostly at night or holidays, slung from the bottom of the high rise cars to the 79th floor, thence transferred to the elevators that run to the 85th floor and finally via the tower elevator to the top of the mast and a working platform which has been erected and rivetted by the American Bridge Company, whose erectors were described as being as much at home 1,250 or more feet in the air as on the ground. As work progressed, additional working platforms had to be built: a lower movable platform, where the rivets could be heated and shot up by compressed air through a flexible hose to the riveters above, and an upper fixed mount for the use of the electricians, so that they could attach the batwings to the pole as the pole rises to its final height. These lifts were said to be about 14′ to 15′.

The Multi-Layer Antenna Design: In the spring of '50, when antenna designs for the Empire State pole were being probed, two general solutions presented themselves, a stacked vertical arrangement with the antennas placed above each other, and a ring arrangement with the antennas mounted in the same horizontal plane. Combinations of the two were also considered. Analyzing these designs at the symposium, *Herman Gihring*, of RCA, said that various *ring type* structures were analyzed, but were discarded for structural and appearance reasons. After a careful engineering analysis of all the possibilities, the stacked plan was adopted.

Since an antenna for use in a stacked array must have sufficient cross-section to support the antenna above it, it was decided to use a *supergain* type which was felt to be ideal for this purpose since the tower for this antenna could be ½ wavelength square. The antenna was constructed, with the dipoles supported .3λ in front of a screen for maximum bandwidth considerations. Four screens were fastened on the four faces of the tower to obtain an omni-directional pattern. A triangular leg support structure for the dipole was used to give a maximum amount of rigidity and strength for falling ice, and climbing.

Each antenna element as finally adopted consisted basically of a simple dipole fed through one of the legs by means of a solid dielectric cable, the outer sheath of cable being fastened to this leg and the inner conductor connected across to the other side of the dipole. In some cases, this connection is now made through a series stub which is another short piece of solid dielectric cable placed in the opposite leg. The series stub was said to provide an increase in the bandwidth of the dipole. It was also pointed out that a shorting bar is used on the triangular structure to provide electrical isolation between the supporting structure and the screen; the shorting bar is also used to obtain small impedance variations. Declaring that since the feed system requires the use of only two of the legs, Gihring said that the other two legs can be used for sleet melting heaters if required. While falling ice from the antenna is recognized as a hazard, the same is true of the tower or even the building itself. Some deicing is required to prevent impedance changes in the area between the two halves of the dipole; this is accomplished by placing heaters in the two unused legs.

Since the Empire State Building is located centrally with respect to the service area, Gihring explained that an omnidirectional pattern appeared to be most desirable with the arrangement of radiating elements used. This has been accomplished by feeding the radiators on the north-south and east-west faces of the tower in quadratures, and placing a 90° phasing loop in one of the transmission lines to the antenna.

Since the tower is ½-wavelength square, it was necessary to place the station with the lowest frequency channel at the bottom and progress upward with frequency. The only exception to this has been the channel 4 antenna, which utilizes a superturnstile antenna, placed on top. Supergain antennas are used for channels 2, 5, 7 and 11.

Reviewing the problems of gain and coupling between antennas, Gihring declared that it was considered desirable to keep the gain of all the antennas approximately the same, except that the gain of the high-band channels was to be approximately 20% more. It was decided that the only coupling that could be considered in the antenna design was between antennas proper. Many successful TV installations were noted as being in operation with a coupling of 20 db between picture and sound carriers using both triodes and tetrodes in the output stage. In this instance, to provide an additional safety factor in the event of a difference in power level, a value of 26 db was chosen.

Covering the problem of power, the RCA rep said that RG-35 U solid dielectric cable was selected to handle 100 kw erp. Gihring noted that the manufacturer's rating of the cable was used and a derating applied for standing waves on the cable, and for a temperature in excess of the ambient allowed as specified, on the basis of figures obtained from the New York Weather Bureau and measurements made on the Empire State Building. From the gain, the amount of kilowatts needed for both picture and sound with the picture transmitter operating at black level was computed.

To approach the coupling problem, Gihring pointed out, single screens and dipoles were placed adjacent to each other. A signal was fed from an oscillator into one antenna in series with the measuring line. The product of the maximum and minimum voltage readings established a relative power level, held constant throughout the measurement. As a first step, the output of the measuring line was fed directly into a field intensity meter for calibration purposes. Then, the output was connected back to the antenna and the field intensity meter to a second antenna, and the difference in db between these two readings determined.

The final antennas, screens and feed systems were first adjusted on the ground to determine that the impedance over the band was within the specifications. Meanwhile, four towers were erected for each adjacent pairs of antennas. Thus, there is one tower for channels 4 and 11, one for 11 and 7, 7 and 5, and 5 and 2. Adjacent antennas were placed on these towers and tests were repeated for standing-wave ratios over the band to determine any discrepancies between these tests and the ground tests. After this, coupling measurements were made.

TVE-grams... —Research and Development

Accelerated Testing Technique

Checking Frequency Calibrations: A new method of checking frequencies, using a primary-standard frequency as a basis of comparison, has been developed by the *Naval Research Laboratory*. The new approach is said to eliminate the problem of recognizing complex, high-ratio patterns, still retaining the desirable aspects of the standard 'scope Lissajous patterns, i.e., high accuracy and a multiplicity of check points. This improved technique inherently produces a signal exactly equal to the standard frequency whenever the signal to be calibrated is exactly adjusted to any detectable harmonic of the standard frequency. This equality is automatically indicated as a simple one-to-one Lissajous pattern which is obtained for each usable harmonic point. Thus, with the aid of this technique, less skilled personnel can perform more quickly equipment calibrations equivalent to those obtained through standard Lissajous patterns.

A particular application of this technique was in the measurement of temperature coefficients of capacitance by means of frequency-shift techniques, involving the use of an interpolation oscillator to measure, accurately, small variations in radio frequencies. Over its entire range of 0 to 5,000 cps, the oscillator has been found to have an accuracy of ± 2 cps. Examination of the oscillator showed it to be sufficiently linear such that over any 100 cps portion of the range, the accuracy would be ± ¼ cps, provided the oscillator was set exactly on frequency at some point within the 100-cps portion.

For this application, a 100-cps signal, f_s is generated by using a 10:1 multivibrator driven by a 1,000-cps standard frequency signal which is fed through a peaking circuit to provide more positive locking of the multivibrator. The output of the multivibrator is sufficiently nonsinusoidal so that a harmonic generation stage is not needed to provide an output of adequate level up through the 50th harmonic. This harmonic signal is then fed through a filter designed to suppress the 100-cps component. The next stage is a modulator which is balanced to eliminate from the modulator output the harmonic signal and in particular any remaining 100-cps component not removed by the filter. The interpolation oscillator output, f_x, is amplified and fed through a tuned low-frequency attentuator and then also applied to the modulator. The modulator output signal, consisting of the components, $f_x \pm n(100)$ cps, is then fed through a filter designed to attentuate severely all frequencies above 100 cps. This signal, f', is then applied to one set of 'scope plates for comparison with a 100-cps standard frequency which is obtained from the multivibrator and applied to the other set of plates. Now, if f_x differs from the exact multiple value $n(100)$ by several cycles per second, then the filter output f' also differs from 100 cps by an identical amount. This condition is indicated on the 'scope by a stationary 1:1 Lissajous pattern.

A noteworthy feature of this technique is that it is not restricted in application to any region of the frequency spectrum. The main limitation in any particular application of this technique will likely be an inability to devise satisfactory circuits for certain frequencies. For example, at low (audio) frequencies as compared to radio frequencies, it is more difficult to obtain a filter that will discriminate adequately between the standard frequency and its harmonics. This is one of the main considerations for using a *balanced* type of modulator.

Oscillography

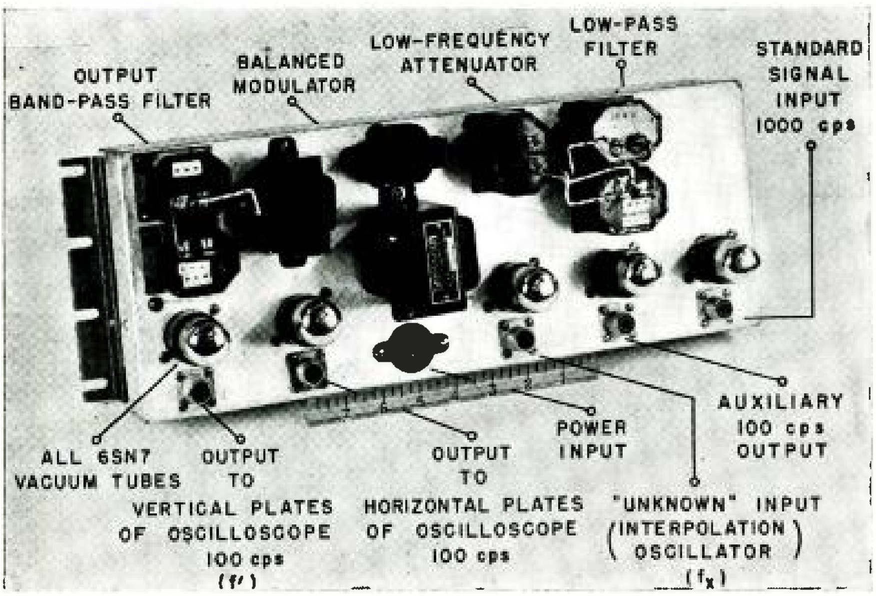
High-Speed 'Scope: The path of current moving at speeds up to 200 inches in a microsecond, or millionth of a second, can now be observed and photographed with an instrument created by *NRL*.

The heart of this new instrument, which makes it possible to obtain this or sweep rate, is a gas-filled hydrogen thyratron. It not only generates the voltage wave forms or sweeps which cause the beam to move across the face of the cathode-ray tube, but generates a 5 milli-microsecond (5 thousandths of a millionth of a second) test pulse.

The 'scope allows each of the test pulses to be studied and recorded for test purposes. Despite the extreme shortness of the time interval involved, the stability of the instrument is said to be such as to allow a delay precision, or jitter, in the order of micro-microseconds.

The sweep circuit consists of a 3C45 thyratron employing a .5-microsecond pulse forming line to develop unblanking and sweep voltage.

The 'scope uses a JAN type 5RP-11A, which is said to be satisfactory for use up to 300 mc.



(Left)
Calibrator built at NRL and employed in improved technique for frequency-calibration work. Inherently produces a signal exactly equal to the standard frequency when the signal to be calibrated is adjusted to any harmonic of the standard frequency, and gives a simple one-to-one Lissajous pattern for all harmonic points.

High-speed 'scope whose sweep speeds can be switched from 20 to 200 inches per microsecond. *(Official USN photos)*

TVE-grams . . . Personals

Convention Activities: The annual IRE national convention at the Grand Central Palace, N. Y. City, played host to practically everyone in industry from coast to coast. Among those present along booth-row were Pyramid Electric's officials *Sy Wolin*, vice prexy, sales; *Bert Kohl*, sales service manager; *Max Kevelson*, chief engineer; *Stanley J. Staklinski*, president, and *Ralph M. Scarano*, executive vice prexy, who were particularly proud of their new capacitor catalog which was being distributed for the first time. . . . *Julian Loebenstein*, sales manager; *J. Kahgan* and *Irwin Wolf*, sales engineers, were quite active, day and night, discussing Seletron selenium rectifiers, products of Radio Receptor. . . . At the Ferris Instrument booth were *Howard Tyzzer*, chief engineer, and *T. Leoser* of the engineering staff. . . . Among those representing Insuline at the show were *Frank Lester*, chief engineer; *B. L. Cahn*, sales manager, and *Sam Specter*, president. . . . Indiana Steel Products chief engineer, *C. A. Maynard*, found himself deluged with questions about material problems and the defense effort. Assisting in the question and answer foray were *A. D. Palamendon*, president, and *F. A. Hayden*, vice prexy of sales. . . . The Measurements Corp. staff were all at the Palace. *Jerry Minter*, chief engineer, spent most of his time at instrument controls, explaining the measurement and test possibilities of the equipment. Participating also in the continuous demonstrations were *John VanBuren*, chief research engineer; *Harry Houck*, president and general manager, and *E. M. Weed*, ad manager. . . . *Roy S. Laird*, Obmite vice prexy, was ably assisted by *Daniel Workman*, sales engineer, during the show. . . . Tinnerman of Cleveland was represented by *H. R. Russell*, general sales manager; *E. E. Griger*, assistant sales manager; *Lou Schweizer*, ad manager; *R. Hartman*, field engineer, and *C. R. Hess*, sales supervisor. . . . In the Webster-Chicago booth were *A. S. Johnson*, manufacturers' division sales manager; *Leland S. Hicks*, sales engineer; *L. G. Barnhardt*, sales promotion manager, and *N. C. Owen*, distributor sales manager. . . . At Aerovox were *Lou Kahn*, director of research; *Joe Collins*, chief engineer; *Charley Golenpaul*, jobber sales manager, and *Carl Bretts*, manufacturer sales manager. . . . American Lava's crew from Chattanooga were also on hand for the show, including *John Kruesi*, president, and *Gus Richter*, vice prexy, sales. . . . *Sam Norris*, Amperex prexy, was ably assisted by *A. Peterson*, the tube company's sales engineer, during the four-day meeting. . . . Boonton Radio Corp. was represented by *Dr. D. M. Hill*, vice prexy in charge of research; *G. A. Downsborough*, president and general manager, and *D. N. Kirkpatrick*, chief engineer. . . . At Centralab were *W. S. Parsons*, vice prexy and general sales manager; *Bob Mueller*, jobber division sales manager; *R. O. Wolff*, chief engineer, and *H. E. Moore*, in charge of capacitors and printed circuit sales. . . . *Emil Maginot*, Cornell-Dubilier ad manager, was on board all week, as were *Art Williams*, sales manager, and *Bill Bailey*, chief engineer. . . . At Freed Transformer Company's booth were *Larry Freed*, prexy, and *M. Salzberg*, sales manager. . . . Among those at Hewlett-Packard from Palo Alto, California, were *Noel Eldred*, sales manager, and *David Packard*. . . . Chief engineer *Walter Weiss* of Hickok was also in town. . . . IRC was fully represented by their executive staff, including *Harry Ehle*, vice prexy, sales; *Jesse Marsten*, vice prexy, engineering. . . . Loops, capacitors and TV transformers were on the daily round-the-clock demonstration schedule of *J. J. Root*, prexy of Square Root Manufacturing Corp. . . . *John K. Hilliard*, chief engineer of Altec-Lansing, revealed that he was on his way to Europe on a three-month tour of laboratories and plants. . . . *Jake Ruiter, Rod Chip, Irving Rosenberg, Tom Goldsmith, Bert Taylor* found themselves besieged by a variety of inquiries on parts, tubes and transmitters at the DuMont booth. . . . *Al Kahn*, prexy, and *Web Soules*, sales manager, were on hand at Electro-Voice, Inc. . . . General Electric was represented by *Don Wilson, Tony Bradford, Ed Malling* and *Doc Baker*. . . . Representing Permaflux was *Russ Fenton*, sales manager. . . . *Mike Roth*, distributor sales manager of Radiart, was also at the show. . . . Among those at the RCA display were *Julius Haber, W. L. Rothenberger, Larry Le Kashman, John Taylor* and *L. A. Goodwin*. . . . *F. E. Anderson and E. I. Montague* were among the representatives of Raytheon at the show. . . . At Sprague Products were *Harry Kalker* and *Sidney Chertok*. . . . At the Sylvania Electric booth were *Terry Cunningham*, ad director; *Bob Penfield*, editor of *Sylvania News*, and a host of others from other plants throughout the country.

