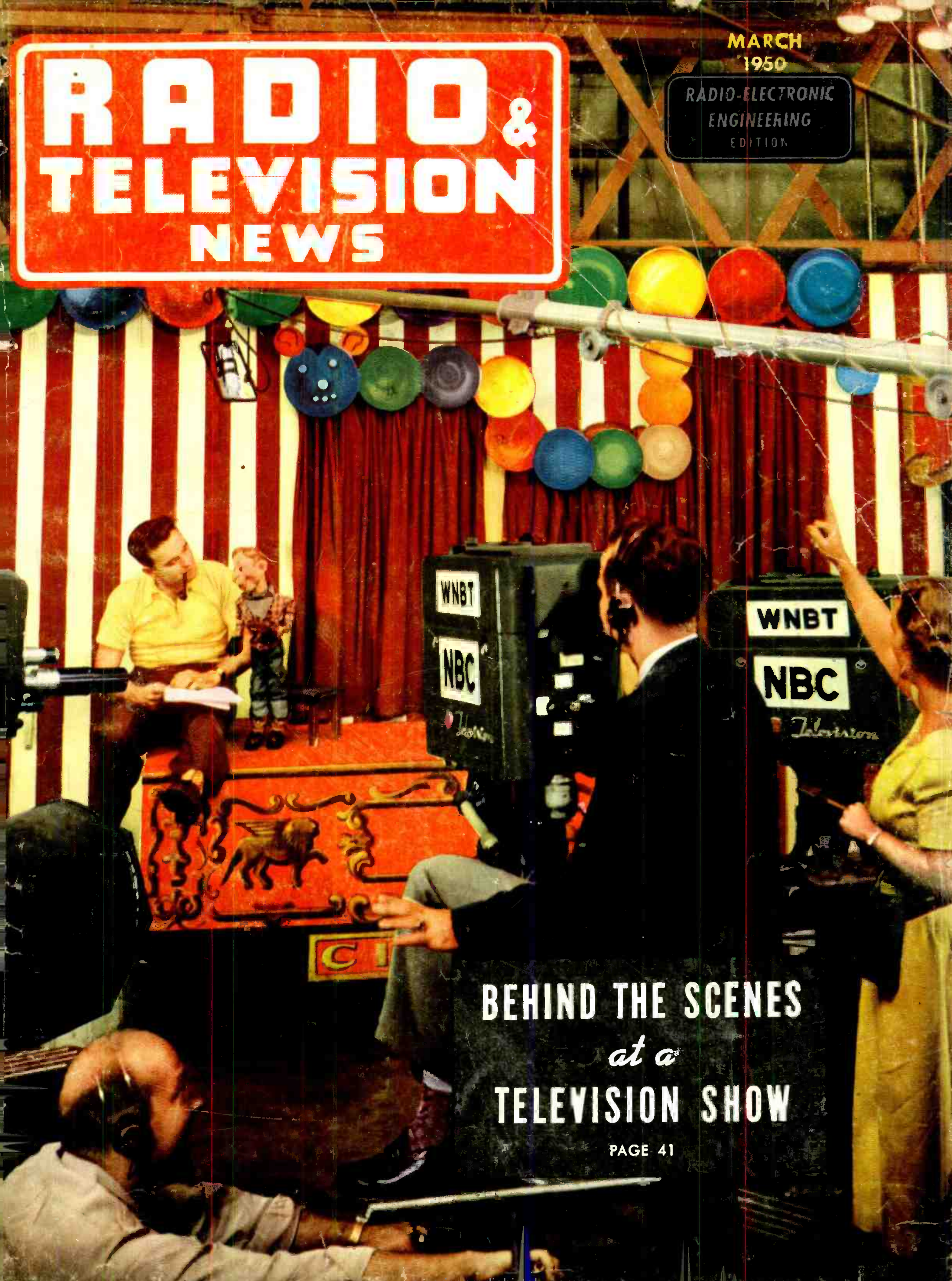
RADIO & TELEVISION NEWS

MARCH 1950

RADIO-ELECTRONIC ENGINEERING EDITION



BEHIND THE SCENES *at a* TELEVISION SHOW

PAGE 41

ANOTHER MILESTONE IN *Television Progress*

. . . the new RCA-16GP4 <u>short</u> metal-cone kinescope with "Filterglass" face plate

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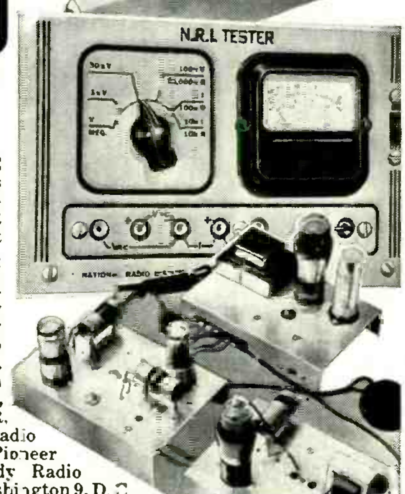

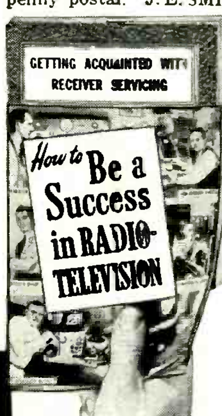

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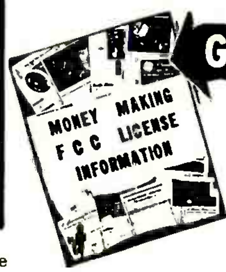

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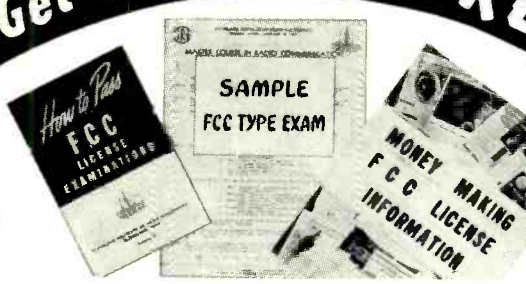

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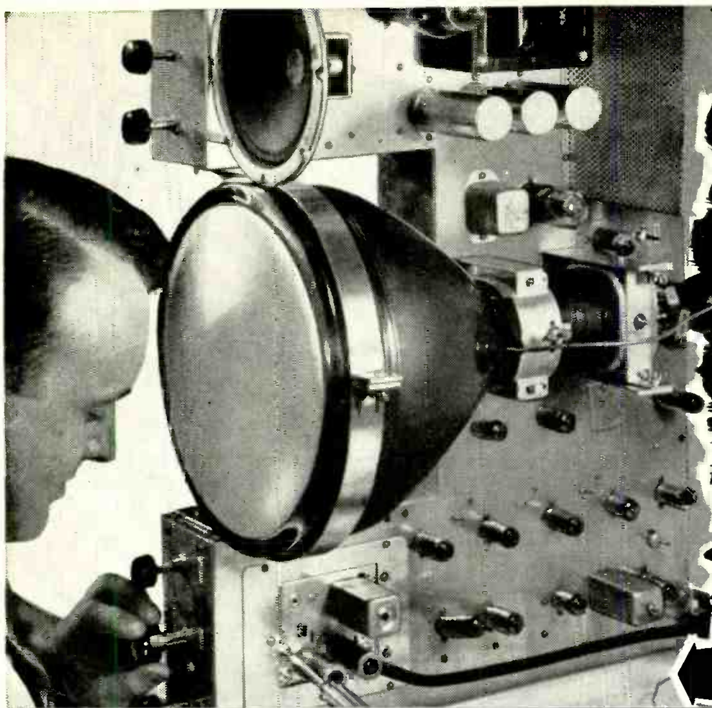

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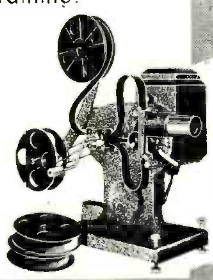

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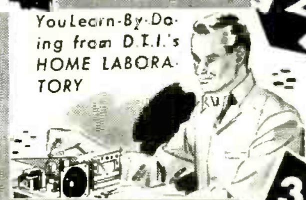

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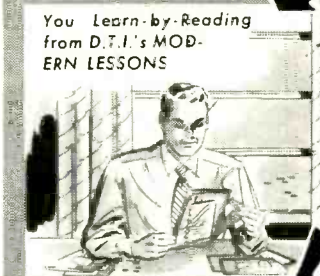

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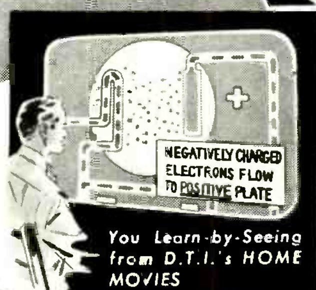

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For the RECORD

BY THE EDITOR

TELEVISION CAN KILL YOU

IT IS generally known that in our homes are several potential instruments of death. These include such items as our electrical lighting systems, an oil lamp, gas stoves and burners, and even a stepladder.

These items are not dangerous when properly used and they have been with us so long that we know their limitations. The introduction of power tubes in our modern radio sets, with increased voltages, presented a new hazard to the uninformed; however we now use caution in the handling of these circuits and components.

Now we have another problem—and one dangerous to the layman if he is not duly warned. It is the television picture tube. We are all familiar with the quite violent implosion (a bursting inwards) of an ordinary electric light bulb or radio tube—but very few users of television sets have ever witnessed the violent and disastrous effects from a large television tube that has let go.

The trend toward bigger and bigger picture tubes has increased the danger of implosion, flying glass, and potential injury and severe shock from high voltage. Most technicians have been duly warned by manufacturers, at lectures, and by releases from RMA. These men in general handle picture tubes with respect but some, and we have seen them, are very careless and scoff at any advice on the matter of safety precautions. These television tubes are not dangerous if handled properly. If they are handled carelessly, scratched, or dropped, they can very well become an instrument of severe injury or even death.

For those technicians handling such tubes for the first time let them heed the advice of the Cathode-Ray Committee of RMA: don't expose picture tubes until you are ready to use them, wear goggles, keep bystanders away when replacing tubes, remove old tube within carton from premises, and never leave a picture tube in the hands of a customer.

It is also important that the face of the tube, when exposed, be placed on a clean soft padding whenever necessary to set it down. Dispose of the used tubes either by; (a) placing the old tube in a shipping carton properly sealed and then drive a crowbar or similar instrument through the closed top of the container, or (b) dispose of the tube in a metal ash can with a plunger operated through the closed top, and finally, don't use regular picture tubes for display purposes.

The popularity of television kits has presented an opportunity for experimenters to build their own sets with a consequent reduction in cost. These people should be especially careful in the manner in which they handle exposed units. Testing of high voltage is another source of danger and we have seen several individuals remove the anode cap to test for an arc in order to determine whether or not high voltage was present. Very few home builders are equipped with television test instruments and for that reason rely on make-shift methods.

As far as television customers are concerned, there are always a certain number who are willing to "diddle" with their sets when a service technician is not available. This is a most dangerous practice, especially where children are present and are watching the proceedings. It is the responsibility of both the dealer and the technician to duly warn each and every customer against the hazards that exist on the inside of their TV cabinets. This can be done tactfully and in such a manner as not to cause alarm which would, of course, discourage sales, especially those where a demonstrator is being installed on trial.

The public always needs a lot of education on things electronic. Just as in the case of the amateur radio operator when television set users were damning them for every streak or blemish that appeared on their screens, so have they blamed service technicians for a host of other bad operating conditions. In the case of an accident resulting from the contents of a television chassis, the service technician would also be blamed. All handlers of electronic equipment must, for their own protection, help to educate the public on the correct use of things electronic—particularly television.

As mentioned, the ordinary electric light bulb, when dropped, is capable of producing flying glass over quite a wide area. This implosion would be multiplied many times in the case of a similar breakage of a large television picture tube. The above may serve as an example when explaining the possible danger to the customer. It would take little imagination to foresee what might happen. If a few "case histories" of accidents, resulting from implosion of television picture tubes, appeared in local newspapers it would do much to discourage the advancement of television. Let's exercise every possible precaution so that it won't happen. . . . . . . O.R.

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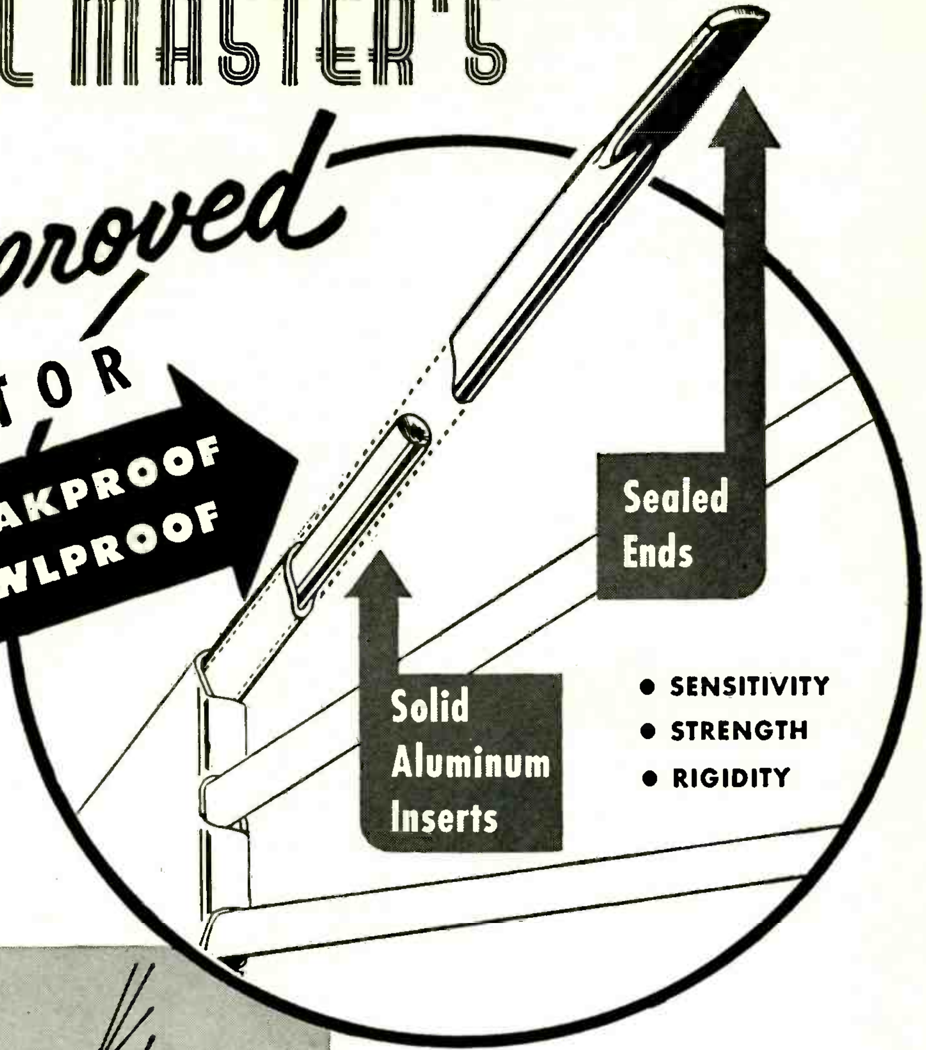

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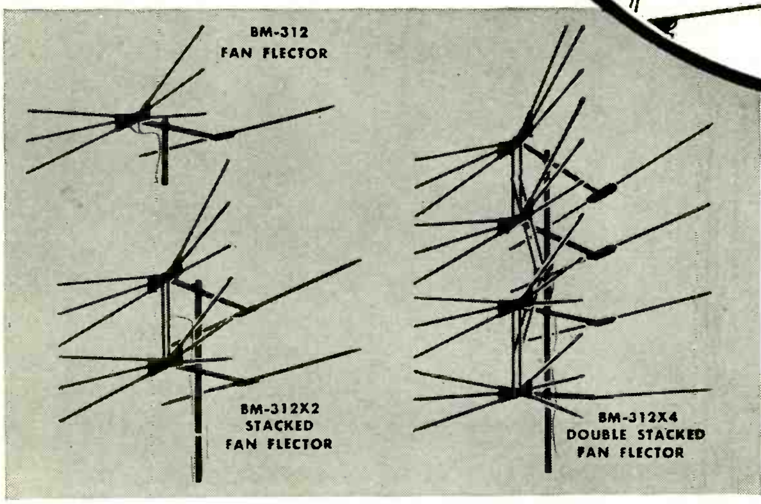

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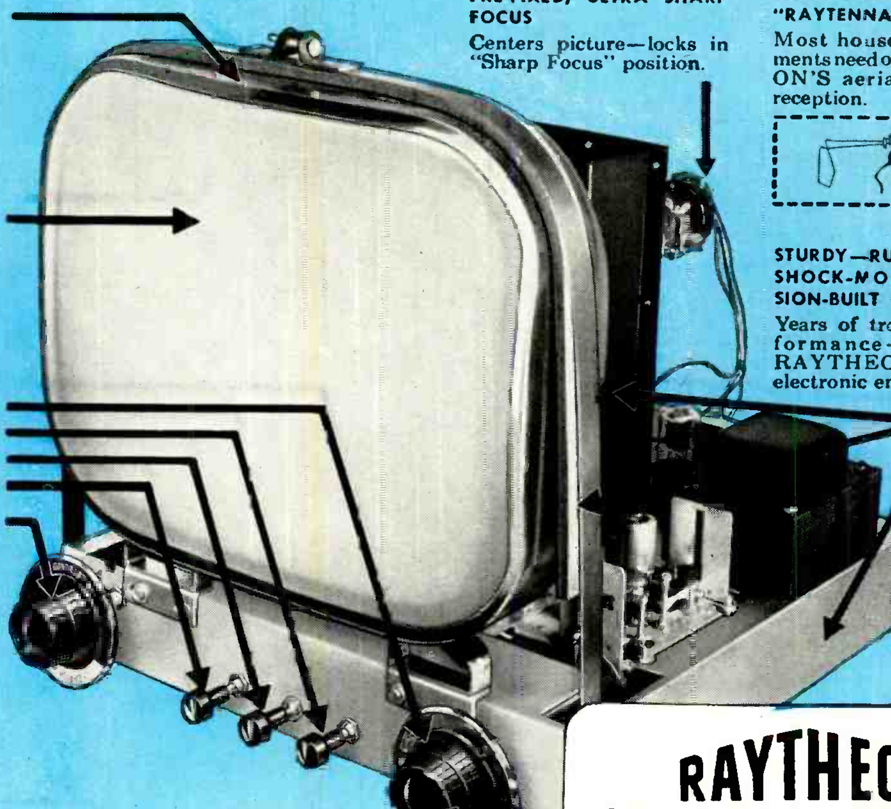

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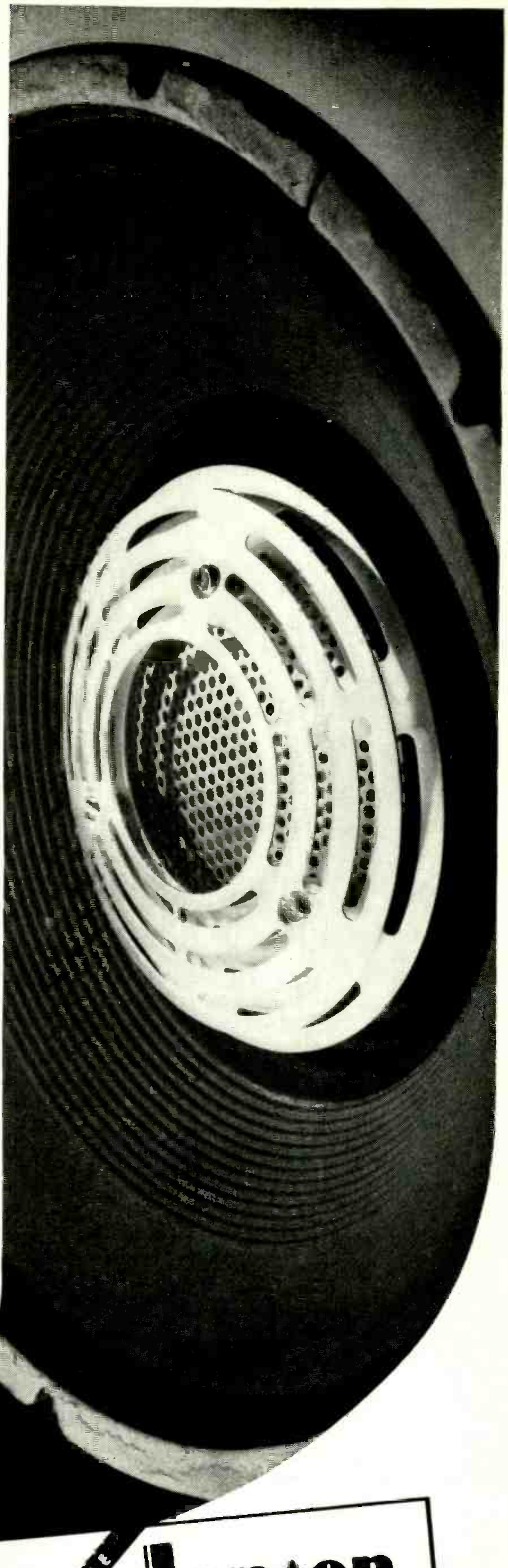

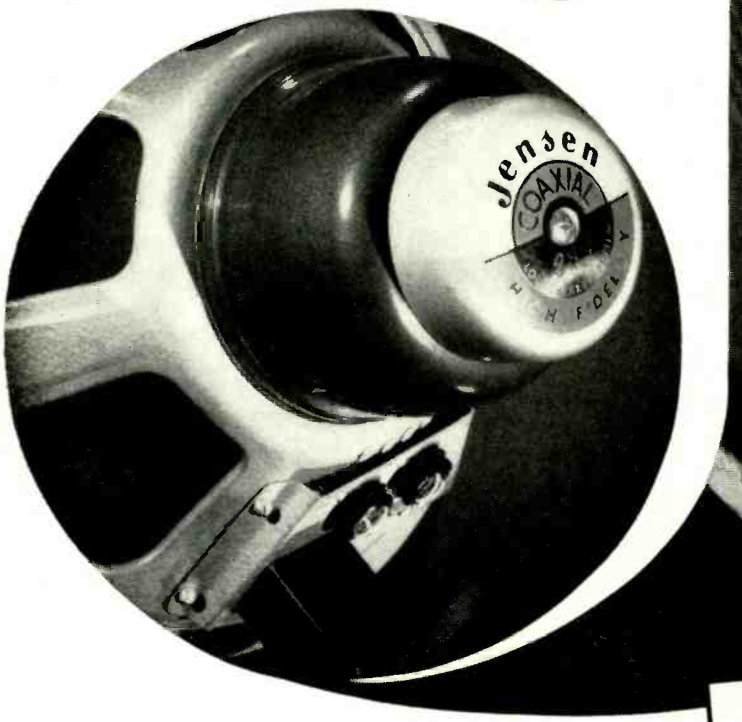

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Spot Radio News

★ *Presenting latest information on the Radio Industry.*

By RADIO & TELEVISION NEWS' WASHINGTON EDITOR

TV, with its color wheels, reflective optics, dichroic mirrors, triple-beam tubes, and field-sequential, line-sequential and dot-sequential red, blue and green systems, transformed Washington and New York into a tense proving ground as the early days of '50 rolled around. With transmitters in the nation's capital and New York City colorcasting on quite an extensive schedule and with specially-built color receivers in strategic locations and under observation by both a technical and man-on-the-street type audience, an all-out polling effort began to race along, viewers being asked to offer opinions which might guide the Commission as they pondered what to do about the blistering problem of color TV.

Activities in the hue quiz centered around Washington during the early days of the trial, with the FCC Commissioners as the pace setters. *CBS* felt that the gentlemen who will eventually say *yes* or *no* to the color idea should have receivers as soon as the test programs went on the air, and thus models were dispatched to six of the officials who were agreeable to the look-in plan: Wayne Coy (chairman of the Commission), Rosel H. Hyde, Robert F. Jones, George E. Sterling, Paul A. Walker, and Edward M. Webster.

Installation in the government expert's homes was followed by a setup of some fifteen models in a building in downtown Washington, where the public could look in on programs coming from WOIC. Admissions to the showings were provided by complimentary tickets available at such points as a cigar counter at the Mayflower Hotel, assistant manager's desk at the Statler Hotel, desk and newsstand at the Willard Hotel, front desk and newsstand at the Carlton Hotel, main floor desk of the *Washington Post* and the Walker building, where the sets were located, and two stations, WOIC and WTOP. Those attending the public viewings were asked to cite what they thought about the quality, detail, and general picture impression.

In New York, the tests of a more technical nature and conducted in one of the *CBS* studio buildings, involved a small group of viewers, looking in on 10-inch screen models equipped with magnifiers providing a 12-inch picture. In Washington, three types of receivers were provided, with 7-inch, 10-inch, and 16-inch basic picture tubes. The 7- and 10-inch images were magnified to 10- and 12-inch sizes, while the 16-inch tube had a mask to reduce the image to about 13 inches and a magnifier to bring the picture back to about 16 inches. The smaller models were featured in the public-viewing arrangements in the Walker building.

The information sought from the New York groups concerned such problems as co-channel interference. With a push-button at the viewer's disposal to vote on the acceptability of the picture as varying degrees of co-channel venetian-blind effects were introduced, *CBS* hoped to compile a report on station spacing for both color and monochrome allocations. WOR-TV, cooperated in the test, supplying a signal which was converted by *CBS* into co-channel type of input.

The *RCA* public tests, which hadn't begun as this column was being prepared, were expected to follow the *CBS* pattern. Technical tests were, however, under way, with the FCC's Laurel laboratories and the Condon Committee, which is conducting an investigation for the Senate Interstate and Foreign Committee, scheduled to receive direct-viewing 10-inch models.

Commenting on *RCA's* color experiences, in a report to the FCC, E. W. Engstrom said that from September 18 to December 30, 1949, a total of 409 hours of test operation on the air were provided by WNBW and KG2XCL, the former using standard channel 4 and the latter an experimental frequency in the 523 to 529 mc. band.

The usefulness of the public-poll information, based on the one-system viewing, appeared to be of little long-term value, according to many observers. They declared that unless it becomes possible to view the systems in a comparative way, the expressions offered can mean little. Answers to such important questions as color values and eye comfort cannot be provided very readily by the average person, these experts added.

When the consensus information is compiled, it may contain the testimony of one viewer who didn't have

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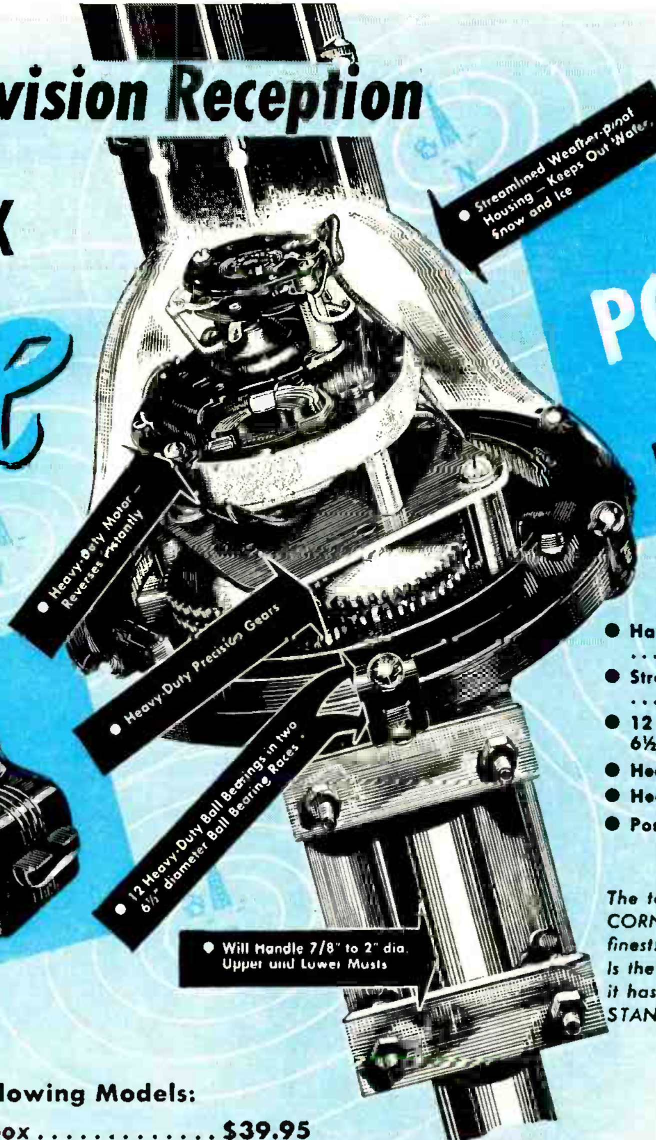

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SUBSIDIARY RADIART

• CAPACITORS • ANTENNAS • ROTATORS • VIBRATORS • CONVERTERS a *CBS* model, but rather one that was built in a shop at home. Forrest W. Killy of Roselle, N. J., reported the color pickup news, declaring that he was able to tune in on the colorcasts by making some minor changes in his set. He accomplished this, he said, by first installing a switch to control the horizontal oscillator of his model. Turning this switch on reduced the number of lines in the picture from 525, the black and white standard, to 405, used in color work. Then he took some cardboard, and sheets of red, green and blue cellophane, and constructed a pie-shaped disc about 12 inches in diameter, with alternate layers of the red, green and blue cellophane. The disc was hooked up to a phono motor, whose speed was increased to provide color resolution. The wheel was then placed in front of the picture tube, which he claims provided good color pictures.

Although no official opinions on the color tests were available from FCC quarters, one member of the Commission did reveal in quite an explicit manner just where he stood on the issues. From color TV's staunchest supporter, Commissioner Robert F. Jones, came the expressions, and there were many, appearing before a luncheon meeting of the American Marketing Association at the Hotel Commodore in New York City, the Commissioner fired away at industry, accusing them of delaying color TV. He said that too many manufacturers had spent little or nothing on color research of their own or field testing of systems proposed by others.

"Instead of offering us the results of field tests," he went on, "we are offered new forms of advisory committees, committees which are but a part of a general scheme which frequently reminds me of the interlocking directorates the public utilities used in the heyday of that industry."

The Commissioner pointed out that in 1941, the National Television Systems Committee showed great interest in color, suggesting that the art should be encouraged and field tested at once. Unfortunately, he added, the war intervened with the steps that were to be taken in advancing color. But since the war's end, the FCC official continued, there has been ample opportunity to continue in the enthusiastic spirit shown eight years ago.

The Commissioner also directed his anger at industry in a letter to *Paramount Television Productions'* president, Paul Raibourn, declaring that the prexy had displayed a "debonaire" attitude toward the art and a "lack of work or at least enthusiasm" for the color systems. The letter was in reply to one from Raibourn which had commented on Jones' questioning during the hearings concerning the absence of the motion-picture executive. The prexy indicated that he would be very pleased to appear and offer his opinions, and had not appeared earlier since he had no new engineering data to offer. The Commissioner noted in his letter that he hoped that when Raibourn appeared he would not . . . "join the parade" of the many who oppose . . . "anyone who dares to have a different view than the vested interests."

THE ANNUAL DINNER of the Federal Communications Bar Association in Washington was the scene of another sharp report on color, with color enthusiast Senator Edwin Johnson providing the views. According to the Senator, an FCC decision in favor of color TV standardization will be made and the Condon Committee's report, soon to appear, will . . . "fortify and bolster the Commission's decision that we are ready for color television now." The Senator added that . . . "Since it is generally agreed that color is practical, most emphatically the public interest would not be served by waiting until thirty million families have invested upward of six billion dollars in black and white sets, before switching to color."

In reply to the blunt words from Washington, industry announced the formation of a new National Television System Committee to help attain industry-wide agreement on technical developments needed for the expansion of television to all sections of the country and for the establishment of basic standards which will bring color television to reality.

Reporting on the formation of the committee, RMA Prexy Raymond C. Cosgrove said: "While color television is not yet ready for commercial application, laboratory development has progressed to a point where pooling of information and concerted action from all sources is essential to creation of standards which will eventually bring it out of the laboratory and controlled broadcast stage and into the home."

"Television manufacturers are eager to present color to the public just as soon as research and field testing have made it practical for broadcasting and home use, but not before," Cosgrove added.

"In the meantime, it is believed that the National Television System Committee will be able to assemble the data necessary to letting all sections of the country enjoy the benefits of television, and not just selected areas," the RMA headman concluded.

Guiding the new committee will be Dr. W. R. G. Baker, who was chairman of the 1941 systems group which drafted and recommended the FCC standards upon which black and white TV has been built. Assisting him will be Don Fink and David B. Smith, serving as vice-chairmen.

According to present plans, the committee will cooperate closely with the FCC during the allocation hearings and will submit regular reports to the Commission, in addition to serving as advisors for the study of special problems.

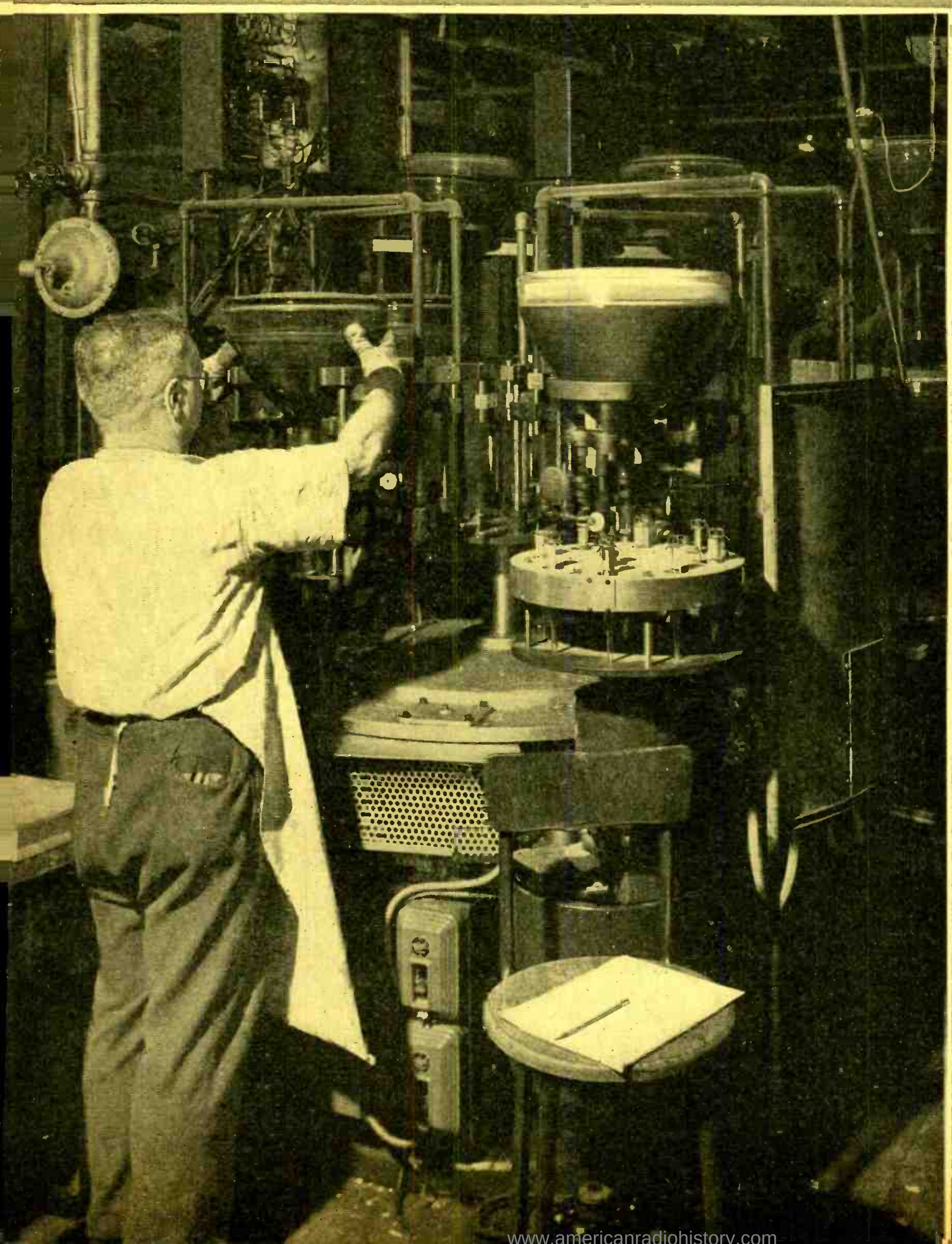
The NTSC of '50 should be the an-

(*Continued on page* 125)

MARCH, 1950

RADIO & TELEVISION NEWS

RADIO-ELECTRONIC Engineering



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MARCH, 1950

DEPARTMENTS

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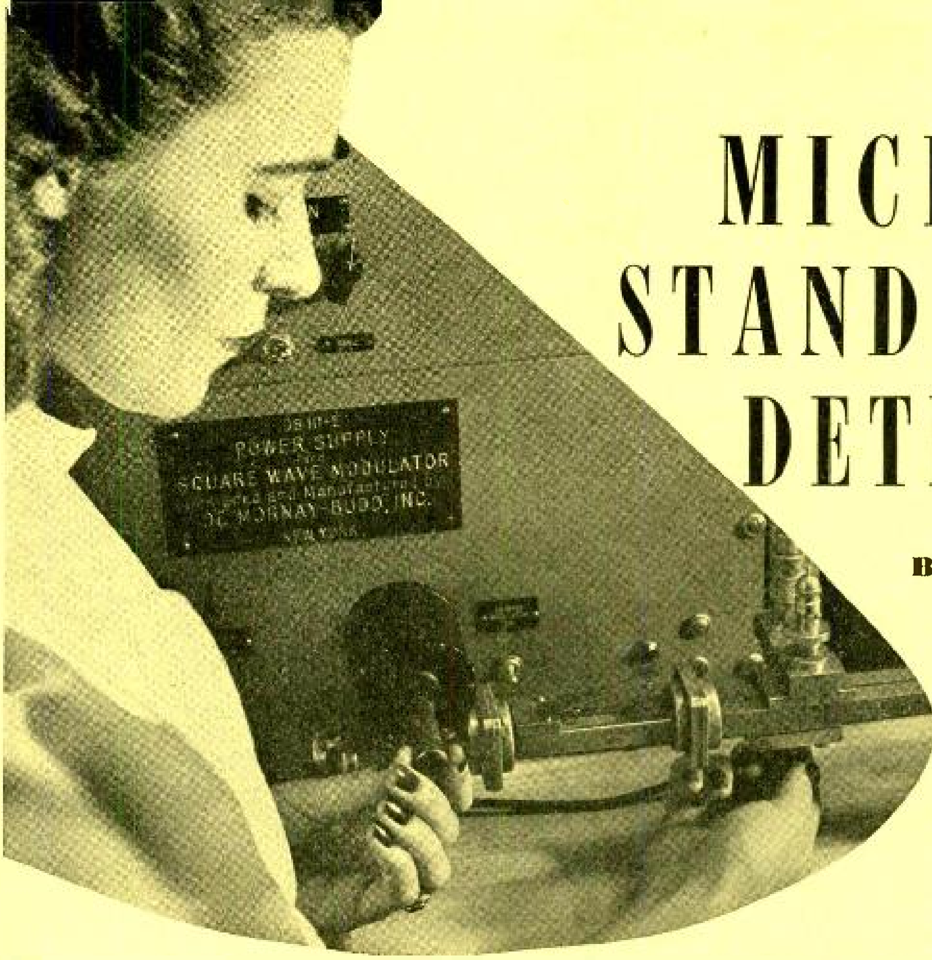
COVER PHOTO—Courtesy of Sheldon Electric Co.

Automatic sealing machine for television picture tubes shown in the Sheldon Electric Company's Irvington, N. J., plant. The "guns", located at the right, are placed in a revolving holder on the automatic sealer. The operator then places the glass blank over the gun. In one stage as the machine and the holder revolve, gas flames heat the glass. A battery of gas torches then cut and seal the end of the glass.



MICROWAVE STANDING WAVE DETECTORS

By SAMUEL FREEDMAN

Fig. 1. Standing wave detector used in conjunction with a flap attenuator (center) and cavity wavemeter (left).

Design, construction and use of standing wave detectors in microwave measurements.

An alternating current may be represented as a wave having a change in voltage during a period of time. When a transmission line is not ideally terminated or matched with respect to its load the alternating current (radio frequency energy) reflects a portion of its energy back to create "standing waves". A "standing wave" means that there exists both a change in voltage with respect to time AND with distance along the transmission line.

The voltage between nodal points of a standing wave changes from positive to negative values and back during the time equivalent to one cycle of the r.f. source. Notwithstanding the designation "standing wave", the positions of the maximum and minimum points stand still while the voltage changes at the r.f. rate. The value and nature of the load determines the ratio of voltage at maximum and minimum points along the line, and also the position of these maximum and minimum points. The VSWR (Voltage Standing Wave Ratio) equals the maximum voltage divided by the minimum voltage. It is an indication of the ratio of mismatch of the load impedance.

The extremely short wavelengths existing above about 2500 megacycles make it feasible to propagate energy through wave-guide pipes of convenient dimension. As a result, it has become possible to develop test and evaluating equipment functioning in a manner which is both direct and obvious. One of the most useful of these devices is the Standing Wave Detector which is part of every modern microwave test and evaluating setup. It eliminates speculation as to the degree of correctness of theoretical results having to do with reflection coefficients, power losses, frequency, wavelength, impedance or attenuation. It is a slotted wave guide in which r.f. energy at microwave frequencies present within the wave guide can be detected at the center of the wide or "*a*" dimension at any point in its vertical plane and anywhere along its longitudinal center axis.

Fig. 3 shows the energy distribution in a wave-guide pipe of rectangular shape operating in the $TE_{0,1}$ mode. This mode of energy distribution exists when a wave guide is more than a half wavelength but less than a full wavelength in width. If a slot is milled in the middle of the wide or "*a*" dimension of the wave guide, a traveling pickup probe can detect the energy distribution of the electric field shown as plus and minus in sine wave fashion. The energy picked up by the traveling r.f. probe will fluctuate in phase and amplitude in accordance with this energy distribution. By connecting this probe to a crystal rectifier or a bolometer device, enough energy can be picked up and transformed to operate an indicating device such as a microammeter or a cathode-ray oscilloscope.

Along each half wavelength pattern, all the circuit equivalents specifically provided by condensers and inductance in the case of conventional lower frequency techniques are simulated as illustrated in Fig. 2. It is in reality a microwave transformer making use of inversion, capacitive, inductive and transformation effects existing along any quarter wavelength of any over-all half wavelength.

Fig. 4 is further helpful in understanding wave-guide phenomena. Here, a standard medium frequency broadcasting station antenna tower (comparable with the probe in a standing wave detector) radiates energy which makes progress to other points on earth by suitably angled reflections between the ionosphere and the earth. Figs. 4A, B and C simulate this in a piece of rectangular wave-guide pipe. Fig 4A shows total attenuation or no progress because the pipe is too small for the wavelength, or the wavelength is too long (frequency too low) for that size pipe. It is exactly comparable with the fading out of radio reception when an automobile is in a tunnel, underpass or on a steel bridge having overhead and side framework. These are all wave guides below cut-off because they are less than a half wavelength in width. Fig. 4B shows attentuation above cut-off with energy able to propagate in the wave guide. The wave guide is more than a half wavelength in its wide dimension. Fig. 4C shows still less attenuation as

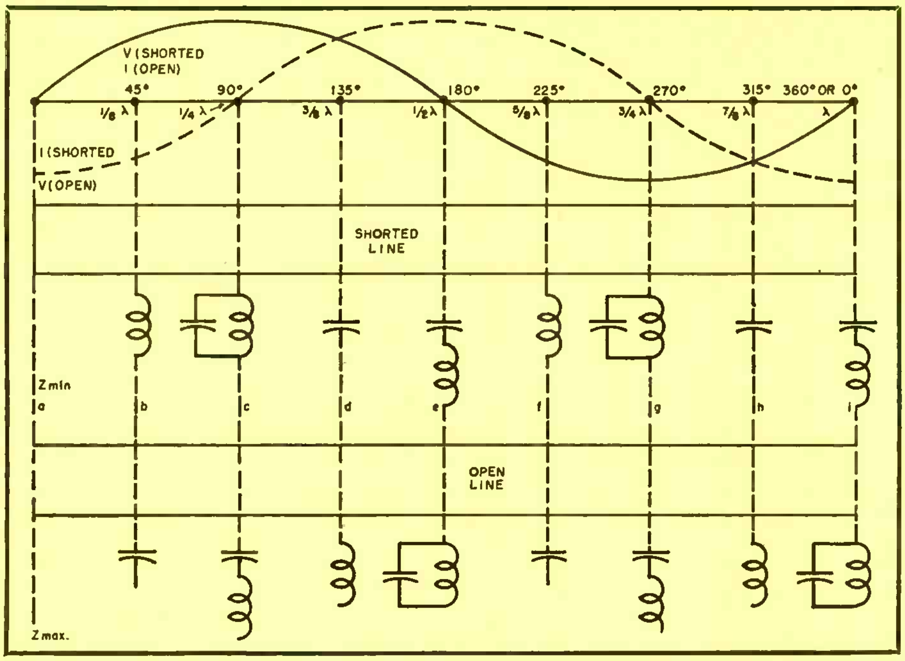


Fig. 2. Circuit equivalents in open or shorted wave guide transmission line.

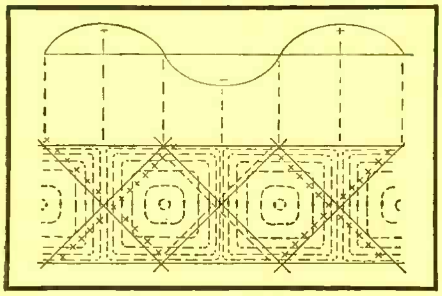


Fig. 3. Energy distribution in a rectangular wave guide operating in the $TE_{0,1}$ mode.

the guide is increased further beyond a half wavelength but kept less than a full wavelength. The losses in transmission go down as the wavefronts have less points of reflection in making longitudinal progress down the guide. Figs. 4B and C may be compared to mobile radio such as used by police and taxicabs where signals can be heard in the same tunnel or underpass while broadcast reception in private automobiles cannot. The 30-40 or the 152-162 megacycle mobile radio bands have wavelengths sufficiently short so that it is easy to develop more than a half wavelength (cut-off) dimension in a tunnel, underpass or bridgeway. The reduced number of reflections per unit length in the case of Fig. 4C means that more effective energy will be taken up by the load. The limit is where the guide width exceeds a full wavelength in which case the energy pattern shown in Fig. 3 divides itself into two or more (depending on how many wavelengths the guide width is) as if there were two or more wave guides of energy parallel to each other. If there were two parallel patterns, the probe traveling in a slot in the center of the guide would be improperly placed for energy pickup, since the electric field cancels out or is zero at the mode boundary. The guide would then be operating in the $TE_{2,0}$ mode, instead of the $TE_{1,0}$ mode.

Free Space Versus Guide Wave Length

A Standing Wave Detector measures the VSWR (Voltage Standing Wave Ratio) based on the wavelength inside a wave guide. This is different than the wavelength in free space for the same frequency. A wavelength is the distance between two points of identical phase. This will vary with the cut-off characteristic of the wave guide or how much above cut-off frequency is the operating frequency in a particular size wave guide.

On page 32 is a nomograph developed by the *Federal Telephone and Radio Corporation* to compare free space wavelength with guide wavelength. It takes into account the "caterpillar" effect existing in a wave guide made up of group and phase velocities. The "group" velocity is the velocity of propagation down a wave guide. This is less than in free space because the energy reflects from wall to wall in a wave guide and has a longer path than the actual length of the guide. It will always be less than the speed of light. It is dependent on the frequency and increases as the wavelength is decreased for a given guide dimension, or as the guide dimension increases for a given free space wavelength. The "phase velocity" changes inversely to the group velocity. It is always greater than the speed of light or the velocity of propagation in a wave guide. Its apparent speed is the true speed divided by the cosine of the angle between wall and direction of travel in a wave guide as shown in Fig. 5. The closer the frequency is to cut-off in a wave guide, the greater becomes the ratio of guide wavelength to free space wavelength, until finally at cut-off, the ratio is infinite and there is no wave propagated down the guide which is measurable.

In a rectangular wave guide operating on the usual $TE_{1,0}$ mode, the electric vectors are parallel to one side of the guide. The width dimension is measured at right angles to the electric vector. It is based on the wide or "*a*" dimension.

The cut-off frequency is determined by the physical size of a wave guide. In the case of the $TE_{1,0}$ mode, the cut-off wavelength will be twice the wide or

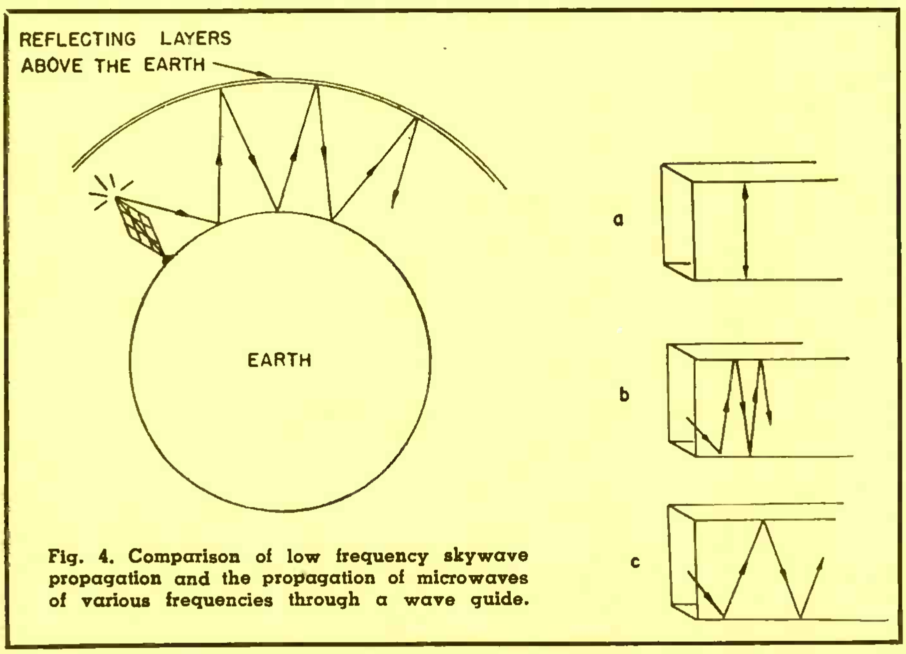


Fig. 4. Comparison of low frequency skywave propagation and the propagation of microwaves of various frequencies through a wave guide.

"a" dimension of the guide. The maximum energy indication is definable in a guide. However, at cut-off, the energy is not definable because in that region, the attenuation becomes very high or infinite. Fig. 6 shows a typical attenuation curve for a wave guide. It is based on a guide having external dimensions of 2" x 1". Allowing for a wall thickness of .064", the internal or effective dimensions are 1.872" x .972". The attenuation is infinite on frequencies below 3154 megacycles for that dimension. The lowest attenuation is just short of twice the cut-off frequency or 6309 megacycles. If used beyond twice the cut-off frequency (dimension larger than a wavelength in maximum width), it will double mode or develop two patterns of energy in the guide to radically change the energy distribution and optimum probe points. In such events, it will also bring the narrow dimension ("b" dimension) of the guide past the cut-off point so that it exceeds a half wavelength to complicate matters for a novice. The beginner in wave guide techniques should confine himself to the areas of least attenuation within the $TE_{0,1}$ mode before reaching cut-off point for the $TE_{2,0}$ mode.

The attenuation in a guide depends on losses in the conductor and losses in the dielectric (normally air). Losses in the conductor depend on the inner surface material of the guide which determines depth of energy penetration. The better the conductor, the less penetration and the less losses. To keep efficiency high, the usual metals employed either as solid or plating are silver, copper, gold, aluminum and brass. Compared to silver, copper is 96%, gold is 78%, aluminum 73½% and brass 50% as efficient. Losses in the dielectric depend on the dielectric constant of the material inside the guide. The higher this constant, the higher the losses. There is nothing lower than air with a relative dielectric constant of 1. The group velocity divided by the square of the dielectric constant gives the wavelength. In the case of polystyrene, the dielectric constant is 2.3 or close to that of air. The advantage of a dielectric constant higher than air is that it makes possible a smaller size guide for a given frequency at the cost of an increase in attenuation. If the guide can be halved in dimension by the use of a dielectric constant of four, then the attenuation is approximately four times that of air-filled guide with a dielectric constant of 1.

Slotted Wave Guide Transmission Line

Fig. 1 illustrates a simplified commercial standing wave detector at the extreme right coupled to a flap attenuator and a cavity wavemeter as used in a klystron-energized microwave test setup. It is a slotted wave guide to permit loose coupling of a traveling r.f. probe to the internal energy distribution. The probe compares with an antenna in Fig. 3 except that it can be moved. A small fraction of the power flowing in the wave guide transmission line is extracted by the probe and connects through a conversion device such as a silicon crystal rectifier or a bolometer heat responding device to a meter or cathode ray indicating device with or without amplification.

By moving the probe along the slot, which is parallel to the axis of the wave guide line, the field inside of the wave guide can be explored. Because the slot is cut so that it runs parallel to the lines of surface current flow for the electromagnetic field in an unslotted guide, its presence disturbs the field configuration within the guide by only a minor amount. As illustrated for the dominant $TE_{1,0}$ mode, the slot must be located at the center of either of the two wide walls of the guide (center of "a" dimension). The slot should be long enough to permit observation of at least one maximum and one minimum. At least a half wavelength is necessary and in practice (particularly on the higher frequencies) the length should be sufficient to observe several maxima and minima.

The slot affects the propagation constant of the line as well as the characteristic impedance. In practice, the guide wavelength is not disturbed more than about 1%. The electric field within the guide can penetrate the slot with some loss of power by radiation. The effect is, however, small since the slot acts as a wave guide far beyond cut-off,

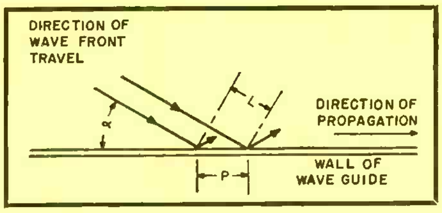


Fig. 5. Illustration of why phase velocity is greater than group velocity. In the time required for the wave front to move the distance L. the point of reflection has moved the greater distance P.

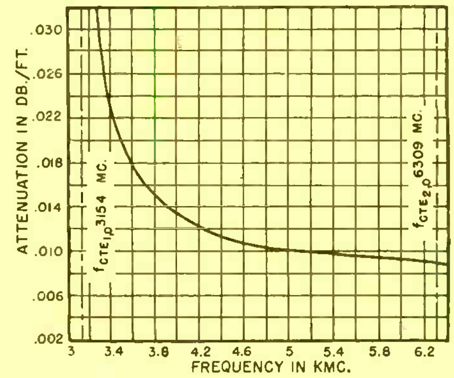


Fig. 6. Attenuation curve between cut-off points for the $TE_{1,0}$ and $TE_{2,0}$ modes in a 2" x 1" copper wave guide.

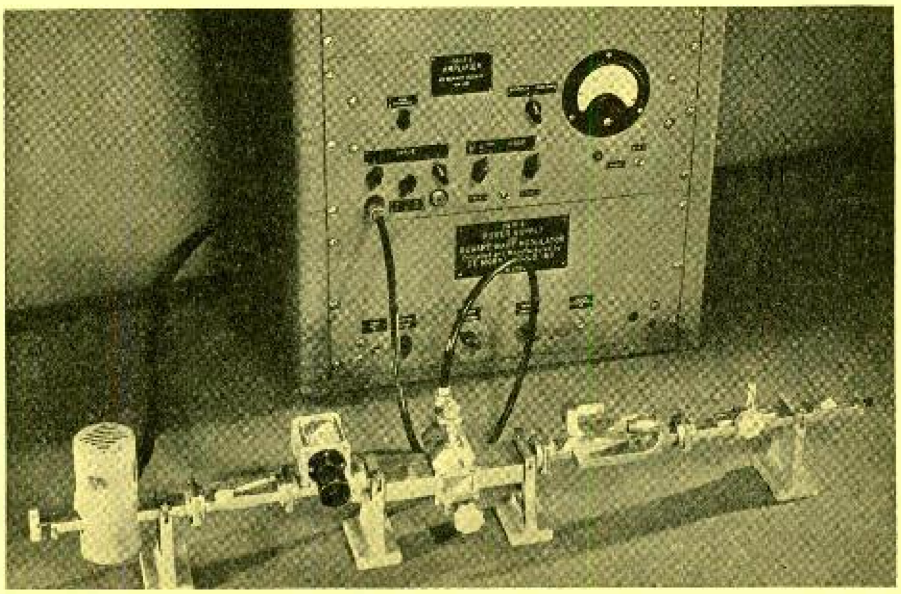
i.e. much narrower than a half wavelength.

The discrepancy caused by the slot is in the order of less than one per-cent, and so is of small concern except for the most precise calculations in the case of advanced research and development.

Standing Wave Detector

Fig. 9 shows the constructional details of a standing wave detector and

Fig. 7. Standing wave detector connected by coaxial cable to an amplifier and indicating meter. Setup from left to right comprises a klystron tube mount energized by a power supply and modulator in the cabinet, flap attenuator, cavity wavemeter, standing wave detector, bidirectional coupler and tunable load.



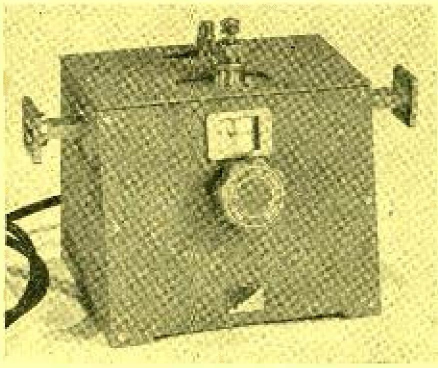


Fig. 8. Standing wave detector calibrated in one division per tenth of a millimeter of probe travel. This unit uses ½" x ¼" wave guide for the 23,000 to 27,000 megacycle band.

Fig. 7 is a photograph showing its use in a microwave evaluation set up for some components under test.

In the best commercial models, the wave guide corresponds to the open hole shown in Flange I. It is machined out of the main block from solid brass stock to assure very close mechanical tolerance and excellent rigidity characteristics. Attached to the main block bottom is a stainless steel dove-tail and slide which in connection with a rack and pinion arrangement permits the carriage frame to keep correct position so that the probe rides parallel to the sides of the wave guide slot.

The traveling carriage has the following design provisions:

1. It can travel in either direction without slack or play.

2. It responds to the least apparent movement of the control knob such as much less than a tenth of a millimeter for which the scale is calibrated.

3. Longitudinal deviation is prevented by the high ratio pinion and gear arrangement controlled by rotation of the control knob.

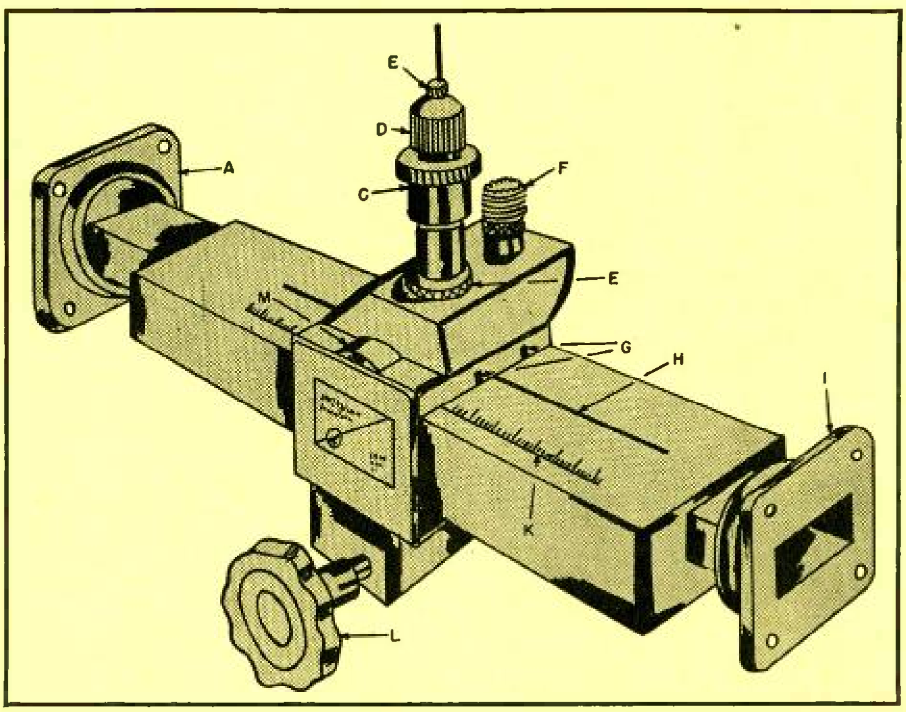
4. Lateral deviation is prevented by means of the stainless steel bearing plate which exerts pressure against the moving bearing surface attached to and underneath the main block. Two allen head set screws adjust and lock the stainless steel bearing plate at optimum pressure as determined by ease of carriage movement and elimination of lateral deviation.

5. Vertical deviation is prevented by having the carriage frame ride on a closely fitted and carefully machined dove-tail which, with the rack and pinion arrangement below the wave guide block, makes for very smooth movement.

The traveling carriage includes a wave guide with a Type 1N23 crystal positioned for optimum coupling. A 1/200th ampere *Littelfuse* may be used as a bolometer to replace the 1N23 crystal. The crystal provides much greater sensitivity. A bolometer may be superior when high standing wave ratios are to be measured since it follows a square law characteristic over a greater range of input power. The rectified low frequency is taken out from the coaxial connector by means of a solid dielectric cable such as the type RG-8/U. When the control knob is rotated, the parts which travel are details B, C, D, E, F, G, J, L, M and the crystal mount as well as the coaxial cable connecting to F.

The r.f. probe assembly comprises a very fine wire that protrudes into the main block slotted wave guide section to couple the radio frequency energy. This connects into a coaxial section which couples into the wave guide on the carriage where the Type 1N23 crystal or the bolometer is housed. The coaxial section is tunable and is adjusted for optimum coupling to the crystal by means of an adjustable nut (detail C). The depth of the r.f. probe is adjusted by means of the round metal knob (detail D). Turning it clockwise pulls the probe out while turning it counter-clockwise will insert the probe deeper into the slotted wave guide section. The probe movement is independent of the tuning of the coaxial section when the lock nut is tightened. A very fine screw thread is used to vary the depth of the r.f. pickup probe critical amounts. The r.f. probe couples into the cavity where the crystal or bolometer detector is located. The coaxial line, of which r.f. probe is an extension, has a variable short circuit that enables the pickup probe to present a very high impedance to the main transmission line. This minimizes discontinuity effects and makes possible a maximum transfer of energy.

Fig. 9. Details of a typical standing wave detector.



Enclosed Standing Wave Detector

Fig. 8 shows a more modern standing wave detector. It contains physical and mechanical refinements over that described in Figs. 1 and 9. It is made in a choice of sizes for each wave guide dimension or frequency band.

Three steel balls roll on the top of the main block and two on the sides. The carriage is supported and guided by these ball bearings which limit five of its six degrees of geometrical freedom. Only one degree of freedom is left, corresponding to rectilinear motion in perfect parallelism to the slot in the main block.

The traveling carriage differs from the other unit in that vertical deviations and wobbling of the carriage are prevented by the three top ball bearings. These balls furnish 3 contact points determining the plane of motion of the carriage. The carriage is therefore compelled to move in a plane exactly parallel to the inner surface of the main block.

Lateral deviations are prevented by the two side balls. The carriage is pressured with constant force against these balls by a spring arrangement so that no play is possible. Since all friction is rolling instead of sliding, the movement of the carriage becomes exceptionally smooth.

Interpretation of Results

While basically a standing wave detector is used to measure amplitude and

(*Continued on page* 27)

STRAIN GAUGE LINK

By ALVIN B. KAUFMAN

The design and application of force-sensitive links giving high output with conventional strain gauges.

Fig. 1. Illustration showing the comparative size of a typical strain gauge.

THE use of strain gauge equipment for the measuring of stresses and forces has come into general use within the war years and the postwar period. There are many applications in industry for this equipment which because of mistaken ideas on cost, accuracy, and the skill required in interpreting and using the equipment has deterred its use.

Generally speaking, applications require three pieces of equipment. These are a power oscillator, amplifier, and output or recording meters. This is the carrier system. Other systems employ high gain d.c. amplifiers. This equipment is required mainly where strain gauges are applied to existing machinery. In the majority of these cases the strain gauge output signal with load applied to the equipment is of such low level that amplification is required.

Where test equipment is constructed to be used with machinery the chances are that the equipment may be engineered to supply a sufficient signal output to operate a microammeter directly or a recording meter of the *Esterline-Angus* type, without any amplification, a d.c. power supply being the only requirement.

The design of a system to indicate tension, compression, or bending loads as indicated may vary quite widely in expense. The system to be described, however, has a material cost of approximately one hundred dollars and a labor cost depending upon the few hours that it takes to machine the strain gauge force sensitive link or beam. With calibration, over-all accuracy of 2% is possible.

This article will concern itself mainly with the design and fabrication of force sensitive links capable of causing a 100 μa. meter to indicate full scale for forces of 3000, 9000, and 27,000 pounds.

In fabricating a strain sensitive link there are a number of factors to be taken into account. Solid bars are very poor, possessing very little rigidity and being totally impractical for compressional loads. Generally speaking, tube type construction is the best design where a force ring is not used. This article will discuss only link type load indicating devices. Where the link is used for tension loads only, little care need be taken with the end holding design of the link. For compression loads it is necessary to have the link and equipment arranged so that very little bending load is placed on the force link. Any bending moment can be cancelled out by proper placement of the strain gauges, and will not affect the compression force indications, but excessive side or bending load can build up to the point of destroying the link. The four strain gauges used in the strain gauge circuit *should* be mounted on the link even though only two can be active gauges. Where dummy gauges are mounted separately they may not automatically temperature compensate the bridge. With the dummy gauges mounted cross-wise on the link, temperature compensation is good. Laboratory tests indicate little change in the calibration curve from room temperature to -65°F.

Another advantage of mounting dummy strain gauges on the link to secure a temperature and side load compensated bridge is a slight decrease of strain required to give the desired galvanometer indication. This is because when axial strain occurs in a member (tension or compression) it is always accompanied by a lateral strain of opposite sign. Thus when a bar of metal is placed under compressional load, besides becoming shorter it also increases in diameter and circumference. The ratio of the lateral to the axial strain is called Poisson's ratio and is designated as u. The value of u is usually between 0.25 and 0.33 for steel and aluminum alloys. For our calculations 30% shall be considered a fair value. As the dummy strain gauges are mounted laterally on the link, the bridge output is increased by approximately 30% due to the signal produced by these gauges.

The photographs and drawings indicate that the link is machined from a square block of steel to have a tubular cross section and square forked connecting ends. The main problem in designing the link is in calculating the area and dimensions for the tubular "force sensitive" section of the link, bolt size and clearances for the connecting ends being standard stress procedure.

In calculating the strain applied to a strain gauge, axial deflection formula applies whether the force sensitive link is in compression or tension. This strain or deflection may be found by employing the formula: $dS = PL/AE$ where P is the total applied load in pounds, L is length, A is cross section area of the link (sq. inches), and E is the modulus of elasticity either in compression or tension.

The modulus of elasticity generally is the same for either tension or compression conditions, varying with some materials however. Steels generally run around 28 to 29 million. Information on the proportional limits of materials and general stress formulas may be found in a government publication ANC-5a, Strength of Metal Aircraft Elements. This may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. for $1.25.

Electrically, strain gauges and recording meters must be

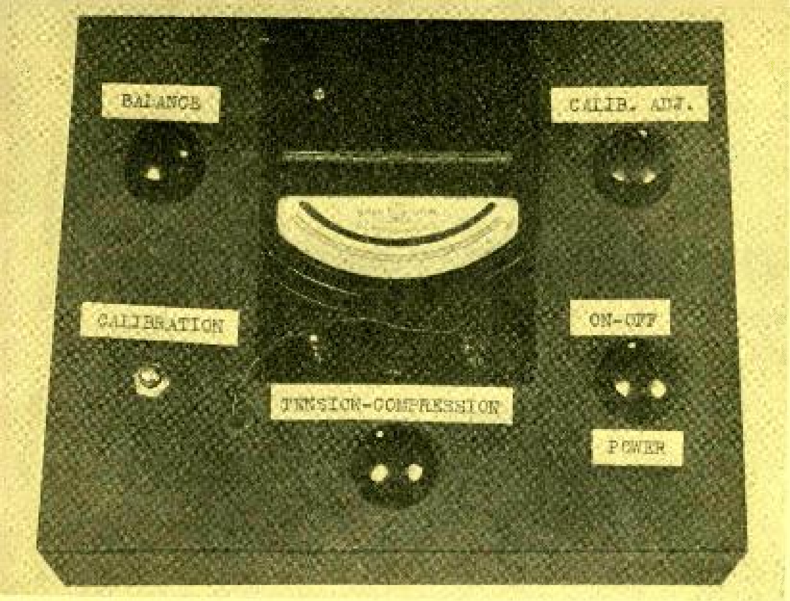


Fig. 2. Strain gauge link control and balance panel.

selected before the calculations concerning the link can begin. According to the strain gauge selected, either paper or bakelite base, and the type of resistance wire, the gauge will be rated at some "gauge factor". Gauge factor is the ratio of resistance change to strain. Most strain gauges have factors of 2 to 3, that is, their resistance change percentage is two to three times the elongation in inches per inch; Gauge Factor = $(d\,R_g/R_g)/dS$. This factor is important of course in figuring the resistive change, per leg, in the strain gauge bridge.

For devices requiring long term stability bakelite gauges are recommended. The *Baldwin* strain gauge price bulletin lists all types. These vary in resistance from approximately one hundred to several thousand ohms. These gauges may be purchased from *Baldwin Locomotive Company*, Philadelphia, Penna.

The resistance value of the gauge should be selected in regard to the indicating meter's internal resistance. For this application one milliampere meters have been used, but microampere meters are usually required for the load ranges and link design being discussed. A suitable microammeter is *General Electric's* DP-9, a 0 to 100 μa. meter with an internal resistance of 75 ohms. Strain gauges of approximately 50 to 150 ohms could be used with this meter. As Laws indicates in his book "Electrical Measurements" a mismatch of two to one causes but little loss of bridge sensitivity. He also indicates that for maximum power or galvanometer current the meter's internal resistance should be equal to the resistance in one leg of the bridge where the four legs are approximately the same. Where it is not desirable to use a ½ of 1% meter, as the DP-9, because required accuracy is not high, then a *Simpson* Model 260 analyzer could be used. Its microammeter range is also 0-100 but its internal resistance is 2500 ohms. One thousand to two thousand ohm gauges would be required and the bridge supply voltage would be much higher than that required for lower ohmage gauges.

In any case the wattage capabilities of the different strain gauges regulates the maximum voltage that may be applied to the bridge. This wattage rating is quite variable depending largely upon the material the gauges are mounted upon. Thus it is not possible to increase the meter reading by raising the unbalanced bridge voltage by any large amount to increase the galvanometer current. In most installations the gauge can dissipate one-half watt of power without affecting the bridge operation.

Another important point is that an increase of meter indication can not be had by jumping from a 100 μa. meter to a 50 μa. meter, because the internal resistance increase, usually accompanying the smaller scale meter, negates any possible improvement.

Assuming then for calculation purposes that a *GE* DP-9 100 μa. meter will be used with *Baldwin* SR-4 75 or 120 ohm strain gauges, we may start our calculations using the following formula from Laws, "Electrical Measurements":

$$I_g = \frac{I_B\ (MP + NX)}{R_g\ (M + N + X + P)\,(M + N)\,(X + P)}$$

This formula indicates the galvanometer current for a given bridge voltage (or current) with an unbalanced bridge, such as would occur with full load on the force link. The total bridge current is calculated by the condensed formula $I_B = E_B/R_p$ where R_p is the parallel series resistance of the bridge. Thus $R_p = \frac{(M + X)\ (N + P)}{M + N + X + P}$

For simplicity all four legs of the bridge may be assumed to be the same; in reality even under load they will vary but a few per-cent. In this situation with four similar legs, all of the above formulas may be dispensed with, the total bridge resistance always being equal to the resistance of one leg. Assuming a 10 volt bridge supply and determining the bridge current would leave only one unknown, the value of resistance of the active strain gauges or conversely (if this were known) the galvanometer current.

The galvanometer current formula can be transposed to secure the value of the unknown resistance of the active strain gauges so that substitution methods need not be employed as indicated below:

$$R_M = \frac{I_bNX - I_gNX - I_gR_gN - I_gR_gX - I_gR_gP - I_gPX}{I_gR_g + I_gN + I_gP + I_bP}$$

This formula may be revised again to a simpler form, as only one bridge leg, the unknown M, differs from the other three:

$$R_M = \frac{I_bXX - 2\ (I_gXX) - 3\ (I_gR_gX)}{I_gR_g + 2\ (I_gX) + I_bX}$$

where X is the static resistance value of one leg of the bridge, I_b is the bridge current, and I_gR_g are respectively galvanometer current and resistance.

As this formula can indicate the value of only *one* active bridge leg, with the other three dummies, then the resistance change indicated must be divided by *two* to indicate the actual change occurring in one active gauge in the bridge with two active legs. Thus the true dR_g per active gauge would be: $dR_g = \frac{R_{M\ static} - R_{M\ loaded}}{2}$

The dR_g calculated from this formula would be correct where the dummy gauges were mounted separately from the link, but as shown previously Poisson's ratio otherwise indicates that this value would be too high and the meter would read 30% high. To compensate this a corrected dR_g must be made for further calculations:

$$\text{Corrected } dR_g = \frac{dR_g \cdot 70}{100}$$

and further mention of dR_g shall be assumed to be the corrected value.

After determining this value we come back to our $dS = PL/AE$ formula which can now be transposed or revised to indicate the cross section area (sq. in.) required in the tubular section of the link. As it is desirable to know not the total elongation but inches per inch (strain) then the L may be deleted from the formula and it may be revised to read $A = P/dSE$. Here P would be the maximum load, applied to the link (i.e. calibration load) and E would be the material's Modulus of Elasticity. The strain (in inches per inch) required to produce the correct strain gauge resistance change is secured from the following formula: $dS = dR_g/R_gK$ where K is the gauge factor and dR_g

is the change in resistance of one of the strain gauges, as previously calculated. R_g is the nominal resistance of the gauge. There is little need to note that regardless of the length of the strained area, the strain remains the same, and that the tubular section of the link can be made any length desirable.

Now that the area of the tubular section of the link has been determined it is a comparatively simple matter to calculate its *ID* and *OD*. For the design shown in the drawing it was thought advisable to use a ⅝ inch *ID* which could be drilled conveniently and then machine the outside. The outside diameter for the given area may be found with the following formula: $OD = \sqrt{\frac{\text{area of } ID + \text{Link area}}{.7854}}$

where area may be found with: Area = $.7854d^2$.

The material the link may be machined from may be selected from ANC-5a or other references. It must have a proportional stress loading in pounds per square inch higher than the stress placed on the link so as to not cause any permanent set in the material and consequent change in calibration, with full load. Knowing the smallest cross section area of the link and the pounds applied, the stress on the material may easily be determined. This would be: Stress (psi) = [Applied lbs (to link)]/[Sq. inches (of link)]. Any steel of any heat treat can be used so long as its Modulus of Elasticity is that of the value used in the calculations. Therefore if it is necessary to change steels because of exceeding the proportional limits it would not be necessary to re-calculate if the new steel or heat treatment did not affect the *E*.

When the link is machined it is necessary to hold the tolerances quite close if accurate results are to be achieved. A variation of plus or minus one thousandth of an inch on these link diameters can cause the calculated results to differ from empirical tests by several per-cent. It is preferable to allow + or − tolerances in a direction that would, were error present, make the link area smaller rather than larger.

In considering the design of the link it is better to err in the direction of excessive sensitivity than lower sensitivity. It is always practical to shunt the meter down and secure full scale indication, but it is not always possible to raise the meter reading. Either of these two conditions can be corrected to a certain amount by varying the bridge supply voltage.

There are a few practical notes that must be added to the constructional section of this article to insure proper use of the equipment. Electrically the bridge diagram shows several resistors and a rheostat not needed theoretically in a simple bridge circuit. In practical use a special network must be used across one side of the bridge to allow balancing of the bridge. The resistor and potentiometer R_7 and R_8 allow any variation between strain gauges to be balanced out. This balance is unaffected by bridge supply voltage and is the first step in using the equipment. It is imperative to balance the bridge with no load on the link. Frequently loads may be indicated on the equipment, after just removing a hydraulic or mechanical load. *Usually* this indicated load is true load, *not* an indication due to hystersis of the link of meter. Before rebalancing under such a situation it is necessary to loosen any mechanical connections to the link.

The first step in using the equipment then, calibration or use, is to balance the bridge with no load on the link.

Variation of the bridge supply voltage or any change in meter sensitivity can cause a change in calibration. It is preferable therefore to include some circuit in the bridge to allow setting of a specific voltage on the bridge and at the same time insure that the calibration is correct. This is accomplished with the aid of a series rheostat R_9 and a calibrating resistor and switch R_6 and *S* wired as indicated on the schematic. With full load on the link, the battery rheostat is adjusted until full scale deflection occurs on the meter. Not touching this rheostat, the load is removed and *S* or the calibration switch is closed. A value of resistance is then selected for R_6 which will give an on scale reading. This resistor should be of the precision type, soldered in place. The on scale reading is noted and it is then the bridge's calibration indication.

From that time on, after balancing the bridge, the battery rheostat (Calib. Adj.) will be adjusted until the meter indicates the "calibration point" with, of course, *S* closed. Then the bridge will be ready to use, calibration checked and bridge supply voltage set to the proper value.

As the force link may be used for compression or tension and it is desirable not to use a zero center scale meter and thereby secure higher accuracy, another switch was added to the circuit allowing reversal of the meter leads with reversal of the load sign.

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Fig. 3. Mechanical construction of a typical strain gauge link. The link is machined from solid stock.

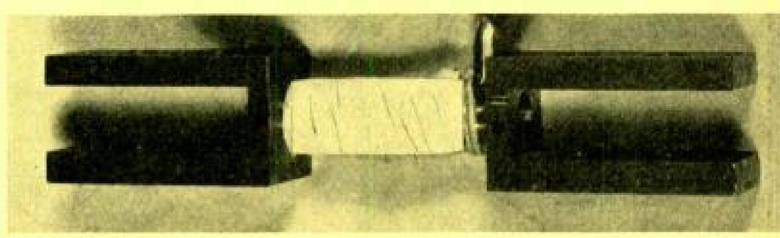


Fig. 4. (A) Practical schematic and (B) basic bridge circuit for the link.

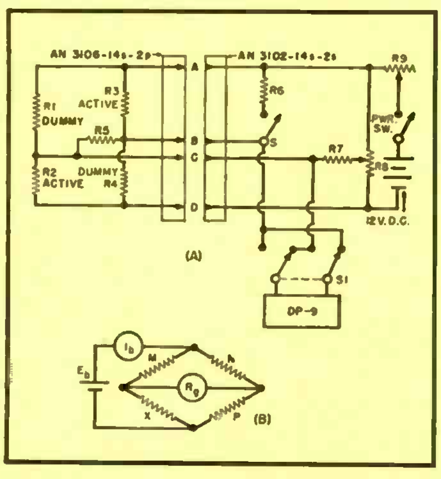
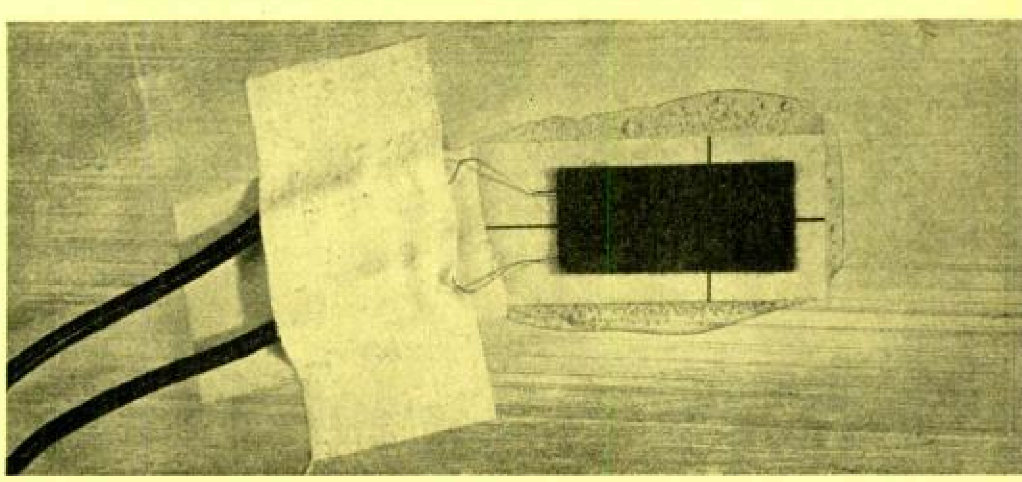


Fig. 5. Typical strain gauge with a protective felt pad hiding the strain sensitive wires. A special cement is used to cement the gauge to the surface under test.



U.H.F. TV CONVERTER DESIGN

By

NICHOLAS T. SIMOPOULOS

Design and development of a tuner or converter for use in the u.h.f. range of 450 to 900 megacycles.

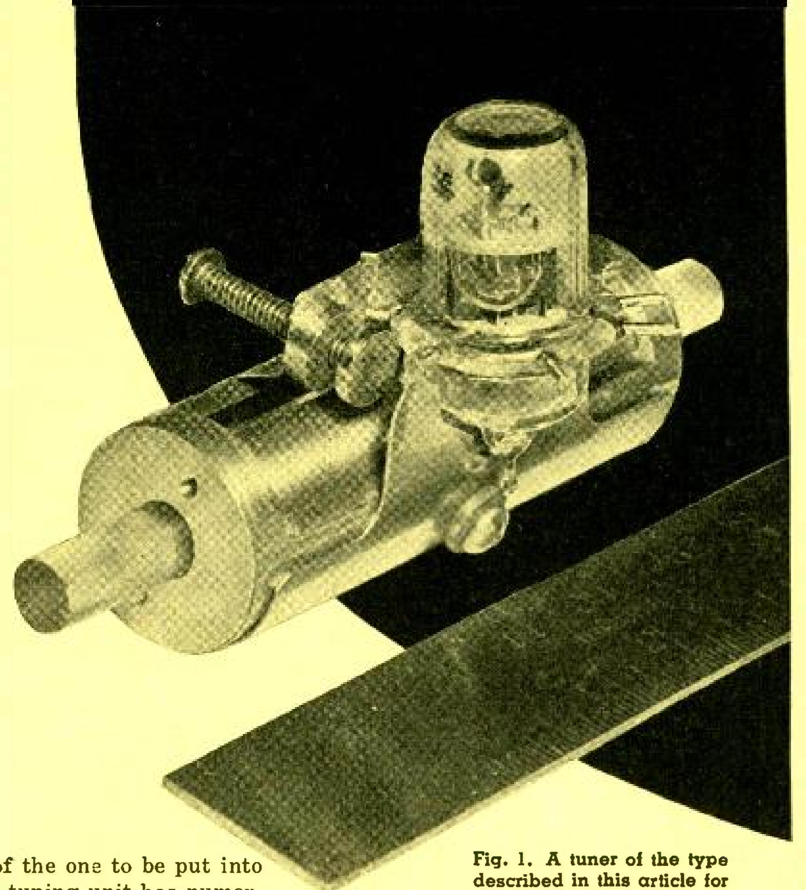


Fig. 1. A tuner of the type described in this article for use in a signal generator.

WITH the forthcoming allocation of television channels between 450 to 900 megacycles, there arises the problem of continuous tracking for television "front ends" at the above frequencies. This article describes a patented tuning unit which covers this band.

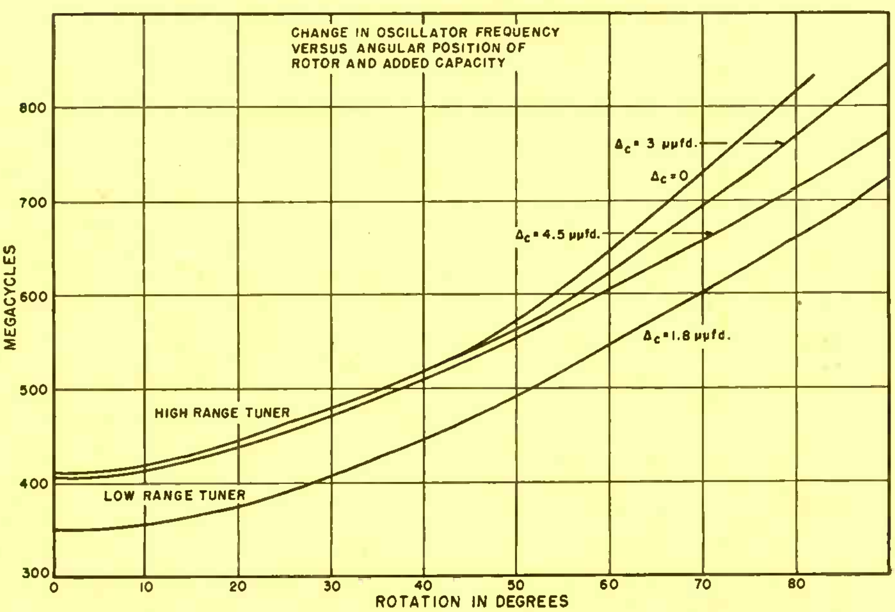
The author had worked with wide range tuners during World War II in the Special Projects Laboratory at Wright Field, Dayton, Ohio for panoramic adapter use. As a result of a study of the problem, a tuner was developed which gave a tuning ratio of more than four to one.

The tuner described in this article is a prototype of the one to be put into production. The tuning unit has numerous possibilities, finding uses in frequency meters, signal generators, and frequency modulated altimeters, in addition to its use in the r.f. and local oscillator sections of television receivers.

A purely mathematical treatment is very difficult due to the fact that inductance and capacity both change with rotation of the rotor. The range of the tuner is covered in a 90° angular change of the rotor. An important advantage is its simplicity of construction. There are no wiping contacts.

A typical tuner installation in a converter is shown in Fig. 6. A tuner for a signal generator use is shown in Fig. 1. A breakdown of the parts used in the tuner of Fig. 1 is shown in Fig. 7. A curve showing changes in frequency versus angular position of the rotor is shown in Fig. 2.

Fig. 2. Curve showing change in oscillator frequency vs. angular position of rotor. Effects of added capacity are also indicated.



The tuner used with the oscillator of the converter shown in Fig. 1 measures 3⅞ inches over-all with an opening of 5/16" by 1¾" on either side of the center web of the rotor. The outside diameter of the rotor is ⅝", and the spacing of the rotor to stator is 0.007" on the radius.

A typical circuit diagram is shown in Fig. 3B. A 6F4 type tube was used in the oscillator circuit and worked rather well in this application with some exceptions. Planar type electrodes lend themselves to easy mounting and low lead inductances. A type 5767 "rocket" tube was used on one tuner but due to its cathode construction and size, did not prove successful. A planar type tube with straps brought out at the tube electrodes (to reduce lead inductance) would prove useful in conjunction with these tuners. However, as mentioned before, the 6F4 tube gives satisfactory results.

Tuners may be made to track very closely by adjusting the shunting capacity of the tuner and if necessary the angular position of the rotor. The tuner has a bandwidth of approximately 5.1 mc. Experimental measurements give a Q of 70 at 360 mc.

Development models of the tuners are available at present for experimental use only.

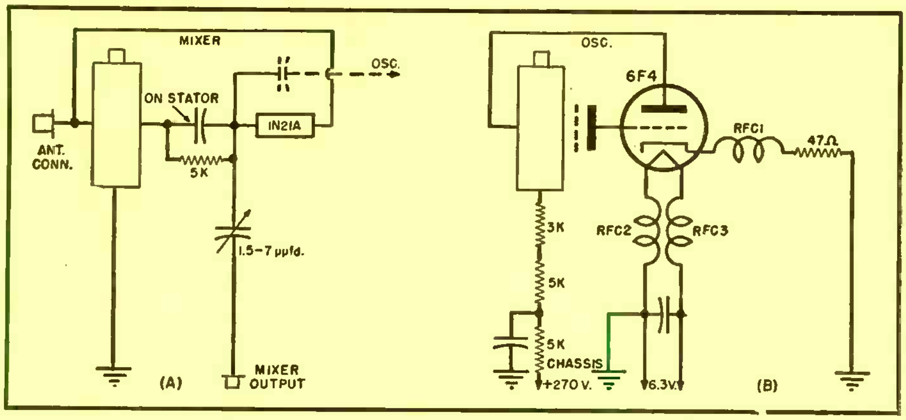


Fig. 3. Circuit diagrams of (A) mixer and (B) oscillator.

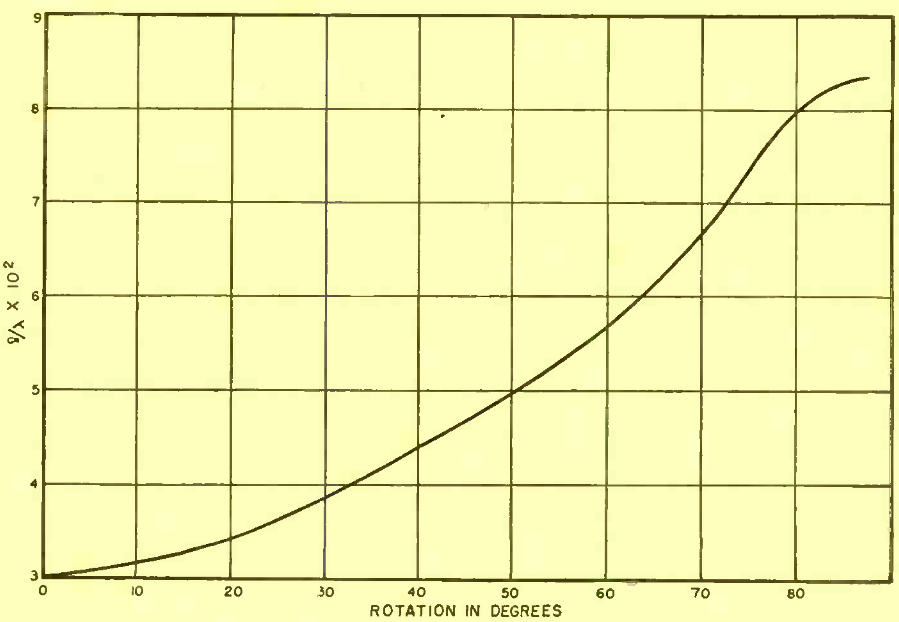


Fig. 4. Curve showing how the ratio varies with rotation.

The equation governing the design of these tuners is approximately:

$$\tan \frac{6.28\, l}{\lambda} = 1.74 \sqrt{\frac{b}{a}}$$

Refer to Fig. 5 where λ is the wavelength.

After a tuner is built with a specified gap and tested (a curve drawn showing frequency change versus angular rotation), then knowing the length of the tuner, we may plot l/λ versus rotation. This curve now holds for a tuner having the same diamentral dimensions as the one tested. All that remains to be done now is to find the required frequency range of the tuner; knowing λ we may find l.

Typical data and a curve showing l/λ versus angular position for a tuner with 0.005 inch gap and a rotor whose diameter is 0.612" and w dimension is 0.400" is shown in Fig. 4.

Antenna tuner gains of approximately two may be obtained by applying the signal at the end bell and the center of the tuner. The antenna tuner may be made to track very closely by adding capacity across the antenna (or oscillator tuner). The effect of shunt capacity on the tuner shown in Fig. 6 (0.007" gap) is shown in Fig. 2. It is seen that the effect of shunting capacity is very little at the low end of the tuning range while at the high end the effect of added capacity (ΔC) is quite noticeable. The tuner may be made to track still closer at mid-range by solving the equations:

$$\tan \frac{6.28\, l}{\lambda_1} = 1.74 \sqrt{\frac{b}{a_1}}$$

and

$$\tan \frac{6.28\, l}{\lambda_2} = 1.74 \sqrt{\frac{b}{a_2}}$$

where λ_1 and λ_2 are the desired wavelengths at the low and mid-points of the tuning range respectively.

a_1 and a_2 are the arc lengths of the stator at the low and mid-point of the tuning range. It should be remarked at this point that these desired dimensions are close approximations only; further refinements are usually necessary.

An experimental unit was made available to a prominent manufacturer. To check the tracking of the tuner, the gear

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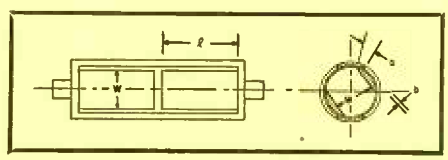


Fig. 5. End and side sketches of the tuner, showing how the values of a, b, l, and w are measured.

Fig. 6. A typical tuner installation as mounted in a converter.

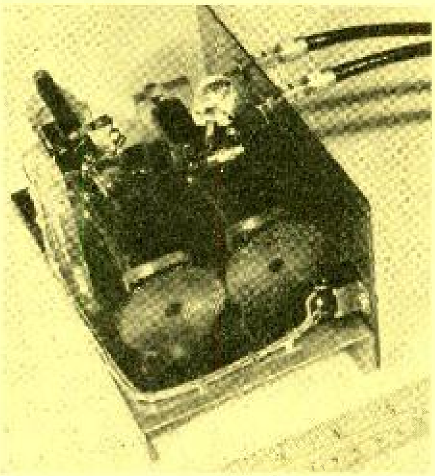
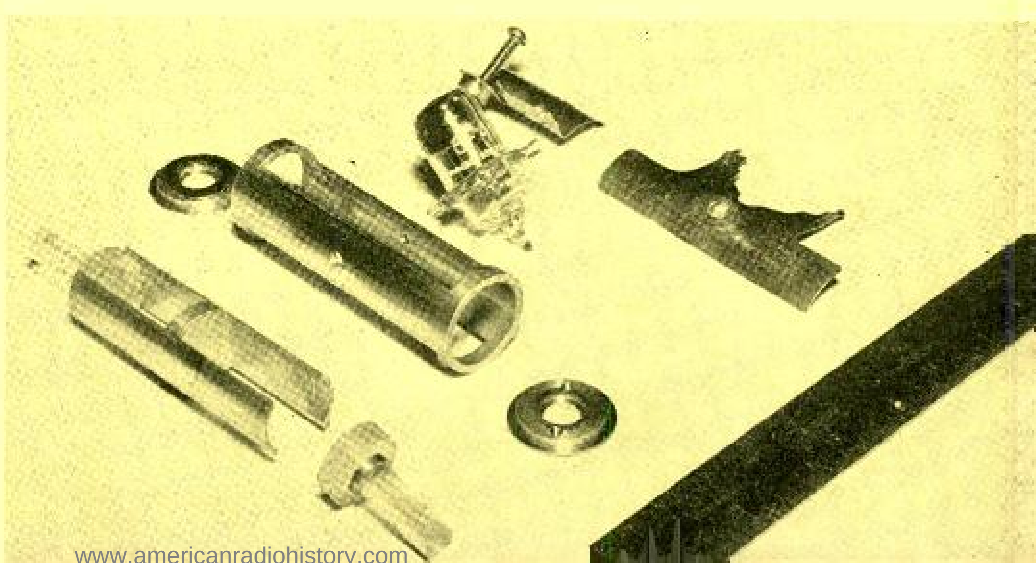


Fig. 7. A breakdown of the various parts used in the tuner of Fig. 1. A sketch of the tuner is shown in Fig. 5.



CRYSTAL SAVERS

By
HAROLD E. BRYAN

Several methods of obtaining crystal control of a large number of channels using only a few crystals.

THE problem of frequency stability in transmitters and receivers has become increasingly important in the past few years. The tendency toward the use of higher frequencies, together with the increase in the number of occupied channels, has made the need for stability combined with flexibility more and more apparent. For example, in one of the v.h.f. bands there are 280 channels, any one of which must be instantly available to the receiver operator. These channels are spaced at intervals of 100 kilocycles, which requires high stability and makes crystal control almost mandatory.

Up until the last few years it has been common practice to obtain the necessary stability by means of low frequency crystals, multiplying to the desired output frequency. This works fine from the standpoint of stability, but leaves much to be desired in versatility. If operation is required on six channels, six crystals are required. This is not too difficult a problem up to ten or fifteen channels, but is impracticable when operation is necessary on one hundred or more channels. Not only would the large number of crystals be expensive and space consuming, but there is not an unlimited supply of natural quartz suitable for manufacture of the crystals indefinitely.

In order to get around this difficulty, the so-called frequency synthesizers, or "crystal savers", have been developed. By means of these circuits, large numbers of crystal controlled channels may be obtained with the use of a relatively few crystals. The chief disadvantage lies in the fact that in some cases very complex circuits are required. In many cases, however, they may be relatively simple and inexpensive. Amateurs in particular should be interested in the application of crystal savers to their problems.

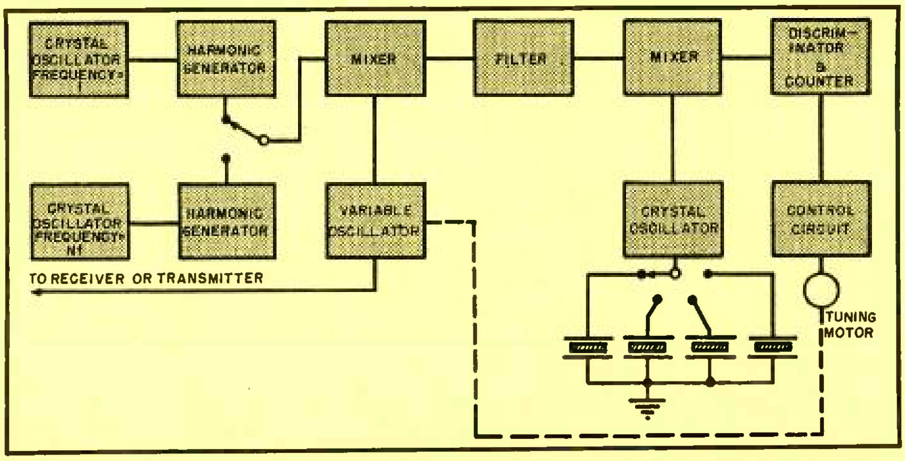
Actually, there is nothing basically new and startling about frequency synthesis. Crystal savers consist fundamentally of stable oscillators, frequency dividers and multipliers, mixers, counters and discriminators, all arranged in the proper sequence to obtain a desired result.

Generally speaking, there are two methods in use for producing the desired number of stable channels. The first sets up a stable crystal controlled monitoring system by means of which a free running oscillator is maintained on frequency by comparison with the crystal frequency. The second method synthesizes the required frequency directly from crystal controlled oscillators.

Basically, the comparison system consists of a low frequency crystal oscillator, a free running oscillator, a mixer and a discriminator-control circuit for the free oscillator. The output of the low frequency crystal oscillator is distorted such that a large number of harmonics is available for comparison purposes. The free running oscillator is then varied from some predetermined low frequency limit and the number of crystal harmonic zero beats passed by it are counted. When the desired number of counts has been made, the discriminator-control circuit is activated and the variable oscillator is maintained on frequency. This system is limited by the number of counts which can be made in a practical system. By using two crystal oscillators for comparison, the effective number of counts of the low frequency crystal harmonics may be greatly increased. If the high frequency crystal frequency is ten times the low frequency, then each count of a high frequency harmonic corresponds to a count of ten low frequency harmonics. In practice, the prescribed number of high frequency counts is made, followed by the low frequency count to the control point. By this means, several hundred channels are not difficult to produce. In commercial equipment, the variable oscillator is tuned by means of a motor and the count is made automatically. It is to be noted that only the low frequency crystal is in the circuit during the time the frequency is being controlled.

By adding another crystal oscillator and mixer, as shown in Fig. 1, another factor may be added to reduce further the number of counts required to establish a frequency. This third crystal oscillator is operated on one of several frequencies. The number of channels available then becomes the product of the maximum high frequency count by the maximum low frequency count by the number of auxiliary crystals. If the discriminator output is reversed, the number determined above is doubled. It is possible to establish in the neighborhood of one thousand channels by means of only a few crystals, using this system.

Fig. 1. A crystal saver using the counter-comparison system.



One difficulty with this type of circuit is that all control frequencies are present at all times. Thus any disturbance which could cause a change in variable oscillator frequency greater than the difference between harmonics would cause the control to take place on an adjacent channel. When this occurs, there is no indication that it has happened, with the resulting improper operation and consequent confusion.

An interesting circuit which makes use of a variable oscillator is the "Drift Cancelled Oscillator" developed by the *Collins Radio Company* and used in several of that company's receivers.* The basic circuit is illustrated in Fig. 4, applied to the 108-136 megacycle band. The circuit contains four mixers and four i.f. amplifiers. Two of the mixers and amplifiers are in the active receiver section and the other two in what might be termed a monitor channel. The first oscillator is a free running variable type operating at high frequency. The output of this oscillator is mixed with the incoming signal to produce the first i.f.; and with a harmonic of a low frequency crystal oscillator to produce the second i.f. The output of this second mixer is fed to a third, where it is combined with the signal from an interpolation crystal oscillator. This latter oscillator operates at a number of frequencies determined by the spacing of the channels desired. The third i.f. thus produced is fed to a fourth mixer, where it is combined with the first i.f. to produce the fourth i.f. This latter frequency is independent of the variable oscillator frequency, since the latter is cancelled out by the operation of the circuit. The variable oscillator must have stability only sufficient to maintain its mixing products within the pass bands of the first and second i.f. amplifiers. Otherwise it is of no consequence. Thus a channel is defined by a low frequency crystal oscillator harmonic and an interpolation oscillator crystal frequency. Stability is therefore very high, since in effect the drift and instability of the variable oscillator is cancelled. The only drift that remains is that of the crystal oscillators and the incoming signal itself. A total of 280 channels can be set up using only 21 crystals with this circuit.

There are many variables in comparison types of circuits making possible almost an infinite number of different combinations to produce certain results. The equipments are often quite complex, however, and therefore lend themselves more readily to commercial than to amateur applications.

The direct synthesis method may also involve very complex circuits if carried to extremes. For limited applications, however, relatively simple and straightforward designs are possible. The basic circuit is illustrated in Fig. 2. A single crystal oscillator is used, from which various harmonics and sub-harmonics are derived. Usually the sub-harmonics are one-tenth, one-hundredth, etc., of the basic frequency. The output of each divider is distorted and followed by a harmonic selector. The signal selected from the lowest frequency chain is mixed with that selected from the next higher chain, etc., until the final mixing is accomplished with the selected harmonic of the basic oscillator. The number of channels is limited by the number of divisions and harmonics thereof, and by the practicability of using the lower frequency derivations. It is not impossible to set up channels spaced by one kilocycle by this means. At high frequencies this may represent a large number of channels. In any event, all channels set up are derived from the basic oscillator and consequently have its stability and accuracy. Since it may be compared with the standard frequency transmissions from WWV, very high accuracy may be obtained.

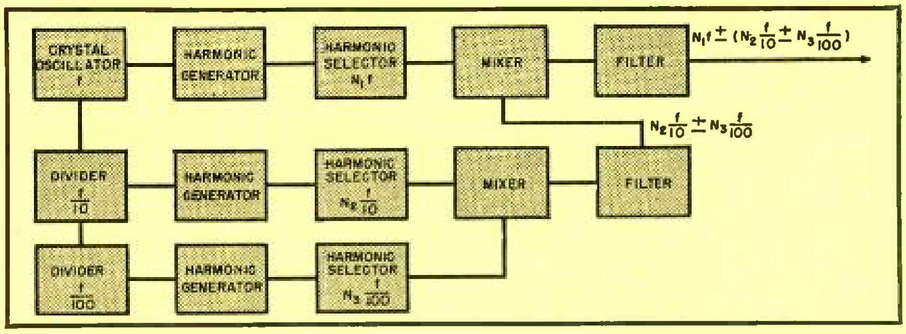


Fig. 2. Block diagram of a basic frequency synthesizer.

