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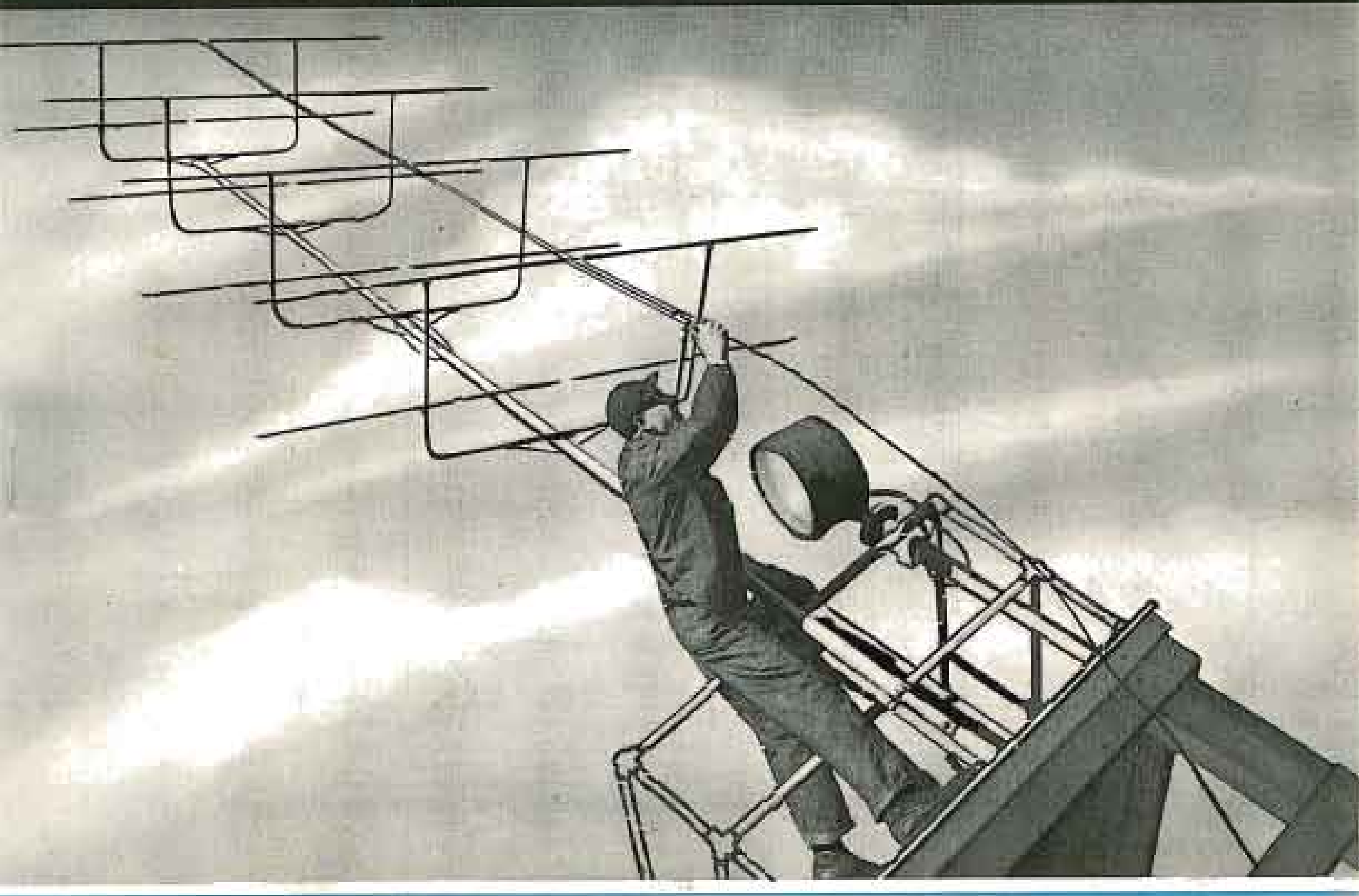

APRIL

★ TAPE RECORDER TIME CLOCK CONTROL

★ 16-ELEMENT FM RECEIVING ANTENNA SYSTEM

★ A REPORT ON THE 1949 IRE NATIONAL CONVENTION

1949

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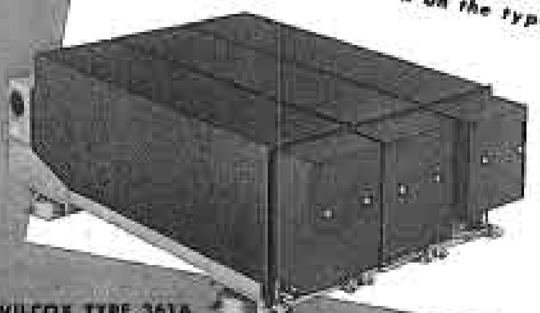

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COMMUNICATIONS

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COVER ILLUSTRATION

Connecting transmission line to 16-element FM receiving antenna recently installed at WIBW, Topeka, Kansas.
(See page 8, this issue, for complete details on antenna design and installation.)

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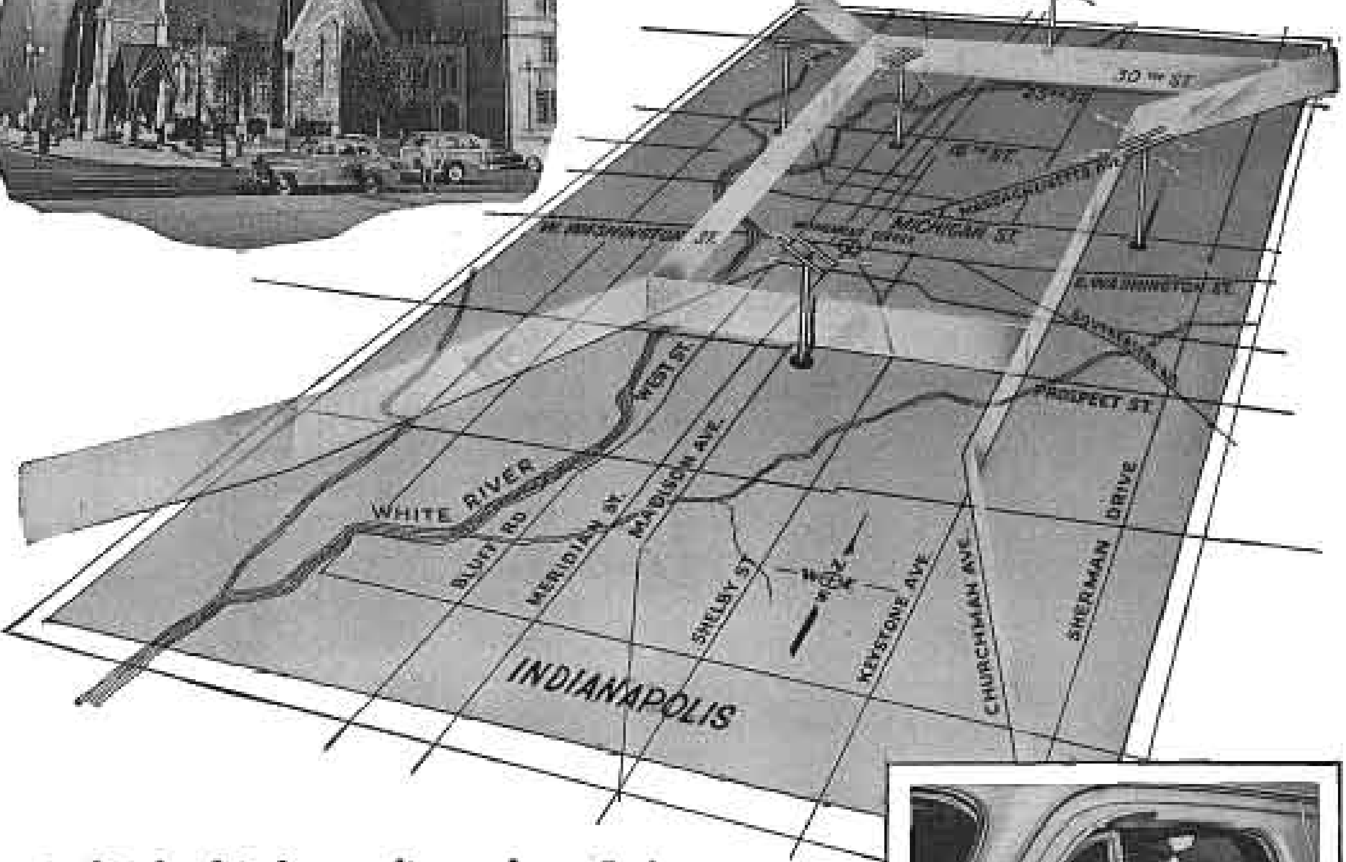

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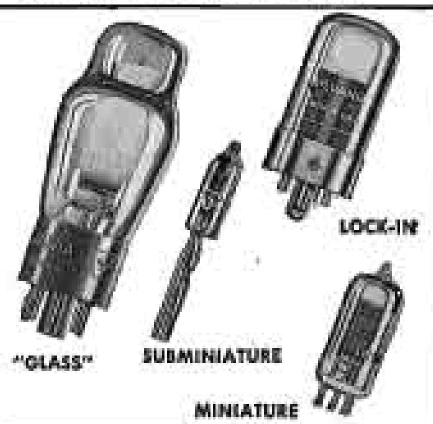

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COMMUNICATIONS

LEWIS WINNER, Editor

APRIL, 1949

Communications' Progress Report

THE VAST potentialities in communications, cited in innumerable editorials and government reports, have now become widely recognized by industry.

Reporting on the program achieved in the art since VJ Day, FCC chairman Wayne Coy, speaking before the annual meeting of the Armed Forces Communications Association in Washington, pointed out that we now have in service or authorized for construction a grand total of 265,000 land stations and mobile transmitters, five times as many as before the war. We were also told that the fire departments of over one hundred cities now have communications systems in service or scheduled for early construction. The report also disclosed that more than 26,000 utility trucks are now radio equipped, and the police, who blazed the trail for the mobile services before the war, today have 4,000 land stations and 50,000 mobile units in service or scheduled to be constructed, an increase of over 300% since the end of the war.

According to Coy, in five years a half-million cars, trucks and buses will be two-way equipped.

A roaring tribute to a new and growing industry!

The Billion Dollar Air Forces Program

THE SIGNIFICANCE of communications was also emphasized at the Washington meeting by the military, who disclosed that Congress is now studying an Air Forces budget involving $4,200,000,000, a substantial portion of which covers communications equipment for air and ground service. For instance, $311,000,000 have been asked for the purchase of communications and electrical equipment and $90,000,000 for new radar and other specialized type of equipment, including interphones, etc. For ground and air control services a sum of $115,000,000 is being requested. For design, research and development the Air Forces have asked for $30,000,000 and an additional $5,000,000 for specialized technical assistance.

Quite a few dollars for equipment and talent!