James B. Lindsay

Howard J. Rowland

William P. Short

Personal Notes: *Maurice L. Levy* has been named director of engineering of Tele-Tone. . . . *Robert B. Dome*, G.E. consulting engineer at the company's Electronics Park plant in Syracuse, N. Y., received the Morris Liebmann Memorial Prize for '51 for his intercarrier work, at the IRE convention. . . . *Howard J. Rowland*, chief electrical engineer of Workshop Associates, received patent 2,538,915 for developments incorporated in the *Dubl-Vee* TV antenna. . . . *Sidney Lidz* has been appointed chief engineer of Starrett Television. . . . *Robert S. Peare*, vice president of G.E. public relations and advertising policy, died recently. . . . *James L. Emaus* has been appointed sales application engineer of the sales department of the electronics parts division of DuMont Labs. . . . *Louis H. Niemann, Sylvania Electric*, has been named chief of the electron-tube section of the electronics division of NPA . . . *C. M. Lewis* has been named manager of the broadcast and communications sales section of the RCA engineering products department. . . . *Dana Pratt*, formerly sales manager for RCA broadcast transmitter equipment, has been named manager of the communications and microwave sales group. . . . *Henry S. Bamford* has been elected president of Electronic Tube Corp. . . . *R. D. Hall* has been appointed senior engineer in the research and consulting department of the Canadian Marconi Co. . . . *F. J. Cooke* has joined Reeves Soundcraft, on the manufacturing executive staff. . . . *James B. Lindsay* has been elected vice president and director of engineering of Thomas Electronics, Inc. . . . *D. W. Gunn* has been named equipment sales manager, and *G. V. Bureau* has been named government sales manager, of the radio and television tube divisions of Sylvania Electric. . . . *William P. Short* has been appointed chief engineer of General Precision Laboratory, Inc. . . . *Frank D. Langstroth*, formerly general manager of sales and commercial relations of the Lansdale Tube Co., a wholly-owned subsidiary of Philco, has been elected president of Starrett Television. . . . *Howard Chinn* of CBS is putting the finishing touches on a TV broadcast operation handbook, scheduled for early publication.

Expediting TV Receiver NOISE CALCULATIONS

by DAVID A. MILLER and E. A. SLUSSER

Nomograms and Graphs Evolved to Provide Rapid Calculation of Thermal Noise Voltage, Equivalent Input Noise Voltage, Noise Factor F (Expressed as a Ratio or in Db) and Noise Contributed by Any Single Network to the Overall Noise Figure of a Series of Networks.

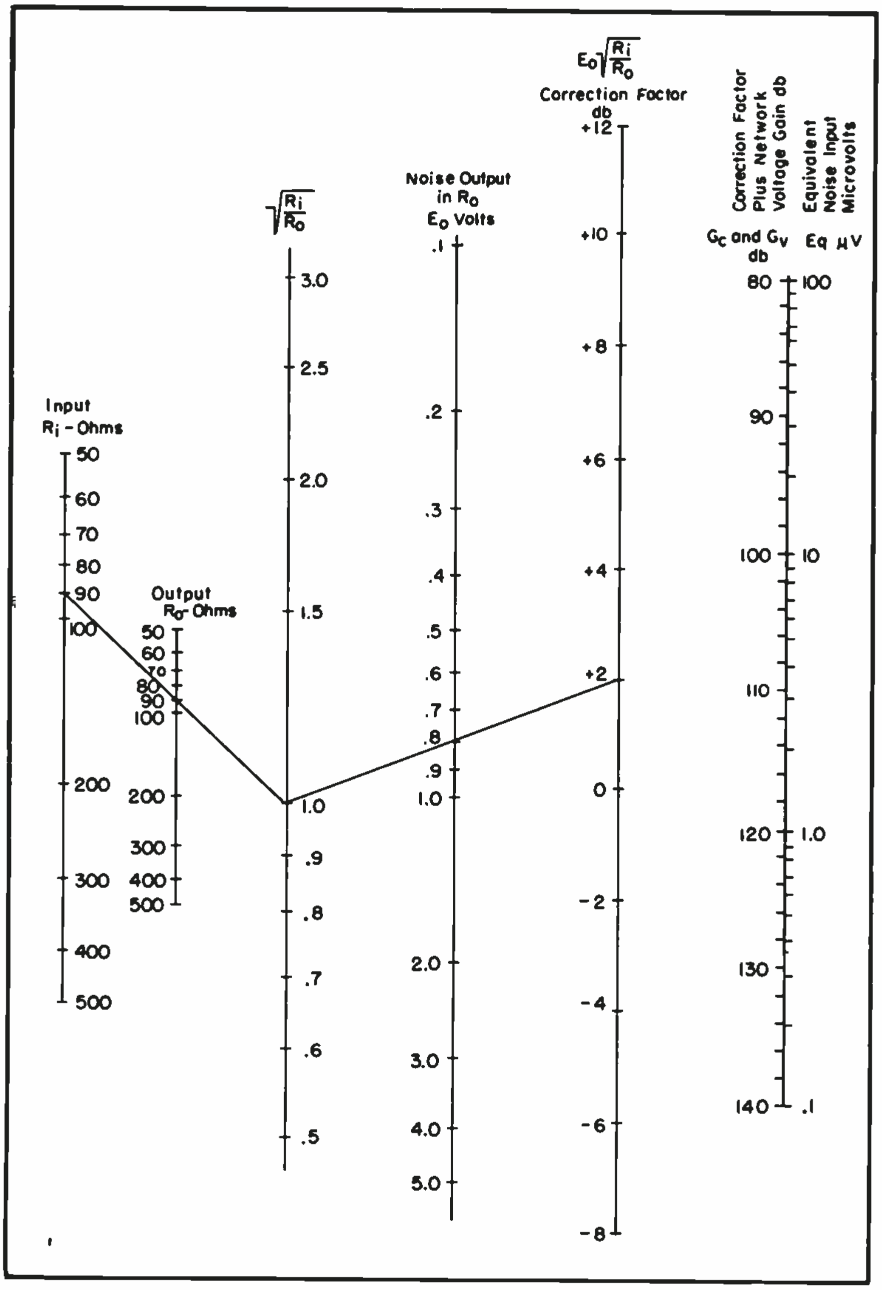
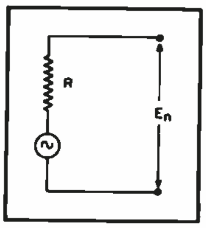


Figure 2
Values of E_n can be determined by this nomogram.

In the TV chassis, noise is a particularly vital factor, involving close control of the gain which is limited by the input noise and the inherent noise factors of the networks in the circuit. To determine the amount of noise, it is necessary to resort to calculations which can often be quite a tedious procedure. In an effort to simplify this task, a series of nomograms and graphs were evolved. These charts have been found to expedite calculations of the thermal noise developed in a resistor (*Johnson noise*), equivalent input noise voltage of an amplifier, network or receiver, noise factor F expressed as a ratio or in *db*, and the noise contributed by a single network to the overall noise figure of a series of networks. The parameters have been selected so that measurable quantities are the starting points.

The noise voltage developed in a resistance R due to the thermal agitation of electrons is



$$E_n^2 = 4RKT\Delta f \qquad (1)$$

Where: K = Boltzmans constant = 1.38×10^{-23} joules/degree Kelvin

Δf = bandwidth in cps

E = *rms* noise voltage

As a general rule in temperate climates, T is assigned a value, so that KT becomes 4×10^{-21}. Thus

$$E_n^2 = 1.6 \times 10^{-20} R\Delta f \qquad (2)$$

The value of E in microvolts can be obtained by substituting values for R_i,

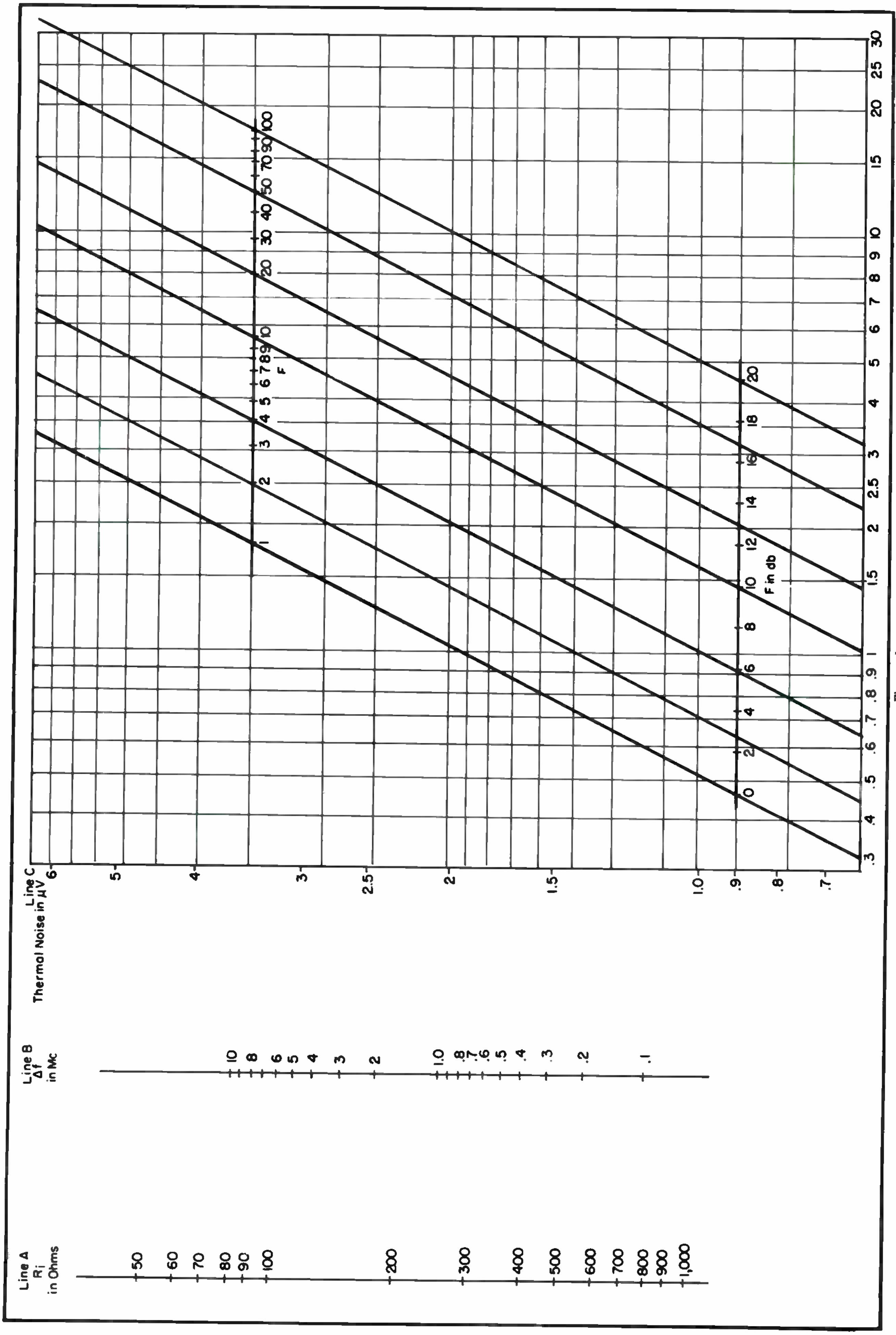
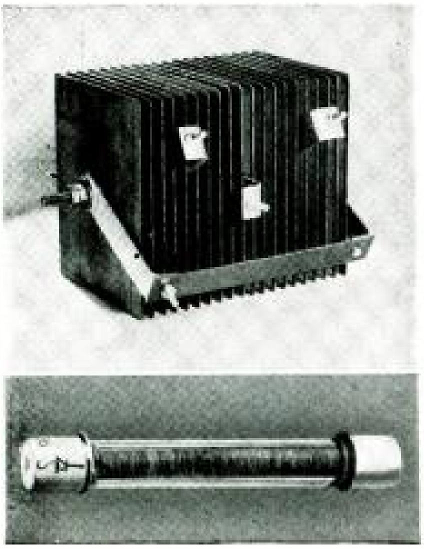


Figure 1

Value of E in microvolts can be obtained by substituting values for R_i, Δf and E in lines A, B and C of this nomogram and graph. Values of noise factor, F, can also be determined by inserting values of R_i and Δf in the nomogram portion, and reading across in the graph portion.

SELENIUM RECTIFIERS



Power rectifier and enclosed high voltage selenium rectifiers. 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 millamperes in full-wave circuits. (Courtesy Rectifier Division, Sarkes Tarzian, Inc.)

by RUFUS P. TURNER

SINCE THE CLOSE of World War II, the selenium rectifier has enjoyed increased acceptance as a circuit component. It has been found capable of providing a high operating efficiency, long life, economical operation, and unattended service. Its temperature rise above ambient has been found to be very low, when compared with tube-type rectifiers and, because it has no filament to heat up, it is ready at all times for instant operation. Moreover, since selenium rectifiers are simple *2-terminal* devices they can be easily installed in or removed from a circuit.

Important advantages which have been found to accrue from the use of selenium rectifiers in TV circuits include a reduction of operating temperature and of power supply size and weight. An entire multiplier-type selenium power supply weighs only a fraction of the weight of the transformer alone required in an equivalent non-selenium supply. In voltage-multiplier circuits, such as the doubler, tripler, and quadrupler, the units have been used, without a transformer, to supply all of the *dc* voltages required by the low-level *rf* detector, oscillator, *if* video, and audio stages of a TV chassis.