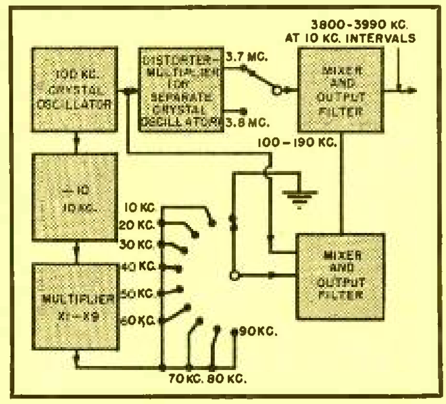
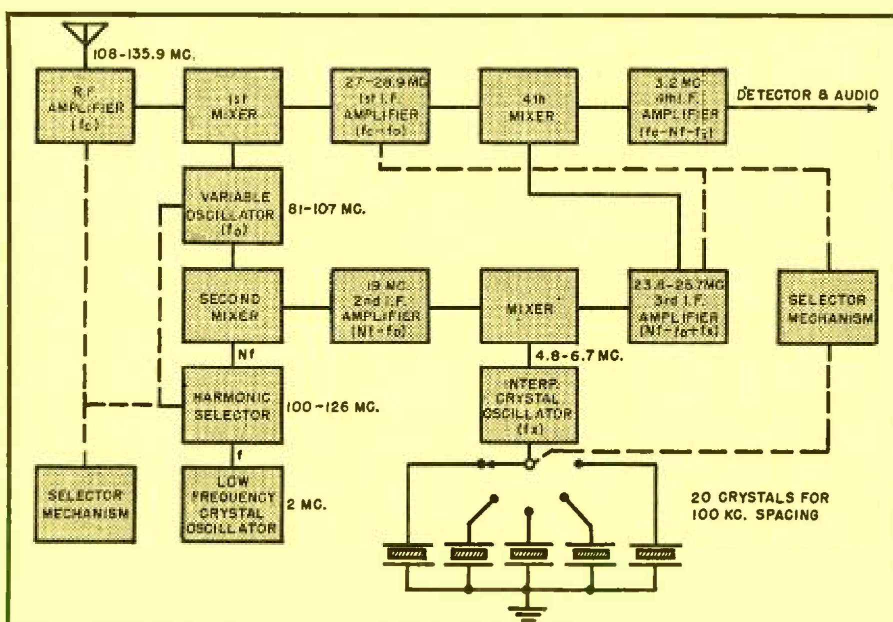


Fig. 3. Synthesizer producing channels at 10 kc. spacing from 3800 to 3990 kc.

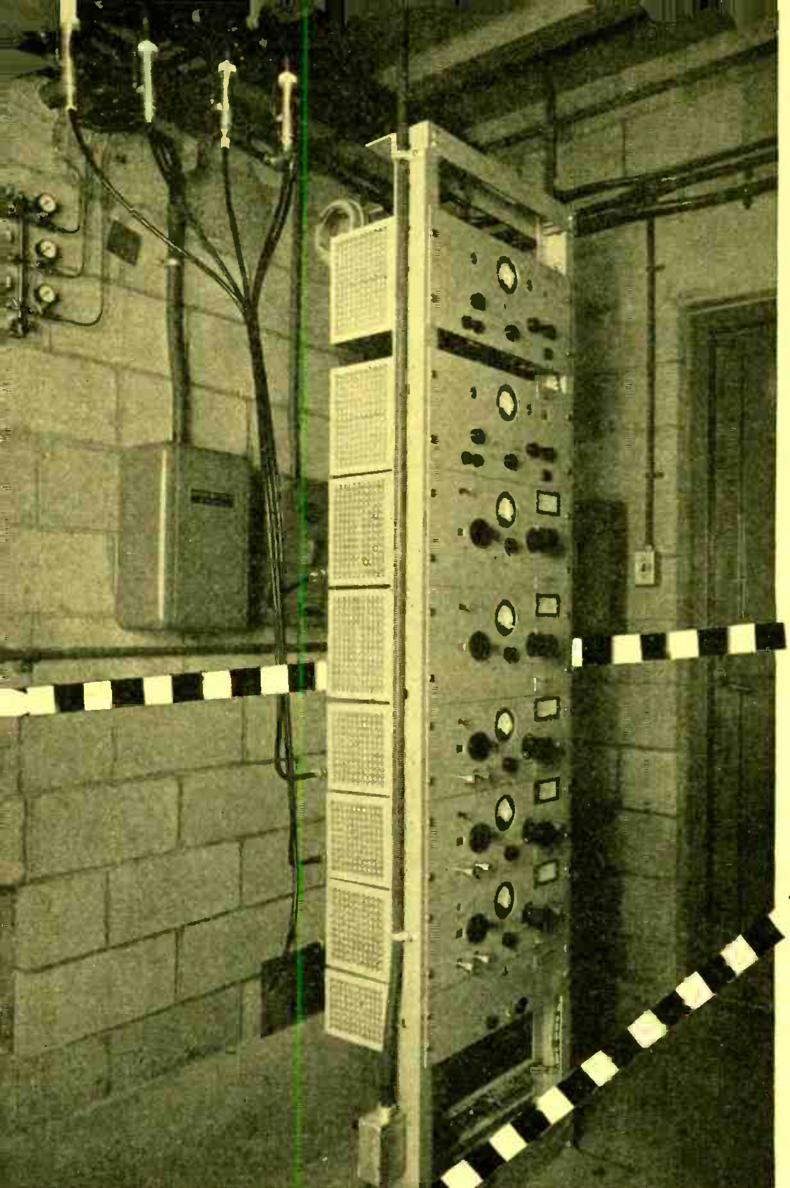
The principal objections to this type of circuit are to the large numbers of tuned circuits required and the initial setting-up complications. Otherwise the method provides very reliable and satisfactory operation. Due to the physical bulk involved, these synthesizers have generally taken a back seat to the comparison methods when large numbers of channels are required, except in laboratory measuring equipment, in which the greater stability of the frequency standard is desired.

(*Continued on page* 27)

Fig. 4. Drift-cancelled oscillator in 108-136 mc. receiver; 280 channels spaced 100 kc.



* "*The Drift Cancelled Oscillator*"—*The Collins Signal (Collins Radio Company)*—*April*, 1947.



MICROWAVE TRANSMISSION LINES

By J. RACKER
Federal Telecommunication Laboratories

Fig. 1. Typical r.f. terminal of microwave link showing transmission line connections. Outputs of individual units are connected to a flexible, dielectric coaxial cable, which in turn is connected to air-dielectric lines.

A discussion of methods of transmitting microwave energy, with particular emphasis on wave guides.

TRANSMISSION of energy at microwave frequencies is effected through the propagation of electromagnetic waves. Transmission lines, used at these frequencies, therefore function primarily to guide these electromagnetic waves and the study of these lines is closely linked with wave theory. As a matter of fact, at the higher frequencies (about 7000 mc. and above) it is possible to confine microwaves to such a narrow beam that transmission of energy from one point to another can be achieved efficiently without the use of physical lines. This article will be concerned with the practical problem of how to select the optimum transmission line system for any given application. Sufficient theory will be introduced to enable the engineer to understand the reason for the choices involved.

As indicated in the introductory article to this series, "Microwave Techniques", two basic types of transmission lines are used, i.e., coaxial lines and wave guides. Coaxial lines are normally used for frequencies up to about 2500 mc. This figure is based upon a number of factors including size, attenuation, and cost of the lines. It will be shown that the size of the wave guides (such as those shown in Fig. 4) varies inversely with frequency (hence they are employed almost universally for frequencies above 2500 mc.) while the size of a coaxial line increases with frequency for constant attenuation, all other factors remaining equal. At about 2500 mc. the size of the coaxial line is increased to the point that it becomes comparable to a wave guide designed for this frequency, for equivalent line attenuation.

At microwaves, transmission lines may be used for one of two functions. The first is the one normally associated with transmission lines and that is for the transfer of energy from one point to another. Sections of these lines can be used to obtain inductive and capacitive reactances, transformers, and filters. This aspect will be considered separately in the next article. This article will cover the use of lines for the point-to-point transmission of microwave power such as would be required to connect transmitter to antenna, or antenna to receiver.

Coaxial Lines

Coaxial lines are familiar to most engineers since they have been used extensively in FM and television as well as other u.h.f. applications. Since they are used extensively, a large number of standard type cables is available at reasonable cost. Consequently coaxial cable is used whenever possible. It is important to understand the relationship between size, attenuation, power ratings, characteristic impedance, etc., of these cables, since in many cases the information supplied by the manufacturer will cover the u.h.f range only (up to about 500 mc.) and it will be necessary for the microwave engineer to estimate the line characteristics at higher frequencies.

There are two sources of power loss in a microwave line. One is due to the line attenuation and the other to mismatch either between line and load or as a result of impedance variation within the line. The attenuation of a coaxial line is given by[2]:

$$\alpha_T = \alpha_c + \alpha_d = \frac{0.435}{Z_o}\left(\frac{R_1}{d} + \frac{R_2}{D}\right)\sqrt{f} + 2.78\ \sqrt{k}\ pf \quad . \quad (1)$$

where α_T is the total attenuation
α_c is the attenuation due to the high frequency resistance of the conductors
α_d is the attenuation due to the dielectric losses

R_1 & R_2 are equal to the ratios of the d.c. resistance of conductor used to the d.c. resistance of copper
Z_0 is the characteristic impedance of the line
d is the diameter of the inner conductor
D is the diameter of the outer conductor
f is the frequency in mc.
p is the power factor of the dielectric
k is the dielectric constant

The first part of Eqt. (1) is the attenuation of the line caused by the high frequency resistance of the conductors, and as indicated in this equation, the conductor attenuation increases as the diameters d and D decrease, and as the square root of frequency. In order to keep the attenuation constant as the frequency increases, it is therefore necessary to increase the conductors' diameters. It should be noted that the ratio of D/d must be kept constant for a given characteristic impedance, and that the inner conductor, having the smaller diameter, contributes a major part of the conductor losses.

The second part of Eqt. (1) represents losses due to the dielectric. In the u.h.f. region the conductor losses are the major part of the total line attenuation. However, since the dielectric losses increase directly as the frequency, instead of as the square root of frequency, a point will be reached in the microwave band where the dielectric losses become comparable and then exceed the conductor attenuation. To reduce the dielectric loss, the dielectric constant, k, can be decreased. This is done by using air, rather than the usual polyethylene, as the dielectric. Air dielectric lines should be used only when absolutely necessary since they are more expensive, more difficult to handle (most are rigid instead of flexible), introduce mismatch losses due to discontinuities, and require special dehydrating and constant pressure apparatus to maintain uniform operation for all ambient conditions.

The power rating of a polyethylene dielectric cable is a function of the maximum temperature which the insulation can safely withstand. The power-handling capability of the cable is limited by the rate at which the cable can dissipate the heat generated by conductor and dielectric losses and is therefore inversely proportional to the line attenuation. For the purposes of this article, the following relation between power rating and attenuation is sufficient:

$$P = K_c/\alpha_T \quad \text{. . . . . (2)}$$

where K_c is a constant for any given cable.

Knowing the power rating and attenuation of a cable for any u.h.f. frequency, it is readily possible through the use of Eqts. (1) and (2) to estimate its power rating at any desired microwave frequency.

Losses Due to Mismatch

It has been shown in the previous article that when a line is terminated in its characteristic impedance, no reflections occur, and all the power transmitted down the line is absorbed by the load. (Of course loss in power will result if the generator is not matched to the load, but this factor is not due to the transmission line. The assumption will be made that the generator is matched to the line.) However if the load is not equal to the characteristic impedance, reflections occur—setting up standing waves—and losses due to mismatch result.

The ratio of reflected to incident waves for any arbitrary load Z_t is given by:

$$\frac{V_2}{V_1} = \frac{Z_t/Z_0 - 1}{Z_t/Z_0 + 1} \quad \text{. . . . . (3)}$$

where V_2 is reflected wave voltage, and V_1 incident wave voltage. Since the load may be complex, this equation may contain complex quantities and the ratio of V_2/V_1 will not only give the relative magnitude but also the relative phase between the two quantities.

As power varies with the square of voltage, the impedance being held constant, the per-cent power reflected from an arbitrary load is:

$$\%\text{ power reflected} = \left(\frac{V_2}{V_1}\right)^2 \times 100 \text{. . (4)}$$

Two special cases of this equation can be considered. The first is for a load impedance which is purely resistive but not equal to Z_0. The per-cent power reflected in this case is plotted in Fig. 2 for various ratios of R/Z_0. The other special case is for the load impedance to be equal to a resistive plus a reactive component, but the resistive component is equal to Z_0. In this case, Eqt. (4) becomes:

$$\%\text{ power reflected} = \left(\frac{V_2}{V_1}\right)^2 = \left[\frac{jX_0}{2Z_0} \Big/ \left(1 + \frac{jX_0}{2Z_0}\right)\right]^2 \quad \text{. . . . . (5)}$$

This relationship is plotted in Fig. 3 for various values of X/Z_0.

The most direct method of determining power reflection due to mismatch is to measure the standing wave ratio of the line. The power standing wave where η_v = voltage standing wave radio,

$$\eta_p = \left(\frac{V_{max}}{V_{min}}\right)^2 = \left(\eta_v\right)^2 \quad \text{. . . . (6)}$$

where η_v = voltage standing wave ratio,

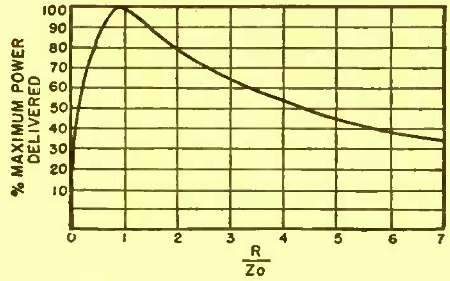


Fig. 2. Variation of power transfer with ratio R/Z_0 when the load impedance has no reactive component.

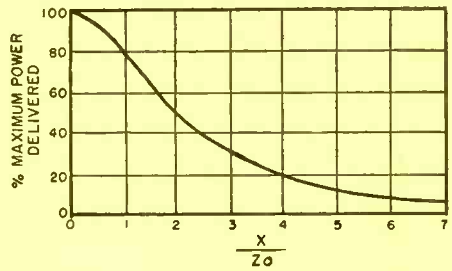
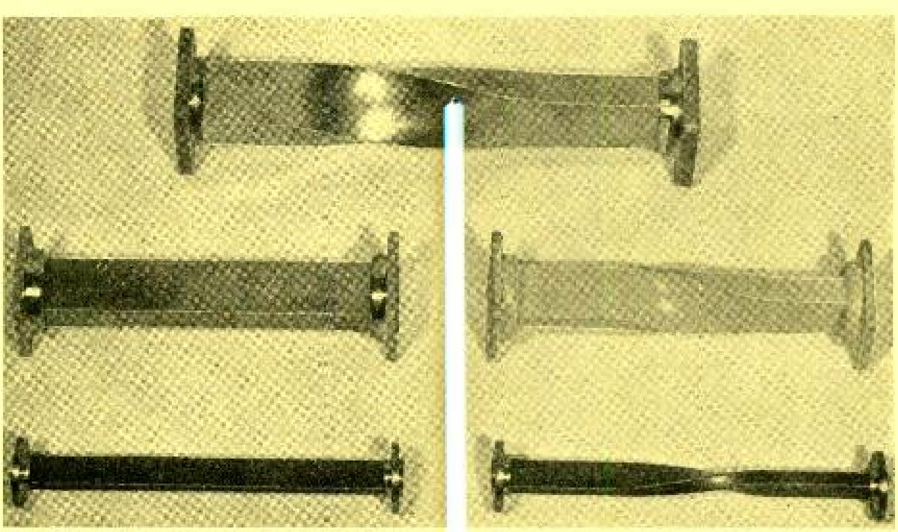


Fig. 3. Loss in power due to load reactance when the resistive component of the load is equal to Z_0.

Fig. 4. Several typical manufactured wave guide sections.



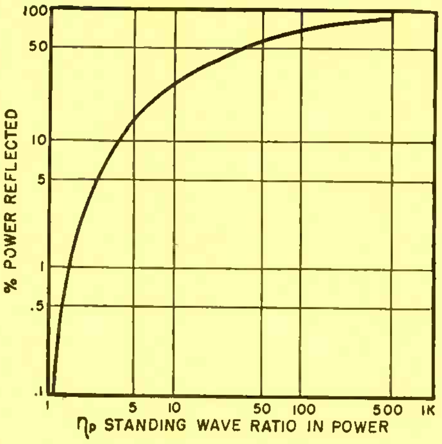


Fig. 5. Per-cent power reflected vs. standing wave ratio in power.

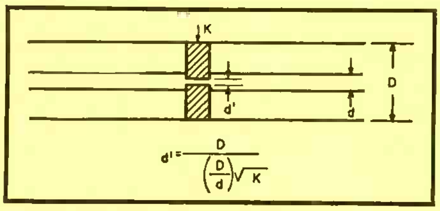


Fig. 6. Undercutting center conductor where bead support is inserted to maintain constant characteristic impedance.

and the percentage power reflected from the line is given as:

$$\%\text{ power reflected} = \frac{\sqrt{\eta_p} - 1}{\sqrt{\eta_p} + 1} \quad . \ (7)$$

This equation is plotted in Fig. 5.

The equations given above assume that the line used is uniform and that no mismatch occurs within it due to discontinuities. However, in air dielectric lines where some insulating supports such as beads or quarter-wave stubs must be used to separate the inner and outer conductors, discontinuities do exist at the points where the supports are inserted. In this case, standing waves will exist on the line even though it is properly terminated. It is possible to minimize this effect by spacing the beads so as to cancel reflections and by adjusting the D/d ratio at the bead so as to hold constant characteristic impedance.

This is illustrated in Fig. 6. Manufacturers of air dielectric lines specify the standing-wave ratio at the frequency desired and this factor should be considered in determining whether a solid dielectric or air dielectric line should be used.

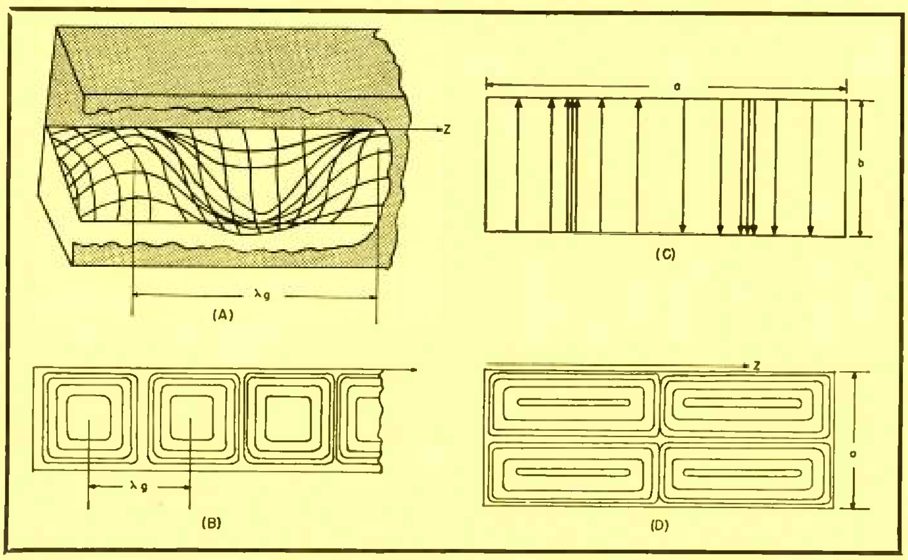
When a line is terminated in a load which has both a resistive and a reactive component it is possible to effect matching by tuning out the reactive component and "transforming" the resistive to the desired value. To do this the input impedance must be calculated to a transmission line with arbitrary load Z_t. This has been derived[1] and is equal to:

$$Z_{in} = \frac{Z_t + jZ_o \tan \beta l}{1 + j\,\frac{Z_t}{Z_o}\,\tan \beta l} \quad \ldots\ldots \ (8)$$

When Z_t is a complex number this equation becomes difficult to solve. A transmission line calculator[2] (*Emeloid Co. Inc.*, Arlington, N. J.) based upon this equation is available which greatly simplifies impedance calculations. Using Eqt. (8) a point must be determined at which the impedance is purely resistive, i.e., j term equal to zero. Then a quarter-wave transformer is used to match this impedance to that of the line.

To illustrate this procedure let us consider an actual problem. A transmitter with a 50 ohm output impedance is to be coupled to an antenna whose impedance at the transmitter frequency is $75 + j25$ ohms, a 50 ohm line is to be used.

Fig. 7. (A) Electric field configuration in rectangular wave guide ($TE_{0,1}$ mode). (B) Magnetic field configuration (top view) in rectangular wave guide ($TE_{0,1}$ mode). (C) Electric field (side view) for $TE_{2,0}$ mode. (D) Magnetic field (top view) for $TE_{2,0}$ mode.



Solution: Determine value of $\tan \beta l$ which will make the j term of Eqt. (8) equal to zero. There are a number of such points, the first is for $\tan \beta l$ approximately equal to 17.5° or for l about 0.036 wavelengths from the antenna. At this point the input impedance is:

$$Z_{in} \approx 1.75\ Z_o \text{ for } \tan \beta l = 17.5° \quad . \ (9)$$

To match this impedance with the 50 ohm line, a quarter wave transformer with the following characteristic impedance must be used:

$$Z_{ot} = \sqrt{Z_o\, Z_{in}} = \sqrt{50 \times 87.5} = 64 \text{ ohms} \quad \ldots\ldots\ldots\ldots \ (10)$$

Fig. 9 depicts the matching section of this system. It should be noted that matching is effected at one frequency only though mismatch for nearby frequencies is small. It is possible to increase the bandwidth of such a system by using two quarter-wave transformers and matching in steps. For example, one transformer would bring the 50 ohm impedance up to 68 ohms, the second to 87.5 ohms. The smaller the impedance steps, the broader the bandwidth.

Wave Guides

In a coaxial line the current flowing through the center conductor creates the electromagnetic field which is propagated down the line. In a wave guide, with no inner conductor, the electromagnetic wave configuration is set up by an input probe (which acts as an antenna) and the dimensions of the guide. If the dimensions of the guide are not correct, the wave generated by the probe will not be propagated down the line. A wave guide is a high pass filter which attenuates all energy below its cut-off frequency.

The fields evolved in a wave guide can be derived through the use of Maxwell's equations by a procedure similar to that used for determining the radiation pattern of an antenna; in this case the walls of the wave guide provide the boundary conditions. It is beyond the scope of this article to present this derivation, but a simple explanation of how waves are set up in certain patterns within the wave guide will help the reader to understand wave-guide calculations.

Consider the electric field that exists between a pair of parallel plates due to a potential difference, V, generated across them. It is known from electromagnetic theory that the electric field lines terminating on a perfect conductor must be normal to the conductor surface. The resultant electric field is therefore oriented as shown in Fig. 10A. If V is a sinusoidal function, the strength of the electric field will vary as V and traveling waves will be sent down the plates in the z direction.

When another pair of parallel plates is placed at the sides of the former two —to form a wave guide—a reorientation of the electric field must take place since no tangential component of the electric field can exist parallel to the surface of a perfect conductor. Therefore the electric field at the sides of the guide must be equal to zero. One resulting pattern, shown in Fig. 10B, is in the form of a sine wave with maximum amplitude at the center of the guide (in the XY plane) and dropping to zero at both sides. This pattern must be maintained at any point along the guide in the XY plane. A picture (Fig. 7A) of the instantaneous electric field in the guide would then be a series of sine-wave hills.

This arrangement of the electric field cannot be produced by any single wave but requires two waves properly phased, just as was described for the short-circuited transmission line in the previous article. In this case, the problem is three dimensional and the waves involved are plane waves. This field can be achieved by two plane waves traveling within the guide at the same time as shown in Fig. 10C. For the purpose of this illustration, the angle between the wave guide walls and traveling waves can be considered to be:

$$\sin \alpha = \frac{\lambda}{2a} \quad (11)$$

It is readily seen that when $\lambda = 2a$, $\alpha = 90°$, or the waves are not propagated down the guide but bounce back and forth between the walls. For $\lambda > 2a$, $\sin \alpha$ does not exist which indicates that unless the wavelength of the wave is smaller than $2a$, it cannot be propagated down the guide.

From electromagnetic theory it is known that the existence of an electric field in the guide which varies with time develops a magnetic field which is transverse at the center of the guide but bends and becomes axial at the sides. A top view of the wave guide showing the magnetic field created by the previously described electric field is shown in Fig. 7B.

The original boundary condition requiring the electric field to drop to zero at the side walls could also be met by a full sine wave configuration, rather than a half wave. This pattern can also be achieved by two plane waves, but, in this case, the angle of the waves with the walls can be considered to be:

$$\sin \alpha = \frac{\lambda}{a} \quad (12)$$

and the cut-off wavelength, λ_c, is equal to a. The field configuration for these waves is shown in Fig. 7B.

Another possible configuration consists of the existence of an electric field which is normal to the side walls. A wave of this type will exist if the b dimension of the guide is large enough to permit propagation. To describe the various field configurations possible in a wave guide, a system of modes and subscripts has been evolved. Two basic types of waves can exist in wave guides, TE and TM waves. A TE wave indicates that there is no component of the electric field along the z-axis, while a TM wave indicates that there is no component of the magnetic field along the z-axis. A TEM mode is a wave in which both electric and magnetic fields have no z component. This latter mode exists only in free space and in a coaxial cable.

TE and TM waves are given numeral subscripts which represent the configuration of the electric or magnetic fields along the "a" and "b" dimensions of the guide. $TE_{1,0}$ represents a wave with a half sine waveform (1) of the electric field along the "a" dimension, and no (0) electric field along the "b" dimension. This wave is shown in Fig. 7A. The configuration shown in Fig. 7B is that of a $TE_{2,0}$, i.e. a full sine wave along the "a" dimension (2), no (0) electric field along the "b" dimension. A $TE_{1,1}$ wave is one which has an electric field in both "a" and "b" dimensions, in each case in the form of a half sine wave.

A wave guide acts as a high pass filter. The cut-off wavelength varies with the dimensions of the guide and the different modes. The generalized equation for the cut-off frequency of a rectangular guide is:

$$f_c = \frac{c}{\lambda_c} = \frac{c\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}{2} \quad (13)$$

It has been shown that the electromagnetic waves traveling down the wave guide do not follow a straight line but are reflected between the sides of the guide at some angle α. The wavelength of the resulting field configuration, such as the one shown in Fig. 7A, is not the same as the free space wave-

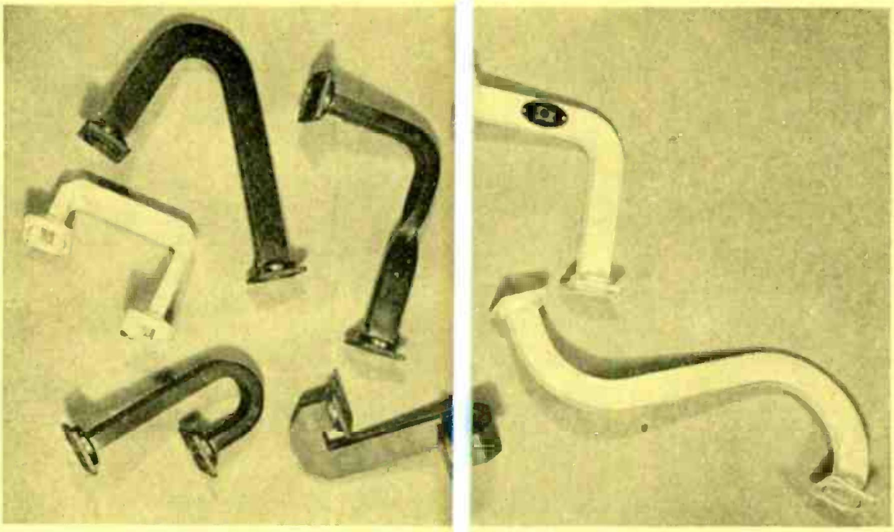


Fig. 8. Some of the many wave guide shapes available to meet the mechanical requirements of individual applications.

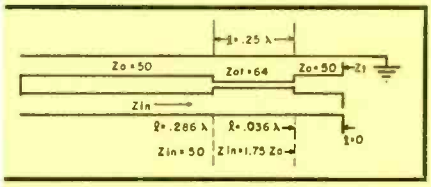


Fig. 9. Matching a 50 ohm line to an antenna having both reactance and resistance.

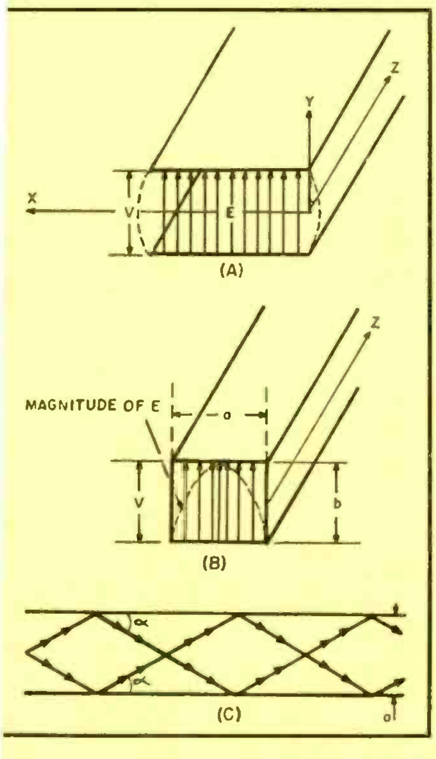


Fig. 10. (A) E field in pair of parallel plates. (B) E in rectangular wave guides. (C) Plane waves in guide.

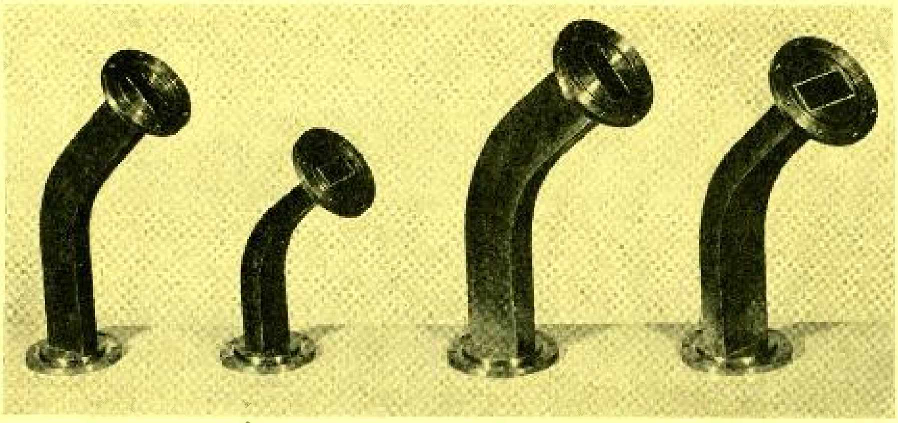


Fig. 11. Typical forty-five degree wave guide sections.

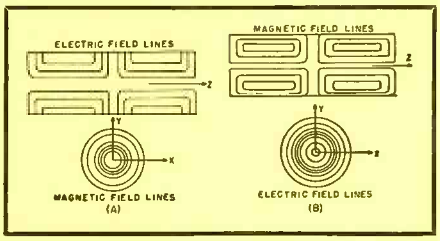


Fig. 12. Field configuration for (A) $TM_{1,0}$ mode and (B) $TE_{1,0}$ mode of a circular wave guide.

length λ of the original wave, but varies in accordance with the following equation:

$$\lambda_g = \frac{\lambda}{\sqrt{1-\left(\frac{\lambda}{\lambda_c}\right)^2}} \quad . \ . \ . \ . \ . \quad (14)$$

where λ_g is guide wavelength.

The velocity of propagation down the guide, equal to the frequency times the guide wavelength, is:

$$v_g = f\lambda_g = \frac{c}{\sqrt{1-\left(\frac{\lambda}{\lambda_c}\right)^2}} \quad . \ . \ . \quad (15)$$

These parameters can be determined for $TE_{1,0}$ mode from the nomograph on page 32.

Power Carrying Capacity and Attenuation of a Rectangular Wave Guide

The maximum power that can be transmitted through an air-dielectric wave guide will depend upon the maximum electric field strength than can exist without breakdown. For the $TE_{1,0}$ mode the theoretical maximum power that a wave guide can carry is:

$$P = (E_{max})^2 \times 6.63 \times 10^{-4} \times ab\left(\frac{\lambda}{\lambda_g}\right) \quad (16)$$

where P is maximum power in watts and E_{max} is maximum permissible voltage gradient. This equation gives the theoretical power and assumes that no standing waves, due to mismatch, exist in the guide.

A value of 15,000 volts per centimeter E_{max} is usually used. This value has been arrived at empirically and is used by the Army and Navy in applying power ratings to wave guides. Figs. 13A and B show theoretical power rating curves for two typical wave guides.

The attenuation of a copper wave guide with air dielectric and for $TE_{1,0}$ mode is:

$$\alpha_{copper} = \frac{0.001107}{a^{3/2}} \times \left(\frac{\frac{a}{2b}\left(\frac{f}{f_c}\right)^{3/2} + \left(\frac{f}{f_c}\right)^{-1/2}}{\sqrt{\left(\frac{f}{f_c}\right)^2 - 1}}\right) \quad . \ . \ . \ . \quad (17)$$

For metals other than copper, this equation must be multiplied by $\sqrt{R_1}$, where R_1 is the resistivity ratio of the conductor used to that of copper. Curves of attenuation versus frequency are also given in Figs. 13A and B. These curves indicate that it is not desirable to operate a wave guide at frequencies close to cut-off. The attenuation is high in this region and decreases rapidly to the point where it is fairly constant.

Circular Wave Guides

It is also possible to utilize wave guides of circular form for transmission of microwaves. In practice this type of wave guide is rarely used because it is very difficult—due entirely to physical reasons—to maintain proper mode orientation. However in some specialized applications, such as when a rotating antenna is used, it is advantageous to use this type of guide. In these latter applications, it is necessary to utilize a "circular" type pattern such as the $TE_{0,1}$ or $TM_{0,1}$ modes shown in Fig. 12.

The following relations describe the characteristics of the circular guide:

a) Cut-off frequency (TE modes):

$$f_c = \frac{cu'_{n,m}}{\pi D} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (18a)$$

where D is the guide diameter and the constant $u'_{n,m}$ is the mth root of the Bessel equation $J_n'(u) = 0$.

b) Cut-off frequency (TM modes):

$$f_c = \frac{cu_{n,m}}{\pi D} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (18b)$$

where $u_{n,m}$ is the mth root of the Bessel equation $J_n(u) = 0$.

c) Wavelength and velocity of propagation (same as for rectangular guide)

d) Power Carrying Capacity ($TM_{0,1}$ mode):

For $D/2\lambda < 0.761$,

$$P = (E_{max})^2 \times 0.5 \times 10^{-3} \times \frac{D^4}{\lambda^2}\left(\frac{\lambda}{\lambda_g}\right) \quad (19a)$$

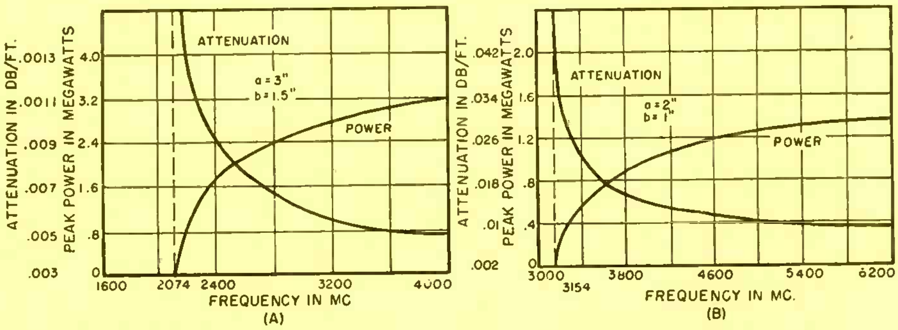
For $D/2\lambda > 0.761$,

$$P = (E_{max})^2 \times 0.75 \times 10^{-3} \times D^2\left(\frac{\lambda_g}{\lambda}\right) \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (19b)$$

e) Attenuation ($TM_{0,1}$ Mode):

$$\alpha_{copper} = \frac{.00485}{D/2}\,\frac{\left(\frac{f}{f_c}\right)^{3/2}}{\sqrt{\left(\frac{f}{f_c}\right)^2 - 1}} \text{ db./ft.} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (20)$$

Fig. 13. Peak power and attenuation vs. frequency of $TE_{1,0}$ mode in (A) 3" x 1½" wave guide and (B) 2" x 1" guide. Dotted lines represent the cut-off frequency.



Choosing a Wave Guide

In order to operate a wave guide at its optimum efficiency the dominant mode is usually used. The dominant mode is the lowest frequency mode that will propagate down the wave guide. In a rectangular guide, which is virtually always employed, this mode is $TE_{1,0}$.

The propagation of more than one

(*Continued on page* 27)

TWO-WAY RADIO COMMUNICATION FOR MOTORCYCLES

MADE POSSIBLE WITH . . .

Equipment by

VETRIC A Link RADIO CORP. AFFILIATE

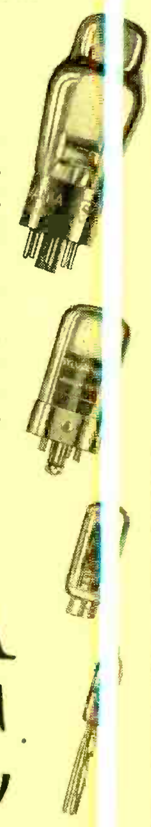
Link Radio and VETRIC

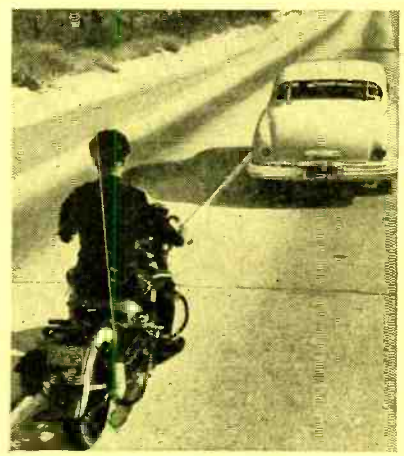
Tubes by

SYLVANIA ELECTRIC

The long arm of the Law is just that much longer through the combined skill of Link-Vetric and Sylvania. In designing this compact two-way radio for the Los Angeles Motorcycle Police, one quality was paramount . . . faultless performance under the toughest conditions. Nothing must fail when the call comes through!

Link-Vetric uses Sylvania low-drain miniature tubes because every step in their manufacture is quality controlled, ensuring longer life under the most adverse conditions. From Regular Glass Tubes to the famous Lock-ins . . . from Miniatures to tiny Sub-Miniatures, Sylvania tubes give the perfection that can *really* take punishment. Sylvania Electric Products Inc., Emporium, Pa.

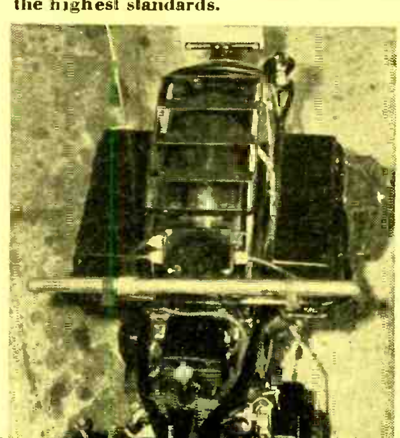




Highway bumps and rutted by-ways often have to be taken at high-speed. Sylvania tubes defy sudden shock, constant vibration. Maintenance work cut to a minimum.

• • •

Neatly installed either side of the rear fender, the two-way radio keeps patrolmen in constant touch with headquarters. All police calls are urgent calls . . . absolute reliability is essential. Sylvania tubes are chosen wherever necessity demands the highest standards.



SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS

MAGNETIC FLUX COMPARATOR

By EDWIN N. KAUFMAN

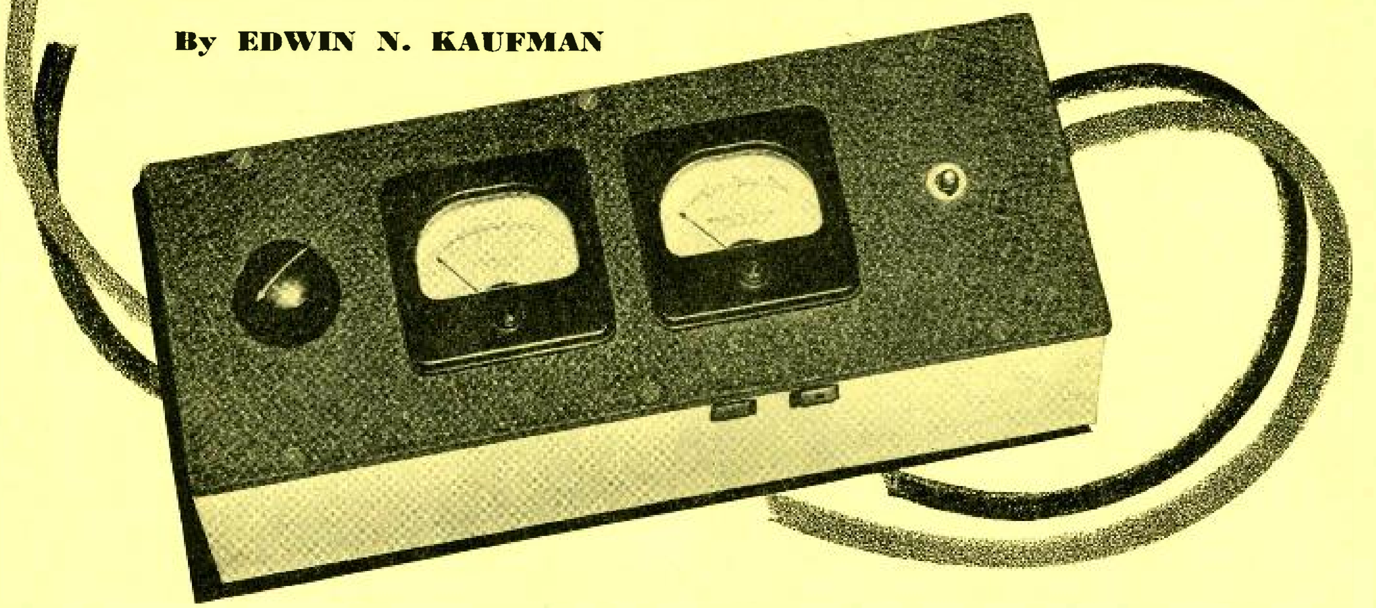


Fig. 1. The completed flux comparator. The two comparator bars may be seen protruding from the bottom of the case.

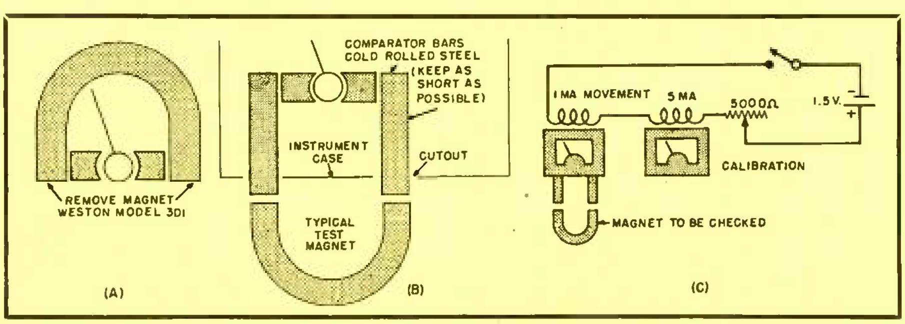
A simple device for comparing the flux in an unknown magnet with that in a standard.

FOR a number of years instruments have existed which will permit magnetic flux densities to be read on a direct reading meter. This means that it is possible to check generators and motors for residual magnetism and for many other magnetic flux determinations to be made. One very practical use for a flux meter is determining to what extent a "charge" has been placed on a magnet after attempting to magnetize it. Applications also include flux measurements of electric instrument magnets, arc blowing chutes, contactor blow-outs, d.c. relays, iron of rotating machinery, voltage regulators, air gaps under pole pieces of rotating machinery, and studies of flux patterns about irregular shaped magnets.

Depending upon the type of instrument, direct readings in Maxwells and Gausses may be obtained or, as in the inexpensive instrument to be discussed here, only magnetic comparison can be made easily.

Three main types of instruments are in use today for measuring flux. The first is the ballistic galvanometer—which today is out of favor, almost completely, as it is very essential that the discharge from the test or search coil be completed before the galvanometer coil begins to move, as well as the necessity of quickly observing the deflection before the galvanometer coil begins to return to zero. The second method—the Sensitive Research Flux Meter—is infinitely better as the search coil may be moved slowly or rapidly through the test area and the pointer will remain at its final deflection. It is essentially a galvanometer movement which has no return springs whatsoever. Naturally when the search coil is removed from the magnetic field the meter is deflected to a certain scale position, due to the electromotive force set up in the search coil. The speed of moving the search coil from the magnetic field has no effect on the scale reading because there is negligible restoring torque. This instrument will measure as low as FIVE lines per square centimeter and as high as 50 MILLION lines per square centimeter with an accuracy of ½ of 1%. This type of instrument operates on the principle that if a closed coil (the exploring search coil) is rotated or moved in a magnetic field, current flows in it owing to the electromotive force produced by the change in magnetic flux linked by the coil. This instrument can be used for many special purposes such as obtaining *BH* curves, determining permeability, measuring flux in a bar or horseshoe magnet, determining the number of turns in an unknown coil, and many other unusual purposes. Another type of instrument, the *General Electric* Gauss Meter, consists of an instrument very similar in appearance to a small D'Arsonval meter. The meter has a probe coming out of the back varying in length from one and a quarter inches to five inches. The probe diameter varies between .052 to .090 inches. The meter is directly calibrated in Gausses from 100 to 5000 Gausses for full scale depending on the meter selected. It is a very useful instrument for production testing of magnets and small magnetic gaps as its tiny probe with small area of sensitivity enables the flux to be

Fig. 2. Steps to follow in rebuilding the 0-1 ma. meter for a flux comparator. (A) The old magnet is removed. (B) Comparator bars are inserted to replace the old magnet. (C) Circuit diagram of the complete comparator.



measured at a single point in the air gap or iron structure. This makes possible a detailed analysis of flux distribution in any magnetic system. It also has the desirable feature of being relatively inexpensive compared to the other instruments mentioned previously. Any one desiring to purchase such an instrument would be wise to bear in mind the use to which it will be put rather than placing the dollar sign as the mark as to which instrument is best. This *General Electric* Gauss Meter is considered an instrument for high level flux measurements. Its operation and design are simple. The instrument consists of a tiny magnet at the end of a probe, which is mechanically connected to a pointer and restraining spring. When the probe is placed in a magnetic field the tiny magnet attempts to align itself with that field and so moves the pointer against the spring action. The amount of the deflection at that point when the magnet is turned to give maximum deflection is a measure of the field being explored. Although the accuracy of this instrument is probably plus or minus 5% it has considerable use for exploring small high intensity fields.

The instrument that the author believes is of possible use to industrial as well as amateur personnel is the Magnetic Flux Comparator. It may be purchased but it is so simple in construction and use that for many applications the instrument diagrammed herein will prove to be more than adequate. Magnetic comparison provides a quick, easy, non-destructive method of inspecting ferrous parts for quality control. Rods, bolts, springs, and small fabricated parts can be compared with pre-selected standards of the same size and shape to detect a difference in composition, heat treating, or other characteristics which alter the magnetic properties. Quality built instruments using a different method than shown here will distinguish between steels whose hardness differs by as little as two points of Rockwell. One very excellent application for this magnetic comparator is determining the magnetic charge of various magnets. It was for this purpose that the author constructed the model shown. In this case the magnets to be used were for Aluminum Drag Cup tachometers. The assembly and disassembly of these tachometers were expensive of time and quite a nuisance. But without a magnetic comparator this was necessary as some magnets took a very high charge and some none at all. Besides this, artificial ageing was desirable to maintain reasonable calibration. With the magnetic comparator as a check numerous uncharged magnets were charged and then discharged by a strong alternating field to a predetermined point. Following this procedure the tachometer assembly was a fast running job with no rejections and consequent disassemblies. The unit described herein consists of a one milliampere D'Arsonval meter and a five milliampere meter. The one milliampere meter had its horseshoe magnet removed and two straight steel bars, replacing the magnet, run out through the instrument case. The bar material should fit snugly against the remaining pole faces. These two meters are installed in an aluminum or wooden case with the two "comparator" bars extending through the case (see photograph). The two meter coils are connected in series and are supplied power thru a 5000 ohm potentiometer, a flashlight cell acting as the power supply. A known magnet is placed against the comparator pole pieces—thus supplying this meter's field strength. The calibration meter's (5.0 milliampere) current is noted when half scale reading is obtained on the Flux Comparator Meter. Substituting the "unknown" magnet will give a deflection in proportion to its magnetic strength, either above or below this point. If full scale occurs the "unknown" magnet has twice the magnetic strength of the known magnet. Other readings can be calculated as easily. If it is desired, a double pole double throw switch can be applied to he Flux Meter to eliminate turning he magnet if it is incorrectly polarized. Another feature is to raise the zero et position of the Flux Meter so that downscale movement can easily be een when incorrect magnetic polarization occurs. Photographs and diagrams ppear in the text of the article.

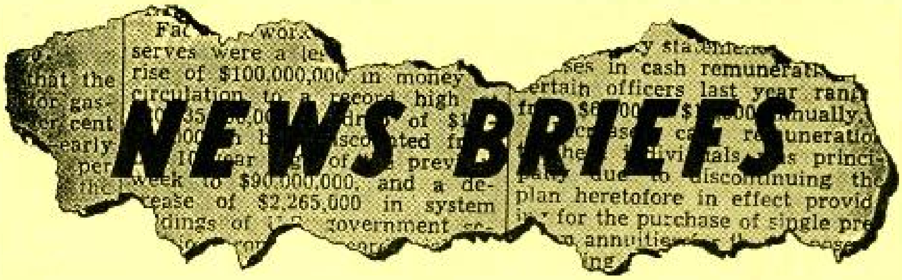
U. H. F. TV Converter

Continued from page 11)

n the antenna tuner is loosened at the et screw allowing the oscillator tuner o remain stationary while the antenna uner is allowed to rotate. A well hielded generator should be used in naking measurements. To reduce radiaion, a trimming condenser is inserted n the mixer output lead. If the leads re not short or making poor contact n both edges of the plate connection, purious oscillations are apt to occur. The range covered by this unit is 520-50 mc. with a 55 megacycle i.f. A N21A is used as mixer.

A circuit diagram for the experimental unit is that shown in Fig. 3A.

A tuner covering the frequency from 60 to 750 mc. (calculated) is now in rocess. These tuners show a great deal f promise for the high band. It appears t present that gaps of 0.010" and .050" will be available at low producion costs.



TV USED IN MEDICAL EDUCATION

A new method of applying television to medical teaching developed by William L. Norvell, manager of *Remington Rand's* television department, was re-

cently demonstrated during the Third Annual Clinical Session of the American Medical Association in Washington, D. C.

With Vericon, a system of closed-circuit television, the visual images of various internal organs of the body can now be televised for group study without resorting to surgery. The system incorporates a special optical link devised by Mr. Norvell and interposed between the eyepiece of a standard gastroscope and the pickup tube of the television camera.

IRE SPRING CONFERENCE

Saturday, April 29th is the date set for the Cincinnati Section of the Institute of Radio Engineers Fourth Annual Spring Technical Conference at the Engineering Society Headquarters in Cincinnati.

The theme of the conference will be "Television" and sessions will be held morning and afternoon and exhibits will be on display. The day's proceedings will be climaxed by a banquet featuring a prominent speaker.

TELREX APPOINTS ENGINEERS

Telrex, Inc., of Asbury Park, New Jersey, has announced three recent appointments to its Engineering Staff. Those appointed are: Dr. H. Giuliani as Chief Chemical and Mechanical Engineer, Mr. Irvin Guttman as Chief Electronics Project Engineer and Sales Engineer, and Mr. Joseph P. Stephanile as Associate Electronics Engineer.

Dr. Giuliani formerly conducted research and development work at the Sheffield Engineering School, Yale University, and will direct many phases of plant development at *Telrex.*

Mr. Guttman was formerly associated with several prominent Electronics engineering firms as well as the U. S. Signal Corps Laboratories in Eatontown and Belmar in various engineering capacities.

Previously engaged in technical and engineering work with several Government installations, Mr. Stephanile joined *Telrex* in June and is conducting experimental work on new equipment.

DR. ULREY RETIRES

Dr. Dayton Ulrey, an early researcher into vacuum tube design and well-known as an administrator and teacher, has

retired as Chief Engineer of the Lancaster, Pa., plant of the *RCA* Tube Department.

Dr. Ulrey's contributions to radio and television research include the development of processes for creating vacuum-tight metal-to-glass seals, the vital principle used in today's metal-coned television picture tubes. He was also responsible for important studies in the production of high vacuum, particularly the absorption and evolution of gases by glass and metals. Dr. Ulrey is shown examining one of the many intricate electron tubes which is the result of his development work.

RCA has announced that Dr. Ulrey will be retained as consultant to the company.

REVISE WWV SERVICES

A new series of technical radio broadcast services over radio stations WWV, Beltsville, Md., and WWVH, Maui, Territory of Hawaii, has been inaugurated by the National Bureau of Standards.

Revised services will not differ greatly from those given in the past, and include: (1) standard radio frequencies of 2.5, 5, 10, 15, 20, 25, 30, and 35 megacycles, (2) time announcements at 5-minute intervals by voice and International Morse code, (3) standard time intervals of 1 second, 4, and 5 minutes, (4) standard audio frequencies of 440 cycles and 600 cycles, (5) radio propagation disturbance warnings by International Morse code consisting of the letters W, U, or N, indicating warning, unstable conditions, or normal, respectively.

Radio station WWVH, recently established in Hawaii, broadcasts on an experimental basis on 5, 10, and 15 megacycles. The program of broadcasts on the three frequencies is essentially the same as that of station WWV.

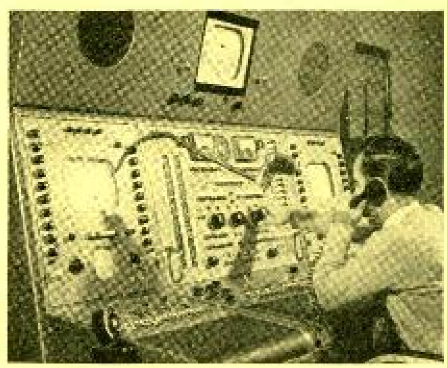
Reports on reception are welcomed, and further information on these services, as well as forms on which to submit such reports, may be obtained on request from the National Bureau of Standards, Washington 25, D. C.

10th ANNIVERSARY FOR WRGB

General Electric's television station WRGB at Schenectady, N. Y., recently celebrated its 10th anniversary which marked the beginning of a new, completely modernized station containing the latest *General Electric* equipment throughout.

The studio has been enlarged to make room for a new master control room which acts as a control center for the entire system and is the distribution point for programs from the local studio, network programs which are brought from New York via the *GE* microwave relay and from the WRGB mobile pickup equipment.

At WRGB's master control panel, Stanley Godell is shown controlling the



quality of the photo being transmitted. This control panel is part of the station's new equipment, including cameras, control and transmitting equipment made at the *General Electric Company's* Electronics Park plant in

Syracuse, N. Y. Installation of the new facilities was completed on the eve of WRGB's 10th anniversary.

TV TUBE PRODUCTION INCREASES

Sylvania Electric Products Inc., New York, is expecting to set a new record in television tube production in 1950. With six television picture tubes per minute now coming off conveyorized production lines, production is now running 3½ times last year's rate.

Photograph shows a cleaning and inside-coating station under a conveyor

in the Ottawa, Ohio, picture-tube plant where both metal and glass tubes are processed side-by-side.

Sylvania's second new plant in Seneca Falls, N. Y., is reported to be near completion and both plants will produce standard and "gray-face" tubes and the new "short" and rectangular-face types.

I.R.E. AWARDS

Announcement has been made of the I.R.E. awards which will be presented at the annual I.R.E. Convention in New York. The awards and recipients are as follows:

Browder J. Thompson Memorial Prize, Joseph F. Hull and Arthur W. Randals.

Editor's Award, E. J. Barlow.

Morris Liebmann Memorial Prize, Otto H. Schade.

Harry Diamond Memorial Award, Andrew V. Haeff.

Medal of Honor, Frederick E. Terman.

In addition to the above, thirty Fellow awards will be presented.

REFLECTION OF RADIO WAVES

A system whereby radio waves are being reflected around a mountain in Pennsylvania has been reported by A. A. Johnson, manager of central station engineering for the *Westinghouse Electric Corporation.*

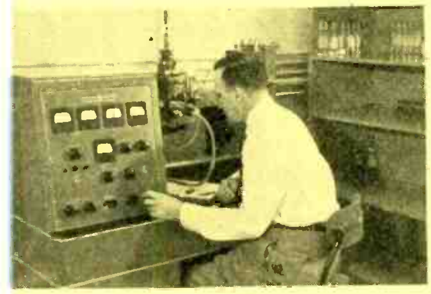
A microwave communication system recently installed between a sub-station and generating plant of the *Pennsylvania Electric Company* at Johnstown has shown the reflection principle to be both efficient and economical.

Since the sub-station and generating plant were 12 miles apart with a large hill between, microwaves were reflected around it. In operation the microwaves are beamed at a large aluminum reflector sheet placed some two miles from the sub-station. This sheet, which measures 20 ft. square, is mounted on a 50-foot tower and is in the "line of sight" of both the sub-station and the generating plant. Microwaves striking this mirror-like reflector are deflected around the side of the mountain to the receiving apparatus.

ELECTRON DIFFRACTION INSTRUMENT

An electron diffraction instrument which can "see" film surfaces as thin as two millionths of an inch is being used in the development of new and improved lubricants and catalysts at the *California Research Corporation* (subsidiary of *Standard Oil Company of California*) at Richmond, California.

The instrument, developed by *General Electric*, is said to be the most sensitive device yet developed for observing chemical and physical changes in extremely thin films. Before development of this equipment, the only means of studying these very thin films was by x-ray dif-
·action or chemical analysis, which ·ıow only one chemical composition. ·lectron diffraction photographs will ·veal a very thin surface layer of an-·her material.



Shown is the *GE* electron diffraction ·ıstrument in use. According to *Cali-·ornia Research* engineers, the electron ·iffraction method permits a truer eval-·ation of surface-active materials, and ·ıay lead to the discovery of new lubri-·ants or lubricant additives. Another ·nportant advantage of this method is ·ıe speed with which the analysis of ·ırfaces and thin films can be made.

·AFEGUARD FOR ATOMIC LABS

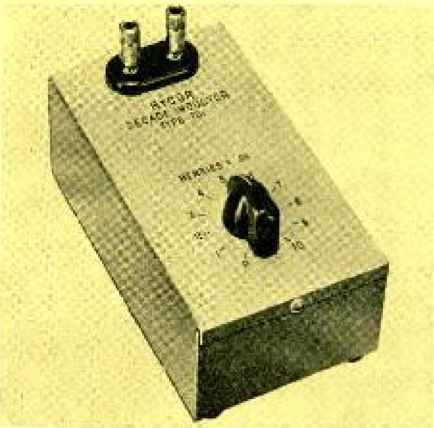
An instrument which measures simul-·aneously the extent of beta and gamma ·ontamination on hands and feet of ·ıose engaged in handling radioactive ·ıaterial, while compensating automat-

(*Continued on page* 29)

NEW PRODUCTS

DECADE-INDUCTOR UNITS

The Hycor Company, 11423 Vanowen St., North Hollywood, California has announced four individual high "Q"



Decade-Inductor units to cover .001, .01, 0.1 and 1 henry steps.

The four units may be connected in series to form a four dial unit covering 11.11 henries in .001 henry steps. High "Q" toroid coils are used throughout to provide the features of high "Q" and low pickup from external fields.

Full information is covered in Bulletin "D" which may be obtained upon request from the manufacturer.

PREDETERMINED ELECTRONIC COUNTER

A high-speed predetermined electronic counter which will count at rates up to 60,000 per minute with absolute accuracy and will reset instantaneously without missing a count is now avail-

able from the *Potter Instrument Co. Inc.*, 136-56 Roosevelt Ave., Flushing, N. Y.

The Model 133 Three-Decade Predetermined Electronic Counter shown will predetermine any count from 1 to 999 continuously and provide a high-speed relay action each time the selected predetermined count is reached. Other models having capacities of 2, 3, 4, 5 and 6 digits are available.

I.F. COMPONENTS

Seven new picture i.f. components giving improved sensitivity, selectivity, and response have been announced by *RCA*'s Tube Department, Harrison, N. J.

These new components are: Converter Transformer, Type 202K5; 1st Picture I.F. Transformer, Type 202K6; 2nd Picture I.F. Transformer, Type 202K7; 3rd Picture I.F. Transformer, Type 202K8; 4th Picture I.F. Transformer, Type 202K9; 5th Picture I. F. Transformer, Type 202K10; and cathode-circuit trap, Type 202K11.

The use of a link-coupled, double-tuned circuit between the converter

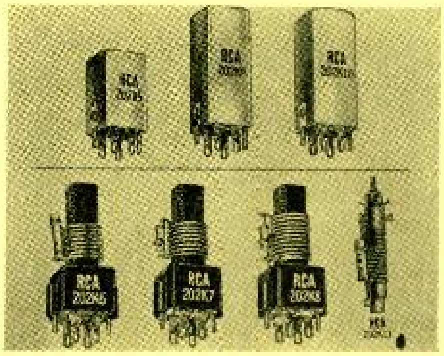


plate and the grid of the 1st i.f. tube increases the sensitivity of the system. These compact components are designed for a sound i.f. carrier of 21.25 megacycles and a picture i.f. carrier of 25.75 megacycles.

DETECTOR RECORDS MINUTE CURRENTS

The Brown Instruments division of the *Minneapolis-Honeywell Regulator Company*, Minneapolis, Minnesota, has designed the Brown electrometer to measure and record very small currents like those developed in an ionization chamber as a result of radiation.

According to reports, the instrument has great possibilities for helping diagnosticians in the medical profession. When isotopes are injected into a person, this measuring instrument could be used to trace the course of the isotopes by detecting the location of the isotope rays. It is capable of measuring to 100 millionths of a millionth of an ampere.

A single instrument without any alteration has a hundred-fold variation in currents which it will measure by means of a range-changing switch.

RADIOACTIVITY DEMONSTRATOR

A radioactivity demonstrator for science instruction which is safe and simple to operate for use in high schools

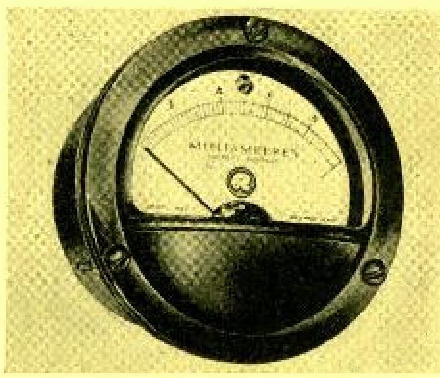
and colleges, has been produced by the *Nuclear Instrument and Chemical Corporation*, 223 West Erie St., Chicago 10, Illinois.

The Model 1613 Demonstrator consists of the basic counting instrument which gives a visible, neon tube flash and an audible "click" indicating each disintegration, and an easy-to-read meter shows the amount of radioactivity. A twenty-eight page manual which describes and explains graphically how to use the accessories in the complete setup is included.

PANEL INSTRUMENTS

The Marion Electrical Instrument Co., of Manchester, N. H. is announcing their new Ruggedized line of electrical meters said to meet performance requirements heretofore unattainable by conventional panel instruments.

Included in these performance requirements are high shock testing with



the Ruggedized meter mounted firmly to panels and subjected to 2,000 foot pound blows in each of three orientations with respect to direction of applied blows; extremely severe vibration for six hour periods; and tumble testing in a large compartmented tumbling barrel for one hour.

Detailed information regarding the meter and its performance may be obtained in a new booklet by writing direct to the manufacturer.

HIGH-SPEED D.C. RELAY

Stevens-Arnold Inc., 22 Elkins St., South Boston 27, Mass., is now offering its Millisec Relay in 6-pole, double-throw construction. Previously these relays had been made in two sizes only.

The advance from two poles to six poles was made possible by the availability of a 20-pin, hermetically sealed header and a 20-pin octal socket. This relay is claimed to have an operating time as short as 1/3 millisecond.

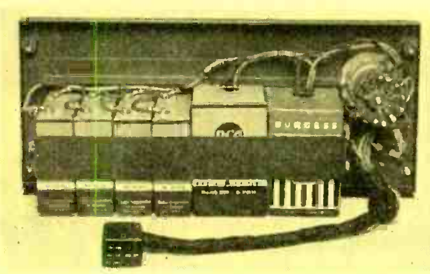
Contact rating is 110 volts d.c., ½

ampere. The life expectancy varies from 22 million operations at ½ ampere to 100 million operations at ¼ ampere. Coils are wound for d.c. only.

KIT FOR BROADCASTERS

RCA Engineering Products Department, Camden, N. J., has designed a convenient kit which permits easy conversion from a.c. to battery operation for their Type BN-2A remote amplifier and eliminates carrying standard "A" and "B" batteries in a separate battery case.

This new battery-container and cover,

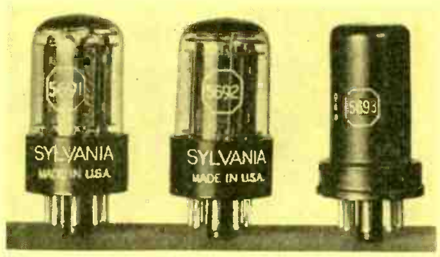


which can be mounted on the unit in place of the usual top cover, contains an a.c. receptacle, a switch to select a.c. or battery operation, and a clamp for holding two 6-volt "A" batteries and four 67½-volt "B" batteries.

This battery pack will supply power for the remote amplifier for 1½ to 2 hours of continuous operation.

ELECTRON TUBES

Available now for distribution by *Sylvania Electric Products Inc.*, New



York, N. Y. are three new electron tubes suitable for a wide range of industrial services where dependable operation and a service life up to 10,000 hours is required.

The three types include 5691, a high-mu twin triode recommended for voltage amplifier use and supplied with series-unit heaters; 5692, a medium-mu twin triode with series-unit heaters suitable for balanced d.c. amplifier, multivibrator, blocking oscillator and resistance coupled amplifier applications; and 5693, a sharp cut-off pentode designed particularly for high-gain resistance coupled amplifier service. The 5693 may be operated with number 1 grid resistance values up to 40 megohms.

DIELECTRIC HEATER

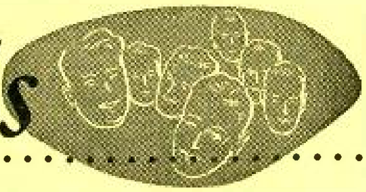
A pre-form heater which is automatic, portable, and built for long and

dependable service in pre-heating, drying, sealing and processing plastics, rubbers, and other dielectric materials has been announced by the *High Frequency Heating Company*, 143 Glen Park Avenue, Gary, Indiana.

The new HFH 1.5 AH Dielectric Heater is a bench machine operated by a pushbutton or foot switch. For preforming, one or several large or small "pills" are placed on a loading

(*Continued on page* 30)

Personals



CLARENCE G. FELIX has been appointed Assistant to the General Manager of the *Crosley Division, Avco Manufacturing Corporation*, Cincinnati, Ohio. Beginning in the engineering department 22 years ago, Mr. Felix was named product manager of Government radio during *Crosley's* full-time war production in 1941 and later became manager of all Government products. He is a native Cincinnatian and attended the University of Cincinnati.

NORMAN L. HARVEY, formerly head of the Applied Research Branch of the Physics Laboratory of *Sylvania Electric Products Inc.*, Bayside, N. Y., has been appointed director of engineering at *Colonial Radio Corporation.* During the war, Mr. Harvey served actively in research and development on proximity fuzes, airborne electronics, and advanced types of radar equipment. He is a senior member of the IRE and associate member of the AIEE.

DR. CUTHBERT C. HURD has been appointed director of *International Business Machines Corporation's* Applied Science Department. Prior to joining *IBM* in March, 1949, Dr. Hurd was a research head at Oak Ridge, Tenn. Dr. Hurd, author of two books and several papers on mathematics and on educational philosophy, holds degrees from Drake University, Iowa State College, and the University of Illinois.

REAR ADMIRAL WALTER S. MACAULAY has been appointed assistant executive engineer in the Knolls Atomic Power Laboratory being operated for the Atomic Energy Commission as part of *General Electric's* Research Laboratory. Admiral Macaulay was formerly on the assistant General Manager's staff of the Nucleonics Department. He is a graduate from the U. S. Naval Academy and received his M.S.E.E. at Columbia University.

J. E. PAYNE has been appointed Manager of the *Westinghouse Electric Corporation's* Central District and will supervise their apparatus business in Cleveland, Detroit, and Cincinnati and will make his headquarters in Pittsburgh. A graduate from the Alabama Polytechnic Institute as an honor student with a degree of Bachelor of Science in electrical engineering, Mr. Payne has been with *Westinghouse* since 1925.

C. A. PUTNAM, president of the *Markem Machine Company* of Keene, N. H., is now President of the National Association of Manufacturers. Several years ago, Mr. Putnam joined the *Markem Company*, makers of the power-driven marking and identifying devices used by radio, television and electronic equipment manufacturers, as the company's sales engineer, traveling in the United States and Europe. In 1929 he became the company's president.

Strain Gauge Link

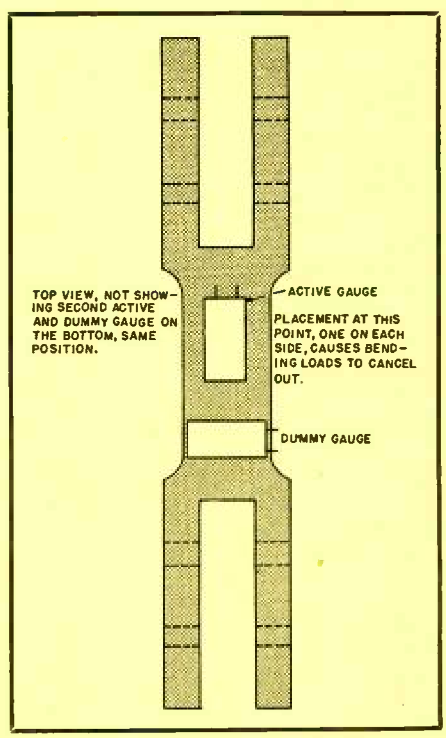
(*Continued from page 9*)

The two active strain gauges should be mounted as indicated on the photograph and drawing, on the sides subjected to any bending load. The dummy gauges are then mounted crosswise, 90 degrees from the bending plane. With the active gauges wired as indicated, any bending load will cancel out. The installation of these gauges is made per the instructions and bulletins issued by the *Baldwin Locomotive Company.* Bulletin 279B in particular gives complete step by step instructions for applying strain gauges. Roughly, the gauges are cemented in place with special glue after the surface has been degreased.

Voltage regulated power supplies may be used with such equipment. If so there will be no need for the bridge voltage regulating rheostat. The bridge accuracy will, however, be directly proportional to the regulation of the power supply.

The description of the above equipment stems from the design and use of similar equipment at a prominent west coast aircraft plant for the measurements of loads on special devices. Hydraulic loads were being used, but it was felt that the pressure gauges used in conjunction with the hydraulic cylinders were not always indicating true loads, especially when the fluid movement was at a high rate. Where the gauge could have been tapped directly into the cylinder this doubt would not

Fig. 6. Drawing showing location of active and inactive gauges.



have occurred. Calibration tests of a special jig, using the strain gauge link, did show up serious errors in the hydraulic load computations, but only as suspected at high flow rates. A restriction existed between the gauge and the cylinder through the smallest of the cylinder outlet connections and the connecting hose. This back pressure on the cylinder became much higher than the line pressure could indicate, as the cylinder piston was forced down rapidly.

The strain gauge link operating directly from the mover can indicate true load, whereas other devices such as hydraulic cylinders and gauges may not indicate binding loads in the cylinder, jig, or other associated equipment.

Crystal Savers

(*Continued from page* 13)

A circuit of the direct synthesis type, adapted to the 75 meter amateur band, is illustrated in Fig. 3. A 100 kilocycle crystal oscillator is used to develop the primary signal. This is applied to a frequency divider, the output of which is at 10 kilocycles. The latter is in turn multiplied so that harmonics at 10, 20, 30, 40, 50, 60, 70, 80, and 90 kilocycles may be obtained at will. These harmonics are selected by means of a switch and mixed with the original 100 kilocycle signal, producing an output every 10 kilocycles from 100 to 190 kilocycles.

The 100-190 kilocycle signal is then mixed with another signal at either 3700 or 3800 kilocycles to produce an output every 10 kilocycles from 3800 to 3990 kilocycles. The 3.7 and 3.8 megacycle signals may be obtained from harmonics of the basic oscillator or by means of auxiliary crystal oscillators. The latter is probably the most economical method for the amateur or experimenter since a distorter, an amplifier and associated tuned circuits will be required to derive them from the 100 kilocycle oscillator.

By increasing the complexity of the circuit somewhat, outputs may be obtained every 10 kilocycles starting at 3805 kilocycles instead of 3800. Adaptations can also readily be made for other frequencies and other amateur bands. The main thing to watch in any of these crystal savers is the production of spurious signals. Since several mixers and harmonic amplifiers are used in any of them, such unwanted responses are easy to obtain and sometimes difficult to eliminate.

Frequency synthesis should be welcomed by those amateurs who demand the stability of crystal oscillators but at the same time wish a certain degree of flexibility not economically attainable with the usual methods of crystal control.

Standing Wave Det.

(*Continued from page* 6)

phase of the reflection coefficient in a wave guide transmission line system, in practice it has such additional uses as:

1. To measure effect of discontinuities in any wave guide equipment.

2. To determine rectification characteristics of a crystal, bolometer or other type of detector or rectifier.

3. To measure directivity of directional couplers.

4. To calibrate fixed and variable attenuators.

5. For simple rapid quantity testing of standard wave guide component production.

6. For measurement of normalized impedances.

7. To predetermine and experimentally check position and dimensions of matching irises and stubs. This may be expanded to include any constriction existing or developing in a wave guide.

Measurements are obtained in terms of reflection coefficient K or Voltage Standing Wave Ratio (VSWR). The relationship between these values is as follows:

$$K = \frac{\text{VSWR} - 1}{\text{VSWR} + 1}$$

In the case of interpretations of the results in terms of normalized impedance, reference is made to a standard impedance chart such as the Smith chart used in advanced research and development.

In measuring reflection coefficients, the signal generator should be as stable as possible and the probe should disturb the fields in the wave guide the least possible amount. The use of an attenuator of not less than 20 db. prevents the tube (signal generator) from being affected by changes of the impedance for a component under test. The probe will least disturb the fields in the slotted wave guide if minimum probe depth consistent with the sensitivity of the output measuring equipment is employed. This is the reason for tuning the coaxial structure connected with the probe. It can thus be kept small without decreasing the sensitivity.

Since little power is available at the output terminal (coaxial cable connection), particularly with the use of an attenuator in the test setup, it necessitates sensitive measuring equipment. This may be provided in the form of either:

1. Use of an audio frequency amplifier and modulating the signal generator by means of a square wave separately generated. A square wave should be used instead of a sine wave in order to avoid FM behavior.

2. The use of a sensitive galvanometer (not over .001 microampere/mm of scale deflection on a 10 cm. scale) and c.w. conditions in the oscillator.

Microwave Trans.

(*Continued from page* 18)

mode in a wave guide is undesirable as it results in impedance mismatches for the various modes; reflection and generation of spurious frequencies; and an over-all loss in power. It is therefore necessary to select the physical dimensions of the guide so that only the desired mode can be propagated.

For the propagation of a $TE_{1,0}$ mode the "*a*" dimension of the guide should be such as to fall between $\lambda/2$ and λ. This can best be understood by working out a simple problem. A wave guide must be designed for the propagation of a $TE_{1,0}$ mode at 3000 mc. ($\lambda = 10$ cm.) with maximum efficiency. The dimension of the guide at the cut-off frequency of 3000 mc. would be:

$$3 \times 10^9 = \frac{3 \times 10^{10}}{2x} \text{ ; } x = 5 \text{ cm.} \quad . \quad . \quad (21)$$

However, we do not want to use a guide

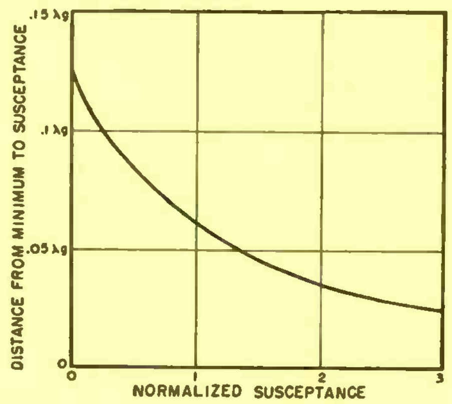


Fig. 14. Plot of the distance from minimum to susceptance (d_1) vs. the normalized susceptance (B).

with this dimension since the attenuation is high. With $a = 5$ cm., the cut-off frequency of the next highest mode, $TE_{2,0}$ is:

$$f_c = \frac{3 \times 10^{10}}{5} = 6000 \text{ mc.} \quad . \quad . \quad . \quad . \quad (22)$$

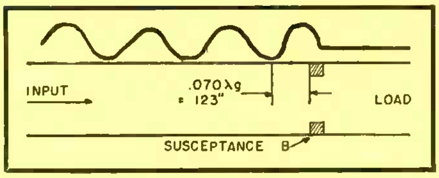


Fig. 15. Use of susceptance B to match load to wave guide.

and this mode will therefore not be propagated for $a = 5$ cm. and $f = 3000$ mc. However, if we increase the "a" dimension to 10 cm., then the cut-off frequency of the $TE_{2,0}$ mode would be 3000 mc., and this mode could propagate. We therefore choose a width which is some point between $a = 5$ cm. and $a = 10$ cm. For minimum attenuation this point should be as close to 10 cm. as possible, consistent with bandwidth requirements and allowing a safe margin.

The "b" dimension is subject to a compromise on many points. It must be small enough to eliminate the propagation of "n" modes. It is made as large as possible to minimize attenuation and increase power handling capability. In practice the ratio of b to a is kept to about 0.5.

Standard sized wave guides are available to meet virtually every application. Table I lists the standard sizes together with their wavelength range, attenuation factors, and Army-Navy type numbers.

Impedance Matching in Wave Guides

The principles outlined previously for matching coaxial lines apply also to wave guides. Any obstruction placed in the guide will cause reflection of some of the energy, setting up standing waves. Thus in effect such an obstruction can be considered to be an impedance and since, in general, it cannot absorb energy, it will be in the form of an inductive or capacitive reactance. The impedance of such an obstruction can be determined by measuring the magnitude and phase of the incident and reflected waves and introducing these values in Eqt. (3).

In order to do this it is necessay to know the characteristic impedance of the guide. The characteristic impedance of wave guides has been variously defined, and the parameter used in matching problems is frequently called the "specific wave impedance." This impedance is:

$$Z_{TE} = \sqrt{\frac{\mu_1}{k_1}} \times 377 \frac{\lambda_g}{\lambda} = 377 \frac{\lambda_g}{\lambda} \text{ for air (TE waves)} \quad (23a)$$

$$Z_{TM} = \sqrt{\frac{\mu_1}{k_1}} \times 377 \frac{\lambda}{\lambda_g} = 377 \frac{\lambda}{\lambda_g} \text{ for air (TM waves)} \quad (23b)$$

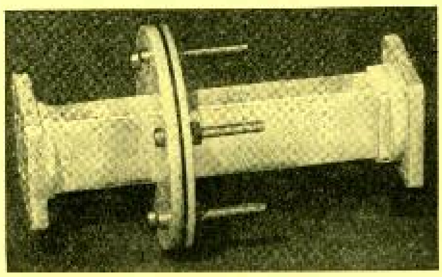


Fig. 16. One method of connecting two wave guides together.

The value of Z_0 obtained from these equations is used for normalizing load equations. (An equation is "normalized" by dividing through by Z_0, for example, the normalized version of $R + jX$ is $R/Z_0 + jX/Z_0$). In wave guide matching it is more convenient to use admittances, rather than impedances, and the normalized input admittance, Y, to a matched line is represented by $Y = 1 + jB$, where B is the normalized susceptance of the reflecting element. This element may be the load or a matching element simulating an inductance or capacitance.

The following procedure is used to match wave guides. Consider the system illustrated in Fig. 15. The wave guide is connected to the load and it is found that a certain standing wave ratio (voltage) exists. A susceptance B must be placed in the guide which is equal to:

$$B = \frac{\eta_v^{1/2} - 1}{\eta_v^{1/4}} \quad (24)$$

Then to match the load to the line impedance, it should be placed at a position determined by:

$$d_1 = \frac{90 - \tan^{-1}\left|\frac{B}{2}\right|}{720} \lambda_g \quad (25)$$

where d_1 is the distance between the reflecting element and a voltage minimum. If the reflecting element is inductive (B is negative) it should be placed at a distance d_1 on the load side of a minimum, while if capacitive it should be placed at a distance d_1 on the generator side of a minimum. The distance d_1 is plotted against B in Fig. 14.

As a typical example of impedance matching with a reflecting element, consider a 1" x ½" rectangular guide with $\lambda = 3.2$ cm. feeding a load that gives a standing wave ratio of 5 to 1 in the guide. With the chosen wave guide and wavelength, the wavelength in the guide is $\lambda_g = 1.764''$ *and* $\lambda_g/a = .96$. It is desired to correct this mismatch with a reflecting element.

1. From Eqt. (24) the susceptance B must be equal to 0.82.

2. From Fig. 14 this susceptance should be located at a distance $d_1 = .070\ \lambda_g = .123''$ toward the load (B is negative) from a voltage minimum. For minimum frequency sensitivity the susceptance (usually in the form of a window) should be placed as near the load as possible, yet not so near that there will be interaction of the higher modes.

In this latter section as well as in the section dealing with matching of coaxial lines, the use of matching elements has been discussed, but the details of how to design such elements have not been covered. This subject will be covered in the next article in this series entitled "Microwave Components" which has been tentatively scheduled for the April issue of RADIO-ELECTRONIC ENGINEERING.

Table I. List of standard wave guides and connectors.

Dimensions inches	Army-Navy type number	Cutoff wavelength cm.	Usable wavelength range for $TE_{1,0}$ (cm.)	Connectors		Attenuation in brass db./ft.
				choke	flange	
1½ x 3 x 0.081 wall	RG-48/U	14.4	7.6-11.8	UG-54/U	UG-53/U	0.012 @ 10 cm.
1 x 2 x 0.064 wall	RG-49/U	9.5	5.15-7.6	UG-148/U	UG-149/U	0.021 @ 6 cm.
¾ x 1½ x 0.064 wall	RG-50/U	6.97	3.66-5.15	UG-150/U	contact type	0.036 @ 5 cm.
⅝ x 1¼ x 0.064 wall	RG-51/U	5.7	3.0-4.26	UG-52/U	UG-51/U	0.50 @ 3.6 cm.
½ x 1 x 0.050 wall	RG-52/U	4.57	2.4-3.66	UG-40/U	UG-39/U	0.076 @ 3.2 cm.

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TECHNICAL BOOKS

"RADIO-FREQUENCY HEATING EQUIPMENT" by L. L. Langton. Published by *Pitman Publishing Corp.*, 2 West 45th Street, New York, N. Y. 196 pages. $3.75.

This volume deals mainly with the generation and transfer of radio-frequency power in a manner suited to the needs of those having interest in radio-frequency heating. The design of equipment for radio-frequency heating is also presented with some applications of the technique. Reasons underlying the advantages gained by using the technique in these applications are fully discussed.

It is not intended that this volume should be regarded as a handbook, and the application of the technique is treated in only a broad manner in Chapters 9 and 10.

Equations of a somewhat unfamiliar nature will be found in the book as the author has not given a full derivation of such expressions. However, the reader should have little difficulty in developing these expresions from a study of the earlier mathematics in the relevant chapters and with the assistance of Appendix 1.

Of special interest to readers having a second or third year knowledge of electrical or radio engineering, is the Design Section. Users as well as designers of such equipment will find this book of valuable assistance.

The author has suggested that this entire volume be read thoroughly before the reader returns to those particular chapters which are of interest to him.

"TERRESTRIAL RADIO WAVES" by H. Bremmer. Published by *Elsevier Publishing Co. Inc.*, 215 Fourth Avenue, New York 3, N. Y.

The initial form of this book was written during the war years as a continuation of the work initiated by Professor Van der Pol and the author on the propagation of radio waves. The considerable amount of work in this field published since then made a revision of this work desirable.

It presents the treatment of mathematical-physical methods for the computation of transmitter fields and describes how the electromagnetic field of a radio transmitter can be computed taking into account the curvature of the earth's surface.

The first part of this book deals with the theory relating to a homogenous atmosphere which concerns only that part of the field which is independent of the ionosphere. The theory is then extended for an inhomogenous atmosphere in the second part.

News Briefs

(*Continued from page* 23)

ically for background radiation, has been developed by the *RCA* Engineering Products Department.

Designed by *RCA* under the Atomic Energy Commission's program to safeguard those engaged in atomic work, the instrument is designated the EMA-2B Hand and Foot Monitor. It consists of a platform flanked by two posts designed for installation in a passageway where workers leaving the radioactive area must pass through the aperture, and a control cabinet which may be installed in any out-of-the-way space that is free from contamination and excessive vibration.

SYNTHETIC MICA

As part of a broad program of fundamental research on fluorine-type artificial minerals carried on by the National Bureau of Standards, Dr. Herbert Insley, Alvin Van Valkenburg, and Robert Pike have successfully crystallized synthetic mica. Under the sponsorship of the Office of Naval Research, the synthetic mica phase of the program has been carried out in cooperation with the U. S. Bureau of Mines and the Colorado School of Mines.

Because of the extremely high pressures as well as high temperatures involved in duplicating the conditions under which mica is formed in nature, the Bureau's scientists are using fluorine as a crystallizing agent to grow crystals of mica without using high pressure. Although natural fluorine is a gas, poisonous and difficult to control, a group of synthetic fluorine compounds, the fluorosilicates, provides a convenient way of introducing fluorine into mica synthesis.

Photograph shows flakes of the synthetic mica being examined under a binocular microscope to locate any structural defects. Impurities, gas bubbles, faulty orientation, and incomplete crystallization are revealed by this method. Clear crystals are selected for further analysis.

ATOMIC WASTE RESEARCH

New York University College of Engineering, through its Research Division, is currently actively engaged in a project sponsored by the Atomic Energy Commission which seeks to find solutions for problems concerned with atomic energy wastes.

Research assistant, Werner N. Grune, is shown removing a radioactive specimen from its lead container with a set of tongs in Carpenter Sanitary Engineering Laboratory at University Heights.

MEASURING DEVICE

A new measuring machine which will select in sequence the quantities to be measured, make the measurement, transmit these readings as far as desired, and record them in numerical form properly tabulated was recently described at the Winter General Meeting of the AIEE.

The machine was described in a technical paper entitled "The Metrotype System of Digital Recording and Telemetering" presented by G. E. Foster of the *Metrotype Corporation.* In describing *Metrotype* recording, Mr. Foster stated that the machine combines the electronic computer technique with that of the printing telegraph and records data by means of "log sheets."

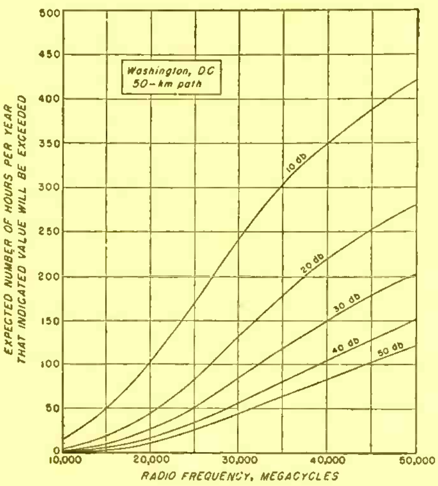
DAYTON IRE PICKS COMMITTEE

The board of directors of the Dayton Section of the Institute of Radio Engineers has announced the members of the executive committee in charge of the 1950 Dayton IRE Technical Conference to be held May 3, 4, and 5.

George Rappaport was named President, Harold V. Noble, Vice President, Gerald C. Schutz, Secretary, and Gilbert H. Arenstien, Treasurer. Chairmen appointed are as follows: Edward P. Spandau, Arrangements Committee, Paul G. Weigert, Exhibits Committee, Emanuel A. Blasi, Program Committee, Albert O. Behnke, Publicity Committee, and Mary Wheeler, Ladies Program Committee. Chairmen for the publications and registration Committees have not yet been announced.

ATTENUATION STATISTICS

Annual probability curves for the expected duration and magnitude of atmospheric attenuation at microwave frequencies for both one-kilometer and 50-kilometer path lengths have now been obtained by Howard E. Bussey at the National Bureau of Standards.



These attenuation statistics have been derived from meteorological records, using accepted theoretical and experimental coefficients for converting rainfall values into radio attentuation values.

Microwave radio signals decrease in intensity as they travel through the earth's atmosphere because of absorption and scattering by oxygen, water vapor, or precipitation. The attenuation increases sharply for microwave frequencies above 10,000 megacycles, and quantitative information on this effect is important in the selection and allocation of microwave radio frequencies.

The curves shown here give the expected number of hours per year that microwaves propagated over a 50-kilometer path near Washington, D.C., will experience rainfall resulting in attenuation values of 10, 20, 30, 40, or 50 decibels in the microwave frequency range from 10,000 to 50,000 megacycles.

DIGITAL COMPUTER MANUFACTURING

Dr. Samuel Lubkin, formerly consultant to the National Bureau of Standards on mathematical, logical and engineering phases of electronic digital computers, has announced the formation of *The Electronic Computer Corporation* with offices and plant at 265 Butler St., Brooklyn, New York.

Headed by Dr. Lubkin, the new company is prepared to build electronic digital computers capable of multiplying two thirteen decimal digit numbers and obtaining an answer correct to twenty-six digits in three one-thousandths of a second.

The first practical machine of this type was the ENIAC completed at the Moore School of Electrical Engineering and now engaged in the solution of problems at the Ballistics Research Laboratories. The most recent one is the Mark III Computer built at Harvard University and unveiled a few months ago.

New Products

(*Continued from page* 25)

tray that slides into the heater. Heating is automatically started and continues for the pre-set time cycle.

The basic heater (less tray) also supplies high frequency energy to bar sealers, electronic ovens, special fixtures, and laboratory apparatus.

16" PICTURE TUBE

RCA's Tube Department, Harrison, N. J., has announced the 16GP4, a short, directly viewed, 16" picture tube of

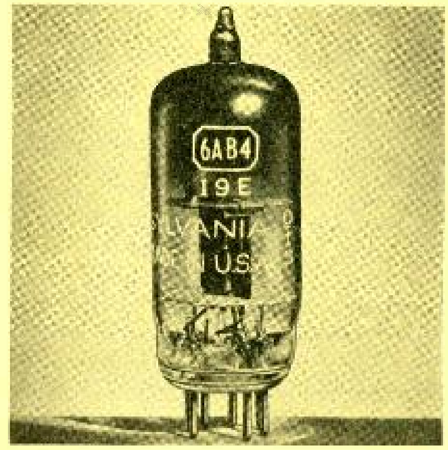
the metal-cone type for use in television receivers designed for it. A rounded-end picture 11" x 14⅝" is obtained by utilizing the full-screen diameter.

Having a maximum over-all length essentially 5 inches shorter than the 16AP4, the new wide-angle 16GP4 offers designers of television receivers greater flexibility in chassis design and cabinet styling, and makes possible greater compactness. In addition, the 16GP4 permits economies in tube stocking.

The comparatively flat face of the 16GP4 is made of "filterglass" to provide increased picture contrast particularly in a lighted room. The new design of cone-to-neck section makes possible the design of a longer and more efficient yoke than would otherwise be practical. Other outstanding features include an ion-trap gun which requires only a single-field magnet, and a duodecal 5-pin base which permits the use of a lower-cost segment socket.

MINIATURE TRIODE

A miniature triode, Type 6AB4, suitable for use as a grounded-grid r.f. amplifier, frequency converter, or oscil-



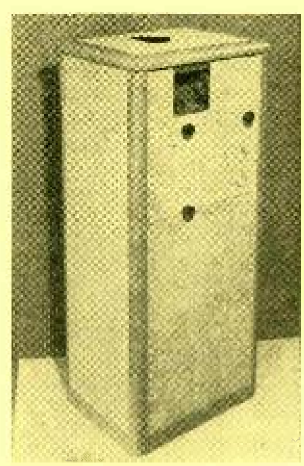
lator at frequencies below 300 megacycles is now available through distributors for *Sylvania Electric Products, Inc.*, 500 Fifth Avenue, New York 18, N. Y.

Frequency range of the 6AB4 makes it applicable for use in currently allocated television bands. High frequency performance is comparable to that of types 6C4, 6J6 and 7F8. It is supplied with a 6.3 volt, 150 milliampere heater.

VIEWER FOR STYLUS POINT

Tape Recording Apparatus Company, Box 221, Caldwell, N. J., has developed the Shadowgraph which will give a 500 times magnified view of the two cross-sectional profiles of the stylus point.

Other features include a perfect reproducing stylus curve as a comparison, a shaded screen for viewing, and a simple straight-forward focusing system



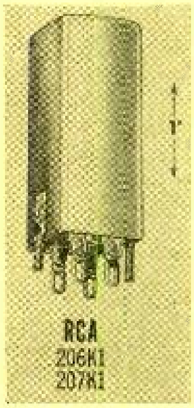
which allows movement of the stylus in three planes. The instrument is enclosed in a leather-finished tempered masonite case and occupies only 12½" x 15" of floor space.

Additional information may be obtained by writing the company direct.

TV COMPONENTS

Two new components for television receivers have recently been offered to equipment manufacturers by the Tube Department of the *Radio Corporation of America,* Harrison, N. J.

The first of these new components is a sound-i.f. transformer Type 206K1 designed to operate at 21.25 megacycles per second with the miniature sharp-cutoff pentode 6AU6 as sound-i.f. amplifier tube. It is capable of providing a voltage gain of about 35 times between the grid of one sound-i.f. tube and the grid of the following sound-i.f. tube.

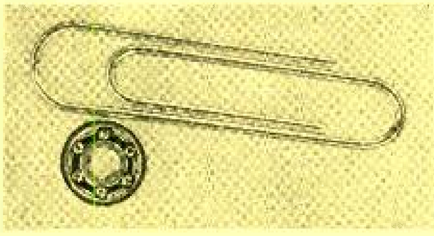


The second component, a sound-discriminator transformer Type 207K1, is designed for use between the last sound-i.f. stage utilizing a 6AU6 tube and the sound-discriminator stage employing the miniature twin diode 6AL5. This transformer can provide 0.08 volt of audio output for each kilocycle of frequency deviation from its operating frequency of 21.25 megacycles per second, when a 1-volt signal is applied to the grid of the last sound-i.f. amplifier tube.

With these two components, a sound-i.f. amplifier and discriminator can be designed to give an audio-voltage output which is linear up to a bandwidth of 150 kilocycles and usable up to 300 kilocycles.

BALL BEARING

A Micro Ball Bearing reported to represent a 33% reduction in size from the smallest of its type previously available in this country has been developed by *New Hampshire Ball Bearings, Inc.,* of Peterborough, N. H.

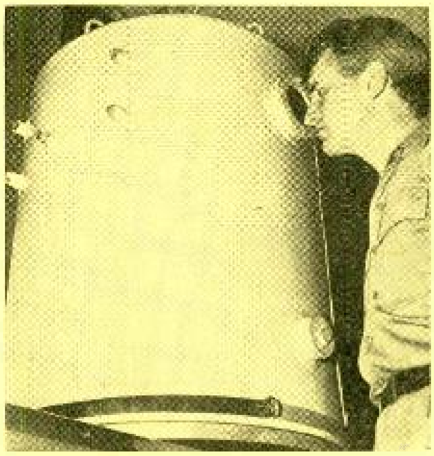


The bearing is fully ground, consistent with precision bearing practice, measuring ¼" outside diameter by 3/32" wide, with a bore diameter of 5/64", both diameters being held to tolerances plus zero, minus .0002" from the nominal.

Immediate uses of this bearing are reported to be chiefly in the fields of instrumentation and control, particularly in widely used "Synchro" and "Servo" devices.

HIGH VACUUM CHAMBER

Pacific Universal Products Corporation, 168 Vista Avenue, Pasadena 8, California is now offering a new and larger high vacuum chamber for the vacuum evaporation of metals and dielectrics.



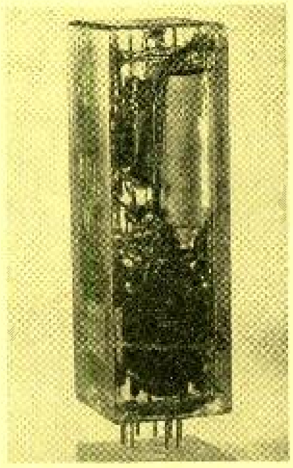
Front surface mirrors, one of the products of the new equipment, are in increasing demand in nuclear work as periscopes, for viewing radioactive processing, in television projection systems, for viewing large screen picture tubes mounted vertically, and for countless mirror applications in electrical and optical instruments.

Bob Frazer, Chief Engineer of *Pacific Universal Products,* is shown supervising the equipment's initial tests. Engineers confronted with problems which lend themselves to high vacuum treatment are invited to communicate with the company.

CASTING RESIN

A casting resin designed specifically for encapsulating subminiature electronic circuits has been developed by *Melpar, Inc.,* 452 Swann Ave., Alexandria, Virginia.

Melpak IV is recommended by the manufacturers for audio or video applications where size, weight, temperature, moisture, or rough handling is a problem. Especially noteworthy is the wide temperature range of the resin which is −85°F (ambient) to +320°F (hotspot). Further information on this and other Melpak resins will be supplied upon request.



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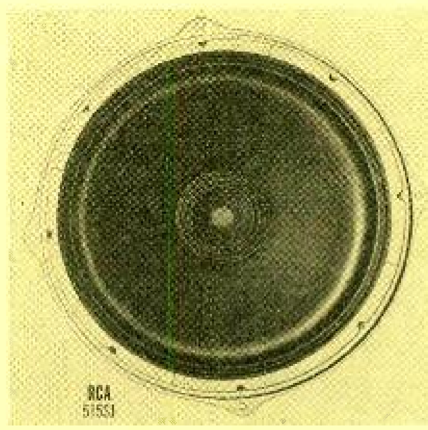
15, 17, 18, 28..Carl W. Schutter Co.

HIGH-FIDELITY SPEAKER

The Tube Department of the *Radio Corporation of America,* Harrison, N. J. has announced the 15-inch, duo-cone, high-fidelity speaker, RCA-515S1, designed to provide exceptionally fine tonal reproduction. It is particularly suited for high-quality radio and television receivers, low-distortion reproducing systems, and broadcast station monitoring applications.



The 515S1 speaker employs a unique magnet structure and vibrating system consisting of a dual cone, each section of which is driven by its own voice coil operating within its own air gap. The two cone-sections are mounted in a single housing and vibrate as a single cone over the range of cross-over frequencies centered at 2000 cycles per second.

$TE_{0,1}$ WAVES IN RECTANGULAR WAVE GUIDES

Nomograph for determining wavelength and group velocity in a guide, knowing free-space wavelength and guide width.

In a rectangular wave guide for a $TE_{0,1}$ wave (transverse electric), the electric vectors are parallel to one side of the guide; the width dimension is measured at right angles to the electric vector. The wavelength within the guide and the group velocity are determined by the following equations:

$$\frac{\text{Group Velocity}}{\text{Velocity of Light}} = \sqrt{1 - (\lambda/2b)^2}$$

$$\frac{\text{Wavelength in Guide}}{\text{Wavelength in Free Space}} = \frac{\text{Phase Velocity}}{\text{Velocity of Light}}$$

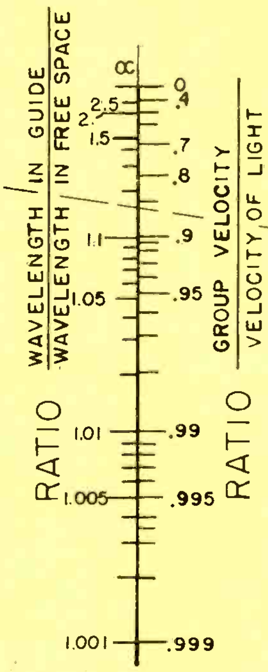
$$= 1/\sqrt{1 - (\lambda/2b)^2}$$

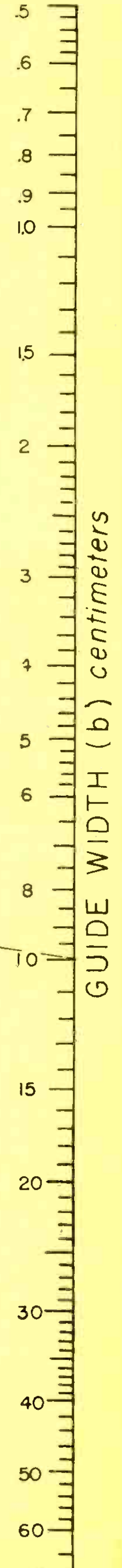
where λ = wavelength in free space in centimeters
b = width of the guide in centimeters

Example: A rectangular wave guide with a width of 10 centimeters has a radio-frequency wave of 10 centimeters (free space wavelength) fed into it. A straight line connecting 10 on the GUIDE WIDTH scale with 10 on the WAVELENGTH IN FREE SPACE scale will intersect the RATIO scales

at $\frac{\text{Wavelength in Guide}}{\text{Wavelength in Free Space}} = 1.15$

and $\frac{\text{Group Velocity}}{\text{Velocity of Light}} = .866$





Courtesy of Federal Telephone and Radio Corporation.

YOU Need My PRACTICAL Training to Make Money in TELEVISION-RADIO and ELECTRONICS!

Learn at **HOME** IN YOUR SPARE TIME

I'll Send You

8 BIG KITS of

Radio Parts and Equipment . . .

NOW IS THE TIME To Get Into This Fast Growing Industry—Prepare For A Fine Paying Job Or Your Own Business!

If you want to get into Radio-Television and Electronics . . . you owe it to yourself to get the facts about my training. I have trained hundreds of men to become outstanding service technicians—and I'm ready to do the same for you. Whether your goal is a fine paying job in one of Radio's many branches—or a successful Radio and Television business of your own—*you need the kind of training I offer!* My training is practical and down to earth. YOU NEED NO PREVIOUS EXPERIENCE. You'll be astonished at your rapid progress. I start you with basic fundamentals and give you plenty of practical shop-bench training with many kits of parts I send you. This is the training that sticks with you and makes money for you on the job!

Get Paid For Spare Time While Learning

Soon after you start training I send you my famous BUSINESS BUILDERS that show you how to make money in spare time doing interesting Radio jobs. Look at the useful and valuable equipment you get while training with me (illustrated at left)—I send you these 8 big kits of Radio parts and equipment and help you build step-by-step a powerful 6-tube superhet radio, a 16-range test meter, plus other mighty useful equipment for Radio and Television servicing. You will perform over 175 fascinating experiments while training. You will learn about Television—so that you will be qualified to step into this fast growing, profitable field. I also send you many valuable service manuals, diagrams and my book telling exactly how to set up your own Television and Radio shop. *I want you to learn all about my training*—and that is why I urge you to clip and mail the coupon below for my two big FREE Radio books. I employ no salesmen—and nobody will call on you. The important thing is to act now and get the facts.

HAVE A BUSINESS OF YOUR OWN

A profitable Radio and Television Service Shop may be started with little capital. I will show you how to get started and how to build your small business. At left is pictured one of my graduates, Mr. Merrit C. Sperry of Fairmont, Minnesota in his own shop. The way is also open for you to build a good SERVICE BUSINESS FOR YOURSELF.

ALL KITS ARE YOURS TO KEEP

Each of the hundreds of Radio parts and other items I send my students is theirs "for keeps." You may use this equipment in your Radio and Television service work and save many dollars by not having to buy expensive "ready-made" test equipment. Each of my 8 kits will help you advance and learn important steps in Radio and Television servicing.

CALVIN SKINNER of New Orleans, La. tells us he makes $5 to $10 in spare time repairing radios. He is now also working with his own Television set.

LOREN D. SAUCIER of Coloma, Mich. reports that my training has made it possible for him to repair large numbers of Radio and Television receivers.