Standards for Reproducing and Recording

THOSE ALL-IMPORTANT and long-awaited standards for reproducing and recording involving mechanical, magnetic and optical systems, have been completed and very soon will become the bases of national and undoubtedly international audio-system planning. Prepared by the NAB recording and reproducing standards committees' nine projects groups, the standards cover recorded groove shape; reproducer stylus contour; distortion; signal-to-noise ratio; recorded level; recording characteristics; magnetic recording; reproducing turntable diameter; height; torque; speed; wow; concentricity of record center hole; frequency response characteristics and output level of disc reproducer and equalizer combination; tracking error; vertical force of disc reproducer; disc tone records; translation loss; lacquer recording blanks; glossary of terms and definitions, and symbols.

Every aspect of the recording and reproducing problem appears to have been considered. For instance, in the standards on the method of measurement of turntable speed, we find the recommendation that the stroboscopic disc for 33⅓ rpm measurement shall have 216 spots in 360° and the stroboscopic disc for 78.26 rpm shall have 92 spots in 360°; at either 33⅓ or 78.26 not more than 21 dots per minute in either direction should pass or drift by a reference point. The turntable recovery time standard has been indicated as .3 second. Covering the recording groove shape standard, the committee recommended that the groove, for a finished lateral record, should have an included angle of 88° ±5°; a radius of 1.5 mils maximum and a top width of not less than 4 mils. In the standard on lateral recordings the term *recorded velocity* has been substituted for *stylus velocity*.

The magnetic tape dimensions have been divided into two groups; thickness which should not exceed .0022" and width which should not exceed .250" or less than .244". Two standards of tape speeds were also set up; a primary speed of 15" per second and a secondary speed of 7.5" per second. In a standard on flutter and wow for magnetic equipment the instantaneous peak flutter and wow were placed at .2% (peak-to-peak .4%).

The glossary of definitions is extremely interesting amd we find many descriptions which should now definitely end those year-long debates. As an example, the term flutter (or wow or drift) has been described as a deviation of frequency which results in general from irregular motion during recording duplication or reproduction: the term *flutter* refers to cyclic deviations occurring at a relatively high rate or about 10 cps; *wow* refers to cyclic deviations occurring at a relatively low rate or about a once per revolution speed variation of a phono turntable; *drift* refers to a random rate close to zero cps. Covering constant amplitude and constant velocity recording, the glossary defines constant amplitude recording as a mechanical recording characteristic where for a fixed amplitude of a sinusoidal signal the resulting recording amplitude is independent of frequency. Constant velocity recording is defined as a characteristic where for a fixed amplitude the resulting recorded amplitude is inversely proportional to the frequency.

With films playing a more and more important role in recording work, it has been necessary to consider some of the technical aspects in the standardization program, and accordingly we have definitions of such terms as gamma and the *H* and *D* curve (*Hurter* and *Driffield*). Gamma is defined as the slope of the straight line portion of the *H* and *D* curve, representing the rate of change of photographic density with the logarithm of exposure; gamma is actually a measure of the contrast properties of the film. The *H* and *D* curve serves to analyze the photographic emulsion and is a plot of density against the logarithm of exposure.

Eleven types of pickups are defined in the glossary: acoustical, pickup arm or tone arm, capacitor, cartridge, crystal, light-beam, magnetic (variable reluctance), mechanical reproducer, moving coil (dynamic reproducer), variable inductance, and variable resistance.

Defined too is that particularly important factor, transition frequency or crossover or turnover frequency. The transition frequency is described as the frequency corresponding to the point of intersection of the asymptotes to the constant amplitude and constant velocity portions of its frequency response curve. This curve is plotted with output voltage ratio in db as the ordinate and the logarithm of the frequency as the abscissa.

There are over 150 definitions in the glossary, which will undoubtedly become a bible of reference in audio work.

Congratulations to the NAB and its affiliated committees for a job well done!
—L. W.

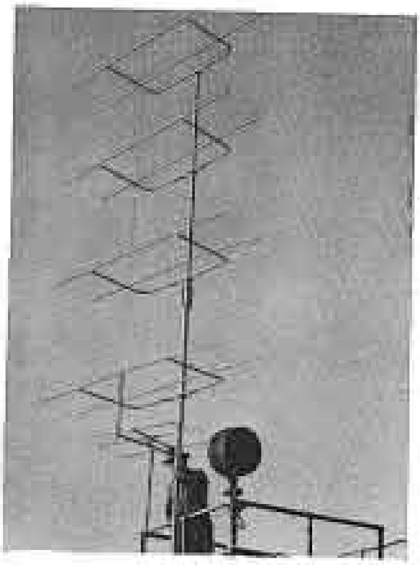


Figure 1
The sixteen-element FM receiving antenna developed by K. G. Marquardt and Lewis Dickensheets, chief engineer and assistant chief engineer of the WIBW and KCKN stations in Topeka and Kansas City, in cooperation with the engineering department of these stations. The original three-element receiving antenna appears at the left.

A 16-Element

Our AM/FM outlets in Kansas City, Kansas, KCKN-FM and KCKN, with their extensive sports coverage which includes Big Seven basketball and football, as well as local hockey games and professional baseball, provided program material which was considered ideal for our Topeka FM station WIBW-FM. Unfortunately, the sixty-mile airline distance between the two cities introduced quite a land-line cost factor. To overcome this problem, it was decided to investigate remote air pickup.

Our initial consideration was the strength of the signal we would be able to pick up. Since KCKN-FM operates with a 250-watt transmitter,[2] a single bay[3] doughnut antenna atop the KCKN-AM tower, 220′ above the ground level with 1⅝″ transmission line, and the *erp* is 190 watts, our wildest calculations indicated that we would have a 2.7 microvolt signal to work with at our proposed receiving location, on the Kansan Hotel 100′ above the street level. This meant that an antenna with a voltage gain of 10 (20 db) would be needed to give us a 27 microvolt signal which would be the minimum to insure satisfactory reception under all conditions of fading, noise, etc. Preliminary tests with a simple-three element parasitic type antenna were very encouraging. A receiver[1] designed to give 20 db limiting with one-microvolt input signal was used. This receiver, a double conversion superhet, with one stage of *rf* amplification, two *if* and two limiters, together with a good audio system, proved very effective for this purpose.

K. G. Marquardt, chief engineer of WIBW and KCKN, and the writer considered various types of antennas. Discussion of the problem with members of the engineering staff who have had experience with radar antennas gave us some ideas. We found it necessary to balance gain against the amount of iron we could safely put in the air over the hotel in the downtown area, and finally evolved the antenna illustrated on the cover.

Wide spacing between antenna and reflector elements was chosen because prior experience with similar types had shown that with .2 wave spacing the maximum gain was secured when the antenna and reflector elements were the same length. This also simplified the construction somewhat.

Element lengths and spacing between bays were based on established formulas. No attempt was made to tune the antenna to exact frequency. Here again experience had shown the formulas to be exact. We had, on previous occasions, cut and pruned extensively on *plumber's delights*, only to come up with the same figure the formula gave us in the first place.

When the antenna was erected[4] it was oriented by the use of aeronautical maps and a prominent landmark about six miles distant. Later, however, we oriented for maximum signal as indicated by maximum limiter voltage in the receiver, and found about a 3 to 5° error in our original calculation. This small difference, however, was sufficient to give a decided increase in signal, indicating the sharpness of the beam. No attempt was made to plot the pattern of the antenna. A comparison of the antenna with a single dipole cut to the same frequency and using the same length of transmission line showed a voltage gain of 5 or 14 db.

Antenna Construction

The individual bays were constructed first, using ¾″ conduit pipe for the element supports. These were bent as shown in Figure 3. The usual conduit bender was used to make the bends in this piece. We guessed wrong on the first one, but after that had no further trouble. Actually considerable adjustment can be made with the conduit bender if the first trial doesn't give the exact spacing. An arbitrary distance of 10″ was chosen for the spacing of the reflectors from the supporting mast.

The individual elements were cut in

[1]RCA. [2]G.E. [3]Link 7388.

[4]Construction was by the John A. Costelow Co., Topeka; erection by Famtev, Inc., a subsidiary of the Costelow Co. The writer was on hand during all construction and checked carefully the lengths of elements, spacing and final assembly of units on the mast.

Figure 2
Plot illustrating the height of the receiving and transmission antennas at Kansas City and Topeka and the elevation of the intervening land between these two points.

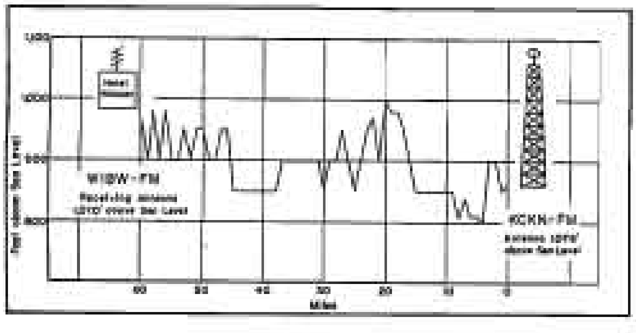
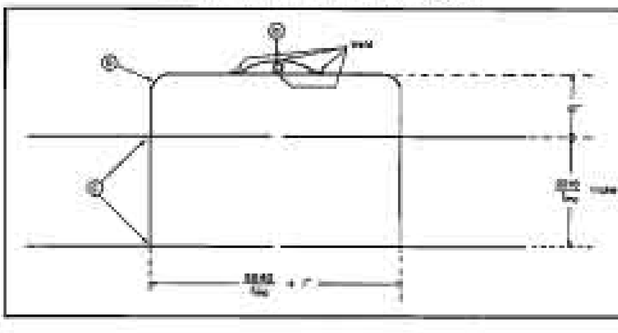


Figure 3
Design features of the element supports of the antenna. At (*a*) is a 1″ iron strap welded to support mast and element. Element support was also welded to support mast. At (*b*) is illustrated the bend made on ¾″ pipe with a conduit bender. Points at (*c*) indicate elements brazed to support.



FM RECEIVING ANTENNA

Antenna, 1,070 Feet Above Sea Level, Provides Consistent Pickup of Signals from 190-Watt FM Station, 60 Miles Away, for Link Service Between Topeka and Kansas City.

by LEWIS DICKENSHEETS

Assistant Chief Engineer
WIBW, WIBW-FM, Topeka, Kansas
KCKN, KCKN-FM, Kansas City, Kansas

accordance with the formula $\frac{5540}{f_{mc}}$ for the length in inches. Both antenna and reflector were made the same length. As stated before, experience with wide spaced beams of this type had shown this condition to give maximum gain in the forward direction. One-half inch steel tube conduit was used for these elements. The elements were brazed to the element support, being careful to keep them square and maintaining a spacing of one inch between the inside ends of adjacent elements. The elements, of course, had to be brazed to their support at their exact centers. For this reason the element support had to be true or the entire bay would be untrue. Spacing between antenna and reflector was .2 wave, or $\frac{2216}{f_{mc}}$ for the spacing in inches.