Construction of Rectifiers

The selenium rectifier consists of several series-connected plates or discs mounted in a compact stack. Each of the plates itself is a separate rectifier. Thus, the complete stack consists of a number of rectifiers connected in series to withstand the applied voltage. For maximum safety, about 20 volts *rms* are allowed to each plate in the assembly. The 120-volt type rectifier accordingly has 6 plates. While the rectifier is shown in circuit diagrams as a single anode and cathode, it actually consists of a series arrangement.

A single rectifier plate or *cell* substantially is a sandwich composed of a thin layer of specially processed selenium between two metallic plates or discs. The selenium is applied to one of these plates termed the *back* or *base* plate. The second plate, termed the *front electrode* or *counter electrode*, is placed in intimate contact with the top surface of the selenium layer. These two metallic plates, contacting opposite faces of the selenium layer, constitute the electrodes.

Action of the Rectifier

Current flows most readily through the rectifier cell when the back plate is made positive and the front electrode negative, and much less freely when this polarity is reversed. In other words, electrons pass in larger numbers from the front electrode into the selenium, than in the opposite direction out of the selenium to the front electrode. The *forward* current thus is large as compared to the *reverse* current. In receiver rectifiers, the forward current is a number of milliamperes at the rated applied voltage, while the reverse current may only be a few microamperes. In power rectifiers, the forward current is measured in a number of amperes, while the reverse current is only a few milliamperes. The *forward resistance*, accordingly, is low compared to the *reverse resistance*.

From the foregoing explanation, it will be noted that the selenium cell is an asymmetrical resistor exhibiting low resistance when its anode is made positive and very high resistance when its anode is made negative. It is this non-symmetry of conduction which enables the device to be used for the rectification of alternating current. This resistance property is the greatest point of difference between the selenium rectifier and an equivalent vacuum tube rectifier. The tube is a true valve, passing no current when its plate is made negative with respect to its cathode. However, it is always necessary to consider the reverse current of the selenium rectifier. Since some current, however small, does flow through the selenium cell during the negative half-cycle of applied *ac* voltage, this current

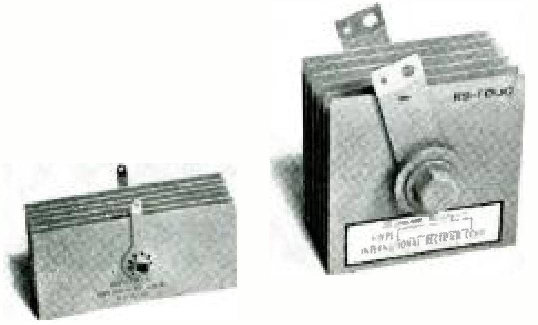
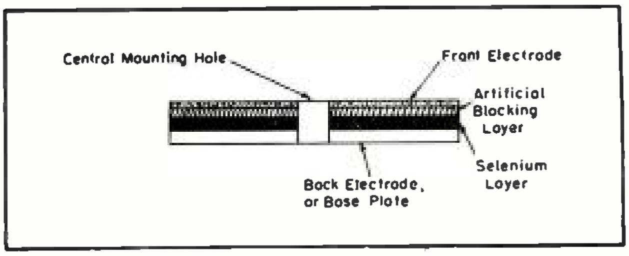


Figure 1 (left)
High-current type selenium rectifiers; stack on the left is for 500 milliamperes dc output; one at the right for 1000 milliamperes. (Courtesy, International Rectifier Corp.)

Figure 2 (below)
Cross sectional view of a single-plate rectifier.



For TV Applications

Manufacture-Circuitry Analysis of Metallic Units Which Are Now Being Widely Used in TV Chassis as Doublers, Triplers and Quadruplers.

contributes to the total heating within the rectifier.

It is important to note that rectification is not a *bulk* phenomenon. That is, it appears not to be the result of current conditions within the body of the selenium. Rather, it has been shown to be an effect occurring at the boundary or *barrier* between the selenium and the front electrode. Other devices, such as the crystal diode, also demonstrate barrier layer rectification. The barrier layer may be natural (forming as a result of the junction of the two dissimilar materials) or artificial (being applied in the form of some suitable material, generally an extremely thin layer of an appropriate insulator). There are barrier layer effects between the selenium and back plate, as well as between the selenium and front electrode. However, in the manufacture of selenium rectifiers, care must be taken to reduce to the lowest practical minimum any effect between the back plate and active material.

Maximum Current Possibilities

The maximum current which can be handled safely depends upon the area of the rectifier plate. The larger the plate, the higher will be the current rating. The maximum voltage which the plate will withstand without puncture or excessive heating is governed by thickness of the selenium layer, chemicals added to the selenium, and nature and thickness of the barrier layer.

Cooling is provided by mounting the plates in the assembled stack in such a manner that each is separated from the other by an adequate air space.

Rectifier Manufacture

Amorphous raw selenium has no value as a semiconductor. It is, in fact, a fairly good insulator while in this state. But, when the selenium is converted to its gray crystalline form, by appropriate heat treatment, it begins to show the properties of rectification.

The manufacture of selenium rectifiers varies somewhat with individual producers. Nonetheless, it follows a general order of procedure.

Preparation of Back Plates

Aluminum plates for use as back plates are roughened by sandblasting or acid etching. One face of each plate then is electroplated lightly with nickel. The reason for the latter operation is that selenium does not react readily with nickel, while it does with aluminum. If selenium were applied directly to the aluminum face, aluminum selenide would be formed and this material, being an insulator, would increase the forward resistance of the finished rectifier and reduce its efficiency.

Preparation of Selenium

The raw selenium is melted and often is doped with one of the halogens (usually bromine, chlorine, or iodine) which acts to reduce forward resistance in the completed rectifier. The exact halogen used and the proportion of this material is a matter guarded as a trade secret by individual manufacturers. After cooling, the treated selenium is granulated and then is ready for application to the nickled plates.

Application of Selenium to Back Plates

The granulated selenium usually is dusted evenly on the nickel-plated faces of the back plates, either by hand or machine. But in some plants, suitable masked back plates are dipped into molten selenium. The coated plates next are placed into a hydraulic press and subjected to high pressure and temperature for several minutes. This treatment converts the selenium to a crystalline form, causes it to adhere firmly to the back plate, and starts the natural formation of a barrier layer on the exposed selenium surface.

Annealing of Pressed Plate

The pressed plates are heat treated further in some form of oven, to con-

(Continued on page 27)

Figure 4 (right)
An asymmetrical conduction curve of a selenium rectifier. (Milliampere and microampere axes are not in proportionate ratio.)

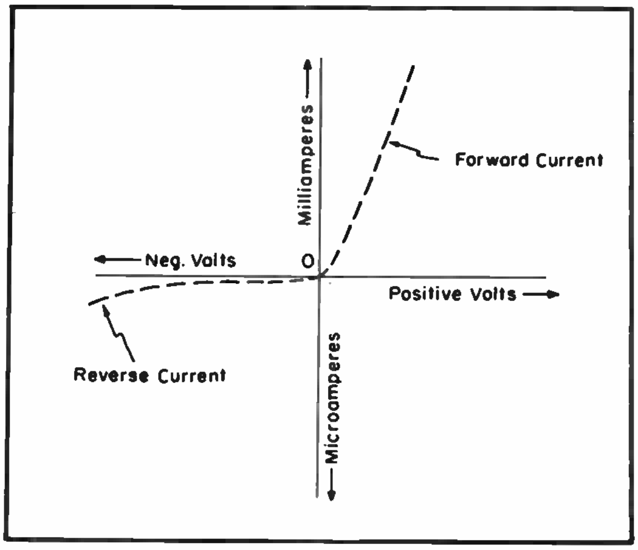
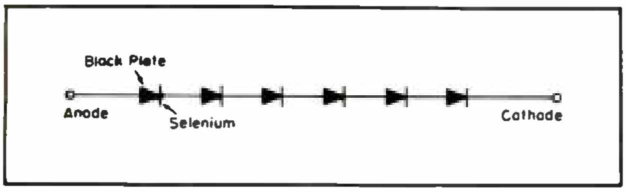


Figure 3 (below)
A six-plate series arrangement of selenium rectifiers.



TV Maintenance Practices

by JOHN B. LEDBETTER

Engineer, WKRC-TV

Preinstallation checking of batwing TV antenna, a key factor in the station maintenance program. (Courtesy WKRC-TV)

Maintenance Procedures in the Film Room . . . Studio Maintenance Techniques . . . Maintenance of Switcher, Monitor, Distribution, Stabilizing, Sync-Stretch Equipment . . . Sync Generator Checks . . . Tests for Audio Gear . . . Test Equipment.

In the maintenance of the film room, there are fourteen analysis steps that must be followed in the monthly program. As indicated in the initial installment[1], the first group of items to check involves the camera cable connections, and the coax fittings on the junction boxes, control console, relay and distribution amplifier panels. In addition, it is necessary to set up a schedule for the cleaning of the control console as well as the film camera chassis. All voltages and currents of the power supplies must also be checked, all readings being entered in the regular studio maintenance form.

In the second probe category are the relays in the switching panel, which must be cleaned. Burnishing tool or strip of clean bond paper should be used. The use of crocus cloth or other abrasives *must be avoided!*

In the next step the output voltage of the 24-volt *dc* power supply should be measured, recording the reading on the *studio power supply record form.*

Tightening of all wiring terminal screws in the film projector follows. Then there are four cleaning and inspection measures, involving all power supplies, all other rack-mounted equipment and the inside of Balopticon, including lenses. Check Balop alignment after this operation.

The emergency supply of fuses must also be inspected. See that the proper size and number are available at all points required. If a fuse of proper rating fails prematurely or at too-frequent intervals, the current drain of the equipment must be checked.

In the quarterly check, relays in film projector control circuits should be cleaned and tube records should be analyzed for tubes approaching maximum usable hours of service. Tube readings should be checked for evidence of borderline operation.

[1]TeleVision Engineering; February, 1950

Studio Maintenance

Normally a 500-hour check is required for camera chains. This involves the following steps:

(1) Check of all tubes on a mutual-conductance tube tester. Any tubes in which G_m is less than 70 per cent of rating must be replaced. In addition, it is necessary to check balance in power supplies and replace 6AS7s if current variation exceeds 20 per cent. When new 6AS7s are installed, the algebraic sum of all current readings should be taken; this can be established as an *average* plate current for future checks on current values.

(2) Check of all power supply voltages, checking voltage range on both 300 and 400-volt supplies. The ripple current and regulation percentage should also be checked.

(3) Inspect visually for loose parts and overheating. Tightening as required should follow, making any temporary repairs permanent. The supervisor should be informed of all replacement parts used so that stock will be kept up to date.

(4) Check of all fuses for corrosion, loose ends; see that clips and holders are tight. It is important to make certain that correct ratings are in use.

(5) Faces of all picture tubes should be washed; in camera controls, viewfinders, control consoles, monitor receivers, etc. Mild soap and warm water should be used, applying with a soft, lint-free cloth, and polishing with another soft dry cloth.

(6) The faces of all image orthicon tubes must be cleaned, using only recommended lens tissues and moistening with breath if necessary. The shoulder pins of the tube should be cleaned with fine sandpaper. Avoid pressure on inserting tube into socket;

(Continued on page 29)

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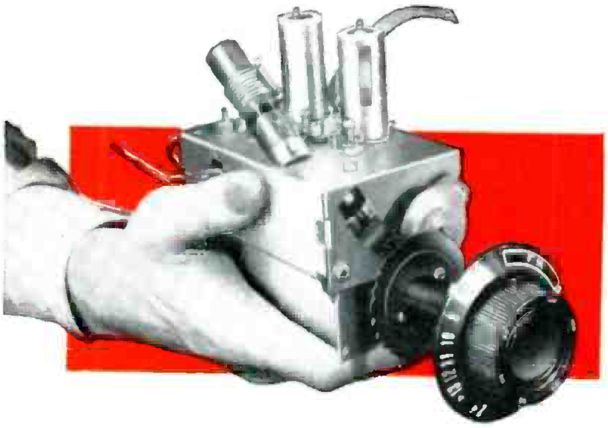

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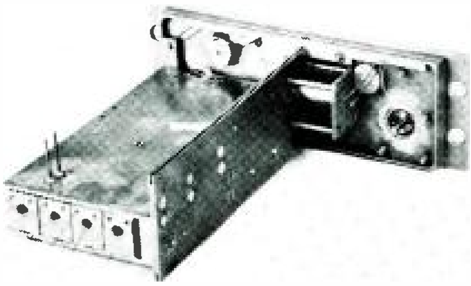
Mechanized Production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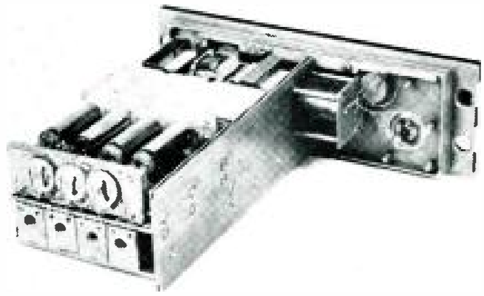
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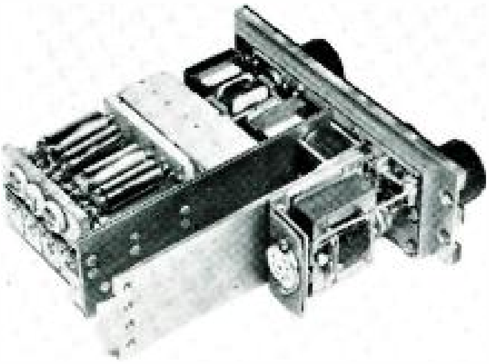
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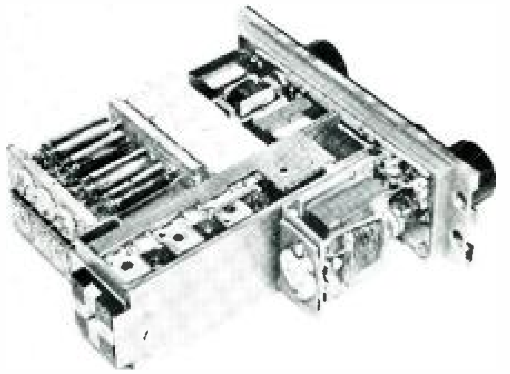
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An interesting illustration of subassembly design, a subminiature lf receiver, recently developed by the Bureau of Standards: A, back-of-panel view with mechanical tuning assembly and rf inductors in place; B, rf amplifier and power-filter assemblies added; C, output transformer, potentiometer, switch, and associated hardware in place; D, addition of if intermediate-frequency assembly, and the input-output connector. Design provides for encasement and hermetic sealing in nitrogen. To simplify heat and replacement problems, the audio output tube assembly plugs into a set-back outside the main case.