RADIO AND TELEVISION INDUSTRY BOOMING

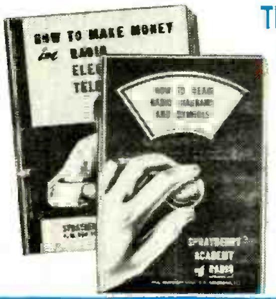
You couldn't pick a better time to get into Radio-Television and Electronics. New Television stations are going on the air to serve every major city—hundreds of new AM and FM Radio broadcasting stations are also on the air to serve practically every community in America. All this creates new and bigger opportunities for the trained man who knows Radio-Television and Electronics. Good Radio and Television service men are needed NOW!

VETERANS

THIS TRAINING AVAILABLE TO YOU UNDER THE G.I. BILL

My Training Includes:

Radio Servicing
Television
FM Frequency Modulation
Public Address
and High Frequency Applications



These Two Big Radio Books FREE!

Just mail coupon for a FREE sample Sprayberry Lesson and my big FREE book, "How To Make Money In Radio-Television and Electronics." Learn why my really *practical* training is best of all for you. Discover what's ahead for you in the fast moving Radio-Television and Electronics Industry. No obligation. Don't delay—the future is too important to you. Mail the coupon now—and count on me for fast action.

SPRAYBERRY ACADEMY OF RADIO
111 N. CANAL, DEPT. 25-G, CHICAGO 6, ILL.

RUSH COUPON *Today!*

SPRAYBERRY ACADEMY of RADIO, Dept. 25-G
111 North Canal St., Chicago 6, Ill.

Please rush my FREE copies of "How To Make Money In Radio-Television and Electronics" and "How To Read Radio Diagrams and Symbols."

Name .... Age ....

Address ....

City .... State ....

( ) Check here if you are a Veteran.

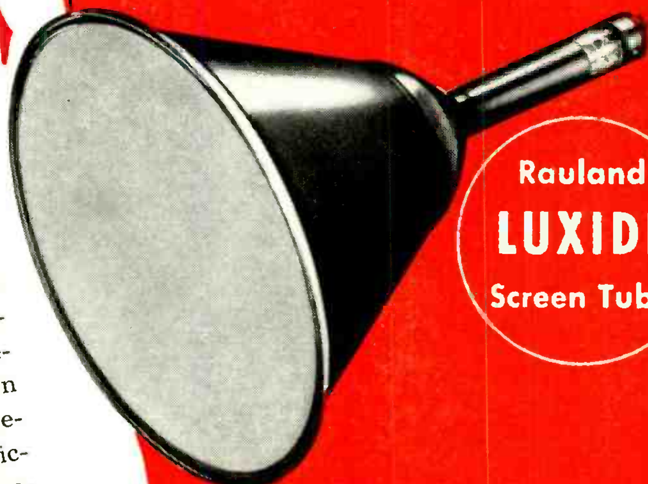
For "Better-than-New" Performance

..sell RAULAND replacements!

Here are the two greatest improvements in picture tubes since the war — both available from Rauland for your replacement business. Leading jobbers and dealers prefer and recommend them because they actually give customers better pictures than when their sets were new—assuring customer satisfaction that pays off in extra profits.

Rauland Luxide Screen Tubes

The public is clamoring for new Television sets featuring this new Rauland-developed tube. Now the Luxide Screen is available for replacement use in two tube types—metal-coned 16AP4-A, and all-glass 12LP4-A. The face of this new "black" tube contains a metallic oxide which gives the glass desirable light-absorbing characteristics. Both the reflection of ambient light and halation within the tube face are materially reduced. The result is a sharp, clear picture with such greatly increased contrast and clarity that it can be viewed in lighted rooms without "washing out" and without annoying glare.



Rauland Aluminized Luxide Screen Tube

This Rauland-developed replacement tube has brought thousands of owners clearer, brighter pictures than they enjoyed before. The Rauland aluminized screen gives pictures up to 80% brighter than conventional tubes—with better contrast and sharper definition. The Rauland aluminized tube does not require any ion trap magnet—the adjustment of which, on ordinary tubes, is critical and if improperly made, will result in damaging the tube. The Luxide Screen feature is now available in the aluminized tube as type 12KP4-A.

THE RAULAND CORPORATION

Perfection Through Research

4245 N. KNOX AVENUE • CHICAGO 41, ILLINOIS

Within the INDUSTRY

ALFRED C. VIEBRANZ is the new general sales manager of the Electronics Division of *Sylvania Electric Products Inc.*, succeeding George C. Conner who is GSM of the Photoflash Division.

Mr. Viebranz was formerly government sales representative for the Electronics Division at Washington. He joined the *Sylvania* staff as sales engineer in 1946 and during the war served as a lieutenant, USNR in submarine service.

He holds a B.S. in Physics from St. Lawrence University and later took graduate work at the U. S. Naval Academy and was graduated as a communications engineer. He is a member of the IRE, the Radio Technical Commission for Marine Services, and the Radio Technical Commission for Aeronautics.

* * *

AMERICAN STRUCTURAL PRODUCTS COMPANY, a subsidiary of *Owens-Illinois Glass Company*, has announced that seventy-five per-cent of its television bulb production capacity will be devoted to the new all-glass rectangular bulb.

The increased production rate for the new all-glass rectangular bulb has been necessitated by the increased demand for this type of television tube. Approximately 33 per-cent of the company's capacity was devoted to production of the 16 inch tube during January and 50 per-cent devoted to 14 and 16 inch production in February.

The company developed and introduced the rectangular bulb late in 1949.

* * *

J. J. CLANCY of Fort Wayne, Indiana has been named sales representative of the northeastern Indiana and southern Michigan territory for *Webster Electric Company*. He recently took over representation of the *Radio Merchandise Sales, Inc.* line in Michigan while continuing to serve *R.M.S.* customers in Ohio, Indiana, and Kentucky . . . **ALLEGHENY HOME APPLIANCE COMPANY** of Huntington, West Virginia will handle the *Du Mont* line in the Huntington and Charleston areas . . . **W. BERT KNIGHT CO.** has been named manufacturer's representatives for *The House of Television, Inc.*, New York. Working out of Los Angeles, the *Knight* outfit will cover southern California and Arizona . . . *Raytheon Manufacturing Company* has appointed **LAY AND NORD** of Yakima, Washington and **TROJAN RADIO COMPANY** of Troy, New York as distributors for the company's line of receiving, television, and special purpose tubes . . . **SOUTHWEST DISTRIBUTING COMPANY** has been appointed distributor of *Stewart-Warner Corporation's* radio and television products in the Kansas City territory . . . **WALLACE SCHNITZER** has joined the *Gerald B. Miller Co.* of Hollywood as an engineer in the company's industrial instrument division . . . Jobbers in Ohio, western Pennsylvania, West Virginia, and eastern Kentucky will have **J. R. DANNEMILLER ASSOCIATES** as their new jobber representatives for the *Utah, Inc.* line . . . *John Meck Industries, Inc.* has named **TURNQUIST BROTHERS COMPANY** of Los Angeles as franchise distributor for its line of television and radio receivers.

* * *

EDWARD A. MALLING has been appointed to the post of sales manager for component parts in the *General Electric Receiver Division* at Syracuse.

He will be responsible for the sale of parts to initial equipment and distribution accounts. This includes the sale of such items as loudspeakers, television receiver components, antennas, phonograph tone arms, and the variable reluctance cartridge.

Mr. Malling has been associated with *General Electric* since 1935 when he joined the Electric Refrigeration Department at Nela Park, Cleveland. Since that time he has served in the Appliance and Merchandise Department and the Electronics Department. He has held several positions in the latter department since being assigned in 1945.

* * *

MARTIN L. SCHER has been named general sales manager of *Motorola-New York, Inc.*, New York distributor for *Motorola, Inc.* of Chicago.

Prior to joining *Motorola*, Mr. Scher was for four years general sales manager for *Admiral Corporation's* New York distributing division and for the *Dale Distributing Company*, predecessor to the *Admiral Division*.

During the war he served as sales

says FRANK SMOLEK,

General Service Manager of Zenith

In addition to providing all necessary signal sources, the new Simpson Genescope includes a high sensitivity oscilloscope of unique advanced design, complete in every detail. Sensitivity 25 millivolts per inch. Wide band response to 3 megacycles or more. Equipped with a high frequency crystal probe for signal tracing. AM and FM oscillator sections provided with large, easy to read dials with 20-1 vernier control and 1000 division logging scale. *Revolutionary, Ingenious, Exclusive* output termination provides for various receiver impedances, either direct or through an isolating condenser.

Step attenuator for control of output.

Size: 22"x14"x7½". Weight 45 lbs. Shipping Weight 54 lbs.

DEALER'S NET PRICE complete with Test Leads and Operator's Manual $375.00

CHECK THESE RANGES AND YOU WILL SEE HOW MUCH THE SIMPSON GENESCOPE CAN DO FOR YOU

RANGES
FREQUENCY MODULATED OSCILLATOR

Band A—2-120 megacycles
Band B—140-260 megacycles
Sweep width variable from zero to 15 megacycles
Sweep rate 60 cycles per second
Specially designed frequency sweep motor
Continuously variable attenuator
Crystal calibrator—5 megacycles ± .05%
Audio Oscillator 400 cycles

AMPLITUDE MODULATED OSCILLATOR

Band A—3.2-16 megacycles
Band B—15-75 megacycles
Band C—75-250 megacycles
30% modulation at 400 cycles or unmodulated
Continuously variable attenuator
Visual method of beat frequency indication

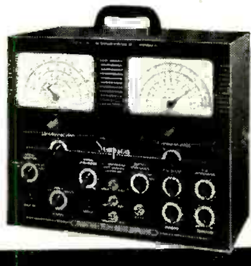
Modern FM and TV development and servicing requires the use of test equipment made to exacting standards. With this in mind Simpson offers you the Genescope with the assurance that everything possible has been done to make it the most accurate, flexible and convenient instrument available. The Genescope will render many years of uninterrupted service and always produce accurate results.

HERE'S THE SIMPSON—MODEL 479 TV-FM SIGNAL GENERATOR

Exactly the same circuits, ranges and functions as the Model 480, described above, with the exception of the oscilloscope.

Size 17"x14"x7½". Weight 34 lbs. Shipping Weight 40 lbs.

DEALER'S NET PRICE with Test Leads and Operator's Manual $245.00



Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON ELECTRIC COMPANY
5200-5218 WEST KINZIE STREET • CHICAGO 44, ILLINOIS
In Canada: Bach-Simpson, Ltd., London, Ont.

director for the Electronic Research Supply Agency of the RFC where he was in charge of stockpiling critical electronic components.

* * *

H. JAMES TAIT was recently appointed Eastern States regional sales manager for the receiver sales division of *Allen B. Du Mont Laboratories, Inc.*

Mr. Tait, who has been with the *Du Mont* organization for some time, has been working out of the New York Regional Sales Office, handling the Bronx-Long Island territory. In his new post, he will head receiver sales activities in the states along the eastern seaboard from Maine to South Carolina.

He will make his headquarters at the company's offices at 515 Madison Avenue, New York City.

* * *

RADIO MANUFACTURERS ASSOCIATION, in cooperation with the Institute of Radio Engineers and the American Institute of Electrical Engineers, is sponsoring a "Conference on Improved Quality Electronic Components" to be held in Washington May 9-11. Military and government representatives will confer with the representatives of the industry organizations.

New techniques for producing longer-life components, especially for military, aircraft, and industrial electronic equipment, will be discussed at the symposium to be held in the new Department of Interior auditorium.

The symposium will give emphasis to the following topics; improved quality of circuit elements for greater dependability of electronic equipment, unitized packaging as a means for greater dependability through simplified maintenance, miniaturization, particularly as applied to the unit package, and circuit elements compatible with design requirements of the unit package.

* * *

PAUL B. H. SMITH was elected to the post of vice-president and director of *Zenith Radio Corporation of Canada, Ltd.* at a recent meeting of the directors of that company.

The Canadian corporation is a subsidiary of *Zenith Radio Corporation* of Chicago and has headquarters in Windsor, Ontario.

In addition to his new duties, Mr. Smith will continue as general sales manager of the company's hearing aid division, with headquarters in Chicago. Previously, he was manager of the Canadian subsidiary for a two year period. From 1935-1944 he was affiliated with the sales, sales promotion, and public relations departments of the *Ford Motor Company* of Canada in Toronto and Windsor.

* * *

CHARLES A. GARDINER has been named treasurer of the *Hudson Wire Company* of Ossining, New York. He joined the company 20 years ago, and has been serving as controller . . . **JAMES M. SCALES** is the new district sales manager for the northwestern territory of *Zenith Radio Corporation* . . . **W. H. SALEE** has taken over the post of general sales manager of *Janette Manufacturing Company,* Chicago manufacturers of rotary converters and gear-motors. He succeeds Harvey Klunder who resigned . . . *General Electric Company* has made three new appointments in the Tube Division. **E. F. PETERSON** has been named manager of sales, **L. B. DAVIS** is the new manager of the receiving tube division at Owensboro, Ky., and **K. C. DEWALT** has been appointed manager of the cathode-ray tube division at Syracuse . . . **JOHN D. SMALL** was elected vice-president of *Emerson Radio and Phonograph Corporation* while **ABRAHAM ROSEN** was promoted from controller to assistant treasurer. **A. A. VOGEL,** assistant controller, takes over Mr. Rosen's former post . . . **HUGO SUNDBERG** has been upped to the post of vice-president and manager of *Oxford Electric Corporation,* Chicago manufacturers of loudspeakers . . . *Gertsch Products, Inc.*

(*Continued on page* 96)

Sylvania's NEW Tube Testers are one jump ahead of tomorrow!

MODEL 220

Once again Sylvania has anticipated radio and television developments. Sylvania's new tube testers, both counter and portable models, are not only capable of testing every modern receiving tube . . . they are calibrated to Sylvania's latest tube production standards.

Experts in tube-testing have built this new instrument . . . but you don't have to be an expert to operate it. Counter clerks, uninitiated in radio technicalities, can use it after a few minutes' instruction. For the benefit of the customer, the illuminated meter reads "GOOD" or "REPLACE" for all tubes, including diodes. Gas tests can be made easily. It is the first tester with both circular and linear subminiature sockets. The new fast, smooth-running roll-chart is easily removable from the front panel.

Modern styling of both models tells even the layman that your up-to-the-minute service is one jump ahead of tomorrow!

MODEL 219

A few more facts on what's NEW

In Tube Testers 219 (Counter) and 220 (Portable)

- Novel voltage controls prevent tube damage
- Switch-numbers correspond to tube pin-numbers
- Switching arranged for easiest operation
- Exclusive ohmmeter-type indicator for shorts and leakage
- Shorted tube reads "REPLACE"—no neon lamp
- Double-size power transformer

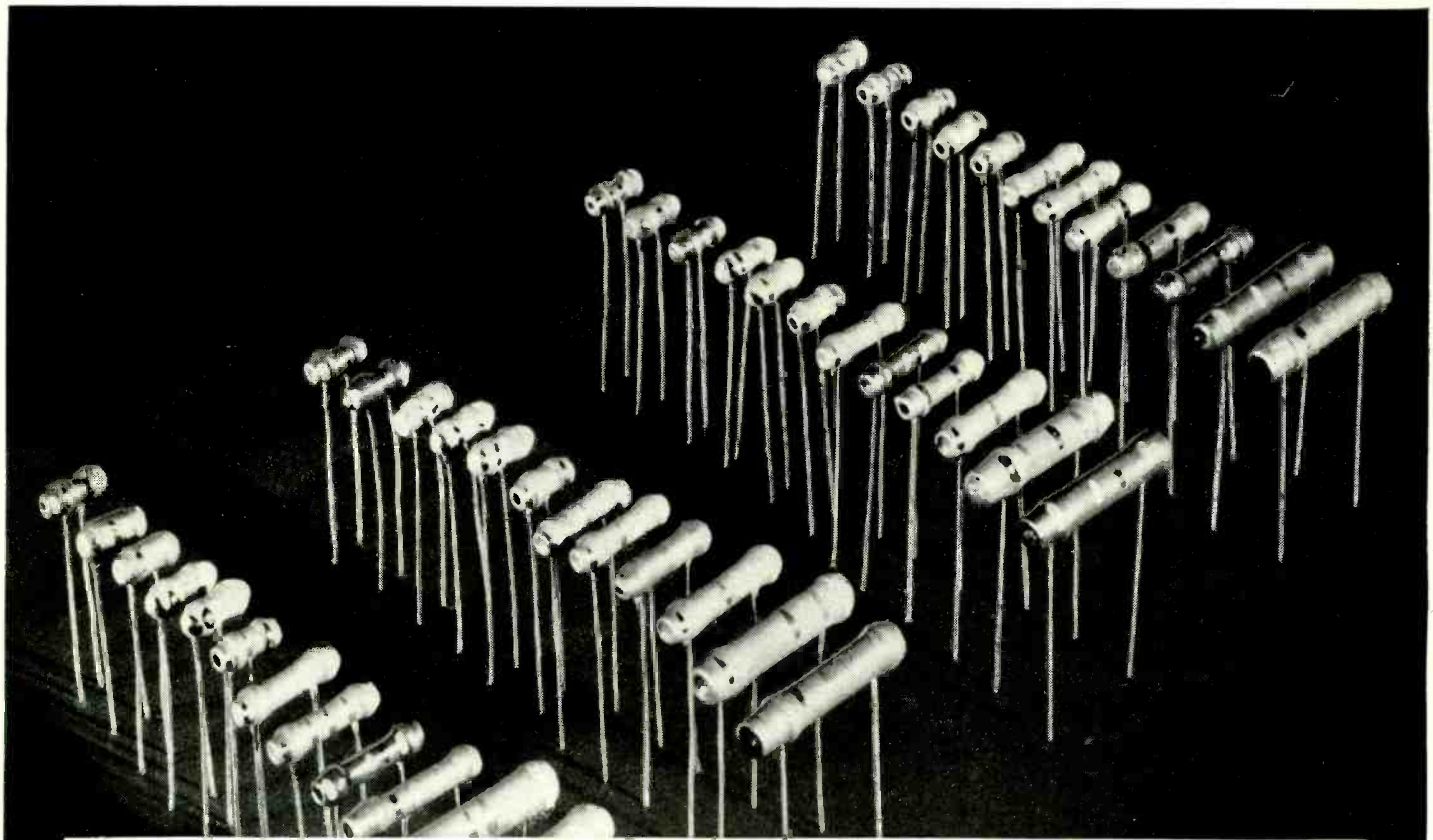
NOTE ON "KNOW-HOW"

A comprehensive explanation of tube characteristics and tube tester applications comes free in each Operating Manual.

SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS

NOW..A NEW, WIDER LINE



Choose from this Complete Ceramic Capacitor Line

Your radio parts distributor can supply you with these BC HI-KAP Tubular Ceramic By-pass and Coupling Capacitors in the following values — all rated at 600 WVDC, flash tested, 1000 VDC. Packaged in cellophane envelopes, 5 of one value per envelope.

Capacity	CRL Cat. No.	Capacity	CRL Cat. No.	Capacity	CRL Cat. No.
10MMF	D6-100	120MMF	D6-121	1,000MMF	D6-102
12MMF	D6-120	150MMF	D6-151	1,200MMF	D6-122
15MMF	D6-150	180MMF	D6-181	1,500MMF	D6-152
18MMF	D6-180	200MMF	D6-201	1,800MMF	D6-182
20MMF	D6-200	220MMF	D6-221	2,000MMF	D6-202
25MMF	D6-250	250MMF	D6-251	2,200MMF	D6-222
27MMF	D6-270	270MMF	D6-271	2,500MMF	D6-252
33MMF	D6-330	300MMF	D6-301	2,700MMF	D6-272
39MMF	D6-390	330MMF	D6-331	3,000MMF	D6-302
40MMF	D6-400	390MMF	D6-391	3,300MMF	D6-332
47MMF	D6-470	400MMF	D6-401	4,700MMF	D6-472
50MMF	D6-500	470MMF	D6-471	5,000MMF	D6-502
56MMF	D6-560	500MMF	D6-501	5,600MMF	D6-562
68MMF	D6-680	560MMF	D6-561	6,800MMF	D6-682
75MMF	D6-750	680MMF	D6-681	7,500MMF	D6-752
100MMF	D6-101	750MMF	D6-751	10,000MMF	D6-103

For other ceramic capacitor replacement needs, use CENTRALAB's line of TV HI-VO-KAPS, KOLORDISKS and TC capacitors.

OF TUBULAR BC HI-KAPS!

Mr. Service Engineer . . . If your profits and reputation depend on guaranteed repairs, then this message is for You! Centralab . . . the First name in ceramic components . . . gives you famous ceramic tubular BC Hi-Kaps in 48 different and many new values. Check their advantages . . . see why CRL BC Hi-Kaps are absolutely safest for guaranteed repairs.

The present trend to *guaranteed service policies* demands that service engineers take no profit-risking chances with replacement parts of doubtful performance and durability. Chart below gives you the facts. Read them. See why we say *no other tubular by-pass and coupling capacitors made will outperform or outlast CRL Tubular Ceramic BC Hi-Kaps!*

Centralab

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.

Check these Features . . . See for Yourself why CRL BC Hi-Kaps are "safest"

<table>
<tr><th>"HI-KAP" FEATURES</th><th colspan="3">DESCRIPTION</th><th>WHAT IT MEANS TO YOU</th></tr>
<tr><td>1. Impervious to moisture</td><td colspan="3">Ceramic-X is non-hygroscopic. Moisture absorption is .007% or less.</td><td>No deterioration, no shorting. Longer life even under the most adverse conditions of humidity.</td></tr>
<tr><td rowspan="6">2. Low mass weight
3. Small Size
4. High capacity</td><td>AV. WT.</td><td>DIMENSIONS</td><td>VALUES</td><td rowspan="6">For unit size and weight, Centralab BC "HI-KAPS", made with Ceramic-X, are the only capacitors on the market which provide these voltage ratings.</td></tr>
<tr><td>.029 oz.</td><td>D— .260"
L— .530"</td><td>10—390 mmf.</td></tr>
<tr><td>.044 oz.</td><td>D— .260"
L— .810"</td><td>400—3000 mmf.</td></tr>
<tr><td>.050 oz.</td><td>D— .280"
L— .900"</td><td>3300—5000 mmf.</td></tr>
<tr><td>.082 oz.</td><td>D— .330"
L—1.200"</td><td>5600—10,000 mmf.</td></tr>
<tr><td colspan="3">Ratings: 600 WVDC — 1000 flash test.</td></tr>
<tr><td>5. Special insulation</td><td colspan="3">Low power factor resin and high temperature wax coatings, with an additional special phenolic jacket.</td><td>Prevents any possibility of shorting to adjacent leads, chassis or components.</td></tr>
<tr><td>6. Convenient side leads</td><td colspan="3">Heavy No. 22 gauge tinned copper, silver soldered to electrodes.</td><td>Permit rapid, close-coupled connections. No tricky bending or fitting required.</td></tr>
<tr><td>7. Low power factor</td><td colspan="3">Initial — .6%. After 100 hours, 95% humidity test — 3.0%.</td><td>More efficient circuit operation, fewer failures.</td></tr>
<tr><td>8. High leakage resistance</td><td colspan="3">Initial — 5000 megohms. After humidity —500 megohms.</td><td>Long life, more efficient performance.</td></tr>
<tr><td>9. Maximum dependability</td><td colspan="3">Pure silver electrodes, electro-bonded to Ceramic-X dielectric. Protected against oxidation or mechanical damage by coatings of electrolytic copper and solder.</td><td>Moisture and puncture proof. Will not short or become intermittent.</td></tr>
<tr><td>10. Factory tested</td><td colspan="3">For your protection, all units 100% factory tested before packaging and shipping.</td><td>Your guarantee to your customers of reliable service and performance.</td></tr>
</table>

WE'RE STILL IN THE *RADIO* BUSINESS

Seems as though everything nowadays is TV . . . TV . . . TV. We've had so much TV news for you! Hytron's new 16RP4 rectangular picture tube. Hytron's new low-cost deflection-circuit tubes: 1x2, 6BQ6GT, 6U4GT, 6W4GT, 25BQ6GT, and 25W4GT. And many more Hytron designed-for-TV tubes coming.

But we're still in the *radio* business — both of us. Radio still is king. We realize that. Also that most service problems are still radio — not TV. You can depend on Hytron *radio* tubes. Whether it is the original Hytron GT . . . miniature . . . G . . . metal . . . or loctal. For a-c/d-c, portable, f-m, phono, or auto radio. Hytron will strive to give you the most dependable *radio* (as well as TV) replacement tubes.

OLDEST MANUFACTURER OF RECEIVING TUBES
HYTRON
RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

FREE

New Hytron Tool Catalogue. Describes all the famous Hytron service-shop tools to date: Soldering Aid, Tube Lifter, 7-Pin and 9-Pin Straighteners, Tube Tapper, and Auto Radio Tool. Find out how these Hytron tools can ease your work. Mail the coupon today.

HYTRON RADIO & ELECTRONICS CORP.,
Salem, Massachusetts

I want to know how the Hytron tools can help me make more money. Please send me the free Hytron Tool Catalogue at once.

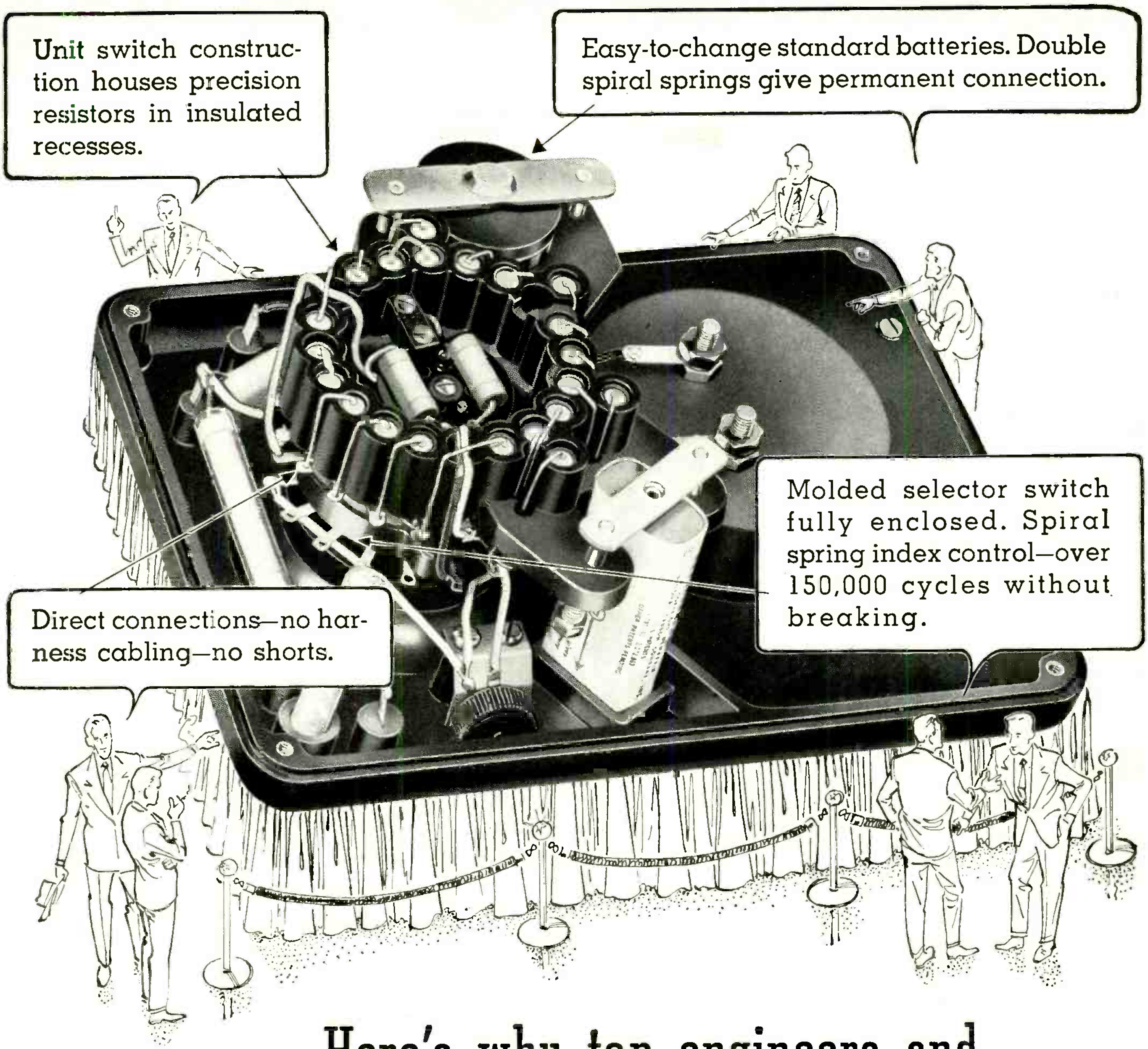
(PLEASE PRINT)

NAME ....

STREET ....

CITY ....

STATE .... R.N.



Here's why top engineers and technicians use Model 630

Features like those shown above are what make this popular V.O.M. so outstandingly dependable in the field. The enclosed switch, for instance, keeps the silvered contacts *permanently clean*. That's rugged construction that means stronger performance, longer life. And tests show that the spiral spring index control, after more than 150,000 cycles of switch rotation, has no disruption or appreciable wear! Investigate this history-making Volt-Ohm-Mil-Ammeter today: 33 ranges, large 5½" meter.

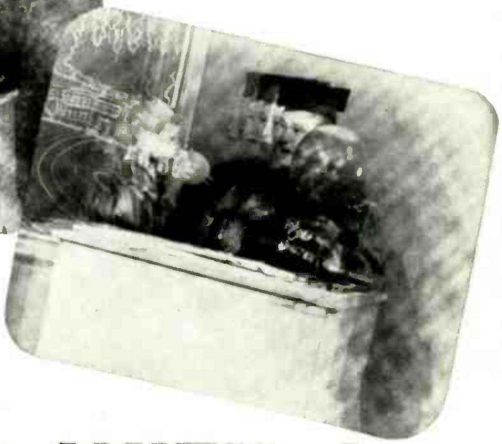
ONLY
$37.50
AT YOUR DISTRIBUTOR

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY BLUFFTON, OHIO, U.S.A.

If your Pictures look like this →



YOUR TELEVISION WILL BE IMPROVED WITH A WARD OUTDOOR AERIAL

to give you Pictures like this →

The modern miracle of pictures by air can be a most satisfying means of entertainment. But be satisfied only with a picture comparable to a class "A" motion picture—on every station in your area. *It is unnecessary to compromise!*

HERE'S WHY: Television waves are like light beams – solid objects reflect and refract them, making it impractical to pick up all stations from an indoor aerial. That is why you get double images on some stations.

In addition, indoor aerials have poor signal pickup making it difficult to get good pictures on all stations.

FURTHERMORE: Your indoor antenna may have a high noise level which increases the amount of interference as you advance the contrast control to bring up a weak picture. All of these technical difficulties are eliminated by a WARD outdoor aerial installed by a competent radio serviceman. In *every case*, a Ward outdoor antenna will improve reception over an indoor aerial. Also, Ward aerials are so well designed, they are attractive on a house. *It is unnecessary to compromise!*

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The ANTENNA RESEARCH LABORATORY

Fig. 1. Tiny crystal receiver, shown in engineer's right hand, is used to detect signals from model antenna. Plate on side of model plane is removable to permit receivers to be installed within the hollow fuselage of plane.

By
JOSEPH M. BOYER
Consulting Engineer

Douglas Aircraft's laboratory eliminates costly full-scale experiments by using tiny replicas in solving complicated antenna design problems.

NEVER before in the history of radio has interest in the antenna beam been at such a feverish pitch! No longer are "aerials" merely required to transfer electromagnetic energy into space. Experts today, working with surrealistic shapes of metal and plastic, are molding radiated energy into the precisely shaped beams needed for the varied classes of radar—for highly eavesdrop-proof communication links, or even changing the beam's contour from instant-to-instant, automatically following the boiling vagaries of the Heaviside layer.

The center of all such investigation is the *antenna research laboratory*. Here antenna engineers work with worlds in miniature. Out on the model antenna range of one such laboratory it is not uncommon to see a complete scale replica of a television station: the tiny buildings, the accurately-made antenna towers, even the green rolling hills of the surrounding country. This Lilliputian model slowly revolves on a turntable, a large horn-type radiator some distance away "illuminating" it with microwave signals. The miniature antennas of the model station detect such energy and feed it back to high gain amplifiers in the laboratory. Thus, as the model turns, automatic plotting instruments draw an accurate trace of the radiation pattern of the station for later study. Such model tests save costly cut-and-try procedures previously made on full scale installations.

Even more important, in view of our National Preparedness Program, is the investigation of aircraft antennas. With aircraft now operating both near and beyond the speed of sound, no object of any kind is permitted to project from the sleek, polished metal skin to add parasitic drag. This requirement is a death warrant for the numerous masts and wires which once were draped lavishly over aircraft exteriors. In the high-pressure search for distinctly new antenna types which may be faired flush into the skin of a high speed airplane, several of the large airframe manufacturers have aided the radio art immeasurably by taking the lead in such research. In order to see, at first hand, the evolution of a new antenna, a visit was made to the El Segundo, California antenna laboratory of the *Douglas Aircraft Company* which pioneered in this field. Here, work begins with the presentation of the Navy specifications to the aircraft antenna designer.

[1] Military frequencies are classified. Those given are only representative.

Such specifications call for a v.h.f. communications antenna. This unit is to be mounted flush within the skin of a high speed carrier type fighter, yet provide full 360-degree coverage about the horizon. When used for transmitting, the antenna must produce most of its signal in a zone approximately twenty degrees above and below the airplane. Efficiency must be equal to the older type protruding antenna because airborne power requirements are stringent. Finally, as if to complete the designer's frustration, such an antenna must be capable of operating from 300 to 590[1] megacycles while remaining matched to the coaxial transmission line feeding it. Specifically, it must not exceed a *voltage standing wave ratio* of 2 to 1.

The resourceful engineer begins a strenuous period of reading the available technical literature, making rough preliminary calculations, and weighing and discarding a number of configurations which come to mind. In this process the crude pencil sketches which litter his desk would be unrecognizable to prewar engineers. There is not a sign of wires or porcelain insulators. One sketch may show a small square portion of the metal skin isolated from the surrounding surface and fed by a tapered funnel section of coaxial line. Or perhaps a flat disc of polystyrene a foot or so in diameter is shown, excited at its center by a sphere of silver designed to function as a wide-band dipole.

Finally, the antenna designer may feel he has what is needed. Before he makes a preliminary shop drawing he must refine his design. This step involves extremely complex calculations. For some such problems he must discard his slide rule, set up the equations he wishes solved, and pass them on to electronic or mechanical

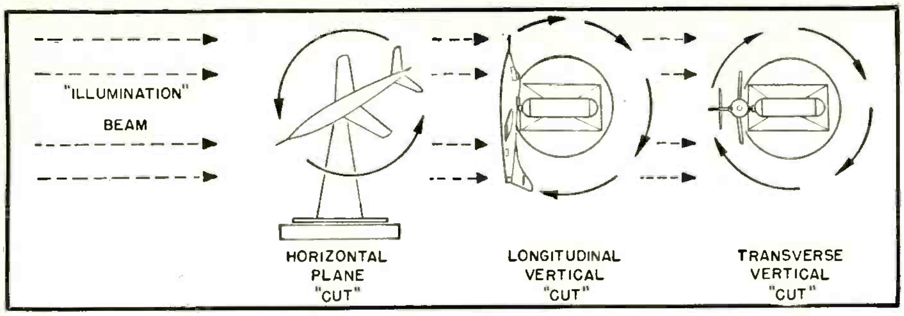


Fig. 2. Diagram shows position of model aircraft and rotation axis for each of the three principal radiation pattern "cuts" made during pattern study.

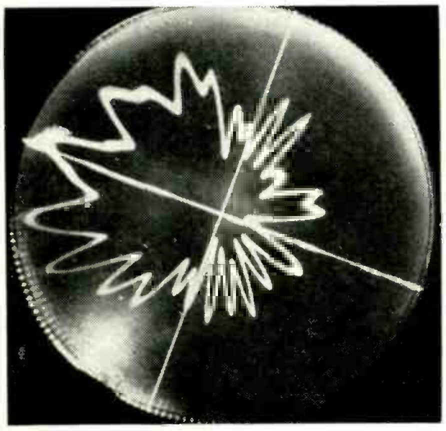


Fig. 3. Typical aircraft antenna radiation pattern. The pattern shown was photographed on the screen of antenna range cathode-ray "pattern painter." Magnetic deflection coils move in synchronization with rotation of model under study, tracing out an accurate polar diagram of antenna signal variation around the plane model.

computing machines. Satisfied that his *"brain child"* has a good chance of success, the engineer authorizes the experimental shop to fabricate a full size antenna and pass it on to the antenna laboratory for measurements.

Impedance Measurements

The antenna laboratory technician, highly-trained and experienced in this specialized field, first may mount the prototype antenna upon a large *ground plane*. This usually is a metal wall forming one side or the roof of the laboratory building. In some cases the antenna may actually be mounted into a full scale wire cloth *mock-up* of the aircraft itself. A precision section of slotted coaxial transmission line (Fig. 5) is connected in series with the antenna and a laboratory v.h.f. oscillator. Beginning at one end of the frequency range to be covered by the antenna, the technician makes measurements of the voltage standing wave ratio in the transmission line. If the antenna is a perfect match there will be no change in the measured voltage from one end of the transmission line to the other. Such "flat" lines, however, are rarely encountered. There usually is a small v.s.w.r. but it must be under the called-for 2:1 ratio. If the designer has done his job properly this condition will be met over the entire frequency range desired. So far so good, but more hurdles remain to be cleared.

Once more an order goes to the experimental model shop: "Fabricate one 1/20th scale model of the antenna for range pattern tests." The men who receive this assignment are not ordinary machinists or metalsmiths. They are, for the most part, former instrument makers used to working with tiny precision parts under a powerful lens. They are fantastically ingenious in devising ways of soldering and welding parts the size of a pin head into place within complex assemblies, of bending and twisting metal into shape while it is glowing in the flame of an alcohol lamp. An idea of the difficulty of their job can be obtained when it is realized that ordinary RG 8/U coaxial cable reduced to 1/20th scale is the size of store string. The inner conductor of such cable is the diameter of a human hair, yet must be soldered to the minute antenna without melting an extremely thin, easily-destroyed polyethelyne sheath which insulates the assembly. Upon completing his exacting task, the model shop craftsman places the tiny antenna into the metal skin of a previously prepared 1/20th scale model of the aircraft in which it is intended to see service.

Radiation Pattern Measurements

Briefly, the basic idea behind the use of the model antenna pattern range is this: an aircraft operates far from the earth. The only environment which affects the antenna on the airplane is the configuration of the craft itself. Any attempts to measure radiation patterns on a full size aircraft resting on the earth would be futile. Patterns taken by means of flight tests are not only prohibitively expensive, difficult to measure and interpret, but usually end in doubtful results. However, by reducing the aircraft to 1/20th or 1/40th of the full scale dimensions it is possible to mount it from 40 to 60 wavelengths from the ground. This can be done because the operating frequencies must also be multiplied by 20 or 40 to keep in step with the model dimension change. That such theory is correct, when suitable precautions are taken, has been demonstrated conclusively.

The scaled-down model aircraft, complete with its test antenna, is mounted upon a special dielectric

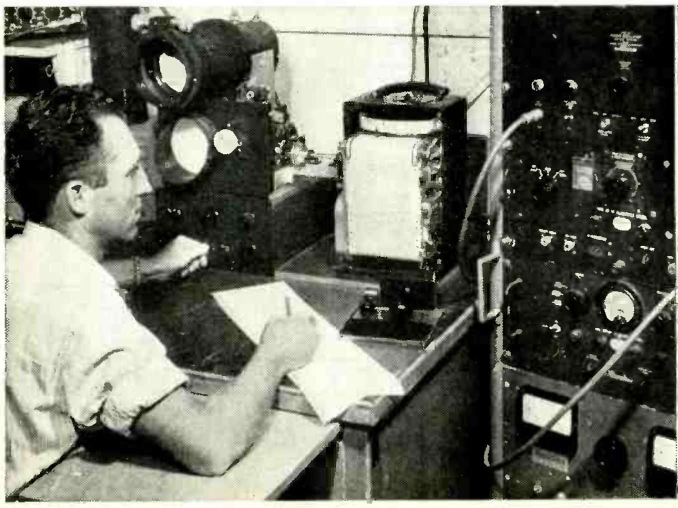


Fig. 4. Operating and recording position. Shown are the v.h.f. and microwave transmitters, power supplies, and switching panel. In front of operator is a pen recorder and the Douglas cathode-ray "pattern painter." The "full moon" labeling device is seen as the white window below the cathode-ray tube.

Fig. 5. A coaxial slotted line in use. The slotted coaxial line is used to measure the voltage standing wave ratio of the prototype antenna. The radiator under test is mounted on the outside metal surface of the wall, directly behind the Hewlett Packard Voltage Standing Wave Ratio meter shown in photo.

tower, the base of which rests on a motor-driven turntable. Within the hollow belly of the little plane is a simple *receiver* usually consisting of an impedance matching transformer and a silicon crystal detector or hot wire bolometer.

With the tower placed as many as 100 wavelengths from the laboratory building, technicians energize a tunable Klystron transmitter which excites a large horn type antenna projecting toward the model through the wall of the laboratory. The transmitter's signal is amplitude modulated by a square wave with a repetition rate of 1000 cycles. A square wave is needed to avoid frequency modulation of the Klystron. Operating frequency is carefully adjusted to be 20 or 40 times the full scale point in the spectrum where the antenna is intended to function.

Reference to Fig. 2 will make clear the patterns to be described. The antenna specialist refers to such patterns as "cuts." The first "cut" is made by slowly rotating the model so that every portion of the plane's horizontal axis is exposed to the radio beam from the laboratory transmitting horn antenna. The model on the tower is then turned 90 degrees and again rotated by means of the turntable, exposing its nose, belly, topside surface, and tail to the beam. Finally, a "cut" is made presenting the wingtips, belly, and topside surface of the model. This triad of cuts—the horizontal, longitudinal vertical, and transverse vertical, are fundamental in any pattern investigation and quickly tell if the radiation pattern of a new antenna is going to meet specifications. At least the three patterns just described must be made at frequent intervals over the simulated radio spectrum in which the antenna is going to operate. An antenna may frequently have the desired radiation pattern at one end of its frequency range and fail miserably at the opposite extreme.

Leaving the antenna designer for the moment with his problem let us enter the laboratory building proper and investigate the equipment used to study the radiation characteristics of antennas. Several racks of audio amplifiers are the first instruments seen. These are quite special items. There are preamplifiers capable of boosting the few millivolts or so of signal received from the model to about 10 or 20 volts. This piece of equipment is linear in response and features a tuned feedback network which permits the amplifier to operate with full gain only at 1000 cycles. All other signals of random frequency and noise are sharply attenuated. The output of the linear preamplifier drives a logarithmic amplifier which is also sharply tuned to 1000 cycles. Logarithmic response is desired so as to properly record variations in the model signal which may extend over 50 decibels or more. To graphically present the radiation pattern several different types of recorders are used.

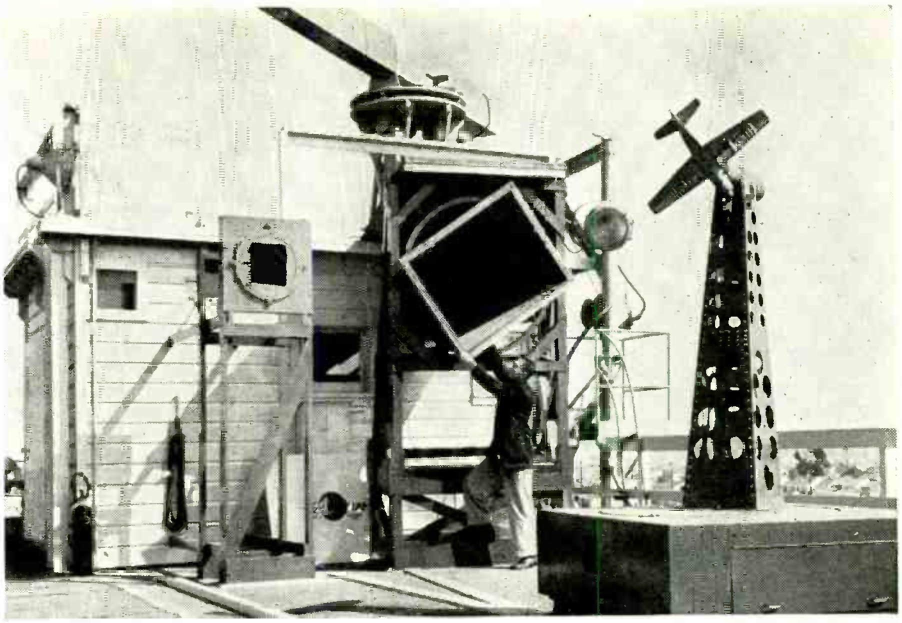


Fig. 6. General view of antenna model pattern range. A scale model of the Douglas "Skyraider" is shown mounted on the motor driven dielectric tower. The large electromagnetic horn antenna to the right is being turned to change electric polarization of signal to model. Smaller horn to the left of the picture covers the three centimeter frequency range.

The most common is a so-called *polar recorder* in which a pen is driven by signal variations from the model through the use of a servo-mechanism. In appearance this unit may resemble an automatic phonograph record changer. A circular piece of polar graph paper is placed upon its turntable and centered by means of a pinpoint of light at the center. The paper edges are clamped down by means of small Alnico magnets. Rotation of the recorder turntable is synchronized by means of selsyns to turn in step with the model out on the pattern range. When the model is rotated the servo-driven pen moves back and forth on a radius, tracing out the pattern.

Also used is a cathode-ray *pattern painter* illustrated in Fig. 4. This instrument has several important advantages over the pen type recorders. One of the most valuable is lack of mechanical inertia. There are occasions when a radiation pattern being recorded varies from a deep null to maximum signal intensity within a fraction of a degree of rotation. Even for the slow speeds at which the model turns (¾ to 1 r.p.m.) this condition requires the pen to whip over the graph paper at an exceptionally fast rate. The consequent lack of response and "overshooting" of the pen distort such patterns.

This difficulty is absent in the cathode-ray *"pattern painter."* Here the magnetic deflection coils actually rotate about the neck of the cathode-

Fig. 7. Scale model aircraft and antenna shown in process of construction. Craftsman in foreground solders a connection in minute cavity type slot antenna. The 1/20th scale aircraft model shown is of wood.

Fig. 8. Closeup of 1 cm. transmitter and horn antenna. A complete 30,000 mc. Klystron transmitter, cavity wavemeter, and high gain horn radiator makes only a light handful of microwave equipment.

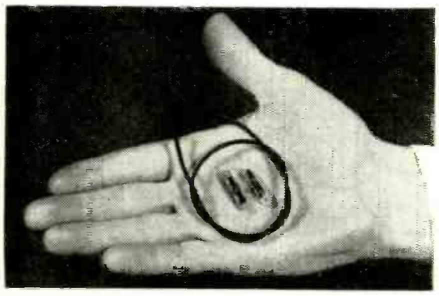


Fig. 9. Slot antenna and cable. The size of a pair of 1/20th scale slot antennas and miniature coaxial cable may be judged by comparison with hand holding them.

ray tube in synchronism with the model. Thus, as the signal intensity changes the electron beam can follow the speediest variation with no time lag, no error. When used for radiation pattern plotting the screen (long persistence) of the tube is photographed on 35 mm. film for a permanent record (Fig. 3). Another fine feature of the particular model developed at the *Douglas* laboratory is an edge-lighted *Lucite* disc seen in the illustration mounted below the cathode-ray tube. This disc is called the "full moon" because of its characteristic of glowing with evenly distributed white light. All pertinent data such as frequency, aircraft type, and description of the "cut," is typed on transparent gummed paper and this is then fixed over the face of the "full moon." Easily photographed on the same film as the pattern, such a screen label feature permits the laboratory to obtain a very complete, foolproof record of work in progress.

Frequency Coverage

Antenna laboratories must have transmitters available to cover enormous ranges of frequencies. To see the reason why, let us assume that the full scale frequencies of three antennas to be tested span the region 80 to 1600 megacycles. Not only must oscillators be on hand for these exact frequencies but, in addition, if the model range measurements are to be made at 1/20th scale, r.f. generators are required for the simulated range 1600 to 32,000 megacycles. Spanning such an expanse of radio territory calls for an imposing collection of coaxial cavity, and "butterfly" type oscillators, many, many Klystron tuners as well as elaborate high-voltage regulated power supplies and frequency measuring equipment of great accuracy. It is no wonder that antenna engineers always ask for bargains in frequency coverage when shopping for transmitters; otherwise such equipment would overflow the laboratory.

To cover the multitude of problems which trouble an antenna specialist's slumber would be beyond the scope of this article. Some of the especially serious ones, however, may be of interest. The first and worst of these is spurious reflected signals. Exactly the same problem is faced by television service technicians in the form of "ghosts." The aircraft model itself is, of course, placed carefully "in the clear." Any posts, buildings, fences, or personnel in its vicinity would reflect signals into the model as if they were secondary transmitters. Such reflections, depending upon their instantaneous phase, either add or subtract in certain directions from the true magnitude pattern of the model.

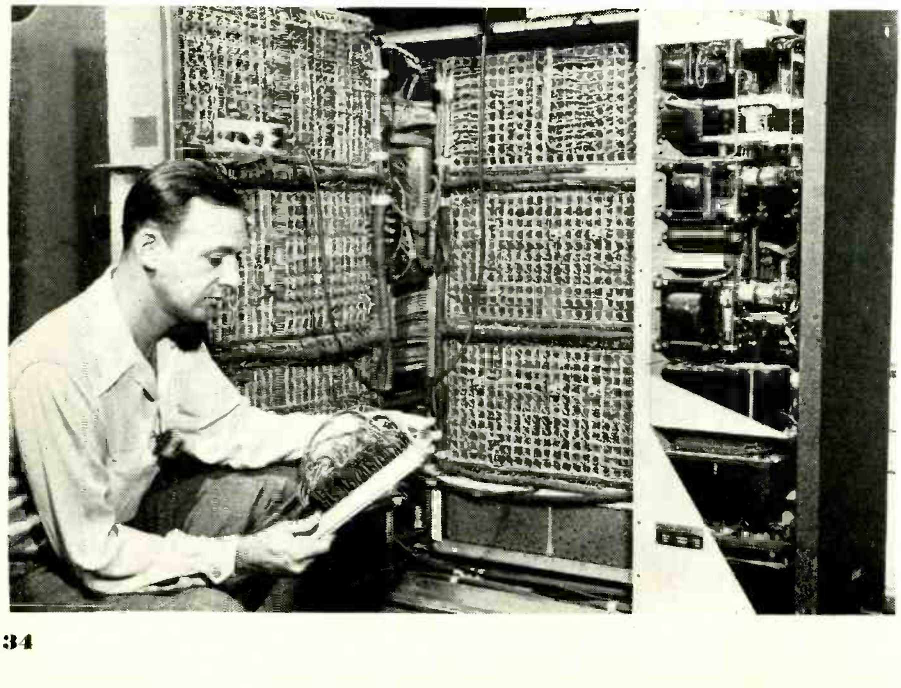
The real villain of this story, however, is the ground or platform upon which the antenna laboratory rests. "Splash" from this source is almost impossible to eliminate completely. Great care is exercised in designing the large sectorial horn antennas which "illuminate" the models so that just enough beam width with uniform phase front is produced to cover the model with r.f. energy. Even though this precaution lowers the magnitude of floor "splash" it does not completely remove it. Sometimes low metal fences properly called *defraction edges* are placed on the model range to deflect the "splash" signal into a harmless area. Placing these fences for each frequency used (and sometimes as many as 200 "cuts" are made on a single model) is more of an art than a science.

Another troublemaker is the small coaxial cable which conveys the detected signal from the model down the tower to the laboratory. This is, of course, a metallic conductor of many wavelengths projecting from the model. Pattern distortion will be introduced by this cable, and only highly experienced personnel can minimize this difficulty by judicious placement of the cable when setting the model up for a "cut." To overcome this hazard some researchers have actually placed midget transmitters *inside* the model aircraft. Battery power or an air-driven generator energized by a high pressure hose are used, but the attendant cooling problems and frequency drift due to lack of power supply regulation makes this technique a last resort measure.

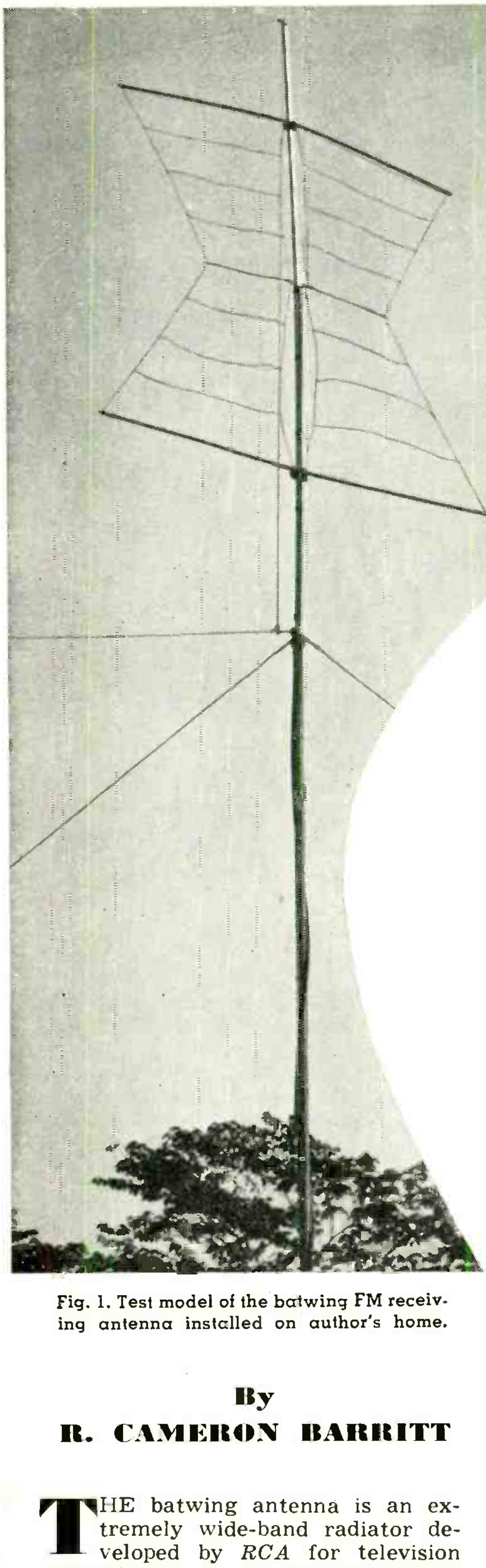
The problem of distance in wavelengths at the operating frequency between the model under test and the "illuminating" horn antenna poses, at times, a nightmarish enigma for the antenna worker. In order that an accurate radiation pattern be secured, the model aircraft must sometimes be placed as many as 100 wavelengths from the laboratory antenna, otherwise true "free space" conditions are not realized. Even at the microwave frequencies 100 wavelengths may be a sizable distance physically. Unfortunately, the power output of laboratory type Klystron tubes is only about 200 milliwatts for the region up to

(*Continued on page* 108)

Fig. 10. View of computer showing vacuum tube bays. Mathematician inspects plug board which inserts problem into the 1285 vacuum tube electronic computer used to solve complex antenna equations. Such machines are now routine tools in the search for new antenna designs and antenna improvements.



The Batwing
FM RECEIVING ANTENNA



A single element will provide high-gain reception over entire FM band. In some areas its bi-directional pickup pattern is a desirable feature.

Fig. 1. Test model of the batwing FM receiving antenna installed on author's home.

By
R. CAMERON BARRITT

THE batwing antenna is an extremely wide-band radiator developed by *RCA* for television transmitting. In its omni-directional form, it is known as the "superturnstile" and is used by nearly all television stations. This "current sheet" antenna has been employed for FM transmitting, but so far has been given little attention as an FM *receiving* antenna. In our opinion, it has many advantages and is worthy of consideration. A single element used as an FM receiving antenna results in bi-directional high gain over the whole FM band. For those who, like the writer, are situated so that desired stations are in two opposed directions (Fig. 2), the figure 8 pickup pattern may be best utilized. The pattern in the vertical plane is similar to that of two vertically stacked dipoles ½ wavelength apart; however two dipoles so situated present their highest impedance at only one frequency because the natural resonance of a dipole is sharpened in stacked arrays. The wide-band batwing does not exhibit this undesirable single-frequency effect, and has almost unchanging impedance over the whole FM spectrum while still retaining its bi-directional high-gain feature.

Important dimensions of the antenna are shown in Fig. 3. These are not critical. The two edges of the wings are grounded and are fed at the center. The area within the wing may be filled in at the discretion of the constructor, however, to eliminate the dangerous wind resistance, this area should not be solid. Copper screening or chicken fence wire may be used. If horizontal members are utilized, there should be at least seven between top and bottom.

Fig. 1 is a test model constructed quite inexpensively of two ½" diameter aluminum tubes and some 7/22 copper antenna wire. The antenna is mounted on the roof of the writer's home, 50 feet above street level, and is affixed to a 25-foot mast made of ½" and 1" conduit and ¾" diameter aluminum tubing. A hundred feet of RG-8/U cable (available at five cents a foot) runs to the first floor from the roof. Since the batwing is a completely grounded type of antenna, the sheath of the cable may be grounded somewhere near the end, affording complete lightning protection. The output impedance of the antenna is not exactly the impedance of the cable (52 ohms), but is close enough for all practical purposes, as the wide-band radiator yields an unvarying standing wave ratio.

Our experimental batwing has performed extremely well, considering the fact that it is situated approximately 100 feet above the Susquehanna River, which is only 500 feet above sea-level at West Pittston. In spite of the poor location, we have managed to pick up WSBA, York, Pennsylvania, which is 110 miles distant. WKOK—Sunbury (60 miles), WRAK—Williamsport (65 miles), and WPPA—Pottsville (60 miles) are all received at limiter level.

The antenna shown in Fig. 1 was merely a test model, and although it has withstood the fierce March winds of Wyoming Valley, it is not expected to have a long life. It will be replaced with one fabricated entirely of aluminum tubing welded together. It is con-

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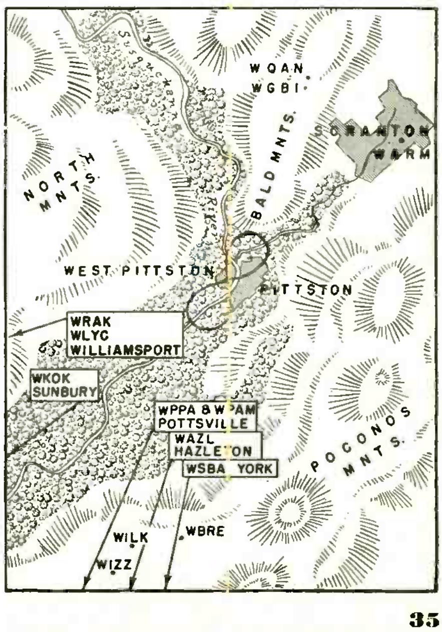
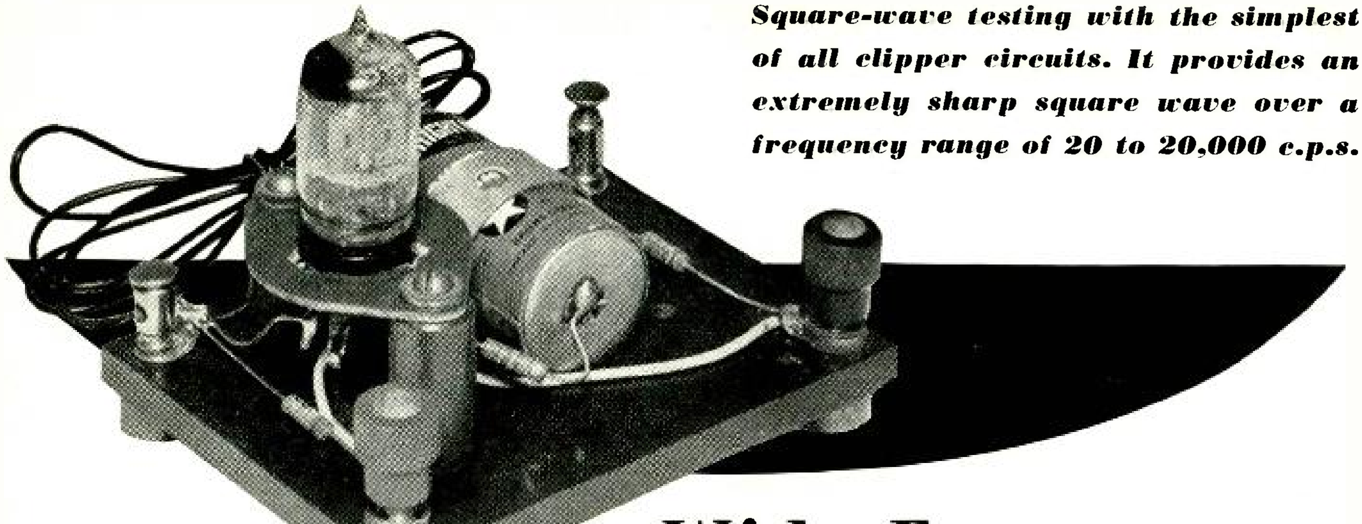
Fig. 2. Map of a typical locale requiring a bi-directional antenna. All stations that can be received are either to the northeast or southwest, with the mountains blocking reception from either the east or west.



Square-wave testing with the simplest of all clipper circuits. It provides an extremely sharp square wave over a frequency range of 20 to 20,000 c.p.s.



Single tube, square-wave clipper. Only 5 components are used in its construction — 3 resistors, a battery, and a dual diode.

Wide Frequency Range Square-Wave Clipper

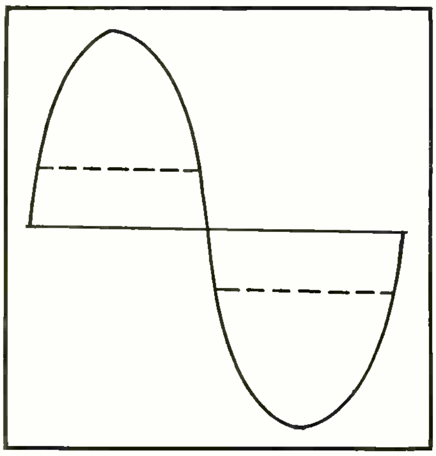
By
LOUIS E. GARNER, JR.

CHECKING the response of an amplifier to a square-wave signal provides the fastest and easiest method for testing frequency response, phase shift, transient response and similar characteristics. Unfortunately, commercial square-wave generators, particularly those covering a wide frequency range, are comparatively expensive and hence not easily available to the average service technician or experimenter.

However, a close approach to a square wave may be obtained by "clipping" the peaks of a sine-wave signal as illustrated in Fig. 1. A number of clipper circuits may be used to do this, the most popular being illustrated in Fig. 4A.

In operation, whenever the voltage of the input sine-wave signal exceeds the d.c. voltage applied to the diodes by means of small cells, the diodes conduct. Diode V_1 conducts on positive peaks and diode V_2 conducts on negative peaks. When either diode conducts, it acts practically as a short circuit and the input signal is dropped across series resistor R_1.

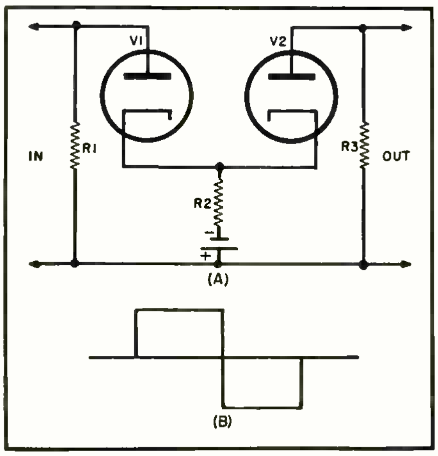
Fig. 1. Principle of clipper circuit. Peaks of sine wave are clipped to get square wave.



The effectiveness of clipping in this manner depends on the combined value of the diode resistance (when conducting) and the battery resistance in comparison with the value of R_1. If R_1 is very large compared to the combined diode and battery resistance, reasonably good clipping is obtained.

This circuit, though widely used, does not give a really close approach to a "perfect" square wave, and hence is not suitable where more exacting tests are required. First, regardless of how large R_1 is made, the diode and battery still have some resistance and a small voltage will appear across them. This voltage will vary with the changing resistance of the diode. Thus, a "rounded" square wave is obtained, with both trailing and leading edges rounded somewhat and with a slight bow instead of a perfectly flat top, as illustrated in Fig. 4B.

Fig. 2. Clipper circuit designed by the author. See text for values of components.



In addition to this disadvantage, the circuit also has a limited frequency range, for as R_1 is made larger, distributed capacities become important and limit the frequency at which even a close approach to a square wave can be obtained.

By using a different arrangement, the clipper circuit shown in Fig. 2A can be obtained. This circuit, when properly driven, will provide almost perfect square waves, with sharp corners and a flat top, over an extremely wide frequency range.

In operation, diodes V_1 and V_2 are normally conducting and thus act as resistors, passing any signal applied to the input. However, when the peak of the input signal exceeds the battery voltage, then one of the diodes stops conducting and acts as an open circuit, preventing further passage of the signal and effectively clipping the peaks.

On negative peaks, the plate of V_1 is made negative with respect to its cathode and hence it stops conducting and acts to open the circuit. On positive peaks, diode V_1 continues to conduct, but the cathode of V_2 is made positive with respect to its plate and this tube acts to open the circuit.

A practical circuit can be built using a 6AL5 dual diode, a 1.5 volt single penlight or flashlight cell, and half-watt carbon resistors. R_1 and R_3 have a value of 18,000 ohms, and R_2 has a value of 2200 ohms. Filament voltage can be obtained from the amplifier under test, or a small filament transformer can be provided.

In the clipper circuit built by the author, using these values, an almost perfect square wave was obtained with a constant amplitude of 1.5 volts peak-to-peak over the range 20-20,000 c.p.s., when driven with a sine wave having an amplitude of approximately 90 volts peak-to-peak. It could not be determined how high in frequency this clipper would continue to produce a square-wave signal since no sine-wave source supplying a signal of sufficient amplitude was available. However, since the resistor values are low, minimizing the effects of distributed capacities, and since no "frequency conscious" components are used, the maximum frequency at which a good square wave could be obtained should be comparatively high.

As in any clipper circuit, the square wave can be improved by increasing the amplitude of the input sine-wave signal, and, by using a signal of sufficient amplitude, a square-wave with an extremely short rise time can be obtained. Normally, the amplitude of the input signal should be from 50 to 100 times the amplitude of the output square wave.

In this circuit, the level of the output signal remains constant at the battery voltage. If a higher output voltage is desired, additional cells can be connected in series to increase the d.c. voltage and the level at which clipping starts. In this case, however, it is necessary to increase the amplitude of the input sine signal still further if a good square wave with a short rise time is to be maintained.

Application

When testing either a single stage or a complete amplifier, the equipment is arranged as shown in block diagram form in Fig. 5. A good oscilloscope and a sine-wave signal source are required in addition to the clipper. The square-wave signal at the output of the clipper is first observed on the oscilloscope. Next, the output signal from the amplifier is observed and any departures from a perfect square wave noted.

It is best to adjust the horizontal sweep of the oscilloscope so that at least two complete cycles can be observed on the screen.

An input square wave and distorted square waves showing the effect of different amplifier characteristics are shown in Fig. 3. The perfect input square wave is shown in Fig. 3A.

A drop-off in high frequency response in the amplifier causes "rounding" of the leading edges of the square-wave signal as shown in Fig. 3B. Usually, the rounding off will be easily noticeable if there is a decided drop in amplifier gain by the tenth harmonic (or less) of the square-wave fundamental frequency. Thus, if a 1000 c.p.s. square wave is passed without appreciable rounding, you can be reasonably sure that the amplifier is "flat" to 10 kc. But this gives no indication of the response below the fundamental frequency of the square wave. To do this, a lower frequency square wave is required.

Since this clipper, when properly driven, can easily supply a 20 kc. square wave, it can be used for checking the response of wide-band amplifiers (up to 200,000 c.p.s.) as well as audio amplifiers.

If there is phase shift in the amplifier so that phase leads at low frequencies, the top of the square wave is tilted as shown in Fig. 3C. If phase lags, the tilt is as shown in Fig. 3D. The amount of "tilt" depends on the degree of phase shift. Phase shift is usually not too important in audio amplifiers, as the ear is unable to detect it. However, in video and oscilloscope amplifiers no phase shift should be present.

The effect of accentuated gain at low frequencies is shown in Fig. 3E, while the effect of a drop in gain is shown in Fig. 3F. The drop in gain (Fig. 3F) is at the fundamental frequency of the square wave. It is assumed that there is no phase shift in both cases.

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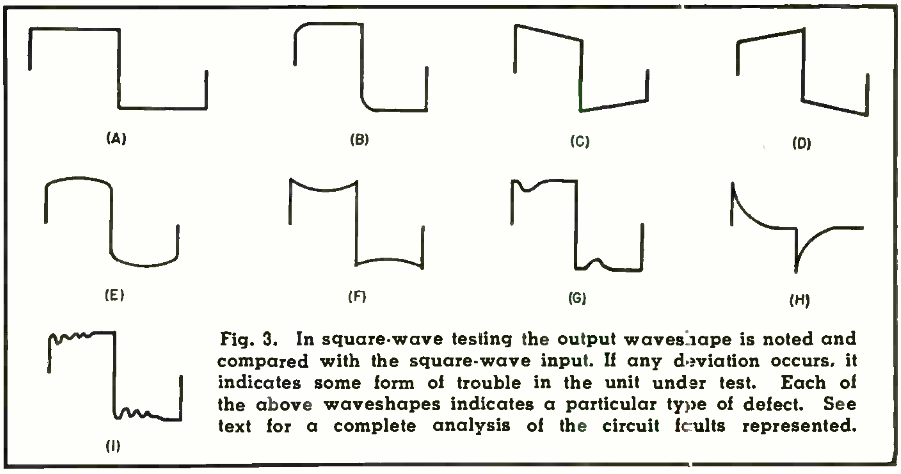


Fig. 3. In square-wave testing the output waveshape is noted and compared with the square-wave input. If any deviation occurs, it indicates some form of trouble in the unit under test. Each of the above waveshapes indicates a particular type of defect. See text for a complete analysis of the circuit faults represented.

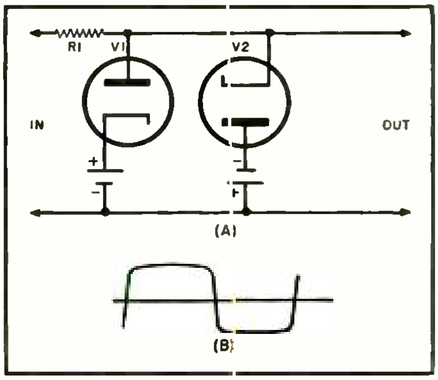


Fig. 4. Diagram of square-wave clipper tested by the author. Its waveshape is not as sharp as that of the final circuit shown in Fig. 2.

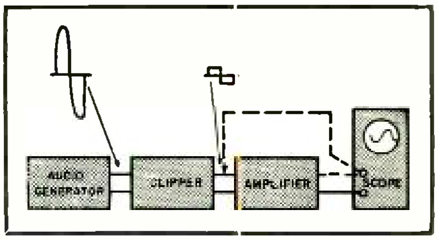
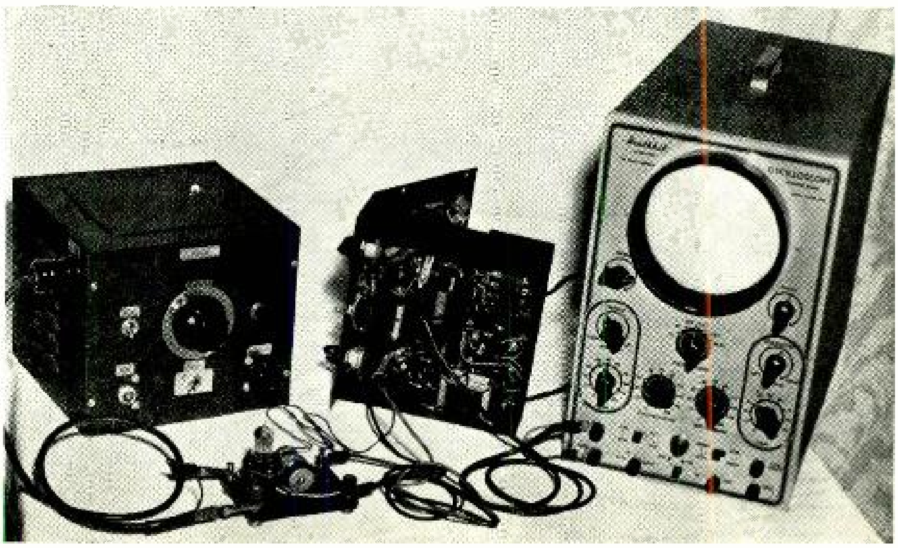


Fig. 5. Test setup used for checking audio amplifiers. It is pictured in photo below.

Clipper connected for checking the characteristics of an audio amplifier. The sine-wave audio oscillator is to the left, the test amplifier is in the middle, and the oscilloscope appears at right. The clipper itself is in the foreground.

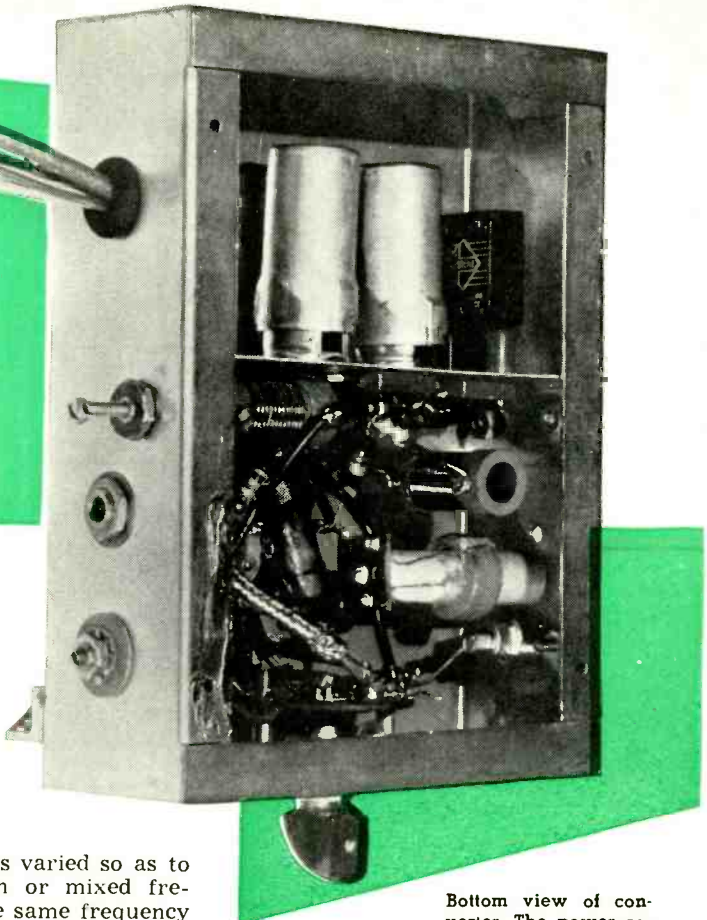


BROADBAND CONVERTERS

By

ALVIN B. KAUFMAN, W6YOV

Construction details for several types of short-wave converters for use on the 75, 40, 20, and 10-meter amateur bands.



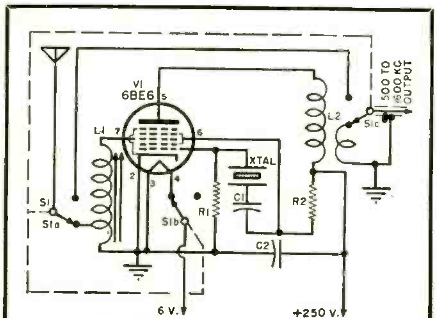
Bottom view of converter. The power cable and antenna RG 29/U wire to the receiver are at top left, while the r.f. trimmer, mike jack, and antenna padder are directly below.

AN EXAMINATION of the short-wave converters available commercially reveals several deficiencies both from the financial angle and because of technical imperfections.

The amateur or SWL, either with limited finances or with the desire to build a really simple though excellent 75, 40, 20, or 10 meter converter without any of the bugs and complications attendant with most such units, will be pleased by the simplicity and straightforward design of this converter.

In general, there are two types of converters presently in use. By far the most common is the tunable converter wherein the receiver is tuned to a fixed point and the converter oscillator frequency is varied so as to produce a conversion or mixed frequency, always at the same frequency to which the receiver is tuned. The other type of converter, not commonly in use, employs a wide-band r.f. input and output and a fixed frequency oscillator. This is the "broadband converter." Its output frequency varies with the frequency of the incoming signal and must be detected by tuning the receiver rather than the converter. The converters to be described are of the "broadband" variety with another important innovation added, crystal control, in some cases of a very unusual type.

Fig. 1. Schematic diagram of 75- and 40-meter converter. It can also be used, though not desirable, for 20- and 10-meter operation.



R_1—20,000 ohm, 1/2 w. res.
R_2—150,000 ohm, 1/2 w. res.
C_1, C_2—.001 μfd. mica cond.
L_1—R.f. coil (National XR-50 coil form)
L_2—R.f. coil (Miller UA-472 coil)
Xtal—Westline trans. crystal (see text)
S_1—3-pole, 2-pos. rotary sw.
V_1—6BE6 tube

One common complaint with practically all high frequency converters is frequency drift, and for the builder without a signal generator this presents difficulties in securing proper operation. Crystal control eliminates both of these troubles. There are no tricky adjustments or trouble encountered in tuning or finding the frequency range that this converter covers. With the proper crystal frequency your car or house radio tunes the ham band as a perfect "bandspread" unit. Transmitting or receiving type crystals are used in the converter; the crystal frequency and type of converter to use for the different bands will be indicated during a discussion of the three converters shown schematically. The crystals used are not expensive as an accurate frequency is not required. No special frequency is required for the ten meter band.

A one- or two-tube converter of this type admittedly does not have the gain of a four- or five-tube unit, but neither does it cost as much. In its field of use its good points certainly outweigh any objections to lowered sensitivity or a little loss of bandwidth when used on the ten meter band. On the ten meter band the author has received signals from all over the country (2-tube unit) and considers the sensitivity satisfactory.

There is one prerequisite that *must* be met if a broadband converter is used. The broadcast receiver tunes in the converted signal as if it were on the broadcast band. This means that the BC receiver must be completely "dead" with close to full volume when its antenna is not connected. Car radios being well shielded generally have no pickup, but the average inexpensive a.c.-d.c. may have excessive pickup in which case it would interfere with the short-wave signal. In any case a shielded cable must be used from the converter into the broadcast receiver. This cable should be of the low loss coaxial type such as the RG 29/U, etc. With the converter connected to the receiver a small amount of broadcast signal may come through until the converter warms up and supplies a signal and background noise to operate the a.v.c. in the receiver.

Three converters were designed by the author. The 6BE6 converter was designed primarily for 75 and 40, while the dual 6AG5 unit was designed primarily for 20 and 10. Although either unit may be employed for any band there are reasons which make each better suited for a different range of frequencies.

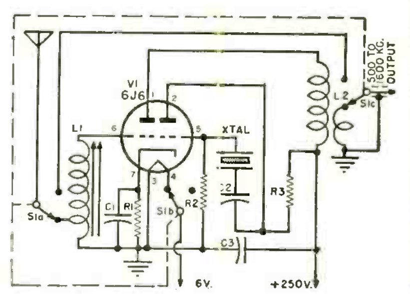
The 6BE6 converter (Fig. 1) employs a pentagrid tube with a crystal controlled oscillator section. Starting at the antenna, the r.f. signal may be tapped into the r.f. coil a few turns from the bottom or fed in through the all impedance matching network as shown in Fig. 3. This coil is of the high "Q" type. A *National* XR-50 coil is wound according to the specifications given in the coil table accompanying Fig. 3. This variable iron core coil and the tube's input capacity permit tuning throughout the band. The coil shows high "Q" over a wide frequency range, falling off rapidly outside this range. Rather than lower the "Q" by loading the coil with a resistor, which would "broaden the response" at a loss of the center frequency gain, no loading devices were used. Summed up in simpler words, the unit will be "hottest" near the peaked frequency of the coil. This coil's iron core should be adjusted after it is connected to the antenna so that it will resonate close to the frequency at which the transmissions are taking place or to any section of the band where peak performance is desired. In actual practice the performance over the complete band is quite satisfactory.

The plate of the 6BE6 is connected to a *Miller* UA-472 r.f. coil. This coil is a broadband broadcast coil designed to couple an antenna to the grid of the first r.f. tube, which is untuned. Here it is used in reverse. The grid winding is used as the plate winding in the converter, while the antenna coil feeds the converter output into the broadcast receiver's antenna input. This coil must be modified slightly from the manufacturer's configuration to fit this circuit. The grid return and bottom of the antenna coil are connected and are common on one post. These leads must be unsoldered and one wire shifted to the unused lug available on the Micarta strip. The associated aluminum shield can may be discarded to provide a more compact converter.

The use of a broadband broadcast frequency coil in the plate circuit of the converter makes special shielding unnecessary. Where both the plate and grid circuits are tuned to the same frequencies (some converters) careful shielding is required or the circuit may "take off" into tuned-plate, tuned-grid oscillator action.

As the crystal oscillator is of the Pierce type, no tuning is required in its circuits. Thus it can be seen that with the proper crystal, only the antenna input coil requires tuning to make the converter operative. This coil is tuned by operating the converter into a receiver without a.v.c. or into a short-wave receiver with an "S" meter. The receiver is tuned until a signal is received and then the coil is peaked by screwing the iron core in or out, as required. The windings for L_1, the input coil, are the same for all three units and are indicated on the schematic.

The 6BE6 converter, as can be seen, is a choice converter for 75 and 40 meters; only two coils, two resistors, two condensers, a crystal, and a tube being required. And it works excellently. It can be used on 20 or 10 meters, but as crystals with a fundamental mode of oscillation are made only down to 40 meters, it becomes necessary, when using a 40 meter crystal in the circuit, to employ its second or fourth harmonic, as developed in the tube circuit, to beat with the incoming 20 or 10 meter signal. The author has used this converter with a 40 meter crystal on the ten meter band. Its sensitivity is fair but not as good as the dual 6AG5 circuit where a 10 or 20 meter signal is injected into the mixer tube. Although the input coil was tuned to 10 meters, certain powerful 40 and 20 meter signals produced an undesirable signal in the receiver. The converter can be used for all bands by switching crystals and r.f. input coils, but, as indicated, is best suited for 75 and 40 meters.

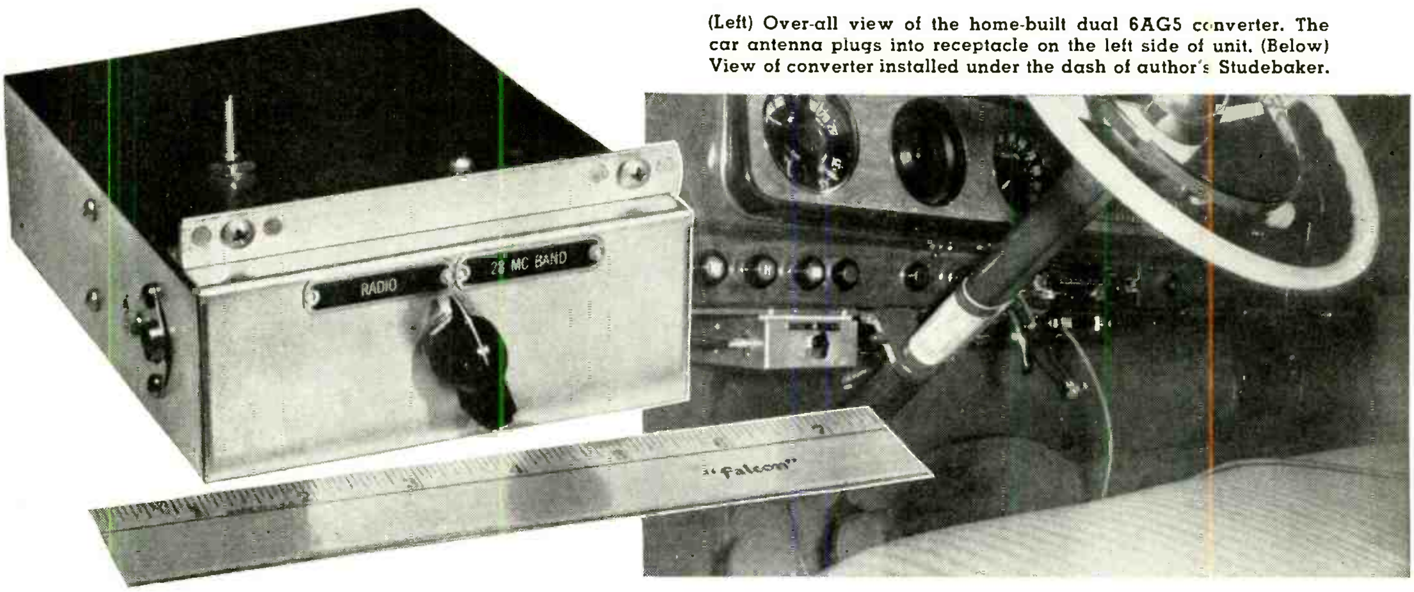


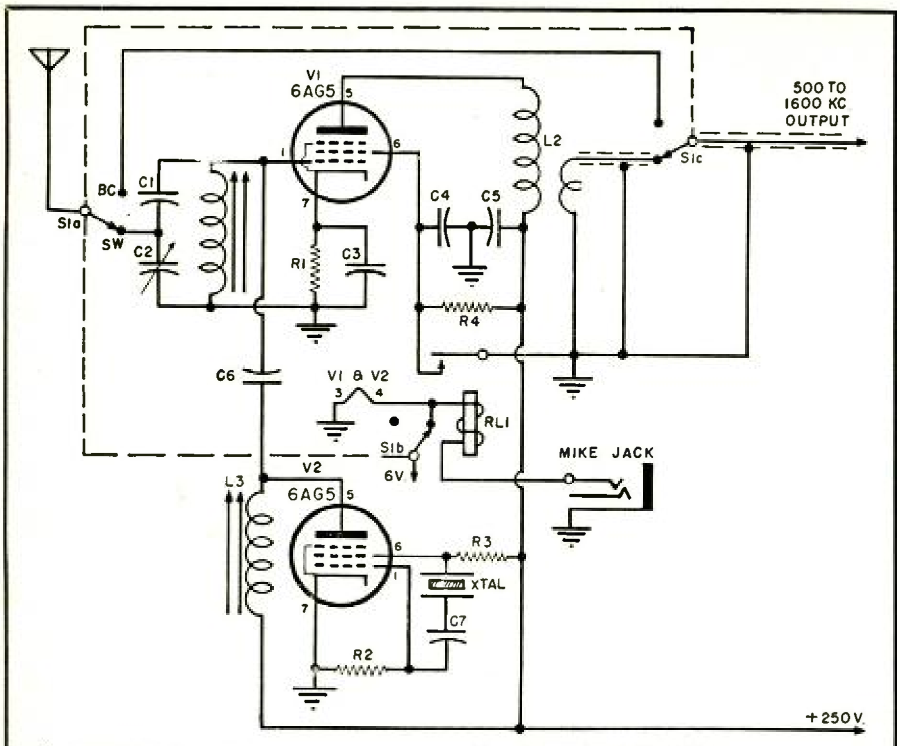
R_1—400 ohm, 1/2 w. res.
R_2—20,000 ohm, 1/2 w. res.
R_3—30,000 ohm, 1/2 w. res.
C_1—50 μμfd. mica cond.
C_2, C_3—.001 μfd. mica cond.
L_1—R.f. coil (National XR-50 coil form)
L_2—R.f. coil (Miller UA-472)
Xtal—Westline trans. crystal (see text)
S_1—3-pole, 2-pos. rotary sw.
V_1—6J6 tube

Fig. 2. Ideal, single tube, 10-meter converter.

The crystals used in any of the converters may be of either the transmitting or receiving type. *Westline* transmitting crystals were used by the author. The crystal frequency selected should preferably be at the low frequency end of the band. This is so that as the incoming short-wave signals increase in frequency the resultant conversion frequency is also higher and thus the receiver is tuned to a higher frequency. On certain bands this permits adding a factor to the broadcast receiver dial and reading it directly in short-wave frequency! The crystals should be of the following frequencies. A 3000 kc. crystal should be used for the 75 meter band. Here the low frequency end of the band, 3500 kc., will appear at 500 kc. on the broadcast receiver while 4000 kc., the high frequency end of the band, will appear at 1000 kc. on the dial, etc. Thus for

(Left) Over-all view of the home-built dual 6AG5 converter. The car antenna plugs into receptacle on the left side of unit. (Below) View of converter installed under the dash of author's Studebaker.





R_1—4000 ohm, ½ w. res.
R_2—20,000 ohm, ½ w. res.
R_3—50,000 ohm, 1 w. res.
C_1—5 µµfd. ceramic cond.
C_2—50 µµfd. trimmer cond.
C_3, C_4, C_5—.001 µfd. mica cond.
C_6—.006 µfd. mica cond.
C_7—50 µµfd. mica cond.
L_1, L_3—See coil table
L_2—R.f. coil (Miller UA-472)
L_4—100,000 ohm, 1 w. res.
S_1—3-pole, 2-pos. rotary sw.
RL_1—Relay (Leach P3-125)
Xtal—Westline trans. crystal (see text)
V_1, V_2—6AG5 tube

COIL TABLE

Band	Wire Size	L_1	L_3
10	20	14	17
20	26	26	35
40	28	58	65
75	28	105	115

All coils wound on National XR-50 form. Tap for L_1 (Figs. 1 and 2) approximately 10% of total turns.

Fig. 3. Ideal, two-tube 20 and 10-meter converter. Winding data for r.f. coil, L_1, covering 10, 20, 40, and 75-meter operation, also applies to r.f. coil L_1, shown in Figs. 1 and 2.

the 75 meter band a factor of 3000 would simply be added to the dial indication. Any crystal frequency close to 3000 kc. would be satisfactory and such crystals may be found in surplus stores or can be ground on special order for a few extra dollars. A 2500 kc. crystal could be used, in which case the 75 meter band would fall between 1000 and 1500 kc. on the receiver. The crystal frequency selected depends, to a large degree, on how accurately you wish the broadcast dial to reflect the short-wave frequency! For the 40 meter band a crystal frequency of 5800 to 6500 kc. can be used. However, 6000 kc. is preferable as the low frequency end of the band would appear at 1000 kc. on the receiver and the broadcast dial would be read directly in short-wave frequency by adding a factor of 6000. The 20 meter band would be covered by a crystal frequency of 6450 to 6750. Again 13,000 kc. would be best, the low frequency end of the band appearing at 1000 kc. on the receiver. A factor of 13,000 would be added to make this band track on the receiver. In this case a 6500 kc. crystal would be used in the separate oscillator circuit, Fig. 3, and its second harmonic of 13,000 kc. injected into the mixer tube. These lower frequency bands present no problem of frequency coverage as they are only 300-500 kc. wide and thus the radio receiver gives more than adequate coverage and sufficient bandspread to be satisfactory. The 10 meter band being 1700 kc. wide means that it cannot be completely covered by a broadcast receiver, but that the bandspread action would be excellent as the band covers more of the dial. Actually, for a given increment of dial movement, the receiver would tune the same frequency difference on any band and there would be no difference in selectivity on any of these bands. The proper crystal frequency for 10 meter coverage depends upon which section of the band you wish to receive. My choice is from 28.5 megacycles to 29.6 megacycles. This calls for a 7000 kc. crystal. Its fourth harmonic falls at 28 megacycles and thus by adding 28 to the receiver dial a 28.5 mc. signal appearing at 500 on the dial would be read 28,500. The factor would be 28 or 28,000. An advantage here is that 7000 to 7010 kc. crystals are easily obtainable as they are 40 meter crystals. To cover from 28,000 kc. up, a 6875 kc. crystal would be required. To cover from 29,700 kc. down, a 7050 kc. crystal is necessary.

The 6J6 converter (Fig. 2) is satisfactory for any frequency of operation, but has the same limitations as the 6BE6 unit for the two high frequency bands. It was determined that a triode mixer of this type does not have a lower noise level at these frequencies than the pentagrid or grid injected converter. The oscillator mixing action takes place in the common cathode resistor and the bypass condenser is critical, 50 µµfd. being the correct value for the 10 meter band. This unit compares favorably with the 6BE6 unit, but if the builder is starting from scratch, the latter is a better unit to build.

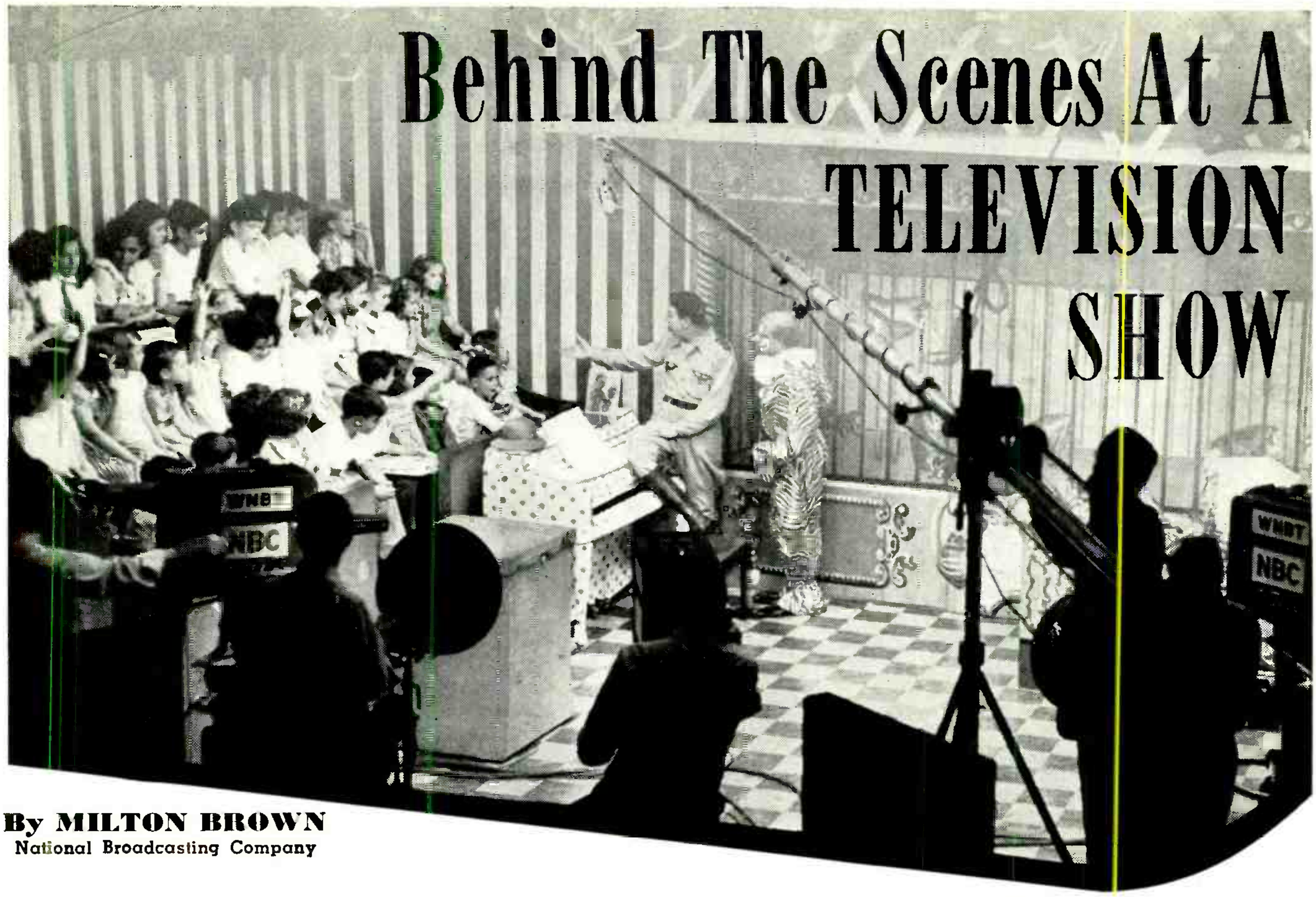
The dual 6AG5 converter (Fig. 3) is very satisfactory for 20 and 10 meter operation. This unit was designed and found suitable for these bands. It is needlessly complicated for the 75 and 40 meter band, the 6BE6 unit being comparable in performance and requiring less material. A 10 meter version was constructed and installed in the author's car to complete a mobile station. Although the previously mentioned points regarding crystals, coils, etc. also apply to this unit, there are additional features requiring explanation. During experimental development of this converter it was determined that the popular 6AK5 tube was not satisfactory for converter service for two reasons. This tube has a rated 180 volts maximum plate supply and the tubes tested were gassy enough to ionize at the admittedly high supply voltage of 250 volts d.c. The worst feature was the wide change in transconductance when the tube was subjected to vibration. The 6AG5 possesses neither of these objectionable features. Of course, this does not condemn 6AK5 tubes for other uses.

The oscillator section of the 6AG5 converter consists of a single 6AG5 tube whose screen grid circuit is wired as a Pierce oscillator and whose plate circuit is resonated (in this case) to the 10 meter band. A low frequency crystal is used, as outlined previously, and the plate circuit of the oscillator tuned to a multiple of the crystal frequency. Both the oscillator coil and r.f. input coil are tuned while operating the converter into a receiver. The receiver must have either an "S" meter, no a.v.c., or a very weak input signal applied to it. If a signal generator is not available any signal may be tuned in by the receiver on the ham band. Even without alignment there will be enough signals coming through for this purpose. After a signal or carrier is tuned in, the r.f. and oscillator coils are tuned by their iron cores for maximum receiver output. It is advisable to make the a.v.c. circuit in the receiver inert if it does not have an "S" meter, otherwise peak tuning is almost impossible. Where a high gain ham receiver is used for this tuning operation, a certain amount of broadcast leakage may be expected which will not appear with car or other radios.

The antenna may be coupled into any of the three converters by direct tapping into the coil or by the variable impedance antenna coupler as shown in the dual 6AG5 converter schematic The variable impedance antenna coupling has been used on many other sig-

(*Continued on page* 145)

Behind The Scenes At A TELEVISION SHOW



By MILTON BROWN
National Broadcasting Company

Putting on NBC's "Howdy Doody" show at the WNBT studios requires the services of many highly trained technicians and engineers.

Back of the smooth and seemingly effortless show appearing on your video screen is a complex and highly trained organization of video technicians.

TELEVISION is a complex scientific operation, combining the action of light and optics, electricity and radio, physics and chemistry, electronics and photography.

One of the most complicated mechanisms in television is the camera—the instrument which is the basis of all television production.

Although the television camera resembles the motion picture camera, it practically begins where the movie camera leaves off. In regular photography, the scene to be photographed is picked up by a lens and focused on a strip of celluloid coated with a photosensitized emulsion and the action of the camera stops there.

On the other hand, the television camera is an electronic device which contains a tube, called the image orthicon, which translates the image transmitted from a lens onto a photosensitized surface into electrical impulses. These impulses are amplified and travel as such until they reach the television receiver in the home, where they are again translated into the image of the originally photographed scene. In greater detail, this is the route taken by a bit of action during a telecast:

The scene is picked up by the television camera, the signal is amplified in the camera, sent through the camera cable to the studio control room, where it is adjusted and amplified, then sent through cable to master control, where it is amplified again, and from there to *NBC's* antenna atop the Empire State Building. At the same time that the telecast is sent to the Empire State Building from master control, it is also sent from there to the telephone company's network terminal point for transmission through the coaxial cable to stations connected to the network.

WNBT's television signal in New York is radiated from an antenna, located on the Empire State Building tower, to be picked up by home receivers. The video signals are brought into the set inside the house and appear on the screen. The sound portion of the program is picked up in the television studio simultaneously with the video, is amplified and transmitted in the same manner as any regular radio broadcast.

The technicians immediately concerned with pickup and transmission of any television show are specialists in many fields; some of the equipment they use is standard to radio and motion picture but most of it represents the best and latest in electronic achievement, a large portion of it designed by *RCA* and *NBC* engineers.

The following is to indicate the relationship of technician to equipment during the actual pickup of a video program:

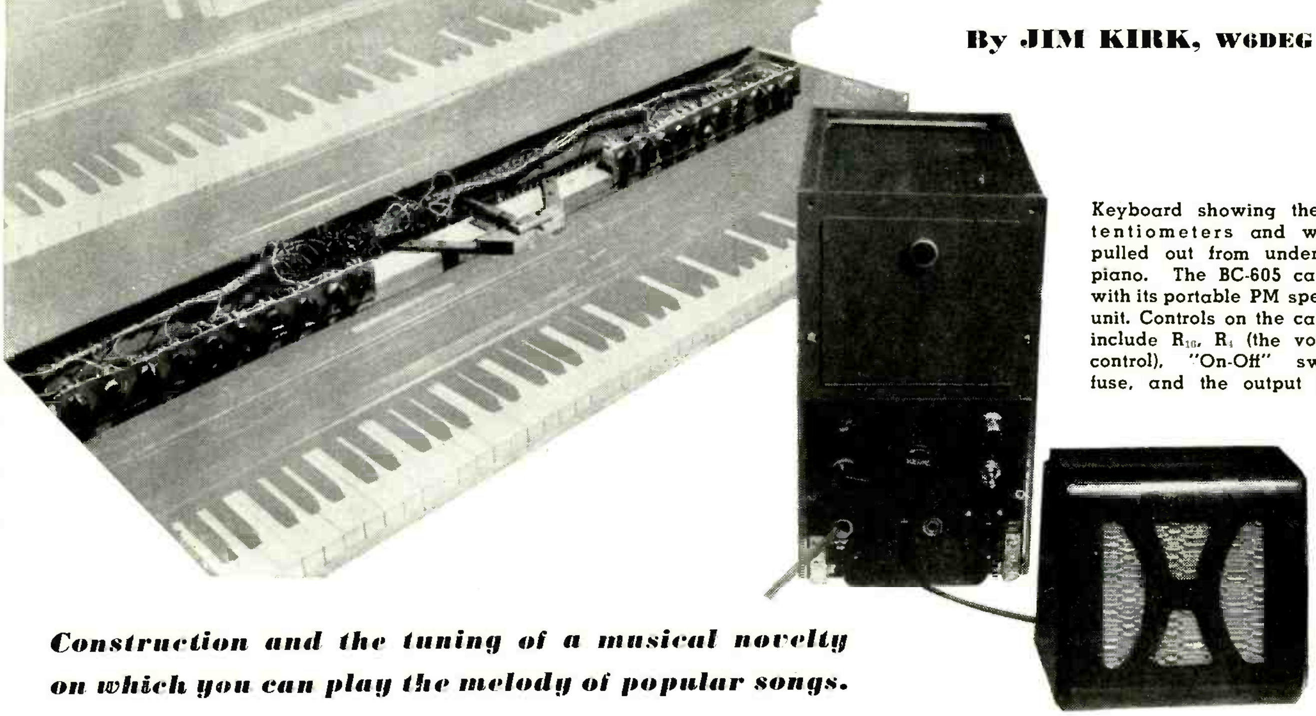
In the Studio

Cameramen—Cameras: Usually, three cameras are used. Camera #1 is mounted on a dolly and is the only camera which is moved to produce moving shots—called dolly or truck shots—during the program. It is used for wide-angle shots. Cameras #2 and #3 are mounted on mobile pedestals, and while they can be moved, they do so only between shots. Each camera has a lens turret with a complement of four lenses of various focal lengths. In general, on camera #1, the lenses have 35, 50, 75 and 135 mm. focal lengths, while #2 and #3 have 50, 75, 135 mm. and 7½-inch focal lengths. For extreme closeups, lenses of longer focal lengths are available and are used when necessary. All lens changes are accomplished by means of a remote control handle in the rear of the camera. Changes in optical focus are made by means of either a focusing handle or a knob on the right side of the camera. While motion picture cameras are focused by moving the lens itself, in a television camera, cor-

(*Continued on page* 148)

A Home-Built ELECTRONIC ORGAN

By JIM KIRK, W6DEG



Keyboard showing the potentiometers and wiring pulled out from under the piano. The BC-605 cabinet with its portable PM speaker unit. Controls on the cabinet include R_{10}, R_4 (the volume control), "On-Off" switch, fuse, and the output jack.

Construction and the tuning of a musical novelty on which you can play the melody of popular songs.