The supporting mast was constructed of two lengths of 2″ conduit and one length of 1½″ conduit. The two lengths of 2″ pipe were fastened together with a short length of steel pipe into which they would fit snugly. This short length was welded to the lower section and the upper section of pipe was fitted into the sleeve and secured with a half-inch bolt. This made it possible to remove the lower section for easier transportation to the point of erection. The length of 1½″ pipe was securely fastened to the upper 2″ piece by telescoping it inside the 2″ section for a distance of about a foot and welding at that point. Further strength was gained by welding four pieces of flat steel, on edge, at 90° intervals around the pipe at the junction. A 10″ steel plate was welded to the bottom of the lower section for a firm footing on the roof of the building.

The bays were then welded to the mast and additional support for them was had by welding a piece of 1″x¼″ strap iron to the back of the mast and to the element support approximately a foot from the mast; this is illustrated in Figure 3.

Spacing between the bays, in inches, was $\frac{5760}{f_{mc}}$; the length of the half-wave line between bays.

No. 12 copper wire was used for the phasing line between bays. This was brazed to the two upper antenna elements, the transposition block inserted at midpoint between bays and the wires then brazed to the next two elements, stretching the line taut as it

(*Continued on page* 29)

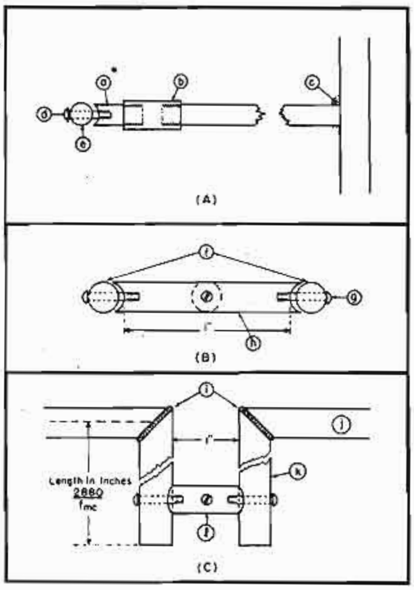
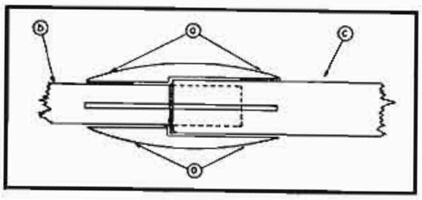


Figure 5 (above)

In *A* appears the construction of the lucite rod which was fastened to the interior of the pipe or coupling by machine screws. At (*a*) is diagrammed the lucite rod threaded into the pipe coupling and at (*b*) we have the ¾″ pipe coupling. At (*c*) appears the cut-away view of the ¾″ conduit which was welded to the mast. The 8-32 screw tapped into the lucite appears at (*d*), and in (*e*) is the lucite rod spacer which appears in the bottom of the stub. In *B* we see how the lucite rod was secured at (*f*) to another piece of lucite for spacing purposes. The 8-32 screw tapped into the lucite is indicated at point (*g*) and the spacer at (*h*). In *C* we have a view of the copper tubing matching stub which was cut to length and brazed to the inside ends of the lower two elements. At (*i*) are the ends of the steel tube and copper tubing which were mitered and brazed. The ½″ steel tube lower element is shown at (*j*) and at (*k*) is the ½″ copper tube matching stub. At (*l*) is another view of the lucite spacer at the bottom of the matching stub.

Figure 4

How strength was gained by welding four pieces of flat steel, on edge, at 90° intervals around the pipe at the junction. At (a) appears a view of the ¼″ steel plate on the edge welded to the joints. The 1½″ pipe section is shown at (*b*) and at (*c*) is the 2″ pipe section.



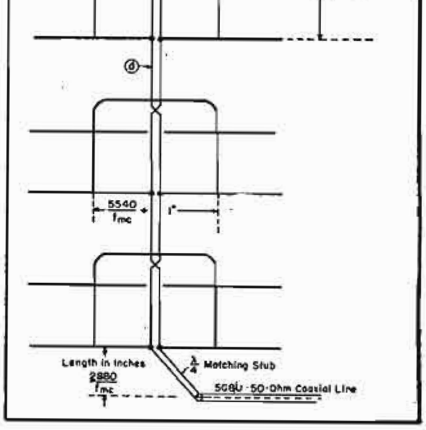


Figure 6 (right)

Schematic of the antenna. In (a) is illustrated the spacing between the element ends and line (1″). The elements of ½″ steel tube are indicated at (*b*), and at (*c*) is the element support of ¾″ conduit or pipe. The phasing line of No. 12 copper wire is indicated at (*d*).

A Report On The 1949

Highlights of Papers Presented by Robert H. Tanner and Arnold Peterson.

Sound in TV, which in the early days of telecasting did not receive too much attention, has begun to acquire the serious consideration of many.

In the September, 1948, issue of Communications, Scott Helt offered quite an analysis of the problem with his article *What Is Wrong With TV Sound*, pointing out that the full capabilities of the studio TV audio facilities were attained in few instances by television broadcasters.

At the recent IRE National Convention in New York City, the TV-sound subject was probed further by Robert H. Tanner of the Northern Electric Company in Ontario.

Discussing one of the problems, acoustics of television studios, Tanner said that TV studios cannot be provided in such numbers nor in such variety as broadcasting studios, where all programs are produced under very similar acoustic conditions. It was pointed out that scenery, screens or variable wall treatment must receive careful attention in the TV studio, with different parts of the studio made *dead* and *live*, to accommodate changes in the sizes of the audience and number of performers.

Microphones and microphone technique were also reviewed in this talk. Since, generally, the microphone is usually further away from the artist than in standard broadcasting the noise level in the television studio is always higher, and thus the maintenance of an adequate signal-to-noise ratio is quite difficult. Acoustic perspective becomes important and must be adjusted continuously to match the picture, frequent changes in camera angle requiring corresponding changes in sound. The problem can be solved, in part, according to Tanner, through the use of uni-directional microphones, both to improve signal-to-noise ratio and to reduce cross pickup, e.g., pickup of the orchestra on the soloist's microphone and vice-versa. Confirming Helt's comment on microphone boom control, Tanner stated that the mike on the boom must not produce rumbles when swung reasonably fast. A certain amount of low frequency attenuation can normally be inserted in the boom circuit, since this microphone is used primarily for speech, solo singing or emphasis of featured instruments, while in a musical show, the full orchestra may be picked up on a stationary microphone with no correction.

Binaural reproduction was expressed as being a solution to many TV-sound problems. Tanner indicated that with this system, a very marked apparent increase in signal-to-noise level is achieved by restoring to the listeners' ears their power to concentrate on any particular source of sound. At the same time, he said, the need for exaggeration of the balance between soloist and orchestra, which has for so long been accepted in all forms of sound reproduction, would no longer exist. Two distinct methods of binaural reproduction were described as possibilities; the first using headphones and the second loudspeakers. Although the illusion produced by the former method is much more perfect, Tanner said it is doubtful whether viewers could be persuaded to revert to the use of headphones.

Commenting on the usual argument against binaural systems, that it is uneconomical to double the bandwidth required, Tanner declared that this view loses most of its force when it is considered that the sound program is accompanied by a television signal occupying many times the sound bandwidth. Pulse transmission offers a possible solution to the binaural system problem, it was stated, with one transmitter providing the two-channel service.

•

Non-Linear Distortion Measurement

The subject of sound was featured in another IRE paper by Arnold Peterson, of General Radio, covering the measurement of non-linear distortion, who declared that everyone seems to agree that non-linear distortion is undesirable, but few of us agree on the amount of distortion that is tolerable or on the method of measuring this distortion.

Tests have shown that tolerable distortion can be considered from two different points of view; namely, a certain amount of non-linearity is tolerable, or that only certain amounts of various distortion components are tolerable. It would be very useful to classify the various possible distortion components according to the amount of each component that is tolerable so that the results of measurements could be adequately interpreted, but sufficient subjective data to make this classification is not available. At the present time Peterson said that we are forced to consider the distortion in relation to the extent of non-linearity in an audio system.

There are three most generally used methods for measuring non-linear distortion: (*1*) Harmonic method;[1] (*2*) modulation or carrier-analysis intermodulation method;[2] and (*3*) difference-frequency intermodulation method.[3]

Analyzing the effects of preemphasis, particularly *hf* preemphasis, which is now widely applied in recording and in FM, Peterson said that in addition to the normal increase in distortion at high frequencies in recording, this preemphasis has a marked effect on the distortion problem. If distortion takes place after preemphasis and before deemphasis, the distortion determined by the three methods is markedly different after deemphasis.

It was then pointed out that the harmonics of a signal will be deemphasized more than the fundamental, so that after deemphasis, the percentage harmonic distortion will be lowered. The value of distortion obtained by the carrier-analysis method of intermodulation measurement will not be significantly altered by deemphasis, since the components that determine this value are all closely spaced in frequency. The value of quadratic distortion measured by the difference-frequency method will be markedly increased, since the high-frequency signals are greatly deemphasized com-

[1]IRE: Standardized for years and the method most widely used.

[2]SMPE method recently standardized; Has certain advantages for measurements on film recording systems.

[3]CCIF; Comité Consultatif International Téléphonique method used as an alternative to the IRE system.

IRE National Convention

Assortment of miniature components used in a recently developed test tool kit exhibited by the U. S. Navy at the IRE National Convention. Components in the kit include a tube tester, signal tracer, voltage indicator probe, rf indicator probe, resistance indicator probe, decade resistor, decade capacitor, wrench set, neon test light, pen-type soldering iron and assortment of screwdrivers, pliers, etc.

Ye editor, IRE prexy Stuart Bailey and Virgil Graham, discussing the IRE National Convention exhibits and papers at a press meeting held in the Commodore Hotel in New York City.

pared to the unwanted second-degree difference-frequency component, f_2-f_1. This increase, said Peterson, is not merely a mathematical one; it is very significant to the ear, and thus quadratic distortion at high frequencies in preemphasized systems must be kept very low. For high-quality FM broadcasting this value should be much lower than is generally realized, and the method best suited for measuring the distortion is by the difference-frequency method. According to Peterson, the other two standard methods do not yield results that are significant for this type of distortion.

Systems that are restricted in the *hf* range or that include elements that are restricted require difference-frequency tests for distortion at the high-frequency tests for distortion at the high-frequency end. While all systems are restricted in range, we were told that the systems to which the discussion particularly applied were hearing-aids, filter networks, noise suppressors of the Olson type, high-efficiency speech systems, and similar types of equipment. For this class of equipment, harmonic distortion measurements at frequencies higher than one-half the effective cut-off frequency are of little value, because of the attenuation of the generated harmonic components.

In a discussion of the carrier-analysis type of intermodulation measurement it was learned that this method is not satisfactory for distortion measurement on these systems, because the indicated level of distortion is determined mainly by low-frequency behavior, owing to the dominating low-frequency signal. If the relative levels of low and high-frequency signals are reversed, more significant measurements at high frequencies can be made.