IN THE PRODUCTION OF TV and allied equipment, there have been concerted efforts to effect cost reductions, through a variety of streamlined techniques. It is interesting to note, though, that one extremely effective cost-reducing procedure, the mechanized system, has not been too widely adopted.

It appears logical to suppose that any substantial attainment of mechanized production would require a break-away from conventional construction practices. Such a break-away is now in progress, as is illustrated by the new miniaturized equipment construction practices including associated printed circuit techniques.

There are seven methods which can be applied to lessen labor requirements in manufacture:

(*1*) Division of equipment into subassemblies: allows easier access to components and specialization on the part of factory workers.

(*2*) Mechanized component construction: well-developed techniques have already reduced component costs tremendously, and further improvements are being made.

(*3*) Multiple-component units: built by component manufacturers and installed by equipment manufacturers as single units.

(*4*) Prefabricated circuits applied to insulating panels: fully mechanizable, replacing hand-wiring process which now requires more hand labor than any other step in equipment manufacture.

(*5*) Components of specialized form: facilitates installation in equipment by automatic or semi-automatic methods.

(*6*) Mechanized component assembly, a practice not very highly developed: components are now assembled almost entirely by hand.

(*7*) Mechanized connection of components to prefabricated circuits: techniques already developed can replace hand-soldering.

Methods (*1*) and (*2*) represent older methods, the use of which is being extended on modern equipment. Methods (*3*) to (*7*), however, represent substantially new trends.

A well-established method of facilitating production is to divide an equipment into subassemblies, thus providing for ready access and for specialization among factory workers. Present trends to the use of packaged subassemblies are consistent with retainment of the production advantages of the subassembly approach. It has been noted that in the non-mechanized production of some of the modern hearing aids, the subassembly device is used since some provision must be made to give accessibility. (Contrary to the impressions of some, it is reported that workers rapidly become skilled in the use of miniaturized hand tools in work on miniaturized equipment). Another interesting example appears in the production of equipment, featuring very small plug-in assemblies which not only provide for rapid assembly and wiring but also permit very rapid inspection and tests during production phases. In this procedure the manufacturer uses plug-in test *jigs*, which consist essentially of electrical *go, no-go* gauges.

In the production of components mechanized processes have been used to a significant extent. Examples are improved machinery for winding paper capacitor elements, and for processing and testing resistors. The now popular

*From a report on Electronic Equipment Construction, prepared by Stanford Research Institute, and distributed by the Office of Technical Services, Department of Commerce.

and Unitized Construction*

by RALPH G. PETERS

New Accelerated Fabrication Techniques Cited As Offering Significant Advantages, With Seven Methods Now Available For Stepping Up Production and Reducing Costs: Division of Equipment into Subassemblies . . . Mechanized Component Construction . . . Multiple-Component Units . . . Prefabricated Units . . . Specialized Form Components . . . Mechanized Component Assembly . . . Mechanized Connection of the Components of Prefabricated Circuits.

high-dielectric-constant ceramic capacitors represent newer components inherently well adapted to mechanized processing. A more radical departure from conventional practice recently appeared in a large production machine[1] for building vitreous enamel capacitors. It is believed by some that machines of this type might be modified to produce a variety of components and small assemblies.

The rapidly increasing use of functional multiple component units constitutes an interesting trend contributing to a reduction in time and manpower requirements. The trend to the use of such units in assembly has several desirable attributes. Part of the traditional assembly function is taken from the equipment manufacturing plant and placed in the component manufacturing plants where there is greater experience in the use of mechanized construction techniques. Tendencies to standardize the use of such functional units as these should eventuate in a still greater degree of mechanized construction.

It is well established that circuit conductor patterns may today be mechanically applied to insulating panels by a variety of methods. A considerable variety of processes are available from which to select those best adaptable to various manufacturing firms and also to various types of circuitry. Etched foil circuits are becoming increasingly popular; they are easy to produce in laboratories, amenable to mechanized production, and promise good reliability. Stamped foil circuits on insulating base plates are produced by one manufacturer[2] at production rates of 1,800 per hour. Flat panel constructions, not only of the circuit panel itself, but of its assemblage with component, provides commodities that can be readily handled by production machinery. It appears that cylindrical printed circuits offer promise of coming into further usage to supplement flat panel construction. The construction of cylindrical circuits of this type has already been reduced to machine production.

Without question, printed circuit techniques will ultimately contribute extensively to the possibilities of mechanized manufacture of electronic equipment. Tangible progress, although as yet applied to limited extent and to a limited number of types of equipment, has been illustrated by the products of several manufacturers[2,3,4] and by techniques developed at the Bureau of Standards.

Examining the types of components available for use with circuits prefabricated upon insulating panels, we find that leadless parts have played a leading role. Examples of such developments are leadless tubular or rod resistor units, and leadless ceramic capacitors. Another mechanized-type item is the flat *tape* resistor element. Components have been made with right-angle leads for passing through holes

[1]Herlec Corp., Milwaukee, Wis.

[2]Franklin Airloop Corp.
[3]Centralab. [4]Telex.

	Mechanical Rigidity	Temperature Resistance High	Temperature Resistance Low	Heat Transfer	*Effective Dielectric Constant	HF Losses	Humidity Protection	Ease of Service
Resin Embedment	E	P	P-F	P	2.5-4.0	P-G	E	P
Foam Embedment	G	P	F	P	1.03-1.2	G	G	P
Ceramic Embedment	E	E	E	F	10	F-G	E	P
Plastic Coating	P-F	P	F	P-F	1	G-E	F-G	F-G
Silicone Film	P-F	G	G	P-F	1	G-E	G	G
Silicone Fluid Filling	P	G	F-G	F-G	2.5-3.5	G-E	E	F
Gas Filling	P	E	E	F	1	E	G-E	F-G

E = Excellent G = Good F = Fair P = Poor

*Circuit stray capacitance are increased by approximately this factor.

Relative merits of hermetic sealing techniques.

in the conductor ends of printed circuits established on panels. It appears possible to develop specialized components more comprehensively for automatic addition to panel circuits.

Although prospects appear good that automatic means can add and connect components into prefabricated circuits, no great amount of tangible progress has been made. Components with right-angle leads may be mounted on panels (with the leads projecting through the panel for connection to a prefabricated circuit) quite easily by hand, but machinery for dropping them in place automatically might be rather complex. On the other hand, components of standardized length with stub leads in each end may be mounted post-like between two such panels. Components of this type might be chute-fed from hoppers into a jig, and the panels placed over the ends of the components, by fairly simple automatic machinery. (In this type of construction, direct connections between panels may be made by means of conducting members of the same form as the components.) Both of these possibilities, i.e., using components with right-angle stub leads and end extension stub leads, seem worthy of further study.

Soldering of the connections, once the components have been mounted in the prefabricated circuit panels, can be accomplished in the conventional manner, using a soldering iron, much more readily than can the corresponding operation be carried out in the jumble of components on the traditional chassis. Of considerable interest, however, is a process of dip-soldering now in limited production use, but more comprehensively demonstrated as practicable in various laboratories. In the assembly of components to prefabricated circuit panels, the connections to each panel may be dip-soldered in one operation by placing the assembly, with the prefabricated circuit side of the panel down, upon a molten solder bath.

Worthy of mention are the possibilities provided by automatic riveting for both attaching and connecting circuit members and components. The practice has long been used in certain components. Welded connection is also being investigated; this is an established practice in assembling the internal structure of vacuum tubes.

Miniature electronic assembly has been accomplished by a *tag board* construction. It appears possible that the advantages of single-operation dip-soldering can also be realized with a modified tag-board construction. It is possible, also, that present developments on welded wiring connection may apply to tag-board construction as well as to other systems of post-wiring component assemblies.

Hermetic Sealing

It appears evident that hermetic sealing through use of resin embedment is amenable to mechanized production, and should in general cost less than metal containers. Low melting point alloy *strip-away* molds[5] are already in use. Long-cast resin blocks[6] containing many similar units later sawed apart is another technique. More automatized techniques are readily possible. Resin embedment, furthermore, contributes another gain to mechanized manufacture. Components can be automatically secured against shock and vibration without the necessity of time-consuming bracket mounting.

The problem of utilizing these presently-available techniques for the production of representative electronic devices has been studied by the Signal Corps Engineering Laboratories who have formulated an interesting *autosembly* method of construction. This method proposes assembly of conventional components to *printed* conductor patterns by dip soldering. A given piece of equipment may employ several such panels assembled into *decks* which are spaced apart in the over-all assembly precisely as are the decks of a ship, with *headroom* for the components determining the deck spacing.

Probably the most comprehensive attempt which has yet been made to mechanize fully construction of electronic equipment appeared in the work done in England immediately following the last war by Sargrove Electronics, Ltd. A complete production machine was built at a cost of approximately $250,000 and operated in the production of five-tube chassis intended for a large-volume market. Conventional receiver construction was largely abandoned, as conductors, resistors, and capacitors were fabricated directly upon a base panel during its passage through the mechanism. Certain parts such as tube sockets were automatically fed and attached into this panel, leaving only a few of the larger components as speakers, electrolytics and transformers to be attached by hand labor. Significant and limiting was the fact that a minimum run of 20,000 sets was required before this machine could compete with conventional manufacture; production rates were 500,000 sets per year. Tooling for production of a new model ranged from eight to ten weeks although changeover, once tools were built, could be done over a weekend.

Unitized Construction

This important technique, which is finding increasing use in construction, involves dividing the system into subassemblies or units, each of which can be readily removed from the system. The major advantage of this type of construction is the manner in which it simplifies maintenance of equipment. Unitization allows servicing equipment by replacing major subassemblies rather than by finding and replacing isolated components. This offers important advantages in terms of required maintenance time and personnel training, and allows for less complexity in the equipment of the field maintenance station. Unitized construction has another advantage beyond allowing easy correction of equipment faults. If a system is divided into a number of subassemblies, each containing several components, the problem of determining the location of the fault is much simpler than the problem of finding a particular inoperative component. With the problem thus simplified some form of a built-in fault location system becomes feasible.

The foregoing motives are the principal factors responsible for the current interest in this mode of construction. Other instances of unitized construction can be found which aid the maintenance problem, but which were designed on the subassembly basis for other reasons. Ease of manufacture is one of these reasons. The possibility of standardizing often-used assemblies is another. A further reason for division into subassemblies has been found by organizations using resin embedment. The characteristics of typical resins, particularly poor heat conduction and tendency to crack at points of strain, tend to limit the number of tubes and components which can be embedded as a single unit. This forces division of the equipment into a number of small subassemblies.

In many cases unitization of the entire system has not been attempted, but certain portions of the equipment have been designed as removable subassemblies. Examples are to be found in the television local oscillator and input section used by Crosley.

Although the number of complete systems which have been designed and constructed on a unitized basis is still small, there is a definite trend toward increasing use of this method of construction. For the foregoing reasons, as well as from the viewpoint of simplifying maintenance procedures and personnel training requirements, this trend is very desirable. The net results should be an increase in the effective reliability of electronic equipment brought about by reduction of the time necessary to locate the fault and repair inoperative equipment.

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[5]Melpar.
[6]Emerson and Cuming Co., Boston, Mass.

Speed of Response of the

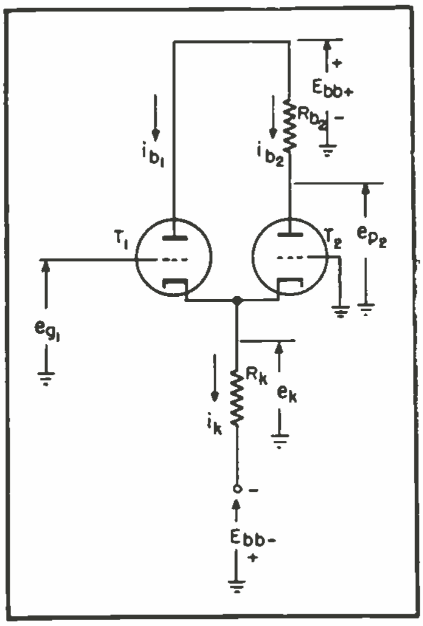

Figure 1

Schematic of cathode-coupled clipper.

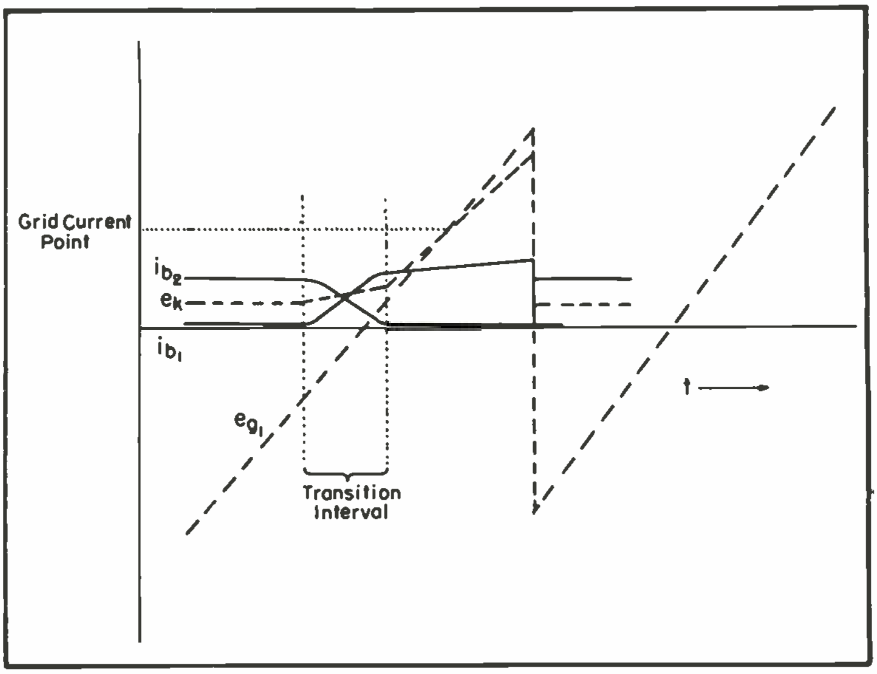

Figure 2 (right)

Behavior of the clipper when e_{g1} is a sawtooth wave. When the voltage applied to the grid of tube 1 has highly negative values, this tube is cut off because the plate current of tube 2 maintains the cathode-ground potential e_k at some minimum value. Under this condition (at $t = 0$) the applied voltage e_{g1} has no effect on the plate current i_{b2} of tube 2. As e_{g1} rises in potential it ultimately reaches the cutoff potential of tube 1, and any further increase in e_{g1} causes plate current to flow in tube 1. The current i_k in the cathode resistor, and hence the cathode potential e_k, tends to increase only a small amount because the increase in e_k reduces the plate current i_{b2} of tube 2. As the potential e_{g1} continues to increase, i_{b2} decreases to zero and from that point on tube 1 acts as a cathode follower with load resistance R_k. In the transition interval where both tubes are conducting, i_{b1}, and i_{b2} change rapidly at a rate determined either by the rate of change of e_{g1} or by the time constants of the circuit. In the range where tube 1 operates as a cathode follower the plate current increases rather slowly, and the cathode voltage e_k follows the applied signal e_{g1} until the grid-current point ($e_k = e_{g1}$) is reached. At the discontinuity in e_{g1}, the currents and voltages in the circuit change rapidly to the values corresponding to the start of the cycle.