I HAD taken the pledge and sworn off. Yes sir—from now on—no more surplus. Then our local junk dealer demoralized me by offering, right in his window, a stack of brand new BC 605's for $5 per copy. That was too much of a bargain to pass up. Besides, I told myself, I need a cabinet and chassis for the experimental electronic organ I am building. A cabinet that I'd be proud to set on top of my piano. Furthermore, the parts I did not use would be worth much more than the price of the whole BC 605 with tubes. Just try and buy those leftover parts new and see what they cost. Just one more little purchase of surplus—the reader can guess what happened.

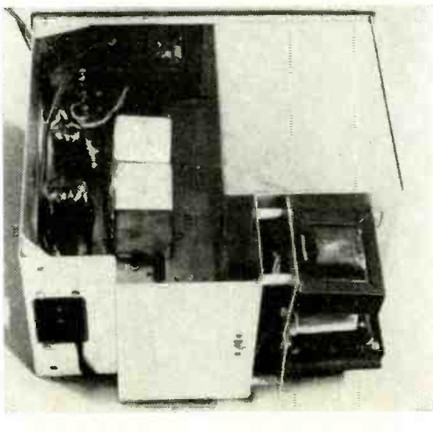
Search for a Keyboard

Then I needed a keyboard for my electronic organ. If I could get a keyboard that I could mount near or under my piano, I could use the electronic organ to play the melody and play chords on the piano to accompany it. I shopped at local toy stores for toy pianos. All they had were little plastic toy grand pianos. They would not do. They could not be taken apart without wrecking them. One shop did have a handsome little wooden toy piano. It wasn't so little, at that, and beautiful tunes could be played on it. It had 25 keys. That would suit my purpose fine but the price was $24.50. With tax, that was five times what the BC 605 cost.

Silent Practice Keyboards

A canvass of the piano stores for practice keyboards revealed several for $49.50. Very beautiful—more keys than I needed and too costly. The last company had two *Virgil* "Claviers" for sale at ten dollars each. They were full size piano keyboards for soft or hard keying or for silent or click keying. It would be too simple to install a copper strip back of the moving metal fingers. The whole thing could be cut down and moved right under the piano with the keyboard protruding. Just what I wanted. I bought the best looking one. Inside was some printing showing when the manufacturer's guarantee expired—the year I was born—1895!

> EDITOR'S NOTE: *The author has used a surplus BC 605 unit to obtain a cabinet, miscellaneous parts, and a chassis. This is not necessary as any new or junk box parts and cabinet may be substituted.*
>
> *Since only 21 notes are required to play the melody of most popular pieces a full piano keyboard is not required. The author used a "Clavier" with a standard-sized keyboard simply because it was available at low cost. The entire keyboard may be utilized by adding additional octaves to the circuit as presented.*



Chassis view of the unit. The choke, condenser, and power transformer are shown mounted on a strip of aluminum. The 5Y3GT tube, not visible, is behind the choke and condenser.

Converting the BC 605

All the inside parts of the BC 605, including wiring, were removed, except the two tube sockets and two condensers. The front panel was left intact for appearance sake and because we are going to use the volume control, the switch, the fuses and the telephone jacks. A little strip of aluminum was mounted on the posts in the dynamotor well—identical to the method I use to power the popular BC 604 receivers. From the diagram it will be noted that two oscillator tubes in the one 6SN7 envelope are used. The reason being that the condenser *and* the resistance in the circuit control the frequency of the audio oscillation. If only one tube is used to cover the wide range wanted, a high resistance would be in the circuit by the time the low notes are wanted. The tube did not sound well on the low notes with a small grid condenser and a high grid leak. Better use one tube for the top half and another tube for the lower half. Since the 6SN7 tube is two tubes in one and since it takes up no more room than one tube and since surplus audio transformers are plentiful—two oscillators are employed.

Cutting Down Howls

The volume control is invaluable for playing and especially for tuning up, if you have any regard for the neighbors. I did not want to further antagonize my neighbors—what with them already up in arms and threatening to chop down my transmitting antenna because of BCI. That was before I installed NBFM, I hasten to explain.

When I first got the electronic organ all connected up and ready to try out, I struck a low note and received the Bronx cheer. That was all right. I had always wanted to know how to duplicate the Bronx cheer electronically. Now I knew.

Tuning Up

You really need three hands for tuning up but if you are not so fortunate, there are two stunts you can employ. You can strike the piano note and remember what it sounded like, then hold down the organ key and try to tune the potentiometer to the same sound. You *could* put a roll of solder on the organ key and strike the piano note and tune—but it isn't much better than remembering. Start with the highest note and try to make it sound like high "F". Then try matching about four other keys. At this point, try playing some simple tune. If your experience matches mine, the tune will sound sick-like. However, if you have an ear for music, you can correct the sound better this way than by trying to match all the piano notes one by one.

Audio transformers will not oscillate unless the polarity is right. The method I employ is to go ahead and permanently hook the grid to "G" post and the "F" to the chassis. Then hook the plate to "B plus" and the power to the "P" post with flexible wires. If no oscillation, just reverse these flexible wires.

Using the Organ

The reason for wanting 21 notes on my electronic organ was so I could play the melody for all popular ballads. These notes—from high "F" to a low "A"—cover every note used in one hundred popular ballads I have on hand and am fond of playing on the piano. At first glance, the 21 potentiometers (22 with the volume control) look like the most expensive part of the outfit—but you do not reckon with my Scotch blood. I could have saved money by discovering the exact resistance needed in each case and using cheap one half watt fixed resistances, but that would not hold for every piano and it would not hold if the piano changes tune with age. With potentiometers one can keep the organ in tune, just like tuning up a violin. (My organ sounds like a violin, I insist.) Just because the potentiometers scratch a little when used as volume controls, does not impair their usefulness in this application except the volume control on the 605 panel. Being a radio serviceman, I had a flock of used volume controls on hand and I only had to use a value larger than the resistance I needed.

The audio transformers are surplus transformers from the GF 11 transmitter, but any inexpensive 3 to 1 audio transformers from the junk box will do as well because I have tried several in the experimental stages. You compensate with the potentiometers, anyway, so a difference in the transformers is not noticed. The only reason why I wound up with these surplus transformers is that they look neat and are handy to mount and wire in this application. Placement of parts and wiring is definitely not critical so the builder may easily deviate from this arrangement without harmful results.

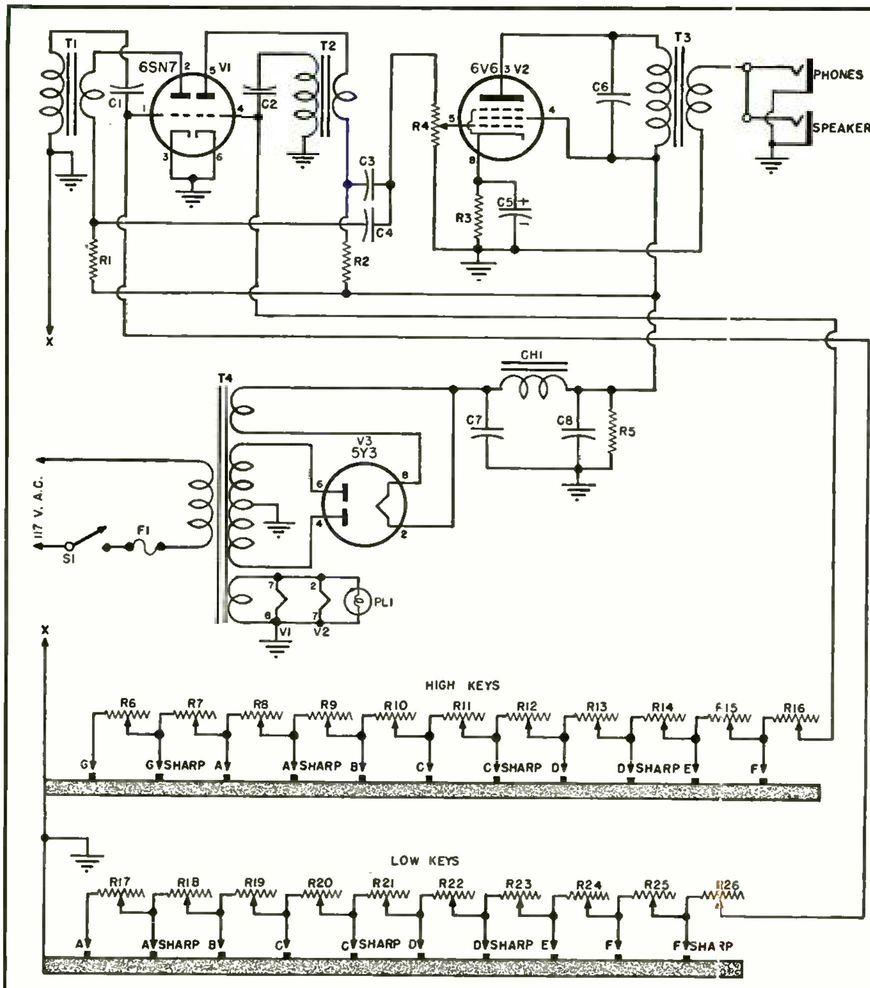
It may be noticed that several of the potentiometers have switches. This is because some of the used potentiometers that I had on hand were equipped with switches and I saw no reason for removing them in this application. The switch cover performs the function of keeping the dust out.

I must explain that this "organ" is tuned an octave lower than the melody for which the music is written. This is because it brought it in range of my singing voice and I can accompany my "music" with my rich baritone voice, if my guest insists. If you want to tune it to the melody that the music is written in, every key will be an octave higher and every potentiometer will have less resistance in the circuit. No change will have to be made in the components, however.

I built this organ five times before it reached its present form. I tried a neon oscillator first. Then I tried dif-

(*Continued on page* 111)

Circuit diagram and parts list covering the electronic organ. The approximate resistance values for the various potentiometers are given below the parts list.



R_1, R_2—100,000 ohm, ½ w. res.
R_3—500 ohm, 10 w. wirewound res.
R_4—500,000 ohm pot.
R_5—20,000 ohm, 10 w. wirewound res.
R_6, R_8, R_{17}, R_{23}, R_{25}—250,000 ohm pot.
R_7, R_{24}, R_{26}—500,000 ohm pot.
R_9, R_{18}, R_{19}, R_{20}, R_{21}—100,000 ohm pot.
R_{10}, R_{11}, R_{12}, R_{16}, R_{22}—50,000 ohm pot.
R_{13}, R_{15}—10,000 ohm pot.
R_{14}—25,000 ohm pot.
C_1—.001 μfd. mica cond.
C_2—500 μμfd. mica cond.
C_3, C_4—.5 μfd., 400 v. cond.
C_5—10 μfd., 25 v. elec. cond.
C_6—.05 μfd., 400 v. cond.
C_7, C_8—10/10 μfd., 350 v. elec. cond.
T_1, T_2—Midget audio trans., 3:1 ratio
T_3—Output trans., 6V6 (5000 ohms) to v.c.
T_4—Power trans., 275-0-275 v. @ 50 ma.; 5 v. @ 2 amp.; 6.3 v. @ 2 amp.
CH_1—Filter choke, 50 ma. midget type
PL_1—6.3 v. pilot lamp
S_1—S.p.s.t. toggle sw.
F_1—3 amp. fuse
V_1—6SN7 tube
V_2—6V6 tube
V_3—5Y3 tube

Note: Approximate resistance values of pots for correct tone are:

R_6, R_{25}—100,000 ohm
R_7—400,000 ohm
R_8—130,000 ohm
R_9—88,000 ohm
R_{10}, R_{11}—30,000 ohm
R_{12}—32,000 ohm
R_{13}—6000 ohm
R_{14}—10,000 ohm
R_{15}—8000 ohm
R_{16}—42,000 ohm
R_{17}—150,000 ohm
R_{18}, R_{27}—75,000 ohm
R_{19}—55,000 ohm
R_{20}—95,000 ohm
R_{22}—35,000 ohm
R_{23}—200,000 ohm
R_{24}—270,000 ohm
R_{26}—400,000 ohm

An Effective SYNC "Lock-in" CIRCUIT

By

DAVID GNESSIN

Details of a new circuit for television receivers developed by Transvision and available in kit form.

DOES your television horizontal hold control act skittish, requiring adjustment to a single sensitive position, otherwise the picture tears? You can lock-in the horizontal hold with the circuit described in this article so that once set a deliberate rotation of the control (up to 30 degrees of rotation) will not throw the horizontal sync out of hold.

Despite its efficiency this device is simple. Comprising a single dual-diode tube with its coupling circuit, this automatic frequency device leans over backwards to hold the sync locked even when the hold control is moved off oscillator frequency. This article will discuss the theory of operation fully.

Fig. 1A shows a simple sync amplifier. This could be an amplifier common to both horizontal and vertical sync, or it might be the horizontal sync amplifier alone. Note the phase reversal of the sync pulse. Due to inherent plate amplifier action the positive sync pulse applied to the grid results in a negative sync pulse developed in the output.

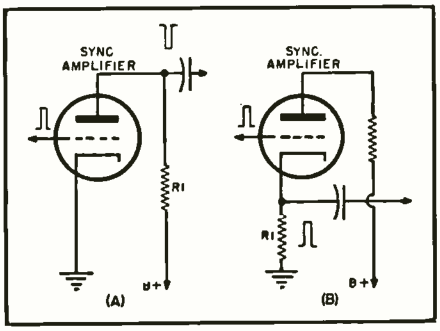


Fig. 1. Two versions of simple sync amplifier.

Next examine Fig. 1B. By placing R_1 in the cathode circuit the sync pulse now developed in the circuit has the same polarity as that applied to the grid input.

This leads to Fig. 2 where R_1 and R_2 are placed in the plate and cathode circuits respectively. Thus, a voltage of the same potential but of opposite polarity is developed in the two outputs. This charges condensers C_1 and C_2 in opposite polarities. (Condenser C can be considered an extension of the plate-cathode tube capacity. It is part of the inherent phase-shifting network).

The filament circuit of the phase converter is omitted for simplicity. It may be readily seen, however, that while conducting, the diode is an effective low-resistance path from C_1 to C_2. Thus, while the sync amplifier is passing a horizontal sync pulse the condensers C_1 and C_2 charge, right through the diode. Resistors R_3 and R_4 act as bleeding control returns to ground.

Due to the time constant of circuit components, condensers C_1 and C_2 are not fully discharged before the next sync pulse is applied to the input of the sync amplifier. Thus an effective d.c. is established within the circuit which may be measured say, at point "X." Since this is a balanced circuit, if incoming sync pulses are of equal amplitude, the voltage at reference point "X" would be *zero*.

A short digression is in order to explain the "phase converter" whose real work is yet to begin. The horizontal sync pulse has been rectified and it is ready to be mixed with the horizontal sweep pulse tapped off of the horizontal yoke (not shown). This latter pulse is the one developed by the local horizontal oscillator which is not shown.

The essence of the mixing within the phase converter lies in the following reasoning. The horizontal oscillator circuit of the TV receiver is triggered by the horizontal sync pulse in normal operation. This "trigger" pulse rides on the modified saw-tooth sweep which leaves the horizontal output circuit and is impressed on the horizontal yoke. Naturally the question arises—Is it really doing all this?

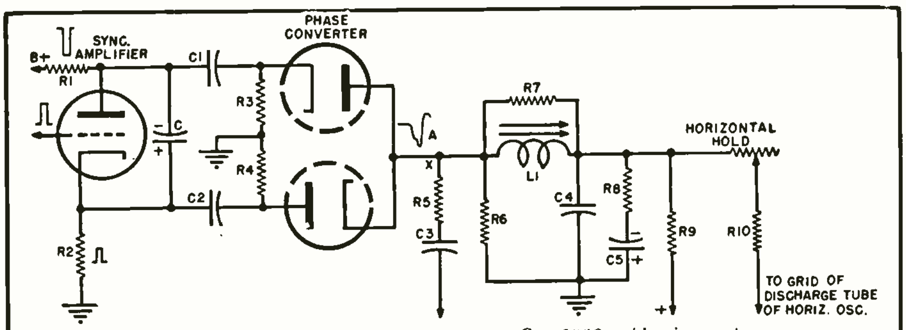
The phase converter circuit is a checking and correcting device which answers that question. It examines the pure sync pulses stripped from the composite video signal and simultaneously examines the sweep pulses already corrected by that same sync, checking them against each other for accuracy.

Since these two pulses pass through the phase converter tube together to be rectified, conversion will take place, just like the converter in the common superheterodyne. Only it won't be a conversion to *change* frequencies. (The frequency difference will be in the order of a fraction of a cycle.) The comparison will be one of *phase* difference. Thus the name, phase converter.

No matter how sharply the circuits are tuned in superheterodyne converter stages, the resulting conversion

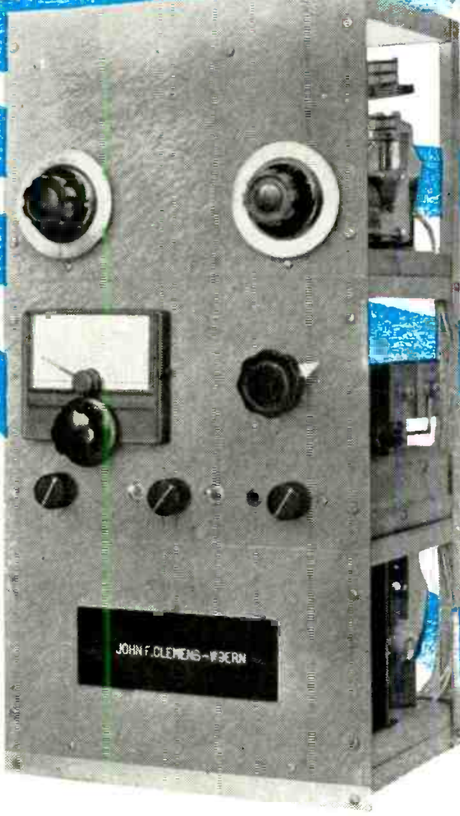
(*Continued on page* 88)

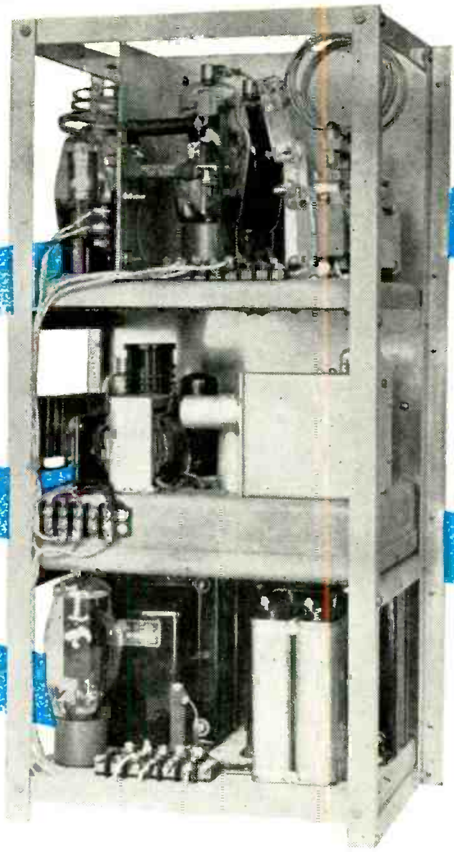
Fig. 2. Schematic and parts list of Transvision's lock-in circuit for TV receivers.



R_1, R_2—6800 ohm, 1/2 w. res.
R_3, R_4, R_6—100,000 ohm, 1/2 w. res.
R_5—56,000 ohm, 1 w. res.
R_7—10,000 ohm, 1/2 w. res.
R_8—2200 ohm, 1/2 w. res.
R_9—1 megohm, 1/2 w. res.
R_{10}—56,000 ohm, 1/2 w. res.
C, C_1, C_2—500 μμfd. mica cond.
C_3—1000 μμfd. mica cond.
C_4—.05 μfd., 400 v. cond.
C_5—4 μfd., 50 v. elec. cond.
Hor. Hold—100,000 ohm pot.
Phase Conv.—6AL5 tube
L_1—Standard slug-tuned linearity coil (Transvision Part No. 377)

The MINI-RACK TRANSMITTER





Complete 100-watt, all-band c.w. transmitter which is housed in a miniature relay rack, 19" x 10". The front panel is aluminum, finished in grey crackle. The rack frame is made of ⅝" aluminum angle stock and self-tapping screws. The three decks, from top to bottom, are: final amplifier, the v.f.o. exciter unit, and the final amplifier power supply assembly.

By
JOHN F. CLEMENS,
W9ERN

Designed for clickless and chirpless keying, this compact, home-built transmitter is smaller than most of the present-day communications receivers.

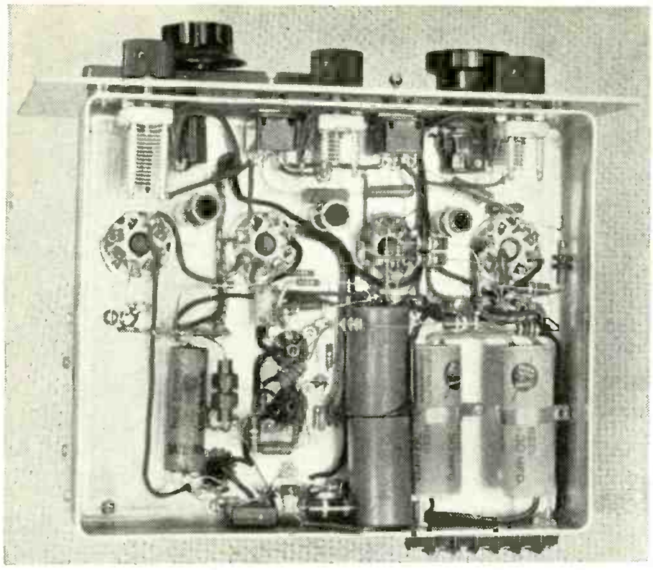
THE modern amateur station invariably uses some form of variable frequency control. The current trend in transmitter design accents speed and flexibility of control but these advantages are usually obtained at an increase in complexity and bulk. After several attempts at transmitter layout along conventional lines, the author concluded that a standard relay rack occupied too much operating table space. Finally, the pictured layout evolved and proved quite satisfactory from the standpoint of operating convenience. The transmitter is constructed in miniature relay rack style. The front panels are ten inches wide and the three decks, final power supply, v.f.o. exciter, and final amplifier, total 19 inches high. The rack is eight inches deep. Thus the complete 100 watt, all-band transmitter occupies only 8x10 inches on the operating table.

The absence of a transformer-type exciter power supply greatly facilitates compact construction. The voltage doubler power supply for the exciter uses selenium rectifiers and makes the exciter a completely self-powered, all-band, 15-watt transmitter. The voltage doubler power supply using vacuum rectifiers has never gained wide popularity among amateurs due to its notoriously poor voltage regulation. Selenium rectifiers tell a different story due to their extremely low resistance in the conducting direction. As a result, the voltage regulation is excellent. In the exciter, the key-up to key-down voltage change is from 295 to 270 volts when the current change is 40 to 130 ma. The power supply generates very little heat which is important since it helps in obtaining frequency stability.

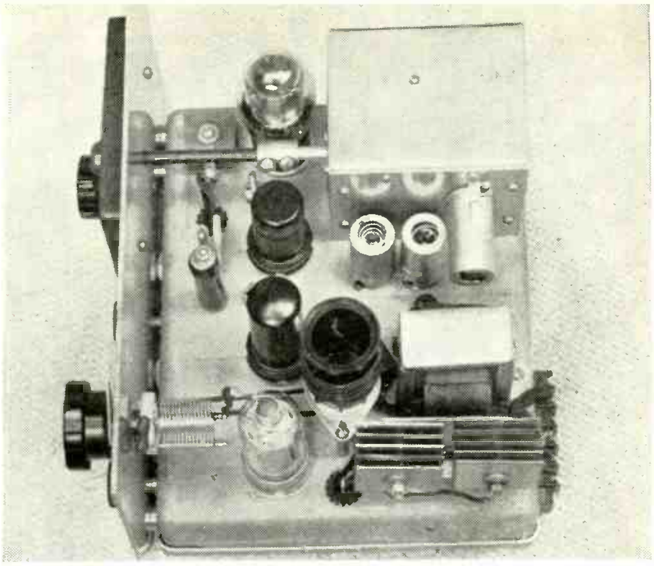
One objection to the transformerless power supply remains: the fact that one side of the power line is connected to the chassis. This need cause no difficulty if the operator is careful to insert the wall plug with the grounded side of the line connected to the chassis. If the transmitter is located some distance from any grounded object, *e.g.*, on the second floor and not near a radiator, the grounded line needs little consideration since neither plug position can cause a shock. Of course, the safest procedure is to provide a good ground lead from the chassis to a water pipe and to be careful to insert the plug correctly. The single wire plug system with the ground lead may also be used.

The variable frequency oscillator uses a 6C4 or 9002 in the now-famous *Clapp* circuit. The tuning range is 1.7 to 2.0 mc. so that all the amateur frequencies from 3.5 to 29.7 mc. are covered. A great deal has been written recently about the advantages of the *Clapp* circuit so there is no need to review it here. One point should be mentioned in connection with the stability of the oscillator. If maximum dynamic stability is to be ob-

Coming Next Month
"THE MINI-RACK MODULATOR"
A 50-watt modulator designed as a companion unit to this transmitter.



Bottom view of exciter. The exciter chassis is provided with a cover which has been removed to show wiring. The three variable condensers tune 80, 40, and 20 m. doubler tank circuits.



Top view of exciter. The unit is a self-powered, 15-watt transmitter. The rectifiers are mounted with the fins vertical to aid cooling. The 2E26 plate coil socket is mounted on spacers.

tained it is essential that the oscillator coil have maximum "Q." This requirement necessarily imposes a limitation on the construction since a coil must have a diameter of at least two inches at this frequency if high "Q" is to be obtained. In addition, the shield around the coil should clear it everywhere by at least the coil diameter. It is apparent that the oscillator will become a bulky unit if these conditions are realized. The keying ability of the oscillator depends on the frequency-change versus plate voltage characteristic which we have referred to as the "dynamic stability." Dynamic stability is of only secondary importance if the oscillator is not keyed and is supplied from a voltage stabilized power source. The oscillator still retains the stability which accrues by virtue of the large capacities between grid and cathode, and ground and cathode so that thermal variations in tube constants and changes in load cause little effect on the frequency. It should be emphasized that where dynamic conditions are maintained constant by voltage regulation and by continuous, rather than keyed operation, the *Clapp* oscillator will be stable even though the coil does not have the highest possible "Q." This is the basis for the compact construction of the exciter. It was reasoned that the best oscillator keying would do no better than approach buffer keying and if backwave effects could be eliminated the latter would be superior.

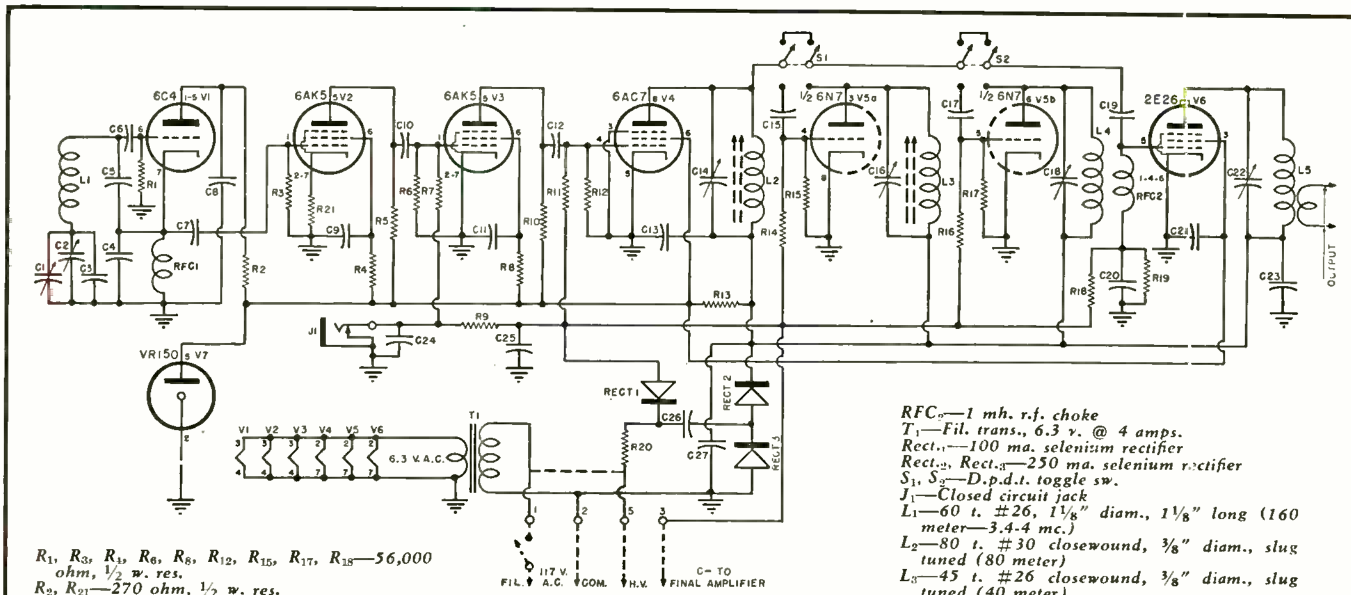
In order to provide a constant load for the oscillator the second stage is not keyed. It is coupled to the oscillator through a 1 $\mu\mu$fd. condenser. This loose coupling prevents reaction of subsequent stages on the oscillator.

A second 6AK5 is keyed by the blocked-grid system. The network of resistors and condensers in the keying circuit has been carefully proportioned to give excellent keying. From the diagram it can be seen that resistors R_6, R_7, and R_9 set the key-up bias. The voltage at this point, used to block the grid, should be no greater than necessary to completely cut off the tube or the stage will generate clicks by acting as a pulse-sharpening amplifier. This same rule applies to all the succeeding stages. Next, R_9 and C_{24} form a time-constant circuit to round off the keyed characters with a slight lag and filter r.f. from the key leads. Third, the value of R_7 is made as low as possible to reduce phase modulation of the wave at high keying speeds which could cause a keying chirp or thump. Phase modulation might result from the variation of the impedance represented by R_7 in parallel with the input capacity of the 6AK5 as this capacity varies with the bias due to *Miller* effect. Since R_7 is quite low, the impedance of the combination is virtually unaffected by the changing capacitive component.

The second 6AK5 produces sufficient output to excite a 6AC7 80 meter doubler. Like all the following stages of the transmitter, this tube has cut-off bias applied from the bias supply. The method in which the bias is applied varies from the usual series fed system. The selenium rectifier bias supply furnishes 125 volts across the 20 μfd. filter condenser. Since this voltage is considerably higher than is required by the exciter stages, voltage dividers are used to introduce the bias to each stage. In the 6AC7 stage, resistors R_{11} and R_{12} comprise this bleeder. When the key is up the cut-off bias is determined by the ratio of R_{11} to R_{12}. When the key is down the bias is almost entirely determined by R_{12} alone, since the impedance of the path through R_{11} and the bias supply is infinite by comparison. This method of applying bias has two advantages: (1) No high current bleeder is necessary, and (2) the self-regulatory character of grid leak bias is obtained. Although an extra resistor is used in each stage, cathode bias resistors and bypass condensers have been eliminated. The final amplifier bias is applied in the more conventional manner from the VR tube with the exciter bias supply furnishing ignition potential. The five milliamperes drained from the exciter bias supply keeps the VR tube lighted when the key is up. Because of the extremely small current drawn from the bias supply, a single filter condenser is adequate.

It has already been mentioned that key click prevention demands low bias. A second requirement is that the bias on each stage be sufficient to completely cut off each tube when the key is up. This conflicting requirement is necessary if backwave radiation is to be prevented. While reasonable care in shielding the transmitter will reduce the radiation in the key-up position, the tube cut-off measure will give the final touch so that break-in operation may be used on the oscillator frequency. A vestigal signal may be heard in the receiver on the 80 and 40 meter bands but it is too weak to mask any other signal. This is a small price to pay for 100% clickless keying. It is possible to monitor the 40 meter band with the transmitter being operated on the same operating table and same band without trouble from clicks. An auxiliary lag circuit is used at the bug, consisting of a small "a.c.-d.c." type filter choke in series with the key and a .1 μfd. condenser across the key.

The 80 meter tank circuit of the 6AC7 is tuned by the knob on the left below the v.f.o. dial. Ordinarily this control need only be touched if a frequency change is made from one end of the 80 meter band to the other. All three doubler tank circuits are low capacity, low "Q" circuits so that the tuning is not critical. Much simpler than ganged tuning, this system is just as satisfactory and the trans-



R_1, R_3, R_4, R_6, R_8, R_{12}, R_{15}, R_{17}, R_{18}—56,000 ohm, ½ w. res.
R_2, R_{21}—270 ohm, ½ w. res.
R_5, R_{19}—15,000 ohm, ½ w. res.
R_7—1500 ohm, ½ w. res.
R_9, R_{11}, R_{14}, R_{16}—470,000 ohm, ½ w. res.
R_{10}—4700 ohm, ½ w. res.
R_{13}—2500 ohm, 10 w. wirewound res.
R_{20}—10 ohm, 2 w. res.
C_1—3-12 μμfd. zero-temp. trimmer cond.
C_2, C_{16}, C_{18}—50 μμfd. var. cond.
C_3—100 μμfd. zero-temp. ceramic cond.
C_4, C_5—.001 μfd. silver mica cond.
C_6, C_{10}, C_{12}, C_{15}, C_{17}, C_{19}—100 μμfd. mica cond.
C_7—1 μμfd. mica cond.
C_8, C_9, C_{11}, C_{20}—.001 μfd. mica cond.
C_{13}, C_{21}, C_{23}, C_{24}—.01 μfd., 400 v. cond.
C_{14}, C_{22}—100 μμfd. var. cond.
C_{25}—20 μfd., 150 v. elec. cond.
C_{26}—120 μfd., 150 v. elec. cond. (two dual 30 μfd. cond.)
C_{27}—80 μfd., 450 v. elec. cond. (two 40 μfd. cond.)
RFC_1—2.5 mh. r.f. choke
RFC_2—1 mh. r.f. choke
T_1—Fil. trans., 6.3 v. @ 4 amps.
$Rect._1$—100 ma. selenium rectifier
$Rect._2$, $Rect._3$—250 ma. selenium rectifier
S_1, S_2—D.p.d.t. toggle sw.
J_1—Closed circuit jack
L_1—60 t. #26, 1⅛" diam., 1⅛" long (160 meter—3.4-4 mc.)
L_2—80 t. #30 closewound, ⅜" diam., slug tuned (80 meter)
L_3—45 t. #26 closewound, ⅜" diam., slug tuned (40 meter)
L_4—30 t. #26 closewound, ⅜" diam. (20 meter)
L_5—1¼" diam., 1¼" long with 2-turn links; 80 meter—40 t. #20; 40 meter—20 t. #20; 20 meter—14 t. #18; 10 meter—6 t. #18
V_1—6C4 tube
V_2, V_3—6AK5 tube
V_4—6AC7 tube
V_5—6N7 tube
V_6—2E26 tube
V_7—VR150 tube

Circuit diagram and parts list covering the 15-watt, all-band exciter unit used in the Mini-Rack transmitter.

mitter is always ready to be peaked to the limit of its last ounce of output for a bit of choice DX.

Although the coil forms used in the exciter unit were home-built from bakelite tubing, an almost identical coil form is available from the *Cambridge Thermionic Corp.* It is the Type LS-3 and is supplied complete with a tuning slug. Since slug-tuning is used only on coils L_2 and L_3, if the coil form for L_4 (20 meters) has slug-tuning, this must be removed before the coil is wound for this circuit.

Next to the 80 meter tuning control is the 80 to 40 meter bandswitch, an ordinary d.p.d.t. toggle switch. This method of doubler switching is not at all new but was revived after considerable experimenting with wafer and other types of bandswitches. It has the advantage that it is not necessary to backtrack in the wiring since the wiring progresses logically from stage to stage with a bandswitch occurring between the doublers. If possible, toggle switches of the molded bakelite type should be selected in preference to the laminated type. The r.f. losses in either type are quite small but the molded type has a more convenient terminal arrangement with all the lugs on the rear.

Functionally, this switch determines which tube receives the 80 meter signal; in the "up" position the 80 meter output is applied to the doubler stage while in the "down" position the 80 meter signal may be applied to the 2E26 grid. No power supply switching is necessary because of the cut-off bias on the unused tubes.

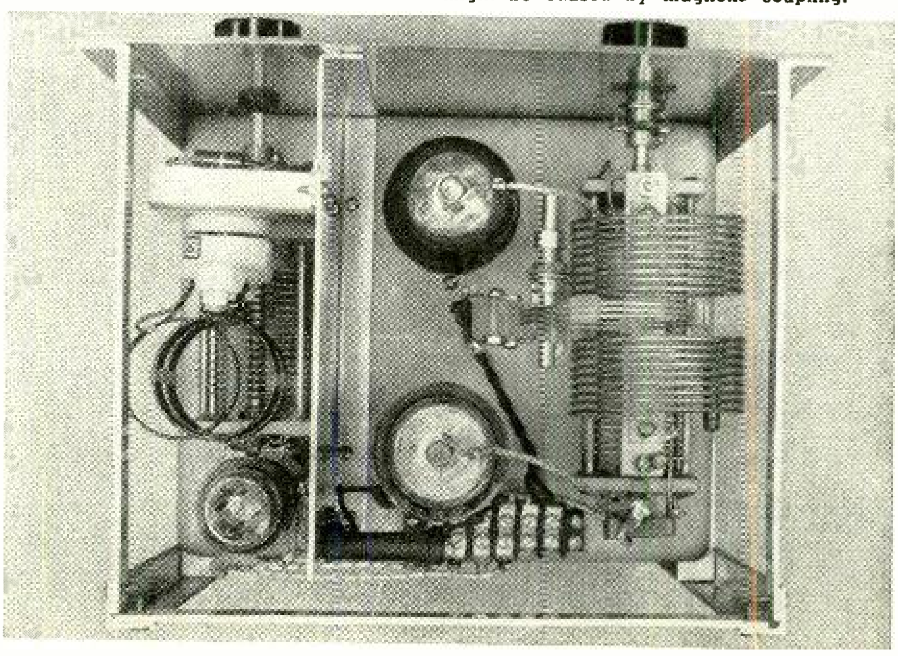
For 40 and 20 meter doubling, the two halves of a 6N7 are used with a similar toggle bandswitch between them. Thus it is possible to drive the 2E26 grid with 80, 40, or 20 meter excitation merely by flipping the toggle switches. Due to the high mu of the 6N7, very little bias is required to cut off the stages and it is a very efficient doubler. It is operated well below its rating in driving the 2E26.

The 40 meter tuning knob is in the center of the lower row with the 20 meter tuning knob on the right. Between the 40/20 meter bandswitch and the 20 meter tuning knob is the key jack with the 2E26 plate tuning knob above it.

The principal design features of the 2E26 are wasted in the buffer application since the tube is designed for higher frequency operation. The double-ended construction keeps all the plate circuit components above the chassis but since the stage doubles on all bands except 80 meters, there

(*Continued on page 114*)

Top view of the final amplifier section used in the Mini-Rack transmitter Push-pull 807's are used. The grid coil is mounted at right angles to the unit's plate coil in order to prevent self-oscillation which might be caused by magnetic coupling.



Small Capacity CONDENSER TESTER

By
T. A. BENHAM
Asst. Prof. of Physics
Haverford College

This versatile, home-built test instrument will measure capacities up to 90 μμfd. accurately.

WHENEVER it is suggested that a ham build a circuit in which tuned elements must be carefully adjusted, the immediate reaction is, "How am I going to adjust all those circuits without having expensive trimmers all over the place?" This understandable reaction might prevent many interesting developments from materializing. Many of these adjustments could be made through the proper selection of a fixed condenser if there were some convenient way of selecting the proper value. One suggestion would be to connect, temporarily, a variable condenser across the circuit, adjust for desired results, remove the condenser without disturbing its setting, measure its capacity, and then select a fixed condenser of the same capacity. This would imply that all hams have a large assortment of high grade fixed condensers on hand, but with the excellent bargains in these small capacity condensers which are still available, this is not an unreasonable assumption.

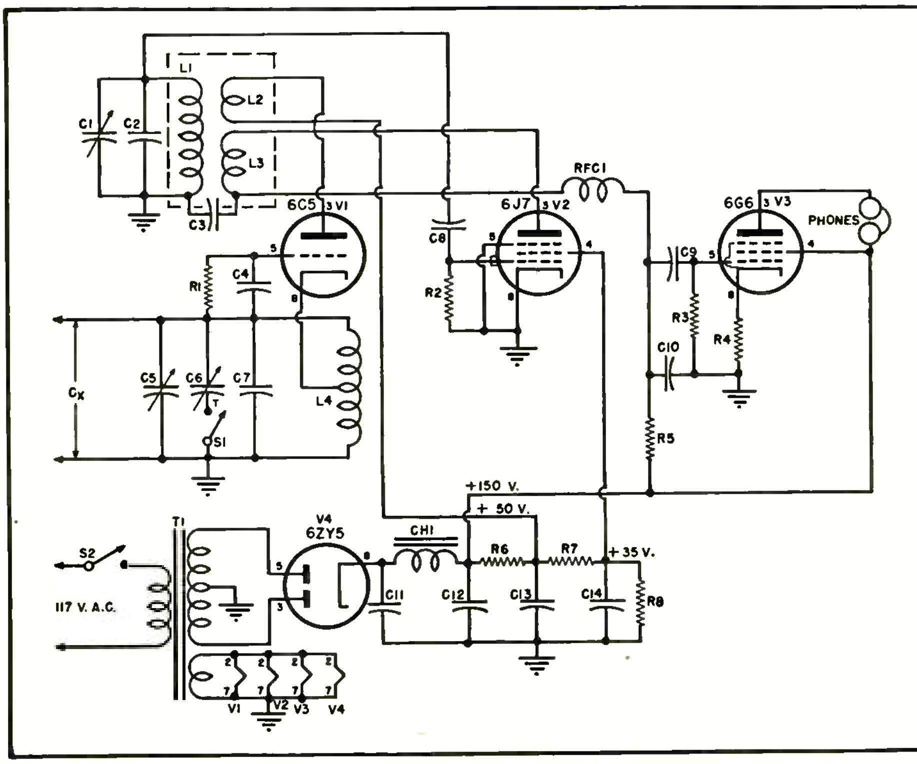
The instrument described in the following paragraphs makes the above suggested procedure feasible.

If an oscillator is built and tuned to a known frequency and the unknown condenser is then connected across the tuning condenser in the oscillator, the capacity of the unknown can be easily determined by reducing the capacity of the tuning condenser until the frequency has again been brought to the initial value. The unknown capacity is the difference between the two tuning capacities. All that is necessary is to have a tuning condenser whose capacity versus angle of rotation is known and a detector for determining when the oscillator has been returned to the initial frequency. The absolute capacity of the tuning circuit need not be known, only the change in capacity is required.

The first of these requirements was met by obtaining a small variable condenser which had a straight-line capacity versus angle of rotation. A *Hammarlund* MC50S high grade condenser, having a capacity range of 45 μμfd., was employed. The dial plate for this was marked off in nine equal divisions with each division being equivalent to 5 μμfd. In order to extend the range to 90 μμfd., a second adjustable condenser was connected across the first condenser through a single-pole, single-throw switch. If the capacity being checked is between 45 and 90 μμfd., it will be necessary to remove the second condenser by opening the switch and adjusting the calibrated unit. If the unknown

(*Continued on page* 146)

Schematic diagram of condenser tester. A straight-line capacity taper variable condenser should be used.



R_1—47.000 ohm, ½ w. res.
R_2, R_3—2 megohm, ½ w. res.
R_4—500 ohm. 1 w. res.
R_5—10.000 ohm, 1 w. res.
R_6—10.000 ohm, 10 w. wirewound res.
R_7—2000 ohm, 1 w. res.
R_8—5000 ohm, 1 w. res.
C_1—200-500 μμfd. mica padder (see text)
C_2. C_8—250 μμfd. mica cond.
C_3. C_{10}—100 μμfd. mica cond.
C_4, C_7—500 μμfd. mica cond.
C_5—5-50 μμfd. calibrated tuning cond. (Hammarlund MC50S)
C_6—20-70 μμfd. semi-adj. cond.
C_9—.05 μfd., 400 v. cond.
C_{11}, C_{12}—8 μfd., 400 v. elec. cond.
C_{13}—.01 μfd.. 200 v. cond.
C_{14}—1 μfd., 200 v. elec. cond.
T_1—Power trans., 300 to 400 v. each side of c.t. @ 40 ma.; 6.3 v. @ 2 amp.
RFC_1—2.5 mh. r.f. choke
CH_1—15 henry, 50 ma. filter choke
S_1, S_2—S.p.s.t. toggle sw.
L_1—175 μh. coil, 102 t. #32 en. on 1" form, spaced 1". For other coil form diameters see "ARRL Handbook"
L_2—1 t. at grid end of L_1
L_3—Approx. 15 t. #32 d.s.c. (or equiv.) wound at ground end of L_1. See "ARRL Handbook" on oscillating detectors
L_4—7.55 mh. coil, 720 turns (8 layers) #30 en. wound 1" long on 1" diam. form. Tap at 200 t. from ground end. Adjust to 80 kc.
P—Single earphone, 1000 ohm d.c. res. (not critical). A small loudspeaker with suitable output trans. may be substituted for earphone and resonant chamber
V_1—6C5 osc. tube
V_2—6J7 det. tube
V_3—6G6 audio amp. tube
V_4—6ZY5 rect. tube

SIMULATING TV INTERFERENCE PATTERNS

By
E. G. LOUIS

The ability to recognize trouble by the type of pattern is an asset in servicing video receivers.

WHEN television "comes" to a town or city, practically every local radio technician who has not already been studying television will try to get all the information possible within a few short days or weeks. By reading articles, studying manufacturers' service manuals, and, in many cases by actual experimentation (building sets from kits, etc.), he will try to acquaint himself with the principles and practices of the new (to him) field.

It is one thing, however, to read about a condition or circuit, and quite another to actually work on the circuit, or to work on a set with a given defective condition.

One of the most valuable assets that a TV technician can acquire is the ability to recognize trouble by the type of pattern (or lack of pattern) obtained on the screen of the TV receiver. Such an ability enables the technician to reduce servicing time by making his diagnosis much more rapidly, and enables him to isolate the defective section of the TV set much more quickly.

Therefore, for a radio technician or student first learning television, or even for the man with some experience, it is often desirable for him to spend a few days experimenting with a TV receiver known to be in good operating condition. Common defects can be introduced, and their effect on set operation noted. A leaky coupling condenser might be simulated by shunting a condenser with a high value resistance. An open condenser may be simulated by either opening the lead, or by substituting a much smaller condenser. Low emission tubes may be simulated by placing a small resistor in series with the filament lead in order to drop the filament current.

By carrying out this program, the technician can soon learn what symptoms to expect from the more common defects, and is thus in a better position to go right to the source of a complaint.

Some complaints are not too easy to simulate. Interference, for example, apparently cannot be duplicated under test conditions unless an actual interference condition exists. However, a simple technique has been worked out by which the effects of certain types of interference on the screen may be easily shown. By actually demonstrating the patterns obtained, the technician will be in a better position to recognize the cause and so take corrective steps.

The only item, besides a television set, needed for demonstrating some of the more common TV interference test patterns is an ordinary AM signal generator . . . preferably one that can supply either an audio tone, an unmodulated r.f. signal, or a modulated r.f. signal, and in which the operating frequency can be easily varied; in other words, the type of signal generator found in the majority of service shops in the nation.

The signal generator is simply connected across the video second detector load resistor as illustrated in Fig. 1E. It is assumed that the signal generator has a built-in d.c. blocking condenser in series with the "hot" lead. If not, or if there is any doubt, then a .01 μfd, 600 v. paper condenser should be connected in series with the "hot" lead.

Both the signal generator and the TV receiver are now turned on. If a station is on the air at the time the experiments are to be carried out, then a program can be tuned in so that the "interference" pattern will appear superimposed on the program picture . . . such as would be the case if actual interference trouble were encountered. But even if a program is not available, the basic patterns can still be shown to advantage.

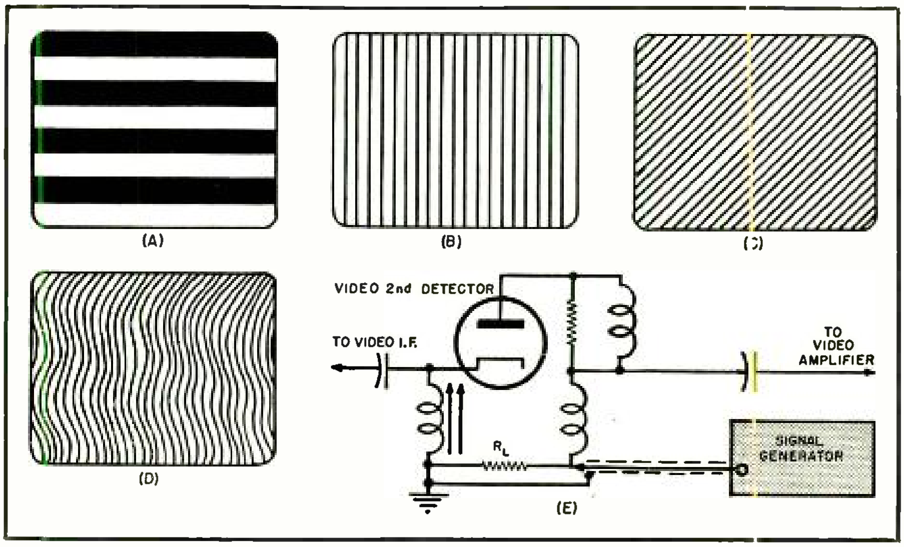
If a program is not being received, adjust the brilliancy and contrast controls on the TV set so that a raster appears on the screen. Then adjust the signal generator to deliver an audio signal.

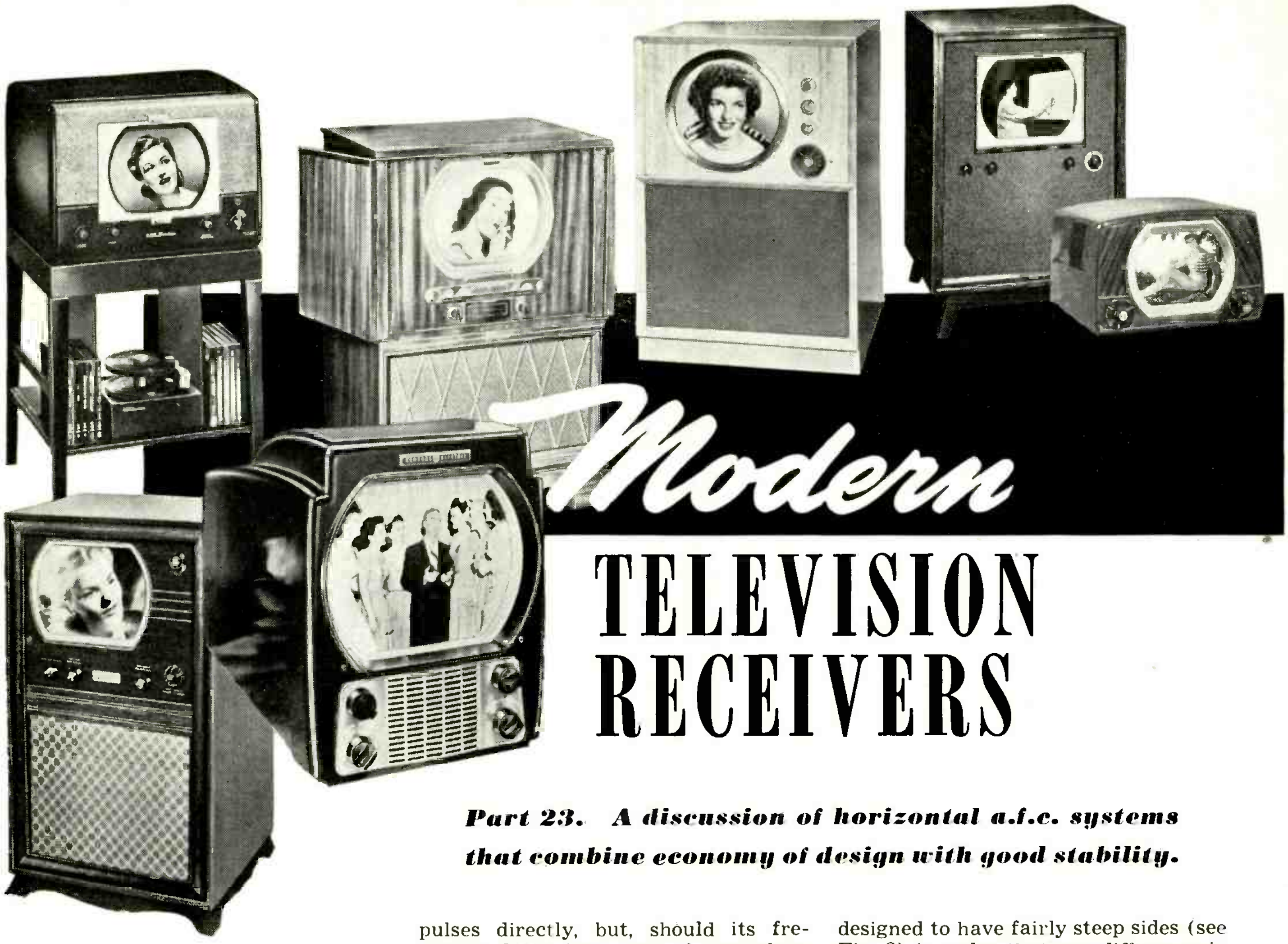
Since the frequency of the audio signal will be far below that of the horizontal sweep, several lines at a time will be made brighter and darker by the audio signal, resulting in "bars" horizontally across the TV screen as shown in Fig. 1A. If a program is being received, these bars will be superimposed on the picture.

These are the well known "sound bars" that may result from misadjustment of the fine tuning control or local oscillator in a TV set, or from misalignment in the video i.f. stages. Whenever bars of this type (horizontal) appear on a TV screen, you can be pretty sure that an audio signal is get-

(*Continued on page 144*)

Fig. 1.





Modern TELEVISION RECEIVERS

Part 23. A discussion of horizontal a.f.c. systems that combine economy of design with good stability.

1950 TV models—(counter-clockwise) Arvin Model 4080 TV (8½"); RCA Model TC-124 (12½"); Stromberg-Carlson Model TC 125-LA4 (12½"); G.E. Model 12C109 (12½"); RCA Model T-100 (10"); Starrett "Sam Houston" (12½"); and G.E. Model 10T6 (10") in plastic cabinet.

By

MILTON S. KIVER

THE television industry, although very young in years and experience, is already fiercely competitive. Any economy in design which will permit the cost of a set to be lowered without appreciably lowering the standards of set operation is highly desirable. The previously discussed sine wave and saw-tooth wave a.f.c. systems required three and two tubes respectively. The pulse width a.f.c. system, about to be examined, requires only one tube, a relatively inexpensive 6SN7.

The circuit schematic, shown in Fig. 1, consists of a single control tube, a long time-constant filter, and a blocking oscillator. The 6BG6G horizontal output tube is added to the diagram because part of its output voltage is fed back to the control tube. Basically, the horizontal oscillator is a free-running oscillator and discharge circuit. It does not receive the incoming pulses directly, but, should its frequency differ from that of the pulses, the control tube, V_1, will alter the negative bias on the grid of the blocking oscillator and thereby change its frequency. It can accomplish this because the cathode resistor R_1 of the control tube is common to the grid of the blocking oscillator. The incoming sync pulses, positive in polarity, are received by the grid of V_1 through a 120-μμfd. condenser. This same grid also receives a pulse from the horizontal output transformer, plus a parabolic wave from the output of the horizontal oscillator (V_2) itself. The pulse from the output transformer and the parabolic wave from the horizontal oscillator form a combined wave, which then reacts with the incoming sync pulses to maintain the blocking oscillator on frequency.

Fig. 1 illustrates the shape of the various voltages reaching V_1. The wave obtained from the output of V_2 is originally a saw-tooth wave, but it is converted into a parabolic wave by the 150,000 ohm resistor and condenser C_4 before reaching V_1. The pulse which appears at the secondary of the horizontal output transformer is modified somewhat in form by an integrating network consisting of a 560,000 ohm resistor, a 5 μμfd. condenser, and C_3. The shape this pulse finally assumes is shown in Fig. 1.

The combined wave is specifically designed to have fairly steep sides (see Fig. 2) in order that any difference in frequency between the blocking oscillator and the incoming sync pulses will have a marked effect on the circuit. Here is how this occurs.

A portion of the bias from the blocking oscillator is applied to the grid of the control tube and is sufficient to keep the control tube cut off except when the incoming sync pulse is high on the slope of the grid waveform (the combined wave mentioned previously) as shown in Fig. 2A. If the blocking oscillator changes phase so that the pulse arrives at a time when it is down the slope, the length of time that V_1 conducts will diminish. This is indicated in Fig. 2B by the narrow width of the waveform extending above the cut-off point of the tube V_1. On the other hand, if the blocking oscillator frequency changes so that the sync pulse arrives at a time when it is closer to the top of the combined wave (Fig 2C), then the plate conduction time of V_1 will increase. When the control tube conducts, C_1 and C_2 in its cathode circuit will charge to a d.c. potential proportional to the length of time that current flows through the tube. This d.c. potential is applied as a bias to the grid of the blocking oscillator, thereby altering its frequency and tending to bring it back into line.

A long time-constant filter to

achieve an averaging effect is placed in the cathode leg of V_1 and consists of R_1, R_4, and C_2. Note, however, that these are not the only components in this portion of the circuit. C_1 (a .02 µfd. condenser) and R_5 (an 8200 ohm resistor) are also present and their purpose is to provide better sync control of the oscillator by permitting a small component of the sync pulse to reach the grid of the oscillator tube, V_2. The combination of the long time-constant filter with the short time-constant filter thus presents to the oscillator a large d.c. component (due to the averaging effect of R_1, R_1, and C_2) plus a much smaller a.c. component (due to C_1 and R_5).

There are five controls associated with this circuit and they function as follows: The blocking oscillator transformer, L_1, is slug-tuned to permit coarse adjustments in oscillator frequency. C_3, connected across the resistor common to the control tube and blocking oscillator, can provide fine adjustments in frequency. The horizontal hold control will affect the plate voltage of the control tube and, in this manner, the amount of voltage developed across R_1. This is the only front-panel control of the group. C_4 is part of a voltage divider network that controls the amplitude of the waveform on the grid of the control tube. C_4 will therefore control the point at which V_1 starts to conduct. Finally, C_5 is part of a capacitance voltage divider and regulates the amount of voltage reaching V_3. It partially controls the width of the picture and partially the linearity of the left-hand side of this image. An additional linearity control located at a subsequent point in the horizontal sweep system regulates the over-all horizontal linearity.

Several components of the oscillator and control circuits have special coefficients or characteristics and, in case of failure, should be replaced only by an exact duplicate. R_2 is a special resistor capable of stability of 1 per-cent or better. R_3 is a high negative coefficient resistor to compensate for warm-up drift. It is mounted within about ¼ inch of the power transformer and chassis for good heat transfer.

Adjustment of Pulse-Width A.F.C. System. When the pulse-width a.f.c. system is operating properly, it should be possible to perform the following test on it. Permit the set to warm up for about 5 minutes and then tune in a station with the station selector control. The picture should be locked-in. Now, rotate the horizontal hold control, R_6, over its entire range. It should be possible to hold the picture in sync throughout three-fourths of this range. Next, place the control at mid-position, switch to another channel and back again. The picture should immediately lock into synchronization. It will be found when switching stations, that the picture will lock in throughout more than half the range of R_6, although generally not when this control is set at either extreme position.

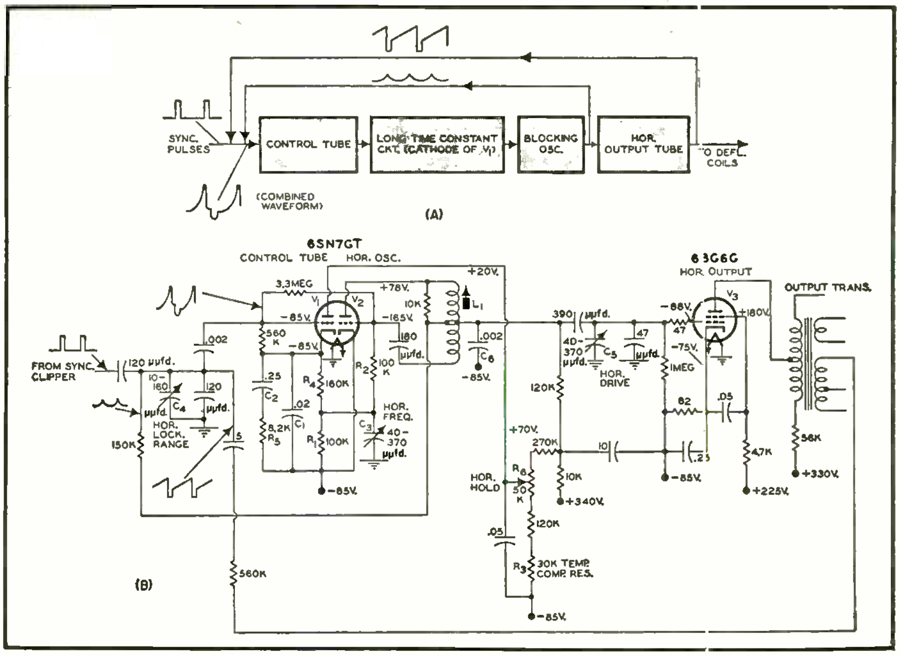


Fig. 1. Schematic diagram of the pulse-width a.f.c. system. The waveforms are shown as to shape only and are not indicative of their relative size.

If it is found that the picture tends to slip out of synchronization or that after switching stations, the picture does not immediately lock-in, the following adjustments should be made.

Adjust the iron core of L_1 for a steady picture, with the front panel horizontal hold control at mid-position. Note whether the picture remains locked-in as R_6 is rotated through half its range. Set the hold control to its mid-position, switch to another channel and then back again. If the picture does not remain in sync, back off the horizontal locking trimmer, C_4, to 2 to 2½ turns from tight. Next, turn the horizontal hold control to the extreme counter-clockwise position and back off on the horizontal frequency trimmer, C_3, until the picture tends to slip to the right, then turn the hold control clockwise until the picture locks in. When this has been done, it should be possible to switch stations or turn the set on and off without losing synchronization.

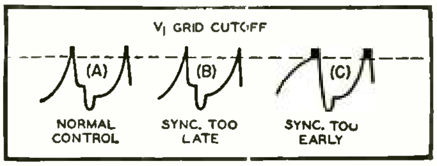


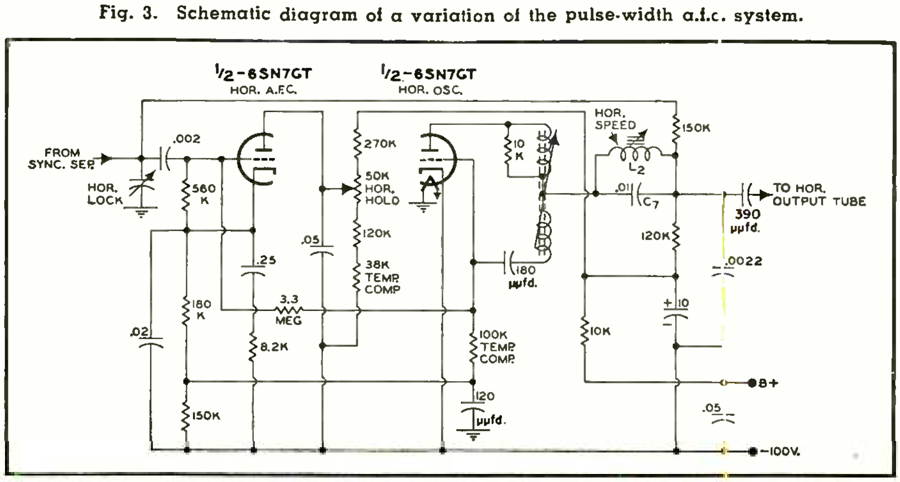
Fig. 2. Horizontal control waveforms. Area above dotted line is portion of waveform effective in controlling oscillator.

A slight modification of the circuit of Fig. 1, which is frequently seen, is the circuit shown in Fig. 3. The horizontal frequency trimmer condenser, C_3, has been replaced by a fixed condenser and a parallel resonant circuit consisting of C_7 and L_2 has been placed in series with the charge and discharge condenser, C_6. This is a stabilizing circuit, designed to improve the stability of the oscillator and control circuits. With these additional components in the circuit, the adjustment procedure is as follows:

1. Set the horizontal hold control to the full clockwise position.

2. Adjust the horizontal lock

Fig. 3. Schematic diagram of a variation of the pulse-width a.f.c. system.



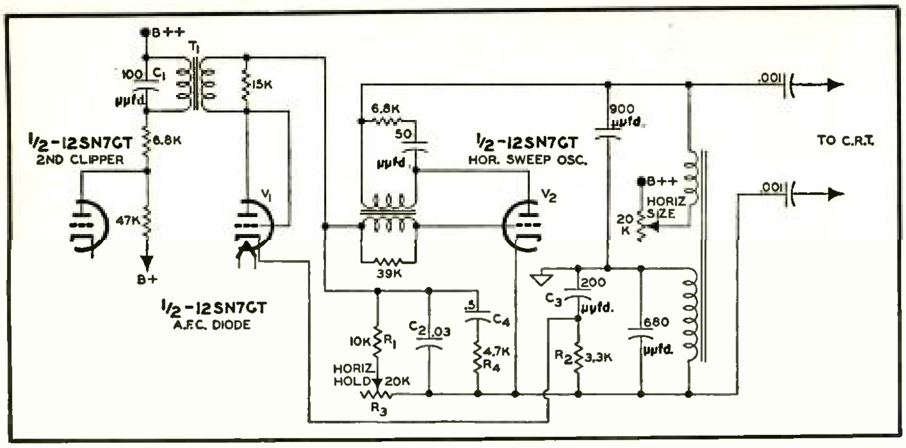


Fig. 4. A simple a.f.c. system employed by Motorola in their 7-inch TV sets.

trimmer to at least two turns from maximum tightness.

3. Short circuit L_2.

4. With a signal being received, and with the horizontal hold control in the full clockwise position, set the iron core adjustment of L_1 to frame the picture.

5. Remove the short from L_2 and adjust the iron core of L_2 until the picture remains in sync over the greatest range of the horizontal hold control.

Additional A.F.C. Systems

Continuing in the same vein of economy and simplicity of construction, *Motorola* has devised two a.f.c. circuits which are currently being used in many of their television receivers. The first circuit, employed principally in their 7-inch television sets, is shown in Fig. 4. It consists of a triode connected as a diode and obtained from the same envelope as the horizontal blocking oscillator. (The operation of this particular oscillator was described previously.)* In common with all other a.f.c. systems, the incoming sync pulses do not directly affect the sweep oscillator, but rather influence its operation by varying the plate current flowing through the a.f.c. diode (V_1). Note that the plate of the diode connects directly to the grid of the sweep oscillator. Further, the cathode of the a.f.c. diode is attached to R_2 which is part of a differentiating network receiving the output sawtooth deflection voltage that V_2 applies to one deflection plate in the 7JP4 cathode-ray tube. During retrace, a sharp negative pulse develops across R_2 and it is the frequency of these pulses which is compared with the frequency of the incoming sync pulses. If the two are not identical, the plate current of the a.f.c. diode is altered, altering the negative bias on the grid of the horizontal sweep oscillator and thereby producing a frequency change.

In detail, the circuit functions as follows: Condenser C_1 and the primary winding of T_1 form a parallel resonant circuit which receives the incoming horizontal sync pulses and converts them to an a.c. wave. See Fig. 5A. (Actually, this tuned circuit is self-resonant to a frequency close to 15,750 cycles and the incoming sync pulses merely maintain oscillations in this n e t w o r k by continuous triggering. Resonant circuits used in conjunction with class C amplifiers operate in the same manner.) At some time during this a.c. cycle, the cathode of V_1 receives a sharp negative pulse from R_2. The negative retrace pulse on the cathode of V_1 is equivalent to a positive pulse on the plate. The combined sync wave and firing pulse on the plate of V_1, with respect to the cathode, is shown in Fig. 5B. This particular position of the retrace pulse along the slope of the sync wave represents the desired operation, *i.e.,* when the two are in frequency step with each other.

If the horizontal oscillator tends to run fast, its triggering pulse will appear sooner and its position would then be higher up on the slope of the sync wave. See Fig. 5C. With this condition, the positive plate voltage of the diode will be greater, causing more plate current to flow. The current, flowing through R_1 and R_3, will raise the negative voltage developed across these resistors and across C_2. This will bias V_1 more negatively, causing the tube to remain non-conductive for a longer period of time and thereby lowering the sweep frequency.

By the same token, if the horizontal sweep frequency should decrease below the desired value, the triggering pulse from R_2 will appear later than usual, or farther down on the slope of the sync wave. See Fig. 5D. The plate voltage of the diode will now be less positive, resulting in decreased current flow. Less current through R_1 and R_3 will lower the negative voltage here (and across C_2, also) and permit the blocking oscillator to come out of the cutoff sooner. The result: an increase in frequency. Thus, any tendency on the part of the sweep oscillator to change frequency will be compensated by the diode drawing more or less current.

Condenser C_4 and resistor R_4 form a long time-constant filter to hold the horizontal sweep oscillator in synchronization for approximately 50 lines.

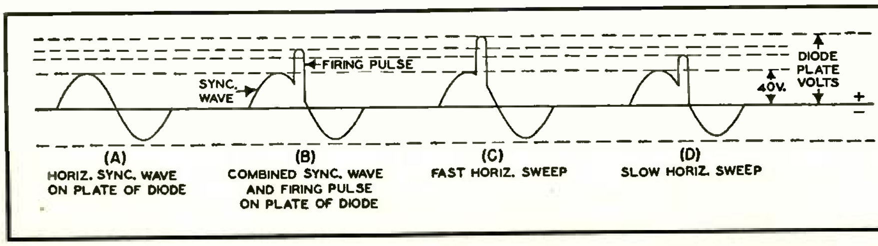
A second a.f.c. circuit that *Motorola* has begun to use is shown in Fig. 6. (Strictly speaking, this is not an a.f.c. circuit in the same sense as the previous a.f.c. circuits. It does not, for example, compare the horizontal sweep frequency with the frequency of the incoming pulses. What it does is to synchronize the horizontal oscillator through an intermediate locked-in oscillator. However, it does represent another approach to automatic frequency control and hence can justly be included under a.f.c. systems.) The circuit consists of a diode sync clipper (V_1, 6AL5), a Colpitts oscillator (V_2), and a horizontal blocking oscillator, V_3. The incoming sync pulses lock-in the frequency of the Colpitts oscillator and the positive pulses obtained from the Colpitts trigger the following horizontal blocking oscillator. When no sync pulses are reaching the receiver, the Colpitts still continues to oscillate and trigger the blocking oscillator.

In operation, negative sync pulses from the cathode of the sync separator tube (not shown here) are differentiated by C_1 (.002 μfd.) and R_1 (10,000 ohms). This provides a negative pulse at the leading edge of all sync pulses and a positive pulse at the trailing edge of all sync pulses. Since V_1 is a diode, it will conduct only when its plate is positive with respect to its cathode and this occurs only at the leading edge of all sync pulses. The positive pulse that appears at the trailing edge is unable to pass through the diode and is effectively suppressed. The negative pulses that do cause diode conduction produce the same effect as though the cathode were grounded and the plate of the tube had received a positive pulse. The diode plate current, flowing through R_2, develops a triggering pulse here which controls the frequency of the Colpitts oscillator tank circuit (R_2, L_1, C_2, and C_3). The result of this lock-in is the generation of a 15,750 cycle sine

(*Continued on page* 110)

* Kiver, Milton S.: "Modern Television Receivers," Part 19, RADIO & TELEVISION NEWS, October, 1949.

Fig. 5. Waveforms in the a.f.c. circuit shown in the schematic of Fig. 4.



By
SAMUEL FREEDMAN

Elimination of RADIO INTERFERENCE By OFF-FREQUENCY INVERSION

Improvement in receiver selectivity may be obtained with this new circuit.

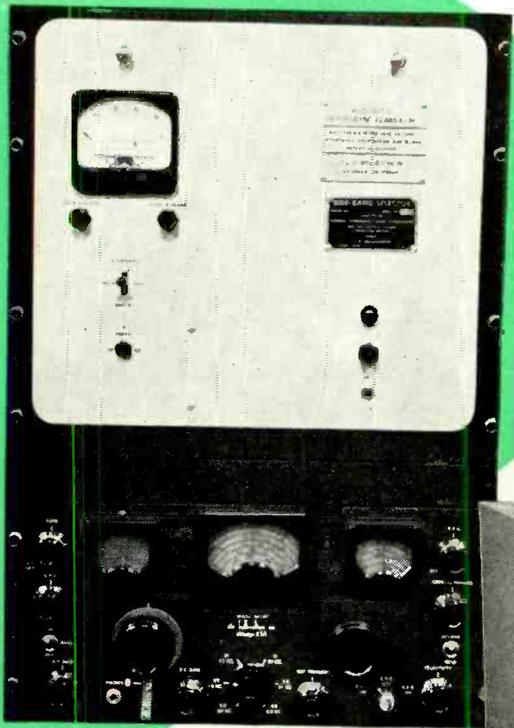


Fig. 1. First heterodyne eliminator using off-frequency inversion. Originally built for the FCC, it is now in the Commission's Instrument Museum.

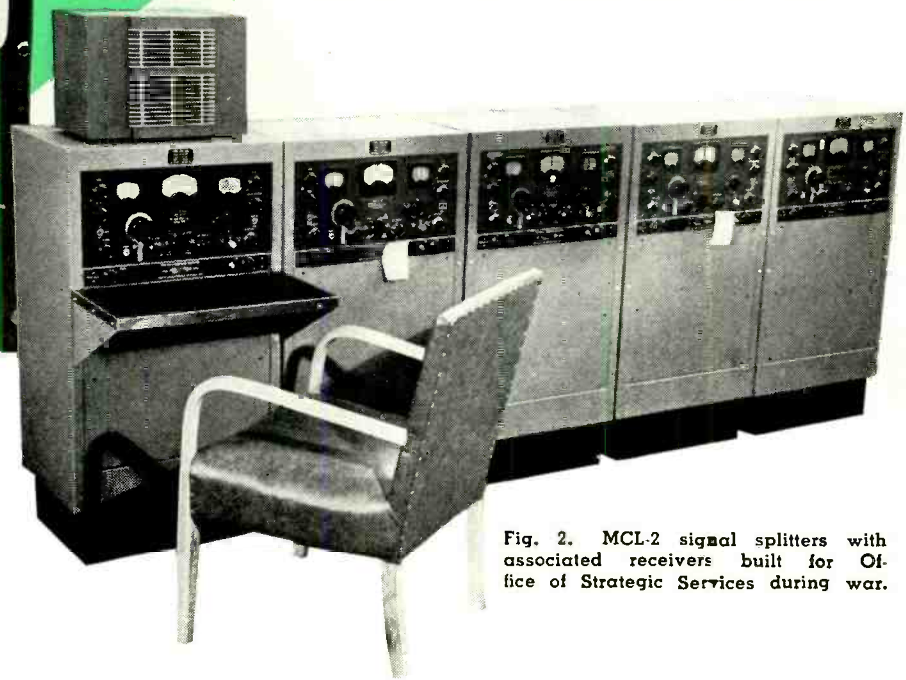


Fig. 2. MCL-2 signal splitters with associated receivers built for Office of Strategic Services during war.

THE first improvement in radio receiver selectivity in twenty years—since James Lamb's invention of phasing control to permit the use of crystal filters—is the asymmetrical off-frequency inverter type of heterodyne eliminator developed by James L. A. McLaughlin of LaJolla, California. It is an outgrowth of wartime developments undertaken in his laboratory for the Radio Intelligence Division of the Federal Communications Commission and for the Office of Strategic Services (OSS).

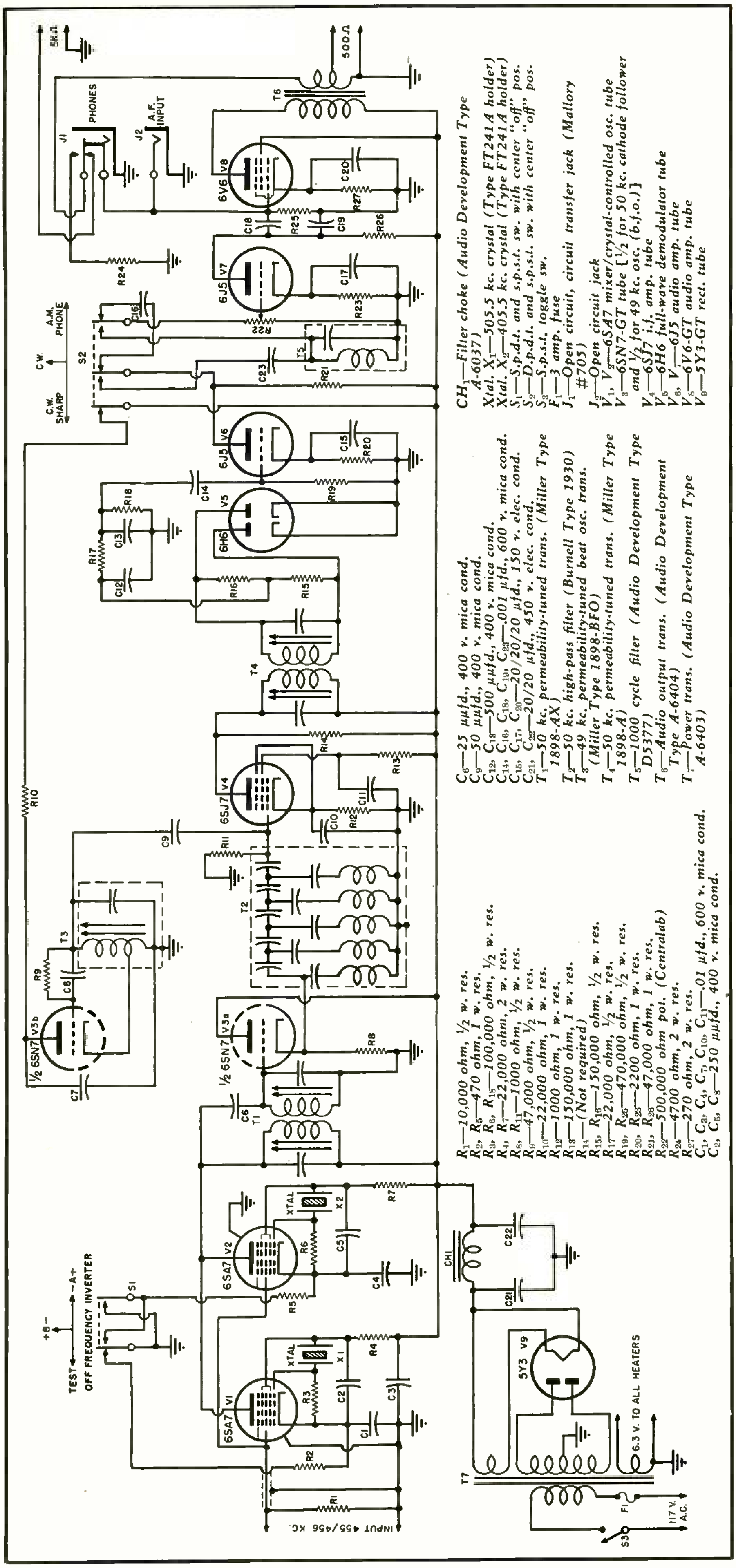
At the outbreak of World War II, the Federal Communications Commission had the problem of monitoring and receiving Japanese signals. Spoken Japanese contains very high frequencies not encountered in spoken English. The sibilants of the Japanese language are as much a part of the meaning or interpretation of the word as are the syllables themselves. Where English, as spoken by Americans, can be quite intelligible with a maximum modulating frequency of 3000 c.p.s., our translators might require as much as 5000 c.p.s. to get the gist of material in Japanese.

During the search for more suitable radio receiving apparatus to cope with this problem, an FCC engineer obtained Mr. McLaughlin's original model of the heterodyne eliminator as shown in Fig. 1. This signal splitter, or heterodyne eliminator, was designated the Type MC-1. This was later modified to become the first automatic heterodyne eliminator. The instrument is now in the Instrument Museum of the Federal Communications Commission in Washington and represents the first unit of its type ever constructed.

This early model was used in conjunction with a standard *Hallicrafters* Model SX-28 receiver. On the basis of extensive tests these units were ordered for all of the primary monitoring stations of the Radio Intelligence Division.

When the Communication Branch of the Office of Strategic Services was established in 1942, it was faced with the task of copying signals through terrific jamming. Similar apparatus for anti-jamming purposes was ordered and evolved as the MCL-2 shown in Fig. 2. These units were used extensively during the war wherever the jamming problem was encountered.

By the end of the war a third type of heterodyne eliminator had been developed. Known as the MCL-3 this apparatus did not require any modification of the receiver. An internal view of this model is shown in Fig. 4. With this unit if interference was encountered on one side of a mean fre-



R_1—10,000 ohm, ½ w. res.
R_2, R_5—470 ohm, 1 w. res.
R_3, R_6, R_{15}—100,000 ohm, ½ w. res.
R_4, R_7—22,000 ohm, 2 w. res.
R_8, R_{11}—1000 ohm, ½ w. res.
R_9—47,000 ohm, ½ w. res.
R_{10}—22,000 ohm, 1 w. res.
R_{12}—1000 ohm, 1 w. res.
R_{13}—150,000 ohm, 1 w. res.
R_{14}—(Not required)
R_{15}, R_{16}—150,000 ohm, ½ w. res.
R_{17}—22,000 ohm, ½ w. res.
R_{19}, R_{25}—470,000 ohm, ½ w. res.
R_{20}, R_{23}—2200 ohm, 1 w. res.
R_{21}, R_{28}—47,000 ohm, 1 w. res.
R_{22}—500,000 ohm pot. (Centralab)
R_{24}—4700 ohm, 2 w. res.
R_{27}—270 ohm, 2 w. res.
C_1, C_3, C_4, C_7, C_{10}, C_{11}—.01 µfd., 600 v. mica cond.
C_2, C_5, C_8—250 µµfd., 400 v. mica cond.
C_6—25 µµfd., 400 v. mica cond.
C_9—50 µµfd., 400 v. mica cond.
C_{12}, C_{13}, C_{18}—500 µµfd., 400 v. mica cond.
C_{14}, C_{16}, C_{18}, C_{19}, C_{23}—.001 µfd., 600 v. mica cond.
C_{15}, C_{17}, C_{20}—20/20/20 µfd., 150 v. elec. cond.
C_{21}, C_{22}—20/20 µfd., 450 v. elec. cond.
T_1—50 kc. permeability-tuned trans. (Miller Type 1898-AX)
T_2—50 kc. high-pass filter (Burnell Type 1930)
T_3—49 kc. permeability-tuned beat osc. trans. (Miller Type 1898-BFO)
T_4—50 kc. permeability-tuned trans. (Miller Type 1898-A)
T_5—1000 cycle filter (Audio Development Type D5377)
T_6—Audio output trans. (Audio Development Type A-6404)
T_7—Power trans. (Audio Development Type A-6403)
CH_1—Filter choke (Audio Development Type A-6037)
Xtal. X_1—505.5 kc. crystal (Type FT241A holder)
Xtal. X_2—405.5 kc. crystal (Type FT241A holder)
S_1—S.p.d.t. and s.p.s.t. sw. with center "off" pos.
S_2—D.p.d.t. and s.p.s.t. sw. with center "off" pos.
S_3—S.p.s.t. toggle sw.
F_1—3 amp. fuse
J_1—Open circuit, circuit transfer jack (Mallory #705)
J_2—Open circuit jack
V_1, V_2—6SA7 mixer/crystal-controlled osc. tube
V_3—6SN7-GT tube [½ for 50 kc. cathode follower and ½ for 49 kc. osc. (b.f.o.)]
V_4—6SJ7 i.f. amp. tube
V_5—6H6 full-wave demodulator tube
V_6, V_7—6J5 audio amp. tube
V_8—6V6-GT audio amp. tube
V_9—5Y3-GT rect. tube

quency it could be manually switched to invert the frequency and select the side which was free or freer of interference. Some of the units were constructed so that this operation could be performed automatically.

The result of all this development work was the standardization on the Type MCL-4 shown in Fig. 6. This unit contains an important improvement over the MCL-3 which has been described previously.[1,2] High-pass filters replaced the tuned permeability type of transformers, which required critical alignment, used in the earlier models. Fig. 11 shows the internal view with the cabinet opened for servicing or inspection. Fig. 9 shows the easy accessibility of all tubes in the MCL-4 when the dust cover is removed. The largest can (marked T_2) in Fig. 9 is the compact high-pass filter which is made up of five toroidal coils and nine fixed condensers. Over 10% of the total cost of the MCL-4 is represented by this single unit.

This new model takes care of all the previous requirements of the FCC and OSS as well as the general receiving problem of virtually every type of radio communications service. The latter may include problems associated with adjacent channel interference, stations in close proximity irrespective of the amount of frequency separation, accidental or malicious interference, simultaneous usage of a common communications band by more than one station, etc. In this connection, this type of equipment is suitable for such users as airways radio networks, mobile radio systems, common carrier radiotelephone systems, marine radiotelegraph stations ashore and afloat, or wherever dependable radiotelephony and radiotelegraphy must be maintained irrespective of interference or heterodyning.

Four patents, with variations, have been applied for and two have already been granted on the principles of off-frequency inverters. It will be used more and more often to afford relief during S.O.S. emergency situations, interference, the presence of uncooperative signals, variations in receiver selectivity, and wherever the radio spectrum is congested or overcrowded.

Development work is now being expanded with newly filed patents on a heterodyne elimination system for single sideband transmission which will automatically remove the beat of a carrier lying in the band of intelligence. It is a well-known fact that most radio and electronic equipment is obsolescent by the time it reaches the user and obsolete within about five years. The common receiver basic selectivity, or signal separating ability, is twenty years old. Nothing of real importance has been done in the past two decades to improve signal separation since the first receivers were built incorporating a crystal filter. This new development seems to be the first

Fig. 3. Complete schematic diagram of the McLaughlin Type MCL-4 signal splitter.

worthwhile improvement along this line.

Fig. 3 is the circuit diagram of the MCL-4 heterodyne eliminator or signal splitter together with a complete parts list. Fig. 5 is an elementary block diagram of a heterodyne suppressor of the off-frequency inverter type suitable for unmodulated reception.

Let us assume that a desired signal of 455 kc. is present, for example a code signal from the i.f. of a receiver, and that an interfering signal of 455.8 kc. is also present. As shown, two fixed oscillators are used, separated from the desired signal by 1 kc. Thus, if the 456 kc. oscillator is used, the desired signal will be converted to a frequency of 1 kc. and the undesired signal to 200 cycles. This mixed signal is sent through an asymmetrical off-frequency filter with a center frequency of 1000 cycles. This filter will permit a 1000 cycle signal to pass through but attenuates all signals below 1000 cycles very sharply. Thus, in this case, the desired 1 kc. signal would pass through while the undesired 200 cycle interfering signal would be attenuated 60 db.

If the 454 kc. oscillator is used, the desired signal again becomes 1 kc. and the undesired signal 1.8 kc., which will be attenuated 25 db. in the filter. Thus, either oscillator may be switched on, the one giving the highest attenuation of the undesired signal being the most satisfactory operating position in most cases. This is true whether the unwanted signal is higher or lower in frequency than the desired carrier.

Fig. 7 is a simplified block diagram of the heterodyne eliminator for either voice or code reception. It will be noted that two off-frequency inverters are used, one feeding the 50 kc. asymmetrical off-frequency filter and the other the 1 kc. filter previously described. The 50 kc. filter is of the high-pass type, cutting off very sharply below 50 kc. The off-frequency inverter is switched so that the undesired signal is below 50 kc., and is thus highly attenuated. For example, a carrier 1.5 kc. off center may be down as much as 100 db. on phone-type signals. Even greater attenuation is possible with code signals due to the action of the second off-frequency inverter and filter.

Normally, the MCL-4 signal splitter is intended for use with any communications receiver having an intermediate frequency of approximately 455 kc. If the i.f. is other than 455 kc., it is only necessary to change the two local oscillator crystals to 50 kc. above and 50 kc. below the appropriate i.f. setting. No realignment or circuit changes are required in the associated receiver. The unit connects to the receiver through a small coaxial cable, the end of which has an insulated loop. This loop is placed over the plate pin of the first i.f. amplifier tube and the tube is replaced in its socket. The signal splitter has been designed for con-

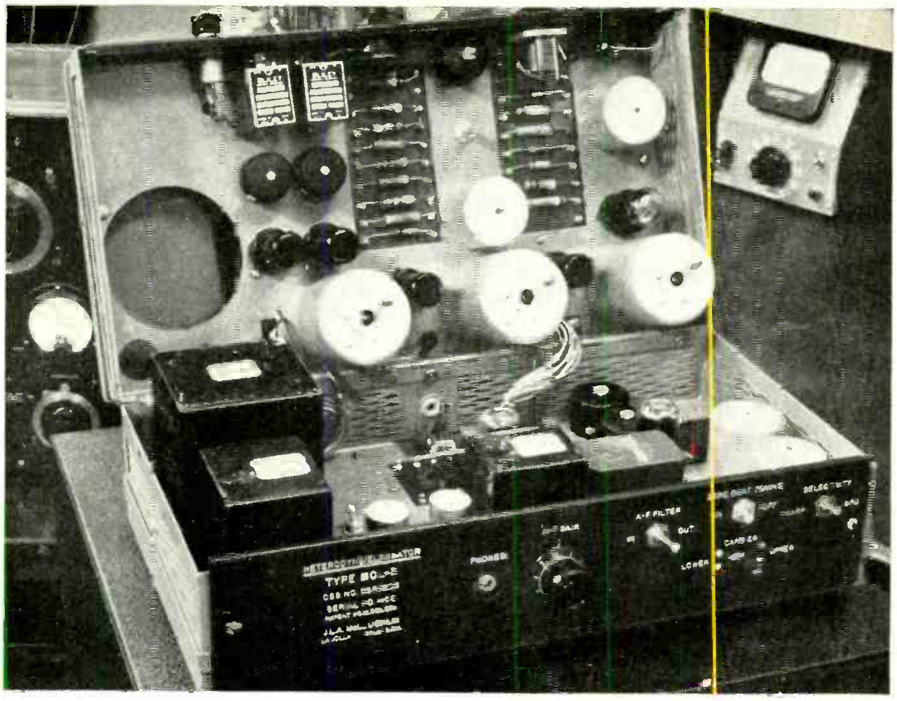


Fig. 4. Type MCL-3 heterodyne eliminator using tuned transformers instead of filters. This eliminator may be used without modification of the associated receiver unit.

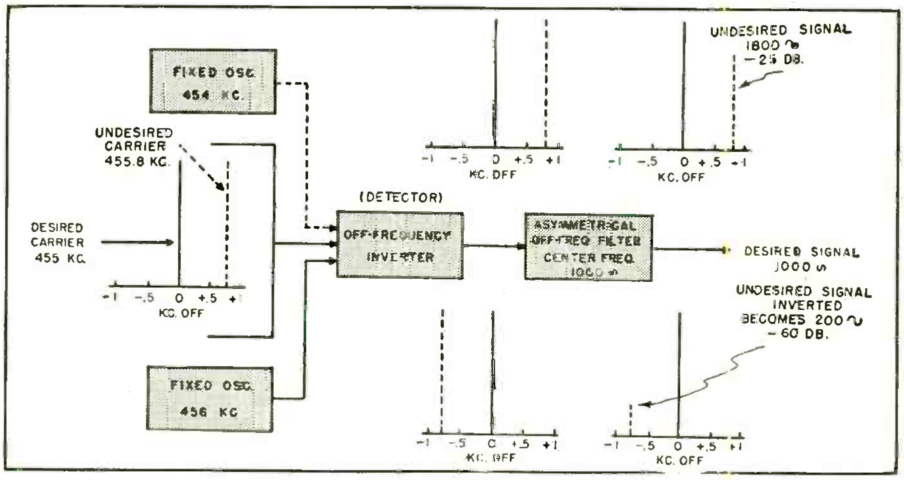


Fig. 5. Elementary block diagram of a heterodyne suppressor of the off-frequency inverter type which is suitable for the reception of continuous wave signals.

Fig. 6. Type MCL-4 signal splitter built for U. S. Coast Guard radio stations.

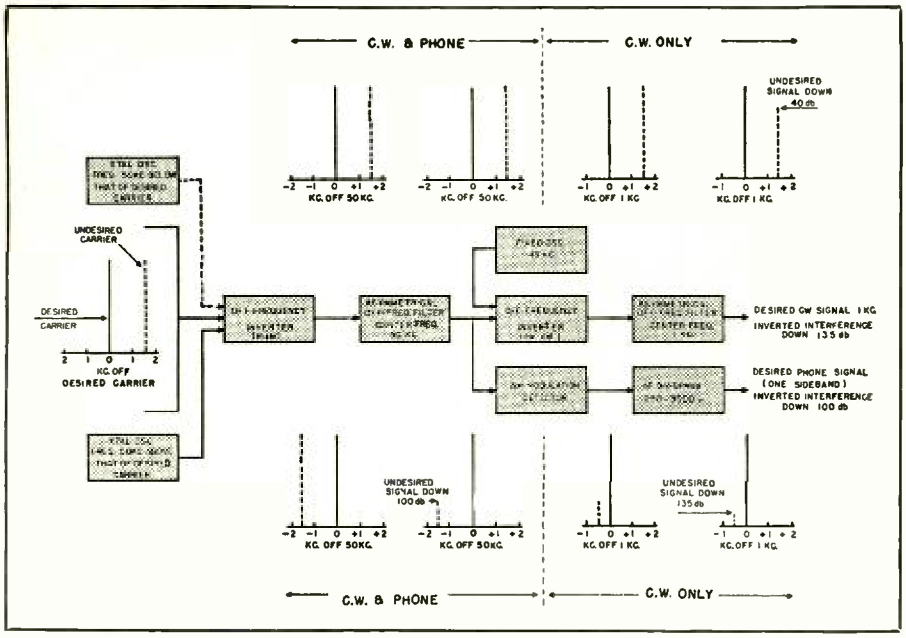
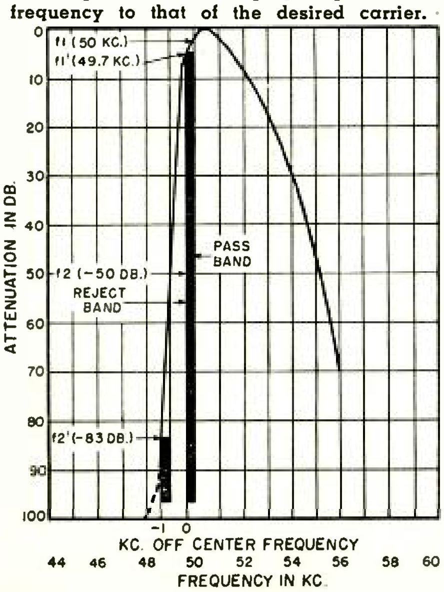


Fig. 7. A simplified block diagram of the Type MCL-4 signal splitter.

tinuous operation and has a power drain of 70 watts from a 105/125 volt, 60-cycle, single-phase source. The audio output of the instrument at 5% harmonic distortion is approximately two watts. On c.w. reception 4 to 5 watts output power can be achieved without noticeable distortion.

Fig. 8. Asymmetrical selectivity curve of the MCL-4 signal splitter. As illustrated, the desired signal will be at 50 kc. Should an undesired signal lie 1 kc. removed (51 kc.) there would exist a heterodyne beat note of 1000 cycles which would be disagreeable. By using the frequency inverter feature, 51 kc. will be changed to 49 kc., while the desired signal remains at 50 kc. The undesired signal will be attenuated 50 db. Should an unusually strong signal and greater attenuation be required, a shift of but a few hundred cycles in tuning will provide an increase in attenuation of the desired signal. The solid line at 50 kc. is 300 cycles wide. Should greater attenuation be desired, the operator shifts his tuning. The desired signal is now 49.7 kc. (f_1') instead of 50 kc. (f_1). The interfering signal, f_2 (49 kc.) has now been shifted 300 cycles to position f_2' showing an increase of 33 db. attenuation (−83 db.) thus affording extreme selectivity to heterodyne interference lying very close in frequency to that of the desired carrier.



A signal that will drive the receiver to full output will develop a voltage across the primary of the i.f. transformer (connected to the plate of the first i.f. tube) sufficient, when coupled through the capacity loop, to drive the signal splitter to approximately full output. If this capacity loop is placed around the pin of the second i.f. tube instead of the first, serious overloading of the signal splitter will result. This overloading could seriously impair the instrument's ability to reject heterodynes. For this reason, it is necessary that the capacity loop be coupled to the plate of the *first* i.f. tube.

With regards to phone-type signals, this system takes advantage of normal double sideband modulation. The fact that intelligence is duplicated on both sides and a carrier which can produce a beat note lies within one band, the system permits cutting off that whole band without losing the demodulated intelligence since it is also present on the other sideband. In such cases where the interference is of excessive magnitude in both bands, no further improvement can be made. This has led to investigations and further development of an improved communications system. This development now forms the basis of new patent applications which are as yet not ready for release to the public. It involves improved forms of modulation which permit an interfering carrier lying within a single sideband of intelligence to be handled with as much ease as the present systems requiring two sidebands.

In the case of professional c.w. code reception, the desired c.w. signal becomes a beat note of 1000 cycles due to the sharply tuned 1000 cycle bandpass filter in the audio circuit and the fact that the b.f.o. is fixed at 49 kc. In Fig. 8 it may be noted that the image frequency will be 48 kc. (derived by 49 kc. minus 1 kc. beat note) while the desired signal will be 50 kc. (49 kc. plus 1 kc.). In this example, it means that the undesired signal will be over 100 db. down. Fig. 8 shows the increase in attenuation to low frequencies that a slight detuning of the desired carrier achieves (50 kc.) toward the cut-off side. The left hand edge of the solid line at 50 kc. indicates a frequency shift of the carrier of approximately 300 cycles. At this point the carrier will be down 5 db. The bottom of the curve illustrates the increase in attentuation this small frequency shift gives a signal 1 kc. removed from the desired carrier, 33 db. greater attenuation has been realized. Frequencies closer to the carrier than 1 kc. will receive proportionate improvement in attenuation. Frequencies below the voice range are satisfactorily attenuated in the a.f. amplifier.

Even though the undesired signal is over 100 db. down it does not mean that the beat produced will be of this value since it is necessary to take into account the peculiar action of detectors. The detector is working as a square law detector on a weak signal and a linear detector on a strong signal. In this instance, the beat is proportional to the b.f.o. and the weak signal where in the case of the linear detection the signal is proportional to the weaker of the two mixed. In practice, it has been found that the beat note's actual measured attenuation is in the order of 80 db. This is sufficient attenuation for good reception of the desired signal. The theory of detection also applies to a crystal filter. For example, there might be many curves which show an attenuation of 60 db. whereas the beat note attenuation actually may not be more than about 40 db. This explains the disparity between theoretical crystal filter selectivity curves and those encountered in practice.

Fig. 10 is a block diagram of the automatic version of the anti-jamming or heterodyne eliminator which is similar to the apparatus shown in Fig. 1. A frequency discriminator "senses" the interference and operates the heteromatic (heterodyne automatic) switch to cut out the malicious interference automatically. It can perform this function automatically at any required rate even where FM jamming is taking place. It was developed during the war for use by radio intelligence groups which encountered this type of interference.

The effect of a drift in frequency of the receiver's local oscillator is not important. The operator, in practice, is fighting interference all the time and adjusting controls. The amount of drift present in any brief period is not too great.

The i.f. mean frequency of 455.5 kc. normally employed is supposed to take care of the fact that most receivers use either 455 or 456 kc. The i.f. is un-important because 455 or 456 kc. is actually wide-band amplification compared to the selectivity of the signal splitter. Radio receivers are considered good when their i.f. stability is ± 2%. The same holds true for crystal filters when they are ± 10 kc.

Unlike most accessory items, the MCL-4 signal splitter reduces rather than increases the complexity of operation. For example, in the case of c.w. reception without this accessory, an operator trying to receive through interference may have to adjust the volume control, tuning control, crystal phasing control, b.f.o., etc. When the MCL-4 unit is employed, the entire process of shifting from the interfering side to the clear side of the mean frequency is automatically and instantly achieved by means of one off-frequency inverter toggle switch. The operator does not have to fuss with controls and lose time as well as signals. He quickly determines which side has the minimum interference and concentrates on that side. When a heterodyne is picked up, it is tuned in for maximum on the receiver. Then, by throwing the toggle switch, it is automatically cut out. It is actually easier to tune with a heterodyne than without. When no heterodyne is present the procedure is to tune by ear to the best response and throw the off-frequency inverter switch to the cut-off side.

Referring to Fig. 6, the front panel controls from left to right are: pilot light which comes on when adjacent toggle switch is in the "on" position; the off-frequency inverter triple-throw toggle switch with the top position "—A+" to invert with middle position, the middle position "+B—" to invert with top position, while the down position is labeled "Test" for precise tuning. In the "Test" position, both oscillators are employed which produces two signals moving in opposite directions as the receiver is tuned. The difference between the two signals is heard as a beat note. The correct position will be indicated at zero-beat; the audio gain control out of the unit; a triple-throw toggle switch with the top position for "AM Phone" reception the middle "CW" position is broad c.w. without the 1000 c.p.s. filter, and the bottom "Sharp" position for sharp c.w. with the 1000 c.p.s. filter; and phone jacks. If it is desired to feed both audio output of the receiver and the signal splitter to a common speaker or line, a patch cord should connect from the "Phones" jack of the receiver to the "AF Input" jack on the signal splitter. By turning down the audio gain on the signal splitter and bringing the gain up on the receiver, normal operation of the receiver is permitted. When the audio gain of the receiver is turned off as far as it will go and the gain of the signal splitter is brought up to operation level, the heterodyne elimination action of the signal splitter becomes possible.

There has been a tendency for persons operating this unit for the first time to confuse it with single sideband transmission even though recognized as an off-frequency inverter. They reach this conclusion because the inverter selects the best sideband. It is actually a sideband selector functioning with either single or double sideband receivers. When used with a single sideband receiver, it performs no useful function other than its inherent selectivity. In the case of c.w., which has no sidebands, the asymmetrical (i.e., unsymmetrical) response of the system permits the off-frequency in-

(*Continued on page* 154)

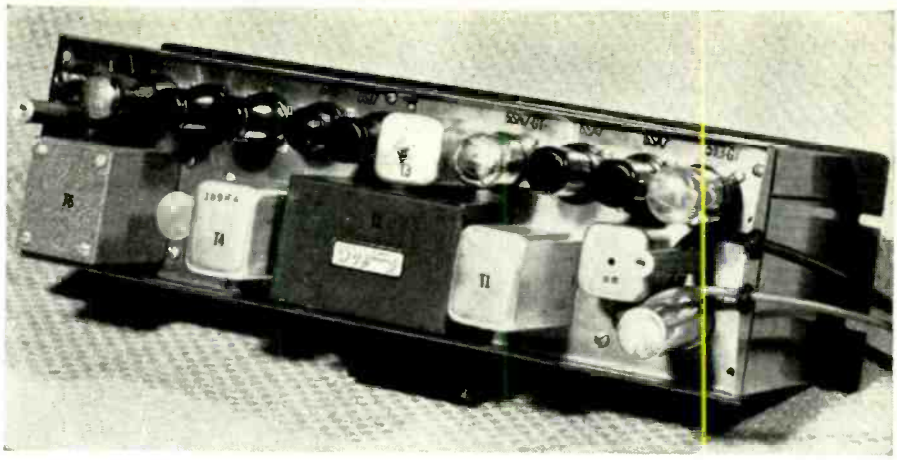


Fig. 9. The tube and transformer layout of the MCL-4 signal splitter.