Covering FM intermodulation, Peterson declared that the type of intermodulation that occurs when two signals are applied to a system may be a very complicated interaction. If the carrier-analysis method of distortion measurement is considered, the distortion is expressed as a modulation of the high-frequency by the low-frequency. In actual systems (for example, loudspeakers, amplifiers with iron-core elements, and FM distorted in linear networks), this modulation may be partly or mainly a phase or FM type of modulation as well as the usually considered AM type. The standard intermodulation analyzer was described as being able to measure only the AM component of this modulation. In contrast, the FM type of modulation can be observed by the difference-frequency method by measuring side-band components; a combination of FM and AM is easily observed by the disymmetry of the side-band components. This disymmetry is readily observed in audio power amplifiers, although the effect is usually slight.

The Difference-Frequency Method

In applying the difference-frequency method of intermodulation measurement it is necessary to use a two-signal audio generator, having continuously adjustable frequencies, and an analyzer for measuring the various intermodulation components. The two-signal audio generator and analyzer (a standard audio-frequency wave analyzer) combination permits measurements to be made by the three methods discussed, but it is particularly adapted to the difference-frequency method. The generator is arranged so that the two signals can be separately adjustable or so that the two can be varied over the audio range with a constant difference-frequency maintained between the two. This latter arrangement is particularly convenient when investigating objectionable quadratic distortion, since the wave analyzer needs to be tuned only to the fixed difference frequency. Peterson stated that the cubic distortion, which is often the most important form of distortion, is determined by separate tuning of the analyzer to the required components for each frequency.

We were informed that there are several complicating effects that can occur with this system, so that it is always best to check the results by direct measurement with the wave analyzer. Exploring the magnitude of the distortion as a function of frequency, as well as amplitude, is very helpful in any analysis of sources and ultimate effects of distortion. This technique is very worth while in making harmonic measurements, and it is equally helpful in using difference-frequency measurements.—L. W.

Figure 1
The WOW-TV field car.

The WOW-TV

IN DESIGNING a field car for TV pickup, there are many factors to consider. For instance, our experience with television field equipment showed that considerable physical labor and time was consumed in pickups not readily accessible to the mobile unit. Accordingly, when we developed our car* a special type of console dolly was included. On such pickups the equipment is removed from the unit and transported to the actual originating point. With the dolly it is not necessary to disconnect the equipment; instead, it is wheeled as a unit to the originating point, where it is necessary only to plug in power, cameras and video line. A special steel ramp was constructed to be used when the unit is removed from the car, or when it is necessary to move it up short flights of stairs or over obstructions. The overall width of the unit is 26″, allowing for passage through any standard width door.

Tube and Supply Case

A special tube and supply case was constructed, which is mounted on the dolly and insures availability of all spare parts, tubes, fuses, etc., at the control point at all times. If necessary, this space can be used for a third camera control unit.

*Car built by the Henney Motor Co., Freeport, Ill.

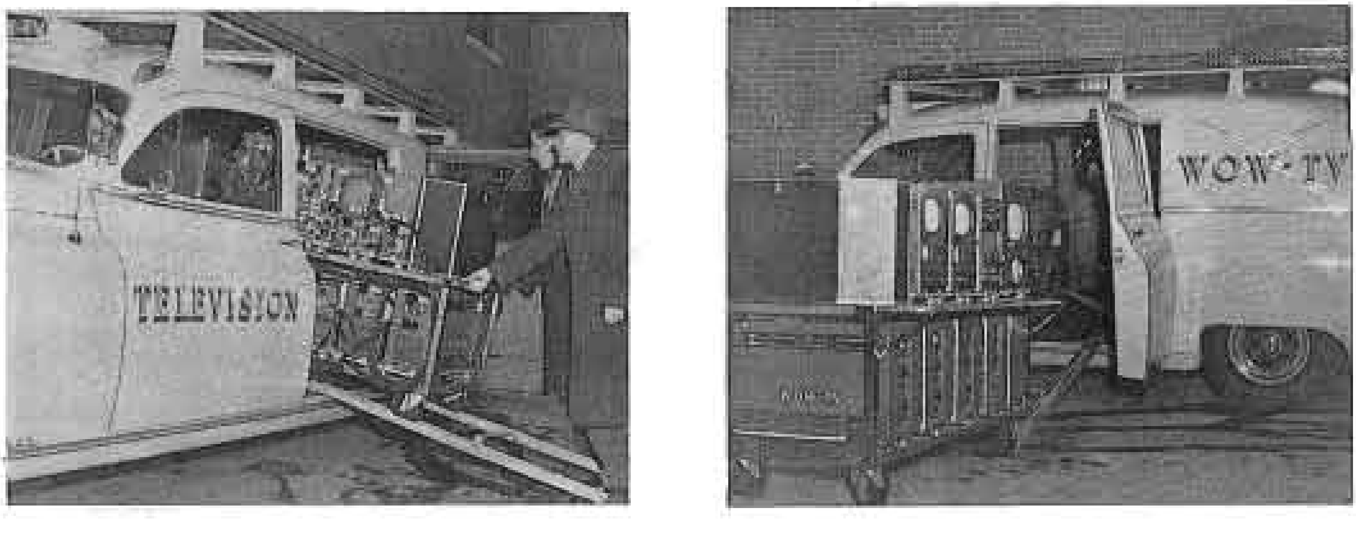
Portable Camera Uses

In the WOW-TV studio installation the portable cameras are used for one studio. The dolly makes this plan very practical, as equipment can be moved from the mobile unit and set up in the studio, ready for operation, in a very short time.

Hydraulic Leveling

A patented feature of the field car is a hydraulic leveling unit. This al-

Figures 2a (left) and b (right)
In these views appear the special type of console dolly built into the truck to facilitate movement of the remote equipment.



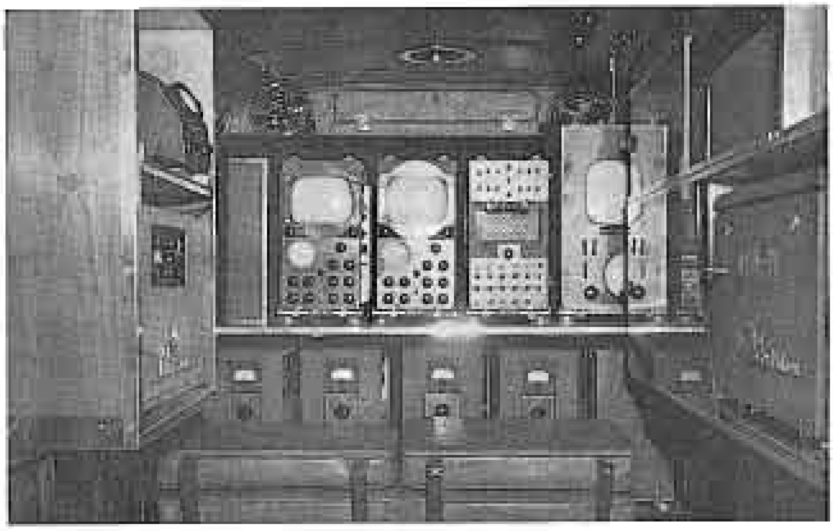


Figure 3
Interior view of car illustrating the built-in cabinets which are used to store a variety of equipment, including cameras, view finders, lenses, etc.

TELEVISION FIELD CAR

Car Features Easily Removable Console Dolly on Which All Equipment Can Be Mounted for Rapid Transportation to Point of Pickup. Also Provided Is a Hydraulic Leveling Unit to Level Body When Car Is Being Used for Relay and Camera Work.

by JOSEPH HEROLD
Technical Supervisor
WOW, Omaha, Neb.

lows for leveling the body of the unit when it is used for relay and cameras. A spirit bubble located on the dash board adjacent the leveling button control, indicates the angle of tilt. The leveling feature also makes the body rigid so that personnel walking on the deck, or climbing off or onto the deck, will not disturb the picture being picked up by the camera. The car is tilted by this unit when the console dolly is removed or restored to the car so that the ramp rise will be at a minimum.

Storage

Cabinets have been built in to store the cameras, view finders, lens and other equipment; Figure 3.

In this view, on the left, are a TV relay transmitter control unit, audio amplifier and 'scope cabinets. The photograph also shows the console dolly in place. A well built in the floor at the rear provides for cable storage.

Deck

The deck, Figure 4, is especially reinforced to support personnel and equipment. It is equipped with tripod clamps, a collapsible railing and waterproof porthole for cable entry. It is accessible from the rear by means of a ladder stored in the unit. The floor of the unit at the rear projects about two feet further than the deck, which simplifies loading or unloading of equipment to the deck.

Special Facilities

The unit is also equipped with a radiotelephone, a service of the local telephone company. It is also supplied with front and rear special flasher lamps to provide for driving through traffic. A neon sign above the windshield provides identification from that angle. Side windows are one-way, mirrored from the outside but allowing good vision from the inside. Windows are raised or lowered hydraulically.

Trailer Hitch

The car also has provision for a trailer hitch which will be used to haul a special trailer gas engine in which a 6½ kw power generating unit is installed.

Figure 4
The reinforced deck of the field car.

Modernizing A

Revamped Amplifier, Incorporating Simple Mixing Circuit, With 1620s in the Low-Level Stages and a 6SN7 as a Voltage Amplifier and Phase Splitter, Provides a Frequency Response Flat Within 2 db From 20 to 20,000 cps.

by ADELBERT KELLEY

Chief Engineer
WINR, Binghamton, N. Y.

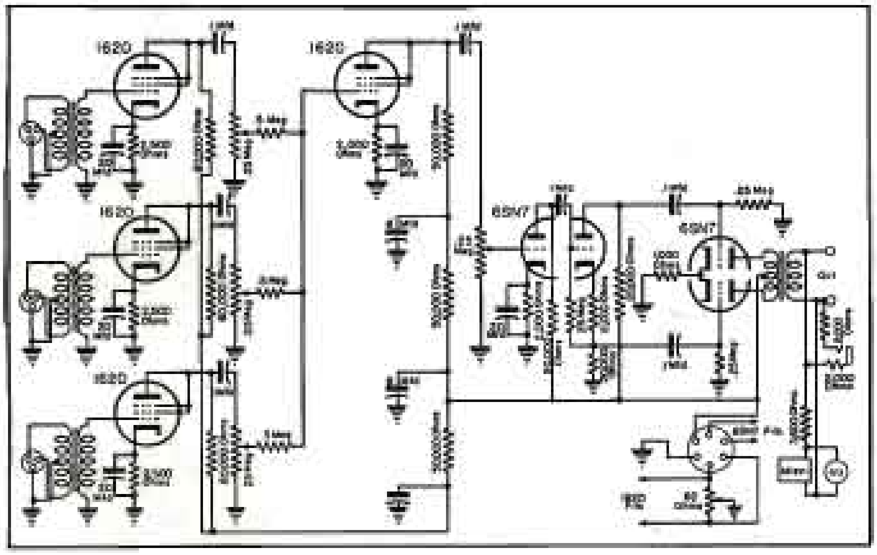


Figure 1
Circuit of the revamped remote amplifier.