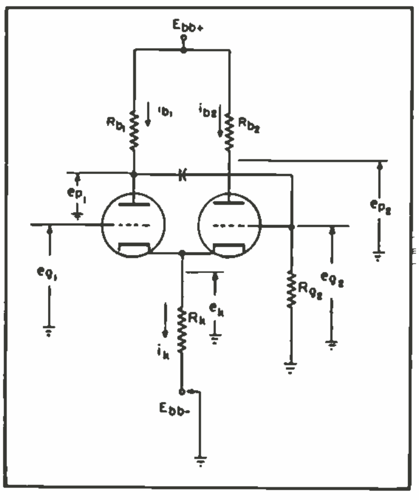

Figure 3

The regenerative clipper. If a resistor R_{b1} is inserted in the plate circuit of tube 1 and the voltage developd across this resistor is coupled to the grid of tube 2, as shown, the resulting regeneration tends to reduce the width of the transition interval.[1]

One of the prerequisites for a good clipper circuit is that the width of the transition interval should be small compared to the total swing that can be impressed on the grid of tube *1*, without drawing grid current. As e_{g1} goes from one transition limit to the other, the plate currents of both tubes undergo large change; hence a high transconductance is desirable for clipper operation. Furthermore, since the upper limit to the rate of change of output voltage will be determined by stray capacitance, a tube with low interelectrode capacitances is desirable. Tubes such as the 6J6 and 6J4 satisfy these requirements. In evaluating the speed of response, in our static tests, a particular 6J6 was used.

The operating conditions for the tests were selected in the following manner. To keep the transient time small, low resistance values must be employed in the circuit; hence tube *2* must draw a large plate current to achieve a reasonable amount of output voltage. A value of 10 milliamperes was chosen as the maximum value consistent with reasonable tube life. The ratio of the peak-to-peak output voltage to the difference of the values of e_{g1} that define the transition interval is preferably somewhat greater than unity; thus a value of 1000 ohms was chosen for R_b, to give a peak-to-peak output of ten volts. A value of $R_k = 10{,}000$ ohms was selected so that tube *1* would have a fairly large load when tube *2* was cut off, thereby insuring that the grid-current point of tube *1* would occur at values of e_{g1} considerably above the transition interval. With the small change (10 volts) in e_{p2}, a positive plate supply voltage E_{b+} of 150 was sufficient. A negative supply voltage $E_{b-} = -100$ volts was chosen to equal approximately the drop across the cathode resistor so that the grids of both triodes could be returned to ground potential. With the operating conditions established, a series of static tests was made to determine the effect of the circuit resistances and supply voltage on the behavior of the clipper. The circuit used for the tests is shown in Figure 5. In all tests the bias supply

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[1] Goldmuntz, L. A., and Krauss, H. L., *The Cathode-Coupled Clipper Circuit*, Proc. IRE, No. 9, pp. 1172-1177; 1948.

Cathode-Coupled Clipper

by PHILIP F. ORDUNG and HERBERT L. KRAUSS

Dunham Laboratory, Yale University

Probe of Factors Affecting the Speed of Response of the Cathode-Coupled Clipper Circuit When It Is Driven by Essentially Rectangular Pulses, Reveals That the Transient Build-Up Time Is Approximately 50 Millimicroseconds, Indicating That Sine Waves With Frequencies as High as 10 Mc Can Be Clipped with Fair Waveform.

voltage E_{cc2} was adjusted to make $e_{g2} = 0$, when $e_{g1} = 0$.

The effect of regeneration on the transition interval is shown in Figure 6, which shows curves of i_{b2} versus e_{g1} for various values of R_{b1} with $R_{b2} = 0$, and $R_k = 10{,}000$ ohms. The largest value of R_{b1}, 750 ohms, was sufficient to put the circuit on the verge of oscillation, as evidenced by the large slope in the vicinity of $e_{g1} = 0$. Because the tube parameters change near cutoff, the limits of the transition interval are not sharply defined by the curves of Figure 6, and therefore no exact figure can be obtained for the improvement due to regeneration. However, the interval in terms of e_{g1} was found to be about 8 volts with no feedback ($R_{b1} = 0$) and 2 volts with maximum feedback ($R_{b1} = 750$ ohms), corresponding to a ratio of 1 to 4 for the slopes of the two curves. The grid-current point for the circuit was at $e_{g1} = +35$ volts. Thus, with the maximum feedback, the input ratio, defined[1] as the ratio of the peak amplitude of input signal that just reaches the grid-current point to one-half the transition interval, is approximately 35. This means that if a sine wave of 35 volts peak amplitude is applied to the input it will be clipped when it reaches approximately (±)1 volt.

Figure 7 illustrates the effect of variation of the plate-supply voltage with the other parameters fixed at $R_{b1} = 470$ ohms, $R_{b2} = 0$, and $R_k = 10{,}000$ ohms. The positive supply voltage E_{bb} was varied, and E_{cc2} was varied accordingly to make $e_{g2} = 0$ when $e_{g1} = 0$. An increase in the plate supply voltage will raise the grid-current point of e_{g1}, but at the expense of less abrupt changes at the limits of the transition interval. This behavior may be accounted for, because the tube will have a sharper cutoff when the plate voltage is reduced.

The size of the cathode resistance has marked effect upon the grid-current point of the clipper, while it has inappreciable effect on the width of the transition interval or upon the behavior of the clipper within this interval. Figure 8 illustrates the characteristics obtained with several values of R_k, and with $R_{b1} = 470$ ohms, $R_{b2} = 0$. The negative supply voltage E_{kk} was adjusted to make the cathode current i_k substantially the same in all tests. The size of R_k had so little effect on the behavior of i_{b2} in the transition interval, because the values used for R_k were all much larger than the equivalent resistances of the tubes, as seen from their cathodes. The grid-current point for e_{g1} increased with R_k as would be expected from cathode-follower theory.

In Figure 9 the effect of inserting a load resistor, $R_{b2} = 1{,}000$ ohms, in the output circuit is illustrated for the case where $R_{b1} = 470$ ohms and $R_k = 10{,}000$ ohms. The effect was small, but a tendency to widen the transition interval is indicated.

Dynamic Tests—Speed of Response

The unavoidable capacitances between tube elements, across resistors, and resulting from wiring, determine the shortest possible duration of a

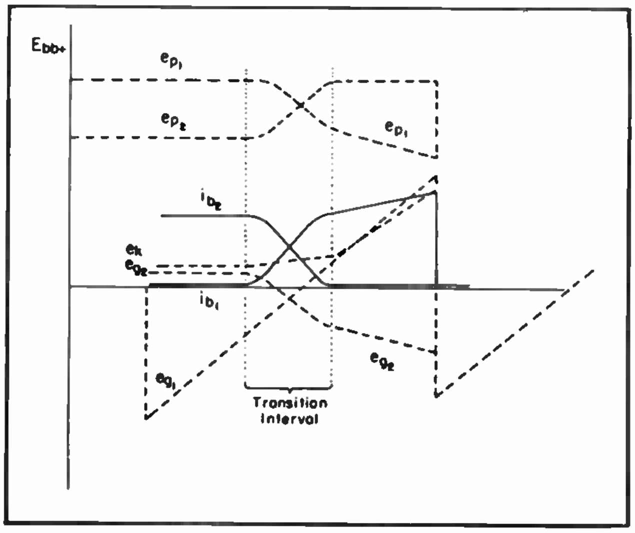


Figure 4

Behavior of the regenerative clipper when e_{g1} is a sawtooth wave. It will be noted from these waveforms that the cathode voltage e_k and the grid voltage e_{g2} move in opposite directions; hence the total variation required of e_{g1} to go through the transition interval is less for the circuit of Figure 3 than for the circuit of Figure 1. The amount of regeneration used must be limited to avoid oscillation. The largest allowable value of R_{b1} for stable operation may be determined analytically, but the behavior of the circuit near the limits of the transition interval where the tube parameters are changing must be ascertained experimentally.

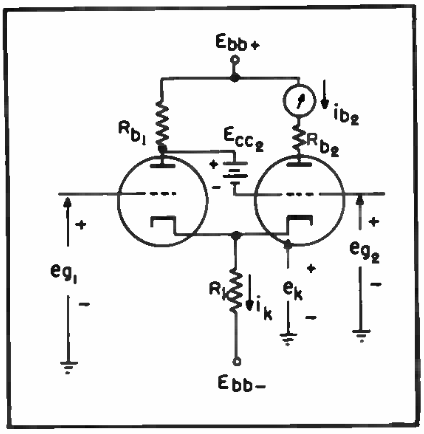


Figure 5

Circuit used for the static tests of Figures 6 to 9.

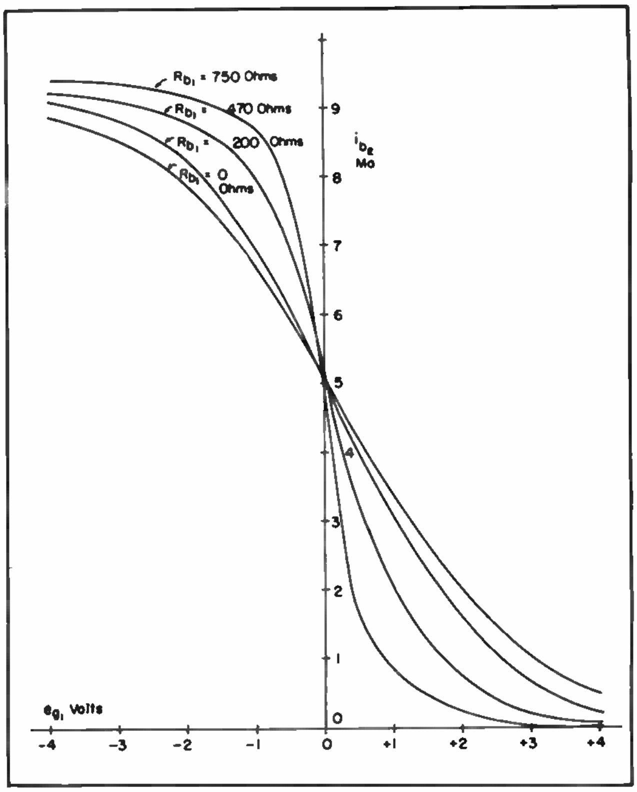


Figure 6

Transfer characteristics of the clipper as a function of regeneration. The grid current point occurs at e_{g1} = + 35 volts for all curves. The conditions were E_{bb-} = — 100 volts; E_{bb+} = + 150 volts; R_{b2} = 0; R_k = 10,000; E_{cc2} adjusted to make e_{g2} = 0.

transient state in the clipper circuit when it is excited with an impulse or step function. The largest of these capacitances are shown with dashed lines in Figure 10. Some of the values can be approximated readily from a tube manual, while others can be determined only by measurement in a particular circuit, and the measurement process is often difficult. A series of dynamic tests were made to determine how these capacitances affect the operation of the clipper and which of them exert a predominant influence on the highest speed of operation. In these tests a voltage pulse that had an extremely short rise and decay time was impressed upon the input grid of Figure 8*a*. The voltages in various parts of the circuit were observed with a special 'scope capable of reproducing pulses having rise times in the order of a few millimicroseconds. The input

(Continued on page 32)

Figure 7

Effects of variation of E_{bb+} or transfer characteristics: E_{bb-} = — 100 volts; E_{b2} = 0; R_{b1} = 470 ohms; R_k = 10,000; E_{cc2} = adjusted to make e_{g2} = 0 when e_{g1} = 0.