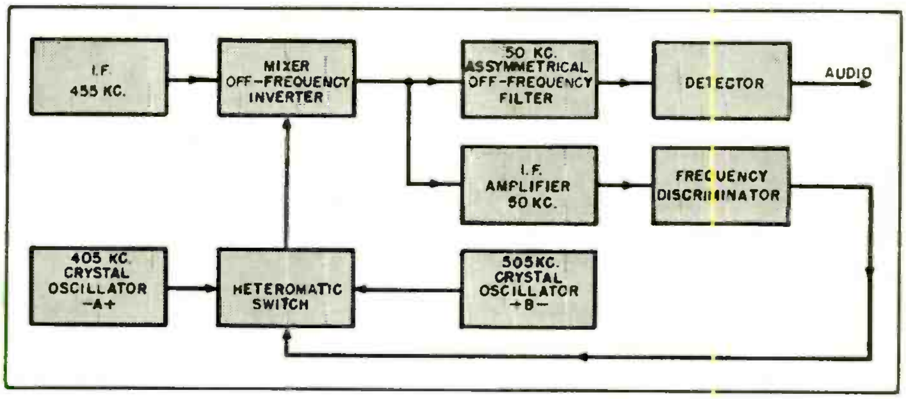
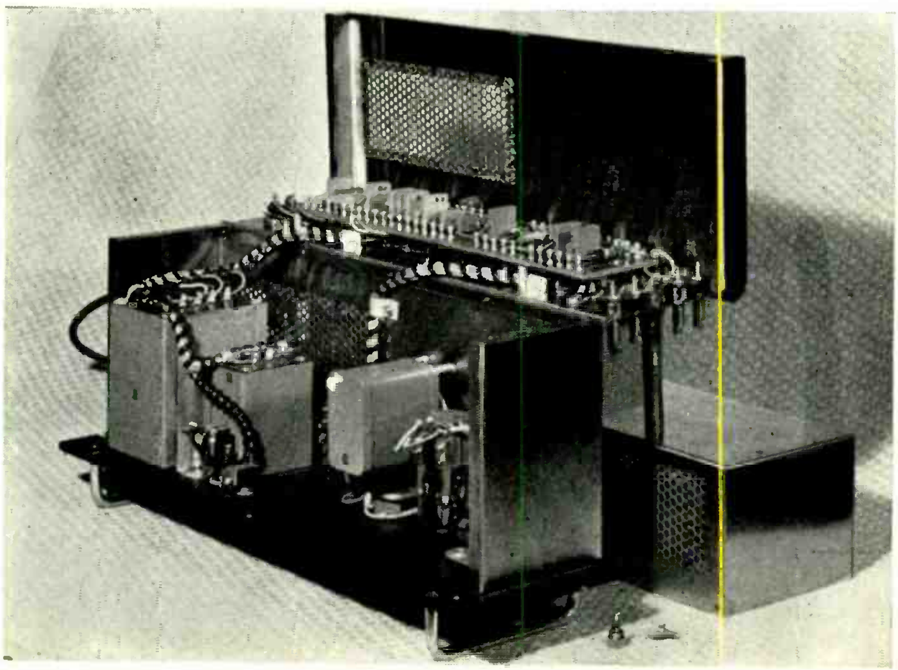


Fig. 10. Automatic version of anti-jamming or heterodyne eliminator.

Fig. 11. Interior view of MCL-4 signal splitter opened for inspection.



AROUND THE CLOCK WITH SHORT-WAVE ENGLISH NEWSCASTS

EST	LOCATION	CALL	FREQ.
0000	Manila	DZH2	9.640
(NS)	Johannesburg	IV	4.800
	(SABC)	V	4.373
(I-NS)	Cape Town		
	(SABC)	III	5.880A
(I-NS)	Pretoria	ZRB	9.110
	(SABC Relay)	ZRB	6.210I
	Buenos Aires	LRY	9.455V
	(SRI-To NA)		
	Los Angeles	KCBF	15.310
	(AFRS-To	KWIX	9.570
	Pacific)	KCBA	6.120
	Edmonton	VE9AI	9.540
	Calgary	CFVP	6.030
(SO)	Vancouver	CKFX	6.080
	Toronto	CFRX	6.070
0015	Melbourne (RA-		
(NSAT)	To W. NA)	VLB5	21.540
	(To W. NA)	VLC9	17.840
(NSAT)	(To Africa)	VLG6	15.320
	(To W. NA)	VLA6	15.200
	Hong Kong	ZBW3	9.525V
0030	Brazzaville		
	(To Europe)		11.972
	(To Africa)		9.973
	(To Middle East)		9.440
	(To Africa)		7.002
	(To Africa)		6.024
(NS)	Salzburg (BDN)		9.533V
	Toronto	CFRX	6.070
0052	Buenos Aires	LRY	9.455V
	(SRI-To NA)		
0100	London (GOS)	GRA	17.715
		GSO	15.180
		GSF	15.140
	(To Pacific)	GSN	11.820
		GSD	11.760
	(To Pacific)	GRH	9.825
	(To Pacific)	GRX	9.690
		GRY	9.600
		GSC	9.580
		GSB	9.510
	(To Pacific)	GSW	7.230
		GSL	6.110
(NS)	Singapore (Radio		
	Malaya, Blue		
	Network)		7.220V
(SO)			6.135
	(Via Kuala Lumpur)		6.025
	Malta (FBS-BBC		
	Relay)		6.140
			4.965
	Vancouver	CBRX	6.160
		CKFX	6.080
	Edmonton	VED	
	(CBC Relay)		8.265
	Melbourne	VLR	9.540
	(ABC-BBC Relay)		
	Perth (ABC-	VLW3	11.830
	BBC Relay)	VLX3	9.610
	Brisbane (ABC-		
	BBC Relay)	VLQ3	9.660
		VLM	4.917.5
	Sydney (ABC-	VLI3	9.500
	BBC Relay)		
(I)	Via Pt. Moresby-		
	ABC)	VLT7	9.520
	Johannesburg	III	4.895
	(SAEC-BBC		
	Relay)	IV	4.800
	Cape Town	III	5.880A
	(SABC-BBC Relay)		
	Pietermaritz-		
	burg (SABC-	II	4.878
	BBC Relay)		
	Los Angeles	KNBX	15.250
	(AFRS)	KWID	11.900
		KCBF	11.810
		KGEI	9.670
		KWIX	9.570
		KCBA	6.120
	Tokyo (AFRS)	JKL2	9.605
		JKK	6.015
0110	Edmonton	VE9AI	9.540
	Melbourne	VLR	9.540
	(ABC)		
	Brisbane	VLQ3	9.660
	(ABC)	VLM	4.917.5
	Dacca (Karachi		7.635
	Relay)		
0115	Belgrade		9.505
	London (ES)	GWJ	9.525
		GSU	7.260
		GWL	7.210
	London (ES)	GRO	6.180
		GSX	6.060
0120	Melbourne	VLR2	6.150
(SO)	(ABC)		
0130	Wellington	ZL4	15.280
	(BBC De-	ZL7	6.080
	layed Relay)		
(NM)	Rangoon		9.543
			6.035
	London (Radio	GSN	11.820
	Newsreel-	GRH	9.825
	To Pacific)	GRX	9.690
		GSW	7.230
0145	Wellington	ZL4	15.280
	(BBC Relay,	ZL3	11.780
	Radio Newsreel)		
0200	London (GOS)	GSH	21.470
		GSV	17.810
		GRA	17.715
		GSI	15.260
		GSO	15.180
		GSF	15.140
		GWG	15.110
		GSC	9.580
		GSB	9.510
		GSL	6.110
	Malta (FBS-BBC		6.140
	Relay)		4.965
	Los Angeles	KNBX	15.250
	(AFRS-To	KWID	11.900
	Pacific)	KCBF	11.810
		KGEX	11.730
		KGEI	9.670
		KWIX	9.570
		KCBA	6.120
	Edmonton	VE9AI	9.540
	Vancouver	CKFX	6.080
	Melbourne	VLR	9.540
	(ABC)		
0210	Lahore (Karachi		6.075
	Relay)		
0215	London (ES)	GWT	9.675
		GWJ	9.525
		GWN	7.280
		GSU	7.260
		GWL	7.210
		GRO	6.180
		GRW	6.150
		GSA	6.050
0220	Berne (To	HER6	15.305
	Pacific, Far	HER5	11.865
	East)	HEI5	11.715
0230	Lake Success	KNBA	9.700
(NM)	(UN via	KNBI	6.060
	VOA)		
	(Via		
	Honolulu)	KRHO	17.800
	(Via Manila)	II	15.330
0245	Colombo	ZOI	4.897V
0300	Vancouver	CKFX	6.080
(SO)	Salzburg (BDN)		9.533V
	Delhi (AIR-To	VUD5	21.510
	W. Europe)	VUD7	17.830
		VUD10	17.780
		VUD3	17.760
		VUD9	15.290
		VUD11	15.190
		VUD2	9.660
		VUD4	9.630
	Bombay	VUB3	7.240
	(Delhi Relay)		
	Calcutta	VUC3	7.210
	(Delhi Relay)	VUC2	6.010
	Madras (Delhi	VUM3	7.260
	Relay)	VUM2	6.085
	Los Angeles	KNBX	15.250
	(AFRS-To	KWID	11.900
	Pacific)	KCBF	11.810
		KGEX	11.730
		KGEI	9.670
		KWIX	9.570
		KCBA	6.120
(NS)	Lake Success	KNBA	9.700
	(UN via VOA)		
		KNBI	6.060
	(Via		
	Honolulu)	KRHO	17.800
	(Via Manila)	II	15.330
	Tokyo (AFRS)	JKL2	9.605
0315 (NS)	Melbourne	VLR	9.540
	(ABC)		
	Brisbane	VLQ3	9.660
	(ABC)	VLM	4.917.5
0320 (SO)	Melbourne	VLR2	6.150
	(ABC)		
0330	Wellington	ZL4	15.280
	(To Pacific)	ZL3	11.780
(SO)	Salisbury	ZEA	6.000
0345 (SO)	Montreal	CHOL	11.720
	(CBC-To	CKLO	9.630
	Pacific)		
0355 (NS)	Melbourne	VLH3	9.580
	(ABC)		
	Brisbane	VLQ3	9.660
	(ABC)	VLM	4.917.5
0400	Melbourne	VLH3	9.580
	(ABC)	VLR2	6.150
	Perth (ABC)	VLW3	11.830
		VLX3	9.610
		VLX2	6.130I
	Brisbane (ABC)	VLQ3	9.660
		VLM	4.917.5
	Sydney (ABC)	VLI2	6.090
	(Via Pt. Mores-		
	by—ABC)	VLT5	7.280
	Kure (BFOS		
	from ABC)	WLKS	6.105
	Melbourne	VLA6	15.200
	(RA—To	VLC4	15.310
	Forces,	VLB4	11.860
	Japan, Asia,	VLG10	11.760
	N. Pacific)		
	Cebu	DYH2	6.140
	Los Angeles	KWIX	11.860
	(AFRS—To	KCBF	9.700
	Pacific)	KGEI	9.670
		KWID	9.570
		KCBA	6.120
	New York	KGEX	11.730
	(VOA—To	KNBX	9.600
	Far East)	KCBR	9.515
		KNBA	6.185
		KNBI	6.060
	(Via	KRHK	11.790
	Honolulu)	KRHO	9.650
	(Via Manila)	III	17.760
		II	15.330
		I	11.890
	Tokyo (AFRS)	JKK	6.015
		JKL	4.860
0405	Berne (To	HER6	15.305
	Pacific)	HER5	11.865
		HEI5	11.715
0430 (S-I)	Salisbury	ZEA	6.000
0440 (NS)	Salisbury	ZEA	6.000
0455	Manila	DZH3	9.505A
0500	Saigon (Radio	FZS4	11.780
	France Asie)		
(NW-S)	Manila	DZH3	9.505A
(NS)	Manila	DZH6	6.030
		DZH7	9.748
	Salzburg (BDN)		9.533V
(NS)	Hilversum	PHI	21.480
	(To Pacific)	PHI	17.775
		PCJ	15.220
		PGD	6.026
	Los Angeles	KWIX	11.860
	(To Pacific)	KCBF	9.700
		KGEI	9.670
		KWID	9.570
		KCBA	6.120
0515			
(NSS-M)	Bangkok	HSG3	9.796A
(Daily)		HS8PD	6.240A
(NS)	Manila	DZH4	6.000
	Port-of-Spain	VP4RD	9.625
0520V	Rome (To Pacific,		15.120
	Far East)		11.810
0530	London (ES—	GRG	11.680
	Dictation	GWT	9.675
	Speed)	GSW	7.230
		GSY	6.040
(NF)	Damascus		11.750
			6.000
			5.005A
	Perth (ABC)	VLX2	4.897
	Singapore (Radio		9.712
	Malaya, Blue		7.200V
	Network)		
	St. Johns	CBNX	5.970
(NS)	Accra	ZOY	9.640
0545	London (ES)	GRG	11.680
		GWT	9.675
	Port-of-Spain	VP4RD	9.625
0550V	Copenhagen	OZH	15.165
(T-Th-Sat)	(To Far East)		

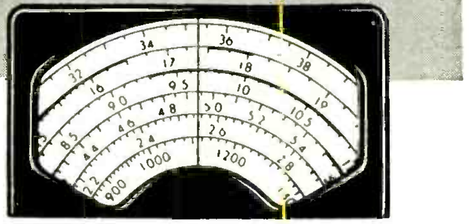
(Continued on page 98)

NOTES: GMT is equal to EST plus 5 hours. Winter schedules are given; in many cases during summer, schedules will be one hour earlier than listed herein. In a few instances, stations temporarily off the air—but scheduled to return this spring—have been included. Frequencies are listed in megacycles; to convert to meters, divide 300 by the frequency in megacycles. In some cases, frequencies are "measured;" in others are "announced" or "listed" channels.

"A" means "approximately." "I" means "irregularly." "V" means "may vary." NS—Not Sunday. SO—Sunday only. NSAT—Not Saturday. SATO—Saturday only. NM—Not Monday. WO—Wednesday only. NF—Not Friday. TO—Tuesday only. FO—Friday only. MO—Monday only. FSATO—Friday, Saturday only. NFSAT—Not Friday, Saturday. SSO—Saturday, Sunday only. NSS—Not Saturday, Sunday.

ABC—Australian Broadcasting Commission. AFRS—Armed Forces Radio Service. AIR—All India Radio. BBC—British Broadcasting Corporation. BDN—Blue Danube Network. BFEBS—British Far Eastern Broadcasting Service. BFOS—British Forces of Occupation Station. CBC—Canadian Broadcasting Corporation. ES—European Service. FBS—Forces Broadcasting Service, Middle East. GOS—General Overseas Service. NA—North America. RA—Radio Australia. RDF—Radiodiffusion Francaise. RNE—Radio Nacional de Espana. SABC—South African Broadcasting Corporation. SRI—Servicio Radiofonico Internacional (International Service). UN—United Nations. VOA—Voice of America. WWBC—World Wide Broadcasting Corporation.

International SHORT-WAVE



Compiled by KENNETH R. BOORD

DIRECT from Djakarta (formerly Batavia), Ir. M. P. Breedveld, Chief Engineer of *Djakarta Radio*, sends me this data:

The broadcasting organizations in Indonesia have been consolidated into a government broadcasting service called *Radio Republik Indonesia Serikat* ("Serikat" means "United"); address is Sambir Selaton 17, Djakarta, Indonesia.

The new 100 kw. transmitter is now in regular service as YDF on 6.045 with Indonesian programs 1700-1900, 2300-0130, 0400-1000 weekdays, and 1800-0130, 0400-1000 Sundays; a *new English* period follows at 1000-1100 for South East Asia and the West Coast of North America. The 100 kw. transmitter is used as YDF3 on 11.795 for programs in Arabic 1115-1200, French 1200-1300, and Dutch 1300-1400, beamed to India, the Near East, and Europe; the *English* period for Europe has not been put into effect yet, but in the spring when propagation conditions improve, it may be added for around 1400-1500. The *English* program for Australia and Malaya is on YDC, 15.150, and YDB2, 4.910, the former with antenna radiating the power of YDC in a narrow beam to Australia only. The French program 1000-1100 for South East Asia and Africa is radiated on YDC, 15.150, to South Africa; YDE, 11.770, to Indo-China; YDB3, 7.270, to India, and YDD2, 4.865, omnidirectional.

These transmitters at Djakarta were listed as active:

YDB, 2.240, 300 watts; YDB2, 4.910, 1 kw.; YDB3, 7.270, 3 kw.; YDC, 15.150, 3 kw.; YDD, 2.600, 300 watts; YDD2, 4.865, 3 kw.; YDE, 11.770, 3 kw.; YDF, 6.045, and YDF3, 11.795, 100 kw.

* * *

Radio Club Notes

England—Roy Patrick is now vice-president of the *Sweden DX Fan Club* and is starting a monthly bulletin for that organization. It will contain broadcast, s.w. and amateur band news, as well as club news. The club is arranging several special DX broadcasts for 1950. Membership fees in this club are now 4 IRC's a year. Headquarters is 5, Aldred Street, Worksop, England.

New Zealand—The *New Zealand Radio DX League* recently chose these officers for the year: President, Jack F. Fox; vice-presidents, Arthur T. Cushen and Jim I. Martin; secretary-treasurer, Des L. Lynn; board members, Lynn M. Gerrie, Peter Thorn, Lloyd E. Warburton, Bill March, Alex J. Allan, and A. Mervyn Branks, in addition to the officers. Officials of the club's monthly house organ, *The New Zealand DX Times,* include A. Mervyn Branks, editor; Arthur T. Cushen, short-wave editor and publicity agent; Ron Gray, amateur editor; Alex Allan, circulation manager and assistant editor; Lloyd Warburton, competitions editor; George Goodsir, printer; Bill Marsh, secretary, and Dudley Carter, treasurer.

Sweden—The *Radio Club of Sweden* (SRK) has started a novel service for its *English*-speaking members; each month a digest of the more important items of its house organ—*DX-Radio*—are translated into *English* and are airmailed to *English*-speaking members, while the house organ then follows by regular mail.

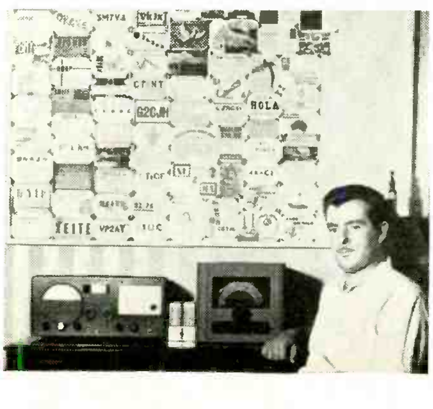
* * *

This Month's Schedules

Algeria—Mesquita e Sousa, Portugal, reports *Radio Alger* on 9.570 at 1400-1500 with Arabic music.

Angola—Widely reported in CR6RG, approximately 9.240, *"Radio Club de Huambo,"* Nova Lisboa, afternoons to 1500 or later. Peddle, Newfoundland, says he hears an outlet on 11.945 in parallel around 1415-1500 or later; announced as operating in the 32- and 25-m. bands. Laubscher, South Africa, airmails that this is a powerful outlet on approximately 9.240, compared to other Angolan outlets, probably at least 1 kw. in power.

Galen Balfe, Massachusetts DX-er, collects both ISW and ham QSL cards. He is using a Hallicrafters S-40A, a RME DB-22A preselector, and a Silver sideband selector. More recently he has rigged up a 100 kc. frequency standard to round out his post.



Australia—VLA6, 15.220, is now in use to Eastern North America 1643-1815; fine level.

Austria—The Blue Danube Network, Salzburg, reported off the air sometime ago, is now being heard on 9.532, operating under heavy QRM. (Radio Sweden)

Burma—A Forces Station reported heard in Israel, Australia, New Zealand, and India on approximately 7.375 around 0800-0830, in *English,* is reported to be *Radio Mandalay;* another report lists it as *"Karen Radio."* (Radio Australia)

Canada—A letter verification from CKFX, Vancouver, British Columbia, stated that this is the s.w. counterpart of medium-wave CKWX and is used "to serve the mountainous areas of British Columbia which cannot be reached by CKWX." Operates on 6.080 with 10 watts, using a quarter-wave vertical antenna; output tube is a single 807 at 400 volts; closes down 0305; is privately-owned. (Cox, Dela., Lyttle, Ontario)

CJCX, 6.010, Sydney, Nova Scotia, 1 kw., relaying CJCB, 1270 kc., 5 kw., is scheduled weekdays 0600-2315, Sundays 0800-2315.

Cape Verde Islands—CR4AA, 5.920, heard in Chicago 1640 with good signal; news in Portuguese. (Whitman)

Costa Rica—TIFC, San Jose, informed Lyttle, Ontario, it is operating with 350 watts from a home-built transmitter; frequency is 9.645; is owned by the Latin American Mission, Inc., Ridgefield Park, New Jersey; usually has *English* 2230-0005; good signal in Ontario.

Cuba—COBZ, 9.026, Havana, noted with *English Lesson* (recorded by BBC) at 1800-1815. (Selman, Texas, others)

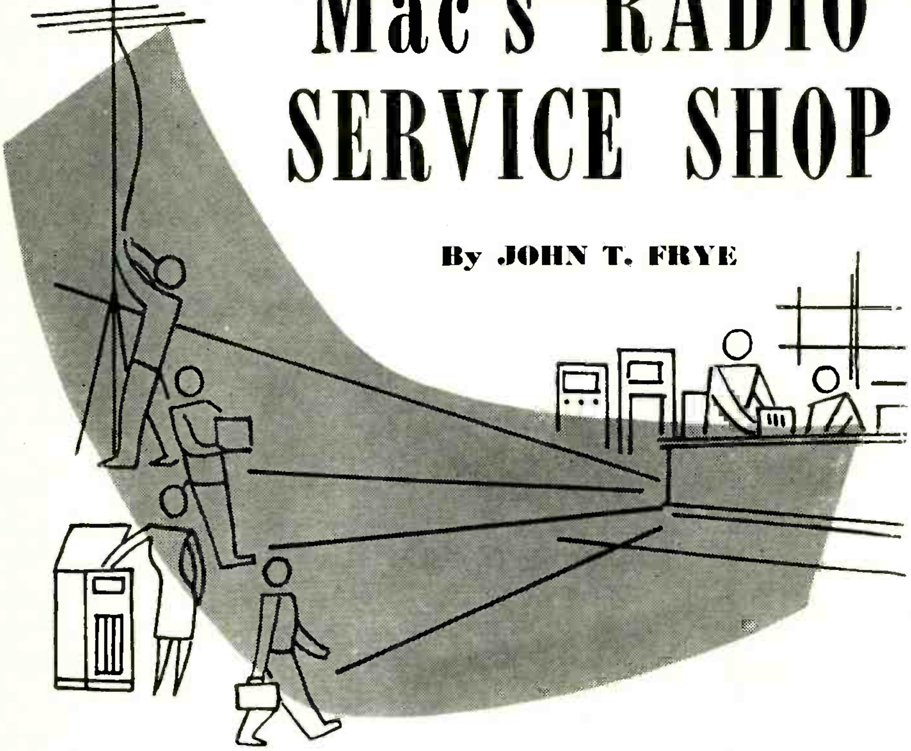
Ethiopia—Bluman, Israel, lists schedule of *Radio Addis Ababa,* "Voice of Ethiopia," as ETA, 9.620, 0600-0645, 0845-1100, with *English* 1010-1100; and ETB, 15.032, which is being used experimentally. He states further that on Tuesdays an additional schedule of 1230-1400 is in effect, with programs

(*Continued on page* 139)

(Note: Unless otherwise indicated, all time is expressed in American EST; add 5 hours for GCT. "News" refers to newscasts in the English language. In order to avoid confusion, the 24 hour clock has been used in designating the times of broadcasts. The hours from midnight until noon are shown as 0000 to 1200 while from 1 p.m. to midnight are shown as 1300 to 2400.)
The symbol "V" following a listed frequency indicates "varying." The station may operate either above or below the frequency given.

Mac's RADIO SERVICE SHOP

By JOHN T. FRYE



A SUDDEN extra-strong gust of wind jerked the opening door from Barney's fingers and slammed it back against the wall. Before he could step inside the service shop and close the door, the same mischievous whirlwind scooped a bunch of papers from the desk at which Mac and the office girl, Miss Perkins, were sitting and sent the sheets sailing wildly about the office.

"That's our boy, Barney," Mac observed resignedly as he recovered the scattered papers. "He and March *both* come in like lions."

"Man! The wind out there is twenty db. over S9," Barney said as he perched himself on a corner of the desk. "What are you two in a huddle about?"

"We were just talking about letting you go and getting an intelligent monkey to take your place," Mac explained blandly. "I was pointing out that with all the climbing that has to be done putting up these TV antennas, a good, reliable, sure-grip tail would be worth more to a service technician than any amount of brains; and as far as there being any great difference in brains, if the monkey is only reasonably intelligent—"

"He's just teasing you, Barney," Miss Perkins broke in quickly as she saw a look of genuine concern cross the boy's freckled face. "We were just working out a parts order in preparation for the April portable-special Mac is planning."

"The whatable special?"

"Portable-special," Mac replied. "During the last two weeks of April we are going to run an offer to check the batteries, tubes, and general operating condition of any portable receiver brought to the shop for only one buck. Newspaper ads and radio spot announcements will urge the good people to dig their portable sets out of the closets and bring them to us so that we can put them in top-notch shape for the picnic-beach-party-and-baseball-game season."

"A single George Washington doesn't seem like much money for the kind of check you will give them—or rather make me give them," Barney said dubiously.

"True, but a high percentage of those sets are bound to need new tubes or batteries or both. Quite a few of them will take some further work to put them into shape. As our advertising will make crystal-clear, that 'George Washington' as you call it simply pays for testing the tubes and batteries and calling attention to any defects that need remedying. Any further service will be charged for at our usual rates."

Before Barney could pursue the subject, the door opened to admit a pretty young woman who was all the prettier with her hair slightly tousled by the wind.

"Hello, Gay," Mac greeted her. "What can we do for you?"

"My big radio has gone dead, Mr. McGregor, and I was wondering when you could fix it."

"Hm-m-m-m," Mac said as he took a quick look at the call-list beside the telephone, "it will probably be two or three days. We are really snowed under this week."

She made a little face of disappointment, but she said, "Well, it will just have to wait until then, for my husband told me never to let anyone touch it but you. Just stop by and pick it up when you get the chance."

"Wait a minute, Gay," Mac said as she started for the door. "I can't run your set around others in the shop during regular working hours; but I guess I can work on it on my own time if I please. I know what that set means to you, and I also know that my wife is having a bridge party at our house tonight. I'll pick up your set right after supper and bring it down here and see what is the matter with it. I'd much rather be here working than sitting at home in the basement re-reading old magazines and wondering if those gals are *never* going home."

"You are trying awfully hard to make it sound as though *I* were doing *you* a favor, but I think you know how much I appreciate this," Gay said with a dazzling smile that seemed to hang in the air long after she had closed the door behind her—or at least it seemed so to Barney, who was more than somewhat susceptible to feminine charm.

"Not that I blame you, Boss," Barney said softly, "but weren't you the one who gave me a lecture last week about not letting a pretty face wheedle special favors out of me? And she's a married woman, too!"

"The pretty face has nothing to do with it," Mac answered gruffly. "I happen to know the circumstances. That set is an all-wave job that she uses to listen for her G.I. husband in Germany who gets a chance to talk over a ham station from there every now and then. Since she actually talked to him over Herb Thorne's ten-meter rig, she spends half her time listening to the ham bands on the off chance she will hear her husband's voice.

"And while we are talking, Fireball, I may as well take up another little matter. I realize I told you the only fair way was to repair sets exactly in the order in which they came in and that you were not to run one radio around another just to keep from losing a service job; but do you *have* to sound so coldly impersonal when you tell a poor guy that you can't get on his receiver immediately, even though it is the only one he has in the house?

"Try to keep in mind that it is not just a radio he has brought you. That dead set he holds in his hands represents a worrisome *trouble* that he hopes you can help him get rid of. If you can't do that immediately, the least you can do is be properly sympathetic and show that you actually would like to help him."

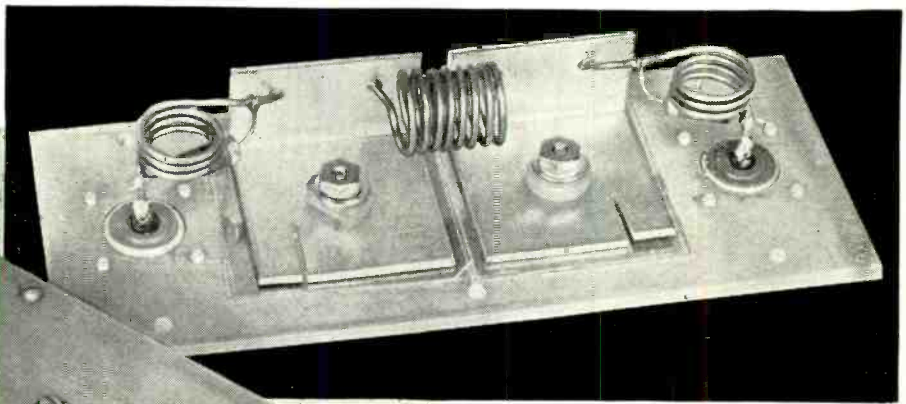
"I get it: you want me to put on the old I-wish-I-could-but-I-can't act."

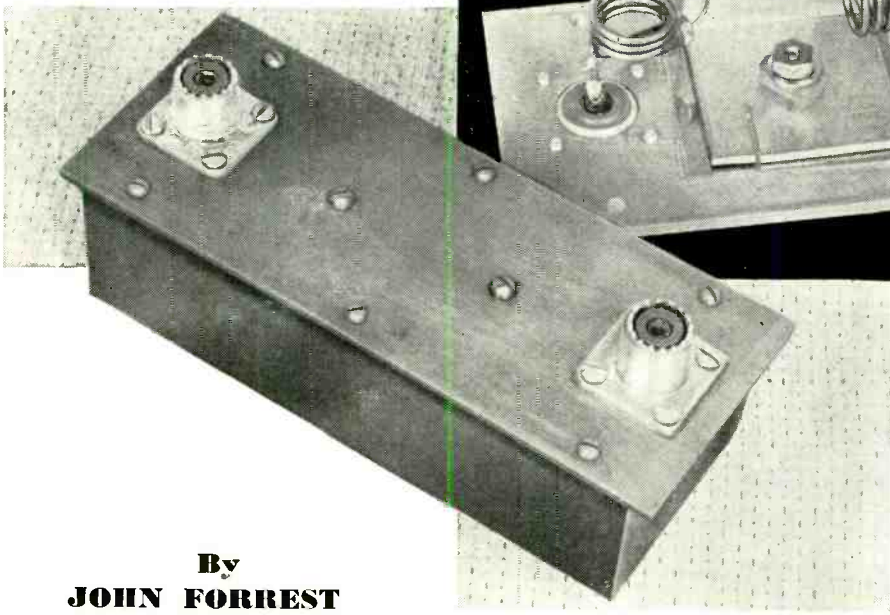
"No you *don't* get it," Mac said with a thoughtful frown. "I don't want you just to pretend you are sorry; I want you to *be* sorry. It's part of being a real service technician. This wacky business we are in is called 'radio service'; and we never want to concentrate so hard on the 'radio' end of it that we forget the 'service' part. People depend upon us to do a par-

(*Continued on page 84*)

A TVI Filter for Coaxial TRANSMISSION LINES

Two views of the TVI filter. Internal view shows method of mounting airwound coils.





By
JOHN FORREST

Complete details for an antenna feedline filter which reduces radiation of harmonics falling in the TV band.

THE increasing number of television receivers is a source of concern to all amateurs. In urban areas the amateur is likely to be completely surrounded by television receivers, each a potential threat to the ham version of "pursuit of happiness." In small communities, remote from television stations, TVI is also a serious problem since the use of high gain boosters and antennas compounds the difficulty. The amateur who wishes to be free of TVI must begin immediately to rid his equipment of spurious radiations. The task of "delousing" the average amateur transmitter is formidable but successful techniques are being developed which may be applied to all transmitters, e.g., shielding, power line filters, class B operation of r.f. stages, use of FM, and finally, antenna feedline filters.

The antenna feedline filter should be considered standard equipment by the amateur who has many television receivers nearby. Excellent filters are available from several manufacturers. These filters are usually designed for coax for several reasons: It is easier to construct a filter for coax than for balanced lines; the excellent shielding of coax reduces the probability of TVI to begin with; and surplus coax such as RG-8/U is cheap and plentiful and has lower loss than any of the other commonly used amateur feedlines. The difficulty of feeding a balanced load with coax is ordinarily sufficient to deter many from using it, but there are several excellent methods of accomplishing the job. For instance, a substantial advance in this respect appears to have been made by W3MTE with the "Gamma match."[1]

The filter shown in the photographs is intended primarily for use in RG-8/U cable feeding a 10 meter beam antenna. It is suitable for use in any 50 ohm coaxial cable on any band between 160 and 10 meters. Transmission characteristics of the filter are plotted from 2 mc. to 200 mc. The measurements were made with a *Measurements Corp.* Model 80 laboratory signal generator and an r.f. voltmeter across a 50 ohm termination. The minimum attenuation in the stop band is 30 db., near 60 mc. This should be adequate to eliminate TVI but there is no reason why any number of similar filters may not be connected in cascade. The filter is merely inserted in the transmission line between the final amplifier and antenna.

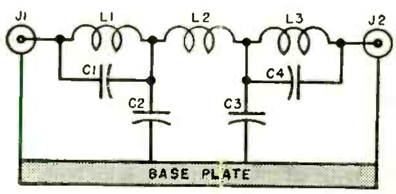
Electrically, the filter is described as a single pi-section *m*-derived, low-pass filter with terminating half sections. The design equations are contained in *Terman's* "Radio Engineer's Handbook" on page 228. A filter to meet a particular requirement may be designed from these equations. The construction technique used in this model is recommended for similar devices operating in the television frequency ranges.

All components are assembled on a ⅛" brass plate. This thick material is used for rigidity so that the bypass capacities will be constant once adjusted. Each condenser top plate is secured by a single screw with a shoulder washer for insulation. The top plates are 1/16" material. Each top plate has a right angle bend in it with holes through the vertical tab thus formed through which the ends of the coils are passed for soldering. This style of condenser has high break-down voltage, high current-carrying capacity, and most im-

(*Continued on page* 128)

[1] Washburn, H. H.; "The 'Gamma' Match," QST, Sept., 1949.

Diagram and parts list for TVI filter.



C_1, C_4—94 μμfd. mica cond. (a 100 μμfd. ±10% is satisfactory)
C_2, C_3—141 μμfd. plate cond. (see text)
L_1, L_3—3½ t. #14, ½" i.d., ⅜" long, airwound
L_2—8 t. #14, ½" i.d., ¾" long, airwound

A Versatile Recording and Playback Amplifier

Panel view of the recording and playback amplifier. Author used his unit in conjunction with the tape recorder shown.

By GLEN SOUTHWORTH

Construction details for building an amplifier which can be used for either tape, wire, or disc.

AN IMPORTANT branch of the audio art is that which deals with transforming sounds into a form in which they may be kept more or less permanently and reproduced at will. Prior to the recent war, disc and film were the two principal recording techniques. Since then magnetic recording on wire, and particularly tape, has experienced a phenomenal growth.

Each system has its own advantages and disadvantages. Disc records are subject to noise, surface wear, warpage, and may often require expensive, high quality recording equipment for good results. On the credit side they may be kept indefinitely, if well treated, and are convenient in that it is easy to find a particular passage on the record quickly. The merits of sound on film recording may be noted at your neighborhood theater, but, in general, this technique is too expensive and complicated for widespread general use.

Magnetic recording has several advantages over other types of systems, one of the chief ones being that no mechanical linkage is used in either recording or playback. This results in considerably lowered distortion, particularly of transients, and the ability to be replayed indefinitely without deterioration of quality. Although good results may be obtained on either wire or tape, tape recording seems preferable from the standpoint of better mechanical properties, ease of editing, and generally greater advancement in the art.

The amplifier described in this article was designed for use in recording or playback of disc, wire, or tape, and may be used for re-recording from any of these media to another. Push-pull 6L6's are used in the output stage to give ample power to drive either a loudspeaker or magnetic disc recording head, while a high frequency oscillator is included to provide bias and erase voltage for either wire or tape.

The high gain required for the playback of tape recordings gives rise to several problems. One of these is reducing the hum level to a low value. Other than inadequate filtering, ground loops are a common source of disturbance and it is recommended that an isolated ground system, connected to the chassis at only one point, be used. Another problem arises when the high frequency energy from the bias oscillator gets into the amplifier stages and creates distortion and lack of sensitivity. A wide range oscilloscope is very useful in tracking down this difficulty and eliminating the trouble through use of proper shielding or bypassing.

Another serious problem occurs when energy from the output of the amplifier gets back into the input, causing oscillation or instability. The simplest way to reduce this effect is to separate the input and output circuits physically, and manually change the position of the recording-playback head connection from output to input. If it seems desirable to have a more convenient switching arrangement, a multiple section switch, such as shown in the accompanying diagram, may be used. In this case, sections of the switch are used as conductors in one position and shields in the other, making good electrical separation possible.

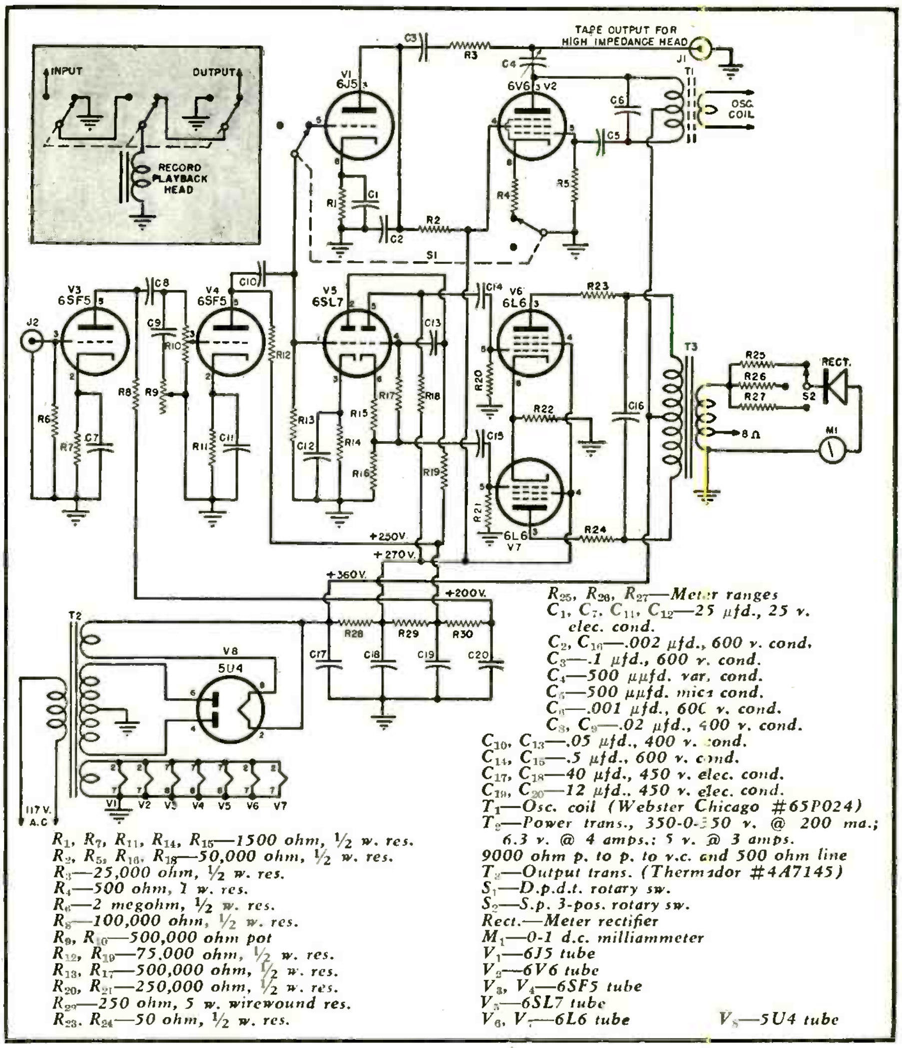
For single track recording the author has found that a small permanent magnet makes a good, yet simple erase mechanism and has the advantage that an entire reel of tape may be cleared in the short period of time during rewind or fast speed forward, while electronic means do not usually work satisfactorily at such high speeds. When using permanent magnet erase, a quieter recording appears to result by placing the magnet on the side of the tape away from the magnetic coating. Using one of the small Alnico magnets, the field is usually intense enough to penetrate the tape and provide complete erasure, while the more uniform field produced tends to lower the amount of noise recorded on the tape during the erase process.

When recording two independent sound tracks on standard tape, electronic erase becomes desirable due to the fact that the erase area may be carefully controlled so as not to overlap and attenuate the adjacent recording. For this reason the bias oscillator in the recording amplifier is designed to supply several watts of high frequency power, sufficient to operate an erase head for either tape or wire.

A considerable variety of recording-playback heads is now on the market. Probably the easiest of these to use is the high impedance head which may be driven by a simple triode voltage amplifier stage. As power requirements are very low, high quality recordings may be made with light, compact equipment. As shown in the amplifier schematic, a separate triode stage is used to drive a high impedance recording head, thus bypassing any distortion that might occur in the power output stages. In the event that a low impedance head is used, the taps on the output transformer may be connected for proper match and the push-pull 6L6's used to drive the recording head. Similarly, the oscillator coil specified has a low impedance winding for use with low impedance erase heads.

As mentioned previously, an oscilloscope is an excellent aid in testing a magnetic recording system. The high frequency bias should be as nearly a perfect sine wave shape as possible and any serious departures from this standard may be observed on the scope. Likewise, the scope provides a simple means of observing hum, regeneration, or bias frequency in the amplifier stage. If a stable audio oscillator is available it may be used as a "wow" meter by recording a constant tone, and during playback applying the output of the recording to one set of deflection plates and the output of the oscillator to the other. Periodic variations in the pattern will indicate wow, while a gradual change will indicate tape slippage or oscillator drift. Meter calibration for recording level may be determined by recording a tone of gradually increasing intensity and observing on the playback the point at which distortion starts to occur. Breaking in at certain levels with voice announcements may make it easier to locate the exact point at which distortion begins.

Assuming a perfectly functioning amplifier, the quality of the recording will depend on a number of factors. Type of recording head, tape, bias frequency, bias amplitude, tape speed, and quality of the original signal should be considered. If using a well matched recording head of good design, the quality of the recording may vary according to the type of tape used with a particular system. This is due to the varying characteristics of different magnetic coatings and the fact that recording level and bias conditions may differ considerably for optimum results. The author's preference is for the brown oxide-coated tape which gives wider range, greater sensitivity, lower distortion and noise, and higher output levels than that obtainable with the less expensive tapes. However, with any tape, if the bias is not correct serious distortion may result, giving either harsh reproduction due to strong third harmonic production or mushiness due to the suppression of low level components, the latter effect apparently being increasingly noticeable at slow tape speeds even though the same frequency range is reproduced.

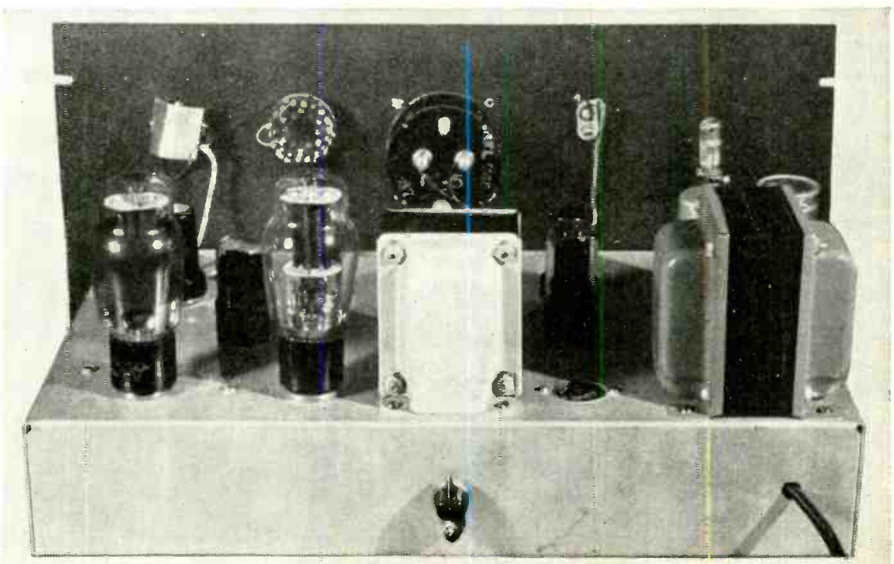


Schematic of the high gain amplifier for tape, wire, or disc recording and playback. Shaded inset shows simple method for switching magnetic record-playback head from input of amplifier to output of recorder. Three-section switch minimizes coupling.

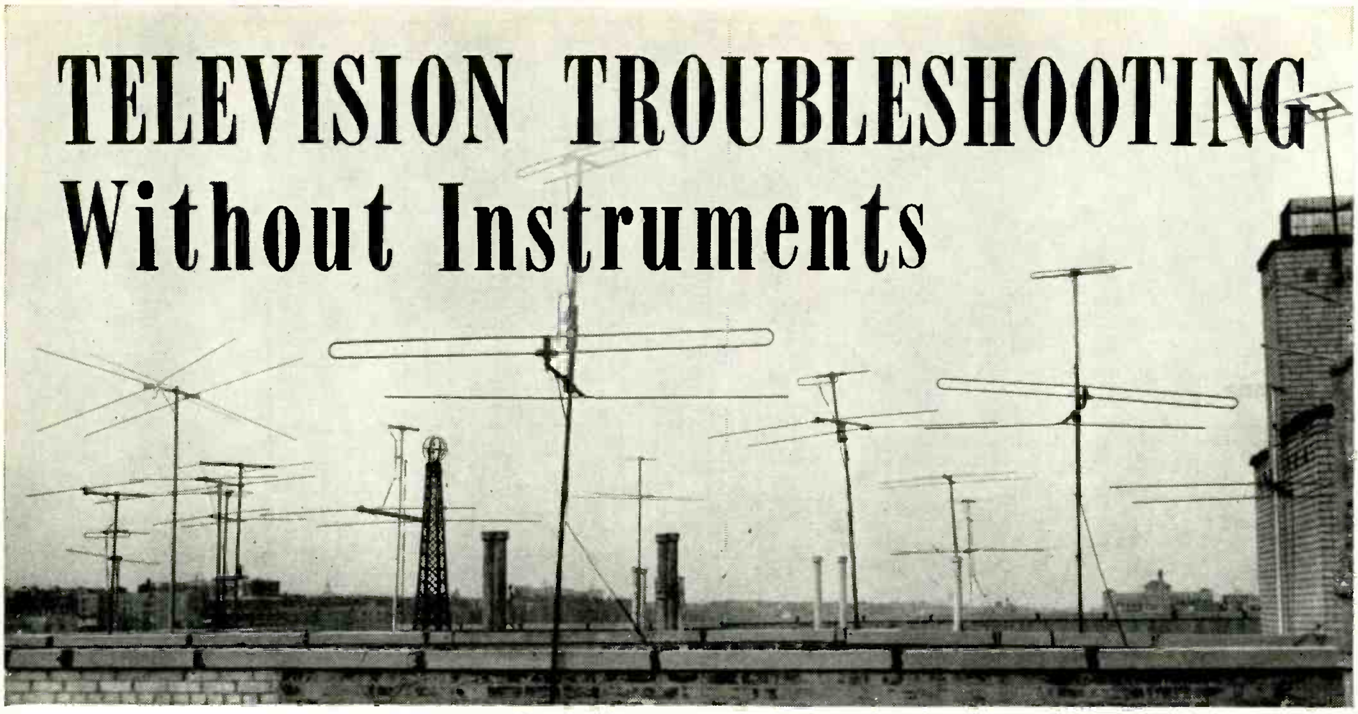
The photograph (see page 62) illustrates an interesting tape pulling mechanism used by the author and available to experimenters. Of primary interest is the fact that it is a three-speed unit, capable of tape speeds of 3.75, 7.5, or 15 inches per second, thus providing three combinations of quality and playing time.

(*Continued on page* 112)

Rear view of record-playback amplifier showing general layout of component parts.



TELEVISION TROUBLESHOOTING Without Instruments



By WALTER H. BUCHSBAUM
Chief Eng., Tech-Master Products Co.

Not all defects can be located—but the procedure outlined describes a method whereby a great number of circuit faults can be found without instruments.

THE title of this article appears to offer a long-awaited panacea to the service industry and the evolution of a nemesis to the test instrument manufacturers. Actually, we do not recommend that you throw out all your instruments, or delay purchasing new ones—not even *after* you have read this article. The method outlined herein is merely a convenient procedure for locating certain defects when instruments are not available. While most service technicians carry a voltohmmeter on all service calls, few can take a signal generator and an oscilloscope along; and in those instances where the defect would normally be found by signal tracing or signal injection, this method is often of great help. It should be understood clearly that we are not trying to suggest a complete system for troubleshooting *all* defects, but merely showing how in some cases, some defects can be found without the use of any instruments.

The principle of this new method of troubleshooting is the utilization of one functioning section of the receiver to locate the defect in another section. A study of any TV circuit diagram reveals that the audio amplifier section resembles the circuit of most AM signal tracers. The video section and the sweep circuits, on the other hand, have some similarity to an oscilloscope. Before showing how these sections of the receiver can be used to locate trouble, it is important that the function of each stage and each section is clearly understood. Lacking this basic knowledge, troubleshooting with or without instruments is only a hit and miss proposition.

Function of Each Stage

Referring to Fig. 1, and starting at the upper left hand corner we find the r.f. amplifier, mixer, and oscillator. These three stages are usually located on a small subchassis and comprise the r.f. tuner or "front end." Because these tubes operate on the television r.f. frequencies and at a relatively low signal level, signal tracing is not practical. If either sound or picture are being received it is safe to assume that the r.f. tuner is operating properly. Even if only static noise is either seen or heard the defect may not be in the tuner. Realigning the local oscillator slightly may be sufficient to bring in either sound or picture, or both. In any event, troubleshooting the r.f. front end is usually a tedious and difficult job, and most service technicians are content with trying out new tubes and measuring the operating voltages until the set can be brought into the shop for a thorough check-up.

The picture i.f. amplifier consists of a chain of three or four tubes, either types 6AG5 or 6AU6 are the most popular in present day sets, and in most cases a system of stagger tuning is used. This means that each stage is tuned to a different frequency and the relatively high gain of each stage at that frequency adds up to the overall, broadband response curve. One of the drawbacks of this system is that in the event two subsequent tuned circuits are close to each others' resonant frequency, a tendency toward regeneration and oscillation exists. The transformer-coupled system where each stage is broadly tuned over the entire bandwidth is more stable, but more costly and more difficult to align. In either system a broad band of frequencies is being amplified and it is possible to signal trace this section of the receiver. How this is accomplished is described in detail in a later paragraph.

After the i.f. signal is amplified sufficiently it reaches the second detector where the picture signal is removed from the i.f. carrier and amplified further. This signal has three main components: the actual picture part which determines the light and dark on the screen, the horizontal sync pulses, and the vertical sync pulses. The horizontal sync pulses and most of the picture consist of frequencies too high to be audible, or to be reproduced by conventional loudspeakers. The 60-cycle pulse which forms the vertical sync signal, however, is audible as a low rasping noise. Where a pair of earphones is connected to the output of the last video amplifier this rasping noise can be heard clearly, but for our new method of troubleshooting the audio amplifier of the set will be utilized to trace the path of the picture signal.

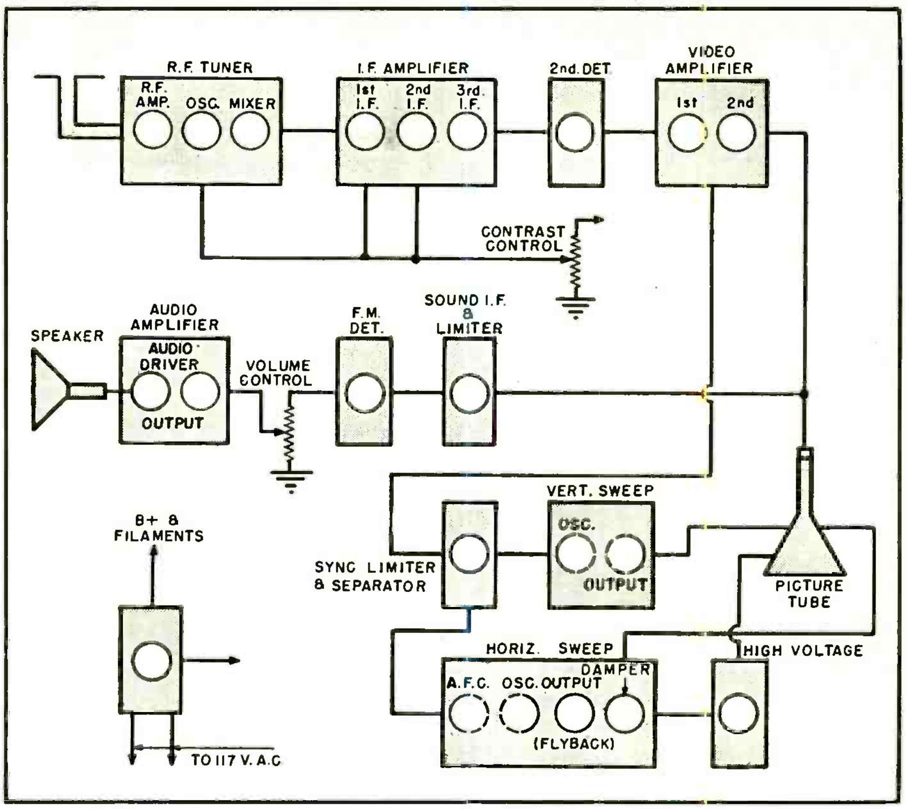


Fig. 1. Block diagram shows functional operation of a conventional television receiver.

The sound signal is separated from the picture signal in two different ways. In the block diagram of Fig. 1, the Intercarrier System is shown, because this system is becoming more and more popular, especially among lower priced sets. The sound and picture i.f. signals are amplified together through the chain of i.f. stages and at the second detector the sound i.f. carrier beats with the picture i.f. carrier. Since their difference frequency is 4.5 mc., a second sound i.f. of that frequency is created which is then amplified, along with the picture signal, through the video amplifiers. This 4.5 mc. signal is trapped out at the plate of the last video stage and fed to the sound limiter-amplifier. The 4.5 mc. carrier is frequency modulated and the sound is detected by a ratio detector type circuit.

After passing through a de-emphasizing filter the audio signal is then applied to a conventional two-stage audio amplifier. This two-stage amplifier is very useful as a signal tracer for troubleshooting either video stages or the vertical sweep and synchronizing section.

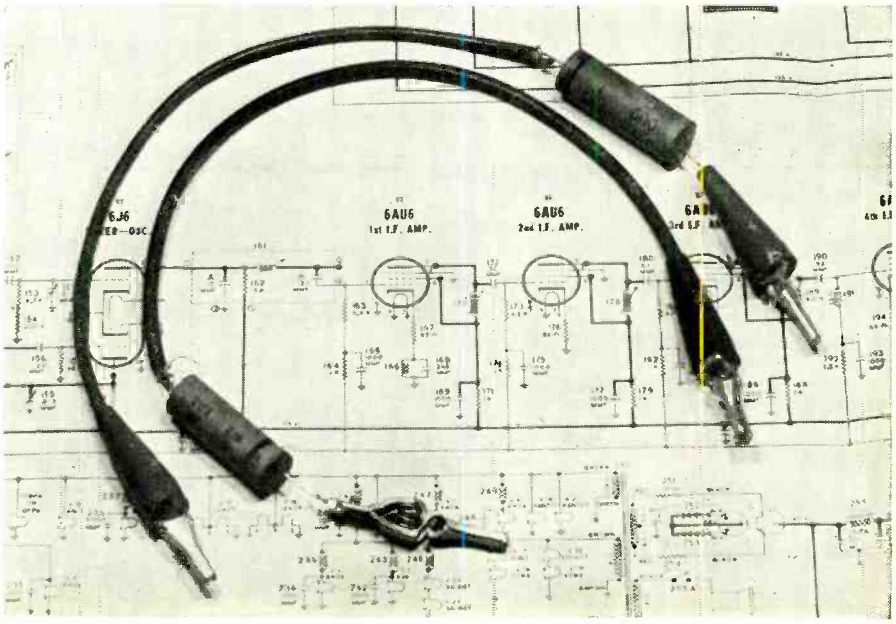
Many older type sets and most of the more expensive models use a separate sound i.f. channel, usually tuned to 21.25 mc., and a discriminator type of detector circuit. The sound i.f. carrier is removed from the picture i.f. signal either through a tuned trap at the mixer plate or in one of the first two i.f. stages. In this system the picture i.f. amplifiers, following the point of sound i.f. removal, will always have at least one more trap to eliminate the sound signal. A conventional audio amplifier circuit is used after the detector, just as in the Intercarrier System.

In addition to the sound and picture signals, a television system also requires synchronizing pulses for both the vertical 60-cycle sweep and the horizontal scanning which has a frequency of 15,750 c.p.s. Both pulses are present in the final picture signal as it reaches the picture tube, and usually a portion of this picture signal is applied to the synchronizing circuits. Depending on the method of generating the sweep voltages, different amplitude and phase of sync pulses may be required. In all cases, however, both vertical and horizontal pulses are passed through at least one clipper-limiter stage as shown in Fig. 1. If this stage is functioning properly, both pulse frequencies will be present at its output, and while the 15,750 c.p.s. signal is nearly inaudible the 60-cycle pulse is clearly distinguished as a low rasping hum, when the signal is run through the audio amplifier. Sync pulse separation is achieved by using an integrating network to pass only the 60-cycle pulses and a small coupling condenser to pass only the 15,750 c.p.s. horizontal sync pulses.

The vertical sweep section shown in Fig. 1 is one of the simplest in use, requiring only a single 6SN7 tube of which one triode section is used as the oscillator and discharge tube and the other as the output amplifier. Some receivers may use two or even three tubes for this purpose, but the principles are the same and signal tracing can be done in a manner similar to that outlined in a later paragraph.

Fig. 1 shows a frequently used system of a.f.c. (automatic frequency control) used to hold the horizontal sweep steady. The actual functions of each stage in the horizontal sweep circuit and high voltage section will not be discussed here because this part of the receiver does not lend itself directly to troubleshooting without instruments. Unless an obvious short or broken part is apparent in the horizontal sweep and high voltage section, the fastest method of locating the defect is by signal tracing with an oscilloscope. The only way in which the method described in this article can be applied to this section is by tracing the sync pulses to the output of the sync separator stage and assuming that since the vertical output is observed there, the hori-

Fig. 2. The only "tools" required to make the troubleshooting tests outlined in article.



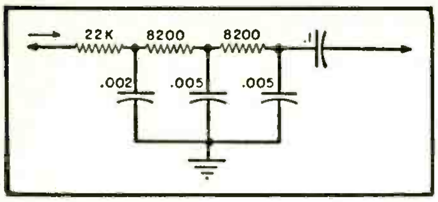


Fig. 3. Vertical sync pulse integrator network used almost universally for removing the horizontal sync pulses permitting only the vertical sync pulses to pass through.

zontal output must also be present and any loss of sync pulse must, therefore, take place in a subsequent stage.

The filament and "B plus" circuits can usually be checked easily by the old radio technician's standby, the spark test. In the event an open filament choke or transformer winding is suspected the audio amplifiers can be used to trace this defect. In general, these circuits can be serviced more efficiently with any conventional volt-ohmmeter.

Practical Applications

If the exact function and the nature of each stage in the modern television receiver is thoroughly understood, the actual application of the method outlined in this article will present no difficulties. A little practice is helpful, especially in those parts where the audio section is used as a signal tracer. Once the technician learns to recognize the different sounds, locating the defective part is usually only a matter of minutes. Among the most frequent applications of the instrument-less method are the following major symptoms which are discussed in detail:

1. No sound, no picture.
2. No sound or weak sound with good picture.
3. No picture or weak picture with good sound.
4. No vertical sweep or very little sweep.
5. Loss of vertical or horizontal sync or both.

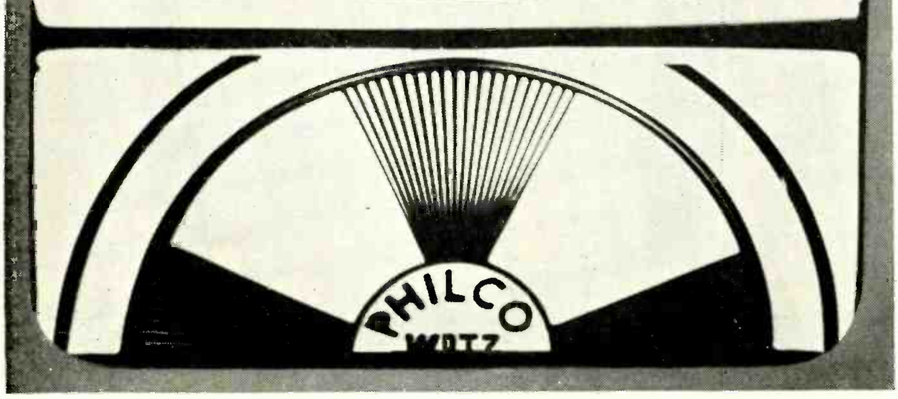
Other defects, such as intermittent front end tuners, no high voltage, burned or shorted components, etc., do not lend themselves readily to troubleshooting without instruments and it will be found that they can be serviced more efficiently with conventional equipment.

1. *No sound, no picture.* This condition can be due either to the loss of the signal in the r.f. stages because of a power supply failure or, especially in sets using the Intercarrier System, because of a defect in the picture i.f. or video amplifiers. To ascertain whether a picture signal is present in the video amplifiers connect a .05 μfd. condenser, through a clip or test lead, to the "high" side of the volume control. Touch the free end of the condenser to a filament pin anywhere in the set. This will produce a loud 60-cycle hum in the speaker, proving that the audio amplifiers are working properly. Next touch the free or "probe" end of the condenser to the plate of the last picture amplifier. If a picture signal is present, a loud rasping hum is heard. If no signal is found, move the "probe" back to the preceding grid, and so on until it is connected to the second detector load resistor. The absence of a picture signal there indicates that the defect must be in either the i.f. or r.f. stages preceding the detector.

To check the i.f. amplifiers would require the insertion of a signal from a generator or at least a multivibrator generating harmonics in the i.f. frequency range. We find, however, that the set itself contains such a multivibrator in the form of the vertical sweep generator. To utilize the vertical sweep connect a .1 μfd. condenser to the plate of the vertical sweep output tube and attach a clip or test lead on the free end. As indicated, the audio system is used again and since we know that the defect is not in the video amplifiers it is usually best to connect the "probe" end of the .05 μfd. condenser from the volume control to the plate of the last video amplifier for best indication. Next touch the free end of the .1 μfd. condenser to the detector load resistor. A loud buzzing will be heard, showing that the signal passes from there to the last video amplifier.

To check the i.f. stages touch the "probe" end of the .1 μfd. condenser in turn to the plate and grid of each i.f. stage, going from the second detector back to the mixer grid. Receivers using transformer coupled i.f.'s may give only a weak indication which is hard to recognize if some inherent hum is present. To definitely identify the signal from the vertical sweep, rotate the vertical hold control a few times and observe the change in pitch as this is done. This method is, in effect, signal substitution with the vertical sweep circuits providing the signal and the audio amplifiers the detecting device. The vertical sweep voltage used in this method cannot be observed on the picture tube because the pulses occur only in the flyback period during which the tube is usually blanked out. If it is not convenient to use the vertical pulses as a signal, it is often possible to connect a .1 μfd. condenser from any filament point to the different i.f. grids and then the 60-cycle hum is visible as well as audible. In many sets this works only on the last i.f. stage, because the attenuation at 60-cycles is too great in each stage, but if a .1 μfd., 600 volt condenser is connected from the cathode of the "B plus" rectifier to the different grid circuits, enough signal is usually passed to cause a dark horizontal bar on the picture tube.

Fig. 4. A double-image pattern of this type indicates loss of vertical synchronization.



2. *No sound or weak sound but good picture.* Since in this condition a picture is present, the .05 μfd. condenser is connected to the plate of the last video amplifier and the free end touched first to the grid of the audio tube. A distinct rasping hum should be heard if this stage is functioning. Next we move the free end to the plate of the audio voltage amplifier. The same hum should be heard. If nothing or a weak sound is heard the coupling network between the plate of the voltage amplifier and the grid of the output tube is defective. Moving the free end of the .05 μfd. condenser back until it is connected to the load resistance of the sound detector will locate any trouble present in the audio amplifiers.

To check the sound i.f. stage in sets using the Intercarrier System just
(*Continued on page* 155)

GENERAL ELECTRIC
Electronic TUBE
MADE IN U.S.A.
"MY BIG SALES ASSET!"
"WHAT helps me sell tubes, and the radio-TV service that goes with them, is buyers' preference for the G-E brand." You hear this from pleased servicemen . . . everywhere . . . who are cashing in on the strong trend to General Electric. Good tubes and popular—available in all the types you need, including latest designs—backed by advertising and promotion aids that really pull business *your* way . . . these form a bright sales picture when you feature the G-E line. Build a fast-growing income on your public's faith in the General Electric monogram! Your G-E tube distributor will be glad to help. Phone or write him today! *Electronics Department, General Electric Co., Schenectady 5, N. Y.*
You can put your confidence in—
GENERAL ELECTRIC
181-JA3
TV PICTURE TUBES
METAL TUBES
GLASS TYPES
MINIATURES
ONE SOURCE FOR ALL YOUR TUBE REQUIREMENTS!
—also GERMANIUM DIODES and SELENIUM RECTIFIERS. Stock G-E 100-percent, to save time and routine in ordering—to have the benefit of bulk deliveries from your distributor—to profit from General Electric tube quality and product popularity.

MARS Station of the Month

MARS BEAMS WEEKLY BROADCASTS

MARS—Army Headquarters station, WAR, located at the Pentagon Building, Washington, D. C., broadcasts a weekly message each Tuesday at 0100Z and at 0400Z. (This is Monday at 8 p.m. and 11 p.m., Eastern Standard Time; Monday at 7 p.m. and 10 p.m., Central Standard Time; Monday at 6 p.m. and 9 p.m., Mountain Standard Time; and Monday at 5 p.m. and 8 p.m.. Pacific Standard Time.)

Simultaneous broadcasts are made on frequencies 6997.5 kc., 14,405 kc., and 20,994 kc. Each message is sent three times, once at 10 words per minute, once at 15 words per minute, and once at 20 words per minute.

Designed especially to transmit quasi-official traffic and training information to MARS members, the broadcast offers an excellent opportunity to all amateurs in building up their code proficiency.

STATION A6ZQL has been designated the Military Amateur Radio Station-Of-The-Month by Captain E. L. Nielsen, Chief of MARS—Army.

The station is licensed to Major Clifford A. Frink, Signal Corps, who is Chief of Technical Production Section, Armed Forces Radio Service, Armed Forces Information and Education Division, Los Angeles Branch Office, Office of the Secretary of Defense. The station address of A6ZQL is 2109 Dymond Street, Burbank, California.

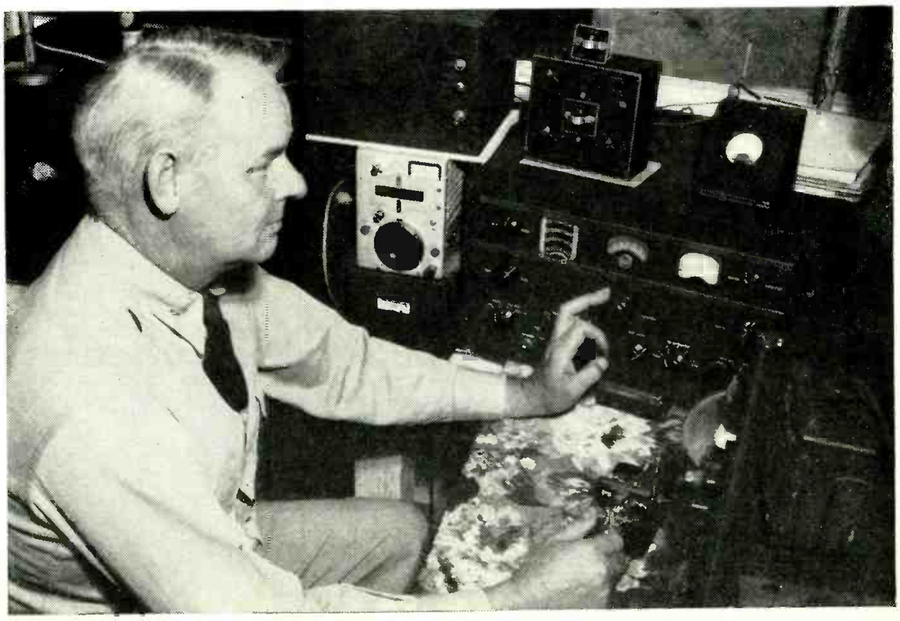
In the ZQL shack are HT-9 and BC-459 transmitters, an R-9er, an *RCA* 88 A receiver and a BC-342 receiver with an LS-3 speaker. The Major says, "Just give a call and I'll help you chew your fat . . . hand key or bug . . . makes no difference to me 'cause they both make dots and dashes!"

Frink's service extends over a period of 23 years as both an enlisted man and an officer. His entire military service has been directly related with some form of radio, but he did not take out a ham ticket until 1939 when he was licensed as W5JJE at Fort Bliss, Texas, where he was a non-com with the 1st Cavalry Division.

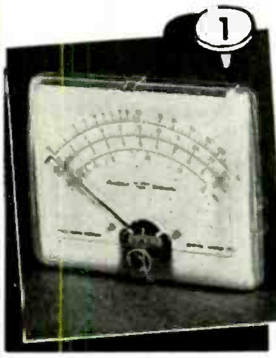
Major Frink was commissioned a Second Lieutenant in the Signal Corps in 1942 and assigned duty with the Western Signal Corps Replacement Training Center at Camp Kohler, California. He was assigned as Officer-in-Charge of the Radio School, and later became Executive Officer of the Signal Communications Branch of this school.

He was assigned duty with the Armed Forces Radio Service in Los Angeles in October of 1943. That same year he went overseas as Engineering Officer for AFRS in the South Pacific and three years later was Chief, AFRS, SOPAC. Still later he served as Chief, AFRS, Middle Pacific and Pacific Ocean Area. He has been assigned in the Los Angeles office, Secretary of Defense, since February, 1947. He went there first as Assistant Chief of the Program Section, then served as Officer-In-Charge, Short-wave Operations Section, before taking over his present duties. —30—

Twenty-three years of radio have developed a sweet fist and a ham's patience in Major Clifford A. Frink. Here he is shown in QSO at his home station A6ZQL/W6ZQL.



Heathkits ARE THE QUALITY LINE OF TEST EQUIPMENT KITS



MODERN STYLING

Heathkits have brought a new conception of beauty to laboratories and service benches.

Many organizations have standardized on Heathkits to make their shops appear attractive and uniform.

The panels are produced in grey and maroon and the modern streamline aluminum handles give the instruments a pleasant, professional appearance.

There is no waste space or false effort to appear large in Heathkits — space on service benches is at a premium and the size of Heathkit instruments is kept as small as is consistent with good engineering design.

COMPLETE KITS

When you receive your Heathkit, you are assured of every necessary part for the proper operation of the instrument.

Beautiful cabinets, handles, two-color panels, all tubes, test leads where they are a necessary part of the instrument, quality rubber line cords and plugs, rubber feet for each instrument, all scales and dials ready printed and calibrated. Every Heathkit is 110V 60 cy. power transformer operated by a husky transformer especially designed for the job.

BEST OF PARTS

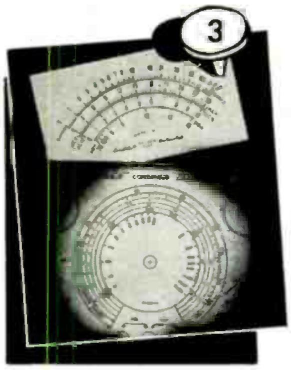
You will find many famous names on the parts in your Heathkit. Mallory switches and filter condensers, Chicago Transformer Corporation and Electrical Assembly Transformers, Centralab Potentiometers. Belden Cable, IRC and Allen Bradley resistors, G.E. tubes, Cinch and Amphenol sockets with silver plated contacts, Defiance variable condensers, Eby binding post and many other quality parts. The finest of parts are used to assure long trouble-free service from Heathkits.

PRECISION PARTS

Wherever required, the finest quality 1% ceramic resistors are supplied. These require no aging and do not shift. No matching of common resistors is required. You find in Heathkit the same quality voltage divider resistors as in the most expensive equipment.

The transformers are designed especially for the Heathkit unit. The scope transformer has two electrostatic shields to prevent interaction of AC fields.

These transformers are built by several of the finest transformer companies in the United States.



LARGE EASILY READ CALIBRATIONS

No charts or calculations are necessary to use any Heathkit properly. All scales are simply and plainly marked.

The operator instantly knows the proper use of the instrument and can proceed confidently. No multiplication is required as each scale is calibrated independently of the others.

COMPLETE INSTRUCTION MANUALS

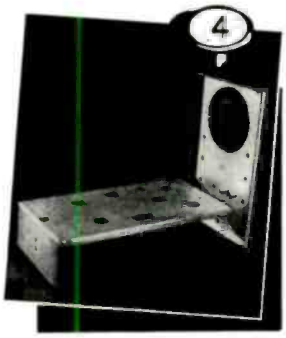
Everyone is pleased at the thorough instructions covering the assembly of each Heathkit instrument. Every detail of the assembly is covered, together with sections on the use of the instrument and trouble shooting instructions in case of difficulty. Actual photos of the assembled instrument enable fast and accurate assembly, clear schematics and pictorial diagrams of the confusing parts such as rotary switches, enable the wiring to be completed quickly.

KITS THAT FIT

Heathkit chassis are precision punched to fit the quality parts supplied. The grey crackle aluminum cabinet and the two-color panels are die punched to assure proper fitting.

Many builders have written marveling at the ease with which assembly can be accomplished.

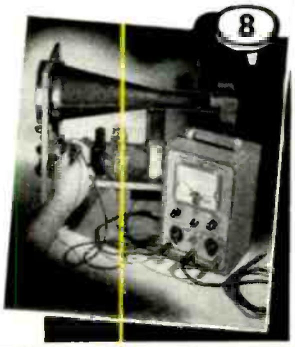
The chassis are specially engineered for easy assembly and wiring — there are no small, tight corners which cannot be reached—the ends of the chassis are left open in order that installation of parts and soldering can be done with both hands.



IDEAL FOR SCHOOLS

Heathkits have been adopted as standard equipment of many of the largest universities and colleges. The low cost plus the fact that the students learn by actual assembly make them ideal training mediums. Many high schools and small colleges are finding that they too can have a modern physics and electronics laboratory by using Heathkits.

Some of the largest technical schools recommend Heathkits to their students as the best means of securing the necessary equipment to start their own shops.



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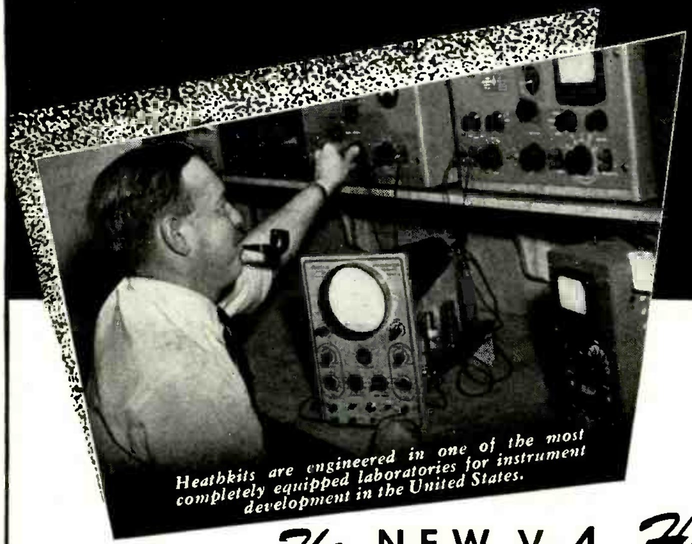
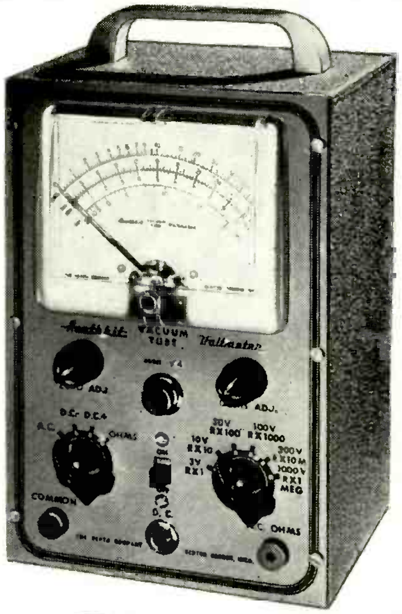
The HEATH COMPANY



Heathkits are engineered in one of the most completely equipped laboratories for instrument development in the United States.

Heathkits ARE LABORATORY ENGINEERED . . .

The NEW V-4 *Heathkit* VACUUM TUBE VOLTMETER KIT



Features

- Meter scale 17% longer than average 4½" meter.
- Modern streamline 200 ua meter.
- New modern streamline styling.
- Burn-out proof meter circuit.
- 24 Complete ranges.
- Isolated probe for dynamic testing.
- Most beautiful VTVM in America.
- Accessory probes (extra) extend ranges to 10,000 Volts and 100 Megacycles.
- Uses 1% precision ceramic divider resistors.
- Modern push-pull electronic voltmeter circuit.
- Electronic AC circuit. No current drawing rectifiers.
- Shatterproof plastic meter face.

The new Heathkit Model V-4 Vacuum Tube Voltmeter has dozens of improvements. A new modern streamlined 200 microampere meter has Alnico V magnet for fast, accurate readings. The new electronic AC voltmeter circuit incorporates an entire new balance control which eliminates contact potential and provides greater accuracy. New simplified switches for quicker assembly. New snap-in battery mounting is on the chassis for easy replacement.

The Heathkit VTVM is the only kit giving all the ranges. Check them — DC and AC full scale linear ranges of 0-3V, 0-10V, 0-30V, 0-100V, 0-300V, 0-1000V and can be extended to 0-3000V and 0-10,000V DC with accessory probe at slight extra cost. Electronic ohmmeter has six ranges measuring resistance accurately from .1 ohm to one billion ohms. Meter pointer can be offset to zero center for FM alignment.

The DC probe is isolated for dynamic measurements. Has db scale for making gain and other audio measurements.

The new instruction manual features pictorial diagrams and step-by-step instructions for easy assembly. The Heathkit VTVM is complete with every part — 110V transformer operated with test leads, tubes, light aluminum cabinet for portability, giant 4½" 200 microamp meter and complete instruction manual.

Order now and enjoy it this entire season. Shipping weight 8 lbs., Model V-4

$24.50

THE FINEST VTVM KIT AVAILABLE FOR THIS PRICE.

Accessory: 10,000V high voltage probe, No. 310, $4.50.
Accessory: RF crystal diode probe kit extends RF range to 100 Mc., No. 309, $6.50.

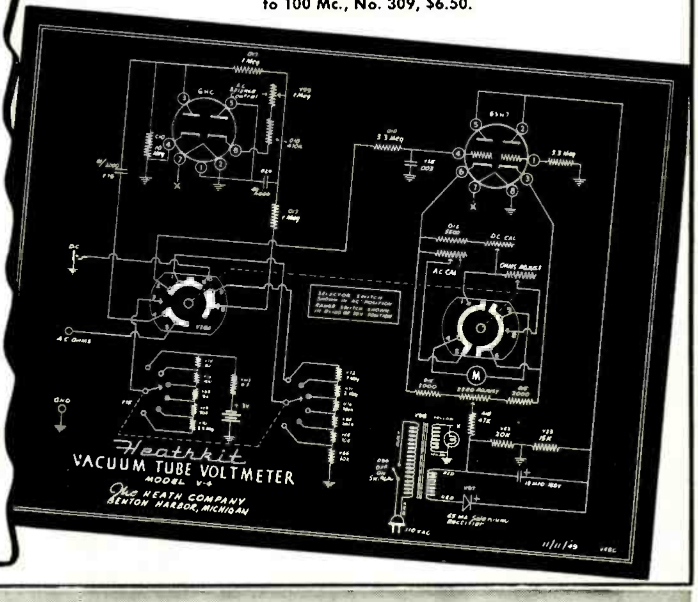
New Heathkit HANDITESTER KIT

Features

- Beautiful streamline Bakelite case.
- AC and DC ranges to 5,000 Volts.
- 1% Precision ceramic resistors.
- Convenient thumb type adjust control.
- 400 Microampere meter movement.
- Quality Bradley AC rectifier.
- Multiplying type ohms ranges.
- All the convenient ranges 10-30-300-1,000-5,000 Volts.
- Large quality 3" built-in meter.

A precision portable volt-ohm-milliammeter. An ideal instrument for students, radio service, experimenters, hobbyists, electricians, mechanics, etc. Rugged 400 ua meter movement. Twelve complete ranges, precision dividers for accuracy. Easily assembled from complete instructions and pictorial diagrams. An hour of assembly saves one-half the cost. Order today. Model M-1. Shipping wgt., 2 lbs.

$13.50



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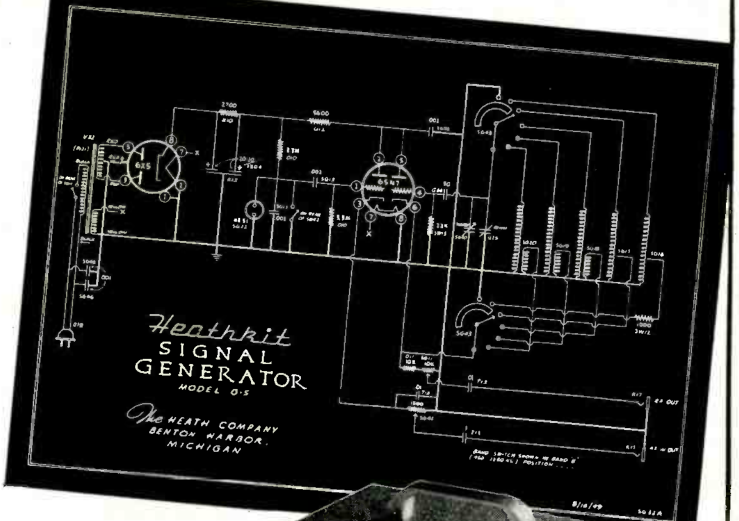
Heathkits ENABLE THE BUILDER

New 1950 VERNIER TUNING RF *Heathkit* SIGNAL GENERATOR KIT



Features

- New 5-to-1 ratio vernier tuning for ease and accuracy.
- New external modulation switch — use it for fidelity testing.
- Covers 150 Kc. to 34 Mc. on fundamentals and calibrated strong harmonics to 102 Mc.
- 400 cycle audio available for audio testing.
- Most modern type R.F. oscillator.
- New precision coils for greater output.
- Cathode follower output for greatest stability.

The most popular signal generator kit has been vastly improved — the experience of thousands combined to give you the best. Check the features in this fine generator and consider the low price $19.50. A best buy for any shop, yet inexpensive enough for hobbyists. Everyone can have an accurate controlled source of R.F. signal voltage.

The new features double the value — think of being able to make fidelity checks on receivers by inserting a variable audio signal. Internal 400 cycle saw-tooth audio oscillator modulates R.F. signal and is available externally for audio testing. The new 5-to-1 ratio vernier drive gives hairline tuning for maximum accuracy in scale settings. The coils are already precision wound and calibrated. Uses turret type coil and switch assembly for ease of construction. The generator is 110V. 60 cycle transformer operated and comes complete in every detail — cabinet, tubes, beautiful two color calibrated panel and all small parts — new step-by-step pictorial diagrams and complete instruction manual make assembly a cinch even for novices. Why try to get along without a signal generator when you can have the best for less than a twenty-dollar bill. Better order it now. Shipping weight, 7 lbs. Model G-5.

$19.50

$34.50

Heathkit SINE AND SQUARE WAVE AUDIO GENERATOR KIT

Experimenters and servicemen working with a square wave for the first time invariably wonder why it was not introduced before. The characteristics of an amplifier can be determined in seconds compared to several hours of tedious plotting using older methods. Stage by stage, amplifier testing is as easy as signal tracing. The low distortion (less than 1%) and linear output (± one db) make this Heathkit equal or superior to factory built equipment selling for three or four times its price. The circuit is the popular RC tuning circuit using a four gang variable condenser. Three ranges 20-200, 200-2,000, 2,000-20,000 cycles are provided by selector switch. Either sine or square waves instantly available at slide switch. All components are of highest quality, cased 110V. 60 cycle power transformer. Mallory F.P. filter condensers, 5 tubes, calibrated two-color panel, grey crackle aluminum cabinet. The detailed instructions make assembly an interesting and instructive few hours. Shipping weight, 12 lbs. Model G-2.

Nothing ELSE TO BUY

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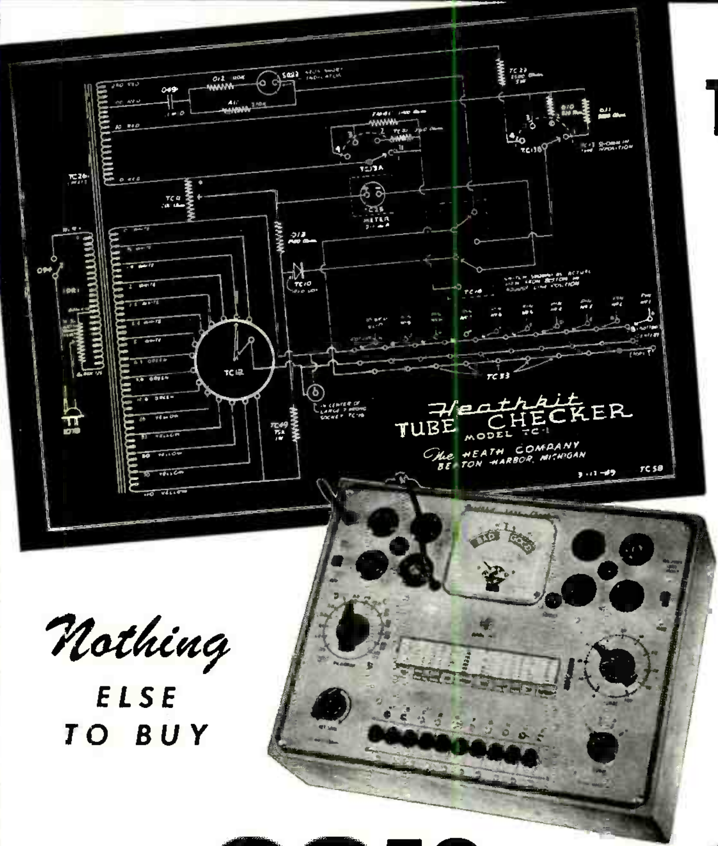
TO USE THE *Best* OF WORKMANSHIP



Heathkit TUBE CHECKER KIT

Features

1. Measures each element individually.
2. Has gear driven roller chart.
3. Has lever switching for speed.
4. Complete range of filament voltages.
5. Uses latest type lever switches.
7. Uses beautiful shatterproof full view meter.
8. Large size 11" x 14" x 4" complete.
9. Checks new 9 pin miniatures.

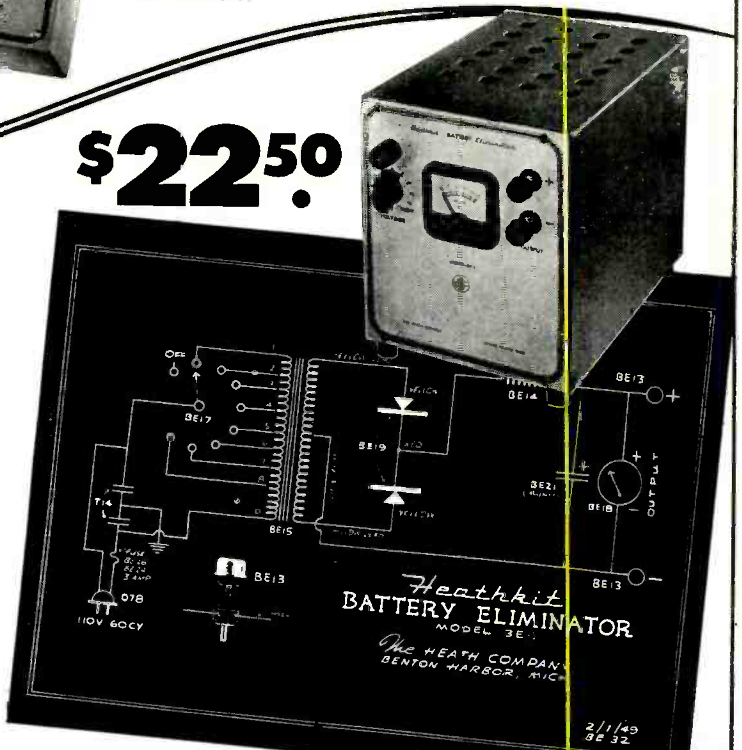
Check the features and you will realize that this Heathkit has all the features you want. Speed, simplicity, beauty, protection against obsolescence. The most modern type of tester — measures each element — beautiful Bad-Good scale, high quality meter — the best of parts — rugged oversize 110V. 60 cycle power transformer — finest of Mallory switches — Centralab controls — quality wood cabinet — complete set of sockets for all type tubes including blank spare for future types — fast action gear driven roller chart uses brass gears to quickly locate and set up any type tube. Simplified switching cuts necessary time to minimum and saves valuable service time. Short and open element check. No matter what arrangement of tube elements, the Heathkit flexible switching arrangement easily handles it. Order your Heathkit Tube Checker today. See for yourself that Heath again saves you two-thirds and yet retains all the quality — this tube checker will pay for itself in a few weeks — better build it now.

Complete with detailed instructions, all parts, cabinet, roller chart, ready to wire up and operate. Shipping weight, 12 lbs. Model TC-1.

Nothing ELSE TO BUY

Only $29.50

$22.50



Heathkit BATTERY ELIMINATOR KIT

Now a bench 6 Volt power supply kit for all auto radio testing. Supplies 5 - 7½ Volts at 10 Amperes continuous or 15 Amperes intermittent. A well filtered rugged power supply, uses heavy duty selenium rectifier, choke input filter with 4,000 MFD of electrolytic filter. 0 - 15 Volt meter indicates output. Output variable in eight steps. Excellent for demonstrating auto radios. Ideal for servicing — can be lowered to find sticky vibrators or stepped up to equivalent of generator overload — easily constructed in less than two hours. Complete in every respect. Shipping wgt., 19 lbs. Model BE-1

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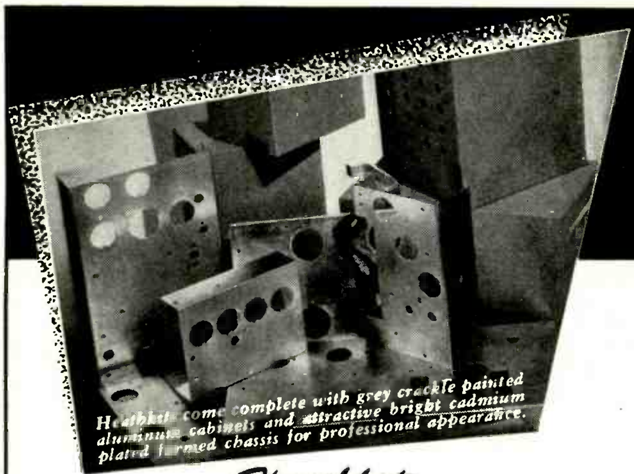
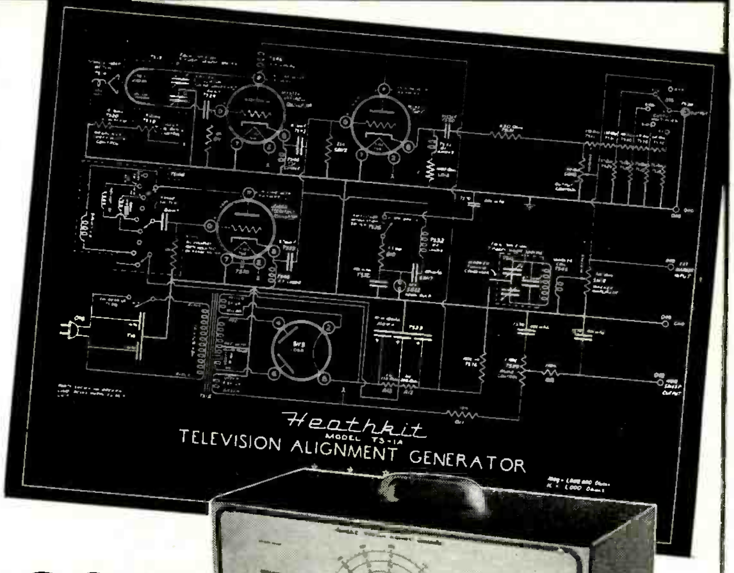
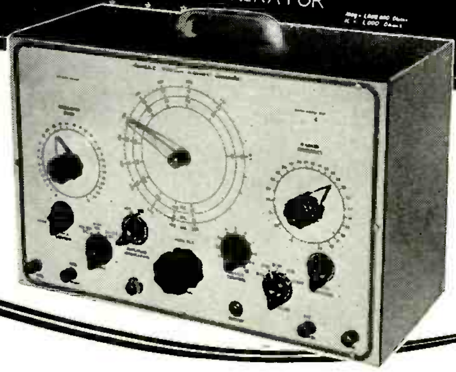


Heathkits ELIMINATE



Heathkit TELEVISION ALIGNMENT GENERATOR KIT

Everything you want in a television alignment generator. A wide band sweep generator covering all TV frequencies 0 to 46 — 54 to 100 — 174 to 220 Megacycles, a marker indicator covering 19 to 42 Megacycles, AM modulation for RF alignment — variable calibrated sweep width 0-30 Mc. — mechanical driven inductive sweep. Husky 110V. 60 cycle power transformer operated — step type output attentuator with 10,000 to 1 range — high output on all ranges — band switching for each range — vernier driven main calibrated dial with over 45 inches of calibration — vernier driven calibrated indicator marker tuning. Large grey crackle cabinet 16⅛" x 10⅝" x 7-3/16". Phase control for single trace adjustment. Uses three high frequency triodes plus 5Y3 rectifier — split stator tuning condensers for greater efficiency and accuracy at high frequencies — this Heathkit is complete and adequate for every alignment need and is supplied with every part — cabinet, calibrated panel, all coils and condensers wound, calibrated and adjusted, tubes, transformer, test leads — every part with instruction manual for assembly and use. Actually three instruments in one — TV sweep generator — TV AM generator and TV marker indicator.

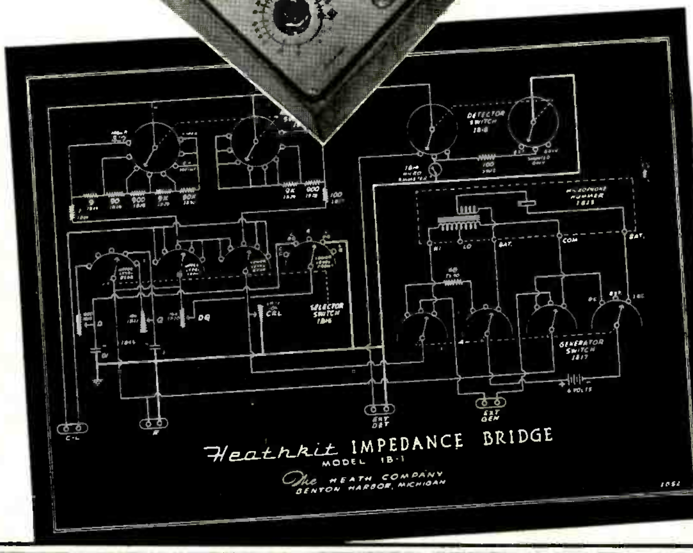


$39.50

Shipping weight 20 lbs.
Model TS-1A

$69.50

Shipping weight 15 lbs.
Model IB-1



New Heathkit IMPEDANCE BRIDGE KIT

A LABORATORY INSTRUMENT NOW WITHIN THE PRICE RANGE OF ALL

Measures inductance from 10 microhenries to 100 henries capacitance from .00001 MFD. to 100 MFD. Resistance from .01 ohms to 10 megohms. Dissipation factor from .001 to 1. "Q" from 1 to 1000.

Ideal for schools, laboratories, service shops, serious experimenters.

An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. All highest quality parts. General Radio main calibrated control. General Radio 1000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp zero center galvanometer — ½ of 1% ceramic non-inductive decade resistors. Professional type binding posts with standard ¾" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready cailbrated capacity and inductance standards of Silver Mica, accurate to ½ of 1% and with dissipation factors of less than 30 parts in one million. Provisions on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.

Internal 6 Volt battery for resistance and hummer operation. Circuit utilizes Wheatstone, Hay and Maxwell circuits for different measurements. Supplied complete with every quality part — all calibrations completed and instruction manual for assembly and use. Deliveries are limited.

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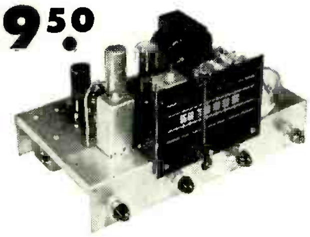
Heathkits PROVIDE PROFESSIONAL LABORATORY APPEARANCE

New Heathkit BROADCAST AND 3 BAND SUPERHETERODYNE RECEIVER KIT

BROADCAST MODEL BR-1
550 to 1600 Kc.

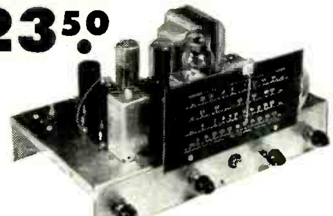
$19.50



Two new Heathkit Superheterodynes featuring the best of design and material. Beautiful six inch slide rule dials — 110 V. 60 cy. AC power transformer operated—metal cased filters—quality output transformers, dual iron core metal can IF transformers — two gang tuning condenser. The chassis is provided with phono-radio switch—110 V. outlet for changer motor and phono pickup jack. Each kit is complete with all parts and detailed instruction booklet. Pictorial diagrams and step-by-step instructions make assembly quick and easy.

3 BAND MODEL AR-1
550 Kc. to 20 Mc.

$23.50



Ideal AC operated superheterodyne receiver for home use or replacement in console cabinet. Comes complete with attractive metal panel for cabinet mounting. Modern circuit uses 12K8 converter, 12SH7 input IF stage, 12C8 output IF stage and first audio 12A6 beam power output stage. 5Y3 rectifier. Excellent sensitivity for distant reception with selectivity which effectively separates adjacent stations.

The husky 110 V. cased power transformer is conservatively rated for long life.

The illuminated six inch slide rule dial is accurately calibrated for DX reception. Enjoy the pleasure of assembling your own fine home receiver. Has tone, volume, tuning and phono-radio controls. Chassis size 2¼" x 7" x 12½" Comes complete with all parts including quality output transformer to 3.4 ohm voice coil, tubes, instruction manual, etc. (less speaker). Shipping Wt., 10 lbs. No. BR-1 Receiver $19.50.

No. 335 Communications Type Table Model Metal Cabinet............**$4.50**
No. 320 High Quality 5" PM Speaker for above............**2.75**

Enjoy the thrill of world wide short wave reception with this fine new AC operated Heathkit 3 band superheterodyne — amazing sensitivity 15 microvolt or better on all bands. Continuous coverage 550 Kc. to over 20 Mc. Easy to build with complete step-by-step instructions and pictorial diagram. Attractive accurately calibrated six inch slide rule dial for easy tuning. Six tubes with one dual purpose tube gives seven tube performance. Beam power output tube gives over 3 watts output.

Separately assembled coil turret with band switch eliminates difficult construction. Conservatively rated 110 V. power transformer supplies full operating voltages to all tubes for maximum reception. Has band switch, tuning, volume, tone and phono-radio controls. Chassis size 2¼" x 7" x 12½" — supplied complete — punched chassis — tubes — controls — transformers (quality output to 3.4 ohm voice coil) — all small parts — hardware and instructions (less speaker). Shipping Wt., 10 lbs. No. AR-1 Receiver $23.50.

No. 335 Communications Type Table Model Metal Cabinet............**$4.50**
No. 320 High Quality 5" PM Speaker for above............**2.75**

Heathkit PUSH-PULL HIGH FIDELITY AMPLIFIER KIT

$12.50

Build this high fidelity push-pull amplifier and save two-thirds the cost—has two preamplifier stages, phase inverter stage and push-pull beam power output stage. Comes complete with six tubes—quality output transformer (to 3-4 ohm voice coil) tone and volume controls—varnish impregnated cased 110V. power transformer and detailed instruction manual and all small parts. Six watt output with output flat within 1½ db between 50 and 15000 cycles. Build this amplifier now and enjoy it for years.

Shipping Wt. 7 lbs. Model A-4
12" PM Speaker for above............**$6.95**

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. . . BENTON HARBOR 15, MICHIGAN

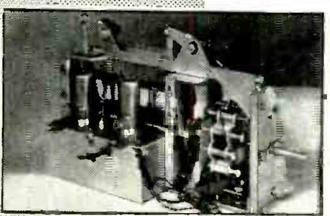
The GREATEST TELEVISION *Buy!*

A 18 TUBE *Complete* TV RECEIVER KIT

WITH 12 CHANNEL TUNER *Actually* LESS THAN COST OF TUNER ALONE

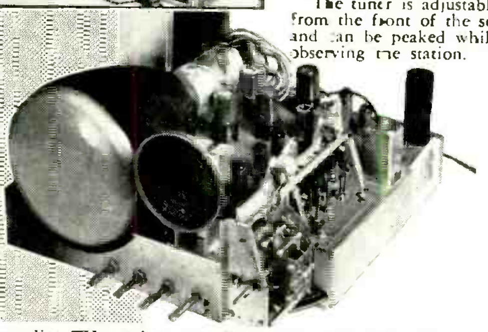
$34.50 *less* TUBES AND CABINET

COMPLETELY ASSEMBLED 5000 VOLT PICTURE TUBE POWER SUPPLY
This husky 5000 volt supply provides adequate voltage for the picture tube and gives perfect black and white reproduction. It is of the R.F. type and comes complete with the 50L6 R.F. oscillator and the 1B3 rectifier tubes installed.



COMPLETELY ASSEMBLED 12 CHANNEL TUNER
One of the finest tuners available is supplied completely assembled. The tuner has three permeability tuned circuits for both the high and low bands. A 6BH6 is used as R.F. amplifier while a 6J6 twin triode operates as mixer and oscillator.

The tuner is adjustable from the front of the set and can be peaked while observing the station.



This quality TV receiver uses latest type miniature television tubes 6AG5 - 6BH6, etc. The chassis comes complete with all brackets, CR tube mounting, I.F. coils, speaker — everything to build a powerful factory quality television receiver.

Think of it. A beautiful factory engineered 18 tube television receiver with all parts (less tubes and cabinet) for the cost of the tuner alone, $34.50. Now you can afford to learn the fascinating secret of this new industry by actually assembling a high quality receiver. This TV receiver kit has everything, 12 channel Defiance tuner using 6BH6 RF stage and 6J6 as oscillator and mixer, all assembled and adjusted. Completely assembled 5000 Volt high voltage power supply ready to operate. A circuit incorporating the latest developments. The panel controls are station selector, volume, vertical and horizontal hold and contrast. At the rear are brightness, vertical and horizontal size, focus, vertical and horizontal centering. The circuit uses three stages of high gain I.F. with 6AG5 tubes, 12AU6 limiter 6AL5 second detector, 12AU6 syn. separator, 12AU6 video amplifier, 12SN7 horizontal multivibrator, 50L6 horizontal output, 12SN7 vertical multivibrator, 12SN7 vertical output, 50L6 high voltage oscillator, 1B3 high voltage rectifier, 19T8 as FM detector and audio amplifier, 25L6 audio output.

The cadmium plated chassis is punched and formed ready to assemble — every coil, condenser, resistor supplied. Comes complete with large (18 x 24) pictorial and manufacturer's instruction manual.

BEAUTIFUL STYLING

This modern beautifully styled TV receiver will bring untold pleasure and entertainment to the entire family. The pleasant appearance compliments any living room while the steadily improving programs will please the entire family. There are excellent vaudeville programs to entertain your friends, excellent children's programs, Arthur Godfrey, United Nations programs for serious thinkers. A television set aids in the education of the family and by building it vast technical knowledge of this new profitable field is obtained.

Remember we have a limited quantity. Order now while still available.

Complete 7" Television Receiver Kit (less tubes and cabinet)	**$34.50**
Complete set of tubes as outlined above with RCA 7JP4 picture tube (18 tubes for less than price of picture tube)	**20.00**
Beautiful piano finish mahogany cabinet for above TV set	**20.00**
Buy all at one time and save. Complete Receiver Kit with tubes and cabinet	**69.50**

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13 East 40th St.
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CABLE: ARLAB—N.Y.