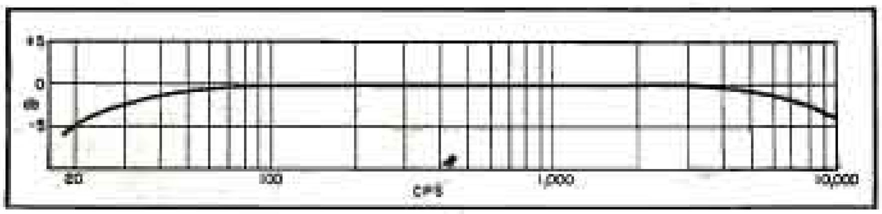
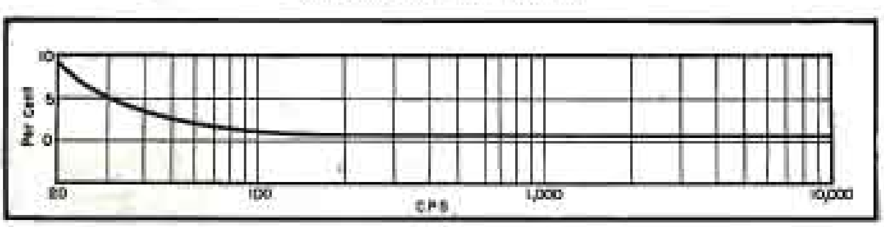


Figure 2
Frequency[1] plot of the amplifier.

Figure 3
Distortion[2] plot of the amplifier.



RECENTLY, we found an urgent need for an additional remote amplifier and since one could not be obtained in time, a bit of improvisation appeared to be required. Searching our racks we came across a remote amp unit* which was rarely used because it had two microphone inputs, the volume indicator meter was obsolete and old type glass tubes were required. However, the amp seemed to offer revamping possibilities.

Simple Mixer System Used

We found that the simplest mixer system could be used with very satisfactory results. Maximum variation of the faders in any position only changed the output of the amplifier ½ vu. With this type of circuit, ordinary volume controls can be used which makes replacement, if it ever becomes necessary, an easy and inexpensive procedure.

Our assumptions proved correct, since the revamped unit provided a frequency response flat within 2 db from 20 to 10,000 cycles.

At a gain of 70 db, the noise was measured at −58 db for the rated output of +10 vu. The distortion from 100 to 10,000 cps was about .7%, with the usual increase in the lower registers.

Old Case Used

The amplifier was built into the old case which measured 12" x 7" x 7¼". All parts were first removed from the old chassis which was in two sections; the sides, and the top mounted to the sides by shock mounting grommets. The top plate was then removed and taken to a metal shop where they used it as a template to cut out and bend a new aluminum chassis top. All the socket holes and transformer cutouts were made before the new top was fastened to the old sides.

The back panel of the chassis had to be modified to accommodate three microphone connectors[3] by moving the power connector socket into the space formerly occupied by the output binding post. This binding post found its

*RCA 62A.
[1]Made with Hewlett-Packard 200-B oscillator.
[2]Made with Hewlett-Packard 200-B oscillator and RCA 69-B noise and distortion analyzer.

REMOTE AMPLIFIER

home in the front panel. New holes had to be cut in the cover to clear the power connector cable.

In laying out the parts, we found that the channel control number sequence, which read from left to right, would no longer be accurate. However, this didn't matter since the channels actually correspond with the connectors on the rear, channel *1* filling the hole which formerly held the old db range switch.

Low Level Stages

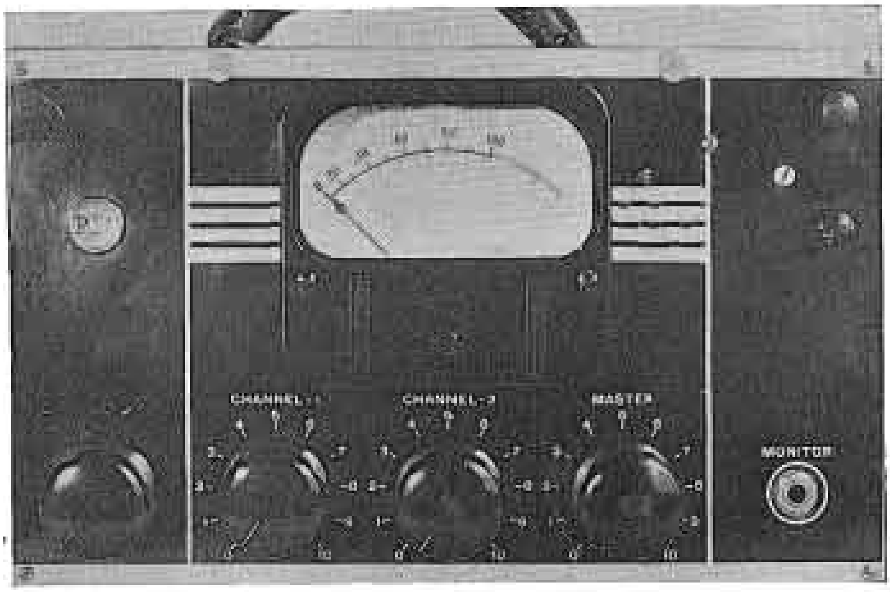
We used 1620s in all the low level stages since their performance has been found superior to other types. They were not mounted on shockmount sockets since it was felt that rarely would the amplifier be subjected to enough vibration to make any difference in the noise level.

Since we had spare input transformers[2] for our consolette[2a] it was decided to use them in the input circuit in preference to other lighter inputs that are on the market. The 1620s were wired to a separate input circuit so they could be balanced to ground with a hum balancing pot. The remainder of the heaters were connected to the center-tapped winding of the filament supply.

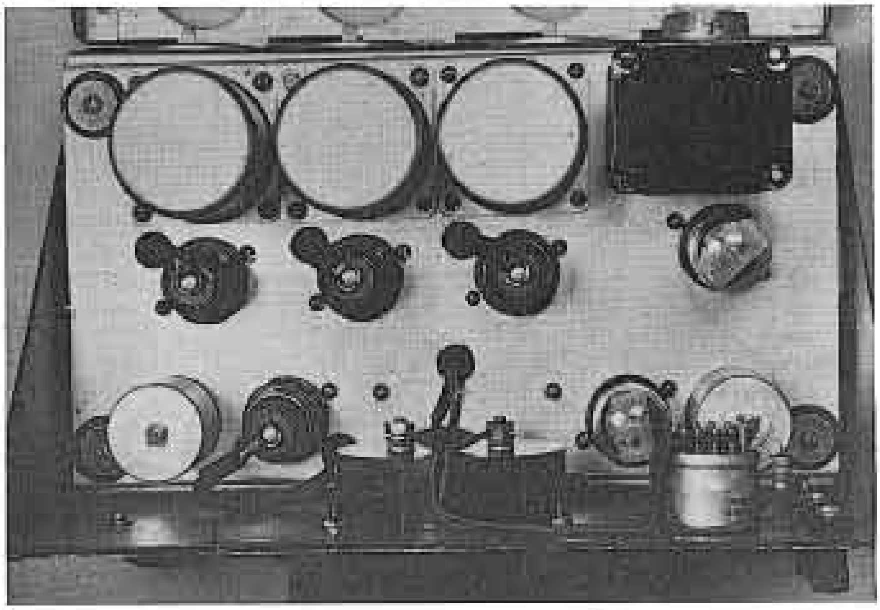
A 6SN7 dual tube was incorporated as a combination voltage amplifier and phase splitter. This type is often microphonic, but when used in a stage where the signal is high enough so it is not affected. The phase splitting circuit, a simple arrangement, provided excellent fidelity.

The same power supply used to energize the old remote was used, with but one modification; the voltage regulator circuit was removed to raise the output voltage to about 275.

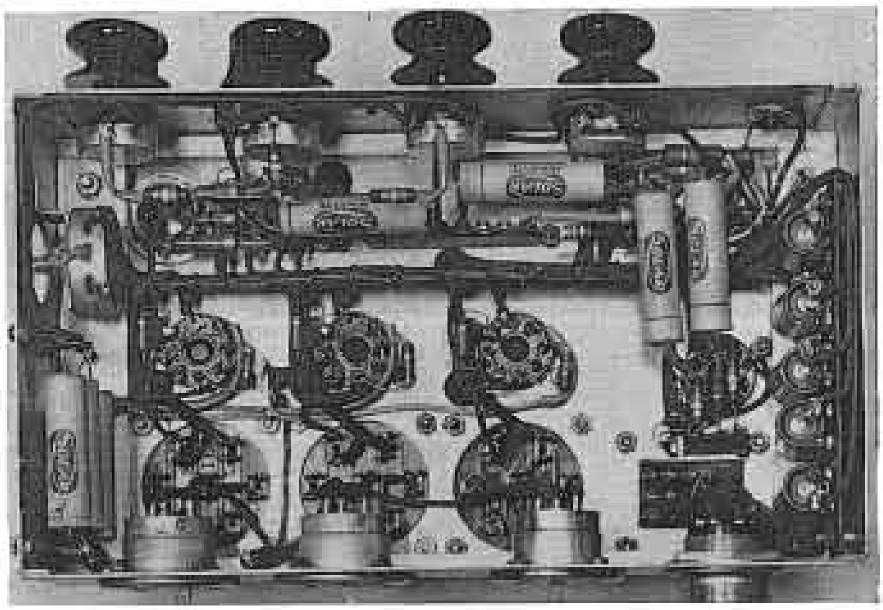
[1]Daven RC-134-1. [3]Cannon P3-13.
[2]RCA 901046. [2a]RCA 76B-2.



(Top, right)
Front view of the modernized remote amplifier.



(Center, right)
Top view of the rebuilt remote amplifier. Attenuator[1] mounted next to the binding post was set for 4 vu attenuation so that the meter would read 8 vu at zero scale, providing sufficient reserve and eliminating the possibility of distortion showing up should the amplifier become sufficiently overloaded.



(Right)
Bottom view of the rewired amplifier.

AM-FM Console

Output and Signal Switching Setup Provides Feed to the AM and FM Lines or Both, With Practically Instantaneous Switching to Each Console. Signal Switching Also Provides On-the-Air Indication to Studio Performers.

by F. E. BARTLETT

Chief Engineer
KSO and KSO-FM
Des Moines, Iowa

Operating two radio stations, AM and FM, from a single control room often presents many vexing problems. Not the least of these problems is the matter of output switching.

In analyzing our requirements, for a solution, we found six factors to consider in the matter of output switching:

(*1*) Each console must be able to feed either one, or both of two lines (AM and FM).
(*2*) Switching for this operation must be practically instantaneous.
(*3*) This switching operation must be convenient to each console.
(*4*) Such switching must be interlocked to reduce operating errors.
(*5*) Indication of the function performed must be visual to the operating personnel.
(*6*) We preferred not to use relays.