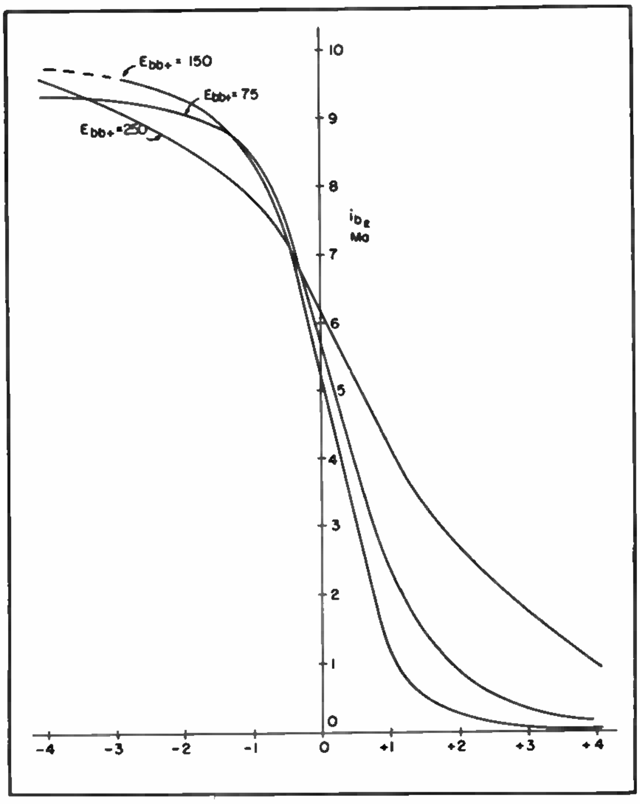
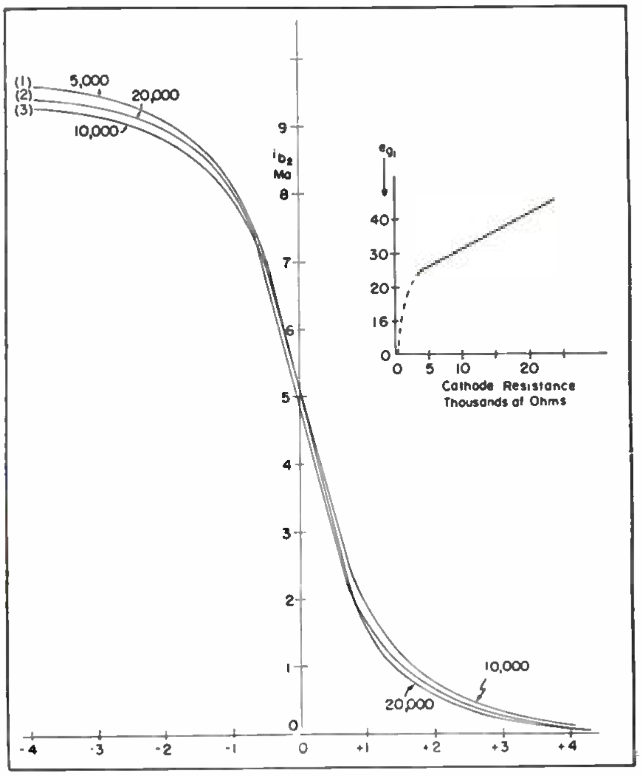


Figure 8

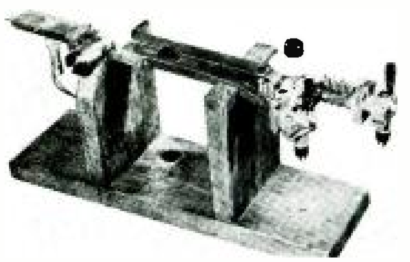
Effects of change in size of cathode resistor. The ratio of cathode resistance to E_{bb-} was held constant: E_{bb+} = + 150 volts; R_{b1} = 0; R_{b2} = 470; E_{cc2} = adjusted to make e_{g2} = 0 when e_{g1} = 0. At curve (1) R_k = 5000 and E_{bb-} = — 50 volts; (2) R_k = 20,000 and E_{bb-} = — 200 volts; (3) R_k = 10,000 and E_{bb-} = — 100 volts. In (a) at the upper right is a plot which illustrates grid current points as a function of cathode resistance.



Instrument News

Wide Band Sweep

A WIDE-BAND SWEEPING OSCILLATOR is now available. Featured are two bands selectable by front panel switch, 50 kc to 10 mc and 50 kc to 20 mc; pulse type markers connected directly to 'scope crystal-positioned at 1, 2, 5, 10, 15, 20 mc; output of .3 volt; 72-ohm output; all-electric sawtooth sweep, and sawtooth available for sweeping 'scope. Output flat said to be within .1 db/mc. *Marka-Sweep; Kay Electric Co., Pine Brook, N. J.*



Kay Electric sweeping oscillator

Video Amplifiers

A VIDEO AMPLIFIER, designed for waveform inspection in connection with a 'scope, has been announced.

Unit is said to have a gain of 1000, frequency response flat from 15 *cps* to 4 mc within 1.5 db of 10 kc response point. A cathode follower input stage is used for circuit isolation and includes an input attentuator providing 1:1, 1:10 and 1:100 attentuation ratios as indicated by a control knob on the front panel. Input impedance, without probe, is approximately 2.2 megohms and 40 mmfd on all attenuator ranges.

A gain control is provided for adjusting the output from 0 to 50 volts *rms*. Signal polarity switch on the front panel varies the cathode bias so that the amplifier unit may be adjusted for optimum performance regardless of the polarity of the input signal. Phase shift is minimized to provide satisfactory reproduction of pulses on the order of one microsecond and square waves at repetition rates as low as 100 per second. *Ripley Co., Middleton, Conn.*

Ripley video amplifier

Wide-Frequency Range Bridge Oscillator

A BRIDGE OSCILLATOR with a variable frequency source of moderate power output has been produced. Three audio frequencies, power line, 400, and 1000 cycles, and a wide continuous range of *rf* from 5 kc to 50 mc, either modulated or unmodulated, are provided. Output voltage is 10 volts, and it is said that more than one watt can be delivered into a 50 ohm load over most of the frequency range. Two levels of internal modulation at either 400 or 1000 cycles are available over the range from 15 kc to 50 mc. *Type 1330-A; General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

G-R bridge oscillator

Waveguide Test Instruments

A LINE OF WAVEGUIDE TEST EQUIPMENT based on a concept of waveguide instrumentation has been announced. Frequency coverage from 2.6 kmc to 18.0 kmc in six most-needed waveguide sizes are provided.

One of the instruments of the line has a single carriage which accepts either slotted waveguide sections or coax sections covering frequencies from 1 to 12.4 kmc. The carriage itself travels on a three-point continuous ball-bearing suspension. Waveguide and coaxial slotted sections may be interchanged.—*Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.*

H-W waveguide test unit

Square Wave Generator

A STEP-FREQUENCY type square-wave generator for high speed testing of response characteristics of wide-band amplifiers, wide-band 'scopes and TV video amplifiers has been announced.

Featured are five fixed output frequencies of 50, 1000, 10,000, 100,000 and 500,000 cps, individual calibration control for each frequency, rise time of .05 microsecond, output voltage from .8 to 8 volts peak-to-peak, *ac* operation and output impedance of 50 to 550 ohms. *Model SG5; El-Tronics, 2647 N. Howard St., Philadelphia 33, Penna.*

Automatic Resistance Comparator

A RESISTANCE COMPARATOR that is said to test as many as 17 resistors a minute has been developed. Meter scale is calibrated in three scale ranges: −5 to +5%, −25 to +30% and −50 to +100% deviation from standard. Provides a range of 100 ohms to 100 megohms. Accuracy said to be ± 1%. *Type PR-5; The Clippard Instrument Laboratory, Inc., Bank St., Cincinnati, Ohio.*

Clippard resistance comparator

Five-Inch 'Scope

A 5-INCH 'SCOPE that is said to have a wide band amplifier *dc* frequency response from 0 to 4.5 mc, down 3 db, is now available.

Vertical *dc* and *ac* amplifier is said to have a 10-25 mv per inch sensitivity. Unit is said to provide a maximum input potential of 1000 volts peak, and an input impedance of 2 megohms, 50 mmfd. Horizontal amplifier has a direct deflection factor of 20 volts rms per inch. *Model 640; Hickok Electrical Instrument Co., 10529 Dupont Ave., Cleveland 8, Ohio.*

Test Oscillator

A TEST OSCILLATOR with seven 330° scales is now available.

Featured are five fundamental ranges: 165 kc to 40 mc, and two harmonic ranges directly calibrated 36 to 120 mc, range selector with a five-position follow-up coil switch with complete shielding, and high and low *rf* output selector. Output attenuator is said to provide fine control of *rf* output to coax output cable connector. Circuit selector provides for internally modulated signal, variable 0 to 100% at 400 cycles. Variable amplitude of external modulation is 40 to 15,000 cycles. All *rf* and audio circuits are double shielded with copper-plated steel shields. *Model 3432; The Triplett Electrical Instrument Co., Bluffton, Ohio.*

Triplett test oscillator

TV Parts & Accessory Review

Production

Ferrite-Core Deflection Yoke

Ferrite core deflection yokes, featuring distributed windings, have been designed. For use with TV tubes of 60° to 70° deflection angle.

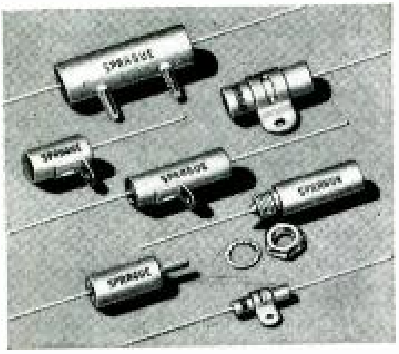
Available for use with transformer or autotransformer output circuits and with different networks and lead lengths, or without networks and leads. Yoke is said to withstand continuous operating temperatures up to 90° C. and voltages up to 4 kv between any windings or between windings and frame. Standard horizontal inductance is 10.5 millihenries, and vertical inductance 12 millihenries.—*Y24; Electronic Parts Division, Allen B. Du Mont Laboratories, Inc., 35 Market St., East Paterson, N. J.*

Du Mont ferrite yoke.

Subminiature Paper Capacitors

Subminiature 125° C capacitors are now available.

Capacitors use Vitamin Q, an organic polymer capacitor impregnant. Units are available in voltage ratings from 100 to 1,000 volts *dc* in both inserted tab and extended foil constructions.—*Complete data available in bulletin 213A; Sprague Electric Co., North Adams, Mass.*



Sprague subminiature capacitors.

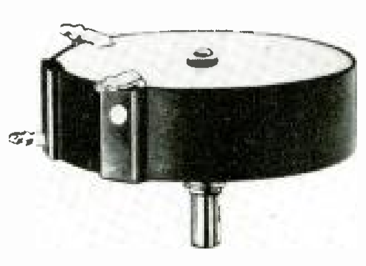
Knights Crystals

A series of crystals, the G Series, employing a glass envelope for hermetic sealing that is said to result in higher crystal *Q* and freedom from the effects of supersonic reflections has been announced.

Available in the 90 to 200 kc range.—*James Knights Co., Sandwich, Ill.*

HV Electrostatic Focusing Control

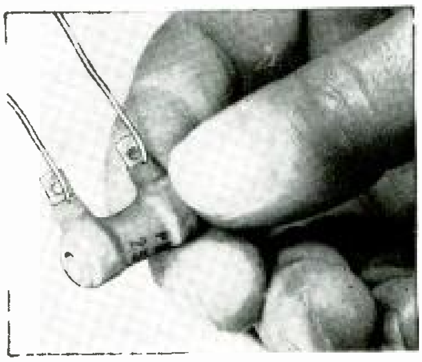
A high-voltage control for electrostatic focusing has been developed.—*Type 85; Chicago Telephone Supply Corp., Elkhart, Ind.*



Chicago Telephone electrostatic focusing control.

Five-Watt Wire-Wound Power Resistor

Five-watt fixed wire-wound resistors with inorganic-cement coatings are now available in values of 8000, 8500, 9000 and 10,000 ohms.—*PR5F Greenohms; Clarostat Mfg. Co., Inc., Dover, N. H.*



Clarostat wire-wound resistors.

High Voltage Supply

A high-voltage unit providing 4500 volts *rf dc* has been announced. Voltages up to 7500 at 1 milliampere said to be available. Supplied with either negative or positive polarity outputs.—*Spellman Television Corp., 3029 Webster Ave., New York 67, N. Y.*

Selenium Rectifiers

Tiny selenium rectifiers with a longer leakage path that is said to reduce the possibility of a short circuit have been developed.

Outside diameter is 3/32" for a completely insulated, or a hermetically sealed assembly. The length varies according to voltage requirements. Plates are only 1/16" in diameter and are available for such applications as direct mounting into the base of a printed circuit, or other usages where an enclosed unit is not required. These units are said to deliver 300 microamperes of current for an indefinite period of time.

Companion units with ferrule or pigtail leads and current ratings up to 25 milliamperes are also available. Voltage ratings up to 25,000 volts are standard.—*Hardy Instrument Co., 104-18 Metropolitan Ave., Forest Hills, N. Y.*

Ferramic Cores

Ferramic cores in cup, ring, or E and I types have been developed. Ferramic, a soft magnetic materal, is lightweight and claimed to have a high permeability, high volume resistivity and a low-loss factor. Cores of this material can be extruded, molded or machined to the desired shape. Laminations are not required.—*General Ceramics and Steatite Corp., Keasby, N. J.*

Lacquers and Varnishes

Lacquers and varnishes for *rf* service have been produced. Can be applied to windings ranging from single layer *uhf* coils to multi-layer windings. Clear lacquer is said to feature a high *Q* coil treatment which is constant in drying phases from fluid to hard solid.

Lacquer can be used for bonding single layer coils to supporting forms, for preventing turns from loosening or touching, or as a saturant for *rf* and *if* windings where distributed capacity must be minimized.—*No. A-27, Q-Max; Communication Products Co., Inc., Broadway and Clark St., Keyport, N. J.*

Picture-Tube Rings and Sleeves

Mounting and insulating rings and insulating sleeves* for 24" glass-metal picture tubes have been announced.—*Type 24H14F (Ring) and 24AP4/IC (Sleeve); Anchor Industrial Co., 533 Canal St., New York City.*

*U. S. Pat. 2,503,813; other patents pending.

Cable Harness Tester

A universal harness tester for production and maintenance testing of multi-conductor cables has been announced. Equipped with a pair of coax cable connectors, a pair of 47-contact connector receptacles and a pair of 35-contact connector receptacles.

Unit is operated by connecting cables, type of test selected, and each conductor tested by turning a contact selector which visually indicates the conductor being tested.

A full amp is passed through the conductor in continuity testing. In insulation resistance testing, every conductor, but the one being tested, is grounded and 1500 volts *dc* applied. A continuous variable *dc* potential up to 5000 volts is applied to the conductor being tested in insulation breakdown testing.

Instrument can be used for point-to-point testing.—*The Welch Electric Co., 1221 Wade St., Cincinnati 14, Ohio.*

Selenium Rectifiers

(Continued from page 15)

plete the formation of crystalline selenium. This process, like the preceding one, is carried out in a room in which both temperature and humidity are controlled.

Application of Blocking Layer

After cooling, an artificial barrier or blocking layer may be applied. Some manufacturers omit this operation. The blocking layer usually takes the form of a lacquer which is sprayed lightly on the exposed surface of the heat treated selenium. The exact composition of the lacquer is another trade secret.

Application of Front Electrode

The front electrode is sprayed over the blocking layer, and consists of a low-melting-point alloy (usually bismuth, cadmium, and tin). The melting point of this metal must be low, to prevent damage to the selenium and blocking layer. Its temperature characteristics largely determine the maximum operating temperature of the rectifier, inasmuch as the front electrode will melt when the rectifier temperature rises to the melting point of the alloy.