The **HEATH COMPANY**
. . . BENTON HARBOR 15, MICHIGAN

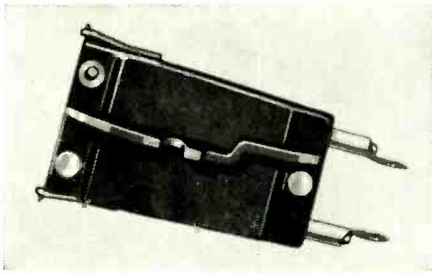
What's New in Radio

For additional information on any of the items described herein, readers are asked to write direct to the manufacturer. By mentioning RADIO & TELEVISION NEWS, the page, and the issue number, delay will be avoided.

UNIVERSAL CARTRIDGE

A new universal cartridge, the "Featheride" Type A1, which will fit almost all record changer arms and play any combination of record speeds has been announced by *Webster Electric Company* of Racine, Wisconsin.

The cartridge measures 19/32" wide by 1" long which makes it suitable for most of the modern designed tone arms. Tracking pressure is 7 grams, meeting the requirements of 33⅓ and 45 r.p.m. record speeds and providing unusually light tracking in the playing of standard 78 r.p.m. records.



Needles are held firmly in position by specially designed friction chucks.

CROSSOVER NETWORK

University Loudspeakers, Inc. of 80 South Kensico Avenue, White Plains, New York has announced a new filter network of the *LC* type for use with coaxial or duplex loudspeaker systems.

Designated the Model 4410 filter, this high fidelity accessory provides a proper attenuation rate at a crossover of 600 cycles. The new unit is housed in a cast aluminum container which is compact and carefully finished throughout. A high frequency attenuator is supplied with this network for properly balancing the low and high frequencies.

SPRAGUE CONDENSERS

A line of electrolytic condensers for 115-volt continuous duty alternating current service is a new development of the *Sprague Electric Company* of North Adams, Massachusetts.

Known as the *Sprague* Type 11A, these units are suited for across-the-line power factor improvement at low voltages, particularly with appliances and light industrial equipment. They may be used in applications where starting voltage surges across condensers may exceed rated voltages by as much as 50 per-cent for a maximum of two seconds.

They may also be used in applications where a voltage drop is required without power dissipation. An engineering bulletin (No. 301) is available on this line when requests are made on company letterhead.

EMC "VOLOMETER"

Electronic Measurements Corporation, 423 Broome Street, New York 13, New York, has developed a new compact and lightweight multimeter, the Model 104 "Volometer."

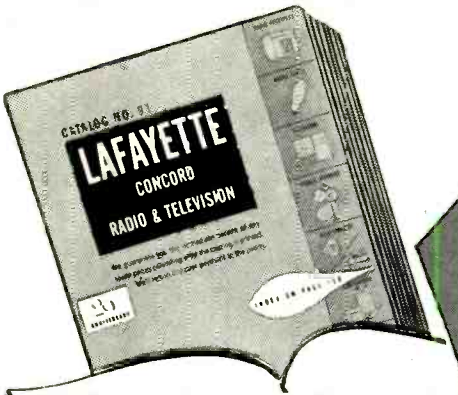
Although inexpensively priced, the new unit has such features as 4½" square, 50 microampere meter with Alnico magnet, three a.c. current ranges to 3 amperes, three resistance ranges to 20 megohms, five d.c. voltage ranges at 20,000 ohms/volt to 3000 volts, and five a.c. voltage ranges to 3000 volts.

The instrument, which is housed in a high-impact, round-cornered Bakelite case with carrying strap, measures 5¼" x 6¾" x 2⅞" and weighs only 2 pounds and 5 ounces.

3-INCH CR TUBE

A new three-inch cathode-ray tube, said to be the shortest electrostatic tube of its classification made in the United States, has been announced by the Tube Divisions of the *General Electric Company.*

Designated the 3MP1, it was originally designed for use in small indus-



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THE GREATEST CATALOG FROM LAFAYETTE IN 29 YEARS

164 large-size pages filled with
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Everything in Radio and Television at the Lowest "Net" Prices!

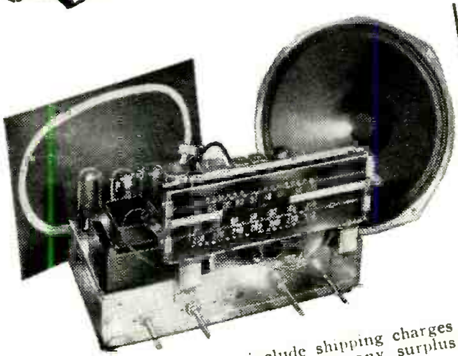
DON'T just take our word for it. Invest a penny postcard and send for your copy of the great new 1950 Lafayette Catalog. Then sit down with a pencil and paper and make a price comparison test yourself. Check the famous-make equipment, model for model, and see if Lafayette doesn't save you anywhere from a few pennies to a few dollars on most every item.

And remember—Lafayette gives you the service of a *national organization*, with 2 great centrally-located mail order centers and 6 strategic outlets for personal shopping. That means you save more money on postage, and get the parts you need a couple of days sooner.

So if you're a service man, experimenter, ham, hi-fi bug, engineer, or set-builder—send for your new 1950 Lafayette Catalog now. It's one of the biggest things in America you can get "for free"!

Check these spec's—then look at the price!

LAFAYETTE-ENGINEERED FM-AM CHASSIS



- 11 tubes plus rectifier
- Pre-amplifier for variable reluctance pick-up
- 10-watt push-pull beam-power output

only $59.50 (When ordering, include shipping charges based on weight and zone—any surplus will be refunded.)

INCLUDING THE MATCHED 12" PM SPEAKER!

This is, without question, Lafayette's greatest chassis value in 10 years. For $59.50 you get a chassis that compares favorably in performance with sets that have been selling as high as $300 or more. Look at these excellent features: Latest 11-tube circuit, plus rectifier. Push-pull beam power output. Rated at 10 watts, undistorted. Built-in pre-amplifier for variable reluctance pick-up. Automatic volume control. Equipped with phono input jacks for low and high impedance inputs. Full-range tone control. Slide rule dial, indirectly illuminated. Receives 88-108 MC FM band, 550 to 1700 KC broadcast band. 105-125 volts, 60 cycles. AC only. Chassis dimensions: 13x9x9½. Shipping weight: 25 lbs. Complete with tubes, dial escutcheon, two indoor antennas (folded dipole for FM, loop for AM), and matching 12" PM speaker. $59.50.

Lafayette RADIO

2 Great Mail Order Centers:
NEW YORK: 100 Sixth Avenue, New York 13
CHICAGO: 901 W. Jackson Blvd., Chicago 7

29th ANNIVERSARY

6 Outlets for Shopping in Person:

- **NEW YORK:** 100 Sixth Ave. and 542 E. Fordham Road (Bronx)
- **CHICAGO:** 901 W. Jackson Blvd.
- **ATLANTA:** 265 Peachtree St.
- **BOSTON:** 110 Federal St.
- **NEWARK:** 24 Central Ave.

RUSH COUPON

LAFAYETTE RADIO, DEPT. RC-50
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or 100 Sixth Avenue, New York 13, N. Y.

☐ Check here for FREE 1950 Catalog
(Please don't check if you have already received your catalog.)

☐ Please rush the Lafayette FM-AM chassis (including speaker) at $59.50. I enclose $............ in postal note, money order or check. (Please include shipping charges based on weight and zone. Any surplus will be refunded).

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PASTE COUPON ON PENNY POSTCARD

trial oscilloscopes. The new tube is expected to find numerous applications for television servicing and for

testing industrial apparatus such as welders, amplifiers, and electronic timing devices.

Special processing of the screen gives a brighter trace than normal tubes of the same electrical ratings, according to the company. The new tube is an electrostatic focus and deflection type with a bulb diameter of 3⅛ inches and a useful screen diameter of 2¾ inches. It is equipped with a small-shell, duodecal base which has been set as the standard base on all television tube types.

Maximum ratings for the new tube are available from the company's Tube Divisions at Schenectady, New York, along with other pertinent data on the 3MP1.

PLYWOOD MAST

A new sectional mast which is capable of supporting a television receiver antenna up to 90 feet above the ground has been introduced by *Special Purpose Products Co.*, 155 Perry Street, New York 14, New York.

Available in kit form, these masts are of a special plywood tubing, Woundwood, which has been designed especially for such purposes. Parts for a 60-foot antenna mast include Woundwood sections for mast and erection boom, guy lines, block and fall, base, boom socket and stakes.

The lead wires are protected inside of the hollow core of the mast, which is weather-resistant and non-rusting.

GROUND CLAMPS

Of interest to service technicians and amateurs is the new adjustable ground clamp recently announced by *Blackburn Specialty Co.*, 6541 Euclid Ave., Cleveland 3, Ohio.

The clamp is now available in two sizes, one to fit ⅜" to 1¼" pipe and the other to fit ⅜" to 3" pipe. A tightening screw chafes the pipe, draws up slack, cuts through rust and dirt and at the same time contracts the band around the pipe surface, assuring a perfect ground.

Solder or solderless terminal types are available for various applications. The clamp itself consists of a flexible, perforated pure copper band which encircles the pipe. A boss raised on the flat end of a removable copper alloy terminal lug fits into band holes and is machined to give a clean and smooth contact surface. The tightening screw with a lock nut is threaded through the boss. The clamp carries *Underwriters' Laboratories* approval.

NEW-TYPE TAPE RECORDER

A new tape recorder, which is being marketed under the trade name "Reelest," has been introduced by *Universal Moulded Products Corporation* of 1500 Walnut Street, Philadelphia 2, Pennsylvania.

Some of the unit's exclusive new features include twin-track recording without interruption for rewinding; no "flip-flop" of reels as a patented "Revers-A-Matic" plays or records in two directions for one hour without

attention; a new "Thred-A-Matic" feature which simplifies threading of tape; and a volume indicator (an elec-

(*Continued on page* 134)

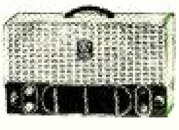
McGEE'S BIG SCOOP SALE ON "WEBSTER-RACINE" AMPLIFIERS

McGee makes another terrific purchase. A solid truck load of brand new factory cartoned public address equipment. The following advertisement prices you the material at less than the original jobbers' cost. As you experienced sound-men know, the Webster Electric Co. of Racine, Wisconsin, is a renowned builder of the finest in audio equipment. All amplifiers are conservatively rated and could be rated at 25% higher wattage and still be rated lower than some makers rate their amps. The terrifically high retail list prices originally placed on these articles is indicative of their No. 1 quality. To the best of our knowledge, these are the best amplifier values in the U. S. today. These prices will be good only as long as our inventory lasts.

WEBSTER MODEL 41-12 12-WATT AMPLIFIER

ORIGINAL LIST $126.50

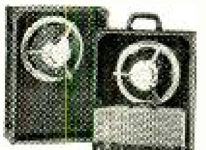
SALE PRICE $33.90



Has Automatic Volume Control

Webster Racine 12 watt amplifier Model 41-12, housed in a 13¾x7" wide and 8" high metal cabinet. Input for one crystal or dynamic mike and crystal phono pickup. One dual type tone control. Wide range frequency response, 40 to 10,-000 CPS, plus or minus 3 db. Output taps, 2-4-250 and 500 ohms. With tubes: 6J7, 6K7, 6Z7, 6H6, 2-6V6G and 80. Has automatic volume control circuit and selector switch. Ship. weight 19 lbs. Original list price on this unit was $126.50. McGee's scoop price $33.90.

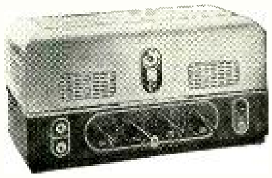
WEBSTER MODEL 12-TN COMPLETE 12-WATT PORTABLE PUBLIC ADDRESS SYSTEM



SALE PRICE $59.95

Complete portable public address system, Webster Racine Model 12TN-1 consists of one Model 41-12 amplifier, one carrying case, two S6025 heavy duty PM speakers and 50 feet of rubber cord with plug. All equipment is contained in the split type amplifier case. A small American crystal mike and desk stand is included. This PA system is conservatively rated at 12 watts. Input for one mike and one phono player. Ship. weight 41 lbs. Less than 50 of these portable PA systems are available at the ridiculous price of $59.95.

WEBSTER MODEL 16A20



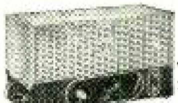
McGEE'S SALE PRICE $42.95

Webster Electric Model 16A20, conservatively rated at 20 watts. Original retail price was $187.00. Housed in a heavy metal case, 16" long, 7" wide and 9" high. Two inputs for microphones (crystal or hi Z dynamic), 1 phono input for crystal pickup, .1 volt required for rated amplifier output. Two mike volume or fader controls. One phono control and one dual type tone control. Wide range frequency response, plus or minus 1 db, from 50 to 10,000 CPS. Output transformer taps, 2-4-8-250 and 500 ohms. Electron-ray eye tube indicates rated power output when eye is closed, in order to prevent overload distortion. Complete with tubes: 2—6J7, 6N7, 6SN7, 2—6L6, 5V4, 6H6 and 6E5. Shipping weight 33 lbs. This is one of the finest public address amplifiers that we have ever seen. We have only 250 to sell, at the ridiculous price of only $42.95. Remember this amplifier's original retail list was $187.00. Amp. are new and in factory cartons. Better order now.

50 WATT WEBSTER MODEL 18-50 SALE PRICE $79.95

Webster Racine Model 18-50, 50 watt amplifier. Similar in appearance to Model 16A20. Original list price was $246.00. Housed in an attractive metal case, 18" long, 9" wide and 9" high. Two inputs for crystal or dynamic mike and one input for phono. Dual type tone control. Frequency response, 30 to 10,000 CPS, plus or minus 2 db. Output taps, 2-4-83-125-166-250 and 500 ohms. Electronray tube indicates maximum power output when closed. This is one of the finest public address amplifiers we know of. Only 40 of these 50 watt amplifiers are available. Regular $246.00 list. McGee's sale price, $79.95. Shipping weight 49 lbs.

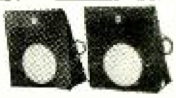
WEBSTER MODEL 50B-12 12-Watt Paging Amplifier Made for 24 Hour Service



WAS $132.00 LIST SALE PRICE $33.90

Webster Racine Model 50B-12. 12 watt paging amplifier. Original retail list $132.00. Designed for continuous operation, 24 hours a day, 7 days a week. Plate voltage is applied to all tubes only during actual speech or sound operation. Amplifier is housed in a metal case 13¾" long, 7" wide and 8" high. One input for crystal or dynamic mike and one input for crystal phono pickup. Mike line has screwdriver adjustment and tamper-proof cap. Dual type tone control. Frequency response 60 to 8,000 CPS, plus or minus 1 db. Automatic volume control, limiter type, provides reasonably constant amplifier output from signals louder than normal. Output taps, 5-7-10-14-20-80 and 417 ohms. With tubes: 6J7, 6L7, 6C8, 6H6, 80 and 2—6V6. Original retail list, $132.00. McGee scoop price only $33.90. Shipping weight 19 lbs.

WEBSTER WAS $156.00 LIST McGEE'S SALE PRICE.... $44.95



Model DS 12-50HN comprises 2—12" A12-PM—$41.00 list heavy duty Jensen PM speakers, housed in a split leatherette carrying case. The original retail list on these speakers and case was $156.00. McGee's scoop price, $44.95. Shipping weight 49 lbs. Only 50 pieces to sell.

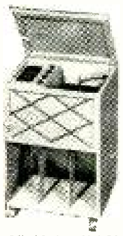
10" 9 watt permanent magnet speaker, Webster Racine Stock No. S6026, 6 ohm voice coil. Net price, each $3.95

12" Jensen PM speaker Model PM-12C, 6 ohm voice coil. Webster Racine Stock No. S-4482. The original retail list on this speaker was $22.95. McGee's sale price, $7.95.

12" Jensen PM speaker, Model A12-PM, 8 ohm voice coil. Webster Racine Stock No. S-4626. Original list price was $41.00. Ship. wt. 19 lbs. McGee offers them to you, while stock lasts, $13.95 each.

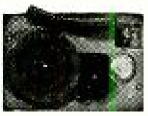
6-TUBE RADIO PHONO COMBINATION

SALE PRICE $39.95



Another red hot McGee Scoop. An attractive blond finish console cabinet with 78 RPM record changer and a full 6 tube superhet broadcast chassis, wired in the nationally known factory. Has R.F. stage, loop antenna, 6 tubes: 2—12SK7, 12SA7, 12SQ7, 35L6, and 35Z5, variable tone control and built-in radio phono switch. 6" Alnico V PM speaker. In order to offer this set at the low price of $39.95, we ship the chassis and changer unmounted. Cabinet has cut to fit radio panel. However it's easy to install the set as an escutcheon plate is furnished. About one hour's time is needed to mount the set and changer. Shipping weight 50 lbs. Stock No. AK-10, sale price $39.95.

ST. GEORGE Wire Recorder MECHANISM



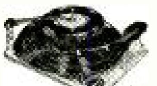
SALE PRICE $12.95

St. George wire recorder mechanism, size 9x13x3½". Crystal pickup for recording from 78 RPM records may be attached, however it is not furnished at the $12.95 price. The units are complete with wire recording head and suggested amplifier diagram. They are new, but need minor adjustments. No broken or missing parts. Only a few to sell at the scoop price of $12.95. Shipping weight 15 lbs. Stock No. SG-J4. Net $12.95.

SALE ON RECORDING WIRE

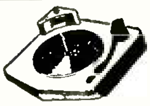
Top quality magnetic recording wire on metal spools. Red hot prices.
15 minute spool. Net $1.19, 10 for $11.00.
30 minute spool. Net $1.79, 10 for $16.90.
1 hour spool. Net $2.79, 10 for $25.00.

VM-406 Tri-O-Matic 3-Speed Changer $33.21



The new VM model 406 Tri-O-Matic automatically plays all records, all sizes and all speeds now on the market. Protective features: records are lowered, not dropped, no wobbling down the spindle, no slip or scrape, no possibility of the tiny microgrooves on the new type records being damaged. Plays 12 10", 33⅓ or 78 RPM, 10 12", 33⅓ or 78 RPM, any 10 or 12" records of the same type intermixed, 12 7" 33⅓ RPM and 12 7" 45 RPM records. Automatically shuts off on the last record, base size 13 13/16 x 12¼", 7¼" high overall. Equipped with flipover crystal cartridge and needles. Stock No. VM-406. Shipping weight 12 lbs. Net price $33.21. New 1950 Model VM-406 with All-in-one General Electric Variable Reluctance Cartridge and Twin Needles. Model 406GE. Specify VM406-GE. Add $2.85 to above cost.

Our Leader Changer Scoop $11.95, 2 for $22.95



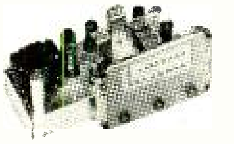
Our leader, automatic changer scoop. Base size 13 x 13". Plays 10 12" or 12 10" 78 RPM records automatically. Has Astatic L-70 cartridge. Priced complete with a metal base, which can be used in slide away compartment or as a table top base, or changer can be lifted off base to fit your needs. Stock No AD-12, Shipping weight 17 lbs. Scoop price $11.95 each, 2 for $22.95.

General Instrument 78 RPM changer with crystal cartridge for 10 12" or 12 10" records. Base size 11 x 12". Weight 11 lbs. Net $12.95, 2 for $25.00.

VM-400, 78 RPM changer with crystal cartridge. Base size 12½ x 13". Plays 10" or 12" records. A super duper value. Weight 12 lbs. Scoop price $12.95, 2 for $25.00.

RED HOT VALUES IN COMPLETE RADIO KITS

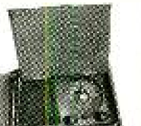
6 TUBE AC SUPERHET KIT BROADCAST AND SHORTWAVE MATCHED PARTS $9.95



MODEL 6-ACX5
2 BAND CHASSIS KIT

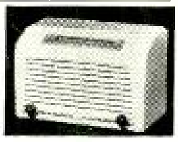
A complete kit of parts, tubes and ready punched chassis to build a fine 6 tube, 2 band AC power transformer type radio chassis. (No cabinet.) We furnish all pieces as well as a printed diagram and photograph. Chassis size 14x7½x7". Receives broadcast and 6 to 18 MC shortwave. 3 gang tuning condenser used on both bands. 90 mil power transformer and 6V6 output tube. The chassis, dial mechanism, gang and coils used in this kit were manufactured for use in a high quality Detrola radio. The heavy plate glass dial has etched-in numerals. This is a complete 2 band AC chassis kit, with tubes. The output transformer is furnished but the speaker is not. Use any standard PM speaker.
Stock No. 6-ACX5. Net price $9.95. 8" Heavy duty PM speaker, $2.95 extra.
10" Heavy duty PM speaker. 3.95 extra. 12" Heavy duty PM speaker, 4.95 extra.

New 3-Way PORTABLE RADIO KIT ONLY $9.95



Sensational new 3-way portable radio kit. 4 tubes plus rectifier. Housed in an all aluminum, leatherette covered case made by Farnsworth, with loop antenna built-in. Size 5x9x6". Build yourself a professional looking radio with this kit. Every piece furnished including tubes: 1R5, 1T4, 1S5, and 3V4, as well as easy-to-follow diagram and photo. This set will make a full two gang superhet, that looks like a $40.00 radio. We should ask $17.00 for this kit. Stock No. FP-4X, complete kit less batteries, weight 8 lbs. Net price, $9.95. Kit of batteries, 67½ volt "B" and "A". $2.25 extra.

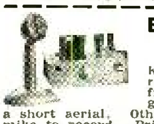
NEW 1950 MODEL 5-TUBE SUPERHET RADIO KIT



MODEL NS-5 $9.95

McGee's new 1950 Model 5 tube AC-DC superheterodyne radio kit. Has loop antenna and 2 gang condenser, with lighted slide rule dial and attractive plastic cabinet. Receives broadcast, 550 to 1650 kc. Full size dynamic speaker, matched 456 I.F.'s, automatic volume control. This is a complete radio kit. Everything furnished, including diagram, photos and tubes: 12BE6, 12BA6, 12AT6, 50B5 and 35W4. Shipping weight 7 lbs. Stock No. NS-5. Net price, $9.95.

BUILD YOUR OWN MINIATURE RADIO STATION KIT MODEL DE-6X $6.95



Kit Model DE-6X. With this simple kit you can build your own radio station in miniature. Has 4 tubes. Broadcast on frequency from 800 to 1500 KC. from either a crystal microphone or phonograph record. (Warning this transmitter must be used with only a short aerial. Otherwise you will broadcast 2 or 3 miles.) One control fades from mike to record. Price includes parts, diagram, instructions, photo and tubes. Everyone will enjoy your miniature broadcast station. Kit Model DE-6X. Shipping weight 4 lbs. Net price, $6.95.
Model DE-6XWT, miniature transmitter, wired and tested. Net price, $8.95.
Crystal mike and desk stand, pictured with transmitter, $4.95 extra.
Dynamic mike, small palm-of-your-hand type, $5.95 extra.
Stock No. NK-T small aluminum cased crystal mike, response 40 to 9000 CPS. About the size of an overcoat button. Furnished less cable. Just solder on connections for concealed use, $3.95 extra.

100 CARTONED RADIO TUBES $29.95

McGee carries a tremendous inventory of individually cartoned and branded Hy-Vac tubes. These are made by a nationally advertised tube manufacturer. These tubes are available at this low price because they do not fall within the rigid testing limits of this factory. However, every tube is guaranteed by us.

1R5	12BA6	12AX7	6AQ5	6W4	19T8
1T4	12BE6	12BA7	6BF6	6AG5	6BJ6
1U5	12AT6	12AU6	6AU7	6AU6	6AT6
3A4	35W4	12BF6	6SU7	12S8	6BA7
1S5	35B5	6BA6	6AQ5	9001	6BJ6
3V4	50B5	6BE6	6AQ6	9002	35C5
3Q4	12AT7	6AT6	6C4	6BH6	
3S4	12AU7	6AL5	6X4	117Z3	

$29.95 FOR 100
34c EACH

Popular Hyvac GT Tubes All Guaranteed and Cartoned 39c

1B4	6C6	6K7	6SJ7	6SU7	12S8	25L6
5Y3	6F6	6P5	6SK7	6V6	12SA7	32L7
5Y4G	6J5	6S8	6SL7	6X5	12SF7	35Z5
6AC5	6J7	6SA7	6SN7	12A8	12SJ7	70L7
6BG6	6K5	6SD7	6SR7	12BF7	12SN7	80
6C5	6K6	6SF5	6SS7	12K8		

STANDARD BRAND TUBES CARTONED AND UNCARTONED 49¢

Standard brand radio tubes. Some are cartoned individually, some are not. We acquire these tubes from manufacturers over-run, radio receiver over-stock, JAN, etc. We cannot give you a choice of brands, but we will give you a good quality standard brand tube. Every tube guaranteed.

0Z4	1G4	3S4	6D6	6L7	6SK7	7A5	7E7	12A6	12Q7	14A7	30	45Z5	50Y6
1A4	1G6	5T4	6D8	6N7	6SL7	7A6	7F7	12A8	12SC7	14B6	32	50B5	41
1A6	1H6	5V4	6F5	6R7	6SQ7	7A7	7H7	12AH7	12SF5	14C7	33	56	35B5
1B4	1J6	5Y3	6F7	6S7	6SR7	7B4	7L7	12AT6	12SF7	14H7	34	57	3Q4
1B5	1L4	6A3	6H6	6SA7	6SS7	7B5	7N7	12BA6	12SG7	14Q7	35	58	14A4
1C6	1R5	6AB7	6J5	6SC7	6T7	7B6	7Q7	12BD6	12SH7	14R7	35W4	70L7	12J7
1C7	1S5	6AC7	6J7	6SD7	6V6	7B8	7R7	12BE6	12SJ7	19	35Y4	75	6AT6
1D5	1T4	6AG7	6K5	6SF5	6X5	7C4	7S7	12C8	12SL7	25L6	35Z4	76	6BA6
1D7	1V	6B8	6K6	6SF7	6Y6	7C5	7V7	12F5	12SN7	25Z5	35Z5	77	
1D8	2A5	6C4	6K7	6SG7	6Z7	7C6	7Y4	12H6	12SQ7	25Z6	38	78	
1F4	2A6	6C5	6K8	6SH7	6ZY5	7C7	7Z4	12J5	12SR7	26	39	80	
1F5	2A7	6C6	6L5	6SJ7	7A4	7E5	10Y	12K8	12Z3	27	43	6BE6	

STANDARD BRAND TUBES

LOCTALS etc. $0.69 EA.

1LN5	1G4	6SN7
1LC5	1LA6	6SL7
1A7	1LA4	3Q5
1Q5	1H5	1LB4
1LD5	1P5	1T5
1LC5	1LH4	117Z6
1LC6	3LF4	35A5
1LE3	1A5	50A5
1N5	1C5	

HYVAC 49c BRACKET

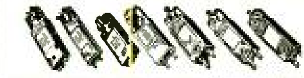
6BG6 6J6 6AK5

STANDARD BRAND Every Day Numbers 59c

12SA7GT 12SK7GT 35L6GT 50L6GT

G.E. RPX010 V.R. CART. $2.95

G.E. RPX010, with permanent needle. $2.95 each; 10 for $24.95.
Kit of parts to build 6SC7 type preamplifier. $2.49 extra.
A lucky purchase by us enables this terrific General Electric cartridge value.



Astatic MLP-2, with needle.......... $1.95
Astatic QT3-M, with needle.......... 2.95
Astatic NJ-1, with needle.......... 2.79
Astatic L-72 or Webster Equal 1.79
Astatic L-40 or Webster Equal 1.79
Astatic L-70 or Webster Equal 1.79
Take 10% off on 10-lot assortment.

McGEE RADIO COMPANY

Prices F.O.B. K.C. Send 25% Deposit with Order, Balance Sent C.O.D. With Parcel Post Orders, Include Postage

TELEPHONE VICTOR 9045. WRITE FOR FLYER
1422 GRAND AVE., KANSAS CITY, MISSOURI

McGEE SPEAKERS ARE LATEST 1950 PRODUCTION — FULLY GUARANTEED

MODEL CU-13X
12-INCH "COAXIAL"
WIDE RANGE SPEAKER
★ **NEW 1950 MODEL** **$9.95**
★ **Regular $32.50 List**
On Sale at McGee's for

McGee announces its new 1950 Model 12" coaxial PM speaker. A regular $32.50 list speaker, but mass production enables a new low price of $9.95. Made especially for McGee by a famous speaker manufacturer, to our own specifications. It's a new 1950 model. The sale of 10,000 coaxial speakers assures you that this speaker is a smart choice. The speaker consists of a 12" Alnico V PM with coaxially suspended 3" hard cone tweeter. The 12" portion has a 6.8 oz. Alnico V magnet with 1" voice coil and heavy one piece ribbed cone. This responds to the lower register of the audio spectrum. The tweeter has its own separate 2.15 oz. Alnico V magnet. A high pass filter is concealed under the pot cover. This prevents low frequency from reaching the tweeter. The 3" tweeter has a very stiff cone and responds only to the upper register of the audio spectrum. With all this the speaker is still just as simple to connect as any ordinary PM. Only two wires to connect. Input impedance is 8 ohms. Designed especially for the critical music listener with a keen ear for the higher audio register. Response is from 40 to 17,000 cps. 18 watts. This speaker is ideal for the home music system. Generally used in only $400 to $800 radio installations. The high piano, cymbal and violin notes will reproduce clearly with our new 12" coaxial speaker Model CU-13X. Shipping weight 8 lbs. Net price $9.95, 2 for $19.00

MODEL P15-8
15-INCH "COAXIAL"
WIDE RANGE SPEAKER
★ **NEW 1950 MODEL**
★ **Regular $62.50 List** **$19.95**
On Sale at McGee's for
"IT WOOFS AS IT TWEETS"

This 15", 35 watt peak coaxial PM speaker is not surplus. It is manufactured by a leading speaker company, to our own specifications. We buy them by the hundreds in order to offer them to you at this low $19.95 price. They are comparable to any $62.50 list speaker on the market. The 15" woofer will reproduce down to 20 cycles. It has a 22 oz. Alnico V magnet and molded cone with 1½" voice coil. The high frequency tweeter is coaxially built in, with a special cone that will produce notes up to 17,500 cycles. The input impedance of both reproducers combined, is 8 ohms. Matching network is concealed under the pot cover. Just hook this up like any other 8 ohm speaker and hear the difference. Shipping Wt. 16 lbs. Stock No. P15-8. Sale price $19.95. Two for $38.00

SUPER QUALITY 12" AND 15" ALNICO V P. M. SPEAKERS — LOWEST PRICES

15-Inch 50 Watt
WIDE RANGE SPEAKER
20 TO 12,000 CPS.
MODEL 15-LS..... $15.95

Regular $45.00 List with wide range molded cone. Model 15-LS. 15" 21½ oz. Alnico V Magnet PM Speaker. Will take 35 watts with ease. Thousands of dollars were spent in building the fine tools to produce this speaker. The 8 ohm voice coil is 1½" in diameter and has been heat treated and plastic coated. Constructed to eliminate loose voice coils, wires and warping. Made by a renowned builder of fine speakers. Truly the King of juke box speakers. Shipping weight 14 lbs. Net Price $15.95. Two for $30.00

15 INCH JUKE BOX P.M. ONLY $9.95
Stock No. 15KR. 15 inch 12 oz. 8 ohm voice coil PM. Ship. wt. 10 lbs. Scoop price $9.95. Two for.... $19.00

Model A-50
$13.95

50-Watt 12" Super Heavy Duty P.M. $13.95

Model A-50—12". 50 watt super heavy duty permanent magnet speaker. Has 1½" 8 ohm treated voice coil and one piece molded cone. Heavy half inch machined pot, with bolt secured 21 oz. Alnico V magnet. Frame is of heavy construction with metal pot cover. Finished in silver-grey enamel. This speaker is the best value possible today. Efficiency is two to three times that of ordinary speaker. Especially recommended for all public address systems and high quality home audio systems. Will handle 35 watts with ease and 50 watts peak or short lengths of time. Its retail value is $50. But, by our large purchase, we are able to offer it to you for only $13.95. Do not confuse this speaker with surplus merchandise. This is the latest production. Model A-50. Shipping wt. 13 lbs.

12-Inch 25 Watt
WIDE RANGE SPEAKER
35 TO 12,500 CPS.
MODEL 1202-X...... $9.95

McGee's model 1202-X. 12" 25 watt 1¼" voice coil Alnico V PM speaker. Model 1202-X has 14½ oz. Alnico V ring magnet and full 1¼". 8 ohm voice coil. One piece molded curvelenier cone forms a trumpet for high note distribution. Ideal for high fidelity home music systems and rugged public address work. Made especially for us, to our own specifications by a famous builder of speakers. Frequency response is from 35 to 12,500 cps. Lustre grey finish with metal pot cover. Shipping weight 7 lbs. Why pay twice as much for some other brand? Every speaker guaranteed. Regular $29.50 list. Model 1202-X. Net price $9.95, 2 for $19.00

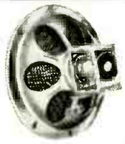
McGEE'S SUPER High Fidelity OUTPUT TRANS. 20-20,000 CPS. **$6.95**
Best Value in U.S.A.

A-403—6600 ohms. Plate to Plate. Why pay $20.00 or $30.00 for an output? Supreme quality and high fidelity output transformer. Designed to match push-pull plates (2—6L6, 2—6V6, or 2—6AQ5) class AB. to 4-8-15-250 and 500 ohm; with 10% feed-back winding. Housed in a compound filled case: 3⅞x4½x3". Actual net weight, 6 lbs. If you want the best quality from your audio system, order this transformer. Response essentially flat from 20 to 20,000 cycles. We have tried several high fidelity outputs in our lab and find this to be the best value. Even though your amplifier only puts out 10 or 15 watts, this 34 watt job is what you should have. Connecting instructions are furnished. Stock No. A-403, shipping weight 8 lbs. Net price $6.95

6-110V. POWER SUPPLY KIT $14.95

Utility Power Supply Kit. Convert any amplifier, up to 30 watts, to either 6 volts DC or 110 volts AC operation. Besides furnishing B+ voltage it supplies 110 volts AC 60 cycle to run phono motor. This kit actually takes the place of your amp's power supply. Complete kit, including rectifier. Ship. weight 20 lbs.
Stock No. 6-110KR........ $14.95
Extra heavy duty 60 cycle vibrators.. $1.95
6-110 Volt Power Trans. Only..... $5.95

ALUMINUM VOICE COIL



REPLACEMENT SPEAKERS—FACTORY PRICES

McGee's Aluminum Voice Coil Double X Line. McGee offers you our Double X line of replacement P.M. Speakers. Made by a pioneer of the aluminum voice coil speakers. All of the Double X speakers have Alnico V magnets. All aluminum voice coils with RMA standard 3.2 ohm impedance. Why pay twice as much for a replacement speaker? McGee buys them by the carload and sells them for half price. Every speaker is unconditionally guaranteed.

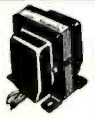
Double X Aluminum Voice Coil, Alnico V Magnet, RMA 3.2 ohm V.C.

Stock No.				
4XX	4" square	1 Oz. Mag.	$1.09 ea.,	10 for $10.00
5XX	5" round	1 Oz. Mag.	1.09 ea.,	10 for 10.00
6XX	6" pincushion	1.47 Oz. Mag.	1.69 ea.,	10 for 14.95
6XX2	6" pincushion	2.15 Oz. Mag.	1.95 ea.,	10 for 17.95
46XX	4x6"	1 Oz. Mag.	1.49 ea.,	10 for 13.95
57XX	5x7" oval	1.47 Oz. Mag.	1.95 ea.,	10 for 17.95
7XX	7" pincushion (Auto set)	3.15 Oz. Mag.	2.79 ea.,	10 for 24.95
8XX	8" pincushion	3.16 Oz. Mag.	2.95 ea.,	10 for 27.95
69XX	6x9" oval	3.16 Oz. Mag.	2.95 ea.,	10 for 27.95
12XX	12"	6.8 Oz. Mag.	4.95 ea.,	5 for 22.50

Universal replacement output transformers for any push-pull or single plate 2500 to 13,000 ohms from 2 to 16 ohm voice coil. Standard size, strap mounting with long leads and lugs for voice coil connections.

U-5	5 watt universal output	$ .79 each,	10 for $ 7.50
U-8	8 watt universal output	.99 each,	10 for 9.50
U-15	15 watt universal output	1.19 each,	10 for 11.00
U-20	20 watt universal output	1.49 each,	10 for 13.95

Any single plate (4-watt) to 3.20 Hy VC. Stock No. JJ-4.. 49c each, 10 for $4.50



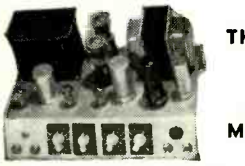
40-Watt Capehart High Fidelity Output Worth $20.00 **$7.95**

Specially built for Capehart for this finest combination. 40 watt capacity all windings interwound to increase high frequency response and decrease capacity losses. High inductance in coils makes for best efficiency at low audio frequency. This high fidelity output transformer is fully shielded and has a net weight of 6 lbs. Made to match push pull 6L6 tubes 5,000 ohm plate to plate. Has tertiary winding for 10% feed back and voice coil windings of 4 and 8 ohms. Frequency response plus or minus 2 DB from 30 to 15,000 cycles. Down 6DB below 20 cycles and above 20,000 cycles. Furnished with connecting instructions. Size 3½x4x4¾ tall. Shipping weight 8 lbs. Stock No. SX-55, net........ $7.95
Stock No. SX-44. Same as SX-55 only 25 watt capacity. Same winding. Shipping weight 5 lbs.. net........ $4.95

12-WATT MUSICAL P.A. AMP. KIT **$12.95**

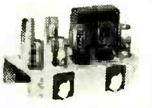
This amplifier kit, when wired, may be used as a musical amplifier, paging system or for any other low power P.A. use. It is a complete kit with diagram, ready punched chassis and matched parts to build an AC transformer type amplifier with push-pull output tubes. (12 watts.) Has heavy duty 8" 7 oz. Alnico V PM speaker, with tubes 2—12AX7, 2—6AQ5 and 6X4. Inputs for two instruments or mike and phono pickup. Leatherette covered case. Stock No. MN-12RC. Shipping weight 18 lbs. Net........ $12.95
Crystal mike and desk stand $4.95 extra.

BUILD A BETTER AMPLIFIER WITH A McGEE MATCHED PARTS KIT



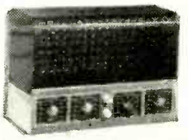
WIDE RANGE THEATRE QUALITY 20-20,000 CPS
AMP. KIT $29.95
Mike, Crystal, and V.R. Inputs

It's the newest thing in audio amplifiers. McGee's wide range, 34 watt amplifier kit with inputs for crystal or dynamic mikes and any crystal phono cartridge, as well as the new G.E. variable reluctance cartridge. Output transformer is wax impregnated, weighs 6 lbs. Voice coil taps 4-8-15-250 and 500 ohms. Push-pull 6L6 output tubes. Separate electronic base and treble boost. Inverse feedback. Input tube filament is DC heated to reduce hum level to nil. Frequency response from 20 to 20,000 cps. Easy to follow diagram and photos for easy assembly of this kit. Ready punched chassis. Every part furnished, including tubes: 2—6L6, 5V4, 3—12AX7. Shipping weight 25 lbs. Stock No. XX-34, net... $29.95
XX-34 WT (wired and tested) $10.00 extra.



12-WATT AMP. KIT HAS INPUT FOR G.E. PICK UP **$9.95**

Kit Model TM-12. 12 watt amplifier kit. Ideal for a high quality record player, as a P.A. system or recording amplifier. Matched component parts, ready punched chassis. One control fades from phono to mike. Input compensation for G.E. variable reluctance pickup. Output matches 8 ohm voice coil. 100 mil power transformer. Complete with tubes, photos and diagram. 2—6V6, 2—12AX7 and rectifier. Variable tone control. Model TM-12. Weight 10 lbs. Net..... $9.95
Crystal utility mike and desk stand $4.95 extra.



COMMERCIAL QUALITY PUBLIC ADDRESS
AMP KIT 20 WATTS $14.95
30 WATT MODEL..... $19.95

Here are the two best amplifier kit values in the United States. 20 and 30 watt models that will look like a manufactured job when wired. Everything fits. Ready punched chassis and cover. Inputs for 2 mikes (crystal or dynamic) and crystal phono pickup. Compact chassis size, 5½ x 12". Universal output transformer. Schematic diagram and photo for easy wiring. Frequency response, 20 to 12,500 CPS. Dealers, you can build your own amplifier for less.
ZR-20, 20 watt amplifier kit, with tubes: 2—6L6GA, 6SN7, 2—12AX7 and 5U4, 160 mill power transformer. output 4-8-16 and 250 ohms. A complete kit. Shipping weight 20 lbs. Net price........ $14.95
ZZ-30, 30 watt amplifier kit, with tubes: 2—6L6G, 6SN7, 2—12AX7, 5U4 and 6SN7, 200 mill power transformer. Output 4-8-16-250 and 500 ohms. A complete kit. Shipping weight 25 lbs. Net price $19.95.
Either the ZR-20 or ZZ-30 may be had with our high fidelity output transformer for $5.00 extra. (Specify when ordering, with hi-fidelity output transformer at $5.00 extra. 4-8-16-250 and 500 ohms. Response, 20 to 20,000 CPS.

CRYSTAL MIKE **$4.95**

McGEE'S MIKE SALE

Our leader High Z Dynamic Mike with 12 feet of cable. Stock No. D-4. Sale price $9.95.
Shure CX-50 Crystal Mike with 20 feet of cable. Sale price $8.95.
Table Top Adjustable Banquet Mike Stand $2.95.
Floor Mike Stand adjustable 2 section chrome stem—cast base $4.95.

OUR LEADER CRYSTAL MIKE AND DESK STAND SHIP. WT. 2 LBS. SALE PRICE $4.95

12 inch slanting front wall baffle with tri-color plastic front. Stock No. 12-R, $3.95 each, 4 for $14.95.

12 inch corner baffle with tri-color plastic front. Stock No. 12-C, net $3.49, 4 for $12.95.

CONSOLE BASS REFLEX SPEAKER BAFFLE $14.95

6 cubic foot utility base reflex speaker baffle. 32" high x 22" x 16". Heavy wood construction, brown leatherette covering and celotex lining. Can be used with any speaker up to 15". This is not a piece of furniture, but a heavy baffle made for utility use. Shipping weight 40 lbs. Stock No. NA-R6. Close out price $14.95.

JUKE BOX OPERATORS SPECIAL

8 Inch Heavy Duty Speaker $2.95

8 Inch Plastic Front Wall Baffle $1.95

8" super heavy duty, 7 oz. Alnico V PM speaker, with 8 ohm voice coil. Made by a nationally known speaker builder, expressly for juke box remote use and general P.A. work. This speaker will take just as much kick as most 12" speakers. It's the best value in the U. S. today. A regular $7.00 value. Shipping weight, 4 lbs. Stock No. SE-8X. Net price $2.95, each, 10 for $27.50, 25 for $62.50 and 100 for $225.00.

Attractive wood baffle with curved tri-color plastic front, for 8" speaker. Very attractive design, well built economical to use. Hundreds have been sold to music box operators for extension speakers. Shipping weight 6 lbs. Stock No. 8-RCM. Net price $1.95 ea. Quantity price, 10 for $17.50, 100 for $150.00.

McGEE RADIO COMPANY

PRICES F.O.B. K.C. Send 25% Deposit with order. Bal. Sent C.O.D. With parcel post orders include postage.

TELEPHONE VICTOR 9045. Write for Flyer
1422 GRAND AVE., KANSAS CITY, MISSOURI

"MOTOROLA" 8 TUBE AUTO RADIO AT McGEE'S for $44.95

OUR FIRST SCOOP FOR 1950

★ MODEL 708-T6 8 WATTS AUDIO
★ BRAND NEW FACTORY CARTONED
★ REG LIST OVER $80.00
★ IDEAL FOR ALL CARS AND TRUCKS
★ FINEST IN THE WORLD

McGee does it again. We offer you at a scoop price the world-famous, powerful 8 tube Model 708T6 Motorola Auto Radio. These sets were made for Tucker but are the regular Motorola 8 tube sets and are branded Motorola. Any push button Motorola remote control may be used. Tuned RF stage for long distance reception. Push pull 6V6 audio, 8 watt output. Wide range audio response with tone control. This is the finest auto set we know of today. Push button tuning. This is a standard size Motorola auto radio and will fit all cars up to '49 with no installation problem. '49 and '50 models are more difficult to install any radio in. Our **$44.95** price includes the radio, speaker for dash installation (6½"), tuning cables, mounting hardware, etc. Check with your local Motorola jobber for custom panel kits. However, we have under-dash controls that can be installed in any car or truck and make a neat installation. The Model 2A1 push button universal under-dash remote control is **$1.95** extra. The following custom dash remote controls are offered by us at the sale price of **$1.95** each: '40 and '41 Pontiac; '40 Ford; '40 Lincoln; '40 Plymouth, etc.; '40 Nash Laf.; '40 Hudson; '46, '47 Hudson; '42 Olds.; '46 Packard.

● UNIVERSAL UNDER DASH CONTROL, IDEAL FOR ALL CARS AND TRUCKS $1.95

COWL OR FENDER AUTO ANT.

Reg. $6.95 List

SCOOP PRICE $2.95

3-Section Top Cowl or Fender Mounting Auto antenna. Fits most all cars. Stock No. DC-F3T. Ship. weight 2 lbs. Net **$2.95**.

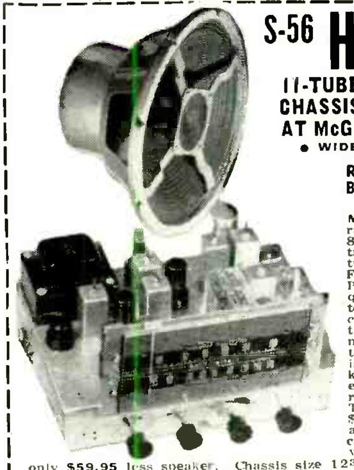
CABINETS FOR S-56 HALLICRAFTERS OR WITH BLANK PANEL

Armchair radio-phono combination cabinet, ready-cut to house the S-56 Hallicrafters. 24" high x 27 x 16½". Hinged lid covers record changer compartment. Will accommodate up to a 12" speaker and space for a record changer up to 14" square. Changer board is blank, you cut to fit your changer. Dial knob and mounting holes cut for S-56 Hallicrafters. Cabinet is of top quality and has furniture type finish. Shipping weight 40 lbs. Available in walnut, mahogany or blond.

Walnut armchair cabinet, cut for S-56. Net $29.95
Mahogany armchair cabinet, cut for S-56. Net $29.95
Blond armchair cabinet, cut for S-56. Net $34.95

Any of the above may also be had with blank radio panel. (Specify blank radio panel when ordering.)

S-56 HALLICRAFTERS



11-TUBE FM-AM CUSTOM CHASSIS. A $110.00 VALUE AT McGEE FOR ONLY..... $59.95

● WIDE RANGE ● AUTOMATIC FREQUENCY CONTROL ON F.M.

Receives 88 to 108 MC F.M. and Broadcast 550 to 1650 KC.

Fine for Custom Installation

Model S-56 Hallicrafters. 11 tube AM-FM radio receiver chassis for broadcast and FM 88 to 108 mc. Automatic frequency control on FM, holds the receiver in perfect tune. Phono connection on rear of chassis. Full range tone control with bass boost. Push-pull 6K6 tubes in audio system. Frequency response essentially flat, from 50 to 14,000 CPS. Wide vision accurately calibrated slide rule dial, with pre-selection on broadcast band. Output transformer matches any 8 ohm speaker. 4 antenna terminals, two for AM and two for FM. This is the finest type of home radio that we know of today. Better get your order in early. Designed to be used in commercial radio selling in the $400 to $600 class. The regular dealers' net on this chassis is $110.00. However, a lucky purchase enables us to offer these brand new, factory cartoned S-56 Hallicrafters chassis, complete with tubes and operating instructions, at only **$59.95** less speaker. Chassis size 12¾x10x7¾". Weight 25 lbs. Brand new factory cartoned. Buy your S-56 with a wide range PM speaker. Pick your combination from the prices listed below and save.

If you need an armchair cabinet for your S-56 Hallicrafters, see ad in left corner of this page.

Hallicrafters S-56 FM-AM chassis, complete with our 12" coaxial PM speaker CU-13X, as pictured. Shipping weight 32 lbs. Net........ **$69.50**

Hallicrafters S-56 FM-AM chassis, complete with our P15-8 15" coaxial PM speaker. Very special. Net. **$77.95**

Hallicrafters S-56 FM-AM chassis, complete with our 1202-X curvelenier cone 12" PM speaker. Net..... **$67.95**

VM-406 Tri-O-Matic Record Changer, **$33.21**.

With new 1950 G.E. variable reluctance cartridge, add **$2.80**.

Pre-amplifier for S-56 $3.95

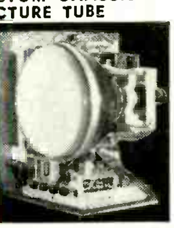
Dual purpose preamplifier for either S-56. Only 4 wires to connect (instructions furnished). With this you can convert set to operate either a G.E. variable reluctance pick-up or a crystal or dynamic mike, making your S-56 a home P.A. system. Preamp Model SS-69. Size 3½x4x3". Shipping weight 2 lbs. Net price, **$3.95**. Crystal mike and desk stand, **$4.95** extra.

NEW 1950 PRODUCTION STANDARD 4-PRONG VIBRATOR 99c

BUY 10 FOR $8.95

Latest 1950 production by a well known vibrator manufacturer. Standard size 4 prong 6 volt vibrator an ideal replacement for all Motorola auto sets. Fills 90% of your vib. needs. Every vibrator guaranteed to satisfy you—full replacements. Stock No. VIB-42. Sale price, 99c each; 10 for **$8.95**.

NATIONALLY FAMOUS 15-INCH CUSTOM CHASSIS WITH PICTURE TUBE



Regularly $250.00

McGEE'S SCOOP PRICE $169.95

McGee does it again. We bought 150 of this nationally advertised brand, 23 tube television chassis. These were made to sell for $250.00 by a famous builder of amateur radio sets. It is the finest construction with 12 channel turret tuner and separate power supply, with heavy duty transformer. Has 8" heavy duty speaker. This is a complete manufactured television chassis, with all tubes, including the 15DP4 picture tube. When it is time for you to replace the picture tube, a 16" size will plug right in. This chassis is all mounted on plywood for quick custom installation. Picture tube brackets at front and back of tube, mounted on heavy plywood. Tube is mounted independently from television chassis, for more versatile installation. Set is pre-aligned and tested. If you do not recognize the value of this set, we will furnish further information by letter. Shipping weight 100 lbs. Stock No. 520E. Minimum space required for mounting as shipped 20 x 20½ high x 23" deep. Net price, complete with all tubes and the 15DP4 picture tube, ready to operate. $169.95

REGULAR $25.00 TELEVISION MAGNIFIER

SALE PRICE $7.95

Stock No. HA-22

FOR 7-10-12 INCH TUBES

Stock No. HA-22 12 x 17 in. television magnifier. Made of crystal-clear plastic and oil-filled. Magnifies your present 7-, 10-, or 12-inch television picture up to four times. We offer you these new factory cartoned magnifiers, you provide your own means of mounting to your set. Edge of magnifier may be drilled and hung on your set with cord. This lens is a $25.00 value, but McGee offers them to you for only **$7.95**. Shipped by express only. Ship. wt. 22 lbs.

McGee special T.V. picture tubes. Slightly irregular, but fully guaranteed. You must be satisfied.

10BP4 10" picture tube........ $17.95
12LP4 12" picture tube........ 22.95
16LP4 16" picture tube........ 39.95

TELEVISION VIDEO COIL KIT—20 MATCHED COILS FOR PICTURE AND SEPARATE SOUND I. F. $7.95

20 matched TV coils; video and sound I.F. McGee Scoop price **$7.95**. Television video coil kit, for TV sets up to 16", using separate sound and picture circuits. Consists of 20 coils for use in the nationally famous 30 tube and 22 tube TV circuit. All coils are of the finest construction, furnished to you, just like they go to a TV set maker. Each coil is identified. These are not made by RCA, but by a top quality coil company, especially for McGee. If you are going to use the RCA circuit, you can use this set of coils.

Coil kit has 1-180 uh, 1-250 uh, 2-120 uh, 2-93 uh peaking coils, 4 picture IF coils for 25.75 mc. 1 cathode trap, 2 sound IF's 21.25 mc. 1 discriminator, 1 convertor and 5 filament chokes. Stock No. 205-XX, shipping weight 3 lbs. McGee's sale price **$7.95**. These coils match the Sarkes-Tarzain TV front end listed below. Why not order both the tuner and the coils.

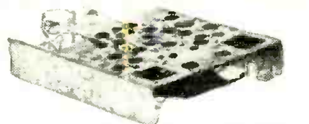
10" TV CABINET $5.95

Stock No. RY-10

Buy this 10" streamlined mahogany television cabinet at less than the cost of manufacture. Originally intended for use with the Farnsworth GVZ-60 television chassis, pictured to the right. It is already drilled to fit. Built-in safety shield in front. All new, size 13x19¾x17" high. Shipping weight 33 pounds. **Stock No. RY-10. Net $5.95.** Order this cabinet by itself or order on combination deal.

Sarkes-Tarzain Tuner and Video coil kit can be used with Farnsworth cabinet and chassis, some revamping is necessary.

Partially Built-Up Chassis $2.95



Stock No. GVZ-60

Buy Both RY-10 Cabinet and GVZ Chassis for $7.95

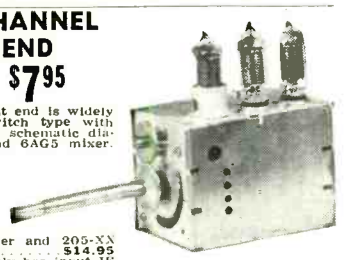
Farnsworth Television Chassis Model GVZ-60 partially built-up Chassis Size 12x17. Has 16 tube sockets and over 150 small parts (Resistor and Ceramic Condensers) no coils or Transformers or tuning unit. Sweep and sync, circuits are all partially wired up. This TV Chassis is ideal for the student and experimenter. Learn TV by building your own set using this chassis to start from. Furnished with a 1948 regular $3.00 Supreme Publications Television Manual which has a complete schematic of this chassis as well as 9 pages of service information. Farnsworth GVZ-60 partially built-up Chassis and 48 Supreme TV Manual all for........ **$5.95**

Include postage for 11 lbs. GVZ-60 Chassis only **$2.95**.

RY-10 Cab. and GVZ60 Chassis **$7.95**. T.V. Man. **$3.00** extra.

SARKES-TARZAIN 13 CHANNEL TELEVISION FRONT END

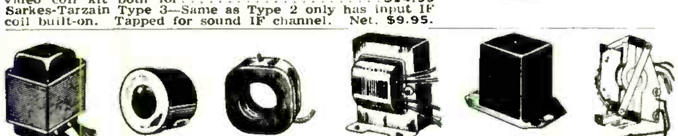
With Tubes and Diagram $7.95



This popular Sarkes-Tarzain television front end is widely used to-day. The 13 channel rotary switch type with individually tuned coils. Price includes a schematic diagram and 3 tubes, 6C4 oas. 6BH6 RF and 6AG5 mixer. Regular factory cost is twice our price. Each tuner and its own tube sockets are wired, ready to hook up to a video and sound IF strip. May be used with either intercarrier or separate sound IF circuits. Built in fine frequency control. Ship. weight 3 lbs. Sarkes-Tarzain Type 2 TV tuner with tubes net...... **$7.95**

Combination deal, Sarkes-Tarzain TV tuner and 205-XX video coil kit both for........ **$14.95**

Sarkes-Tarzain Type 3—Same as Type 2 only has input IF coil built-on. Tapped for sound IF channel. Net, **$9.95**.



- **A.** Power transformer suitable for RCA 630 circuit 760 volts CT at 300 MA. 5 volts 3 amps., 5 volts 3 amps. and 6.3 volts 8 amps. Jefferson built. Shipping weight 12 lbs. Stock No. MB-4F, Net price........ **$5.95**
- **B.** Deflection Yoke 201D1 for 12 or 10 inch picture tube. Net price **$2.95** ea.
- **C.** Focus Coil 202D1, 247 ohms DC resistance, for 10 or 12" picture tube. Scoop price .... **$1.95 each**
- **D.** Vertical deflection output transformer 204T2 for 10, 12 or 16" picture tube. Net price .... **$1.95 each**
- **E.** Vertical oscillator transformer 208T2, for 10, 12 or 16" picture tube. Net price .... **$1.50 each**
- **F.** Horizontal scanning output transformer (flyback) supplies H.V. to picture tube. Has rect. filament winding for 10 or 12" picture tube. Also, feeds horizontal scanning coil of deflection yoke. Net price..... **$3.49**

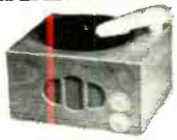
Radio-Phono Combination

ON SALE AT McGEE $14.95

ONLY 300 TO SELL

RED HOT CLOSEOUT SPECIAL

AUTOMATIC RADIO PHONO $24.95



MODEL JA-70 RECORD PLAYER RADIO $14.95

McGee's red hot value of the month. For the children's or recreation room. You can have a radio-phonograph combination for less than the price of just a record player. Here is what you get for only **$14.95**: A full 2 gang, 5 tube superhet broadcast chassis, with loop antenna, wired in the Farnsworth factory, a Ballentine 78 RPM phono motor, a crystal pickup for standard 78 RPM records and a walnut finish cabinet. Uses tubes 12SA7, 12SK7, 12SQ7, 50L6 and 35Z5. When you receive your radio-phono combination all that is necessary is about an hour's work, drilling six small round holes and mounting the wired radio chassis, phono motor and pickup in the cabinet. Off-on switch and phono switch mount on top of the cabinet. This is the nicest deal we have been able to offer for your children's radio and record player combination. Shipping weight 15 lbs. Stock No. JA-70. Net price, **$14.95**.

Automatic radio-phono combination. The same as JA-70 described above, only furnished with a 78 RPM G. I. automatic record changer. The same Farnsworth wired 5 tube broadcast chassis and walnut cabinet. Stock No. AUT-JO. Net, **$24.95**.

McGEE RADIO COMPANY

PRICES F.O.B. K.C. Send 25% Deposit with order. Bal. Sent C.O.D. With parcel post orders include postage.

TELEPHONE VICTOR 9045. Write for Flyer
1422 GRAND AVE., KANSAS CITY, MISSOURI

Mac's Service Shop

(*Continued from page 60*)

ticular job for them that they cannot do for themselves, just as they depend on their doctor, dentist, auto mechanic, or jeweler. In short, we have elected to *serve* the people, with all that big word implies.

"If we are going to serve them well, we have to have a genuine interest in them and their problems. If we have no such interest, we had better get into some other more impersonal business; for while the average person is a very poor judge of radio service work, he is not nearly so dumb about human nature. He may not notice the improvement that your realignment job produced in his set, but he can spot the old brushoff a mile away."

"Then you don't hold with the idea that if you are a super-duper technician the world will seek you out and overwhelm you with business."

"Not by a long shot. I doubt that a man can make a continued success of radio servicing unless he is a good technician; but I know that a good technician can be a flat failure unless he has the knack of making people like and trust him.

"The main idea in the radio service business is the same as that in the famous recipe for rabbit stew that starts out: 'First, catch a rabbit.' The first thing we have to do is to catch and keep customers; yet, being the technical-minded nuts we are, a lot of us get so wrapped up in actually fixing sets and in trying to keep up with the new developments in this galloping field of ours that we neglect our 'customer-relations.' In fact, we go so far as to feel and show actual annoyance when a customer comes in and makes us leave the bench just when we are hot on the trail of an elusive intermittent.

"But I am just wasting my breath. I doubt that you have even the foggiest idea of what I am trying to tell you."

"I resent that—bitterly!" Barney replied as he drew his lanky figure to its full height and looked disdainfully down at Mac. "Just to show you what a grave injustice you have done me, I shall point out that you have spent the greater part of the last quarter of an hour explaining in needless detail What Every Girl Should Know."

"What Every Girl Should Know!" Mac repeated in blank amazement. "How on earth did you ever get that crackpot idea?"

"What Every Girl Should Know: How to say, 'No,'" Barney explained as he started sidling toward the service department door.

Only his youthful agility enabled him to dart through the opening and slam the door behind him before the copy of Turner's *"Radio Test Instruments,"* the first weapon that came to Mac's hand, crashed against the jamb.

—30—

first time in RHS history!

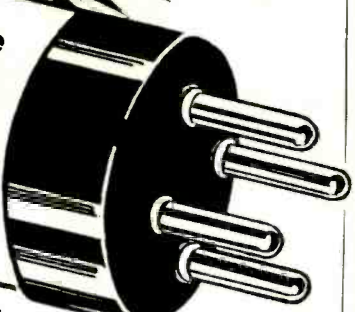
Special Purchase SALE!

while quantities last!

Transmitting—Cathode Ray—Special Purpose

TUBES

Brand New! Standard Brands! No Seconds!



We made a once-in-a-lifetime purchase—and now you can benefit by the terrific savings! No need to tell you these are the most sensational values in our history! Just look at the listing below . . . compare the prices . . . you'll know what we mean when we say that you may neveragain come across a real savings opportunity like this!

DIODE GAS RECTIFIERS

4B26	$3.49	866A	$1.05	RX21	$2.39
249C	1.49	866JR	.98	RX120	8.95
575A	11.95	869B	26.50		
816	.99	872A	1.12		

PENTODES

307A/RK75	$3.69	804	$7.95	1619	$ .15
713A	.79	807	1.09	1851	.69
717A	.49	837	1.19	EF50	.39
803	2.95	1613	.49	HY115/145	.59

UHF TRIODES

2C40	$2.95	703A/368AS	$1.89
2C43	7.95	708A	3.59
2C44	.98	826	.39
2C46	6.95	8012	.89
3C24/24G	.35	GL434A	2.69
388A	.47	HY615	.19
527	5.95	VT127A/100TS	1.95

THYRATRONS

2D21	$ .89	2051	$ .39
3C23	2.19	C6J	3.65
3C31/C1B	1.69	FG17	2.69
3C45	12.95	FG27A	6.95
884	1.19	FG81A	3.29
885	1.19	FG105	8.95
2050	1.19	FG172	13.95

VOLTAGE REGULATORS

OA3/VR75	$ .93	OC3/VR105	$ .69
OB3/VR90	.65	OD3/VR150	.49
874	$ .39		

ACORNS

954	$ .16	957	$ .22	9004	$ .24
955	.25	958	.22	9005	1.39
956	.25	959	.35		

MINIATURES

9001	$ .32	9003	$ .33
9002	.25	9006	.15

TRIODES

2C22/7193	$ .15	710A	$ .25	845	$3.85
2C26A	.15	800	1.49	851	12.95
3C22	39.50	801A	.19	1626	.25
6J4	4.49	805	3.65	8005	4.75
10Y	.19	808	.99	8011/WL538	.25
30 spec.	.19	809/3C30	1.89	8014	22.50
45 spec.	.19	810	7.95	8025	3.69
75TL	3.89	811	1.98	F123A	7.95
100TH	10.49	812	2.45	F127A	15.95
211	.25	814	1.98	F128A	69.50
250TH	18.75	833A	33.95	F862A	397.50
304TH	3.49	838	1.98	HYE1148	.29
304TL	1.29	841	.29	ML101/GL605	49.50
316A	.29	843	.29	WL530	12.95
450TH	16.95				

DIODE VACUUM RECTIFIERS

3B24	$1.49	371B	$ .49	VU111	$ .49
3B26	1.49	705A	.69	WL531	4.75
15R	.49	1616	.49	WL616	37.50
100R/8020	.89	8013	1.39	KC4	37.50
GL451	.89	F660/WL562	49.50	ML100	37.50
250R	5.95	RK72	.59	F606	37.50
371A	.39	RK73	.59		

CATHODE RAY TUBES

2AP1	$3.89	4AP10	$2.95	5JP1	$29.95
3AP1	4.59	5AP1	2.95	5JP2	8.95
3BP1	2.39	5AP4	2.95	5LP1	12.95
3CP1	1.39	5BP1	1.85	7BP7	3.49
3DP1	1.79	5CP1	1.29	9LP7	1.98
3DP1-S2A	2.79	5CP7	2.95	902	3.39
3FP7	.97	5FP7	1.19	905	2.49
3GP1	5.95	5GP1	2.98	908/3AP1	4.95

CRYSTAL RECTIFIERS

1N21	$ .49	1N23	$ .59	1N27	$ .89
1N21A	.89	1N23A	.79	1N34	.82
1N21B	.89	1N23B	1.89		

KLYSTRONS

2K25/723AB	$22.50	417A	$ 8.95	726A	$ 6.75
2K28	24.95	707B	14.95	726B	29.50
		723A/B	12.95	726C	49.50

TWIN PENTODES

3E29	$8.95	829 UHF	$7.45
815 HF	1.59	832A	4.89

TETRODES

3D21A	$ .98	5D21	$24.45	813	$ 6.85
4-65A	14.21	350B	1.39	860	14.95
4-125A	26.05	715A	5.49	861	9.49
4-250A	36.25	715B	6.59	865	.79
4E27	12.45	715C	19.95	1614	1.35
257B	12.45				

GAS SWITCHING TUBES

1B24 TR	$4.59	532A	$1.89
1B26 TR	2.79	1B36 anti TR	3.95
1B27 TR	7.95	721A anti TR	1.98
1B29	.79	724B anti TR	2.49
1B32	1.89	1960/S836 diode	.89

PHOTOTUBES

1P24	$ .59	930	$ .98
1P36	2.93	931A	2.39

TWIN TRIODES

2C21/RK33	$ .24	2C34/RK34	$ .22
1642	.24	RK59	1.69

MAGNETRONS

2J21A	$ 7.95	2J31	$ 8.49	5J29	$11.95
2J22	7.95	2J32	12.95	5J30	47.50
2J26	6.95	2J48	12.75	714AY	3.59
2J27	12.75	2J54B	22.50	725A	6.45

DUO-DIODE GAS RECTIFIERS

3B22/EL1C	$1.98	CK1005	$ .09
4B24/EL3C	1.98	CK1006	.85

SPECIALS

23D4 ballast	$ .29	1625 beam amp.	$ .19
28D7 beam amp.	.29	1629 tuning eye	.19
559 UHF diode	.98	1631 beam amp.	.98
876 ballast	.29	1636 beam amp.	.98
1624 beam amp.	.67	REL21 spark gap	.98
1630 orbital beam hexode	$ .49		
RK60/1641 duodiode vac rect.	.42		

RECEIVING TUBES

OA2	$1.29	6B8G	$ .69	12AT6	$ .44
OA4G	.89	6BA6	.55	12AT7	.79
OB2	1.67	6BE6	.52	12AU6	.57
OZ4	.57	6BF6	.57	12AU7	.67
O1A	.39	6BG6G	1.47	12AV6	.54
1A3	.44	6BH6	.59	12BA6	.55
1A4	1.09	6BJ6	.57	12BE6	.49
1A4P	.97	6C4	.19	12C8	.34
1A5GT	.49	6C5	.47	12F5GT	.58
1A6	.79	6C6	.57	12H6	.27
1A7GT	.67	6C8G	.69	12J5GT	.34
1AB5	.59	6D6	.44	12J7GT	.67
1B3/8016	1.15	6D8G	.79	12K7GT	.52
1B4	1.19	6E5	.69	12K8	.59
1B5/25S	.89	6F5	.47	12Q7	.49
1C5GT	.59	6F6	.57	12SA7	.57
1C6	.89	6F6GT	.57	12SC7	.54
1C7G	.89	6F7	.69	12SF5	.59
1D5GP	.97	6F8G	.87	12SF7	.54
1D7G	.89	6G6G	.69	12SG7	.52
1D8GT	.95	6H6	.39	12SH7	.35
1F4	.75	6H6GT	.37	12SJ7	.47
1F5G	.75	6J5	.47	12SK7	.57
1G4GT	.69	6J5GT	.39	12SL7	.59
1G6GT	.65	6J6	.77	12SN7	.52
1E7G	1.15	6J7	.67	12SQ7	.49
1H4G	.55	6J7GT	.65	12SR7	.49
1H5GT	.54	6K5GT	.79	12Z3	.69
1H6GT	.87	6K6GT	.44	14A4	.79
1J6G	.75	6K7	.49	14A7	.52
1L4	.48	6K8	.79	14B6	.67
1LA4	.79	6L5GT	.79	14F7	.69
1LA6	.89	6L6	1.05	14F8	.79
1LB4	.89	6L6G	.99	14H7	.59
1LC5	.69	6L6GA	.85	14J7	.87
1LC6	.79	6L7	.79	14N7	.85
1LD5	.79	6L7G	.87	14Q7	.53
1LE3	.69	6N7	.75	14R7	.67
1L5	.79	6Q7	.64	19	.69
1LH4	.79	6R7	.79	24A	.49
1LN5	.67	6S7G	.79	25L6GT	.53
1N5GT	.59	6S8GT	.77	25Z5	.44
1P5GT	.67	6SA7	.44	25Z6GT	.43
1Q5GT	.67	6SC7	.59	26	.49
1R4	.59	6SD7GT	.44	27	.42
1R5	.69	6SF5	.49	28D7	.35
1S4	.59	6SF7	.59	30	.37
1S5	.49	6SG7	.59	31	.59
1T4	.53	6SH7	.37	32	.85
1T5GT	.69	6SJ7	.47	32L7GT	.89
1U4	.59	6SK7GT	.44	33	.69
1V	.57	6SL7GT	.59	34	.37
2A3	.87	6SN6CT	.97	35/51	.57
2A4G	1.07	6SN7GT	.54	35A5	.63
2A5	.69	6SQ7	.45	35B5	.55
2A6	.79	6SR7GT	.52	35C5	.59
2A7	.79	6SS7	.49	35L6	.52
2V3G	.69	6ST7	.72	35W4	.39
2X2	.37	6SU7GTY	1.25	35Y4	.49
2X2A	.65	6SV7	.79	35Z3	.57
3A4	.34	6T7G	.89	35Z4	.44
3A5	.79	6U5G	.65	35Z5	.39
3A8	1.59	6U6GT	.63	36	.67
3B7/1291	.29	6U7G	.49	37	.35
3D6/1299	.29	6V6	.89	38	.37
3LF4	.79	6V6GT	.57	39/44	.27
3Q4	.47	6W4	.63	41	.49
3Q5GT	.67	6W7G	.77	42	.49
3S4	.57	6X4	.57	43	.49
3V4	.67	6X5GT	.47	45	.52
5R4GY	1.09	6Y6G	.67	45Z3	.57
5T4	.87	6C7G	.98	45Z5	.55
5U4G	.49	6ZY5G	.59	46	.62
5V4G	.87	7A4/XXL	.49	47	.69
5W4	.67	7A6	.59	49	.85
5X4G	.57	7A7	.53	50	1.39
5Y3GT	.39	7AG7	.72	50A5	.69
5Y4G	.49	7B4	.53	50B5	.53
5Z3	.52	7B5	.67	50L6GT	.52
5Z4	.77	7B6	.56	50Y6	.57
6A3	.92	7B7	.59	53	.87
6A4LA	1.09	7C4	.34	56	.45
6A6	.79	7C5	.48	57	.45
6A7	.69	7C7	.59	58	.49
6A8	.75	7E5	.67	59	.89
6AB7	.79	7E6	.54	70L7	.99
6AC7	.74	7E7	.62	71A	.59
6AD7G	1.09	7F7	.59	75	.53
6AF6G	.79	7H7	.59	76	.44
6AG5	.69	7K7	.89	77	.43
6AG7	.98	7L7	.69	78	.44
6AH6	1.29	7N7	.67	80	.37
6AJ5	.79	7Q7	.59	81	1.25
6AK5	.85	7R7	.69	82	.84
6AK6	.79	7V7	.87	83	.75
6AL5	.59	7W7	.79	83V	.89
6AQ5	.49	7X7	.79	84/6Z4	.56
6AQ6	.59	7Y4	.47	85	.69
6AR5	.52	7Z4	.57	89Y	.35
6AT6	.44	12A	.57	117L7/M7	1.19
6AU6	.59	12A6	.17	117N7	1.19
6AV6	.47	12A7	.89	117P7	1.19
6B4G	.89	12A8GT	.49	117Z3	.49
6B6G	.79	12AH7GT	.80	117Z6	.65
6B7	.87				

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.5	mfd 1000v	.39
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.1	mfd 3000v	1.39
.25	mfd 3000v	1.49
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.1	mfd 5000v	1.98
.25	mfd 5000v	2.29
1	mfd 5000v	2.98
.1	mfd 7000v	1.49
.01	mfd 7500v	1.79
.02	mfd 7500v	1.79
.03	mfd 7500v	1.79
.05	mfd 7500v	1.79
.1	mfd 7500v	1.79
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Mycalex for VT127A	.59
Ceramic acorn	.29
Ceramic for 866A	.59

TRANSFORMERS—115v 60 cyc

HS—Herm. sealed · OF—Open frame · FS—Full shell · FE—Fully enclosed

	Secondaries	Wgt.	Ht.	W.	D.	Price
HS	6350v @ .025 arms (16kv ins)	33½	3	7¾	6	$11.95
OF	6250v or 3850v or 2600v @ .056 arms	37	12	8	5¾	13.95
HS	2500v @ 15 ma	13¼	5½	4¾	4½	3.49
HS	1600v @ 4 ma; 350-0-350v @ 150 ma; 6.3v @ 9A	9¾	5½	4	3¾	4.45
HS	1540v @ 5 ma; 340-0-340v @ 300 ma	16	5¼	5½	4¾	4.35
FS	1120-0-1120v @ 500 ma; 12v CT @ 14A; 2.5v @ 10A; 17v @ 2.5A; 32 v @ 25 ma 115/230 pri	45	7¼	10	7¼	27.00
HS	925v @ 10 ma; 525-0-525v @ 60 ma; 2x5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	14¾	5½	4¾	4½	5.55
FE	700-0-700v @ 300 ma	34	5½	11½	4¼	7.55
FE	500-0-500v @ 175 ma	16½	5½	5¾	4¼	4.55
FS	430-0-430v @ 340 ma; 6.3v CT @ 6.3A; 5v @ 6A	14	5½	4¾	4¼	4.85
HS	425-0-425v @ 75 ma; 6.3v @ 1.5A; 5v @ 3A	8½	5¼	3¼	3¼	3.65
FE	415-0-415v @ 60 ma; 5v CT @ 2A 115/230 dual pri	7½	5	5	3¾	4.97
FS	405-0-405v @ 150 ma; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A	7½	4¾	3¾	3¾	4.35
HS	400-315-0-100-315v @ 200 ma; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A	12¾	5¼	4¾	4¼	5.35
HS	500-385-0-385v @ 200 ma; 3x6.3v @ .6A; 5v @ 3A; 2.5v @ 2A	18	6¾	4½	4¼	4.75
FE	325-0-325v @ 12 ma; 255-0-255v @ 240 ma	15½	5¾	4½	3¾	4.25
HS	300-0-300v @ 65 ma; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A	6¾	3½	3¾	3¾	3.25
HS	120-0-120v @ 50 ma	3¼	4¼	2½	2½	.95
HS	80-0-80v @ 225 ma; 5v @ 2A; 5v @ 4A	6½	4½	3½	3¼	2.97
FE	0-17.4/21.6/25.8v @ 400 ma; 6.4v @ .5A; 2.6v CT @ 2.5A pri 115/230	7	5	5	3¾	3.85

	Secondaries	Wgt.	Ht.	W.	D.	Price
OF	18 or 36v @ 15A	16	6½	6	3¾	$8.75
FS	13.5v CT @ 3.25A	5½	4¼	3½	3	2.17
FS	12.6v CT @ 10A; 11v CT @ 6.5A	12½	6¼	5½	3¾	6.35
FE	3x10.3v CT @ 7A	17½	4½	7	5¾	6.95
HS	6.5v @ 12A; 6.3v @ 2A; 115v @ .1A	9¾	5¼	4½	3½	3.50
HS	6.4v @ 10A; 6.3v @ .6A	7¼	5¼	4½	2¼	2.77
OF	6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A	9	4¾	4¼	3¾	4.17

	Secondaries	Wgt.	Ht.	W.	D.	Price
HS	6.3v @ 1A; 2.5v @ 2A	8	5¼	4¼	3½	$2.29
OF	6.3v @ 1A	½	1¼	2	1½	.77
FE	6.3v CT @ 3.5A; 2x2.5v CT @ 3A	7	3¾	3½	3	2.97
FE	5v CT @ 20A; 10 KV ins	22	7¼	7½	4¼	8.95
HS	4-0-4v @ 1A	1½	2¾	2½	2	.87
HS	.6v @ 15A rms	3½	3¼	3¾	2¼	1.47

TRANSFORMERS—220v 60 cyc

	Secondaries	Wgt.	Ht.	W.	D.	Price
FE	512.5-0-512.5 @ 427 ma	24½	6¾	6½	4½	5.35
FE	3x5v @ 6A; 4v @ .25A	10	5¼	4	4	2.95
FE	3x6.3v CT @ 3A; 6.3v CT @ 1.6A	9½	5¼	4	3¼	2.95
FE	10v CT @ 6.5A; 6.3v CT @ 2.5A; 6.3v CT @ 1.8A 220/440 pri	13	5½	5¼	4½	3.95
FE	Step up/down 110/220 500 watt	25	6	11	5	10.95
FE	Step up/down 110/220, 220/440 600 watt	39	5½	7¼	7	14.95

FILTER CHOKES—HI V INS

		Wgt.	Ht.	W.	D.	Price
HS	600 hy @ 1 ma/500 ohms	1	2¾	2	dia.	3.15
HS	325 hy @ 2 ma/4500 ohms	1	2¼	2½	1¾	3.37
HS	200 hy @ 10 ma/5260 ohms	1½	3¼	2½	dia.	3.37
FE	30 hy @ 60 ma/240 ohms	6	4	4½	3	1.57
HS	30 hy @ 25 ma/870 ohms	1½	2¾	2	2	.97
HS	15 hy @ 70 ma/500 ohms	3	3¼	2¾	2¼	1.15
FS	10 hy @ 200 ma/85 ohms	3½	3¾	3	8	2.17
FS	3/30 hy @ 250 ma/70 ohms	6½	4½	3¾	dia.	3.65
FS	10/20 hy @ 85 ma/2000 ohms	2½	3	2½	2½	1.55
FE	14/3.5 hy @ 40/400 ma	17	4½	6¼	6¼	6.95
FE	3 hy @ 50 ma/300 ohms	½	1½	1½	dia.	.33
HS	2 hy @ 175 ma/60 ohms	1½	2½	1¾	1¾	1.49
FE	5 hy @ 70 ma/100 ohms; .2 hy @ 350 ma/6 ohms dual	5	3¾	4½	3	2.39
HS	.1 hy @ 5A	12	6¼	4½	3½	6.97
FE	.065 hy @ 2.5A	9	4	4¾	3¼	2.49
HS	.05 hy @ 15A	11	6	4¼	3¼	7.97

SELENIUM RECTIFIERS—FULL WAVE BRIDGE TYPE

Input: 0-18v AC — Output: 0-14.5v DC

Type	Max. DC Current	Price	Type	Max. DC Current	Price
18D1	1.2	$ 2.59	18K2	26.0	$17.95
18E1	2.4	3.49	18K3	39.0	24.95
18F1	6.4	4.95	18K4	52.0	29.95
18K1	13.0	8.95	18K5	65.0	35.95
18J1	17.5	11.95			

Input: 0-40v AC — Output: 0-34v DC

Type	Current	Price	Type	Current	Price
40D1	0.6	$ 2.95	40K2	12.0	$18.95
40E1	1.2	3.89	40J2	18.0	22.45
40F1	3.2	5.79	40K4	24.0	32.50
40K1	6.0	9.95	40K5	30.0	37.95
40J1	9.0	12.95	40J4	36.0	42.50

Input: 0-120v AC — Output: 0-100v DC

Type	Max. DC Current	Price	Type	Max. DC Current	Price
40D1	.6	$ 7.85	40K1	6.0	$27.47
40E1	1.2	10.76	40J1	9.0	34.35
40F1	3.2	16.65			

SINGLE PHASE FULL WAVE CENTER TAPPED

Input: 10-0-10v AC — Output: 8v DC

Type	Max. DC Current	Price	Type	Max. DC Current	Price
20D1	1.2	$ 1.89	20K4	48.0	$17.95
20E1	2.4	2.25	20K5	60.0	22.49
20F1	6.4	3.87	20K6	72.0	25.57
20K1	12.0	4.95	20K7	84.0	27.95
20J1	16.0	7.95	20J6	96.0	32.50
20K2	24.0	11.95	20K10	120.0	36.50
20K3	36.0	14.95			

THREE PHASE FULL WAVE—BRIDGE RECTIFIERS

Input: 120v AC — Output: 150v DC

Type	Max. DC Current	Price	Type	Max. DC Current	Price
40D31	.9	$16.52	40K31	9.0	$32.50
40E31	1.8	19.87	40J31	12.0	54.69
40F31	4.75	27.95			

Input: 240v DC — Output: 0-300v DC

Type	Max. DC Current	Price	Type	Max. DC Current	Price
40D61	.9	$27.45	40K61	9.0	$92.76
40E61	1.8	33.65	40J61	12.0	98.75
40F61	4.75	49.95			

Current ratings can be increased 2 to 2½ times by fan cooling.

COMPONENTS

50 mmfd ceramic condensers	$ .59
50 mmfd button condensers	.07
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4-30 mmfd ceramicon trimmers	.29
25, 50 mmfd air trimmers screwdriver	.29
100, 140 mmfd air trimmers screwdriver	.39
50 mmfd 5KV GE vacuum condenser	1.49
1 mfd 600v donut condenser (152 in box) per box	1.98
TMC-300 National variable 300 mmf	1.29
Single gang variable 33-435 mmf	.69
Five gang variable 11.5-30 mmf per section	.98
Three megacycle IF coil double slug	.29
Thirty megacycle IF coil	.19
80 meter osc. coil for ARC5	.29
80 meter PA final coil for ARC5	.29
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Couplings ceramic ¼" to ⅜"	.29
Couplings ceramic ⅜" to ⅜"	.29
Crystal socket ceramic 2 prong 5/32"	.14

EQUIPMENT

APN-1 altimeter transceiver	New	$ 7.95
ATR inverter 12v DC in 110v AC 100w out	New	16.95
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BC 1016 tape recorder	New	139.50
BC 950A-121 xmitter 100-156 mc, modulated	New	49.50
BC 778 Gibson Girl	Shelfworn	3.95
BC375E xmitter, 7 tuning units, dynamotor	Like new	69.50
BC-AL229 receiver	Used	2.95
BC 733 receiver	New	6.95
BC 433 receiver	Used	24.95
BC 456 modulator	New	1.98
BC 434A control box/SCR269	Used	2.45
BC 996T1 interphone amplifier	Like new	6.95
BC 602A control box/SCR522	Used	.49
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BK-22 relay for SCR269	Used	1.95
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"Lock-in" Circuit

(*Continued from page 44*)

takes place over quite a few cycles on either side of the frequency to which the circuits are tuned. In this particular case it is significant to note that the "tank circuit" is aperiodic. Since this means that there are no tuned circuits, the conversion takes place over one complete cycle, which is essential to proper operation in the type of comparator circuit required.

Next, examine the complete circuit of Fig. 2. Note that a *negative* scan pulse (actually a whole line) is drawn from the horizontal yoke. After passing through the phase-shifting network, R_5C_3, it assumes the shape shown at "A." (Note the pip of the original sync is still *riding* the pulse.) For an enlarged drawing of "A," see Fig. 3.

This distorted pulse is injected into the diode at point "X." Mixing with the incoming sync pulse, a d.c. voltage is developed, the value of which is a function of the difference in phase between the pulses of these two sources. This voltage, varying with phase difference (brought about by the various factors which cause loss of sync in normal TV receivers), is used to control the frequency of the horizontal oscillator.

Consider point "X" in Fig. 2. The dual-diode with equal resistors R_3 and R_4 comprise a bridge circuit. Normally the voltage at "X" would be equal to voltage at ground, or *zero*. The distorted negative pulse entering the circuit has an a.c. waveform, due to the distorting network. However, the major lobe is still clearly negative as shown at "A."

Thus the injection at "X" is essentially negative. This causes the upper diode to conduct less heavily and the lower one more heavily, producing a net increase of positive voltage across the load (to right of point "X.") A positive voltage applied to the grid of the discharge tube of the horizontal oscillator will tend to unblock the oscillator, increasing its speed. Conversely, reducing this positive voltage will slow up the oscillator.

Now, with the hold control remaining fairly fixed, the control voltage will have to be practically instantaneous becoming more positive when the oscillator is slow and less positive (negative going) when the oscillator is fast. How is this accomplished?

Consider Fig. 3. Study the picture of one horizontal line scan. This shows a normally locked raster line with the sync pulse riding at point "Z." It could actually ride anywhere between points "M" and "N" without upsetting the oscillator, but it will tend toward point "Z" because that is the maximum (negative) point. If it rode between points "Z" and "O" it would give wrong polarity, kicking the oscillator off frequency. (Once the oscillator goes off frequency for the major part of a cycle the pulse would meet the line in a

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BC 457 Transmitter—as is—fair condition—as they come, some with, some less tubes and Xtal	1.95	——
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R 89 Receiver chassis less tubes and side covers	1.95	——
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BC 602 Control Box	——	.98

BC 639 Receiver with **RA 42** Rectifier
RTA 1B Transceiver
TA 2J24 Transmitter and **MP 10G** Power Pack
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R 5/ARN 7 Compass Installation
MN 26 Compass Installation
I. L. S. Installation (**R 89-BC 733**)
SCR 584 Components

} **Information and prices on request**

HERMETICALLY SEALED CHOKES

10 H.	100 M.A.	59c
59 H.	100 M.A.	95c
3.7 H.	145 M.A.	59c
10 H.	20 M.A.	39c

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1B5/25S	.49	6R7	.39	49	.39
1B22	1.95	6SF5GT	.39	50	.59
1B26	2.96	6S8GT	.59	56	.29
1B29	.59	6SF7	.49	57	.29
1B32-532A	2.95	6SJ7	.69	76	.29
1C6	.49	6T7G	59	77	.39
1C7G	.49	6U7G	39	211/Vt4L	.29
1D5GP	.49	6Z7G	69	316A	.39
1D7G	.49	6ZY5G	39	371B	.39
1F4	.49	7C4/1203A	.29	703A	1.95
1F5G	.49	7E5/1201	.59	705A	.98
1H4G	.39	10Y/VT25A	.19	714AY	5.95
1J6G	.49	12A6	.39	724B	4.95
1J6GT	.49	12A6GT	.39	801A	.69
1N5GT	.49	12A7	.39	836	.96
1P5GT	.49	12A8GT	.39	837	1.95
1V	.49	12C8Y	.39	841	.39
2A6	.39	12F5GT	.39	864	.39
2A7	.49	12H6	.39	872A	1.29
2C26A	.19	12J5GT	.29	954	.19
2V3G	.49	12J7GT	.39	955	.39
2X2/879	.39	12K8GT	.39	957	.39
3B7/1291	.39	12Q7GT	.39	1625	.19
3D6/1299	.39	12SF5	.39	1626	.29
3FP7	.98	12SF5GT	39	1629	.29
4AP10	.98	12SF7	.39	1630	.59
5BP1	1.96	12SR7	.29	1636	2.95
5BP4	2.95	12SR7GT	.29	1638	.69
5CP1	2.95	12Z3	.29	1642	.69
5D21	19.95	15R	.19	2050	.89
5J23	7.95	19	.59	2051	.59
5T4	.69	2J22	3.96	7193	.19
5W4	.59	28D7	.39	9002	.39
6Z4	.59	30SPEC		9003	.49
6B8	69	(Vt67)	.59	9006	.29
6C4	.29	30	.29	GL4A21	.29
6D8G	.59	32L7GT	.69	Amperite 10T1	.29
6F5GT	.39	33	.29	Jan CRP72	1.49
6H6	.29	34	.29	WE 331A	.89
6J6	.89	35/51	.29	REL 36	.89
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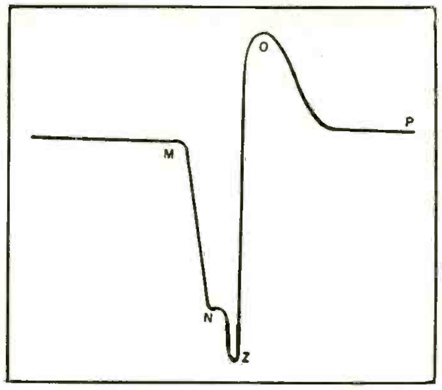


Fig. 3. Enlarged view of "A" in Fig. 2.

more favorable position since the sync pulse is rigidly controlled at the transmitter while the local horizontal oscillator is designed to lock-in when triggered by the sync pulse.)

It could ride between points "O" and "P" but that slope is too broad for sensitivity of control, and the oscillator would vary, permitting sync to strike the more favorable region "M" to "N."

Suppose the oscillator starts to speed up. If it runs away from the sync the sync pulse will start to move toward "M." This would shorten the negative peak, lowering the output voltage at point "X," slowing up the oscillator. If the action were such as to make the oscillator go too slowly, the sync would move forward to the maximum negative point at "Z," increasing the output voltage at "X", increasing the speed of the oscillator. Since the correction takes place within the cycle, the sync correction takes place within one line, causing no visible change from the standpoint of the observer.

The horizontal oscillator (not shown) is a conventional blocking oscillator in which the frequency is controlled by the time constant of the grid resistor and the grid blocking condenser. Variation of either of these two elements will control the frequency of the oscillator. (Examine the horizontal oscillator of the TV receiver it is desired to control. Any *Sams* Photofact Standard Notation Schematic of a TV receiver will clearly indicate this circuit.)

To the normal means of control of the horizontal oscillator frequency may now be added a third means of applying an automatic variable d.c. voltage to the cold end of the grid resistor. (Simply open the ground end of the resistor already in the grid circuit of the horizontal oscillator. Now connect the opened end to the output of the circuit shown in Fig. 2. The rest is automatic.)

The control voltage is derived from the reference point "X" described earlier. It passes through a filter network containing L_1, with its damping resistor, R_1. This offers a low impedance to d.c., and a high impedance to the pulses which appear at "X." Condenser C_4 further removes any pulses which might come through L_1. Since L_1 and C_3 comprise a series-tuned circuit, further damping is necessary. This is achieved by C_5, a large value condenser, and its damping resistor R_8.

Because the horizontal blocking oscillator tends to develop a high negative voltage in its grid circuit, it may be seen that this negative voltage could be reflected back to point "X", upsetting the action of the diode, if it is not balanced out.

To take care of this, resistor R_9 supplies a positive voltage to counter the negative voltage developed by the blocking oscillator. This maintains the d.c. voltage at point "X" near zero, or slightly negative. Further stabilizing may be achieved by the use of R_6 to prevent the blocking oscillator from departing too far from its normal frequency in case the synchronizing pulses from the transmitter are not present.

The author has operated the horizontal hold control on receivers using this circuit and can testify it really holds 'em!

All elements for this lock-in circuit are available in kit form from *Transvision, Inc.*, originators of this circuit. Full instructions for assembly accompany the kit. The circuit may be used with any TV receiver utilizing a horizontal blocking oscillator circuit.

—30—

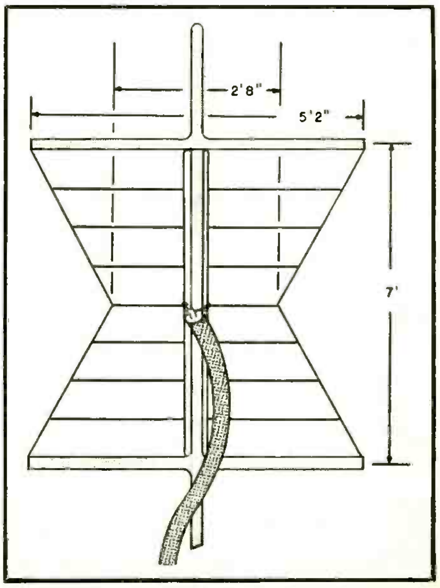
Batwing FM Antenna

(*Continued from page* 35)

templated using ¾" diameter tubing for the top and bottom members, ½" for the vertical members, and ⅜" for the inner horizontals—all mounted on a ¾" mast. An antenna constructed in this manner, we believe, will yield optimum, dependable, weather-proof performance for a lifetime.

If bolted construction is used instead of the welded construction, it is advisable to use tubing and bolts of the same material to reduce the effects of electrolysis. —30—

Fig. 3. Dimensions of a typical batwing unit.



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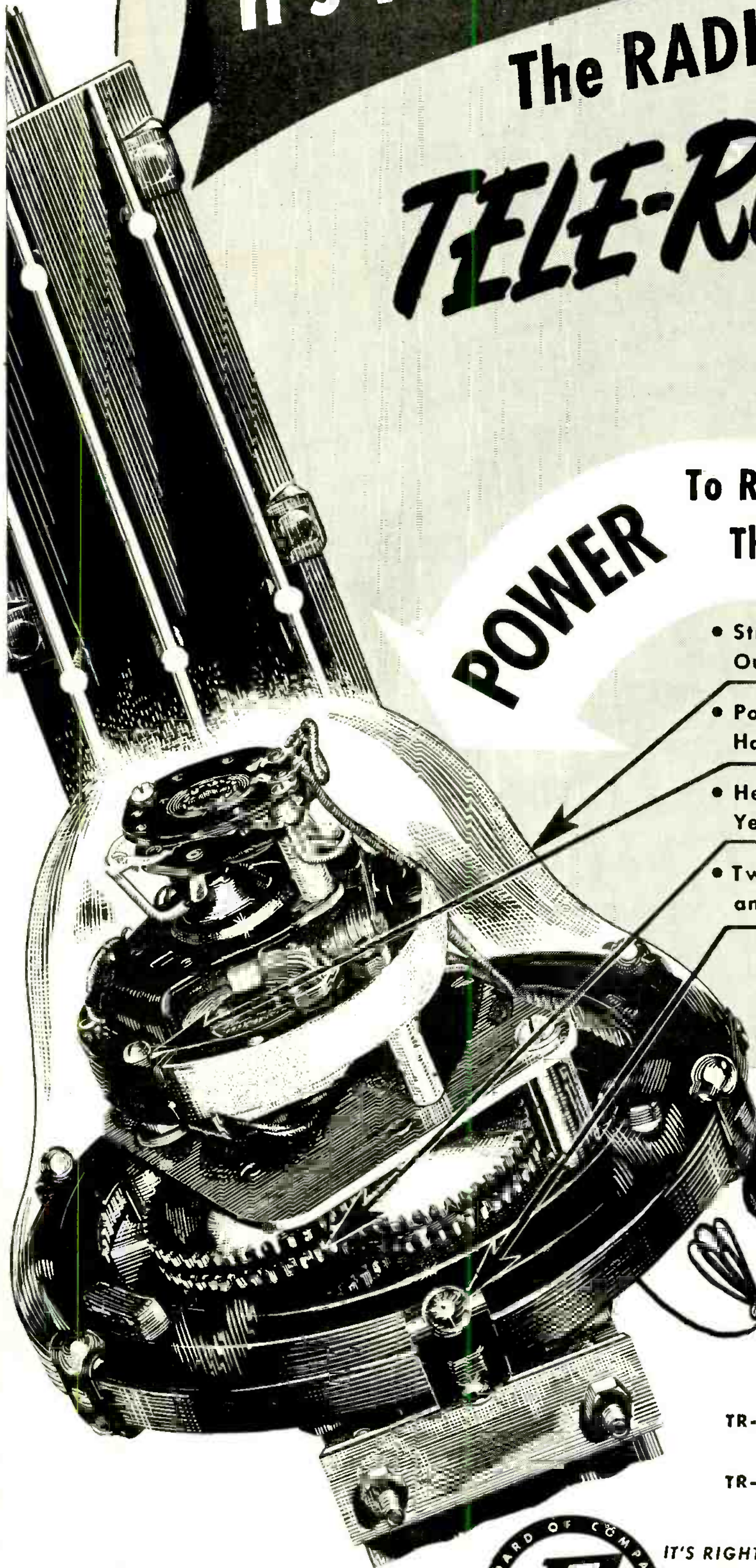

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Technical BOOKS

"THE OSCILLOGRAPH" by Walter Weiss. Published by *The Hickok Electrical Instrument Co.*, Cleveland, Ohio. 47 pages. Price $1.00 (paper).

This is a thoroughly practical handbook that the radio technician can use daily in servicing radio, FM, and television receivers.

It should be emphasized that this manual is not concerned with the operation of the cathode-ray oscillograph but rather with the types of patterns that result from various service faults.

The first six sections are devoted to the subject of superheterodyne troubleshooting. For convenience sake, the author has divided the receiver into six sections; the power supply, the oscillator section, the first detector, the i.f. amplifier, the second detector and first audio section, and the final amplifier. He then outlines and illustrates the oscillograph patterns that should be obtained in a correctly functioning receiver and then the patterns which appear when the receiver is operating incorrectly.

The seventh section of the book is concerned with proper FM receiver alignment procedures to be followed when using an oscillograph for the operation and finally, a section on the proper use of an oscillograph in television receiver alignment.

A separate "Oscillograph Control Settings vs. Positions" chart is attached to the inside of the back cover where it can be easily removed for use above the oscillograph position on the service bench.

* * *

"16 MM. SOUND MOTION PICTURES" by William H. Offenhauser, Jr. Published by *Interscience Publishers, Inc.*, New York. 565 pages. Price $10.00.

This is a definitive work on the subject of 16 mm. films and one of the first comprehensive texts in the literature. Prior to its appearance both amateur and professional film-makers had to search many sources to find the answers to their questions and solutions to their problems.

As to the value of the photographic discussion, this reviewer is not qualified to state but the sections on sound, sound recording, sound recording characteristics and sound recording equipment and its arrangement are valuable additions to the growing library of sound and audio texts.

Although the author has more or less confined his discussion to the photographic recording and reproduction of sound, he does touch on the subject of magnetic tape and its associated recording techniques. The author discusses the general requirements as to frequency range, the influence of noise, theoretical considerations in speech and music reproduction,

practical considerations affecting the low frequency cut-off of a system, practical considerations concerning frequency range and volume range of reproduced sound, production implications of performance range requirements, factors influencing response frequency characteristics in 16 mm. sound recording, transfer steps, process of making release prints and effect on sound, general recording procedures, and practical suggestions for recording.

The chapter covering the equipment used in recording on film lists the general requirements for such equipment, transfer losses and their correction, recommended ranges of response frequency over-all characteristic, pre- and post-equalizing, details of recording equipment, and the physical placement of the various recording components.

For the amateur 16 mm. enthusiast as well as personnel of commercial film outfits, this book is a must on the reference shelf.

* * *

"FACSIMILE" by Charles R. Jones. Published by *Murray Hill Books, Inc.*, New York. 411 pages. Price $6.00.

This is a comprehensive work on the subject of facsimile written for the user as well as the technician who services the equipment.

The book is divided into four parts covering the nature of facsimile; its operation, present-day facsimile systems, and servicing. The first part deals with the historical and technical background of the medium, modern facsimile equipment, the type and scope of facsimile services (both projected and actual), facsimile broadcasting, and other facsimile devices.

The second part covers transmitters and transmission facilities, facsimile reception, synchronization and phasing, tape facsimile, and facsimile standards. The third part deals with the various facsimile systems now available and covers the products of such manufacturers as *Acme Telectronix, Alden Products Company, A.T. & T., Finch Telecommunications, Inc., Radio Inventions, Inc. Times Facsimile Corporation,* and *Western Union.*

The fourth part is for the service technician and deals with such subjects as exciter lamp replacement, replacing the recording element, printer blade adjustment, cleaning and lubrication, mechanical repairs, electronic maintenance, photofacsimile units, and troubleshooting the set. Detailed service notes are provided on the *Finch* Type FRS 140-C, and the *General Electric* Types FR-1 and RX23.

Both technically and non-technically trained persons will find this book of interest. Although the author is a development engineer with *Finch Telecommunications, Inc.,* he has not fallen into the trap which so often ensnares engineer-authors and used highly technical terminology in his text. The book is thoroughly readable and informative.

—30—

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but that's not all! In addition, this finely engineered instrument provides a degree of accuracy never before attained in a unit selling for even double this price. Furthermore in designing this unit, we took advantage of every recent improvement in components. For example, by using slug-tuned coils, we are able to efficiently adjust each instrument for perfect accuracy. This feature will also enable you to recalibrate the model 200 periodically without having to return it to the factory. The use of a Noval tube (the 12AU7) with its extremely low inter-electrode capacity enabled us to reach a higher frequency range than was heretofore possible in a unit of this type.