Signal switching requirements included the use of studio signal lights to inform studio performers when they were on the air, these indicators also informing the studio which station they were on. We also felt that such indicators must also operate independent of a console, so that when lines were switched, lights also would switch.

Contact Analyses

A survey of available equipment revealed two lever type switches with enough contacts to properly handle the number of circuits involved. Drawing a diagram of the contact arrangements and studying the switching possibilities, it was noted that with the switches in the normal position, action should be normal, each console feeding the line of the station with which it was normally associated. It was desirable that the consoles could be reversed, or one normally feeding the AM lines to feed the FM line and vice versa; the operation to function with no time lag but be interlocked with the other console so that, say the AM console could operate the switch to the reverse position but no make-or-break function would perform, the console continuing to feed the AM line, until the FM console switch was thrown to the reverse position. The same would be true of the other console. In other words, we felt that the switches should be interlocked so that either of them could perform the reversing operation, but the actual reversing process would not function until both of them had performed the reversal.

Method Selected

A number of methods were tried and the system shown in Figure 1 finally selected.

After a simplified version of this portion of the switching setup was decided upon, we then attempted to probe the remaining portion of the problem, dual feeding of both lines by one console. In this case where we wanted one console to feed both stations simultaneously, the other console would then be disconnected from any line and would be available for auditions, recordings, etc.

Functional Operation Of Switches

To illustrate the operation of the switches, let us take a case where console *2* is feeding FM, and suppose that after a station break it is desirable that the consoles be reversed, with console *1* then feeding FM, while console *2* takes over the feeding of AM. It may be found that the FM announcer will conclude his station break first and the operator on that console throws his reversal switch to the *up* position which is the position to put him on the AM line. However, suppose the AM announcer hasn't completed reading a spot announcement and the operator on console *1* hasn't thrown his reversal switch; thus, nothing happens, the signal lights on both consoles remaining lighted on the original line. The operator on console *2* therefore holds up the start of the next program awaiting the proper signal. At the instant the AM announcer finishes the spot, the operator will throw his reversal switch and the lines are instantly reversed, console *1* now feeding FM and console *2* feeding AM. At the same instant, the FM signal lamp on console *2* goes out and the AM lamp is lighted, thus notifying the console *2* operator that the reversal has been completed and the next AM program can be started. The same is true on console *1*, where the AM lamp goes out and the FM lamp lights up.

Indicator Light Uses

These indicator lights also serve another purpose, the voltage applied to these indicator lights operating relays in another system which control studio signal lights.

Relay System That Thinks

It is this other system which we have dubbed *a relay system that thinks*.

Switching and Relay System

The wiring of this relay system is shown in Figure 2.

Operation of System

When a microphone in a given studio is turned on, voltage is applied from that console to the proper relay sequence, turning on the *on the air* light and at the same time selecting the AM or FM light depending upon the line which that console is feeding at the moment. Since the light relay actually picks out the signal it wants, one can well imagine it as a *thinking relay*. To illustrate the operation of this system, let us take a case where the operator on console *1*, which normally feeds the AM line, turns on a microphone key for studio *B*. This operation applies a voltage from a console source to a pair of terminals which are connected externally to the second relay in the top row. Actuation of this relay closes both of its associated switches, the one on the left closing the *ac* circuit and applying 110 volts to the *on the air* light in studio *B*. The switches on the right close and *ac* voltage is applied to the fourth relay in the top row. Its position determines which studio signal light, the AM or the FM, is lighted. If the console is feeding the AM lines, the AM light on console *1* lights and since this relay coil is wired in parallel with this light, the coil is energized, switches are closed and we have an AM studio light on. If we assume that console *1* was not feeding AM and the relay not actuated, then we'll find that since the console is not feeding AM, it must be feeding FM and the relay will drop back to the relaxed position and turn on the FM light.

Console 2 Operation

On console *2* just the reverse is true. In this case the fourth relay in the second row is connected in parallel with the FM light on console *2*. This coil is then energized when the FM is being fed, and is relaxed when FM is not fed and the proper signal lights are turned on.

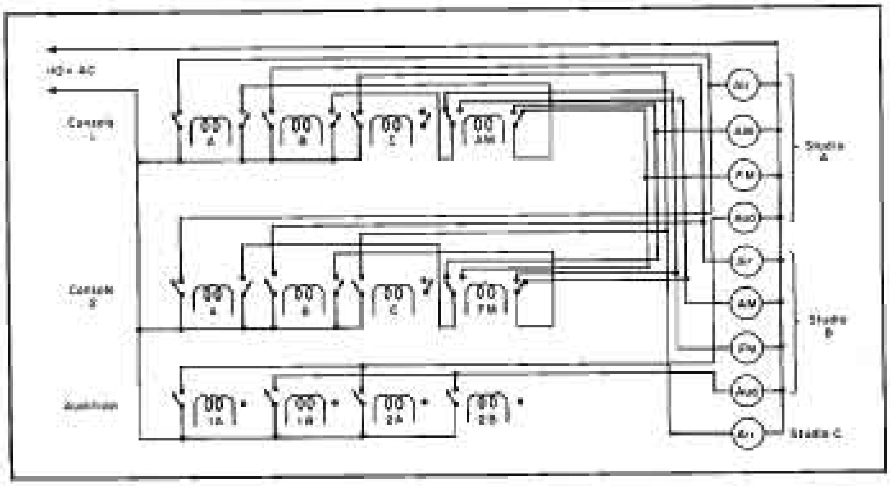


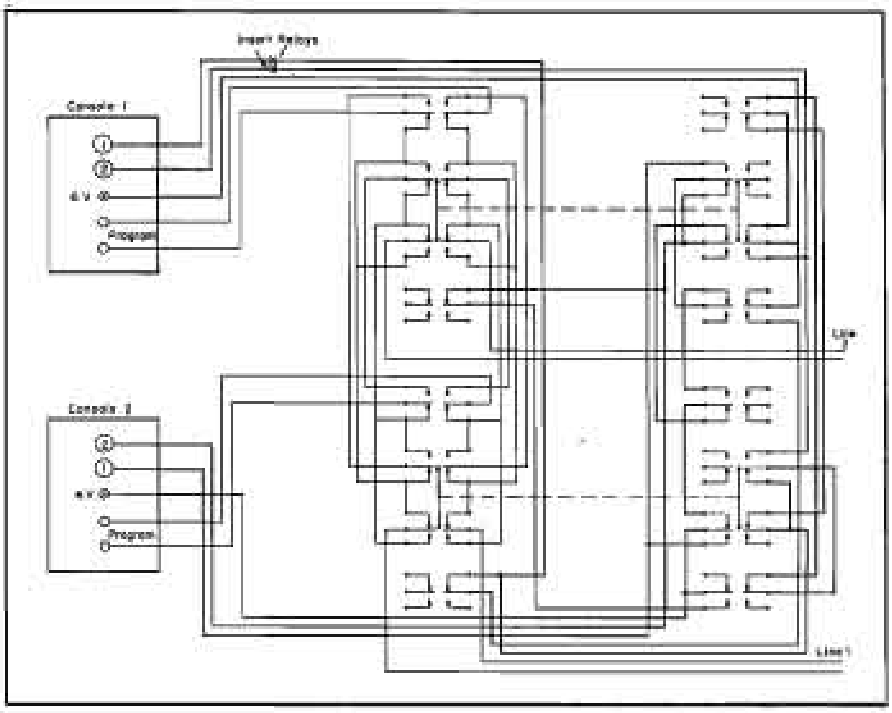
Figure 1
Studio signal switching system.

In our particular case, our studio *C* is used only for one particular type of program and it is not necessary that AM or FM lights, or audition lights be provided. Should they be needed in this studio, an additional relay could be wired into the circuit, each additional relay accommodating two studios.

External Power Supply

Voltage for the operation of the signal light relays, as well as the console signal lamps, is provided by an external power supply which provides 6 volts *dc* from a 110-volt supply.

Figure 2
Relay system setup.



General Folded-Dipole

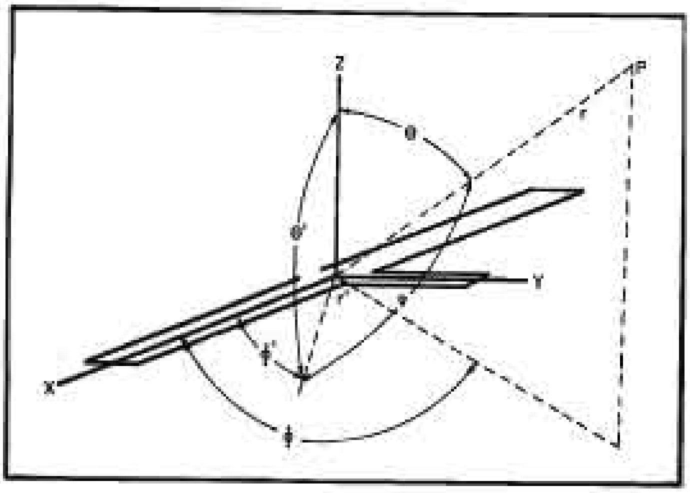


Figure 1
Orientation of antenna with respect to axes.

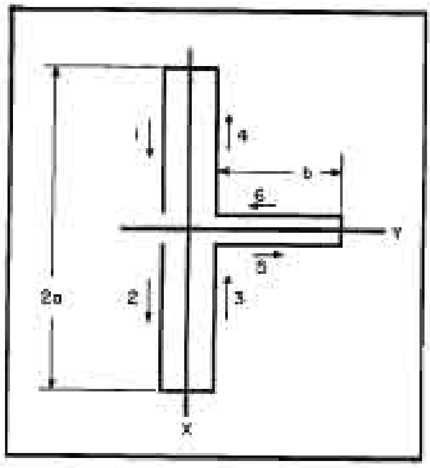


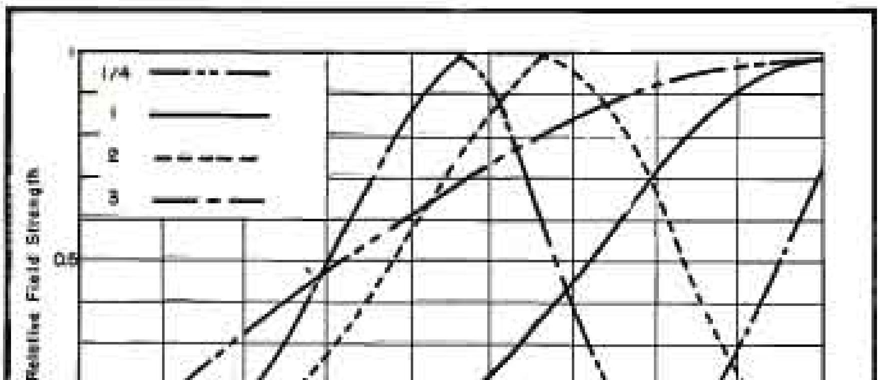
Figure 2
Dimensions and current direction in the folded dipole. Sides 5 and 6 constitute the tuning stub.