Forming of Rectifier

Although when the plate is produced, in accordance with the foregoing practices, it exhibits rectifying properties, it will not yet display the desirable characteristics of lowest forward resistance, highest reverse resistance, and good stability. Its final improvement is obtained through the process of *forming*. Here, the rectifier is connected for an appropriate time continuously to a power source. The voltage must be adjusted to a value which causes rated *reverse* current to flow through the plate. This voltage is started at a low value. It then is increased steadily at frequent intervals to maintain the current at the same value. Toward the end of the forming period, the necessity to increase the applied voltage becomes less and less, until finally the current stabilizes at its rated value. The rectifier then is considered to be completely formed.

Assembly of Rectifier

A simple rectifier stack of the television type is assembled on an insulated bolt with five or six plates so arranged with contacts that the individual plates are connected together in series. In addition to these simple stacks, there also are available *(a)* single plates, *(b)* full-wave single-phase center-tapped, *(c)* full-wave single-phase bridge, *(d)* three-phase half-wave, *(e)* three-phase bridge, and *(f)* three-phase full-wave center-tapped stacks. Other special stack assemblies are available on special order. After final assembly, most TV-type rectifiers are given a paint spray or dip for protection against moisture and damaging of the front electrode.

Classes of Rectifiers

Selenium rectifiers may be grouped into two main classes: *(1) radio-TV type*, embracing those units rated at maximum *dc* output currents between 65 and 1000 milliamperes, and *(2) power type* with output current ratings between 1000 *ma* and several thousand amperes *dc*. Instrument-type rectifiers, employed to convert *dc* meters for *ac* operation, are not at present an important selenium application, this type of rectifier now being dominantly of the copper-oxide type.

VWOA News

Personals

John C. Clayton, Cambridge, Mass., and John V. Drougalis, Red Bank, N. J., are now members of VWOA. Clayton's brass-pounding moments began in '19 when he served on the SS Coldbrook with the old shipping board until '23. For six years he was the *sparks* aboard vessels and in '29 he joined the Dollar Steamship lines as manager of their radio department. Subsequently he became manager of Dollar's subsidiary, Globe Wireless, Inc., of San Francisco. Radio is still his pet project these days. . . . Drougalis' radio service began in '29. Among the ships he sailed on as radio operator were the Bull Lines SS Catherine, several Ward Line ships such as the Antilla, Oriente, J. P. Morgan's yacht the Corsair, the old Independence Hall of the American France Line and others. In '42 he became affiliated with the Signal Corps Labs at Fort Monmouth, N. J., as field engineer in charge of production on wire communication equipment. He is still connected with the Signal Corps. He's also an amateur, with the call W2AGL. . . . Deepest sympathies to life-member, director and first vice president Arthur J. Costigan, who is mourning the loss of his wife. . . . Oldtimer R. P. Huestis, who is electronics engineer for the Keystone Shipping Company, Philadelphia, has charge of all radio and radar equipment used aboard ships operated by his company. . . . E. E. Rackle is now in New Orleans. . . William Q. Ranft is still with WFBR, Baltimore, Maryland, as chief engineer. . . . William E. Rice is now with Raytheon, Waltham, Mass., in the final test section. He has for the last 33 years, worked in almost every branch of the art, serving as a key pusher in '18. Now operates ham station W1HKT. . . . H. A. Robinson has reported that he's still in Pakistan with RCA International. . . . George Street is now at RCAC, Broad St., N. Y. C., as assistant manager of the traffic bureau. . . . Ivan H. Loucks, who is with the FCC in Washington, has recently been promoted from head of the operators license department to chief of the amateur branch in the New Safety and Special Radio Services Bureau. When time permits, which is seldom, Loucks is working on a history of radio operating. Good luck. . . . John V. L. Hogan notes that he has been appointed civilian member of the panel on electronic countermeasures in the Department of Defense. He is also a member of the ECM *Scientific Steering Group*, which serves as an advisory body to the joint committee on Electronics and Communications of the Joint Chiefs of Staff. . . . Lieut. D. A. Bark is now a Communications Officer at the Naval Radio Station, Astoria, Ore. . . . H. J. Buckley, Toulon, Ill., is currently serving as chief engineer of WGN. S. W. Fenton is now in Greece and expects to be there until June. . . . Tropical Radio's traveling installation engineer has recently returned from the tropics on sick leave. . . . J. W. Graham is busy carrying out orders of the FCC at Millis, Mass. . . . L. S. Bennett is purchasing agent of the Mass Radio School, which is run by life member Guy Entwhistle. Bennett is also in charge of maintenance at the school. During his off hours he probes the heavens with his ham outfit, W1HH. . . . George Bonadio, Watertown, N. Y., is still an active inventor, currently holding a pat pending on new type of amplifier tube. Bonadio developed the antenna system which provided for noise-cancellation in the field. . . . Frank Borsody, Arlington, Va., reports that he is deep in defense work, serving as radio frequency allocation engineer in the Defense Department.

VWOA veteran Fred J. Gommo, tuning one of TRT's transmitters in the Panama radio station, which he recently installed.

WHEN YOU CHANGE YOUR ADDRESS

Be sure to notify the Subscription Department of TELEVISION ENGINEERING, 52 Vanderbilt Avenue, New York 17, N. Y., giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

TV Maintenance

(*Continued from page 16*)

see that guide pin is properly positioned.

After the foregoing operations, each camera chain should be set up and tested on the chart and bar generator. The regulated 120-volt supply should be adjusted. Peaking, linearity, target and focus coil current, and beam current should then be probed. Fuse current should be checked, too. A record of the results obtained with each camera should then be made, listing (*a*) line resolution, (*b*) pulling, (*c*) linearity, (*d*) corner resolution, (*e*) shading, and (*f*) distortion.

(*7*) Intercom phones should be checked and repaired if required.

(*8*) Camera tripods should also be checked, anchor chains being repaired if necessary.

(*9*) Tripod heads should be checked. If operation is sluggish, heads should be opened and lubricated with a medium-weight oil. Clean if necessary.

Maintenance of Switcher, Monitor, Distribution, Utility, Stabilizing, Sync Stretch Amplifiers, Camera Controls, Power Supplies, Etc.

(*1*) All tubes should be checked and replaced if G_m is less than 70 per cent of normal rating. The 6AS7 balance should be checked in power supplies, replacing if current variation exceeds 50 per cent. The 6AG7 control tubes should be replaced if the output regulation is not constant, and the VR105 regulator should also be replaced if a flicker is present.

(*2*) The video and sync adjustments of the stabilizing amplifiers and sync stretcher must be checked against the manufacturer's specifications, making peak-to-peak waveform readings if necessary.

(*3*) All power supply voltages must be checked and adjusted.

(*4*) Fuses should be checked for correct values, seeing that clips are clean and tight.

(*5*) A visual inspection of loose parts, overheating, or wrong parts should follow. All temporary repairs should be made permanent.

(*6*) All picture tube and *cro* faces should be washed.

(*7*) Switcher and other moving contacts should be cleaned and lubricated.

(*8*) Switcher should be checked for good operation, checking for *spikes*, correct sync proportion, and set-up adjustments.

(*9*) Monitors should be checked on the bar generator, adjusting for proper aspect and linearity.

Sync Generator

(*1*) The generator should be allowed to reach normal operating temperature.

(*2*) All the foregoing tests should be made.

(*3*) All timer countdown adjustments should be set to mid-range.

(*4*) All pulse widths, etc., should be set with a studio 'scope.[1]

(*5*) The *a/c* sensitivity and operation should be checked.

(*6*) Peak-to-peak voltages of all pulses (sync, driving and blanking) should also be checked.

[1]Tektronix 511, RCA 715B, DuMont 241, etc.

Audio Equipment Checks

(*1*) Tubes should be tested.

(*2*) A visual inspection of all parts, wiring, connections must be made, checking terminal, socket voltages and currents.

(*3*) All microphone cords should be cut back about 6″ from each end, dating and intialing under scotch tape (at mike end).

(*4*) All microphone extension cables should also be cut back 6″ from each end, dating and initialing under scotch tape at one end.

(*Continued on page 30*)

(Continued from page 29)

(5) All microphones should be voice checked.

(6) Potentiometers should be oiled sparingly with Daven oil.[2] cleaning as required.

(7) Frequency response, noise and distortion checks should be made on all program amplifiers, preamps, limiting amplifiers, etc.

(8) All cue lines and headphones should be checked for proper connections, etc., and repaired as necessary; date and initial each line and phone on paper (under scotch tape).

(9) Equipment and racks should be cleaned with vacuum cleaner. Front surfaces can be polished with glass-wax.

(10) A visual inspection of all equipment, connections, etc., should be made.

(11) Anything which has broken down during the week must be repaired.

Test Equipment; Shop Facilities

A well-equipped workshop is extremely important in minimizing equipment troubles and maintaining the efficiency of the engineering staff. Test equipment for a station should include:

(1) A 5-inch 'scope[3]; one for transmitter and one for studio.

(2) Square-wave generator[4]; one at studio and available for carrying to transmitter, or, preferable, one at each location.

(3) Capacitance-resistance bridge[5] at studio.

(4) Volt-ohm-milliammeter[6]; one at transmitter and one at studio.

(5) High-voltage multiplier[7]; one for each *vom*.

(6) Low-distortion audio oscillator[8]; one at studio, one at transmitter. (In small studio installations, only one oscillator is necessary, at the transmitter.

(7) Distortion and noise analyzer[9]; one at transmitter, one at studio. (In small station installations, only one is required, at the transmitter.)

(8) Video sweep generator[10]; one at studio (can be carried or piped to transmitter).

(9) Wavemeter at studio for microwave equipment adjustments.

(10) Wavemeter at transmitter.[11]

(11) Vacuum-tube voltmeter[12]; one at studio, one at transmitter.

(12) Tube tester[13]; one at each site.

(13) A 3-inch scope[14] for remote.

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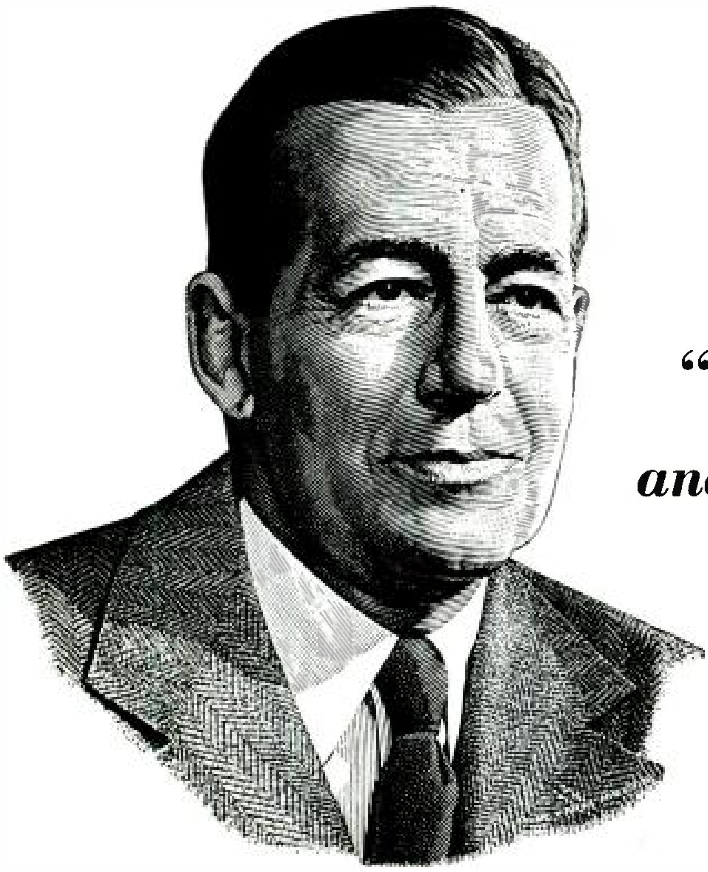
[2]Daven.

[3]G.E. ST-2A; Tektronix 511; RCA 715-B; DuMont 248A. [4]G.E. YGL-1. [5]G.E. YCW-1. [6]G.E. YMW-1A. [7]G.E. YYW-1. [8]G.E. YGA-3. [9]G.E. YDA-1.

[10]RCA WA-21-A. [11]G-R 758-A. [12]RCA Volt-Ohmist 195-A or Advanced Volt-Ohmist. [13]Hickok 534-B or 533-P. [14]RCA WD-79A.



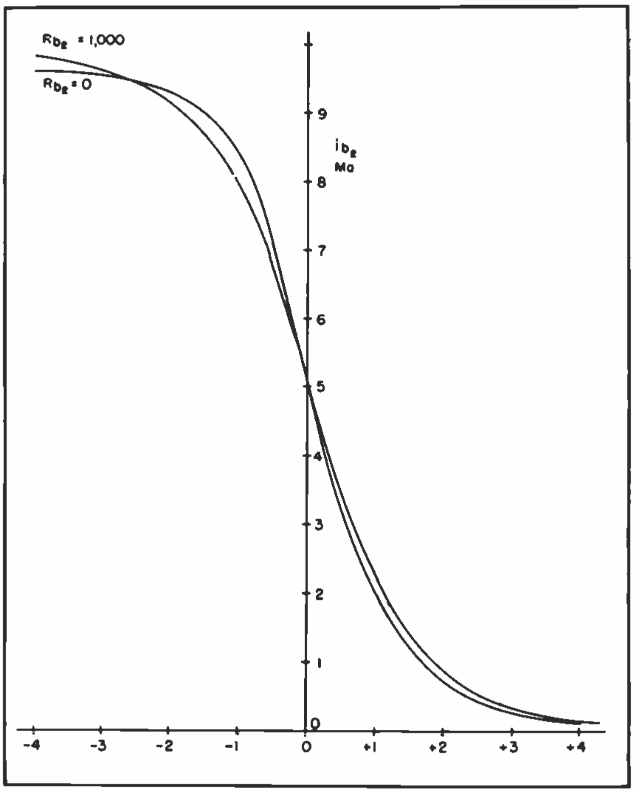


Figure 9

Effects of R_{b2} on transfer characteristics: $E_{bb+} = +150$; $E_{bb-} = -100$; $R_{b1} = 470$; $R_k = 10,000$; E_{cc2} = adjusted to make $e_{c2} = 0$ when $E_{c1} = 0$.

Cathode-Coupled Clipper

(Continued from page 24)

capacitance of the 'scope was 8-mmfd and thus 8-mmfd capacitors were connected to ground from all of the circuit terminals to which the 'scope was to be connected. When the 'scope was connected to a particular point, the corresponding capacitance was removed, to avoid any change in the operation of the circuit.

[The concluding installment of this discussion will appear in the May issue.]