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Within the Industry

(*Continued from page 24*)

of Los Angeles has named **HENRY BECKER** to be in complete charge of mechanical engineering for the firm . . . **WILLIAM R. SPITTAL** has recently formed a new company, known as *The Highland Engineering Company,* which will manufacture transformers, inductors, rectifiers, power supplies, and related items at a new plant in Hicksville, Long Island. **CHARLES W. CUTNEY** is the production manager of the new firm . . . **SAMUEL OLCHAK** has been promoted to the post of advertising and sales promotion manager for *Air King Products Company, Inc.* He will continue his duties as commercial service manager . . . **J. W. LAMARQUE** heads *Graybar Electric Company's* new communications sales department with **R. W. GRIFFITHS** serving as manager of electronics sales . . . **PAUL W. TANNER** will serve as merchandising manager for radio and TV activities at *Noblitt-Sparks Industries, Inc.* while **GLENN MILLS** will act as sales promotion manager for the company's *Arvin* line . . . **FREDERIC C. YOUNG,** formerly vice-president in charge of research and engineering and a director of *Stromberg-Carlson Company,* has joined the staff of *Designers for Industry, Inc.* as vice-president . . . Two of *General Electric Company's* outstanding scientists retired recently from active business; **DR. ALBERT W. HULL,** assistant director of the Research Laboratory and inventor of the magnetron, and **DR. GORTON R. FONDA,** research chemist who, with his associates, developed the American version of the radar screen 14 days after the problem had been assigned to the laboratory . . . **CLARENCE H. ENDRESS** has been named chief engineer of *Willard Storage Battery Company.* He has been with the firm since 1920 . . . **J. D. HEIBEL** heads the new Research and Development Department recently created by *Erie Resistor Corporation.*

* * *

HYTRON RADIO & ELECTRONIC CORP'S new television picture tube plant at Newburyport, Mass., was recently the scene of cornerstone laying ceremonies. The ultra-modern new plant will produce approximately 3000 tubes a day, ranging in size up to 20 inches. Both round and rectangular tubes will be produced . . . **TRANS-VUE CORPORATION** of Chicago has added 12,000 square feet of floor space to its manufacturing facilities to handle the increased demand for the company's television receivers . . . **MOTOROLA, INC.** is doubling the capacity of its Locust Avenue radio plant in Quincy, Illinois in order to free its Chicago plant for greater television production . . . **ADMIRAL CORPORATION** has purchased the 64,000 square foot *General Mills* plant in Bloomington, Illinois. —30—

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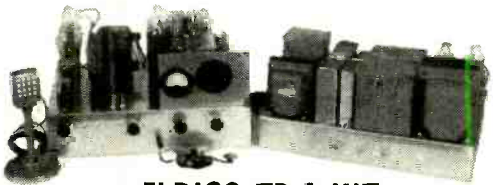

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(*Continued from page 58*)

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		GSD	11.750
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	Cebu	DYH2	6.140
	Colombo (Radio Ceylon—BBC Relay to Far East)		21.620
			17.730
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	Melbourne (RA-BBC Relay)	VLC4	15.320
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	Melbourne (ABC)	VLH3	9.580
	Perth (ABC)	VLW5	9.610
		VLX2	6.130
			4.897I
	Sydney (ABC)	VLI2	6.090
	Brisbane (ABC)	VLQ3	9.660
		VLM	4.917.
	(Via Pt. Moresby-ABC)	VLT5	7.280
	Wellington (BBC Relay)	ZL4	15.280
		ZL7	6.080
	Singapore (Radio Malaya, Blue Network)		9.712
	Georgetown (BBC Relay)	ZFY	5.984A
	Port-of-Spain (BBC Relay)	VP4RD	9.625
	Halifax	CHNX	6.130
(SATO)	Nairobi (BBC Relay)	VQ7LO	6.057
	Hong Kong (BBC Relay)	ZBW3	9.525V
	Kure (BFOS-BBC Relay)	WLKS	6.105
	Salzburg (BDN)		5.933V
	Salisbury (BBC Relay)	ZEA	6.000
	Los Angeles (AFRS-To Pacific)	KWIX	11.860
		KCBF	9.700
		KGEI	9.670
		KWID	9.570
		KCBA	6.120
0600A	Colon	HP5K	6.005
0610	Melbourne (RA)	VLC4	15.320
		VLA6	15.200
		VLG10	11.760
0615 (NSS-M)	Bangkok	HSG3	9.796A
		HS8PD	6.240A
(Daily)			
	Mafeking	ZNB	5.900
	Johannesburg (SABC)	IV	9.870
		V	4.373
(SATO)	Hong Kong	ZBW3	9.525V
	London (ES-Dictation Speed)	GWR	15.300
		GSE	11.860
		GWJ	9.525
0630	Singapore (Radio Malaya, Blue Network to Borneo and Sarawak)		9.712
			7.200V
			4.825I
			4.778I
	(Via Kuala Lumpur)		6.025
(NS)	Georgetown	ZFY	5.984A
(SO)	Salzburg (BDN)		9.533V
	Davao, Mindanao	DYB2	4.985A
(NS)	Sydney	CJCX	6.010
(NS)	Toronto	CFRX	6.070
0645 (I)	Makassar (Comment)	YDQ	9.554
		YDQ2	5.030
0655A	Djakarta (To Asia, Australia, NA)	YDC	15.150
		YDB2	4.910
0700	Karachi		11.770A
	Dacca (Karachi Relay)		7.635A
	Lahore (Karachi Relay)		6.075
	Tel-Aviv (Kol-Israel)		6.830A
			8.900A
	(Via Haifa)		8.170
	Singapore (BFEBS-BBC Relay to Far East)		15.300
			11.880
			9.690
			6.175
	Colombo (Radio Ceylon-BBC Relay to Far East)		21.620
			17.730
	Jogjakarta		5.058
(I)	Stockholm (Sweden To-day-To Europe)	SBT	15.155
		SBP	11.705
(NS)	Montreal	CBLX	15.090
(NS)	Sydney	CJCX	6.010
	Halifax	CHNX	6.130
(NS)	Toronto	CFRX	6.070
	Los Angeles (AFRS-To Pacific)	KWIX	11.860
		KCBF	9.700
		KGEI	9.670
		KCBA	6.120
	Tokyo (AFRS)	JKK	6.015
		JKL	4.860
	Port-of-Spain	VP4RD	9.625
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		GVT	21.750
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0715 (NS)	Helsinki	OIX5	17.800
		OIX4	15.190
	(To NA)	OIX2	9.555
		OIX1	6.120
	Melbourne (RA-To E. NA)	VLC7	11.810
	London (ES-Dictation Speed)	GVX	11.930
		GVU	11.770
		GWT	9.675
		GWO	9.625
		GRI	9.410
		GRJ	7.320
		GSW	7.230
		GWL	7.210
0730	Delhi (AIR)	VUD9	15.290
		VUD3	11.830
		VUD9	9.630
		VUD2	7.290
		VUD8	7.275
	Bombay (Delhi Relay)	VUB3	9.550
	Calcutta (Delhi Relay)	VUC3	9.530
		VUC2	7.210
	Madras (Delhi Relay)	VUM3	7.260
		VUM2	4.920
	Akashvani (AIR Relay)	VU7MC	6.026
	Georgetown (Caribbean News)	ZFY	5.984A
	Cebu	DYH2	6.140
(NS)	Toronto	CFRX	6.070
0745 (NS)	Manila	DUH5	11.840
		DUH4	9.620
		DUH2	6.170
	London (ES)	GVX	11.930
		GVU	11.770
		GRG	11.680
		GWT	9.675
		GWO	9.625
		GRI	9.410
		GRJ	7.320
		GSW	7.230
		GWL	7.210
0750	Berne (To S.E. Asia)	HER8	21.520
		HER6	15.305
		HER5	11.865
0800	London (GOS) (To NA)	GSK	26.100
		GST	21.550
		GSH	21.470
		GSV	17.810
		GSO	15.180
		GWG	15.110
		GVW	11.700
	Halifax	CHNX	6.130
	Sydney	CJCX	6.010
	Toronto	CFRX	6.070
	Melbourne (RA-To Forces, Asia, North Pacific)	VLG6	15.320
		VLA6	15.200
		VLB4	11.850
	Melbourne (ABC-BBC Relay)	VLH3	9.580
	Sydney (ABC)	VLI2	6.090
	Brisbane (ABC)	VLQ3	9.660
		VLM	4.917.5
	Perth (ABC)	VLW5	9.610
		VLX2	6.130
			4.897I
	(Via Pt. Moresby-ABC)	VLT5	7.280
	Koeta Radja, Sumatra (To S.E. Asia)		11.640
	Los Angeles (AFRS)	KWIX	11.860
		KCBF	9.700
		KGEI	9.670
		KCBA	6.120
	Toungoo, Burma		7.380A
	Malta (BFS)		11.782
(NS)	Manila	DZH3	9.505A
	Colombo (Radio Ceylon-BBC Relay to Far East)		21.620
			17.730
(I)	Jodhpur, Rajputana		3.775
0810	Melbourne (ABC)	VLH3	9.580
	Brisbane (ABC)	VLQ3	9.660
		VLM	4.917.5
0815	Melbourne (RA-To E. NA)	VLC7	11.810
	New York (VOA)		17.830
			15.350
	Davao, Mindanao	DYB2	4.985A
	Hong Kong (Delayed BBC Relay, Radio Newsreel)	ZBW3	9.525V
	Rangoon (?) (Forces Station)		7.170A
	Colon (Delayed Relay of VOA)	HP5K	6.005
0820 (NS)	Edmonton	VE9A1	9.540

(Continued on page 100)

(*Continued from page 98*)

0830	London	GVT	21.750
		GWC	15.070
		GRH	9.825
	Peking		10.260
	Hankow (Peking Relay)		9.740
	Nanking (Peking Relay)		9.730
	North Shensi (Peking Relay)		9.040 V
	North Shensi (Peking Relay)		7.500 A
	Harbin, Manchuria (Peking Relay)		7.100
	Chungking (?) (Peking Relay)		6.100 A
(NS)	Toronto	CFRX	6.070
	Delhi (AIR)	VUD5	17.840
		VUD11	15.190
(I)	Vienna via VOA Relay Station, Munich	DTSP	15.280
0835	London (To NA)	GST	21.550
0850	Colombo	ZOI	4.897 V
0900	London (Radio Newsreel)	GSK	26.100
		GSH	21.470
		GSV	17.810
		GSO	15.180
		GWG	15.110
		GSB	9.510
(NS)	Hong Kong (BBC Relay, Radio Newsreel)	ZBW3	9.525 V
	Saigon (Radio France Asie)	FZS4	11.780
	Singapore (Radio Malaya, Blue Network)		9.712
			7.200 V
	(Via Kuala Lumpur)		6.025
(M-F)	Lake Success (UN-Via CBC-Montreal)	CKRP	21.600
		CKNC	17.820
	Toronto	CFRX	6.070
	Edmonton	VE9AI	9.540
(NS)	Edmonton (CBC Relay)	VED	8.265
(NS)	Calgary	CFVP	6.030
(NS)	Montreal (CBC-Regional)	CBLX	15.090
(NS)	Manila	DUH5	11.840
		DUH4	9.620
		DUH2	6.170
(SMWF)	Manila	DZH2	9.640
	New York (VOA)	KGEX	11.730
		KNBX	9.600
		KWID	9.570
		KCBR	9.530
		KNBZ	6.185
		KNBI	6.060
	(Via Honolulu)	KRHK	11.790
		KRHO	9.650
	(Via Manila)	III	17.760
		II	15.330
		I	11.890
	Los Angeles (AFRS)	KWIX	11.860
		KCBF	9.700
		KGEI	9.670
		KCBA	6.120
0915	London	GRZ	21.640
		GSF	15.140
	Hong Kong (China News)	ZBW3	9.525 V
0930	Melbourne (RA-To Britain, Europe)	VLG6	15.320
		VLA6	15.200
		VLB4	11.850
	(To Central NA)	VLC7	11.810
	Singapore (BFEBS-Delayed BBC Relay, Radio Newsreel-To Far East)		15.300
			11.880
			9.690
			6.175
	Halifax	CHNX	6.130
(TO)	Akashvani	VU7MC	6.026
	Manila (UN News)	DUH5	11.840
		DUH4	9.620
		DUH2	6.170
0945 (M, Th Only)	Beirut (Radio Liban)		8.030 V
0950	Berne (To S. Asia)	HER7	17.784
		HER5	11.865
1000	Vatican City	HVJ	15.095
			11.740
			9.643 V
	Rangoon		6.035 (or) 6.070 A
(Tue)	Lusaka	ZQP	7.290
		ZQP	3.914
	Edmonton	VE9AI	9.540
	Edmonton (CBC Relay)	VED	8.265
(NS)	Calgary	CFVP	6.030
(NS)	Vancouver	CKFX	6.080
(SO)	Montreal (CBC-Regional)	CBLX	15.090
1003A	Djakarta (To Asia, W. NA)	YDF	6.045
1005V	Stockholm	SBT	15.155
		SDB2	10.780
1015	Karachi		11.770 A
	Dacca (Karachi Relay)		7.635
			9.645
	Lahore (Karachi Relay)		6.075
(NM or Th)	Beirut (Radio Liban)		8.030 V
1020V	Addis Ababa	ETB	15.032 V
		ETA	9.620
1025	Edmonton (CBX Relay)	VED	8.265
1030	Delhi (AIR-To W. Europe)	VUD5	15.290
		VUD11	11.850
	Delhi (AIR)	VUD9	11.790
		VUD4	9.630
		VUD8	7.275
		VUD10	7.225
		VUD7	6.190
		VUD3	6.010
		VUD2	3.495
	Bombay (Delhi Relay)	VUB3	7.240
		VUB2	4.840
	Calcutta (Delhi Relay)	VUC3	4.880
		VUC2	3.305
	Madras (Delhi Relay)	VUM3	7.260
		VUM2	4.920
	Srinagar, Kashmir (AIR Relay)		4.865
(TO)	Vatican City (To S. Asia and South Africa)	HVJ	17.445
	Melbourne (RA-to Africa)	VLG11	15.200
		VLA4	11.850
	(To W. NA)	VLC7	11.810
		VLB9	9.615
(NSS)	Vancouver	CKFX	6.080
1045	Athens		15.345
(I)	Munich (VOA)	I	15.280
(NS-I)	Addis Ababa	ETB	15.032 V
		ETA	9.620
	Brazzaville (To Far East)		11.972
	(To Africa)		9.973
	(To Near East)		9.440
	(To Africa)		6.024
1053A	Djakarta (To Asia, W. NA)	VDF	6.045
1055 (NM)	Edmonton	VE9AI	9.540
	Manila	DZH4	6.000
1100	London (GOS) (To NA)	GVS	21.710
		GST	21.550
		GSH	21.470
		GRA	17.715
		GSI	15.260
		GSO	15.180
		GWG	15.110
		GSN	11.820
		GSC	9.580
	Colombo (Radio Ceylon-BBC Relay to Far East)		21.620
			15.120
	Colombo (BBC Relay)	ZOI	4.897 V
	Singapore (BFEBS-BBC Relay to Far East)		15.300
			11.880
			9.690
			6.175
	Georgetown (BBC Relay)	ZFY	5.984 A
	Port-of-Spain (BBC Relay)	VP4RD	9.625
	Johannesburg (SABC-BBC Relay)	IV	9.870
		V	4.373
	Moscow (To Asia)		11.765
			9.689
	(Via Ashkabad)		6.179
(NS)	Lusaka	ZQP	7.290
		ZQP	3.914
	Salzburg (BDN)		9.533 V
	Vancouver	CKFX	6.080
	Manila	DZH3	9.505 A
	Cebu	DYH3	6.100
	Hilversum (To S. Asia)	PCJ	15.220
		PHI	11.730
	Nairobi (BBC Relay)	VQG1	4.855V
1115	Belgrade		6.100 A
	Port-of-Spain	VP4RD	9.625
	Sydney	CJCX	6.010
	New York (VOA-To Europe)	WNRX	21.730
		WLWS1	21.650
		WGEX	17.765
		WLWR1	15.250
	(Via Munich)	IV	7.250
	(Via BBC, London-ES)	GRU	11.770
		GRI	9.410
		GWL	7.210
1130 (SO)	Georgetown (Caribbean Review)	ZFY	5.984 A
	Halifax	CHNX	6.130
(NS)	Vancouver	CKFX	6.080
1145 (I)	Forest Side	V3USE	15.055 A
(T, Sat)	Lusaka	ZQP	7.290
		ZQP	3.914
1150	Berne (To Middle East)	HER5	11.865
		HEU3	9.665
(NSAT-S)	Toronto	CFRX	6.070
1200	St. Johns	CBNX	5.970
	Sydney	CJCX	6.010
	Halifax	CHNX	6.130
	Edmonton (BBC Relay)	VED	8.265
(NS)	Calgary	CFVP	6.030
(NS)	Vancouver	CKFX	6.080

(*Continued on page 102*)

(Continued from page 100)

	Montreal (CBC-	CKNC	17.820
	To Europe)	CKCS	15.320
	London	GST	21.550
	(To NA)		
	Johannesburg	IV	4.800
	(SABC)	V	4.373
	Mafeking	ZNB	5.900
	(SABC Relay)		
	Manila	DZH5	9.685
1215	London (GOS-	GVS	21.710
	Radio News-	GVR	21.675
	reel)	GSH	21.470
		GRA	17.715
		GWG	15.110
		GSN	11.820
		GWH	11.800
	Delhi (AIR)	VUD5	15.290
		VUD11	11.850
(NS)	Toronto	CFRX	6.070
1230V (FO)	Khartoum Radio		9.748
	Omdurman)		5.987
1230V	Hilversum (To	PHI	11.730
(NS)	Europe,	PCJ	9.590
	Africa)	PGD	6.026
1230A	Dublin (Radio		17.840
	Eirrean)		
1240V (I)	Stockholm	SBT	15.155
		SDB2	10.780
1245	Prague (To	OLR3A	9.550
	Europe)		
	New York	WNRX	21.730
	(VOA-To	WGEX	17.765
	Europe)	WRCA	15.150
	(Via Munich)	IV	7.250
		I	6.170
	London (ES-	GVX	11.930
	Dictation	GWO	9.625
	Speed)	GRJ	7.320
1245V (NS)	Accra	ZOY	4.915
1255 (SO)	Edmonton	VE9AI	9.540
1300	London (GOS)	GVS	21.710
		GVR	21.675
		GRA	17.715
		GSO	15.180
		GSF	15.140
		GWG	15.110
		GSD	11.750
		GSN	11.820
		GWH	11.800
		GSB	9.510
		GRW	6.150
	Malta (FBS-BBC		4.965
	Relay)		
	Nairobi (BBC	VQG1	4.855 V
	Relay)		
(SO)	Toronto	CFRX	6.070
	Winnipeg	CKRX	11.720
(NS)	Vancouver	CKFX	6.080
(NS, Th,	Edmonton	VE9AI	9.540
Sat)	Wellington	ZL4	15.280
	(BBC Relay)	ZL7	6.080
	Salisbury	ZEA	3.658
	(BBC Relay)		
1303V	Belize	ZIK2	10.599 A
1315	Nairobi (Local	VQG1	4.855 V
	News)		
	Vatican City	HVJ	11.740
			9.643 V
			5.969 A
	Salisbury	ZEA	
	(Local News)		
1325 (I)	Belize	ZIK2	10.599 A
	(Local News)		
1330	Winnipeg	CKRX	11.720
(NS)	Geneva (UN	HBQ	6.672
	Radio-To Europe)		
1335	London (To NA)	GSF	15.140
1337 (NS)	Stockholm	SBD2	10.780
	(To Europe)		
1345	Rome (To		11.810
	Sou. Afr.)		9.630
	Brazzaville (To NA)		17.837
	(To Europe)		11.972
	(To Middle East)		9.440
	Montreal	CKCS	15.320
	(CBC-To	CHOL	11.720
	Europe)		
1350A	Colombo (Radio		15.120
	Ceylon to AIR)		
1350	Berne (To	HER5	11.865
	Europe)	HEU3	9.665
1400	Teheran	EQC	9.660
	Damascus		11.750
			6.000
			5.005 A
	St. Johns	CBNX	5.970
	Winnipeg	CKRX	11.720
	Edmonton	VED	8.265
	(CBC Relay)		
	Vancouver	CKFX	6.080
(SO)	Salzburg (BDN)		9.533 V
(FO)	Athens	JJOY	8.010
	New York	WLWS1	21.650
	(VOA-To	WNBI	17.780
	Europe)	WCBN	15.270
		WRUS	11.790
	(Via Munich)	IV	7.250
	(Via BBC,	GRF	12.095
	London)	GWZ	7.200
		GRR	6.070
	Wellington	ZL4	15.280
	(BBC De-	ZL7	6.080
	layed Relay)		
	Dakar	FHE3	11.896
			3.435I
1415	New York	WGEX	17.765
	(AFRS-To	WBOS	15.210
	Europe)	WNRX	11.890
		WRCA	9.670
1430	Leopoldville	OTC2	9.768 A
	(To Europe)		
(NS)	Calgary	CFVP	6.030
(NS)	Edmonton	VE9AI	9.540
	Warsaw (Radio		6.220
	Polskie)		
	Sofia		7.671 A
	Moscow		7.340
			6.090
			6.000
(I)	Lake Success	WOOC	15.130
	(Un via	WNRI	11.770
	VOA)	WNRA	9.615
1440	Rome (To		11.810
	Europe)		9.630
1445	Ankara (To	TAP	9.465
	Europe)		
	Prague (To	OLR2A	6.010
	Europe)		
1500	London (GOS)	GVS	21.710
		GRA	17.715
		GSI	15.260
		GSO	15.180
		GWG	15.110
		GSD	11.750
		GRH	9.825
		GRY	9.600
		GSB	9.510
		GRW	6.150
	Georgetown	ZFY	5.984 A
	(BBC Relay)		
	Port-of-Spain	VP4RD	9.625
	(BBC Relay)		
	Wellington	ZL4	15.280
	(BBC Relay)	ZL7	6.080
	London (ES)	GWG	9.525
		GSU	7.260
	London (To	GSF	15.140
	NA)	GVW	11.700
	Bucharest (To		11.900
	Europe)		9.253
			6.200
			5.928
	Sydney	CJCX	6.010
	Winnipeg	CKRX	11.720
(SO)	Calgary	CFVP	6.030
(SO)	Edmonton	VE9AI	9.540
	Vancouver	CKFX	6.080
(NSAT)	Melbourne	VLG6	15.230
	(ABC)	VLH4	11.880
		VLR2	6.150
(NSAT)	Brisbane	VLQ3	9.660
	(ABC)	VLM	4.917.5
	Sydney (ABC)	VLI2	6.090
1509 (FO)	Buenos Aires	LRA5	17.720
		LRA1	9.690
1515	Madrid (RNE-		9.369 V
	To Europe)		
	Tiarana (To	ZAA	7.847
	Europe)		
1525V	Leopoldville	OTC2	9.768 A
	(To Europe)		
1530	Tel-Aviv (Kol-		6.830 A
	Israel)		8.900
	(Via Haifa)		8.170
(WO)	Boston	WRUX	17.755
	(WWBC-To	WRUL	15.350
	Europe)	WRUW	11.710
	Melbourne	VLC9	17.800
	(RA-To	VLA4	11.850
	Britain,	VLB2	9.650
	Europe)		
1545	Brazzaville (To NA)		17.837
	(To Europe)		11.972
	(To Africa)		9.987
	(To Middle East)		9.440
	Melbourne	VLG6	15.230
	(ABC)	VLH4	11.880
		VLR2	6.150
	Brisbane (ABC)	VLQ3	9.660
		VLM	4.917.5
	Sydney (ABC)	VL12	6.090
(NS)	(Via Pt.	VLT5	7.280
	Moresby-ABC)		
1550 (NS)	Salzburg (BDN)		9.533 V
1555	Brisbane	VLQ3	9.660
	(ABC)	VLM	4.917.5
1600	London (ES-	GRO	6.180
	Press Review)		
	Winnipeg	CKRX	11.720
(NSAT, S)	Toronto	CFRX	6.070
(NS)	Edmonton	VE9AI	9.540
	Vancouver	CKFX	6.080
(NSAT)	Melbourne	VLH4	11.880
	(BBC)		
	London (To NA)	GVW	11.700
1602	Kingston	ZQI	4.950
1610	Georgetown	ZFY	5.984 A
1615V	Budapest		9.834
			6.247
1630	Sofia		7.671 A
	Moscow (To Europe)		9.670
			7.340
			6.090
	St. Johns	CBNX	5.970
1645	Prague (To	OLR2A	6.010
	Europe)		
	London (ES)	GRO	6.180

(Continued on page 104)

OUTSTANDING VALUES NOW AVAILABLE

6-TUBE TWO BAND RADIO CHASSIS

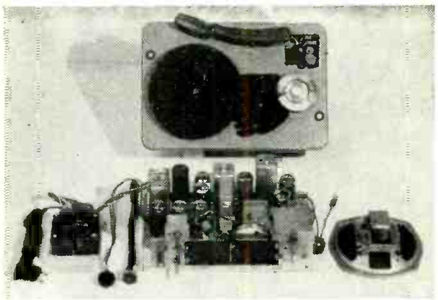
Completely Wired

Broadcast and shortwave with phono input. Dimensions: Length 10″, Width 6″, Overall Height 5¼″. 4 push-button operation. Tone control, volume control. Tubes: 2—14A7, 14Q7, 7C6, 35Y4, 50A5.

The perfect chassis for amateurs, experimenters, and for a fine performing set.

Complete—less tubes....... **$5.95**
Set of tubes for above..... **4.00**
Alnico V 6″ PM for above chassis............. **1.59**

RADIO AND WIRE RECORDER COMBINATION IN CHASSIS FORM



Standard make wire recording mechanism, including phono playback. 8-tube AC operated radio chassis with power supply. Alnico V 6″ PM Controls—tone control, volume control, band switch and tuning knob. Completely wired. Chassis includes recording and erasing and playback circuits to make complete wire recorder. Tubes: 1280, 14Q7, 7C6, 2—50A5, 2—35Y4. Dimensions: 11″ long, 6¼″ wide, 5¼″ overall depth.

This is just the unit you have been looking for, for your custom-built installation. This chassis is and will give big set performance. The wire recorder renders excellent reproduction, directly from the radio, directly from the phono, or from the mike.

Easy to assemble. Complete instructions supplied with each unit. Price, complete—less tubes.. **$35.00**
Set of tubes for above..... **5.50**

Limited Quantity Available—Order Now!

Above chassis less wire recording mechanism (can be purchased alone).
Price, less tubes, less power transformer.......... **$5.95**
With power transformer.......... **8.95**
Complete set of tubes.......... **5.50**

4-TUBE AMPLIFIER

Uses 2—35L6, 1—35Z5, 1—12SL7 in AC-DC Circuit. Separate tone and volume controls. With universal output transformer.... **$5.29**
Less tubes.................... **2.95**

2-TUBE AMPLIFIER

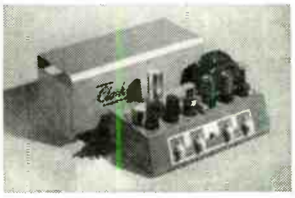
Uses 1—50L6, 1—35Z5. Includes volume control. Comes with universal output transformer. Compact in size.......................... **$3.61**
Less tubes...................... **2.29**

Famous CLARK AMPLIFIER KITS

18-Watt Kit

6 tubes: 1—6SQ7, 1—6SC7, 2—6V6, 1—6SN7, 1—5Y3GT. Mike and phono input. Separate Bass and Treble controls, Heavy steel chassis and cover.

Frequency response 50-17,000 CPS & 1DB. Output impedances 4-8-16-500. Hum level 65DB below rated output. Complete, with tubes............. **$18.95**



25-Watt Kit

6 tubes: 2—6SJ7, 2—6L6, 1—6SC7, 1—5Y3. 2 mike, 1 phono input. Separate bass and treble controls.

Output impedance 2-4-8-16-500 ohms. Frequency response 30-17000 CPS & 1DB.

Attractive heavy steel chassis and cover. Push pull phase inverter driver for hum level.

Complete, with tubes..... **$24.95**

Each kit comes complete with instruction sheet, schematic and parts list.

TUBES

(All Standard Brands)

6SK7GT, 6H6, 12H6, 39/44 — **29c**

1A3, 1L4, 1LN5, 3LF4, 6F6G, 6J7, 6K7G, 6V6G, 6X5GT, 7A7, 12A8GT, 12SJ7GT, 14R7, 35B5, 35Z4, 35Z5, 77 — **49c**

6C4, 6SA7GT, 6SH7, 6SQ7, 7B4, 12J5GT, 12SR7, 76, 12SH7 — **39c**

5U4G, 12SK7GT, 12SQ7GT, 6AU6, 6BA6, 6SJ7, 50L6 — **59c**

CONDENSER SPECIALS

Better Values Than Ever Before

20x30 mfd—150V
40 mfd/350V plug-in type
20 mfd/150v 50 mfd/35v
— **27c** each, 10 for $2.50

20 mfd/50V
20 mfd/25V
10 mfd/10V
— **19c** each, 10 for $1.75

25x25 mfd—150V—200 mfd/10V
30x30 mfd—150V—20 mfd/25V
40x20 mfd—450V common positive
40x20 mfd—150V—200 mfd/35V
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(Continued from page 102)

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	Europe)		
	(To E. NA)	VLA6	15.220
	(To Forces-	VLB11	15.160
	Japan, Asia, N.		
	Pacific)		
	(Via BFOS,	WLKS	6.105
	Kure)		
(NS)	Melbourne	VLG6	15.230
	(ABC)	VLH4	11.880
	Brisbane(ABC)	VLQ3	9.660
		VLM	4.917.5
	Perth (ABC)	VLW5	9.610
		VLX2	6.130
			4.897I
	Sydney (ABC)	VLI2	6.090
	(Via Pt.	VLT5	7.280
	Moresby-ABC)		
(MO)	Colon	HOLA	9.505
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(SO)	Toronto	CFRX	6.070
	Winnipeg	CKRX	11.720
(NS)	Edmonton	VE9AI	9.540
	Montreal	CHOL	11.720
	(CBC-To	CKLO	9.630
	Europe)		
(NSAT)	Melbourne	VLH4	11.880
	(ABC)		
	Sydney (ABC)	VLI2	6.090
1715	Brazzaville (To NA)		11.972
	(To Africa)		9.973
	(To Sou. America)		9.440
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	Sydney	CJCX	6.010
	Kingston	ZQI	4.950
(WO)	Georgetown	ZFY	5.984A
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	(VOA-To	WRUL	15.350
	Europe)	WCBA	15.270
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		WOOW	9.700
	(Via	IV	7.250
	Munich)	I	6.170
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	(Via Tangier)	I	7.220
(I)	New York)	WOOC	15.130
(I)		WNRI	11.710
(I)		WNRA	9.615
1725V (I)	Kingston	ZQI	4.950
1730	Athens		15.345
(Wkdays)			
	St. Johns	CBNX	5.970
(NS)	Vancouver	CKFX	6.080
	New York	WGEX	17.765
	(AFRS-To	WBOS	15.210
	Europe)	WNRX	11.890
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	Moscow		7.340
			6.090
			5.970A
	London (ES-	GRJ	7.320
	Press Review)	GSA	6.050
	Colon	HOLA	9.505
1733	Buenos Aires	LRS	11.880
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		HER5	11.865
		HER4	9.535
1745	Melbourne	VLC9	17.840
	(RA-To Sou.		
	America)		
	(To Britain,	VLG6	15.230
	Europe)		
	(To E. NA)	VLA6	15.220
	(To Forces-	VLB11	15.160
	Japan, Asia, N.		
	Pacific)		
	(Via BFOS,	WLKS	6.105
	Kure)		
(SATO)	Melbourne	VLH4	11.880
	(ABC)		
	Manila	DZH2	9.640
	London (ES)	GRJ	7.320
		GSA	6.050
1755	Halifax	CHNS	6.130
1800	London (GOS-	GWH	11.800
	News)	GSD	11.750
		GSC	9.580
	London (Radio	GRH	9.825
	Newsreel-To	GSB	9.510
	NA)	GSL	6.110
	Georgetown	ZFY	5.984A
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(SO)	Vancouver	CKFX	6.080
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	(VOA-To	KCBF	17.770
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	Honolulu)	KRHO	17.800
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		I	11.890
		III	9.530
(NSAT)	Manila	DUH5	11.840
		DUH4	9.620
		DUH2	6.170
	Manila	DZH3	9.505A
(NSAT)	Manila	DZH4	6.000
1810A	Madrid		9.369V
	(RNE-To Na)		
1815 (I)	Edmonton	VED	8.265

1825A	Moscow (To NA)		9.716
	(To Siberia)		9.630
	(To Siberia)		7.360
	(To Siberia)		7.310
			7.295
	(Via Komsomolsk)		15.230
			9.723
	(Via Kiev)		9.670
	(Via Petropavlovsk)		11.885
1830	Buenos Aires	LRS	11.880
	(SRI-To Europe)		
	Sydney	CJCX	6.010
(NS)	Toronto	CFRX	6.070
1840	Montreal	CHOL	11.720
	(CBC-To	CKLO	9.630
	Europe)		
1845	Saigon (Radio	FZS4	11.780
	France Asie)		
	Caracas	YV5RU	4.880
	Port-of-Spain	VP4RD	9.625
(M-Th)	Boston	WRUX	17.750
	(WWBC-To	WRUL	15.290
	Latin America)		
1900	Brazzaville		11.972
	(To Sou. Afr.)		
	(To Sou. America)		9.973
	(To NA)		9.440
	(To Africa)		6.024
	Prague		
	(To NA)	OLR4A	11.840
(NS)	Manila	DZH2	9.640
	London (Radio	GSD	11.750
	Newsreel)	GRH	9.825
		GSC	9.580
		GSB	9.510
		GRW	6.150
		GSL	6.110
	Stockholm (To	SDB2	10.780
	NA and	SBO	6.065
	Latin Amer.)		
	Vancouver	CKFX	6.080
	New York	II	15.330
	(VOA-De-	I	11.890
	layed Relay	III	9.530
	to Far East-		
	Via Manila)		
1925 (NS)	Helsinki	OIX5	17.800
	(To NA)		
1930	Buenos Aires	LRS	11.880
	(SRI-To Europe)		
	Delhi (AIR-To	VUD5	15.160
	Far East and	VUD11	11.850
	S. E. Asia)		
1932	Kingston	ZQI	3.480
1945	Paris (RDF-		9.680
	To NA)		9.550
	Georgetown	ZFY	5.984A
	(Argosy Newsletter)		
	Edmonton	VED	8.265
	(CBC Relay)		
1945A	Saigon (Radio	FZS4	11.780
	France Asie)		
2000	London (GOS)	GSD	11.750
		GRH	9.825
		GSC	9.580
		GSB	9.510
		GRW	6.180
		GSL	6.110
	Rome (To NA)		15.120
			11.810
	Port-of-Spain	VP4RD	9.625
	(BBC Relay)		
	Stockholm	SDB2	10.780
	(To NA and	SBO	6.065
	Latin America)		
(SO)	Vancouver	CKFX	6.080
(I)	Melbourne	VLR2	6.150
	(ABC)		
	New York	WABC	21.570
	(VOA-TO	KNBA	21.460
	Latin	WCBX	17.830
	America)	WLWK	17.800
		WNBI	17.780
		KWID	17.760
		WRUA	15.350
		WLWR2	15.330
		WCBN	15.270
		WRCA	15.210
		KNBI	15.130
		WRUL	11.790
		KCBR	11.770
		WLWR1	11.710
		WLWS2	9.700
		WNRX	9.670
		WGEO	9.530
		WLWO	6.080
2005A	Moscow (To NA)		9.716
	(To Siberia)		9.630
	(To Siberia)		9.600
	(To Siberia)		7.360
	(To Siberia)		7.310
			7.295
	(Via Komsomolsk)		15.230
			9.723
	(Via Kiev)		9.670
	(Via Petropavlovsk)		11.885
2022V	Buenos Aires	LRS	11.880
	(SRI-To Europe)		
2025 (NS)	Rangoon		9.543
2030	Colon (De-	HP5K	6.005
	layed Relay of VOA)		
2035A	Berne (To NA)	HER5	11.865
		HER4	9.535
		HER3	6.165

(Continued on page 106)

When is a dot not a dot?

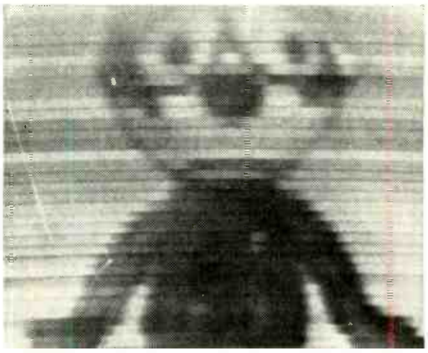
Look carefully at the pictures on this page, to see how television creates an image

•

No. 2 in a series outlining high points in television history

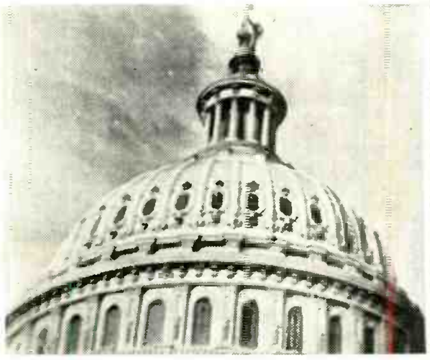
•

Photos from the historical collection of RCA



Felix the Cat was the "stand-in" when this 60-line image was made *mechanically* in tests at NBC's first experimental television station.

Improved definition is obvious to anyone in this *all-electronic* 120-line image of Felix—transmitted in the early days of NBC television.



By increasing the number of scanning lines to 441 lines in each picture frame, RCA scientists gave us a sharper, clearer television image.

And here you see the deep blacks, clear whites, and subtle halftones as transmitted by NBC with our present 525-line scanning system.

• As parlor magicians say: "The hand is quicker than the eye!" But modernize the statement so that it becomes: *Television magic is quicker than the eye*—and that's why you see a photographic image in motion . . . where actually there is only a series of moving dots!

To explain this to laymen, ask them to examine a newspaper picture through a magnifying glass.

Surprisingly, few people know that newspaper pictures are masses of tiny dots "mixed" by the eye to make an image. Even fewer know that the same principle creates a television picture . . . and, when picture after picture comes in rapid succession, the eye sees motion.

Devising a successful way to "scan" an image—to break it into dots which could be transmitted as electrical impulses—was one of television's first basic problems. Most of the methods dreamed up were *mechanical,* since electronics was then a baby science. You may remember some of the crude results transmitted mechanically.

Television as we now know it, brilliant images on home receivers, begins with the invention of the *iconoscope* tube by Dr. V. K. Zworykin of RCA Laboratories. First all-electronic "eye" of the television camera, this amazing tube scans an image—"sees" it even in very dim light—translates it into thousands of electrical impulses which are telecast, received, and re-created as sharp, clear pictures in black-and-white—on the phosphorescent screens of today's home television receivers.

And, just as the first flickering "30-line" pictures—produced mechanically—eventually became our present sharp 525-line images, so the iconoscope itself was improved until it became today's super-sensitive RCA image orthicon television camera. All-electronic, the image orthicon peers deep into shadows, needs only the light of a candle to see and transmit dramatic action.

But every single television development made by scientists at RCA Laboratories depends, in the end, on a basic physiological fact: When the human eye sees a series of swift-moving dots on a television screen, it automatically "mixes" them into a moving photographic image!

Radio Corporation of America

WORLD LEADER IN RADIO—FIRST IN TELEVISION

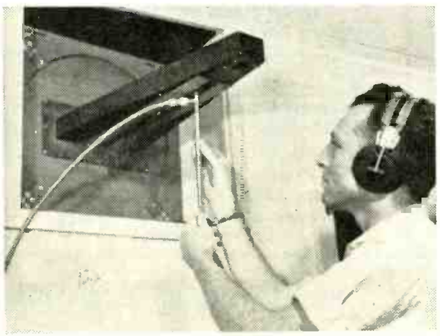
Antenna Laboratory
(*Continued from page 34*)

about 8000 mc. and 40 to 50 mw. for frequencies above this. Sensitivity of the simple receivers used in the models is quite low and, upon numerous occasions, the model simply cannot be placed at the required distance and still secure sufficient signal to record a pattern. The model tower must then be moved into the so-called "near zone" region and many hours spent in calculations and educated guesses in order to replot the pattern to some degree of accuracy. The uninitiated invariably suggest going to higher powered transmitters such as radar pulsed units. When such suggestor, however, ponders over the problem of building or purchasing the number of high power, room-size radars needed to cover the frequencies called for, he soon realizes that a fairly large warehouse would be needed to mount them for use.

Rejoining the antenna engineer it is found that his new antenna has successfully completed its preliminary radiation pattern tests. While mildly jubilant he must still subject his creation to an investigation to determine its response to cross-polarized signals. Also he must investigate what effect additional structures, such as wing mounted rockets or bombs, have on its pattern. The worried frown will remain on his brow for some time to come as he follows the antenna through the intricate maze of production decisions, cost analysis, and lastly the flight test which places the final stamp of approval on his work.

While emphasis has been placed on the aircraft antenna because of its present importance, it should be made clear that the laboratories of such institutions as Ohio State University are carrying on programs of investigation into many other aspects of the antenna problem. For example, in the study of land-based radio stations scientists must content themselves not only with dimensional perfection with regard to towers and buildings,

Fig. 11. View of "feed" end of large horn type antenna. Coaxial cable shown supplies v.h.f. energy to probe "feed" for the large horn type "illuminating" antenna. Microwatts are precious, and technician carefully adjusts the matching stub for the maximum obtainable signal.



but must also actually design the *soil* of these scale models to have proper conductivity at the higher model frequencies in order that it simulate the soil found in the region under study. The "guess and by-gosh" methods of the past in making costly antenna installations are slowly giving way to exact knowledge.

Last but by no means least, Naval research centers are engaged in measuring the radiation patterns of antennas mounted within the complex maze produced by a ship's masts, cables, and other marine structure. As might be expected, Naval antenna designers must take the sea into account when making their scaled-down ships for range tests. To an electromagnetic wave a ship resting upon the sea appears to have an exact mirror image *directly beneath it*. This can be duplicated on the Naval antenna model range by cutting a ship model off at its water line and resting it upon a large sheet of metal. In lieu of this, *two* ship models are constructed, sawed off at the water line, and one fastened upside down to the waterline of the other. The technique of making the actual radiation pattern measurements is identical to that described for aircraft. —30—

ONE MA. METER

By MILTON KALSHIAN

A 1 ma. meter is a very handy item, but unfortunately it is rather expensive and therefore most of us don't have as many of them as we could conceivably use.

Fortunately, most of the units that utilize the 1 ma. meter are rarely in operation at the same time. For example, the v.o.m., the f.s. meter, grid dip meter, modulation monitor, and the absorption frequency meter are all popular pieces of ham equipment which generally incorporate a 1 ma. meter, but seldom are these units used simultaneously.

This being the case, it is a very simple matter to use one meter in all these instruments. The answer to the problem is to make the meter "plug in." This is easily done by purchasing banana plugs that are tapped to take a 10-32 machine screw. Most manufacturers have standardized on this size and thread for the terminal posts on the meters. Next screw these plugs onto the meter terminal posts.

The equipment with which the meter is to be used should have a bracket installed several inches behind the front panel, the exact dimensions depending on the size of the meter used. The bracket should have two insulated banana jacks to match the banana plugs on the meter when the meter body is passed through the front panel meter cutout normally provided for mounting the meter. The mounting bracket should be placed behind the front panel in such a way that when the meter is plugged in the mounting flange of the meter case will be flush with the front panel.

The banana plugs provide enough tension to hold the meter securely in place, therefore mounting screws are unnecessary. Thus all one has to do is unplug the meter from one piece of equipment and plug it into another. —30—

Modern TV Receivers

(*Continued from page 52*)

wave which is locked to the station's horizontal line frequency. The negative peaks of this sine wave drive the grid of V_2 to cut-off, causing only a half-wave to appear in the plate circuit. This wave is differentiated by C_4 and L_2, producing alternate positive and negative pulses which are applied to the grid of the blocking oscillator. These positive pulses trigger the blocking oscillator, keeping it in synchronism with the incoming pulses. The saw-tooth deflection waveform is then developed in the plate circuit of the blocking oscillator by components C_5 and R_3.

The locked-in oscillator for television synchronization possesses one marked advantage over the a.f.c. systems previously discussed in that the synchronization actually becomes more stable as the signal becomes weaker. The stability of this circuit lies chiefly in the "Q" of the resonant circuit (R_2, L_1, C_2, and C_3) of the locked-in oscillator. Now, every tuning circuit functions as a bandpass filter, accepting a small range of frequencies and rejecting all other frequencies. The higher the "Q" of the tuned circuit, the greater its power of discrimination—in this instance, against noise pulses other than the proper horizontal synchronizing pulses.

A logical assumption, then, would be to make the "Q" of the circuits as high as possible. There is one difficulty, however. The sync pulses transmitted by the broadcast station are not absolutely fixed in frequency but possess a certain frequency variation. If the resonant circuit selectivity is made too high, two things will happen. First, if the sync pulses should drift in frequency too far from that of the resonant circuit, sync control will be lost. Second, even if sync control is maintained, slight frequency variations in the sync pulses will cause a phase shift in the generated sine wave. Since the triggering pulses are derived from the generated sine waves, they, too, will shift, producing a horizontal shifting of the television picture.

As a compromise, the "Q" of the resonant circuit is kept somewhere between 10 and 30, depending upon the value of R_2 in Fig. 6. Since the diode, V_1, shunts R_2, it, too, will affect the "Q" of the resonant tuning circuit. When the signal received is strong, the current through the diode is high, the diode resistance is low and the "Q" of the locked-in tank circuit is lowered. On the other hand, when the signal strength is low, the current passing through the diode is low and the diode plate resistance is high. This reduces the diode shunting effect, enabling the "Q" of the tuned circuit to be higher.

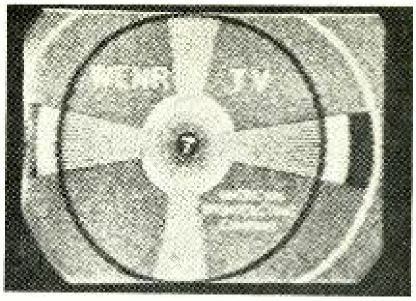
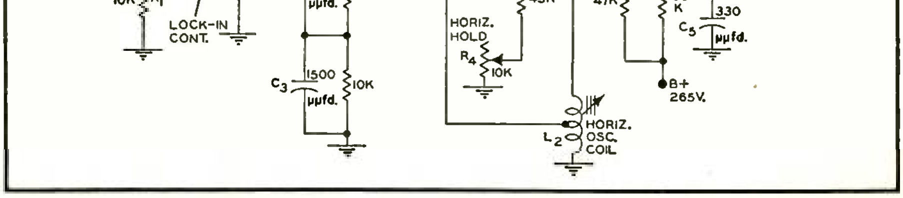


Fig. 7. Appearance of a picture under weak signal conditions in a set not possessing an automatic frequency control.

When the circuit was first designed, R_2 was given a value of 470 ohms. This value was satisfactory whenever the station sync pulse frequency was maintained within the limits established by the FCC. In some areas, however, it was soon dicovered that the station was not adhering to FCC regulations and a higher valued resistor (lowering the "Q" of the circuit) was required. Hence, the indicated value of 1500 ohms in Fig. 6.

There are three adjustments in this circuit: A lock-in control and two frequency controls. The iron core in L_2 can be considered as a rough tuning adjustment whereas R_4 is a fine tuning control. This is the horizontal hold control positioned on the front panel. The third control, labeled lock-in control, is a screwdriver adjustment on the rear of the chassis. It governs the lock-in range of the horizontal sync system and requires adjustment only if the picture does not remain locked in over the entire range of the horizontal hold control. With normal contrast and the hold control in mid-position, the lock-in coil at the rear of the chassis should be adjusted until the

Fig. 6. A locked-in oscillator circuit for television synchronization.



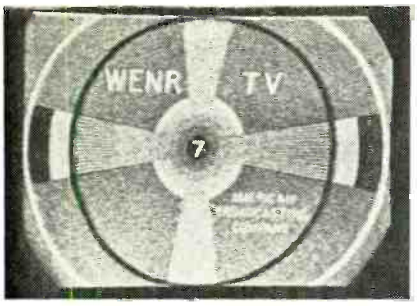


Fig. 8. Same picture as Fig. 7 only in a set using a locked-in oscillator circuit.

picture remains in sync throughout the entire range of the horizontal hold control. However, it is permissible for tearing of the picture to occur at the extreme end of the hold control.

Figs. 7 and 8 show the effect of the locked-in oscillator on a picture being received under weak signal conditions. Fig. 7 was obtained when the set used the incoming sync pulses to trigger the horizontal sweep oscillator directly. Note the improvement in Fig. 8 when the locked-in oscillator was employed. Sync jitter is gone and the readability of the small letters has improved markedly.

The author is indebted to Kurt Schlesinger, who developed this circuit, for an interesting discussion on the properties of this oscillator under various conditions. Figs. 7 and 8 were also furnished by Mr. Schlesinger and are being used with his permission.

(To be continued)

Electronic Organ

(*Continued from page* 43)

ferent tubes and parts and circuits. Probably I have given the reader some ideas which he can combine with some of his own to produce something very different and better. I know I shall rebuild this entirely and immediately. I have drawn the plans of a complete organ that can be used independently of the piano. One on which you may play chords or any piece of music, using all the fingers of both hands. That will make a very expensive and elaborate instrument. I plan on cutting the cost a little by using surplus parts on hand. That is the way of the ham—always trying to make everything better. Very often we succeed by making it worse!

The best transformer to use is the one from the BC-456. Terminal No. 2 goes to grid, No. 1 to ground, No. 3 to plate, and No. 4 to "B plus."

The small single plate to push-pull grid transformer made by *Stancor*, as their type A-53C, will work just as well but is more expensive than the surplus units.

If the *Stancor* unit is used, the green lead goes to grid, the yellow to ground, the red to plate, and the blue to "B plus." This transformer is light and small and will make a small and neat assembly, reducing the over-all space required. —30—

Recording Amplifier

(Continued from page 63)

The three-inch speed is capable of handling a frequency range of up to four thousand cycles, approximately the equivalent of a small table model radio, and is useful for dictation or recording of non-musical radio programs. The seven-inch speed provides reproduction to about eight thousand c.p.s. and is useful for general purpose, medium quality recording, such as musical programs, dance bands, voice, and copying prized disc recordings to tape, as well as other applications. The fifteen-inch speed is useful for full-range reproduction up to 15 kc. and may be used in radio broadcast or master recording for copying onto 7" speed tape or disc.

A number of interesting opportunities are open to the constructor who builds his own system. One of these is the use of simultaneous, dual-track recording, either for binaural reproduction or with a second track for control purposes, such as volume expansion. A number of half-track heads are now on the market and may be adapted for this purpose by using two heads in conjunction with a permanent magnet erase system.

Another application is to use the playback mechanism as a signal generator by running a small, endless belt of tape through the machine. This has the advantage that a number of loops with sine or complex waves may be kept for convenient use. Likewise, a simple sweep frequency audio signal generator might be made in this fashion, the rate of sweep being determined by the tape speed and length of the loop.

For advertising, or other purposes, it may be possible to run a loop of tape the length of the room thus continually reproducing a message of a minute or two duration which could be turned on or off by some external mechanism, such as a photocell or capacity relay. A similar arrangement is to set the machine to "recording" and place a separate pickup head and amplifier some distance down the tape to allow the person talking to hear his own voice, as if an echo. It is possible that the same principle might be applied to difficult public address locations, either to reduce feedback or to synchronize widely separated loudspeakers acoustically.

For the professional or semi-professional recording engineer, a good tape recorder capable of fifteen-inch speed should provide a convenient means for making high quality recordings of bands, orchestras, vocal groups, and other events in which it would be inconvenient for the performing group to use a regular recording studio. In cases where only a limited number of individuals desire copies of a particular piece of music, the master tape may be re-

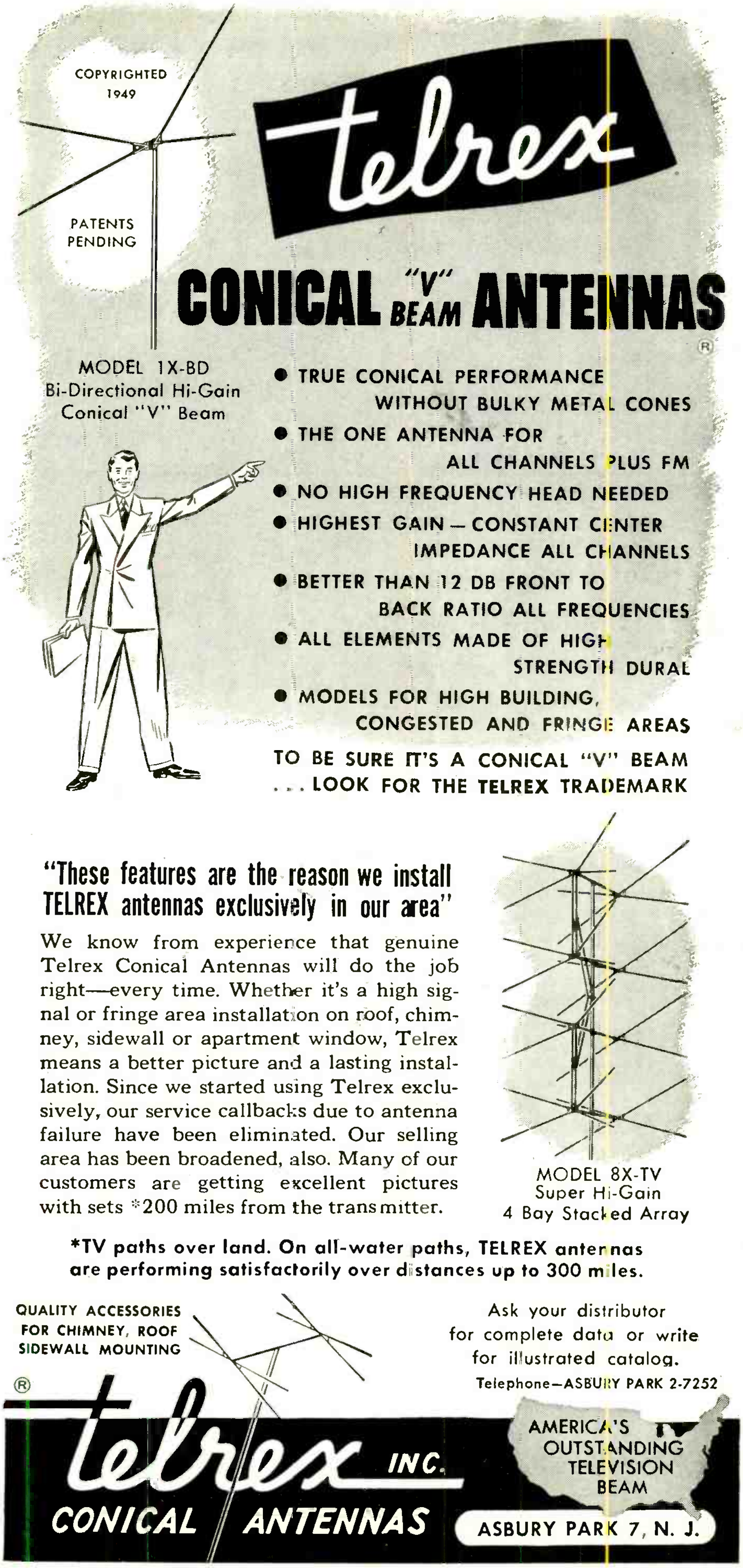
recorded as often as desired on conventional discs or seven-inch tape. The ability to obtain excellent results with a comparatively light weight tape recorder seems to indicate a much wider market for recordings among individual members of dance bands, high school and college groups, and other musical associations.

From a personal standpoint, tape is even cheaper than the new LP records if twin-track operation is used at seven-and-one-half inches per second. The long playing feature is retained and the additional advantages of low noise level, excellent transient response, and freedom from dust, needle wear, and turntable rumble, and eventual reuse, if desired, are included. In building up a tape library a number of factors may be considered. Reels which are to be kept should be clearly marked to avoid accidental erasure, while separate selections on the reel may be easily identified by means of colored crayon marks on the back of the tape. Reels should be stored where they will not be subjected to high temperatures.

Program material may be obtained by re-recording rare discs from your own collection or that of friends, or by recording radio, particularly live FM, broadcasts. First hand recordings of community musicians and concerts often provide an excellent source of material and in some instances are definitely preferred to conventional recordings of well-known artists. In addition, at least one company, the *Amplifier Corp. of America*, has released a catalogue of various selections on tape, with the likelihood that others may follow suit.

In conclusion, a few notes on microphone technique might be advisable. Due to the fact that there is no physical inertia in the tape recording mechanism and no adjacent grooves to overcut, it is possible to record percussion instruments with excellent brilliance and clarity. As a result it is not necessary to place the microphone away from these instruments and the experimenter may indulge his taste for good, heavy bass drum or crashing cymbals. In order to provide the excellent detail that a tape system is capable of recording, a crystal microphone is specifically recommended as an excellent means of picking up transients and low level sounds, and, with a good operating recording and playback system, provides a smooth, clear, approximation of the original sound.

However, as listening tastes may vary greatly with the individual, some constructors may prefer the less brilliant reproduction of a dynamic microphone. Similarly, no specific equalization circuits were included in the amplifier schematic, other than a simple tone control, as proper equalization will depend upon the associated equipment used as well as the constructors' tastes. —30—



Mini-Rack Transmitter
(Continued from page 47)

is no necessity for extreme isolation between the input and output circuits. For this reason, a less expensive 6V6GT may be substituted in the buffer stage without appreciable loss in efficiency. With either tube, plenty of output is obtained to drive the final amplifier for plate modulated phone operation on ten meters.

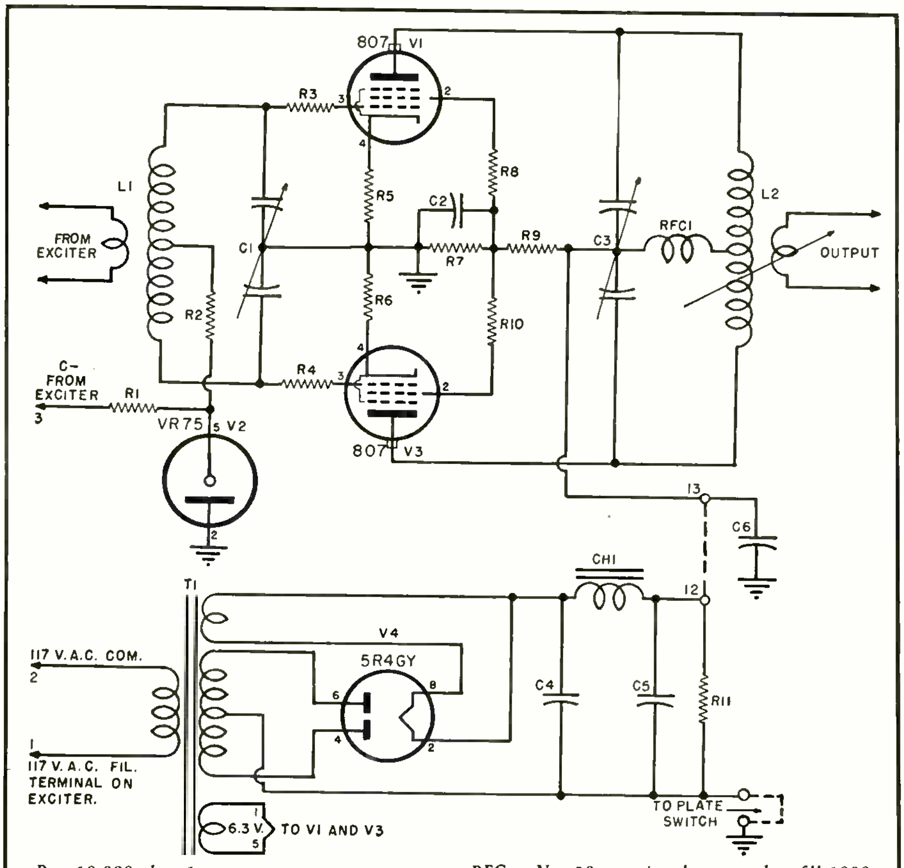
The construction of the push-pull 807 stage is evident from the photographs. Only a single baffle shield is used between the grid and plate circuits, but the axis of the grid coil is at right angles to the plate coil axis to minimize electromagnetic coupling between them.

Either a VR75 or a VR90 may be used for the bias voltage regulator although a VR90 adheres a little closer to the published recommended operating condition for phone. At either bias voltage the key-up plate current is zero. Following standard practice for 807's, parasitic suppressing resistors are used in grid, screen, and cathode leads.

It is sometimes found that it is impossible to load an amplifier up to rated power input with commercial "swinging link" coils, even with the link fully meshed with the tank coil. This condition indicates that the loaded tank circuit "Q" is too low. Since the loaded tank "Q" is directly proportional to tuning capacity, the remedy is a decrease in the *L/C* ratio. It was found necessary to short out two turns on each end of the *Bud* 40 meter plate coil to secure proper loading. A "Q"-meter test of the coil showed that the unloaded "Q" was only slightly reduced by the shorted turns so the tank efficiency is reduced by this measure by only a negligible amount.

The power supply for the final amplifier is inexpensive and constructed using a widely available power transformer. A single 5R4GY rectifier will deliver the 200 ma. output without difficulty. Mercury vapor rectifiers have been avoided because of the "hash" they usually radiate to the receiver. With a somewhat larger-than-necessary (300 ma.) filter choke which happened to be available, the power supply output voltage is 600 volts at a load of 200 ma. Switches were omitted from the power supply since a sepa-

Schematic diagram of the 100 watt final amplifier unit.



R_1—10,000 ohm, 1 w. res.
R_2—220 ohm, 1/2 w. res.
R_3, R_4—22 ohm, 1/2 w. res.
R_5, R_6—10 ohm, 1 w. res.
R_7—30,000 ohm, 10 w. wirewound res.
R_8, R_{10}—68 ohm, 1/2 w. res.
R_9—15,000 ohm, 10 w. wirewound res.
R_{11}—50,000 ohm, 10 w. wirewound res.
C_1—100 μμfd. (per sec.) split stator var. cond.
C_2, C_6—.005 μfd. mica cond.
C_3—170 μμfd. (per sec.) split stator var. cond.
C_4, C_5—4 μfd., 1000 v. cond.
RFC_1—No. 30 en. wire closewound to fill 1000 ohm, 1 w. res.
CH_1—10 hy., 200-300 ma. filter choke
L_1—50 w. adj. link plug-in coil (Bud Type OLS)
L_2—150 w. swinging link plug-in coil (Bud Type RLS)
T_1—Power trans., 600-0-600 v. @ 200 ma.; 5 v. @ 3 amp.; 6.3 v. @ 4 amp. (Stancor P-6170)
V_1, V_3—807 tube
V_2—VR75 tube *V_4—5R4GY tube*

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"K" BAND MIXER $49.50
"K" BAND FEEDBACK TO PARABOLA HORN with pressurized window $30.00
MITRED ELBOW cover to cover $4.00
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3J31 "K" BAND MAGNETRON $55.00

TEST EQUIPMENT

MODEL TS-268/U

Test set designed to provide a means of rapid checking of crystal diodes IN21, IN21A, IN21B, IN23, N23A, IN23B. Operates on 1½ volt dry cell battery 3x6x7. New $35.00

CRYSTAL DIODES

No.	Each	2 for	10 for
IN21	$1.00	$1.79	$ 8.30
IN22	1.50	2.79	14.00
IN23	1.50	2.79	14.00
IN26	3.00	5.90	27.50

10CM ECHO BOX CABV 14ABA-1 or OBU-3 2890 MC to 3170 MCS direct reading micrometer head. Ring prediction scale plus 9% to minus 9%. Type "N" input Resonance indicator meter. New and Comp. w/access. Box and 10 CM Directional Coupler $350.00

3 CM RECEIVER. SO-3 Complete with W.G. Mixer Assy. (723-A/B). Reg. Fil. Power Supply. 6 stages IF (6AC7) $99.50

10 cm. horn assembly consisting of two 5" dishes with dipoles feeding single type "N" output. Includes UG28/U type "N" "T" junction and type "N" pickup probe. Mfg. cable. New $15.50

10 cm. cavity type wavemeters 6" deep 6½" in diameter. Coax. output. Silver plated .... ea. $64.50

10 cm. echo box. Part of SFI Radar W/115 volt DC tuning motor. Sub. Sig. 1118AO $47.50

THERMISTOR BRIDGE: Power meter 1-203-A. 10 cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case. $72.50

W.E. I 138. Signal generator. 2700 to 2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input reg. Pwr. supply. With circuit diagram $150.00

3 cm. wavemeter. Ordnance type micrometer head. New: Absorption type $85.00

9000-9500 MCS Transmission type $92.50

SL wavemeter. Type CW60ABM $125.00

TS 89/AP Voltage Divider. Ranges 100: 1/2 for 2000 to 2000v. 10:1 for 200 to 2000v. Input Z 2000 ohms. Output Z 4 meg. ohms. flat response 150 cy to 5 meg. cy $42.50

AS14A/AP—10 cm. Pick up Dipole with "N" Cables $4.50

TS235 UP Dummy Load $87.50

10 cm. Wavemeter. WE type B435490 Transmission type. Type N Fittings. Veeder Root Micrometer dial, Gold Plated W/Calib. Chart. P/o Freq. Meter X66404A. New $99.50

WAVEGUIDE

½" x ¼" ID .... $1.00 per foot
1" x ½" OD .... 1.50 per foot
⅝" x 1¼" OD .... 1.65 per foot
⅝" x 1¼" OD Aluminum .... .75 per foot
1½" x 3" OD .... 3.00 per foot
2½" x 3" OD .... 3.50 per foot
1" x ½" OD Flexible .... 4.00 per foot
⅞" rigid coax ¼" IC .... 1.20 per foot
(Available in 10 ft. to 15 ft. lengths or smaller.)
UG 65/U 10CM flanges .... $6.75 each
UG 53/U Cover .... 4.00 each
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8 Tubes: 1—3BP1, 2—6SN7, 2—6H6, 1—6C6, 1—2X2 and 6X5. Good deal for conversion. For use as Test Scope. We tried it and it worked by using 50 watt Bulb and the marker pips went up. Excellent cond. Originally $75.00 .... **$21.50**

SCR-522 VHF XMTR-RCVR

10-tube, xtal controlled rcvr. 7-tube xmtr. Makes ideal 2-meter, 2-way mobile rig. 100-156 mc. w/ tubes. Price **$34.95**

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AN/PRSI for locating metal, pipes, gold, treasure, etc. **$12.74**
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30 Watt Transmitter with crystal oscillator control on four pre-selected channels—also master oscillator. Frequency coverage 2000 KC. to 5250 KC. by use of three plug-in coils. Five tube operation. 801 oscillator. 801 power amplifier two 46 modulators, and one 46 special amplifier. Price with TU18 Tuning Unit. 3—4.5MC or 3.5—5.2 MC. $23.95

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926C, 926—16, 926—B1, 926—B2, 926—B8, 926B—16, 926A—14, 926C—19, 926A, 926—C1, 926—A11
928—C15, 928—C13, 926B
13c ea.
100 for $12.00
1000 for 10c ea.

SCR 183 REC. TUNING UNITS

D—Range 850-1330 Kc
E—Range 1330-2040 Kc
F—Range 2.04-3 Mc
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H—Range 4-6 Mc
K—Range 9.05-13.5 Mc
Dual Range 400-600 Kc 6-9 Mc
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1-1.2 Mc $1.49
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FT 232A For 274N Trans
FT 229A For 274N, BC442
FT 225A For 274N, BC456
MT 62 For ARC/5, ARR2
MT 78/ARC5 Control Unit
MT 85/ARC5 Junction Box
FT 141 6⅜x4⅜
MT 80/ARC5 Junction Box
FT 282A P/o SCR 518A
FT 308A P/o PE119A
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C714 3.2-42Mmf.
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Write for Other Values

ARC 3 complete Audio Modulation XFMR pkg. T103 Carbon Mike to Grid .... $ .95
T102 6J5 to PP 6L6 Grids (Modulation) 1.15
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COMPLETE KIT OF THREE **$2.98**

SUPER PRO EQUIPT.

1st and 2nd RF 10-20 MC Coil PT-SA111. — RF ANT OTPT 2.5-5 MC Coil SA-116.—ANT INPT 200-400 KC Coil SA161.—ANT INPT 200-400 KC SA 48.—HI FREQ OSC 2.5-5MC Coil SA118.—ANT OTPT 10-20 MC Coil SA110.
Price Each **65c**

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1800-2250KC
P/o Collins 32RA Plug in 59c

VARIABLE CERAMICONS

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400-520	20c
10-160	20c
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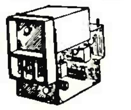
Set of 6	$1.00

T.V. Transformer, 7" or 9" scope, 3000v / 5 MA, 720 vct / 200 MA, 6.4 / 8.7A, 6.4 / .6A, 5 / 3A, 1.25 / .3A.
New, Pr. **$4.95**



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Heineman Ckt Bkrs. For AC-DC Operation. Amperes .010, 3, 7, 50, 80, 100, 150, 180. Ea. $1.45
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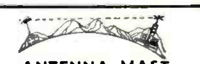
Dual 8 & 25 Amp $2.49



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34"	65"
190"	52"
260"	29"
186"	13"
77"	103"
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Many Others

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0-5MA Sq. 2" Metal Case 98c
0-500MA Sq. 3" Bake Case $2.95

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Mfd	Price
200V	
1	$0.15
400V	
.5	.18
2	.20
4	.30
600V	
.1	.12
.25	.20
.5	.20
1	.25
2	.28
4	.45
1000V	
.1	.20
.25	.28
.5	.30
1	.35
2	.50

TELEV. TRANS.

2300V 4MA, 2.5/2A $6.49
1080VCT 55MA, 6.3 / 1.2, 6.3 / 1.2 .... $5.95

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Dual
10HY 250MA 3.50
20HY 300MA 6.95
6HY 150MA .99
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8.5HY 125MA 1.29
Many Others

TELEVISION CONDENSER

Mfd	Volt	Price
5000	1.5	$1.20
1000	3V	.85
500	6V	.45
2000	6V	1.35
225	15	.30
800	15	.98
1000	15	.85
500	50	.95
6000	12	1.35
9000	12	2.00

Write for Flyer of 100,000 New Electrolytics in Stock.

Electric Motor

115V 60Cy 3500 RPM 3¼x2x1⅝ ¾" L Shaft
$1.95 Each

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Complete. No batteries req. brand new. Leather case. Waterproof w/ ringing CK; operation more than 27 miles. Pair: 2 Phones **$37.50**

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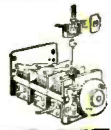


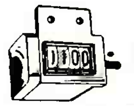
High Grade Unit. Consists of 3 Gang Capacitor. 20 mmf per sect. Ceramic ins. Low drift w/Worm Gear (reduction) 120:1 w/ext. Shaft and Veeder 4 digit Counter. $3.95

ROTARY BEAM COUPLER

RF Coupler 360° rotation 1 turn coupling link. Easily adpt 200 to 300 Mc. Plastic case mount on side. Price **$2.95**

Hi Gain Dynamic Mike Xfmr

Comb hi-gain DynMikeXfmr UTC/Super Elec 3wdg,600ohm CT&4000ohms Tapped 250x150 ohms. Fully Shielded H'sld. Price Each **49c**

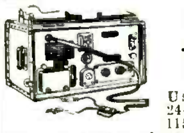


VEEDER COUNTER

Counts to 9999 and repeats. Many uses. ¼" shaft front meas. 1" x 1¼". Price 98c.

Soldering Iron 200W

121-130V iron ⅝" removable copper tip. Heats in a minute. Complete with cord & plug. New with stand $3.95



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Uses 6-2-24-115V DC. 115-230VAC. Can use hookup of over 20 students. Contains 10 keys, speaker, blinker, freq control, etc., in fiber trunk 17"x13"x10½". New. Price **$29.50**

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80 MTR Bar Prong 100 w $1.19
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#1735 2-3.5 MC. 300w Var. Link $1.49
#C390 5-7 MC. 300w Fix. Link $1.19
160 MTR Bar Type 100w $1.19

UHF ANTENNA

12"/30cm AT5/ARR1 Convertible Citizen's Band Threaded Coax Term Insulated Silv Pl Cont w waterproof gask flange & hardware for MOBILE mtg BRAND NEW 39c; 4 $1.00
PL259 for Above 23c
ANT AN130B Spring Swiveled Whip. 33" lg. SPECIAL 93c

SELSYN MOTORS

115 V.A.C. 60 cycle No. C-78248. Can be used to turn small antennas or as indicators. Size 3½" x 5½". Price per pair **$6.95**

MOSSMAN Switch. 4PST N.O. and N.C. **$1.10**

OIL CONDENSERS FAMOUS MAKES BRAND NEW

Mfd.	Volt	Price
15	220AC	$ 2.20
.5.5	400	.50
1	600	.45
6	600	.98
7	600	1.05
.5	750AC	1.69
7	800	1.20
.5	1K	.69
1.5	1K	.75
2	1K	.99
4	1K	.98
10	1K	1.95
15	1K	2.20
.25	1.5K	1.05
1	1.5K	.89
1.5	1.5K	.95
2	1.5K	1.05
6	1.5K	2.25
.1	2K	.98
.1	2.5K	1.20
.15	4K	2.95
.1.1	4.8K	2.95
.4	5K	2.95
.1	6K	2.79
.15.15	6K	3.95
1.5	6K	9.75
.1.1	7K	3.39
.1	7.5K	2.95
1	7.5K	12.95
.15.15	8K	4.95
.1	10K	14.95
.0016	15K	7.95
1	15K	30.95
.015	16K	6.95
.25	20K	16.95
.5	25K	36.95
1	25K	83.95
4	50	.29
1	100	.15
2.5	100	.23
	200VDC	
2x.1	2ST	.15
2x.1	3TT	.15
2x1	4ST	.16
2	2ST	.20
.5	2TT	.15
.5	2ST	.15
	400VDC	
2x.25	3ST	.21
2x.1	3ST	.21
2x.1	2TT	.20
3x.1	3ST	.25
.1	2TT	.19
.5	1TT	.19
1	2ST	.23
2	2ST	.26
	600VDC	
.1	2BT	.20
.1	2ST	.21
2x.1	3ST	.27
2x.1	3BT	.25
2x.1	2ST	.26
3x.1	ST	.25
2x.25	3ST	.23
.25	2TT	.20
1	2ST	.30
2x1	3ST	.35
2	2ST	.40
2	2BT	.39
	1000VDC	
1	2ST	.45

MANY OTHERS

MICA CONDSRS

600VDC	
.027	$0.92
1000VDCT	
.0015	.36
.0175	.45
.00005	.59
.00137	.98
1200VDCT	
.000075	.59
.00027	.59
2000VDCT	
.00003	.98
.01	1.64
2500VDCT	
.00025	.36
.006	1.38
.005	1.00
.000047	.39
.005	.79
.00051	.39
.00005	.54
3000VDCT	
.00007	1.59
.0004	1.25
.002	1.60
5000VDCT	
.0035	.98
.006	1.65
.00015	2.70
.0043	.98
.0002	2.70
.0008	2.70
.0004	2.70
.00075	2.70
.005	2.50

RF CHOKES

1MHY/125MA $0.23
1.9-2MHY .... .10
2.5MHY/500MA .... .89
3.2MHY .... .10
3.3MICHY .... .10
3.65MHY .... .10
5.2MHY/200MA .... .39
5.5MHY .... .98
500MA .... .98
6.4MHY .... .10
10MHY/350MA .... .39
20MHY .... .18
94MHY .... .10
115MHY/150MA .... .39
MANY OTHERS

COMMUNICATIONS EQUIPMENT COMPANY
CABLE ADDRESS: COMSUPO
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RADAR TELEVISION ELECTRONICS
FM MICROWAVE RADIO SONAR
C.E.C. MONEY BACK GUARANTEE, $3 MIN. ORDER.
F.O.B. N.Y.C. SEND MONEY ORDER OR CHECK, ONLY SHIPPING CHARGES SENT C.O.D.

rate switching panel is built into the operating table. The final power supply is switched on and off with the transmitter filaments. Since the bias voltage is applied instantly, the power supply remains unloaded (except for the bleeder) until the key is pressed. A switch should be used in either the "B plus" or "B minus" lead of the final power supply to turn the final amplifier off when zero-beating the exciter on another signal. —30—

CLAMP-ON HOLDER

By ARTHUR TRAUFFER

HERE is a handy and easily made accessory for your mike that allows the unit to be clamped onto an object, or held in your hand.

Buy a photolamp clamp (these can be bought separately in many photo shops and electrical supply houses) and saw off the ball, as shown in the sketch Fig. 1A. Now, remove the coil spring from the male half of a mike cord connector, and solder the connector securely to the top of the clamp, as shown

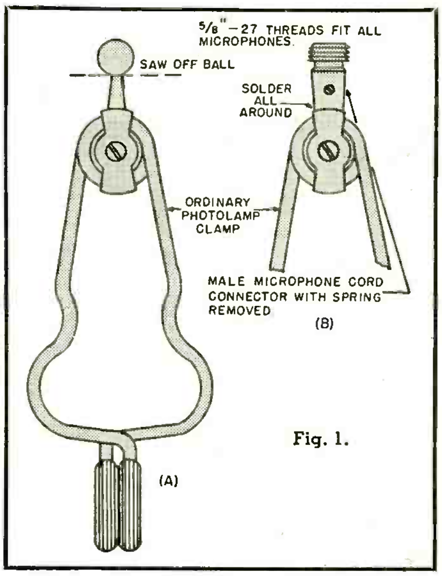


Fig. 1.

in the sketch of Fig. 1B. Now you can screw your mike head onto the clamp and clamp the mike most anywhere.

The clamp can also be held in the hand when desired, yet the clamp screws off easily when you want to put the mike head on a floor stand. Fortunately, the male mike cord connector has a standard 5/8-27 thread that fits all microphones. —30—

Microphone "clipped" to chair back by means of the removable clamp-on holder assembly.

NEW TV PRODUCTS On The Market

19-INCH CONSOLE

Garod Electronics Corporation of 70 Washington Street, Brooklyn 1, New York is in production on a 19-inch

television console, "The Claridge," which provides a 203 square inch direct view screen.

Designated the Model 1900, the new console is housed in a hand-rubbed mahogany cabinet which measures 25 inches wide, 45 inches high, and 22 inches deep. The new *Garod* "Picture-Lock" tuner has been incorporated in this set.

EMERSON CONSOLE

Delivery is under way on the new 12½ inch television console, Model 647, according to word received from *Emerson Radio & Phonograph Corporation* of 111 Eighth Ave., New York 11.

Among the new features of this set is the super-powered circuit for providing satisfactory reception even in fringe areas. The receiver is equipped with a built-in antenna designed for maximum performance in most localities without the use of outdoor or separate in-the-room antennas.

An acoustically constructed console cabinet of pin-striped mahogany veneers houses the new chassis and the 12 inch Alnico 5 dynamic speaker. The set has the new "Simplimatic Tuning" for minimum controls.

TELEVISION TOWER

The *Energy Farm Equipment Company* of Monticello, Iowa has developed a telescopic hydraulic tower which is suitable for both television and amateur antennas.

Available in either 3 or 4 section models, the 4 section unit is 68 feet fully extended and the 3 section model is 54 feet. Installation may be effected by setting the tower in a concrete base or mounting it along the side of the home or building and using metal straps for bearings.

When the 4 section unit is mounted in an open area, either straight or Navy type guys can be used. The installation can be made without the use of a gin pole and the collapsed length over-all runs about 23 feet and the unit weighs 245 pounds.

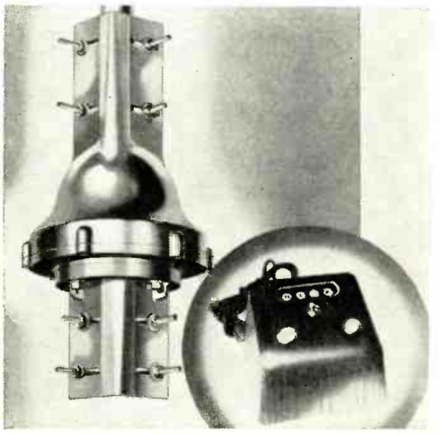
A hand hydraulic pump is used to elevate the tower. During erection the best reception height can be determined and the height held at that point. In case it is necessary to work on the antenna atop the tower, the tower can be lowered and then pumped back up when repairs have been completed.

"TELE-ROTOR"

Ability to take an unusual amount of wind stress and to carry TV and amateur antenna arrays without overloading the motor are among the features stressed by *Cornell-Dubilier Electric Corp.* of South Plainfield, New Jersey, in announcing the "Tele-rotor."

Tests show that the unit will take load stress up to 300 pounds. Not only can more units be built onto the antenna without overloading the motor, but the motor is weather-sealed and lubricated for life. It is instantly reversible and is operated by directional push-buttons.

The housing of the rotator is die cast and heavily reinforced, designed for mast or platform mounting and

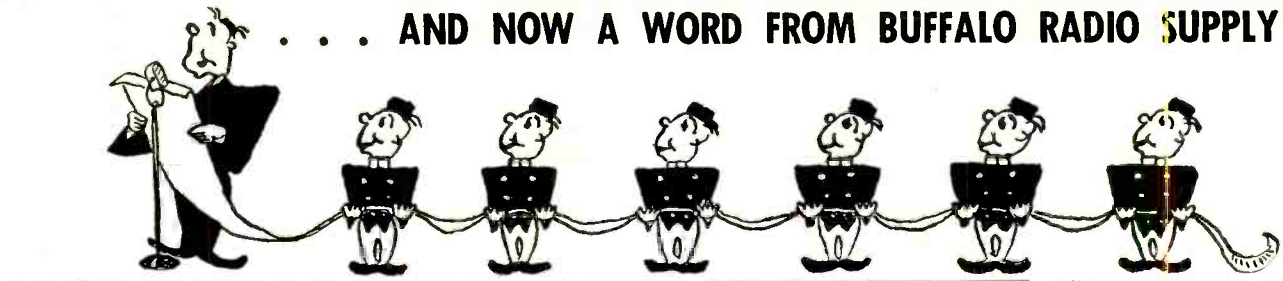


equipped with three heavy-duty guy-wire lugs. It will accommodate ⅞ to 2 inch upper and lower masts.

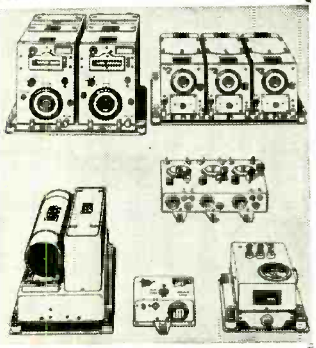
STACKED ARRAY

The LaPointe Plascomold Corporation of Unionville, Connecticut, has developed and is marketing a new low-cost, four-bay stacked array which has been named the Challenger Model HL.

Designed to meet the requirements of viewers in areas where both high and low channel reception is desired, this unit comes custom cut to favor any particular high channel desired. Because of its broadband characteristics it also performs well on the low channel stations. The antenna matches



274N COMMAND SET MADE BY WESTERN ELECTRIC



A mountain of valuable equipment that includes 3 separate Communications Receivers, covering up to 9.1 MC. 2 separate 40 watt Transmitters including crystals. 4—28v. Dynamotors (easily converted to 110v. A.C. operation). Preamplifier and Modulator. 2 Tuning Control Boxes, and 1 Antenna Coupling Box complete with R.F. Ammeter. 29 tubes supplied in all. Receivers and Transmitters instantly detached from mounting racks for use in separate locations. Removed from unused aircraft and in guaranteed electrical condition. A super value at **$59.95** complete.

RT-1655 crystal controlled SUPERHET RECEIVER that covers the FM band. The ultra modern circuit uses the latest types of tubes. Beautiful chassis and aluminum cabinet. Eleven tubes and schematic supplied **$14.95**

PORTABLE ELECTRIC DRILL

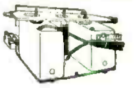
TERRIFIC VALUE

Equipped with 1/4" Jacobs Geared Chuck and Key

$19.95 (Sold at less than established factory price so we cannot mention brand name)

Not an intermittent duty drill, but a full size rugged tool. Most convenient type switch. Natural grip handle. Balance like a six shooter. Precision cut gears. Turbine type cooling blower. Extra long brushes. No stalling under heaviest pressure because of powerful 110 Volt AC or DC motor and multiple ball thrust bearing. Other bearings self-aligning lifetime-lubricated Oilite type. Made for toughest year-in and year-out service in plant or on construction jobs. Amazing perpetual factory guarantee assures you of a lifetime of trouble-free use. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

3-Gang Broadcast Band Permeability Tuner. List Value $7.00. Now $1.50



$6.95 TAKES ALL THREE BIG BARGAINS "E"

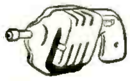
1. AUDIO AMPLIFIER—Brand new push-pull output triode amplifiers having 2 of the valuable and scarce ouncer type audio transformers that sell for over $10.00 apiece. Neat aluminum case, fully enclosed (largest dimension 6 inches). Perfect for intercom systems, phone amplifiers, mike amplifier, or signal tracer amplifier for testing radio sets. A sensational bargain at only........... $3.40 each

2. BANDSWITCHING TUNING TURRET made by Western Electric. Covers 4 bands above 100 MC. All coils wound with #14 silver-plated wire. Complete with tuning condensers and powerful electric driving motor. ONE OF OUR MOST TERRIFIC VALUES —**ONLY** $2.95

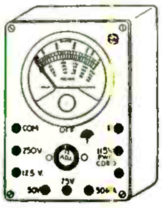
3. CARBON MIKE with Push-To-Talk Switch and Gold Plated Carbon Lapel Mike. Combination offer on both mikes **$1.75**

"DRILLMASTER" ELECTRIC DRILL

Low-priced electric drill, ideal for hobbyists. Complete with sander, buffers, grinding wheels, etc. This is bankrupt stock and only a few are available. A sensational bargain at $9.95. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.



ANALYZER featuring a sensitive repulsion type meter housed in a bakelite case; represents the culmination of 15 years' achievement in the instrument field by a large company specializing in electronic test equipment. Specifications of the AC-DC Model Volt-Ohmmilliameter; AC Volts—0-25, 50, 125, 250. DC Volts—0-25, 50, 125, 250. Milliamperes AC—0 to 50, DC Milliamperes—0 to 50, Ohms Full Scale—100,000. Ohms Center Scale—2400. Capacity—.05 to 15 Mfd. Total Price, prepaid anywhere in the USA $7.00



$7.05 TAKES BARGAIN "C"

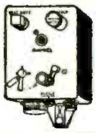
(All three items below)

ALUMINUM GEAR BOX 18x8x7 that contains two powerful electric motors and two matched gear trains. 62 gears in all varying in size from 1/2 to 4 inches in diameter. This unit is readily converted to rotate in beam antenna or any other similar use......... **$5.00**

SIGNAL CORP INTER-CONNECTOR RELAY BOX 730A

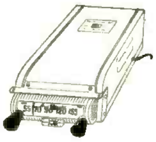
This valuable unit, made by Bell, and more familiarly known by the U. S. Army designation BC616, is encased in a highly polished aluminum case 6 1/2x 5 1/2x2 1/2, and contains 150 mfd. of condenser capacity, sensitive relays, resistors, and terminal strips. Order several at the giveaway price of only **$1.95**

REMOTE CONTROL UNIT Aluminum case 4 x 3 x 2 containing 2 potentiometers, triple pole switch, 4 knobs, phone jack, gear mechanism and revolution counter. Including 8 prong JAN connector to fit box......... **$1.39**

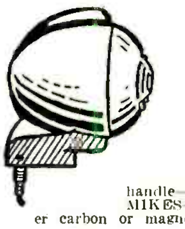


AUTO RADIO DEALERS! ATTENTION!

Car radio specially made by famous American manufacturer of communications sets for export to South America. (Recently imposed currency restrictions make export impossible.) 6 tubes, 3 gang condenser, and unbelievable sensitivity and selectivity. Fungus proofed and tropicalized. Out of this world, compared to any radio built for the domestic market. A sensational value at **$28.00** net, or **$25.00** in lots of 3.



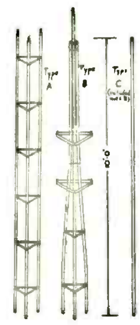
MICROPHONES



Super Special-Highest quality all chrome bullet shaped CRYSTAL MIKE of top-flight nationally known brand —**$5.95.** Bullet DYNAMIC MIKE — **$7.95.** MIKE Jr.—**60c.** PUSH-TO-TALK MIKE switch on handle—**98c.** LAPEL MIKES—(Specify whether carbon or magnetic) **93c.**

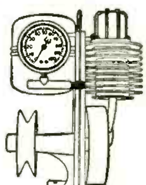
THE BUFRAD SECTIONAL TOWER

This latest addition to the famous line of BUFRAD antenna products makes up to a hundred foot tower from any desired number of ten foot sections of extremely strong welded construction. The sections are shipped assembled so erection is a matter of minutes rather than hours. Finished in gray "TELECOTE," a new time and climate proof finish that will outlast the pyramids. Assembly is a one man job and is accomplished by climbing up the completed portion of the tower with the next 25 lb. section to be installed. Hand and footholds are provided to make the work safe and easy. Cap at top of tower provides bearing surface for rotating, and prevents water from entering tubes. Useful for police, or amateur transmitters, and in addition the tower will provide satisfactory TV reception where otherwise it would be impossible. Ideal for supporting permanent or temporary power lines, wind generators, stadium public address speakers, or spot lights for gas stations or parking lots. "B" and "C" sections together cost a total of $15.75 and total 20 feet. "A" Sections, which make up the entire tower except for the top, are each ten feet long and cost but $12.75 apiece. Those who wish a mast base will be able to obtain one (not shown) for only $6.00. The base is especially useful when erecting the tower on a sloping roof.



COMPRESSED AIR

INSTANTLY ANYWHERE



Portable Air Compressor and storage tank. Ruggedly built. Best Materials. Lifetime lubricated ball-bearing on connecting rod and oil-impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors. **PATENTED** unique air intake system increases efficiency tremendously so that air output is much greater than that from larger compressors powered by heavier motors. Delivers approximately 3500 cu. inches of air per minute at maintained pressure of 30 lbs., or will inflate a 90 lb. truck tire in less than one minute. Complete with 100 lb. gauge. Finger-tip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any 1/4 H.P. motor. Useful for spraying paint, lacquer, disinfectant, insecticide, annealing or brazing with natural gas, inflating tires, etc. Price **$14.50** postage prepaid anywhere in the U. S. Efficient, completely adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose, only **$7.75** with pint container, also prepaid.

NEW G. E. TRANSMITTER

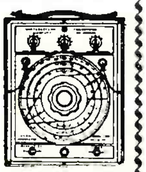
Brand new General Electric BC-375 or BC-191 transmitters, export packed, complete set of spare tubes as well as 10 and 20 meter conversion instructions $100.00. BC-312, BC-348 or BC-224 receivers sold with the above transmitters (unit for unit)............. **$125.00**

SCR610 portable 6, 12 and 24V crystal controlled transmitter receiver with built-in loudspeaker on receiver, complete **$59.95**

SCR522 Transmitter-receiver in guaranteed condition complete with remote controls, antenna and mike.

No conversion necessary to license for taxi-cab use. A natural for any 2 meter use **$100.00**

SIGNAL GENERATOR



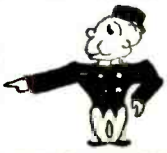
Genuine Laboratory-type precision signal generator Manufactured and sold for $68.00 each in large quantities during the war by Northeastern Engineering Corp., one of the top manufacturers of electronic equipment for the U.S. Govt. Five fundamental bands starting at 150 KC. Strong harmonics up to 120 MC. Five step ladder type attenuator as well as potentiometer output control. Regular 1000 cycle audio oscillator using vacuum tube, not a cheap neon sawtooth audio oscillator. Audio output separately available externally. Weight without packing material 16 lbs. which should show what a world of difference exists between this signal generator and the ordinary cheap oscillator used by the average serviceman. Complete with fused plug and coaxial output lead. Super Special **$38.75.**

ISOLATION TRANSFORMERS

$2.95

Many adjustments on radio and TV sets require that the chassis be grounded for successful results. Using an isolation transformer this can be done as routine procedure on every set on the test bench, ending the hazard of shock. Connected as auto transformers these isolation transformers can also be used to change 110V to 220V or the reverse. We do not believe that 100 watt 110V isolation transformers have ever before been offered at less than double our price of $2.95.

Push-Pull **AUDIO AMPLIFIER** with Hypersil core A.F. transformers — $30.00 Value—**NOW $3.40.**



DELUXE AC-DC RADIO KIT

High quality standard production line RADIO in kit form with complete instructions. No other advertised kit regardless of price offers these features. 2 Iron Core I.F. transformers. Polethylene insulated edgewise-wound antenna loop. 2 gang condenser. Tubes include 12AT6, 12BA6, 12BE6, 50B5, and 35W4. Receives Broadcast Band from 550 to 1700 KC. Kit is **$8.75** or 2 for **$17.00.** Assembled, wired and tested, **$12.95** or 2 for **$25.00.**

CERAMIC INSULATED VARIABLE AIR CONDENSERS

10, 15 or
23 mmf— $.35, 10 for $2.90, 100 for $23
35 mmf— $.40, 10 for $3.40, 100 for $28
50 mmf— $.45, 10 for $3.70, 100 for $30
75 mmf— $.50, 10 for $4.40, 100 for $38
100 mmf— $.55, 10 for $4.50, 100 for $39
140 mmf— $.80, 10 for $7.40, 100 for $64
160 mmf—$1.00, 10 for $8.50, 100 for $75

Butterfly condensers, rotor has double ball bearings and 3/4" shaft.

15 mmf. per section $.50, 10 for $4.50, 100 for $40

30 mmf per section $.60, 10 for $5.50, 100 for $50

50 mmf per section $.70, 10 for $6.50, 100 for $60

SUPER SPECIAL!

2 gang midget superhet tuning condensers with 1/4" shaft and trimmers.. **9 for $2.50**

2 gang 140 mmf—$1.60, 10 for $12.50, 100 for $100

350 mmfd 5 gang—$1.95
3 gang—$1.29

Manufacturers and Distributors: Write for prices on larger quantities. WE HAVE OVER 250,000 VARIABLE CONDENSERS IN STOCK.

Phonograph Scratch Eliminator

Consists of 2 condensers and powdered iron core choke connected in a filter network. Same as used in most jukeboxes to improve low note response and eliminate scratch. Connects instantly between pickup and amplifier. A super bargain at **$2.00**

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. RN-3, BUFFALO 3, N.Y.

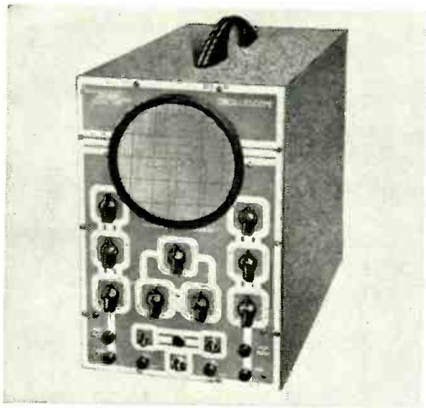
a 300 ohm line with negligible impedance variation throughout the television spectrum. It is constructed of duraluminum and is furnished with an integral 9 foot mast (1⅜" o.d.) and will fit all rotators commercially available without the need of special adaptors. Half-wave spacing provides low vertical angle of radiation, thus affording maximum signal-to-noise ratio.

TELEVISION SCOPE

Of interest to television technicians is the new Model 425 oscilloscope which is currently being offered by *Electronic Instrument Company* of 276 Newport Street, Brooklyn, New York.

Probably the outstanding new feature of this instrument is a push-pull horizontal and vertical amplifier. Other features include extremely high sensitivity and wide bandwidth.

The new oscilloscope is available in

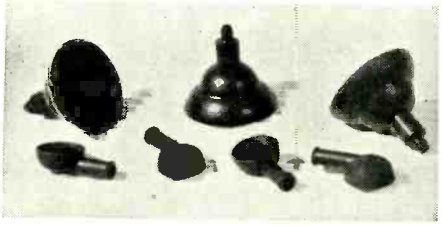


kit form (Model 425K) as well as completely assembled.

RUBBER ANODE CONNECTORS

An injection molding process for making anode connectors and other television parts has been developed by *Minnesota Rubber and Gasket Co.*, 3630-V Wooddale Ave., Minneapolis 16, Minnesota.

The manufacturer claims that this molding process enables him to hold to closer dimensions, tolerances, and provide greater uniformity in production than was hitherto possible. A special television rubber compound has been developed to provide heat resistance,



corona resistance, and high dielectric. Special aging chemicals provide good flexibility even after prolonged use.

MAJESTIC CONSOLE

A name long and favorably known in the radio industry has made its reappearance with the debut of the 1950 line of *Majestic* television receivers.

One of the featured sets in the new line is the Model 16C4, a 16" unit with a black tube. Like all of the receivers in the line, this new model has a built-

in "Channelized" antenna which is said to operate satisfactorily in 8 out of 10 locations, and some recent electronic circuit innovations developed by the company.

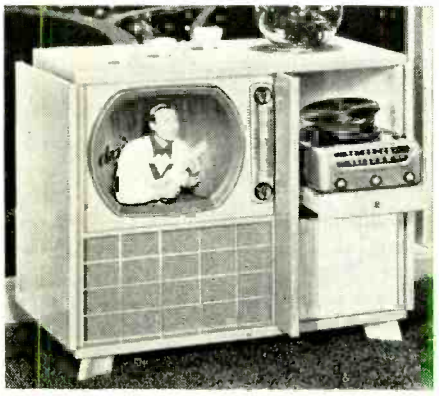
The Model 16C4 is housed in a hand-rubbed mahogany cabinet and is also available in blonde mahogany as the Model 16C5.

The new *Majestic Radio and Television Corporation*, headed by Leonard Ashbach, has headquarters at 743 N. La Salle Street in Chicago.

SIX-WAY CONSOLE

Admiral Corporation of Chicago is marketing a six-way console in its 1950 line of home radio instruments.

This unit, which uses a 19-inch picture tube, features a Dynamagic FM-AM radio with 12-inch speakers as well as the company's three-speed record changer which handles 33⅓, 45, and 78 r.p.m. records on a single spindle. The changer will handle from 12 to 14 records at a time, depending on their size. Both the radio and record



player slide out from the cabinet when in use for easy accessibility.

The cabinet, of hand-rubbed wood, comes in either blonde or mahogany finishes.

INDOOR ANTENNA

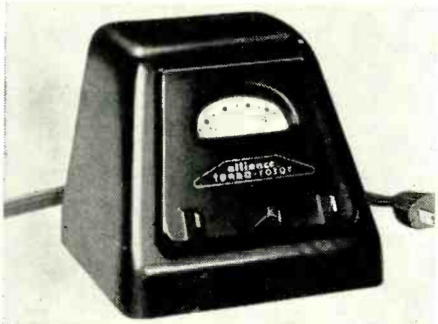
Tricraft Products Company of 1535 North Ashland Avenue, Chicago, Illinois, is currently in production on a new indoor television antenna, the "Vidiette" Model "700."

According to the company there is

no pushing or pulling of rods with this unit, a simple movement of the knob to the desired channel is all that is required. The television receiver is then automatically electrically tuned in to the proper station. The unit is small and compact, making it suitable for installation in apartments and other limited-space locations.

"TENNA-ROTOR"

Production is underway at the *Alliance Manufacturing Company's* Alliance, Ohio plant on a deluxe model of the company's "Tenna-Rotor," the Model DIR.



The new unit features a directional indicator control case. An indicator dial on the control case panel enables the television viewer to select and know the actual compass direction to which the antenna is pointed.

Like the company's standard model, the new rotator is factory lubricated for life, has stainless steel bearing inserts, and is designed to operate in any weather.

Both the deluxe and standard models come with special 4-conductor cable. The cable has a special "zip" feature which facilitates installation.

ANTENAPLEX SYSTEM

The *Engineering Products Department* of *Radio Corporation of America* has announced that the company's Television Antenaplex System is now available for installation in television areas throughout the nation.

Originally restricted to distribution on the Eastern Seaboard, the system is designed as a multiple-outlet antenna unit for apartment houses, hotels, stores, schools, hospitals, and office buildings. The system consists essentially of an individually tuned antenna for each transmitting channel in the given area, a master signal am-

TV SERVICE CONTRACT PRICES CUT

By ROBERT HERTZBERG

IN line with the trend toward lower prices for television receivers in 1950, the RCA Service Co., a subsidiary of RCA-Victor, has announced a series of new low-cost TV service contracts. This move will undoubtedly establish a new price pattern for the entire television servicing industry.

The initial reaction of many TV technicians to the "cut" was dismay. "We're taking a licking now on many contracts," they said. "How will we make out if we charge less?" Study of the new RCA schedule reveals, however, that it will benefit the trade rather than hurt it. The outstanding feature is the restriction of the much-abused "unlimited service" privilege to 90 days, with a flat charge of $5.75 for all calls after that period. The rates vary from $22.95 for a 10-inch set with built-in aerial to $69.95 for projection models with outdoor antennas. Unlimited service contracts at the higher prices heretofore in effect will still be available to customers willing to pay for them.

In announcing the new contract plans, Charles M. Odorizzi, vice-president of RCA in charge of service activities, disclosed that the RCA Service Co. is moving along various fronts to help all service organizations and technicians to keep pace with the rapidly expanding industry. Service notes are being distributed at no charge to recognized organizations, and at a very nominal charge to individual technicians. In addition, a series of six lectures on the practical aspects of TV servicing will be held in various parts of the country during the year, under the auspices of RCA dealers.

"We regard our activities as broader in scope than merely the installation and servicing of RCA and RCA-Victor products," says Mr. Odorizzi. "They are also designed to advance the whole industry, since whatever helps build public acceptance for television will contribute to the sales of all manufacturers and build volume business for all servicing agencies. Our aim is to maintain friendly and cooperative relations with other servicing organizations."

—30—

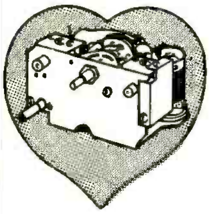
Newly revised factory service contract price list recently released by RCA Victor. This schedule applies to both commercial and residential installations. The adjustments made for various "zones" applies to distances from the transmitter. Thus, Zone A is normally a 22 to 25 mile radius around a TV station, established by 500 microvolt range of the station. Zone B is normally about 10 miles beyond Zone A, while Zone C is normally 10 miles beyond Zone B.

	PLAN I		PLAN II	
	• Complete installation. • Instruction of customer. • Parts and tube protection, including picture tube, for one full year • Unlimited service for 90 days. • After 90 Days Service-as-needed by RCA Factory Technicians at preferred flat rate of $5.75 per call.		• Complete Installation. • Instruction of customer. • Parts and tube protection, including picture tube, for one full year • Unlimited service for a full year	
TELEVISION TYPE	With Built-in Antenna	*With Standard Outdoor Antenna	With Built-in Antenna	*With Standard Outdoor Antenna
TELEVISION ONLY				
All 10" Models	$ 22.95	$ 39.95	$ 45.00	$ 65.00
All 12½" Models	24.95	44.95	50.00	70.00
All 16" Models	29.95	49.95	60.00	80.00
Projection Models	39.95	59.95	75.00	95.00
TELEVISION COMBINATIONS				
All 10" Models	$ 29.95	$ 49.95	$ 60.00	$ 80.00
All 12½" Models	34.95	54.95	65.00	85.00
All 16" Models	39.95	59.95	75.00	95.00
Projection Models	49.95	69.95	90.00	110.00

Above prices apply for Zone A; for Zone B add $7.50; for Zone C add $15.00
*Built-in Antenna prices apply when existing antenna is used.
Portable Indoor Antenna Supplied on Request — $3.50

THERE'S ONLY ONE NIAGARA FOR GREAT RADIO VALUES

HEART OF THE BC-221 FREQUENCY METER



This VFO Sub-Assembly, used In BC-221 Freq. Meter, is ideally suited for home construction of:

1—Amateur V.F.O. 3—Portable Transmitter
2—Freq. Mtr. Foundation 4—Replacement for BC-221

Unit contains two temperature & moisture compensating coils, wafer switch, 3 variable condensers, carbon resistors, & silver mica condensers. FULLY WIRED & mounted on sturdy aluminum sub-chassis, ready for installation. Brand new—in original packing.

N-276 Very special........................ **$6.95**

For Complete List of Tube Prices See Feb. Issue of This Publication.

TERRIFIC PRICE SLASH!

BRAND NEW TUBES

TRANSMITTING		RECEIVING	
E1148	$ .34	1H5GT	$ .50
2C26	.28	3A4	.27
5BP1	1.70	3B7	.29
10Y	.28	3D6	.29
211	.28	6C4	.20
803	3.63	6AR5	.54
805	3.63	6D6	.42
813	6.90	6K7GT	.43
815	1.37	6SH7	.27
843	.38	6SS7	.53
954	.18	7C4	.28
955	.18	12A6	.15
957	.18	12H6	.22
958A	.18	12K7GT	.49
1619	.18	12SH7	.29
1625	.18	12SR7	.29
1626	.18	28D7	.29
7193	.47	35L6GT	.49
9004	.18	50B5	.49
9006	.18	50L6GT	.48

All Quantities Limited

MORE BARGAINS IN SURPLUS EQUIPMENT

1—2 or 3 of each • Check every line!

Wilcox CW-3-110V Superhet Rcvr. New	$75.00
Antenna Rotating Motor—RL-42A Reel Exc.	4.95
W.E. XMTR MOD. Comp. w/controls spares—New	225.00
MN26C Radio Compass—New	32.00
MN26C Radio Compass—Used	26.95
733DD Localized Receiver Exc.	9.95
AN-APN-1 Altimeter—L.N.	18.95
APS-13 Receiver—Exc.	12.95
TG-10 Code Keyer—L.N.	14.95
274N Modulator BC456A w/tubes Exc.	2.65
274N Modulator BC456A Fair less tubes	1.68
SCR 522 Receiver BC624 Exc. less tubes	7.95
SCR522 XMTR-BC625 Exc. less tubes	11.95
BC 1000A Transceiver New	300.00
BC 604 FM XMTR Exc.	14.95
BC 603 FM RCVR. Exc.	14.95
BC 645 Transceiver, Contr. Box, Dyn, Instruction book, New	17.95
T-17 Handmike 200 Ohm Imp. Exc.	.69
T-24 Handmike—7 Ft. Cord—Noise Filter—Plug—New	1.19
PE 94 24V. DYN. for SCR522 Used L.N.	2.95
Surplus Radio Conv. Manual Vol. 1 or 2	2.50
BC 610 Tank Coils—New	1.50
BC 654 80 Meter XMTR & RCVR. w/tubes & XTAL	29.95
Collins 32 RA-7 XMTR VY GD.	125.00
Teleplex Code Machines (Less tapes) Exc.	18.95
ASD Radar Set Complete—New	(Price on Request)
ASD Parabolic Antenna—Rotable—L.N.	(Price on Request)
2601A Parabolic Rot. Ant.—L.N.	(Price on Request)
R784 APS 15A Electronic Camera	(Price on Request)
Sig. Gen. Ferris #16C	(Price on Request)
BC221 Freq. Mtr. w/XTAL & Calib. Book L.N	$75.00
LM Freq. Mtr. w/XTAL. Book Mod.. Exc.	90.00
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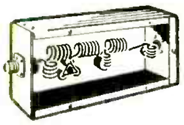
For Hams—DON'T BE BLAMED FOR TVI!

F.C.C. tests have proven that the new Low-Pass Filter Kit,* developed by W2GX, attenuates all frequencies above 40 MCS. This "M" derived filter for 160 through 10 meters prevents TVI



while you're operating. Eliminates all frequencies above 40 MCS at 60 DB or better, passes all frequencies below 40 MCS. Fits any 52-72 ohm feeders. Insertion loss less than 1/60th of 1 DB. Full directions included.