ALONG WITH THE DEVELOPMENT of FM and TV receivers the need for an easily matched antenna at high frequencies has been greatly increased. Commercially this demand is being filled by the half wavelength folded dipole. Several studies[1-4] have been made on the folded dipole and similar antennas, but these studies have been concerned only with the half-wavelength folded dipole. This paper will consider the field patterns and radiation resistance for folded dipoles of any length and with any current distribution in the sides.

Analysis

Figure 1 shows the orientation used in the analysis. Primed quantities refer to points on the antenna, and ordinary quantities refer to a distant point in space at which the electric field is to be determined. The angles and distances are labelled to conform with the general radiation formulas developed by Schelkunoff[5,7] and the form of these equations as presented by Ramo and Whinnery.[8] In Figure 2 the dimensions of the folded dipole are indicated. The dimension $2a$ will be referred to as the length of the folded dipole, while dimension b is the length of the tuning stub. The small numbered arrows indicate the positive direction of the assumed sinusoidal current distribution in the sides of the folded dipole.

Figure 3
Calculated relative field strengths for various sizes of the folded dipole.



Generally, the mathematical analysis consists of:

(1) Assuming a sinusoidal current distribution having a current maximum at the shorted end of the tuning stub.
(2) Obtaining an expression for the radiation vector using the assumed current distribution.
(3) Finding the power radiated per unit solid angle.
(4) Converting the power radiated to an expression for the electric field intensity.

As a result of the mathematical analysis* the electric field intensity E, at any point in space about a folded dipole any number of wavelengths in size and with a current distribution as determined by the length of the tuning stub, was found to be

$$E = \sqrt{\frac{\eta}{2}} \left| \frac{I\,[\sin k\,(a+b)]\,[\cos\,(ka \sin\theta \cos\phi) - \cos ka]}{\pi\,(1 - \sin^2\theta \cos^2\phi)^{1/2}} \right| \quad (1)$$

Where:

a = half of the length of the folded dipole.
b = length of the tuning stub.
η = characteristic impedance of free space.
$k = \frac{2\pi}{\lambda}$ = phase shift constant in free space assuming the attenuation constant is zero.

ANTENNA DESIGN

An Analysis of the Field Patterns and Radiation Resistance for Folded Dipoles of Any Length and With Any Current Distribution in the Sides. General Folded-Dipole Design Theoretical Results Compared With Experimental Results.

by D. L. WAIDELICH
Professor, Electrical Engineering
University of Missouri

θ = angle between the Z-axis and the radius vector to the point in space at which the electric field is to be determined.

ϕ = angle between the X-axis and the projection on the horizontal plane of the radius vector to the point in space at which the electric field is to be determined.

I = the maximum current in the tuning stub.

For the YZ plane, $\phi = 90°$, and *equation (1)* reduces to an expression independent of θ which indicates that the electric field in this plane is constant. Since using $\theta = 90°$ or $\phi = 0°$ will reduce equation *(1)* to expressions which are identical, only the equation for the electric field intensity in the XY plane will be developed, and the relation is

$$E_{xy} = \sqrt{\frac{5}{2}} \left| \frac{I \left| \sin k(a+b) \right| \left| \cos(ka\cos\phi) - \cos ka \right|}{\pi \sin\phi} \right| \qquad (2)$$

It may be shown, in addition, that the field patterns in any planes passing through the axis of the antenna always have exactly the same shapes.

Calculated Results

Since the YZ pattern is constant and the XY and XZ patterns are the same, equation *(1)* shows that the field pattern in a plane perpendicular to the axis of a folded-dipole antenna is a circle. Either equation *(1)* or *(2)* shows that the shape of the electric field pattern in a plane passing through the axis of the antenna is determined by the length $(2a)$ of the folded dipole and is independent of the length (b) of the tuning stub. This indicates that by varying the length of the tuning stub various radiation resistances may be obtained, but the field pattern will be unchanged.

For the field pattern in any plane passing through the axis of the dipole, enough symmetry is present so that it is necessary to present only one quadrant of the pattern. Figure *3* shows the relative field strength in the first quadrant of the XY plane versus angle ϕ for several different antennas with their sizes expressed in wavelengths. The quarter-wavelength case is a *figure-eight* pattern having lobes which are approximately circles on a polar plot and which show up as a sine curve in Figure 3. It is interesting to note that the complete pattern for a one-wavelength folded dipole has only two lobes, while a one-wavelength straight-wire antenna has four lobes. The one-wavelength folded dipole seems to have better directional characteristics than the half-wavelength folded dipole.

A series of curves similar to those of Figure 3 but for various other wavelengths were studied. From these, Figures 4, 5 and 6 were developed to furnish the information necessary to determine the approxi-

*This analysis in detailed form will appear in an early issue of COMMUNICATIONS.

Figure 4
Location of the zeros in the field pattern of the folded dipole.

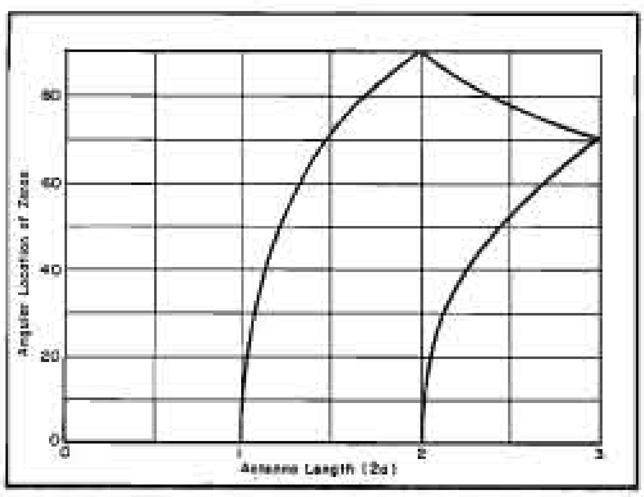
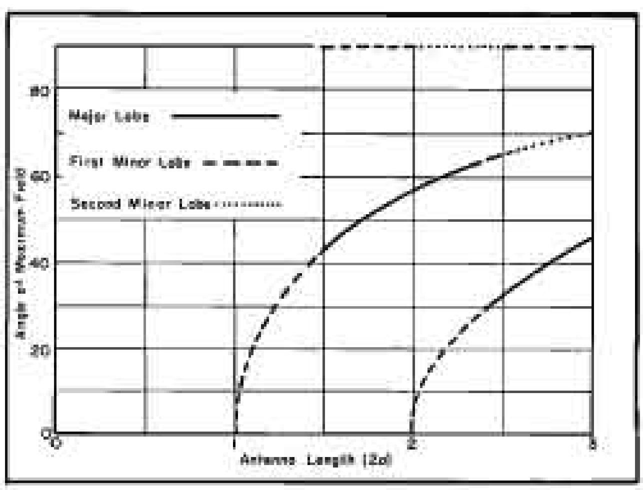
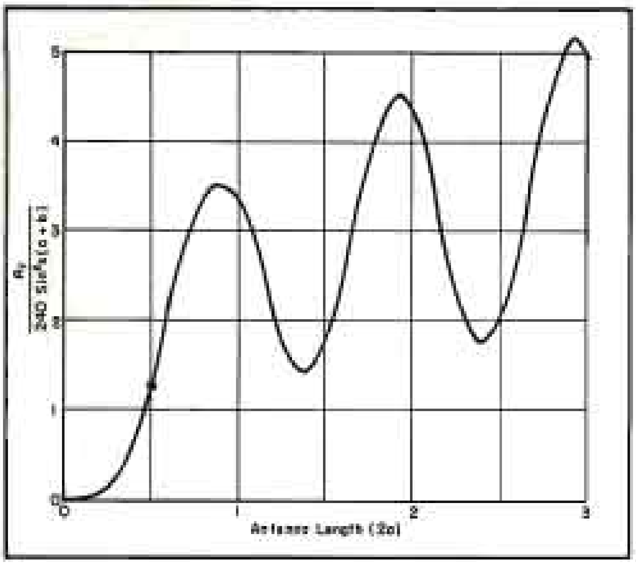


Figure 5
Angle of maximum field in the field pattern of the folded dipole.





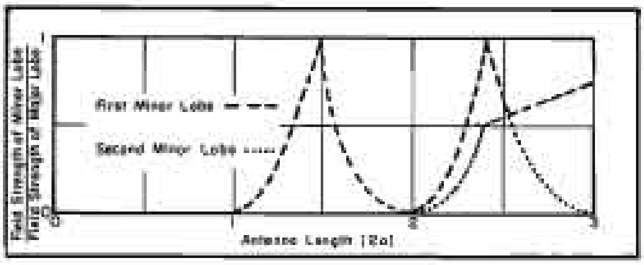


Figure 6
Relative maximum field strengths of the various lobes in the field pattern of the folded dipole.

Figure 7
The radiation resistance of the folded-dipole antenna.

mate shape of the horizontal field pattern for folded dipoles from zero to three wavelengths in size. Figure 4 is a plot of the angle ϕ giving the angular location of the zeros of the electric field versus the length of the antenna in wavelengths. Figure 5 shows the angle of the maximum field strength of the major and of the various minor lobes plotted as a function of the antenna length. It will be noted that, as the antenna length is increased, the angle of the maximum field tends to approach zero degrees, which is the direction of the field for an infinitely long wire carrying a current. Figure 6 shows the ratio of the maximum field strength of a minor lobe to the maximum field strength of the major lobe plotted as a function of the antenna length.

The expression for the radiation resistance R_r for a folded-dipole antenna of any length with a tuning stub of any length was developed as a result of the mathematical analysis; but, due to the complexity, the equation will not be presented here. Figure 7 visualizes the information obtained from the equation by plotting

$$\frac{R_r}{240 \sin^2 b\,(a+b)}$$

versus the size of the antenna expressed in wavelengths. This curve indicates that the maximum value of radiation resistance for a given antenna is determined by the length of the antenna and, by adjusting the length b of the tuning stub, the radiation resistance may be varied from near zero to the previously mentioned maximum value. It should be noted that, with the proper combination of lengths, the radiation resistance can be varied from near zero to about 1200 ohms. The radiation resistance is always calculated with reference to a maximum current point such as the end of the tuning stub. For the usual half wavelength folded dipole, b equals zero and the circled point on the graph indicates the radiation resistance is about 300 ohms.

Experimental Results

Points shown on Figure 8 represent experimental results obtained using a folded-dipole antenna as a transmitting antenna with the tuning stub removed and the place where the stub connected was left open-circuited. Figure 9 gives the results obtained using a folded dipole in which the length of the tuning stub was zero. For the quarter wavelength size, the dipole was used as a receiving antenna, and for the other lengths, as a transmitting antenna. Generally the lobes and zeros were found in the angular position predicted, but as shown on the figures, the magnitude of the minor lobes deviated somewhat from the theoretical.