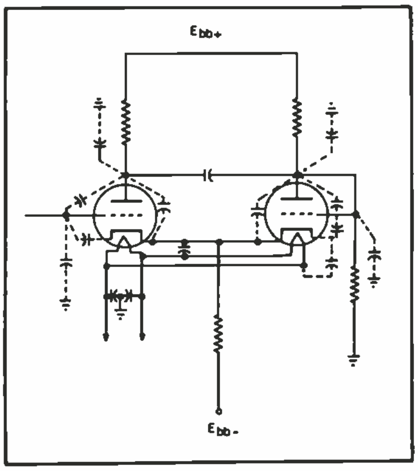


Figure 10
The principal unavoidable capacitances in the clipper circuit.

RELAY MAKERS EXPANDING

Commander Ralph Brengle, Potter and Brumfield sales manager (left), and R. M. Brumfield, president (right), reviewing the site of their new plant in Princeton, Indiana, with Princeton's Chamber of Commerce president, Chose Derbyshire. Present production facilities will be retained.

BURGESS BATTERY RECEIVES CERTIFICATE OF MERIT

D. W. Hirtle, Burgess Battery Company president (seated at right) viewing the Certificate of Merit for 1950 recently awarded to Burgess for outstanding achievements in pioneering artificial electrolytic manganese dioxides and for founding the industry of reserve type cells. The award was made by the New York Hall of Science. Looking on, left to right: D. J. Teare, secretary treasurer; L. H. Harriss, sales manager; F. J. Kirkman, vice president and general manager; J. J. Coleman, chief engineer; L. E. Girard, chief inspector; H. S. Cramer, general superintendent.

Industry Literature

The Muter Co., 1255 S. Michigan Ave., Chicago 5, Ill., have issued the first three sections of a catalog, Forms 100-300, covering radio, TV and electronic parts and components. Form 100 is devoted to ceramicaps (temperature compensating, general purpose, disc and variable ceramic capacitors). Form 200 covers resistors; wire-wound candohms and sensitivity controls. Form 300 is devoted to wiring shield for critical *rf* and *af* circuits.

Taylor Fibre Co., Norristown, Pa., has published a 62-page catalog covering laminated plastic applications. Includes data on vulcanized fibre, phenol fibre and special laminates with special design and machining hints.

Division Lead Co., 836 W. Kinzie St., Chicago 22, Ill., has released a five-page folder describing solder and fluxes. Included is a summary of NPA tin order M-8.

Sylvania Electric Products, Inc., Radio Tube Division, 1740 Broadway, New York 19, N. Y., have made available a 48-page booklet, prepared by Rufus P. Turner, with information on the use of *vtvms* in radio and TV servicing. Text covers different types of *vtvms*, and their adjustment and application for receiver test and measurements, audio amplifier tests and measurements, and miscellaneous uses. Priced at $1.00.

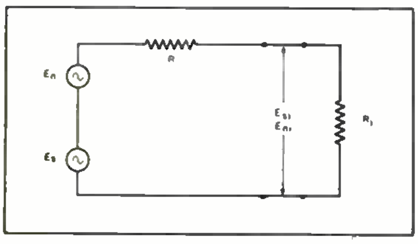
Noise Calculations

(*Continued from page 12*)

N_f and E in lines A, B, and C of Figure 1.

In the case of an actual receiver having a signal input voltage E_s, and noise input voltage E_n, the ratio of $\frac{E_s^2}{E_n^2}$ is equal to the power signal-to-noise ratio measured by a square law detector. Thus

$$\frac{E_s^2}{E_n^2} = \frac{P_{si}}{P_{ni}} = \frac{E_s^2/4R}{KT\Delta f} \qquad (3)$$



The quantities $E_s^2/4R$ and $KT\Delta f$ are the available signal and noise input powers. The noise figure F of an amplifier is, by definition,

$$F = \frac{P_{no}}{P_{ni}} \times \frac{1}{P_o/P_i} = \frac{P_{no}}{P_{ni}G_p} \qquad (4)$$

where the ratio $P_o/P_i = G_p$, the available power gain of the receiver.

The noise factor, F, can be determined by referring the noise power out-

(*Continued on page 34*)

Noise Calculations

(Continued from page 33)

put P_{no} to an equivalent noise voltage input, E_q. As the noise output of an amplifier is generally measured in volts, E_{no}, in a given resistance, R_o, it can be shown that the equivalent noise voltage input of an amplifier having an input resistance, R_i, and a voltage gain G_v, is

$$E_q = \frac{E_o}{G_v}\sqrt{\frac{R_i}{R_o}} \qquad (5)$$

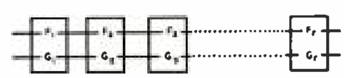
Values of E_q can be determined by means of the nomogram presented in Figure 2; p. 12. Knowing values of R_i, R_o, and E_o, a gain correction factor can be obtained. This factor is in *db* and is added to the actual gain in *db* of the amplifier, giving a corrected gain in *db*, G_r. By applying G_r plus G_c to the conversion scale adjacent to the nomogram, equivalent noise input voltage in microvolts can be obtained.

Substituting $KT\Delta f$ for P_{ni} and $\frac{E_q^2 G_p}{R_i}$ for P_{no} in Figure 4, we have

$$F = \frac{E_q^2}{KT\Delta f R_i} \qquad (6)$$

The value of F can be determined by Figure 1. This can be done by inserting values of R_i and Δf in the nomogram portion. This determines a point on the line C, which is projected horizontally to intersect with a vertical line, determined by the value of E_q, thus giving a value of F.

The overall noise figure of a series of networks or stages, such as



can be expressed as

$$F = F_1 + \frac{F_2-1}{G_1 + G_2} + \frac{F_3-1}{G_1 + G_2 + G_3} \ldots + \frac{F_r-1}{\Sigma(G_1 + G_2 + \ldots G_{(r-1)})} \qquad (7)$$

Where: F_r = noise figure of network N_r

G_r = gain of network N_r in d6

Letting $G' = \Sigma(G_1 + G_2 + \ldots G_{(r-1)})$

and $FN_r = \frac{F_r-1}{G'}$, which is the general term given the noise contribution of any network, N_r, F can be expressed as

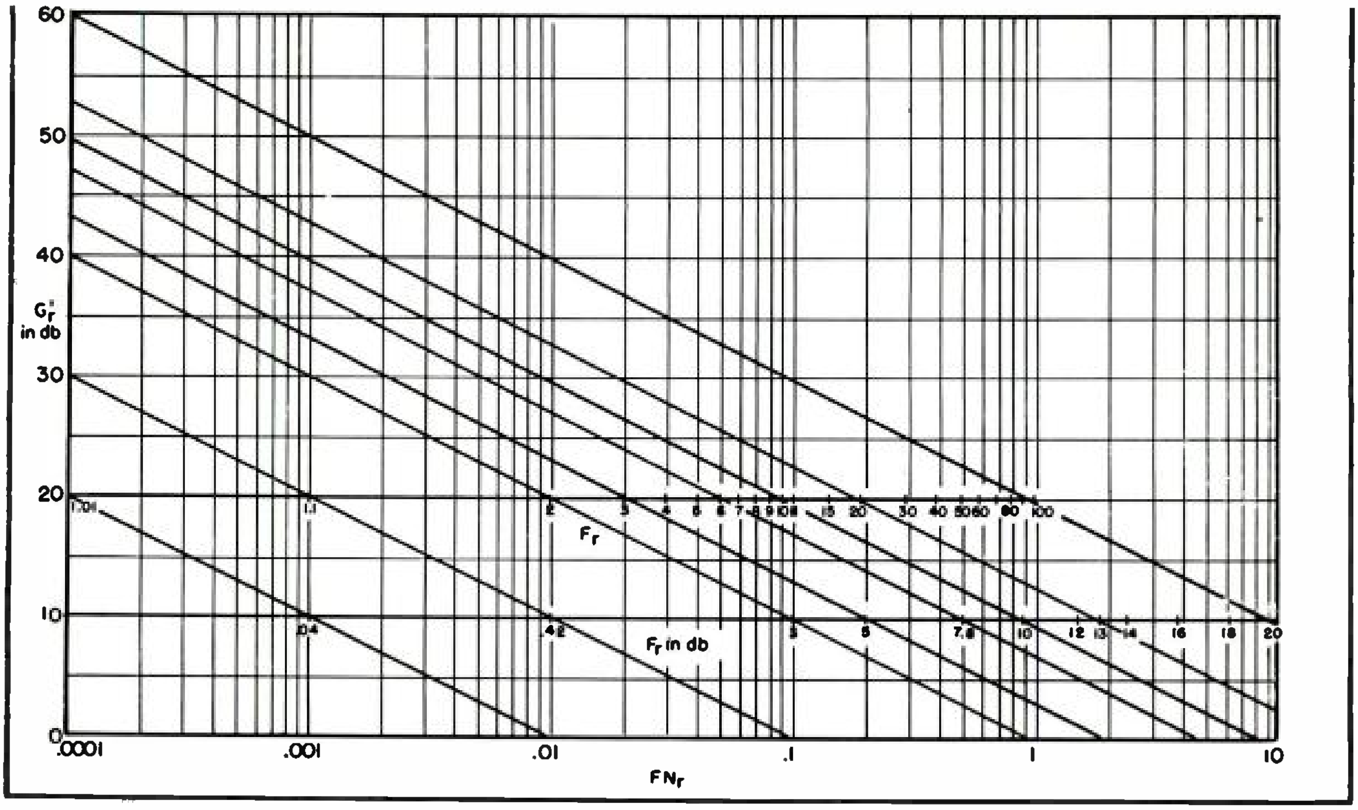
$$F = F_1 + FN_2 + FN_3 \ldots + FN_r \qquad (8)$$

Values of the general term FN_r can be obtained from Figure 3.

The effect of additional networks on the overall noise figure can be determined by the use of equation (8) and Figure 3, which appears at right.

Figure 3

Values of the general term, FN_r, can be obtained from this plot. The effect of additional networks on the overall-noise figure can also be arrived at through the use of equation (8) and this plot.



Briefly Speaking . . .

THE THEME, *Conserve Critical Materials*, has been included in a novel emblem by *Burton Browne*, prexy of Burton Browne Advertising, who has suggested that the slogan be included in all advertising. According to Browne, four manufacturers are already using the shield: Simpson Electric Co., Littelfuse, Inc., Regency Booster and Jensen Manufacturing Co. . . . *Synthane Corp.*, Oaks, Pa., have moved their Kansas City sales offices to 311 Merchandise Mart Building, 2201 Grand Ave. *Gene W. Rankin* represents Synthane in Kansas City. . . . *The Workshop Associates, Inc.*, have been purchased by *The Gabriel Co.*, Cleveland, Ohio. According to present plans, the Workshop operation will remain in Needham, Mass. . . . A phono-cartridge replacement chart has been released by *Electro-Voice, Inc.*, Buchanan, Mich. . . . *Sylvania Electric* has announced plans for a new receiving tube plant in Burlington, Iowa, which is expected to cost approximately $1,500,000, and employ about 800 people. . . . *Technology Instrument Corp.* have moved to a new plant in Acton, Mass. . . . *Philco* has opened three new plants in Bedford, Ind., which will be devoted to government as well as civilian activities. About 100,000 square feet of space will be provided in the new factories which were formerly the property of Tecumseh Products Co., Emerson Electric and Acklin Metal Products. . . . A second edition of *Dr. August Hund's* book on *High-Frequency Measurements* has been published. The book, priced at $10, and released by McGraw-Hill, features use of the MKS system instead of the *e.s. cgs* and *e.m. cgs* units. . . . *IRC* has announced that it will assist distributors in defense operations, providing them with details on procedures required to set up manufacturing or assembly facilities for defense order contracts. . . . *WMBD*, Peoria, Ill., has signed a contract with DuMont for a 5-kw transmitter and a five-bay antenna, for installation when the freeze is lifted. . . . A slide rule, providing wavelength, gain, half-power angles and diameters of parabolic antennas, has been designed by *Workshop Associates, Inc.*, 135 Crescent Rd., Needham Heights, Mass. Slide rules are available gratis when requested on business letterheads.

The Burton Browne emblem

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TELEVISION ENGINEERING

APRIL, 1951

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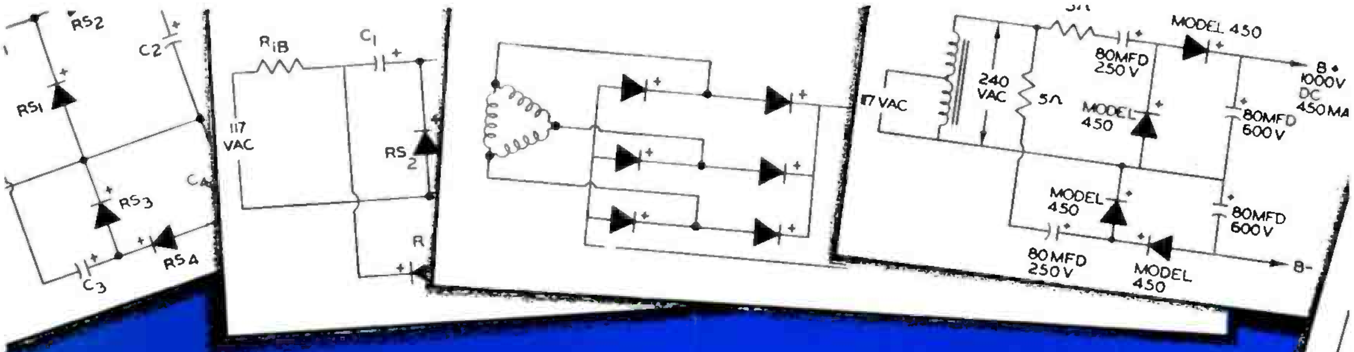

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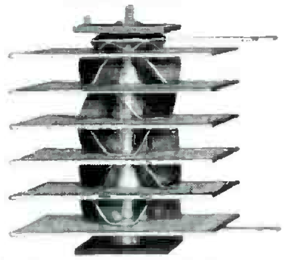
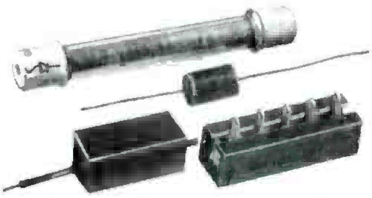


HIGH VOLTAGE SELENIUM RECTIFIERS



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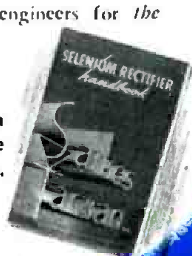

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