Cat. No. N-279.

$4.99 plus 25c shipping charges in U. S.

* Hi and Low Pass Filters manufactured by a division of Niagara Radio Supply Corp. Dealer inquiries invited.

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MI-2454 Type "Q" Cat. No. N-299

Talk up to 10 miles without batteries with these sound powered phones. No loss in power when paralleled. Ample volume, excellent type rubber-cushioned ear phones. Type "Q" has swing-away microphone. Type "O" has mike on chest set. Adjustable headband, Push-to-talk, 22 ft. of live rubber cord and plug on both types. Unit consists of 1 pr. phones, mike, cord and plug as illustrated.

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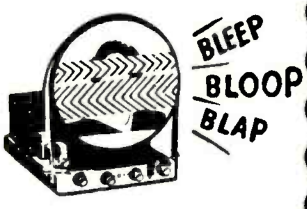
MI-2475 Type "O" Cat. No. N-300

$4.95 EACH

For TV Set Owners—Banish Interference



Niagara's new Hi-Pass Filter Interference kit* is positive protection against amateur and other high frequency RF interference, such as diathermy, etc. Fits any 300 ohm antenna feed line. No loss in pictorial brightness. Easily assembled. Full instructions included.

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MEET THE WINNER! of last month's TALL TALES CONTEST

Walter Berry of Madrid, Iowa, topped them all this month with this lollapalooza and wins the $5 prize for March.

"Last winter in Iowa it got so cold my antenna contracted. Only dots went out, dashes stuck in the feeders. When the dots got out the wind blew them back causing the transmission line to explode, scattering dots and dashes all over the yard."

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plifier to boost the signals received on all channels, and one or more vertical lines of coaxial cable, running through pipe wells in the walls, with branch connections for all outlets.

When using this system it is only necessary to plug the receiver's antenna connection into a wall or floorboard outlet in the same way the power cord is plugged into the utility outlet.

TRANS-VUE'S "ARISTOCRAT"

A new 16-inch direct-view consolette which features "eye-level" viewing has been introduced to the trade by *Trans-Vue Corporation,* 1139 S. Wabash Avenue, Chicago 5, as the "Aristocrat 601."

The new receiver employs the "Ese-O-Matic" tuner which requires only a single knob control. No vernier adjustment of multiple knobs is necessary on this set. All circuits are adjusted by a single adjustment screw, set at the time of installation.

PHILCO TABLE MODEL

A low-priced table model television receiver which uses a 12½" tube is being offered by *Philco Corporation* of Philadelphia, Pa., as one of its 1950 line leaders.

Housed in a walnut cabinet, the new model has the *Philco* Electronic Built-In Aerial System which is claimed to be the only built-in antenna that can

be tuned to match perfectly with any station.

The circuit of this set uses 20 tubes and 2 rectifiers in addition to the cathode-ray tube. —30—

Spot Radio News
(*Continued from page* 18)

swer to the rambling problems of what to do with color TV and when, how to allocate the ultra-highs and how to orient the present channel setups so that no community suffers from a lack of coverage.

MICROWAVE FACILITIES for TV are rapidly becoming an extremely important factor in relaying, according to the fifteenth annual report of the FCC. Circuits, estimated to cost seventeen million dollars, were authorized during the past year, providing a link between Pittsburgh and Chicago, Chicago and Des Moines, Albany and Syracuse, Richmond and Norfolk, and Milwaukee and Madison.

The report also revealed that as of October 31, outstanding radio authorizations exceeded 737,000, an increase of more than 25,000 in the four months since the close of the fiscal year (June, 1949). In a breakdown of these authorizations, the FCC showed that there were 2299 standard broadcasting stations, 815 FM stations, 112 TV and 217 experimental TV, 589 remote pickups, and 29 studio-to-transmitter setups.

On October 31, the official records showed that over 82,000 had been licensed to operate as amateurs and 194 in the citizens service bands.

In an analysis of the status of TV as of June 30, the report disclosed that actually there were only 13 stations licensed, and 58 were operating on a commercial basis under special temporary authorizations. These 71 stations were, according to the review, bringing reception to 42 cities and metropolitan districts as compared with 17 cities served by 30 stations a year ago. The demand for new stations remained greater than the available facilities, so that 237 of a group of pending applications were in the comparative hearing stage at the conclusion of the fiscal year.

Commenting on the experimental TV services, the report declared that there were 175 experimental stations licensed and 30 outstanding construction permits. Included in these figures were 136 relay stations operating in the microwave region and used primarily as pickup, studio-to-transmitter link and interim intercity relay stations. About 30 authorizations were outstanding in the 475 to 890 mc. band, with activities concentrated on studies of propagation, developments in circuits and tubes for use at the ultra-high frequencies, color transmissions, Phonevision, Stratovision, comparisons with transmission conditions in the present bands, and television relaying.

The clear-channel problem, still to be solved, also received a substantial review in the report. According to the FCC, the matter is now awaiting an allocation schedule set up in accordance with the North American Regional Broadcasting Agreement Conference, which recently concluded one series of sessions in Montreal, with a second meeting to begin in the Spring. Detailing the complexity of the issues involved, the FCC discloses that the controversy resolves itself into whether it would be better to share existing nighttime facilities on clear channels with applicants throughout the country proposing to serve areas where little or no satisfactory service presently exists, or to allow only the present licensees on each clear channel to have super power in order to better their coverage. The solution of the problem, said the report, depends on which plan would tend toward betterment of service or duplication of service, particularly as it concerns rural listeners. Also presented are questions such as the economic and competitive effects upon other broadcasters if a few should be allowed super power, and whether this would be conducive to the proper distribution of broadcasting service and the larger and more effective use of radio as contemplated by the Communications Act.

(In a commentary on the "super power issue," made during the Federal Communications Bar Association annual meeting referred to previously, Senator Johnson said: "I hope that the Commission will shortly provide for duplication of clears since the people of this country need more frequencies desperately. Certainly it has the authority to do so. The maintenance of clear channels is an anacronism in modern radio practice. . . . Unfortunately the clears cannot render the local service that many areas deserve, hence they do not serve well. It is archaic to contend any longer that clear channels serve a useful purpose in the country, and the best proof is that the networks now frankly admit that their own seaboard clears might be duplicated without harm to them.")

An interesting dissertation on the operations of the technical information and laboratory divisions of the FCC also appeared in the annual report. In a review of the technical studies probed by the Commission, it was disclosed that radiation and interference received intensive surveying, particularly insofar as television receivers were concerned. The report stated the number of complaints of TVI received by the field division increased far beyond anything anticipated. A study was therefore undertaken to determine the technical phases of TVI, and since the problem is quite complex, a great deal of testing and research will be required before practical solutions can be reached.

The possibilities of single sideband, suppressed carrier applications were also covered in the report. With the ever-increasing demand for frequency space, engineers have turned to the single sideband, suppressed carrier method of operation because it offers a saving in the bandwidth requirements. Many technical questions have arisen concerning the actual bandwidth needed for various types of modulation, methods of calculating and specifying power, and so on. The study of these problems was started early in '49 and will probably be continued next year, the annual review declared.

Eight extensive projects involved in determining the over-all frequency characteristics of the low and high bands of television, the responsibility of the FCC lab groups, were also discussed in the report: A study of the effects of the variable hydrographic conditions on wave propagation; a study of terrain effects upon wave propagation; a study of surface coverage (trees, shrubs, etc.) and their effect upon propagation; analytical studies of tropospheric interference; tropospheric interference studies in the ultra-high bands; tropospheric interference standards for the very-high fixed and mobile services; a study of *scatter effect* and its probable impact on the present and future high bands for TV; and the development of automatic devices to scale field charts and analyze the resulting data.

In the letter of transmittal of the report to Congress, Wayne Coy, FCC Chairman, accented the growing importance of TV by declaring: "Broadcast activities are marked by the booming interest in television, and the attendant problems being dealt with by the Commission in order to meet the demand for video expansion and improvement."

AFTER THIRTY-THREE years at the *Bell Labs,* during which the world saw a continuous procession of brilliant contributions to the science of acoustics, Harvey Fletcher has retired. Fortunately his retirement is but a transfer of operations, for he will now concentrate on education and serve as an honorary professor in the electrical engineering department of Columbia University, in charge of a department of acoustical engineering. Good luck, Doc. . . . . . L.W.

SET PRODUCTION

THE recently-released report on set production by RMA member-companies reveals that 9,680,773 radio receivers of all types were manufactured during 1949 by such companies.

Television set production totaled 2,413,897 with 121,238 sets in January 1949, 118,938 in February, 182,361 in March, 166,536 in April, 163,262 in May, 160,736 in June, 79,531 in July, 185,706 in August, 224,532 in September, 304,773 in October, 414,223 in November, and 292,061 in December. Approximately 20 per-cent should be added to the totals in order to compensate for sets produced by non-RMA companies. This brings the over-all television receiver production for 1949 to 2,896,676 sets.

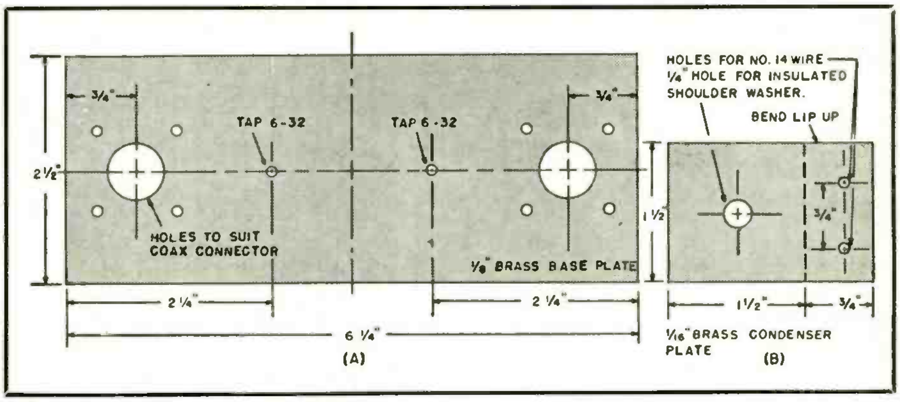
FM-AM and FM sets totaled approximately 963,055 and AM sets 7,030,508 for all companies. —30—

TVI Filter

(*Continued from page* 61)

portant, very low inductance. The design capacity of each plate-type condenser is 141 μμfd. The actual capacity should agree within 10% of this figure and should be adjusted experimentally, stacking mica sheets for the dielectric until approximately the correct capacity is attained. A "Q"-meter is ideal for this adjustment but the transmitter v.f.o. may be used, comparing the frequency change produced by the addition of the plate condenser to the denser assembly is shown in the photograph appearing on page 61.

The self-supporting coils are wound of number 14 wire on a ½" form, and the form then removed. It is best to check the inductances but this is not absolutely necessary provided the dimensions and photographs are followed closely. Small variations in the individual elements will only slightly modify the transmission characteristic of the filter. For instance, no perceptible change was produced when the sheet-copper shield was removed. Coupling between elements, principally magnetic coupling between the coils, should be minimized. Mounting the



Details for laying out and drilling the brass plate on which filter is assembled.

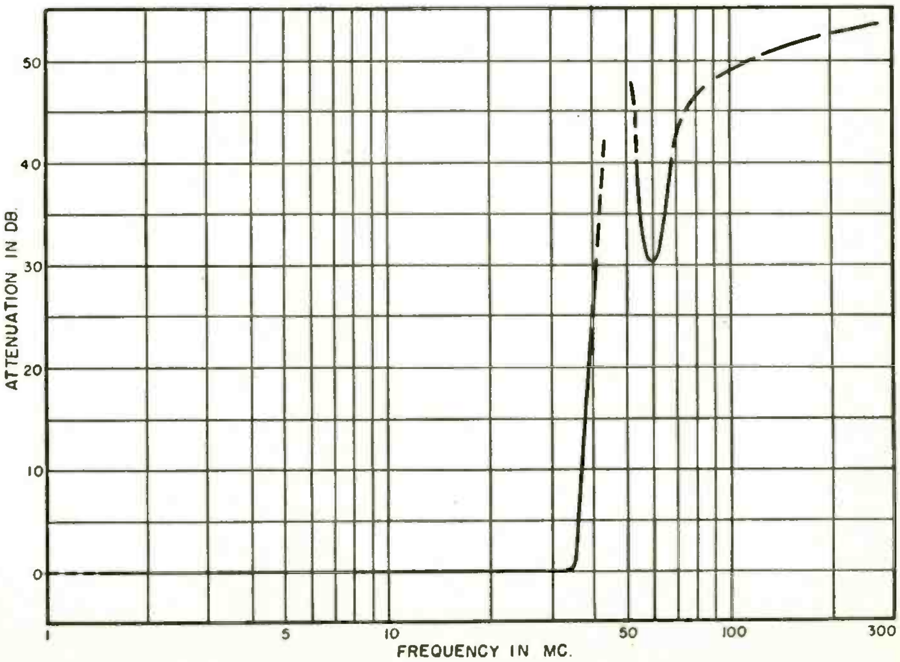
change produced by the addition of a mica or variable condenser of 140 μμfd. In the filter pictured, the mica is stacked to a total thickness of .013", using three or four sheets of .003-.004 mica.[2] A sawcut ⅜" deep and ¼" in from the edge of each plate forms a small tab which may be bent up or down for small variations in the capacity. The over-all view of concoils as shown will produce negligible magnetic coupling.

Although it has not been tested, an acceptable substitute for the sheet mica should be celluloid or old photographic negatives. The latter should have the emulsion removed by a bath of hot water. These materials are inferior to mica in dielectric strength and power factor but should be usable for moderate power applications.

—30—

[2] Mica may be obtained from Mica Insulation Co., 1276 W. Third St., Cleveland, Ohio.

Transmission characteristics of the TVI filter plotted from 2 to 200 mc.



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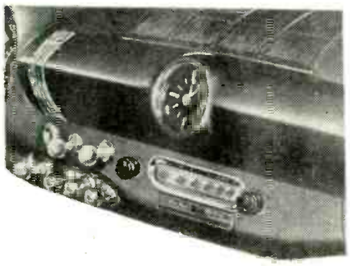
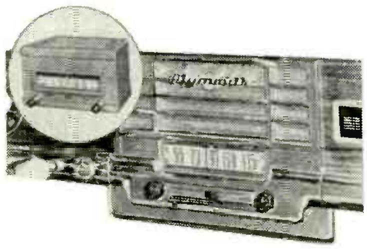


Six-tube superheterodyne. Six volt storage battery operation. Two dual purpose tubes. Eight tube performance. Specifically designed to fit all 1949 and 1950 Ford cars. Features two unit construction. No hole drilling required for mounting Installation in a few minutes. Three-gang tuning condenser and tuned R. F. stage for extreme sensitivity. Permanent magnet dynamic speaker with powerful Alnico #5 magnet. Low battery drain. Weight 10 lbs.

1949 and 1950 PLYMOUTH and DODGE AUTO RADIOS



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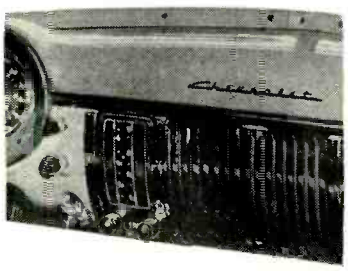

Six-tube superheterodyne. Six volt storage battery operation. Two dual purpose tubes. Eight tube performance. Specifically designed to fit 1949 and 1950 Chevrolet cars. Features two unit construction. No hole drilling required for mounting. Installation in a few minutes. Three-gang tuning condenser and tuned R F. stage for extreme sensitivity. Permanent magnet dynamic speaker with powerful Alnico #5 magnet. Low battery drain. Weight 10 lbs.

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"TELEVISION EXPERT"

"Here's How to be a Television Expert" is the title of a 23-page, two-color booklet published by *Motorola Inc.* and available at dealers.

Of modern design, the booklet's main theme is an elementary explanation of television, its production, its reception, history, and how the networks are made, etc. Numerous sketches are used to illustrate the answers to those questions most often asked about television by the layman.

The booklet is not designed as promotional literature and may, therefore, be used as an educational piece in schools or for any group interested in learning about television.

ACCESSORY PRODUCTS

Three types of biconical television aerials, six handy alignment jigs for servicing *Philco* television receivers, a three-speed record changer, and 45 r.p.m. record adapter disc and non-slip driver are among the new accessory products described in a series of data sheets available from the Accessory Division of *Philco Corporation,* Philadelphia, Pennsylvania.

Detailed descriptions of these products as well as an isolation probe used with the company's Electronic Circuit Master, Model 7001, are covered in these bulletins.

For information on the isolation probe ask for the bulletin on Part No. 43-5127; on the automatic record changer (Model M-20) the bulletin on Part No. 45-9566-1; on the biconical television aerials and the television alignment jigs ask for the bulletins by name.

TRANSFORMER CATALOGUE

A new transformer catalogue which lists a complete line of transformers for broadcasting and other professional applications as well as for amplifier constructors, audio enthusiasts, the replacement field, and hams, has just been published by *Peerless Electric Products Division* of *Altec Lansing Corporation,* 161 Sixth Avenue, New York 13, New York.

The line includes output, input, interstage, plate and filament, power smoothing and swinging chokes, modulation and replacement types. Also listed are several new additions to the company's line including power transformers, television receiver power transformers and chokes, matching transformers for the 70 volt RMA standard line as well as the conventional 500 ohm distribution line, output transformers for the Type 2A3 tubes, a new output transformer for push-pull parallel 6L6 tubes with secondary for the new RMA 70 volt line as well as voice coils, etc.

SELF-LOCKING NUTS

A new 4-page folder prepared especially for design engineers and production men is currently available from *The Palnut Company,* 23 Cordier Street, Irvington 11, New Jersey.

Details of construction savings and assembly with the company's washer-type, self-locking nuts on sheet metal products, decorative parts, and components are given in the booklet. The material included covers assembly procedures and methods of application on electrical equipment, radio, television, ranges, etc.

Pertinent dimensions, screw tension figures, materials, and finishes are also included to provide complete data for the engineer.

AUDIO EQUIPMENT

Laboratory instruments, potentiometers, decades, gain sets, precision resistors, and other products used in the audio field are covered in a new 40-page catalogue published by *Cinema Engineering Co.* of 1510 W. Verdugo Ave., Burbank, California.

Included in Catalogue No. 11-A are graphs and tables for computing attenuators and branching networks. Complete technical tables cover precision wirewound resistors in four different alloys of wire. There is also a listing of laboratory patch panels, cords, jacks, and transmission lines. The material is illustrated with charts, diagrams, mixer circuit, schematic drawings, and attenuator formulas.

TV PARTY BOOK

On the premise that much of today's home entertaining revolves around the television receiver, *Starrett Television Corporation* of 601 West 26th Street, New York 1, New York, has issued a 24-page booklet entitled "21 Terrific Television Parties."

This handy little publication offers 21 new television games including charades, quizzes, puzzles, anagrams, spelling bees, "name" games, definitions, hidden term games, Valentine and Anniversary games, etc.—all pertaining to home television viewing and entertaining. Answers and results are provided in a back section of the booklet and, in addition, detailed suggestions for invitations, refreshments, home decorations, and prizes accompany the instructions for each game.

Distribution is being handled through *Starrett* dealers.

FASTENER DATA

The new 28-page booklet just released by *Pheoll Manufacturing Co.,* 5700 Roosevelt Road, Chicago 50, Illinois, contains valuable fastener information for manufacturers who perform partial or complete assembling operations.

Products illustrated include screws in round, pan, truss, fillister, flat, and oval head styles. These are listed in both slotted and Phillips recessed head types. Hexagon head units are also available in plain, indented, and slotted head types.

A copy of the "Sems" (lock washer screws) bulletin may be secured by requesting Catalogue No. 80-A.

ADC TRANSFORMERS

Audio Development Company of 2833 Thirteenth Avenue South, Minneapolis 7, Minnesota, has recently released a 16-page catalogue covering its line of transformers.

Known as Catalogue No. 49A, the new publication includes data on case dimensions, chokes, filament transformers, bandpass filters, sound effects and special filters, impedance matching transformers, interstage units, input transformers, jacks and jack panels, line-to-grid transformers, line-to-v.c. units, microphone cable transformers, miniature audio and modulation transformers, output and power transformers, patch cords and plugs, preamplifier plate-to-line units, reactors, and subminiature transformers.

Complete performance data and ratings are given on each of the units described.

TV REPLACEMENT GUIDE

Of interest to service technicians is the new 20-page booklet "Television Components Replacement Guide" recently released by *Standard Transformer Corporation,* Elston, Kedzie, and Addison Streets, Chicago 18, Illinois.

This guide, Form DD338C, lists *Stancor* replacement transformers for 215 television receivers and chassis made by 43 manufacturers. Replacement parts numbers are listed together with manufacturers' parts numbers for positive identification.

The guide will be issued periodically as additional information is compiled.

"SELETRON" UNITS

The *Seletron Rectifier Division* of *Radio Receptor Co., Inc.,* 251 West 19th Street, New York 11, New York, has prepared a new 4-page folder showing typical industrial applications of its "Seletron" selenium rectifiers in units up to 75 kw. as developed by the company's customers. Illustrated and described are typical installations used in theaters, electroplating and similar processes, elevator motor supplies, and power packs for d.c. motors.

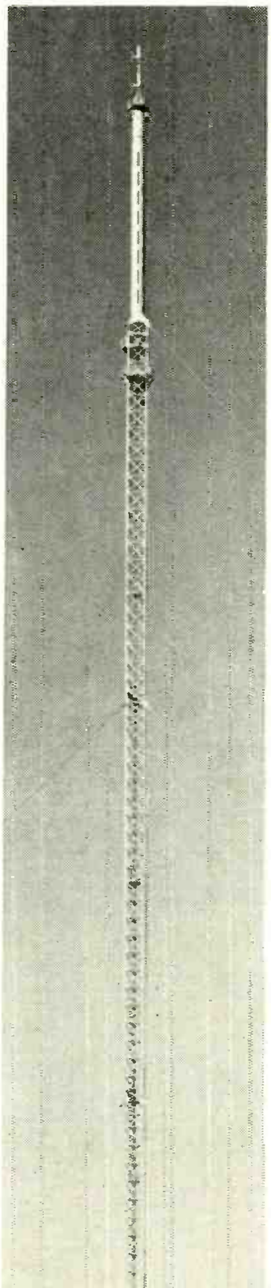
STACKING DATA

An explanation and detailed drawings of the proper procedure in stacking high band antennas is given in Engineering Bulletin No. 58 just released by *Technical Appliance Corporation* of Sherburne, N. Y.

The information is provided in easy-to-understand form as a service to the TV installation technician. Dimensions and proper phasing of antennas (for Channels 7-13) are given for both two-stacked and four-stacked arrays.

—30—

BRITAIN OPENS WORLD'S MOST POWERFUL TV STATION



THE new television transmitting station which was opened at Sutton Coldfield, near Birmingham, England, on December 17th is the world's most powerful video transmitter.

Owned and operated by the British Broadcasting Corporation, the new transmitter has an output of 35 kilowatts. This is several times more powerful than any U. S. television transmitter now in operation. According to the Radio Industry Council, such a high power beam has never before been radiated over such a wide frequency band as 3 mc.

The top of the new 750 foot lattice-steel antenna mast is over 1300 feet above sea level and 385 feet higher from the ground than the cross on the dome of St. Paul's Cathedral. Its base is level with the top of the antenna mast at Alexandra Palace, transmitting site for television programs in the London area.

The entire mast, weighing 140 tons, is pivoted on a steel ball 2 inches in diameter and held in position by four sets of steel guys, the topmost being attached at a height of 710 feet. A two-man electric elevator operates inside the lattice tower to a height of 600 feet. After that maintenance men have to climb. The eight dipole antenna array has electric heaters for de-icing.

The radio relay link, which beams the visual signal from London to Birmingham on a wavelength of 30 centimeters, consists of two terminal and four repeater stations and has unique technical features. It can be reversed to work in the opposite direction so that London can receive television broadcasts originating in Birmingham. Eventually the relay will operate in both directions simultaneously.

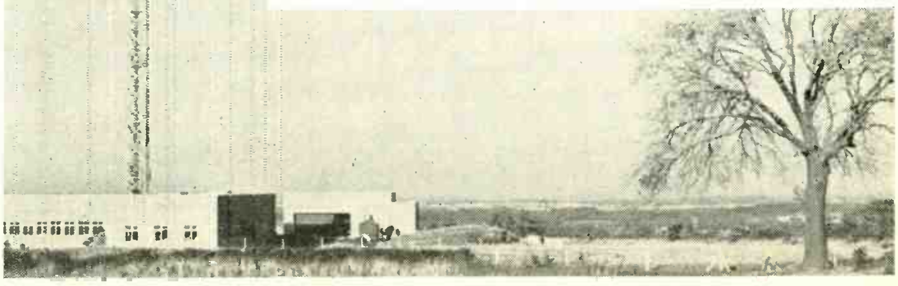
The repeater stations, each of which amplifies the received signal ten million times, are fully automatic and could be left unattended for months. If trouble should develop, duplicate equipment automatically comes into service and the engineers in London and Birmingham are informed by signal lights of what has happened.

At a later stage a new coaxial cable, which has been laid between London and Birmingham, will become available as an alternative to the radio link.

With the opening of the new station in the Midlands, manufacturers of television receivers have been working overtime to meet the demand for new sets. Total production in November was 35,000 units or 8000 more than was produced in October, which was the previous record month. Before the opening of service from the new transmitter, an estimated 40,000 receivers had been sold to dealers in the Midlands and an estimated 250,000 people witnessed the first telecast.

—30—

The BBC's new television transmitter at Sutton Coldfield. At the top of the mast is the wideband antenna consisting of two tiers of four vertical folded dipoles, arranged in cruciform, which radiate both sound and video signals. The section below the TV antenna is to be used for v.h.f. if present BBC plans materialize.



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MC6—1½ Watt Trans-Recr. Tubes, crystal, battery case, antenna. **$31.50**
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PE-103 DYNAMOTOR POWER SUPPLY. COMPLETE with dynamotor, filter, relay unit, battery cables, and shock mount. Part of SCR-284. BRAND NEW **$19.50**

BC-620 Mobile FM Transceiver—P. O. SCR-610. Includes 10 meter band. Excellent condition with tubes. **$11.95**
PE-120 Power supply with tubes—Excellent condition 5.50
Combination BC-620 and PE-120. . Both for 14.95

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TRANSFORMERS—6200 V. @ 325 ma. secondary—easily C.T. for 3100-0-3100 @ 650 ma.—Primary 105/110/115 V. 60 cycles—American Transformer Company. . . . . . . .NEW **$39.50**
2.5 V. @ 10 amps, C.T.—15,000 volt insulation—115 V. A.C. primary—Kenyon S-9883. . . . . 5.95
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400 Cycle INVERTER—G.E. 5DZ1NJ3A Input 27 V., 35 amps. Output 115 V. 485 V.A. single phase. **$12.50**
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24 V. D.C. Blower and Motor—1700 R.P.M.—1.35 amps. A. G. Redmond Co. 1.95

5CP1—5" CATHODE RAY TUBE, 4 for $4.25. . . . . **$1.45 each**

APN-1 ALTIMETER INDICATOR, basic movement 0-1 ma.; 5 ma. shunt, 270° dial. An excellent basic movement for constructing your own meters. . .NEW **$1.95**
METER RECTIFIER, full wave midget Selenium 10 volts, 30 ma. 29
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I.F. Transformer—1st, 2nd or 3rd, from SCR-522, 12,000 K.C. Iron Core tuning, can be tuned to television I.F. Frequency by removing padder cond. 3 for $1.00. . . . . .EACH .35

BC-348 Mounting Base. **$2.25**
BC-348 Outlet Plug. 69
BC-348 Mounting Base and Outlet Plug. 2.50

TEST EQUIPMENT

BC-221 Freq. Meter—125 K.C to 20,000 K.C. Excellent Condition $69.50
I-122 Signal Generator by Espy Mfg. Co. 15-27, 95-127 M.C. 79.50
TS-34/AP Portable Oscillograph made by Western Electric. Excellent condition. . 250.00
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IDEAL MOBILE POWER SUPPLY

PE-237 Heavy duty vibrator power supply. 6, 12, or 24 V., Input 525 V. 95 ma.; 105 V., 42 ma.; 6.5 V., 2 amps; 6 V., 500 ma; 1.3 V., 450 ma.; small supply 100 V., 17 ma.; 1.35-450 ma. with tubes. shock mounted.
BRAND NEW **$27.50**

MINE DETECTOR-SCR-625A Used for locating metal, underground pipes, gold. etc.
NEW WITH MANUALS $59.50
USED EXCELLENT COND. 39.50

SURPLUS RADIO CONVERSION MANUAL, Vol. 1, 115 pages of circuits and data. . . . . .Postpaid $2.50
CD-501 CABLE for PE-103 BC-654. . . . . . . .NEW 1.95
SPEAKER—6" P.M. Compartment. 25 watts, 50-6,000 ohms. Waterproof. Excellent Used. . . . 8.95

TERMS: Prices f.o.b Pasadena. 25% on all C.O.D. orders. Californians add 3% sales tax.

What's New in Radio

(*Continued from page 80*)

tric eye) which makes perfect recording every time.

The "Reelest" has been designed for easy portability. The specially designed case permits the unit to operate with the top cover down while all controls are accessible for operation. A hinged flap protects the controls as well as providing space for cord and microphone when the unit is being carried.

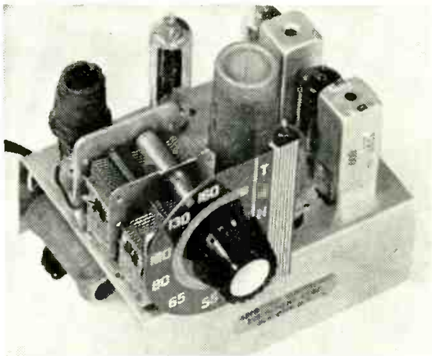
For full particulars or additional data, requests for this information should be addressed to Department E-4 of the company.

MINIATURE BC TUNER

Approved Electronic Instrument Corp. of 142 Liberty Street, New York 6, New York, is currently marketing a miniature superheterodyne broadcast tuner which has been designated the Model A-600 AC.

The circuit of the tuner is a standard superheterodyne using miniature tubes. The power supply is a standard 117 volt, 60-cycle full-wave rectifier. A power transformer isolates the line from the chassis, thus eliminating shock hazards.

The output cable is attached within the tuner to the low output tap but if



higher output is desired connection can be made to the medium or high output taps.

Since the unit measures only 4" x 4" x 5" and weighs 2½ pounds, it is ideally suited for applications where space is at a premium.

SEMI-FLEXIBLE COAX

Andrew Corporation, 363 East 75th Street, Chicago 19, Illinois, now has available a ⅜" diameter, semi-flexible coaxial cable (Type 83) for connecting transmitters to antennas in installations of 300 watts or less, to connect communications receivers to antennas, and to connect the phase sampling pick-up device to the phase monitor in broadcast directional systems.

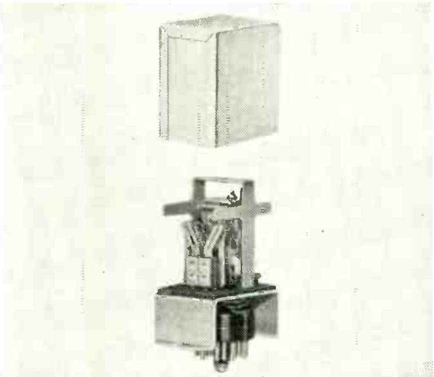
The outer conductor material is a soft-temper copper tubing which is easily bent by hand although the company does not recommend repeated flexure. The cable is easily uncoiled and laid in place and, once installed, it provides a permanent transmission line which is highly stable both electrically and mechanically.

For best results, the cable should be maintained under gas pressure at all times. Suitable gas-tight end terminals and other appropriate fittings are available. Upon request the cable will be shipped under pressure.

Bulletin 29-A gives full details on the cable and accessories. A copy is available on request.

RELAY ENCLOSURE

A new dust-tight, plug-in enclosure for the small *Clare* Type "J" relay is now being offered by *C. P. Clare & Co.*, 4719 West Sunnyside Avenue, Chicago 30, Illinois.



Entrance of dust is prevented by the steel cover and by the use of a Neoprene gasket which is closely fitted to the relay terminals at the factory.

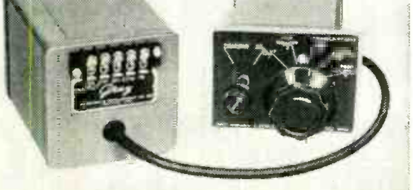
Installation is facilitated by use of a standard radio-type plug, which also reduces wiring costs. The base is secured to the chassis to prevent plug from being jarred or accidentally pulled from its socket. The dust-tight cover is easily removable for inspection.

A bulletin, No. 108, covers the new enclosure and is available on direct request to the company.

GRAY EQUALIZER

The Gray Research & Development Co., Inc. of Hartford 1, Conn., has announced the addition of the Model 603 to its line of equalizers. The new unit is said to provide a greater range of response curves and additional compensation to accommodate pickups of different characteristics than did previous models.

The high-frequency characteristic obtainable with the Model 603 comprise five steps ranging from flat response to a heavy roll-off for worn records. An auxiliary knob permits instant adaptation to the use of either



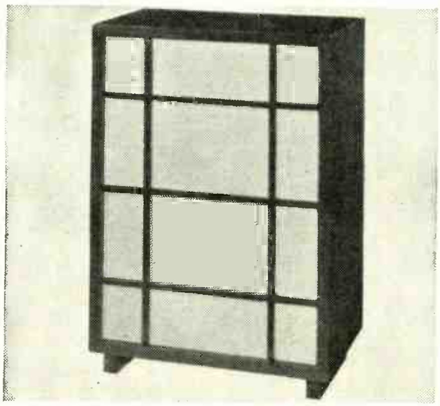
the *Pickering* cartridge or the *General Electric* variable reluctance pickup, for which correct compensations are provided. In all cases exceptionally close adherence to the correct characteristics is obtained.

A selection of 150 or 250 ohms impedance can be made by making appropriate connections to the equalizer terminal board. The controls are mounted on a clearly marked panel which is connected to the equalizer by means of an 18 inch shielded cable.

TWO-WAY SPEAKER SYSTEM

Holl Audio Industries of Hollywood 28, California, has recently added the Model 800 F, low distortion, two-way loudspeaker to its line of audio equipment.

Among the features of this new unit is the special plastic treatment of the cone compliance to improve edge dampening and reduce distortion caused by cone breakup, the reduction of cone resonance and cabinet "boom," the elimination of the usual 60-90 cycle bass reflex boom, correct matching of the highs and lows, thus eliminating the need for pads on the high



section, and a full frequency range from 40 to 15,000 cycles.

The loudspeaker is housed in a furniture-finish cabinet which measures 37½" high by 25½" wide by 16" deep. Bass reinforcement is by the vented tube method. Acoustical padding is used on all interior walls. The multicellular high-frequency horn is driven by an Alnico V PM driver. The woofer section has a 15", 25 watt loudspeaker with 25 ounce Alnico V magnet. The free air resonance of the cone is 40-45 c.p.s. The 800 cycle crossover has air core windings and meets theater standards.

DYNAMIC MICROPHONE

A new dynamic microphone, the TV 655, has been announced by *Electro-Voice, Inc.* of Buchanan, Michigan.

This slim, versatile microphone with ultra-wide range and high fidelity dynamic performance and utility, requires no additional closely-associated auxiliary equipment.

Engineered and built to meet the need in studio and remote telecasting and broadcasting, the new TV 655 is suitable for special events announcing, sportscasting, audience participation, recording, and high quality sound amplification. It can be used either on a stand or in the hand or on a boom. It does not hide the performer's face and can be easily concealed among studio props.

This model is omni-directional, becoming slightly directional at extremely high frequencies. It provides smooth, peak-free response over the range of 40 to 15,000 c.p.s., plus or minus 2.5 db., according to the company.

A bulletin giving specifications and operational characteristics of the TV 655 is available on request. Ask for TV Bulletin No. 156.

NEW V.T.V.M. KIT

Heath Company of Benton Harbor, Michigan, has placed a new v.t.v.m. kit on the market, the V-4.

Positive automatic meter protec-

tion on all functions is given by the electronic a.c. voltmeter and push-pull d.c. voltmeter circuit. The electronic a.c. voltmeter circuit incorporates a new balance control which allows complete elimination of contact potential, removes meter shift with various ranges, and gives accurate readings on all ranges. The 200 microampere meter uses an Alnico V magnet for accurate readings. The divider resistors are 1% precision ceramic units. The unit provides 24 complete ranges. The meter pointer can be offset from zero for FM and TV alignment. The d.c. probe is isolated for dynamic measurements of receiver voltages without disturbing receiver operation.

MIDGET ELECTROLYTICS

A line of small paper tubular condensers, known as Type P85, is now available from *Aerovox Corporation* of New Bedford, Massachusetts.

Featuring the same materials and general processes used for the company's "Aerocon" Type P87, the new miniature size required new production techniques for handling minute sections, wires, and other components without sacrifice of quality and mass production requirements.

The paper section of the Type P85 unit is Aerolene-impregnated and the unit is sealed with Duranite. The resulting rock-hard, paper-cased tubular offers the heat and humidity resistant qualities associated with plastic tubulars. These condensers can be used at 212 degrees F. without drips. They have extremely high initial resistance and recover same upon heating.

MINIATURE TERMINAL LUGS

Designed and engineered to meet the requirements of the radio component parts trend toward lighter and smaller sized equipment, the new line of miniature terminal lugs announced by *U.S. Engineering Co.*, Glendale 3, California, is of special interest to manufacturers of aircraft and armament electronic equipment, and manufacturers of hearing aid devices and other small size radio units.

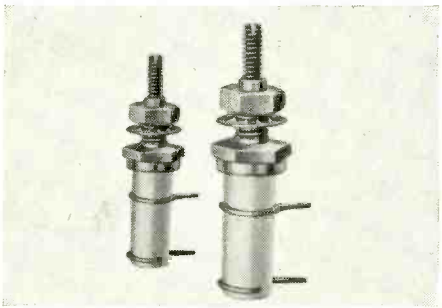
The new miniature series, like the company's standard line, is silver-plated and specially treated to prevent corrosion. All undergo rigid inspection to maintain tolerances.

Full details on the new series are available from Department H. Inquiries should be addressed to the company at 521 Commercial Street.

CERAMIC COIL FORMS

Two new ceramic coil forms, designed to fit into small or hard-to-reach places, have just been announced by *Cambridge Thermionic Corporation,* 463 Concord Avenue, Cambridge 38, Massachusetts.

Designated Types LS-5 and LS-6, these two coil forms are made of silicone impregnated ceramic for high resistance to moisture and fungi. The LS-5 measures 1 1/16" in height (mounted) and 3/8" in diameter. The LS-6 is 13/16" high and 5/16" in diameter. The ring terminals are adjustable. Both sizes are provided with a spring lock for the slug, which can be furnished in high, medium, or low frequencies. The mounting stud is brass, cadmium plated to withstand severe service conditions. The mounting hardware is furnished with the forms.



A new catalogue, the #300, covers these coil forms. A copy may be secured from the company. —30—

International Short-Wave

(*Continued from page* 59)

for listeners in Eritrea. ETB has been heard widely in the United States around 1000-1100 weekdays and on Sundays from as early as 0930; on Sundays, several religious programs are radiated, some of which are in *English*. Schedule seems irregular, signals are poor, badly QRM'd.

Formosa—Sanderson, Australia, still lists BCAF, 8.995, heard 0530 with Chinese program; *English* lesson 0700.

France—Paris is now using 9.550, 9.680 to North America 1945-2000 in *English*.

A frequency of 15.1000 is being used by Paris at 0630-0645; 6.145 is used 0030-0045, 0130-0145, 1300-1445. (Bluman, Israel)

French Indo-China—Station officials have informed Bellington, N. Y., that the name of *Radio Saigon* has been changed to *"Radio France Asie,"* since it is now a Vietnamian outlet. Schedules for the most part remain unchanged.

French West Africa—*Radio Bamako* advises it has an output of 2 kw. on 15.030; the station is operated by the government and is on the air at irregular intervals. Programs consist of meteorological forecasts, government, and industrial news, and now and then some music. (*The Broadcaster*, Perth, Western Australia) FGJ9, Bamako, is listed on 15.025 with 350 watts and as "inactive."

Germany—Patrick, England, reports that some time ago he logged a station on approximately 5.880 around 1200 relaying AFN programs from Munich's m.w. station.

Radio Frankfurt, 6.190, has a good signal around 0130. (Bluman, Israel)

Greece—The Armed Forces in Central Greece, outlet at Larissa, has moved to approximately 6.770 from 6.745, but still has bad CWQRM; is heard afternoons.

Holland—Latest schedules for *Radio Nederland's* International Service are: *English*—0500-0555 to Austra-

(*Continued on page* 140)

lia, New Zealand, and Pacific Area, 21.48, 17.775, 15.22, and for listeners in Europe, 6.025; 1230-1325 to South Africa, Great Britain, Continental Europe, 11.73, 9.59, 6.025; 2100-2155 to United States and Canada, 11.73, 9.59. Dutch—0715-1000 to Indonesia and Far East, 21.48, 17.775; 1330-1530 to Europe and Africa, 11.73, 9.59, 6.025; 1830-2055 to Surinam and Netherlands Antilles, 11.73, 9.59. Afrikaans—1530-1555 to South Africa, 11.73, 9.59, 6.025. Arabic—1400-1430 to Near East and Egypt, 9.59; 1600-1630 to North Africa, 11.73. French (weekdays only)—1130-1215 to Near East and Southeastern Europe, 15.22, 11.73, 6.025; 1630-1715 to North Africa, Europe, 11.73, 9.59, 6.025. Hindustani and *English*—1100-1130 to South and Southeastern Asia on 15.22, 11.73. Indonesia—0800-0900 to Indonesia, 15.22. Spanish (weekdays)—1730-1825 to South America and Spain, 11.73, 9.59, 6.025; 2200-2255 to Central America and Caribbean Area, 11.73, 9.59. The "Happy Station Programs" of Eddie Startz are radiated Sundays and Wednesdays 0930-1100 on 15.22, 6.025 to East, Far East, Europe; at 1600-1730 on 9.59 and (Sundays only) on 6.025; to North America at 2200-2330 on 9.590 and (Sundays only) on 11.730. On Tuesdays 0600-0730 on 21.48, 17.775, 15.22, and 6.025 to Pacific, Australia, New Zealand, and Europe.

Korea—HLKA, 7.933, noted 0445 with Western music, then news in Korean. (Sanderson, Australia)

Lebanon—In Newfoundland, *Radio Levant,* 8.030V, Beirut, fades in around 1230. (Peddle) Starry, Pa., and Sutton, Ohio, report this one around 0000-0130. Pearce, England, airmails that Beirut now has *English* 1000-1100, and signs off that period with "Knightsbridge March."

Madagascar—Tananarive is reported heard on approximately 9.694 around 2215-2245; uses some French.

Malaya—BFEBS, Singapore, has replaced 6.045 with 6.175; when relaying BBC news 0700 gives frequencies as 15.300, 11.880, 9.690, 6.175. (Cox, Delaware)

Malta—Forces Broadcasting Service, Middle East, was still testing when this was compiled; appeared to be using 6.140 and 4.965 from 2330; 4.965 and one of several other frequencies (7.220, 7.270, or 6.140) appeared to be in use around 1100-1700. Bluman, Israel, airmails me that the FBS network to Egypt is being expanded; he had heard FBS, Cyprus, on 11.850, calling Malta on test 0315-0330.

Mauritius—V3USE, Forest Side, is widely reported on approximately 15.055 around 0930 to 1200 when it signs off after playing a few bars of "God Save the King." Uses mostly French. Has been heard irregularly in the U. S. around 2100-2330 close-down, identifying at 2200 and/or 2245 in *English;* it is also reported to have been heard with *English* news at 2200 on occasion. Is a bad spot, has terrific QRM.

Mongolia—*Radio Sweden* reports

Ulan-Bator-Choto in Soviet-Mongolia daily on 8.400 to around 1000.

Mozambique—Laubscher, South Africa, lists *new* schedule of *English* broadcasts from Lourenco Marques as CR7BE, 9.715 (claimed by station, actually appears to be 9.763), 0000-1100; CR7BU, 4.932, 1000-1600; CR7AA, 6.137, 0000-1000; and CR7AB, 3.493, 1100-1600; on Sundays, CR7BE and CR7AA begin 0200.

Nigeria—A station reported on 9.655 by Simpson, Australia, and Cushen, N. Z., relaying BBC's General Overseas Service around 0200 is believed to announce "This is Nigeria." (Radio Australia)

Pakistan—Recently, Pakistan outlets have been moving about a great deal. At the time this was compiled, Karachi seemed to be using 11.770.5 with Dacca, approximately 7.635, in parallel, for news 0700 and 1015; the 15.335 outlet, formerly Dacca, was being heard with news 2100, but Karachi, 11.885, seemed to not be in use; the 15.335 channel at 2115 was announcing as "in the Home Service of *Radio Karachi*," so may be Karachi moved from 11.885 instead of actually being Dacca, as formerly. Karachi has been reported testing on 15.15 and on 9.645, irregularly. A station on approximately 11.81, which has been QRM'g VLC7, 11.81, in the East Coast beam from *Radio Australia* around 0700-0830 or later, is believed to be a Pakistan outlet.

Panama—HP5K, 6.005, Colon, noted 0600-0630 in *English*. (Hefner, D. C.)

Philippines—The *new* Philippine station on approximately 4.985 has been identified by Cushen, N. Z., as DYB2, relaying medium-wave DYBR; it announces "This is Davao," so is assumed to be at Davao, Mindanao; schedule was given as 0500-0900. (Radio Australia) Heard in Australia at 0630 with musical program and news. DZH4, 6.000, heard 0645 with sponsored program of music and news. DZH7, 9.748, noted 0500 with news, then music. DZH3, 9.505, noted 0530 with sponsored program of music.

Poland—Warsaw, 9.527, noted 0200 with Polish news, then music. (Sanderson, Australia)

Portugal—Mesquita e Sousa, Portugal, says Radio Clube Portugues at Parede is now CSB51, instead of CS2WI.

Sao Tome—CR5SA, "Radio Clube de Sao Tome," 9.615, has been heard by DeMyer, Mich., signing on 1445 with nice signal; all-Portuguese; is buried in QRM from 1500.

Saudi-Arabia—Bluman, Israel, says regular schedule of Mecca is now 1200-1300 on 3.960, 5.985, 9.645, and 11.950. (Radio Australia)

South Africa—Laubscher, South Africa, reports that as of May 1, the South African Broadcasting Corporation will begin its commercial program in the Transvaal; other provinces will follow later with commercial programs; the new service will be known as *"Springbok Radio"* and will use s.w. frequencies in the 31-, 40-, 60-, 90-, and

120-meter bands; specific frequencies have not yet been given. Schedules will be 2345-1600. By that time it is expected that regular SABC schedules will most likely be the same, doing away with the "mid-morning" and "mid-afternoon" (in South Africa) breaks as at present.

Southern Rhodesia—Laubscher, South Africa, says, according to press dispatches, a *new* transmitter of 15 kw. should be in operation from Salisbury by this time. While no frequency was listed, it will most likely be 3.320 which Laubscher heard testing some months ago. Plans have been made to extend schedules in both Northern and Southern Rhodesia soon.

Spain—*Radio Nacional de Espana*, Madrid, Spain, is now issuing a monthly program leaflet in *English*, free of charge. (Sklenar, Nebraska, others)

Sweden—*Radio Sweden* is sending out a *new, all-English* verification card. (Skoog, Sweden) A sample sent me is quite attractive.

Syria—Damascus has been testing on 5.000 to 5.005 in parallel with 6.000, 11.750, according to Bluman, Israel; news 0530, 1400. (Radio Australia)

Tahiti—A phone station at Papeete that might possibly come into broadcast use has been heard by Balbi, Calif., with fine signal on 9.035, around 0300-0430, calling Paris.

Tangiers—The *new* "Voice of America" relay station (Tangier I) is widely reported heard with fine signals afternoons to 1730 closedown.

Thailand—Bangkok appears to have replaced 6.010 with 6.240 in parallel with approximately 9.796 for the overseas transmission at 0500-0630 and for the native program at 0700-1030. Now announces as "The Overseas Broadcasting Station of Thailand."

USA—It is widely reported that WWV now announces in *voice* at 5-minute intervals, giving the time.

USSR—Petropavlosk, 6.075, has dropped its 0123-0230 transmission. (Balbi, Calif.)

Vatican—Peddle, Newfoundland, reports HVJ on 7.280 at 1515 in Czech. Is heard in England on 7.28 around 1500 in parallel with approximately 9.643, 5.970, according to Pearce.

* * *

Last Minute Flashes

At press time I received a flash from Dilg, Calif., that he had picked up a strong signal on approximately 6.095 to 6.100 around 1050; played western orchestral music; had numerous breaks but the same type of music continued to after 1200; no announcements 1130 or 1200; signal unusually good for 49 meters that late; evidently was a test of some kind but Dilg did not know from where; from strength must have been at least a 100 kw. transmitter, he said.

Starry, Pa., reports good signal from Johannesburg, 9.523, around 0100-0200.

Radio Douala, Cameroons, sent verification letter in 17 days; listed frequency of 9.150, said using 600 watts with Delta antenna oriented NW-SE; said will have a *new* 1 kw. transmitter ready in 1950 and will then use 7.278; wants reports. (Starry, Pa.)

Paris-Inter, 6.200, 100 kw., is a strong signal in Norway with its Light Program weekdays 0515-0830, 1400-1815; Sundays 0130-1815. (Halvorsen)

I recently heard a Chinese station on approximately 6.100 carrying the 0830 news from Peking; good signal; possibly Chungking?

Radio Pakistan has been heard on 9.645 with news 1015. (Balbi, Calif., Fried, Mich.)

Cebu, Philippines, 6.140, heard in Texas 0830 in *English.* (Stark)

Pearce, England, reports *Radio International, Tangiers,* on 6.110 at 1700 with program in Spanish.

The Chinese Communist outlet around 6.650 does *not* take the Peking network program either before or after 0830. (Balbi, Dilg, Calif.)

Ponta Delgada, Azores, CS9MB, 4.845, is good level in Norway 1700-1900, reports Halvorsen. The same monitor reports the Blue Danube Network, Salzburg, Austria, is now scheduled weekdays 0000-1800, Sundays 0100-1800; that Dornbirn, French Zone, is scheduled 0000-0300, 0500-0810, 1000-1800; Salzburg operates on 9.533, Dornbirn on 6.000.

Port-au-Prince, Haiti, 4VRW, at the time this was compiled had moved from 9.785 to 10.200. (Balbi, Calif.)

Radio Ceylon, 15.12, heard around 1335-1425 calling AIR with news dispatches, talks. (Fargo, Ga.)

Dilg, Calif., flashed that Rangoon seemed to have moved from 6.035 to around 6.070-6.075, heard signing off 1015. Balbi, Calif., flashed that BED2, 11.725, Taipei, Formosa, had replaced the 15.235 channel 2300-0100.

Radio Pakistan at Karachi has been heard on 17.835 at 0110 in parallel with 11.885; heard reopening 0700 on 17.770 and 11.810 as well as on 11.770 which is quite noisy; transmission closes 0830, but comes on again 0900 on 9.645 and 11.770. The "Voice of Free China" at Taipei, Formosa, has moved to the 41-meter band, approximately 7.260, where has news 0610, and identifies as BED2, BED4, and BED7. A station heard a recent Saturday at 0620 on measured 18.406 with news identified as "The Voice of the Viet Nam" and is assumed to be operating from French Indo-China. Australian DX-ers report Bangkok is now heard on 15.910 in parallel with 6.240 at 0500; they list call for 15.910 as HSJ4. DZH7, 9.740, Manila, will soon increase power from 300 watts to 3 kw. and will beam in the direction of Bombay; wants reports to The Far Eastern Broadcasting Company, P.O. Box 2041, Manila, Philippines. (Radio Australia)

On the day this went to press, HVJ, Vatican City, was an excellent signal here in West Virginia in its (daily) 1315 *English* period.

* * *

Acknowledgement

Many thanks, fellows, for the extremely good cooperation, especially with regard to data for the *English* newscast list. . . . . . KRB.

TV Interference Patterns

(*Continued from page* 49)

ting into the video circuit. The frequency of the audio signal determines the number of bars obtained. The higher the frequency, the greater the number of bars.

Now adjust the signal generator to deliver an unmodulated r.f. signal—the frequency is not too important, but should be somewhere between 100 kc. and 1 or 2 megacycles.

In this case, the frequency of the signal is greater than line sweep frequency, so that the individual lines will be made brighter and darker along their length. This may result in the vertical line pattern shown in Fig. 1B. The lines may not only be vertical, but may slant either to the right or left, as shown in Fig. 1C.

Whether the lines are perfectly vertical, or slant to one side, as well as the number of lines seen, all depend on the frequency of the interfering signal with respect to line frequency (15,750 c.p.s.). This can be readily demonstrated by varying the frequency of the signal generator over a fairly broad range. At some frequency settings the line pattern will not be obtained, but a very coarse "grain" effect will be seen.

This type of interference pattern (vertical and slanting lines) may be caused by interference from a strong r.f. carrier signal, whether a ham station, broadcast station, or other source. It is quite a distinctive pattern and easily recognized once seen in its different forms.

To demonstrate the type of interference pattern caused by an AM modulated r.f. signal, simply switch the signal generator to deliver a modulated r.f. output. The vertical lines will still be seen, but horizontal bars will also be present. The modulated r.f. signal may, at certain frequencies, form a "checkerboard" pattern.

If the signal generator is tuned to deliver an r.f. signal with a frequency of 4.5 mc., then a very fine grain-like pattern may be seen on the screen. This is the same type of pattern obtained when there is a strong beat between the video and audio carriers due to misalignment of the video i.f. stages, misadjustments of traps, or due to turning the contrast control too high in high definition sets.

Since fine lines which may be perfectly vertical, or which may slant either to the right or left are obtained with different frequency r.f. signals, we might expect FM interference to give us a combination of changing lines . . . lines which slant first one way, then another, and which vary in number. If the frequency variation is smooth and does not occur in jumps, then the line variation must be smooth, and the effect of a "wavy line" pattern might be expected.

And this is exactly the type of pattern that is obtained due to FM interference, whether from an FM station or from a piece of r.f. equipment whose frequency varies rapidly under load (such as diathermy equipment). The basic pattern can be demonstrated by manually shifting the signal generator frequency rapidly back and forth over a small range, and watching the screen of the TV set. The type of pattern obtained, typical of FM interference patterns, is shown in Fig. 1D.

The general technique of demonstrating television interference patterns as described is not only of value to the service technician trying to gain experience in TV, but may also be used to good advantage in schools, where some of the interference conditions encountered are discussed. An actual demonstration of the type of pattern obtained in a particular case of interference enables the student to get a much clearer picture than the longest lecture type description, or the best photographic reproduction. —30—

Broadband Converters
(*Continued from page 40*)

nal boosters, etc. It should have its variable condenser, a mica padder, open to about half its capacity when the r.f. and oscillator circuits are tuned, and then adjusted for maximum signal. Its adjustment may require a slight touching up of the r.f. coil tuning in order to repeat the output signal.

The photographs of the dual 6AG5 converter may make it appear more complicated than it is. This is because equipment not required for converter operation was mounted in the same box. A break-in relay and antenna switch were added for transmitter operation. The antenna switch can be of the double-pole, miniature type where a transmitter is not to be used in conjunction with the converter. Here it is used for antenna switching, converter and transmitter filament switch, and as a safety to keep the transmitter high voltage from being applied until filament voltage is applied. A triple-pole, double-throw switch is needed in this case. The break-in relay may be applied to any converter so that it removes screen grid or oscillator voltage from the TB-17 (war surplus) carbon mike button when pushed for transmission.

A break-in relay is not a "must," it simply removes the need for turning down the receiver gain each transmission and decreases the recovery time of the receiver by keeping it from becoming blocked. —30—


"Quick! Cut me off! I gotta sneeze!"

Condenser Tester

(*Continued from page* 48)

condenser is larger than 90 μμfd., other means must be employed to determine its capacity.

One other adjustment which is necessary is the initial tuning. This is accomplished by a third variable condenser connected across the tuned circuit. The calibrated condenser is set to zero on the dial and this last condenser adjusted to give zero beat in the detector. When the unknown is connected, the calibrated condenser is then returned to give zero beat. Sometimes zero beat is not a desirable reference point. In this case, some pitch such as 500 cycles can be used, but a special caution is then necessary. There are two adjustments which will give this beat, one either side of zero beat. If the initial adjustment is on the high-frequency side of zero beat, the final tuning must also be on the high side, otherwise, a large error will result.

The detector is of the oscillating type. That is, enough of the output is returned in the proper phase to the input so that the circuit oscillates. This makes it possible to have an audio beat note between the incoming signal and the self oscillations of the detector. The output of the detector which consists of the audio beat frequency plus the two radio-frequency currents which produce the beat is sent through a filter which eliminates all but the audio beat and passes this to an audio amplifier.

The foregoing paragraphs explain the basic principles of the instrument. A few refinements were embodied in the unit which were dictated by necessity. First of these was in the main oscillator. In order to obtain the necessary stability of frequency, an oscillator having a fundamental frequency of 80 kc. was used. On the other hand, the detector was adjusted to 560 kc., the seventh harmonic of the oscillator fundamental. This brings about two advantages. First, the frequency change of the oscillator is multiplied sevenfold so that the observer has no difficulty detecting the change. Second, the frequencies of the two circuits are independent of adjustment of each other. Were the oscillator and detector on the same frequency, they would tend to "pull" each other into zero beat. All the audio amplification that is required is a single beam pentode amplifier. This provides ample output.

The accompanying diagram shows the complete circuit of the unit. C_5 is the calibrated tuning condenser; C_6 is the semi-adjustable condenser which may be removed from the circuit when capacities greater than 45 μμfd. are being measured; C_1 is the initial adjustment condenser. C_1 is actually connected across the detector circuit instead of the oscillator. This was done in order to reduce the components in the oscillator tuned circuit. Since the detector needs a tuning condenser anyway, it was found that greater stability results through this arrangement.

One additional feature which is of interest is incorporated in the audio output circuit. It is necessary to have a reference audio frequency for the initial and final adjustments. An ordinary earphone was tested and found to have a natural resonant frequency of about 800 cycles. This was fastened to a 1.5 inch diameter tube whose length was adjusted to have the same resonant frequency. When the proper audio frequency, 800 cycles, is obtained, the audio output is stronger than at any other frequency.

Top view of the completed condenser tester with the cover removed to show parts layout.

The necessity for having an external audio reference was thus eliminated. A surplus F.L. 8 or F.L. 30 filter could also be used in the input circuit to the audio amplifier with an ordinary transformer and speaker in the output. A 440 cycle tuning fork which may be purchased in almost any music store makes a convenient reference tone if the resonant earphone circuit suggested is undesirable.

The entire unit is housed in a 5" x 6" x 9" standard metal box. A chassis, 8¾" x 4¾" x 1½", was made from a piece of 20 gauge galvanized sheet iron obtained from a local roofing concern. The only special shielding required is the shield can for the detector coil. A metal 6J7 avoids the necessity of shielding this tube. It can be seen from the photograph that the small filter choke and power transformer are on the left below the earphone assembly. Immediately to the right of the resonating cylinder is the rectifier. Next is the 6C5 80 kc. oscillator behind which is the 6G6 audio amplifier. The detector tube is on the extreme right hand end of the chassis with the shield can for the coil mounted behind and to the left.

The variable condenser, C_1, was made from a variable mica padder condenser in order to conserve space beneath the chassis. A short length of ¼" brass rod, to which the knob was fastened, may be soldered to the head of the adjusting screw. —30—

HANDY PLUG-IN ANTENNA

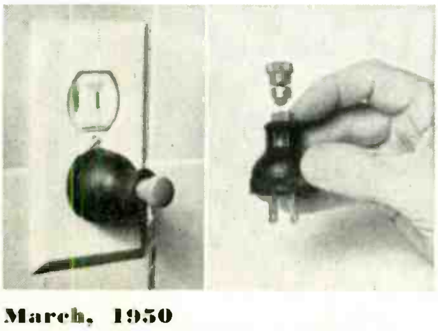
By ARTHUR TRAUFFER

USING the house electrical wiring and the outdoor power lines as an antenna is by no means a new idea, but here is a simple and very handy method of doing it.

As shown in the photographs, you simply push a small mica condenser into the hollow handle of a rubber plug, connect one wire lead to a binding post of the type shown, and connect the other lead to one prong of the plug. The condenser used measures about $\frac{7}{16}$" wide and $\frac{11}{16}$" long. You can enlarge the opening in the rubber handle with a rat-tail file, if necessary, before pushing the condenser in place.

This antenna gives very good results with any AM receiver; it can be plugged into any outlet in the house, and it completely eliminates the nuisance of stringing up an outdoor or indoor antenna. —30—

Two views of the handy "plug-in" antenna showing method of assembling the unit and the unit in use. The largest capacity condenser which will fit plug should be used.



Behind the Scenes

(*Continued from page* 41)

rect focus is achieved by movement of the tube—the image orthicon—while the lens remains stationary.

NBC cameramen are trained according to good motion picture standards, since the composition of the picture is of prime importance. The cameraman's function throughout the performance is to select the proper lens and align optically for best composition. He is in constant communication with the technical director in the control room through a direct phone line, and he wears an ear-plug receiver, specially designed by *NBC* engineers.

Boom man—microphones: The standard adjustable motion picture type of microphone boom is used in a television studio. The microphone is suspended from this boom and its characteristics are unidirectional. This is preferable because of its back sound-rejection qualities. The boom man must manipulate his controls so that the microphone follows the actor as he moves from one place to another during the performance. The boom man receives his instructions from the audio engineer in the control room through a headphone.

Light direction man—lights: The lighting of the show comes under the supervision of the light direction man and two or three assistants.

A highly flexible and controlled incandescent lighting system is used most. Spotlights are used for modelling effects, broad (or flood) lights are utilized for filler light and general key illumination. This is similar to units utilized in standard motion picture lighting practice.

Stage Manager: This man—in the studio—is the visible representative of the program director, and he indicates to the performers the wishes of the director in reference to cues, positions, speeding or slowing of action, and so on. Since the stage manager is constantly on the move around the studio, he would be hampered if he had to use standard phone connections for communications from the director. He is, therefore, equipped with a small radio receiver, called a "pocket ear," over which the director actually broadcasts to him. The power used in this transmission is only sufficient to reach the stage manager . . . it cannot project outside the confines of studio.

The men who control the activities of these technicians operating in the studio are located in the control room.

In the Control Room

Program Director: He is in charge of the entire operation, and is guided by physical and technical limitations as interpreted by his technical director working beside him. It is the program director who, during rehearsals, has set the action of the program, and has determined the actual shots and angles according to his interpretation of the action.

Technical Director: This man is the program director's "right arm." He supervises the entire technical operation of the show and instructs the cameramen as to the type of shot desired by the program director. In constant communication with the cameramen throughout the performance, he manipulates the camera-switching panel which actually puts each camera on the air as the program director "calls the shots." A red light appears on top of a camera when it is switched on the air by the technical director.

A corresponding red light appears in the visor of the camera on the air—as an additional guide to the cameraman. The technical director also manually controls "dissolves," "superimpositions," "split-screen" and other special camera effects. He is in touch with the film studio and passes along "stand-by" and "roll" cues to start the motion picture projectors when film inserts, titles, or commercials on film are used as part of the show.

Video Engineer: During rehearsals and the actual performance, the video engineer adjusts the picture in reference to brightness and contrast before it is sent out on the air. He constantly observes scenes from each camera and tries to match—as closely as the eyes can detect—the pictures of all three. There are also other voltage adjustments necessary from time to time while on the air. Before the program goes on the air, it is his responsibility to make necessary adjustments for the proper functioning of the system—after the hour-long camera warmup period—for linearity, alignment of image orthicon, various voltages, beams, target and proper scanning, done with the aid of a test pattern.

Audio Engineers: The audio engineer is responsible for the sound pickup and its quality for transmission to master control. He also mixes background music and sound effects with dialogue. The boom-man in the studio is directly under his supervision, as is the record man in the control room.

Record Man: This man must pick certain music passages from standard recordings and play them for background or for transition bridges. He takes his cues from a marked script or by direct cue from the program director. This requires exceptionally accurate "spotting" of records—always done by hand. In some puppet shows, the voice of the puppet is recorded and must be played back to fit in with the dialogue of live actors on the air. This is the record man's responsibility. However, sound effects are not handled by the record man, but by a sound effects man in the studio, and are picked up by a separate microphone.

All of the aforementioned technicians and their supervisors, the directors, work in close coordination to achieve the high degree of precision so necessary in modern television. —30—

AFCA NEWS

ARMED FORCES COMMUNICATIONS ASSOCIATION

This Association is a patriotic non-profit organization, with chapters in most of the larger cities, dedicated to developing and maintaining efficient personnel, commissioned, enlisted, civilian, for the supply (including design and development), installation, maintenance, and operation of communications and electronic equipment for Army, Navy, and Air Force and their supporting civilian activities. It publishes a magazine "SIGNALS" at its national headquarters in Washington. Every American interested in any way in communications is eligible and invited to join. Dues are $5.00 per year. Application should be submitted to the secretary at 1624 Eye St., N. W., Washington 6, D. C., who will furnish details upon request.

NATIONAL CONVENTION

For the second time in four years, part of the AFCA annual convention will be held at the Signal Corps Center, Fort Monmouth, on May 13th. The first day of the meeting, May 12th, will be spent in New York City and will be devoted to business meetings, conferences, and the annual banquet, plus a visit to the Photographic Center in Astoria, L. I.

Delegates will arrive at Fort Monmouth as guests of Maj. Gen. F. H. Lanahan, Jr., commanding general, and AFCA's Fort Monmouth Chapter to take part in a full-day program, during which they will be addressed by Maj. Gen. Spencer B. Akin, Chief Signal Officer, and other dignitaries.

The tentative itinerary will include outdoor and indoor exhibits, a tour of the Signal Corps Engineering Laboratories, other post activities, and luncheon with Signal Corps troops in the field.

During the afternoon, the visitors are scheduled to witness a combat problem, high speed wire laying, and other demonstrations, followed by a review of troops during which Signal Corps participation in the Civil, Spanish, and both World Wars will be symbolized.

The exhibits and demonstrations being planned will include television, radar, radio relay, high frequency equipment and others that will present the Army's progress in electronic and communications fields.

* * *

AFCA CHAPTER NOTES

Atlanta

The part that photography has played in the production of visual education aids at Camp Gordon's two Army technical training schools was discussed by Capt. Roger L. Leonard, Signal Corps, at the annual winter dinner-meeting of the chapter on January 10th at the Fort McPherson Officers' Club.

Capt. Leonard was well qualified to present this subject. He is in charge of one of the largest photographic laboratories in the Third Army area, and has helped to develop the use of still photography in preparing training aids used at both the Southeastern Signal School and the Military Police School. He has also helped to develop the film library at Camp Gordon which is considered one of the most complete of its kind.

W. H. Mansfield, Atlanta Chapter President, was elected Secretary of the *Southern Bell Telephone and Telegraph Company* on January 1st. Forty years in telephone service, Mr. Mansfield has been Assistant Secretary and Assistant Treasurer, as well as Assistant Vice-President. He will continue to serve as Assistant Treasurer. He is also a director of the *Inter-Mountain Telephone Company* of Bristol, Va., and of the *Carolina Telephone and Telegraph Company* of Tarboro, N. C.

Chicago

The Chicago Chapter's January meeting was held at the *Automatic Electric Company* plant with C. S. Cadwell, president of the firm, acting as host.

C. F. Ffolliot, director of the company's products design section, described "Automatic Toll Ticketing" and K. A. Regel, manager of industrial sales, spoke on "Adventures in Remote Control."

After a short recess the U. S. Navy's color film entitled "To The Shores of Iwo Jima" was shown.

Chapter President Oliver Read presided over the well-attended meeting and introduced the speakers.

Kentucky

The chapter's January dinner-meeting was preceded by an informal get-together at the Lexington Signal Depot Officers' Club.

"Atomic Warfare" was the subject of a talk by Maj. Frank C. Healy, graduate of a course in radiological defense at the Army Chemical Center, Edgewood, Md.

Louisiana

Louisiana Chapter officers are cooperating with officials of local posts of other military associations in sponsoring the fourth annual Industry-Army conference being held in New

Orleans on February 27th. The chapter will give a luncheon on that day in honor of Maj. Gen. Spencer B. Akin, Chief Signal Officer.

New York

The results of the chapter's annual election are as follows: President—Col. Thompson H. Mitchell, Exec. Vice-President, *RCA Communications, Inc.;* Vice-Presidents—Lt. Col. Ralph G. Edwards, *AT&T Co.;* Capt. Roy W. M. Graham, Chief of Staff of Eastern Seafrontier, USN; Col. Peter C. Sandretto, *Federal Telecommunication Laboratories;* Treasurer—Maj. Theodore N. Pope, *Bell Telephone Laboratories;* Secretary—Lt. Col. David Talley, *IT&T Corp.*

Sacramento

Mather Field Air Base was the scene of the chapter's December 5th meeting. Members gathered at the Officers' Club and were welcomed by Brig. Gen. Carl B. McDaniel, Commanding Officer of Mather Field, who gave a resume of the background, history, mission, and training program of the base.

After dinner, the members were taken by bus on a tour of the training facilities of the base. Of special interest was the great quantity of communication and electronic equipment utilized in the training aids.

The program was concluded at the Officers' Club with the motion picture "Guided Missiles." This picture depicted the early experiments, manufacture and launching of the V-1 and V-2 rockets by the Germans during World War II; the improvements and development made by the U. S.; and the relative dependence of guided missiles upon communications and electronics.

Seattle

Radar was discussed by representatives of three varied activities at the December 13th meeting of the chapter in the American Legion Hall.

Commander Dean of the Coast Guard described the radar equipment used by the Coast Guard in performing its duties in wartime and in peace. Some of the subjects he covered were: air search and warning, safety at sea, aids to navigation, radar beacons, enforcement of maritime regulations, ice patrol, protection of life and property at sea, use of balloons and radar equipment in plotting wind directions.

Mr. Hogg of *General Electric* illustrated his talk with pictures of various types of radar and their uses, ranges covered, technical operations requirements, areas in which certain types are preferred and why. This was followed by a film showing the use of radar in locating enemy craft, homing and navigation in general.

Mr. Kasrow of the CAA concluded the program with a discussion of air traffic control, navigation by instruments, position reports, moving target indicators, identification of planes, and the use of radar in avoiding thunderstorms.

South Carolina

The second meeting of the South Carolina Chapter was held in Charleston on December 1st at the U. S. Navy Shipyard. Arrangements for the meeting were made by chapter members on duty at the Shipyard, under the guidance of Capt. R. E. Melling.

Following dinner at the Officers' Club, Capt. Logan McKee of the Naval Shipyard, welcomed the members and guests and gave an interesting account of his experiences during his Naval career. He emphasized the need for associations of special services to promote a better understanding and closer working arrangements between the armed forces and civilian components.

Ralph Grist, Co-ordinator of Military Services for the *Southern Bell Telephone and Telegraph Company,* then made formal presentation of the chapter charter. He stressed the advantages of the association and the importance of civilian exponents in the development of communications activities applicable to use by the armed forces during time of emergency.

At the close of the meeting, the entire assemblage was conducted on a tour of the Naval Reserve Communications Training Center.

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Square-Wave Clipper

(*Continued from page* 37)

Low frequency phase shift and response tests are usually made with a 20 to 60 c.p.s. square wave, the exact frequency depending on the low frequency response of the amplifier being checked.

A dip at one point in the square wave, as illustrated in Fig. 3G may be caused by a drop in amplifier gain over a narrow range of frequencies (or at one frequency). If the drop in gain occurs at the square-wave frequency, then the dip spreads over the entire half cycle and we get the condition of Fig. 3F.

Too low a value of coupling condenser, too small a value grid resistor, or a partially open coupling condenser may cause differentiation of the square wave, resulting in a pulsed output signal as shown in Fig. 3H.

The transient response of the amplifier may be checked by noting if there is any overshoot or damped oscillations following the leading edge of a high frequency square wave as shown in Fig. 3I. A damped oscillation of this type may be caused by distributed capacities and lead inductances resonating at a low frequency, causing a sharp rise in amplifier gain at that point. This condition may also be caused by an undamped peaking coil in a video or scope amplifier.

The frequency at which the circuit

resonates (and at which the peak in response occurs) can be determined by spreading the observed signal on the oscilloscope screen until the individual "cycles" in the damped oscillation can be counted. The number of individual cycles, multiplied by square-wave fundamental frequency, gives the approximate frequency at which the peak occurs. Although the value determined in this manner is not absolutely accurate, it is sufficient for all practical work.

In general, the low frequency characteristics of an amplifier are checked by applying a square-wave signal with a frequency near the lower limit of the amplifier. If the flat top of the square wave is tilted, phase shift occurs. If the leading edge is gradually rounded, there is a gradual falling off in amplifier gain at higher frequencies. If there is a peak or a dip in the signal there is either a peak or a drop (respectively) in amplifier gain at some particular frequency. The frequency at which the peak or drop occurs can be determined approximately by the ratio of the time of the peak or dip with respect to the time for the complete cycle of the square wave.

The high frequency response characteristics of an amplifier are checked in the same manner. For high frequencies, however, in addition to the above mentioned characteristics, transient response can also be checked.

For p.a. amplifiers, square waves at frequencies of 60 c.p.s. and 1000 c.p.s. are normally sufficient. For high fidelity audio amplifiers, frequencies of 20 c.p.s., 200 c.p.s., and 1500 c.p.s. should be employed. Finally, for wide-band amplifiers, additional square waves with frequencies about a decade apart should be used, the highest frequency being about one-tenth the upper frequency limit of the amplifier.

In all cases, however, make sure the scope you are using has a flat enough response to enable you to observe a square wave at the frequency used.

—30—

FARRIS HEADS "REPS"

R. W. FARRIS has been named head of "The Representatives" of Radio Parts Manufacturers, Inc. to fill the unexpired term of Leslie M. DeVoe, who asked to be released from further responsibilities this year.

Mr. Farris, a member of the Missouri Valley Chapter, has been active in the affairs of the association for eleven years. Prior to his election as a member of the national Board of Governors, he was president of his chapter for three years.

In addition to naming Mr. Farris, the Board of Governors devoted considerable time at its meeting to an extensive review of national activities, organizational matters, and budget allocations for 1950. They confirmed tentative plans made by the Industry Relations Committee for participation by the organization in the 1950 Parts Distributors Conference and Show, to be held May 22-25 at the Stevens Hotel in Chicago.

—30—

Off-Frequency Inversion

(*Continued from page 57*)

verter to remove the interfering signal by placing it on the cut-off side of the asymmetrical filter so that only the desired signal and the sideband free of interference, or containing less interference, is heard.

The unit today is an adaptor or accessory. Whenever industry chooses to incorporate this development in receivers, it would eliminate the separate power supply and audio system now provided in the inverter. As an accessory, the receiver audio system is superfluous. If built into a receiver, only two or three, instead of the present nine, tubes would be required because the detector is duplicated and because more amplification is required under present conditions in view of the loose coupling into the receiver. Building it in could save 20 to 30 db. of gain now needed with the method of coupling employed.

The U.S. Coast Guard is the first large-scale user of MCL-4 equipment. As of September 1949, they have procured or ordered sufficient units for 118 radio stations ashore and afloat. In the mobile radio field channel widths are 60 kc. with heavy interference encountered up to several channels removed when stations are in close proximity. The MCL-4 signal splitter with its ability to attenuate off-frequency interference approximately 100 db. at 1½ kc. removed from carrier on voice reception, 135 db. down on c.w., and 120 db. down on c.w. audio images shows every promise of making satisfactory communication in channels of narrow width and adjacent channel operations possible. Several channels of communication, without sub-channeling, now become feasible in the bandwidth allocated to single stations today.

From all indications the MCL-4 is one answer to our overcrowded frequency spectrum problem.

REFERENCES

[1] *McLaughlin, J. L. A.: "Exit Heterodyne QRM," QST, October, 1947.*
[2] ———: *"Selectable Single-Sideband Reception Simplified," QST, April, 1948.*

—30—

"You'll have to learn to cook your own recipes successfully, Aunt Sophie, we're putting in television!"

TV Troubleshooting
(*Continued from page* 66)

continue using the signal from the video amplifiers or else use the vertical sweep signal, as outlined previously, for checking the picture i.f. stages. Weak sound in Intercarrier type sets is sometimes due to misalignment of the picture i.f. stage, thus preventing adequate sound signal to reach the second detector. This can be verified by detuning the local oscillator on the r.f. tuner slightly. If this brings in the sound stronger, possibly at the expense of the picture, then re-alignment is indicated and a suitable generator and v.t.v.m. or scope are needed.

On receivers using separate sound i.f.'s the chance of misalignment in either the sound stage or the trap in the picture i.f. stages is increased. Detuning of the oscillator at the r.f. tuner will usually show if this is the case. Aside from misalignment, the sound i.f. stages can be checked by the same method as outlined previously for the picture i.f.'s, using either the vertical sweep signal or a 60-cycle signal which can be obtained from the power supply.

3. *No picture or weak picture but good sound.* In Intercarrier type receivers the presence of normal sound indicates that the picture i.f.'s and detector are operating properly. The picture can be lost entirely only in the circuit following the removal of the sound, *i.e.,* in the d.c. restorer, if any, or in the leads or sockets connecting to the picture tube. The audio amplifiers are used as a signal tracer by connecting a .05 μfd. condenser across the volume control and touching the free end first to the plate of the video amplifier from which the sound signal is removed. Then follow the picture signal through all coupling condensers, sockets, etc., until the break is located.

Weak pictures in Intercarrier type sets are usually accompanied by weak sound and the troubleshooting procedure is the same as in the case for no sound and no picture. If the sound is normal and only the picture is weak, check for an open or shorted peaking coil in the video stages by tracing the picture signal through from the second detector and listening carefully for any loss in volume. In receivers using separate sound i.f. stages, no picture may result from a defect in any of the stages between the point where the sound i.f. is removed and the picture tube. The video amplifier stages are checked by signal tracing when a picture signal can be heard with the free end of the .05 μfd. condenser touched to the second detector load resistor. If nothing is heard the method of signal substitution outlined above is recommended, preferably using the signal from the vertical sweep circuits.

4. *No vertical sweep or very little*

sweep. Before attempting to troubleshoot a case of no or improper vertical sweep all vertical adjustments should be tried and, if possible, good tubes substituted in the vertical sweep circuit. Then the vertical oscillator is checked by connecting a .05 μfd. condenser to the "high" side of the volume control and touching the free end to the output of the vertical oscillator. If this circuit is functioning properly, a rasping hum should be heard, the pitch of which varies as the vertical hold control is adjusted. The vertical saw-tooth wave can be traced through all components up to the deflection yoke and, in the event that the height of the picture is much too small, the approximate amount of gain in the vertical output amplifier can be estimated aurally.

Touch the probe end of the .05 μfd. condenser first to the grid of the vertical output tube, then to the plate and observe the increase in loudness. If there appears to be no or little difference, this tube is not amplifying properly and a routine voltage and resistance check will quickly locate the guilty component.

To check the operation of the height and vertical linearity control, touch the probe end of the .05 μfd. condenser to the plate pin of the vertical output tube and adjust these controls. The height control should raise the volume of the hum greatly at one setting and reduce it until it is inaudible while changing the pitch only slightly.

The vertical linearity control will also change the amount of hum coming from the speaker but not as much as the height control. To make sure that the deflection yoke and the connections to it are not shorted or open, touch the probe end of the condenser to each of the three vertical terminals located on the yoke. These terminals can easily be exposed by pulling the cardboard collar off the deflection yoke. A defect of this kind is quite rare and in most cases the tracing of the vertical saw-tooth voltage from the oscillator through the output amplifier will suffice to locate the trouble.

5. *Loss of vertical or horizontal sync or both.* When the picture appears to move up or down and adjustment of the vertical hold control does not keep it steady for more than a moment as in Fig. 4, the most likely source of trouble is in the vertical sync pulse integrator network. This network, shown in Fig. 3, is used almost universally to remove the horizontal sync pulses and permit only the vertical pulses to pass through in form of a sharp pulse every 1/60th of a second. This network consists of a 22,000 ohm and two 8200 ohm resistors in series, bypassed by a .002 and two .005 μfd. condensers. These three condensers are the most likely sources of trouble when only the vertical sync pulses appear to be lost.

A quick and sure method of checking the entire vertical sync system is, again, by means of the .05 μfd. condenser connected to the volume control. The free or probe end of this condenser is touched to the plate of the sync separator tube, then to the different points along the integrator network shown in Fig. 3. At each successive point the sound should get weaker as more of the vertical sync pulse is being attenuated until only a low, buzzing noise is observed from the "cold" or sync pulse side of the vertical blocking oscillator transformer. If the buzzing sound is lost completely at one point, that is the location of the defective part, most likely a shorted bypass condenser.

When the horizontal sweep circuit appears to be lacking a sync signal the defect cannot always be found by the instrument-less method described here, since the frequency of the horizontal sweep is beyond the audible range of most people and certainly beyond the range of most loudspeakers. If the loss of sync pulse occurs, however, in the circuits where it is together with the vertical pulse, signal tracing by the method outlined for the vertical pulse may locate the trouble.

It should be pointed out here that in certain types of either vertical or horizontal sweeps only a very weak sync pulse is necessary to keep the particular circuit in synchronism. This means that both the vertical and horizontal pulse can be almost lost, yet one of the two circuits will appear perfectly stable. Where both vertical and horizontal synchronism is obviously lacking, *i.e.*, the picture sways sideways and moves up or down, the defect must be in those circuits where both pulses are present. Naturally this means that signal tracing with a .05 μfd. condenser to the volume control will be applicable in this case.

First touch the probe end of the condenser to the plate of the video amplifier from which the sync signals are obtained. This assures their presence at that point at least. Follow the path of the sync pulses through each coupling condenser and resistor. It should be kept in mind that the first tube after the video amplifier is usually a clipper which removes the picture component and often passes sync pulses of much smaller amplitude than those present at the plate of the video amplifier. The sound heard from the plate of the sync clipper may, therefore, be lower than that from the grid. Some receivers employ two sync clipper stages, one of which usually gives some gain too. In order to troubleshoot the sync circuits successfully on an unfamiliar receiver it is necessary to have a schematic diagram so that the observations made by the signal tracing method can be correlated with the proper function of each stage.

Conclusion

The suggestions in this article are merely indicative of some of the steps which can be taken right in the customer's home to locate certain types of defects without the use of costly instruments. The skilled service technician will be able to adapt this method to many instances other than those given here, and if you know of some, we would like to hear about them. After using this method for a while, the different sounds from various stages and their defects will become familiar and troubleshooting any of the five symptoms listed here becomes a routine just like checking a 5-tube a.c.-d.c. radio. Although we have shown in this article how some television troubles can be found without any instruments, it should be kept in mind that many other defects cannot be located or remedied without the aid of a v.t.v.m., oscilloscope, and suitable signal generators.

Alignment of the sound and picture i.f. and r.f. stages, as well as the sound FM detector, should never be attempted without a good signal generator and v.t.v.m. or a sweep generator and oscilloscope. For good, clear pictures and sound there is no substitute for the somewhat difficult and time-consuming method of alignment as recommended by the manufacturer of the set. For troubleshooting the horizontal sweep and high voltage flyback circuit only the volt-ohmmeter and the oscilloscope can help you track down the trouble quickly. The oscilloscope is especially important in the case of non-linearity or poor horizontal synchronism. We want to reiterate that the instrumentless method of troubleshooting as outlined is not proposed as a substitute for using instruments, but as an emergency measure for certain symptoms. It is hoped that this article will stimulate further ideas on using sections of the TV set itself to check other sections, and that it will help to speed up the work of the busy service technician.

—30—

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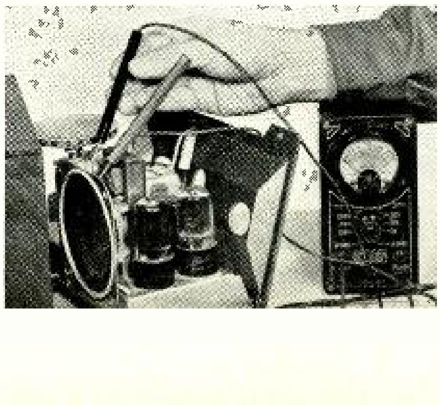
A QUICK check on the speaker voice coil of a radio, when servicing for inoperation, may be made with the small batteries in the service ohmmeter.

It is only necessary to place the two test leads from the ohmmeter across the speaker voice coil terminals (Fig. 1) and listen for a click at the moment of contact which will be forthcoming if the voice coil is OK . . . . . H.L.

Fig. 1.



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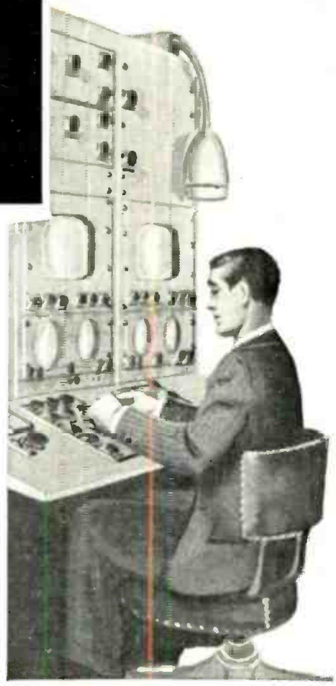

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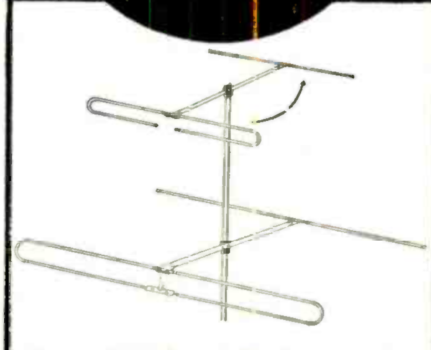

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	Manila	DZH4	6.

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ERRATUM

In Fig. 3, page 65 of the January issu[e] grid connections to the 6SN7 dual-t[riode] phase inverter should be interchanged.

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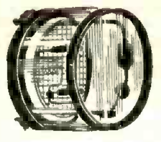

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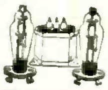

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6BA4	1.08
6BA6	.49
6BE6	.52
6BF6	.52
6BG6G	1.39
6BH6	.52
6BJ6	.59
6BQ6GT	.98
6C4	.24
6C5	.47
6C6	.58
6C6G	.55
6C7	1.26
6C8G	.65
6C21	23.95
6D4	2.75
6D6	.47
6D7	.98
6D8	.75
6E5	.69
6E6	1.05
6E7	1.20
6F5	.47
6F6	.59
6F7	.80
6F8	.84
6G6	.59
6H6	.45
6CJ	3.90
6J4	4.85
6J5GT	.48
6J6	.72
6J7	.54
6J8GT	.95
6K5GT	.79
6K6GT	.42
6K7	.48
6K8	.75
6L5	.84
6L6	.98
6L6Q	.82
6L6GA	.82
6L7	.77
6N4	1.08
6N7GT	.90
6P5G	.81
6Q7	.57
6R7	.77
6S7	.85
6S8GT	.79
6SA7GT	.43
6SB7Y	.81
6SC7	.57
6SD7GT	.45

6SF5	$ .48
6SF7	.58
6SG7	.57
6SH7	.38
6SJ7GT	.55
6SK7GT	.45
6SL7GT	.61
6SN7GT	.59
6SN7WGT	.89
6SQ7GT	.44
6SR7	.56
6SS7	.57
6ST7	.75
6SU7GTY	.85
6T7G	.84
6T8	.98
6U5/6G5	.63
6U6GT	.89
6U7G	.54
6V6GT	.59
6V6GTY	.90
6V6M	.92
6W4GT	.72
6W7G	.87
6X4	.54
6X5GT	.48
6Y6G	.65
6Z7G	1.08
6ZY5G	.67
7A4/XXL	.57
7A5	.65
7A6	.65
7A7	.56
7A8	.69
7AF7	.70
7AG7	.69
7B4	.55
7B5	.70
7B6	.57
7B7	.57
7B8	.70
7C4/1203A	.36
7C5	.49
7C6	.65
7C7	.57
7C23	69.00
7E5/1201	.65
7E6	.57
7E7	.59
7F7	.64
7F8	1.03
7G7/1232	.98
7H7	.64
7J7	.98
7K7	1.05
7L7	.67
7N7	.65
7Q7	.57
7R7	.63
7S7	.89
7T7	1.03
7V7	.89
7W7	.85
7X7/XXFM	.85
7Y4	.49
7Z4	.56
10Y	.60
12A6	.18
12A7	.96
12A8GT	.96
12AH7GT	.93
12AL5	.72
12AT6	.45
12AT7	.79
12AU6	.59
12AU7	.69
12AV6	.63
12AX7	.81
12BA6	.56
12BA7	.81
12BD6	.59
12BE6	.45

12C8	$ .35
12H6	.25
12J5GT	.35
12J7GT	.78
12K7	.65
12K8	.59
12L8GT	1.59
12Q7GT	.55
12S8GT	.79
12SA7GT	.55
12SC7	.55
12SF7	.56
12SG7	.55
12SH7	.34
12SJ7GT	.49
12SK7GT	.55
12SK7M	.52
12SL7GT	.54
12SN7GT	.49
12SQ7GT	.49
12SR7	.45
12X3	.90
12Z3	.72
14A7/12B7	.67
14AF7	.86
14B6	.65
14B8	.77
14C7	.63
14H7	.86
14N7	.86
14Q7	.55
14R7	.65
15E	1.44
15R	.75
FG17	3.98
RK18	.98
19	.95
19T8	.98
20	1.17
FP21	4.98
RK20A	6.98
REL21	4.85
RX21	3.20
PJ22/CE1C	1.49
24G/3C24	.45
25A6	1.04
25AC5	1.14
25B6	1.49
25BQ6	.79
25L6GT	.52
25W4GT	.79
25Y5	1.08
25Z5	.46
25Z6GT	.49
FG27A	9.50
28D7	.35
30	.39
31	.36
32	.89
FG32	4.98
32L7GT	.95
FG33	8.49
35A5	.65
35B5	.59
35C5	.60
35L6GT	.54
35W4	.35
35Y4	.49
35Z3	.61
35Z4	.49
35Z5GT	.41
REL36/6J4	.54
37	.36
38	.34
39/44	.25
CRC40	.54
41	.50
43	.54
45S/VT52	.27
46	.65
48	1.56
50	1.49
EF50	.40
50A5	.73
50B5	.54
50C5	.59
50L6GT	.52
50X6	.98
50Y6	.63

57	$ .47
58	.53
RK65	24.95
HY69	2.29
70L7GT	1.10
71	.65
72	.95
CRP72	1.37
73	1.67
NR74	.29
75	.56
76	.38
77	.45
78	.45
79	.75
80	.38
81	1.29
FG81A	4.45
82	.85
82V	.95
83	.99
83V	1.05
84/6Z4	.57
85	.57
89	.36
VR92	.23
FG104	14.98
FG105	10.75
VU111	.49
HY114B	.81
HY115/145	.80
117L7	1.23
117N7GT	1.36
117P7GT	1.20
117Z3	.49
117Z6GT	.77
117Z7GT	1.49
F127A	16.95
CV148	7.90
155	4.98
FG166	49.00
FG172	19.50
FG190	12.98
205B/VT2	1.69
211/VT4C	.42
RX215	9.95
WE215A	.25
227A	2.90
231	1.20
250TH	24.98
250TL	24.98
282B	8.49
304TL	1.39
304TH	3.70
307A/RK75	3.60
316A	.49
323A	8.98
327A	2.70
350	1.23
350B	1.88
354C	14.95
355A	14.95
368AS	3.75
371B	.84
380A	.79
388A	.89
393A	3.65
394A	3.65
395A	4.95
417A	19.95
GL434	2.90
446A/2C40	1.17
446B	1.80
450TH	17.75
450TL	49.95
GL451	1.90
460/HF200	9.98
WL468	6.75
RH507	9.98
527	12.95
530	12.95
531	1.80
WL531	1.95
GL534/1S21	1.95
544	4.98
GL546	1.69
550P1	19.95
575A/975	12.65

601B	$ .19
HY615	.24
WL619	19.75
KU627	7.49
631P1/SN4	3.98
WL632A	8.98
701A	2.90
702A/702B	2.75
703A	3.75
704A	1.08
705A/8021	1.05
707	7.98
710A/8011	.65
713A	1.49
715B	7.29
717A	.61
721A	2.65
722A/287A	9.95
723A	6.95
723A/B	14.95
724A/B	3.90
725A	6.90
726A	6.98
726C	29.98
730A	10.90
801A	.45
802	4.15
803	3.45
804	6.90
805	4.75
807	1.49
808	1.35
809	2.70
810	7.90
811	2.45
812	2.98
813	8.90
814	2.45
815	2.40
816	1.05
826	.42
5D828	2.98
829B	7.29
832A	4.87
836	.98
837	2.35
838	3.20
842	2.75
843	.39
845	4.15
851	14.95
860	2.98
861	10.79
864	.45
865	1.90
866A	.49
866JR	1.00
868/PJ23	1.90
869	30.00
872A	1.49
GE872A	2.98
874	.55
876	.36
878	1.95
884/6Q5G	1.59
885	.87
920	2.70
922	1.19
923	.85
927/CE25	1.26
930	.80
931A	3.95
954	.35
955	.33
956	.37
957	.20
958	.35
5D968	2.98
991	.23
1000UHF	59.95
FM1000	.95
CK1005	.18
CK1006	.64
CK1089	3.48
CK1090	2.69
1609	5.98
1613/6F6X	.55
1614	1.42
1616	.89

1619	$ .18
1620	4.95
1622	1.75
1624	1.25
1625	.37
1626	.35
1629	.26
1632	.89
1633	.97
1635	1.49
1641/RK60	.48
2050	.95
2051	.42
5514	4.85
5516	5.85
UX6653	.69
8012A	1.45
8013A	2.50
8020	1.25
9001	.34
9002	.28
9003	.30
9004	.34
9005	1.90
9006	.23
C'RAY TUBES	
2AP1	4.98
3AP1	4.63
3BP1	2.55
3BP1A	7.98
3CP1	2.65
3CP1-S1	2.49
3DP1	3.75
3EP1	2.65
3FP7A	.98
3GP1	8.95
3HP7	4.80
4AP10	4.70
5AP1/1805	3.75
5BP1	1.98
5BP4	4.50
5CP1	1.75
5CP7	3.70
5FP5	6.49
5FP7	1.26
5FP14	18.95
5GP1	6.95
5HP1	4.95
5HP4	6.75
5JP2	11.75
5LP1	18.00
5MP1	4.75
7BP7	4.65
7CP1	12.95
7HP7	5.95
9GP7	12.33
9LP7	18.00
10BP4	20.95
12DP7	12.49
12GP1	49.98
12GP7	18.00
12JP4	34.75
12KP4	34.75
12LP4	34.00
12QP4	49.98
16AP4	55.00
902	3.15
905	2.90
910/3AP1	4.63
912	89.98
914	45.00
TUNGAR BULBS	
16X897	2.49
20X672	2.95
189048GE	3.49
199698	2.95
289881	2.50
859483	3.98
BALLAST	
1P1	.49
PM3	.98
PM4	.98
4A1	1.29
6-11	.49
7H12	.49
PM5	.98
PM6	.98
PM7	.98
PM8	.98
9-3	.49
10-4B	.49
13-4	.49
20-4	.49

K49A	$ .36
K55B	.36
M55B	.39
L62A	.49
K80B	.36
WL121A	2.61
C376	2.98
ZB583	3.98
MAZDA PILOTS	
44Box10	.50
49Box10	.60
55Box10	.50
64 Each	.07
S6T4/3W	.18
100W/20V	.25
291Box10	.36
311/28V	.15
313/28V	.15
323/3V	.10
Sylvania S6/6W/120V	.15
Wstghs C7/7W/120V	.09
Med. Screw Base	
15W/125V	.08
25W/125V	.08
NEON BULBS	
NE2/100	3.98
NE16/991	.23
NE32	.35
NE45/¼W	.24
NE51/NE20	.07

DIALCO TYPE
Bull's Eye Pilot Lite complete w/S6 115V Bulb or Neon Bulb Chromed 2/98c

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6, 12, 24, 48, 55V Each .18

XTAL DIODES	
1N21	.50
1N21A	1.00
1N21B	1.49
1N22	1.39
1N23	1.39
1N23A	1.50
1N23B	2.49
1N26	2.69
1N27	1.75
1N34	.83
1N35	2.79
1N43	1.25
1N44	.85
1N45	1.00
1N48	1.15
1N51	1.08

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D167019 Vol. Limiter $2.95
D168391 Thermal Comp...90c
D168392 Thermal Comp..$2.00
D170396 HF Pwr Meas .90
1C Bulb Time Delay .90

VARISTOR USN
CW20259/38C 2.95

XTAL FREQ. STANDARDS
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200 Kc .. 3.98
1000 Kc . 2.95
4700 Kc .98

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5010, 5025, 5055 Kc Each ..14.98

Tubes Gtd Exc. Open Fil. & Breakage. Tubes shipped only via R' Express. Min. Tube Order $5

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G-E Teardrop Filament Xfmr. Input: 115/230V, 50/60 cyc. Output: 5/2.5V, 12KV Ins, 8 lbs. New. "TAB" Special.............. **$5.98**

G-E Power Transformer K34J436. Input: 120V, 50/60 cyc. Output: 90V/1.11 Amp. tapped at 80V and 70V H.Vins. Cased. 16¾ lbs. BRAND NEW.................. **$2.95**

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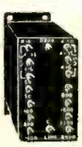
900V/35ma. 2x2.5V/2ACsd........ 4.95
700VCT/120ma, 115V/100ma. 2x6.3V/1A. 5V/2A Csd HiVins..................$2.98
420VCT/120ma, 6.3V/1.9A. Also Inpts 6-12-24-115vdc&230vac $1.98; 10/$16.98
12.6VCT/1.25A, Csd HiVins........$1.49
6.3VCT/4A (gud6.5A)Csd HiVins... 1.69
6.3VCT/0.6A Csd HiVins........... 1.39



RCA UNIV OUTPT XFORMER

10W to 10Kc. Matches ANY Line or Spkrs w/VC's 3 to 4 or 15 ohms to ANY Load & Tube Imped Bet 50 & 10240 ohms. Over 1000 combinations! Acts as EXC Band Pass Filtr or Freq Attn Unit for Dyn Mike. Cuts HI's or LOWS. Ideal Lazy Q-5 action CW or Phone. Get ONLY Signal You Want to Hear. W/Data **$1.39**

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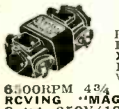
Comb Hi-Gain DynMike and Matching Xfmr (UTC/Super Elec 3wdg. 600 Ohms CT& 4000 ohms Tapped 250 & 150 ohms, Shielded, H'Sld). With Exc Fidelity Dyn Mike. Both units ONLY.. **$1.49**



6 VOLT CARTER "MAGMOTORS"

PermMagnets Extremely Hi-Eff. 5¼x3¾x2½". XMTG "MAGMOTOR" Inpt 5.5VDC; Outpt 400 V/150Ma 57½% Eff. 6500RPM 4¾ lbs. ONLY.....$8.98
RCVING "MAGMOTOR" Inpt 6VDC; Outpt 250V/100Ma 52% Eff. 4800 RPM 4½ lbs. ONLY..........$4.98
Both Units above, SPECIAL...$12.49

PAPER & MICA CONDENSER BUYS!

Paper Tubulars

wvdc	mf	Ea.	10 for
150	.05	4c	36c
200	.05	6c	54c
	.1	7c	63c
400	.01	4c	36c
	.015	5c	45c
	.03	6c	54c
	.05	7c	63c
	.1	8c	72c
	.25	9c	81c
600	.001	4c	36c
	.015	5c	45c
	.02	6c	54c
	.03	7c	63c
	.05	8c	72c
	.1	9c	81c
800	.1	11c	99c
1200	.01	9c	81c

Bakelite Cased

wvdc	mf	Ea.	10 for
200	.02	7c	63c
	.05	9c	81c
500	.001	8c	72c
	.006	9c	81c
	.01	11c	99c

Metal Cased

wvdc	mf	Ea.	10 for
100	.25	9c	81c
110	.25	10c	90c
200	.04	9c	81c
300	.01	8c	72c
400	.01	9c	81c
	.5	15c	$1.35
600	.02	10c	90c
	.05	12c	$1.08
	.1	19c	1.71
	.5	27c	2.43
1000	.01	17c	1.53
1500	.01	29c	2.61
1600	.064	39c	3.51

Mica—(Silver*)

wvdc	mf	Ea.	10 for
500	.0001*	9c	81c
	.0002	4c	36c
	.0002*	9c	81c
	.0003	4c	36c
	.0011*	9c	81c
	.00224*	18c	$1.62
	.003	10c	90c
	.01	15c	$1.35

CIRCULAR SLIDE RULE

Equiv 12"—Only 2⅛" Radius. LAMINATED-Print Stays On! Mult. Div. Sqs. Cubes & Roots, Logs & Dec. Scales. Data & Case 98c; 6 for $5
Mercury Thermo-Regulator 32 & 105°F Dual Ckt. BRAND NEW $20 List w/ Data....98c; 12 for $10

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SOLA Const V'Reg USN Csd Inpt 95 to 190V/50-60cyc; Outpt—115V/2KW/17.4A Const Dty. 1% Reg LN $130; Same new USN Cost $369; Yours for.........$162
GEN ELEC Const V'Reg Inpt 95 to 130V/50-60cyc; Outpt 113/115/117V .78KVA at .80PF $63
VARIAC—General Radio 200C 860 Watts. 0-135 Volts. SPECIAL...........$15.98

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20 Watts PP6L6/2A3/6A5G/etc. Pri 5000 ohms ct: Sec 7 taps 2.5 to 600 ohms PLUS feedback winding..........$4.98
30 Watts UTC High Fidelity Output PP6L6/2A3/6A5G/etc. Pri 4000 ohm CT; Sec 5 taps 2.5 to 250 ohms............$5.98

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MODULATION STANCOR USN H'Sld PP parallel 807'stoPP807's RF/2000 ohm Load 240 Watts Peak..........$6.95
PP807'sto829RCA5500to2600 ohms..$4.50
Amertran USN 3600 or 900 to 30 or 60 ohms/500 Watts $12.95
UTAH 12W UnivOutpt 5999 Any Tube Any Voice Coil $1.39
WE output 300W/PP805 to 90 ohm VC HIFI $12.98
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UTC O-14 "ouncer" 50:1 Mike or Line to Grid 200 ohms to ½ Meg. $13 List. Only $2.98..............10 for $27.00

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BA35 1½VsimBURG 4FH 39c
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BA37 1½V Walky-Talky 29c
BA38 103½V Walky-Talky $1.49
BA39 150/7½VBurgFSA100 .... 1.69
BA40 90/1½VBurg4GB60 .... 1.19
BA43 90/45/1½V 98c
BA51 67½V MiniMax 89c
BA205U 3V Burg F2BP.....8 for $1.00

$1800 BANK-CLIMB Gyro Control

for MK-4 Auto Pilot Mfr for SPERRY. $1800 Govt Cost. BRAND NEW. Only $2.95
Compass, Mark VIII, Special.......$3.98
BC456 Modul Less Tubes & Dyn. As Is 98c
BC457 or BC458 Less Tubes. As Is $3.49
BC455 Rcvr Less Tubes......As Is $4.55
FL-5 Filter w/Sw/&Diag..............98c

FILTER CHOKES

10Hy-125Ma CSD Herm' Sld.......$1.29
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15-29Hy/150Ma CSD 2.95
12Hy/300Ma 3.95
15Hy/400Ma or 20Hy/300Ma/12KV. 7.95
8Hy/150MaNewUTC C'ked T'Bd..2 for 2.25

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Internationally Famous. Simplicity of Design—Extraordinary linearity and lack of distortion. 10 cycles to 20kc with ease. To 1 Mc. for Experimenters & other applications. With RCA chassis, Less Output Xformer $19.95
Super Wide-Range High Fidelity Amplifier Kit 20 to 20,000 cycles. 10 Watts. Pre-Amp Stage. 2 Tone Controls. RCA Chassis. Less Outpt Xfmer. Write for Details $24.95
"LP" Record Anti-Static Fluid. Enough for 800 Applications, Only..........69c

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