Some of the deviations in magnitude might be due to the non-uniformity of the material used in the dipole. Another reason for the deviations might be attributed to the radiation produced by the ends of the antenna, since the equations as derived assumed that the width of the dipole was negligible. This is especially important when the current distribution is such that a

(*Continued on page 30*)

Figure 8
Experimental field-strength points for various folded-dipole antennas with the tuning stub open circuited. The curves are calculated ones similar to those of Figure 3.

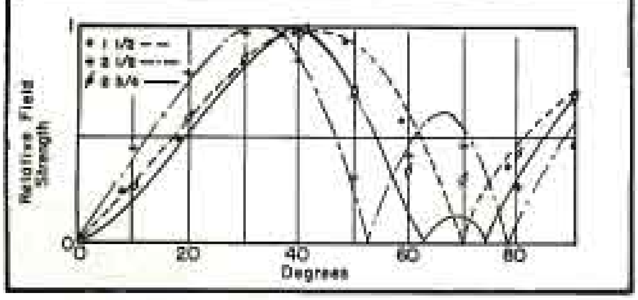
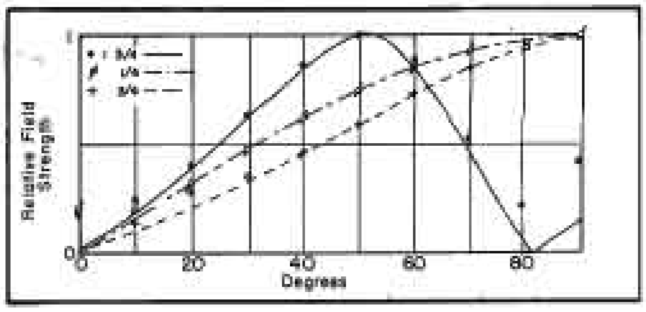


Figure 9
Experimental field-strength points for various folded-dipole antennas with the tuning stub short-circuited. The curves are calculated ones similar to those of Figure 3.



Variable Density Recording On 16-mm Film for TV

Film Recording Directly on Positive Film Minimizes Possibilities of Distortion and Provides Higher Output Level. Process Can Be Used for Kinescope Recording Work.

by LEWIS W. MARTIN

THE PROCESSING of 16-mm film for TV has become quite a specialized art, involving many new techniques. This is particularly true of the sound-on-film types, where there are the dual sight and sound factors to consider.[1]

In a recent study of a sight-sound film preparation problem, it was discovered that the customary negative step could be eliminated by a method,[1] which involves the use of the light valve to produce a variable density track directly on positive film.

Light Valve Recording

In recording with the light valve, an exciter lamp focuses a beam of light on moving film, the light being modulated by the valve which is placed between the lamp and the film. This valve consists of one or more duralumin ribbons located in a magnetic field. As signal currents are applied, the ribbons move toward and away from each other, thus varying the amount of the light which is allowed to strike the film. The result, in the case of variable density track, is a continuing series of narrow bands extending across the width of the track, adjacent bands differing from each other in density, or opacity.

The H and D Curve

Ordinarily a recording is made on negative film and subsequently processed on to positive stock; the film and processing characteristics of all types of film are expressed by plotting the density of the silver image versus the logarithm of the exposure, resulting in what is known as an *H* and *D* curve[2]. Variable density recordings with the light valve are usually made on the relatively straight portions of the negative and positive *H* and *D* curves, where the relationship between density and the logarithm of the exposure is linear. Printing from negative to positive results in a linear relation between exposure of the negative and transparency of the positive if suitable exposure and development are used for negative and print.

[1]Method developed by Electrical Research Products Division, Western Electric.
[2]See editorial, this issue.

Direct Positive Recording

A direct positive is recorded on the toe of the *H* and *D* curve without the use of an intermediate negative. Consequently it is desirable to use other means if the lack of linearity which would normally occur is to be overcome. This has been achieved by superimposing upon the light valve ribbons, together with the signal currents, a high frequency bias of the order of 24 kc.

The effect of this bias is to alter the exposure produced during recording in such a manner as to offset the nonlinearity which occurs by recording on the toe of the *H* and *D* curve. The light transmitted through the light valve is ordinarily directly proportional to the ribbon opening. When the signal current is sufficiently high in the closing direction, the light is completely intercepted by the closing of the ribbons. However, when the *ac* bias is simultaneously applied, the valve is rapidly opened and closed at the bias frequency for each value of signal current. Consequently the exposure for each value of signal current is the average light transmitted in a cycle of the high-frequency bias. Since the bias is applied at an amplitude of about 200%, 100% being the point at which the ribbons apparently meet, the valve is closed during at least a portion of each cycle for signals of normal amplitude. Therefore the exposure is averaged over a cycle during which the ribbons are closed for part of the time. The 200% amplitude does not cause the ribbons to clash, since they are strung in different planes.

Print of 35-mm track of variable density film, which is 100 mils wide. In 16-mm film the track is 90 mils wide.

Linear Relationship

The bias thus changes the linear relationship usually existing between the transmission of light through the valve and the relative size of the ribbon opening in such a way as to effectively offset the nonlinear characteristics associated with recording on the toe of the *H* and *D* curve.

Why 24-kc Was Chosen

The frequency of 24 kc was selected as the bias frequency to escape intermodulation and harmonic distortion effects which might result if a frequency nearer the audible range was used. On the other hand, the frequency is not so high as to cause undue mechanical strain on the ribbons.

FM Proof-of-Performance

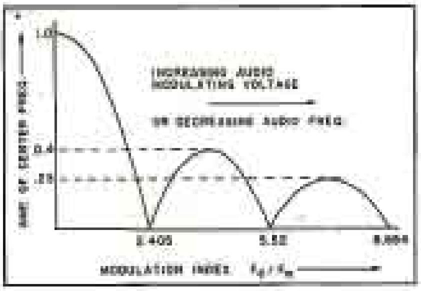


Figure 11
Center frequency wave shape variation with increasing audio modulating voltage.

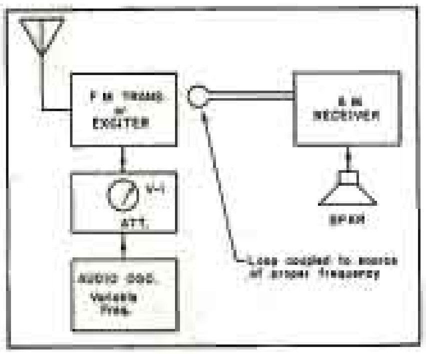


Figure 12
Test equipment arrangement for determining *Bessel zero points.*

Last month, reference was made to four appendices, covering lists of measurements required by the FCC, the FCC electrical performance standards, bessel zero system for measuring FM transmitter frequency swing and design and operation of a diode detector system which can be used to make hum and noise measurements.

These data are offered in this installment.

Appendix No. 1

(Lists of Measurements Required.[8])

Attach as Exhibit No. —— data, diagrams, and appropriate graphs together with description of measurements procedures and instruments with regard of the following: (See sections 8 and 11 of the Standards. All measurements shall be made with the equipment adjusted for normal program operations and shall include all circuits between the main studio microphone terminals and the antenna output, including telephone lines, pre-emphasis circuits, and any equalizers employed except for microphones, and without compression if a compression amplifier is installed.)

A. Audio frequency response from 50 to 15,000 cycles for approximately 25, 50, and 100 per cent modulation. Measurements shall be made on at least the following audio frequencies: 50, 100, 400, 1,000, 5,000 10,000 and 15,000 cycles. The frequency response measurements should normally be made without deemphasis, however, standard 75 microsecond deemphasis may be employed in the measuring equipment or system provided the accuracy of the deemphasis circuit is sufficient to insure that the measured response is within the prescribed limits.

B. Audio frequency harmonic distortion for 25, 50, and 100 per cent modulation for the fundamental frequencies of 50, 100, 400, 1,000 and 5,000 cycles. Audio frequency harmonics for 100 per cent modulation for fundamental frequencies of 10,000 and 15,000 cycles. Measurements shall normally include harmonics to 30,000 cycles. The distortion measurements shall be made employing 75 microsecond deemphasis in the measuring equipment or system.

C. Output noise level (FM) in the band of 50 to 15,000 cycles in db below the audio frequency level representing a frequency swing of of 75 kc. The noise measurements shall be made employing 75 microsecond deemphasis in the measuring equipment of system.

D. Output noise level (AM) in the band of 50 to 15,000 cycles in db below the level representing 100 per cent amplitude modulation. The noise measurements shall be made employing 75 microsecond deemphasis in the measuring equipment or system.

[8]Reprinted from FCC form, 302 section II-B, paragraph 6.

[9]Reprinted from section 8 of the FCC Standards of Good Engineering Practice concerning FM Broadcast Stations.

Appendix No. 2

(FCC Electrical Performance Standards.[9])

A. Electrical performances standards: The general design of the FM broadcast transmitting system (from input terminals of microphone preamplifier, through audio facilities at the studio, through lines or other circuits between studio and transmitter, through audio facilities at the transmitter, and through the transmitter, but excluding equalizers for the correction of deficiencies in microphone response) shall be in accordance with the following principles and specifications:

1. Standard power ratings and operating power range of FM broadcast transmitters shall be in accordance with the following table:

Standard Power Rating	*Operating Power Range*
250 watts	250 watts or less
1 kw.	250 watts-1 kw.
3 kw.	1-3 kw
10 kw.	3-10 kw.
25 kw.	10-25 kw.
50 kw.	10-50 kw.
100 kw.	50-100 kw.

Composite transmitters may be authorized with a power rating different from the above table, provided full data is supplied in the application concerning the basis employed in establishing the rating and the need therefor. The operating range of such transmitters shall be from one-third of the power rating to the power rating.

The transmitter shall operate satisfactorily in the operating power range with a frequency swing of ±75 kilocycles, which is defined as 100 per cent modulation.

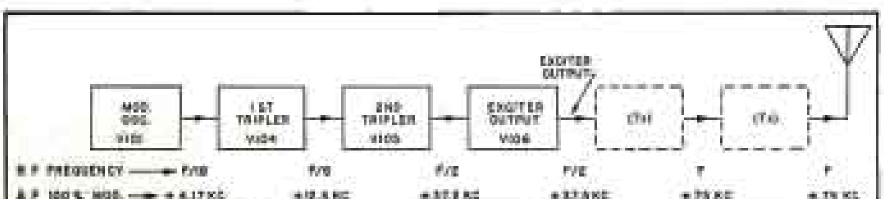
2. The transmitting system shall be capable of transmitting a band of frequencies from 50 to 15,000 cycles. Preemphasis shall be employed in accordance with the impedance-frequency characteristic of a series inductance-resistance network having a time constant of 75 microseconds. (See standard preemphasis curves.) The deviation of the system response from the standard preemphasis curve shall lie between two limits as shown in standard preemphasis curves. The upper of these limits shall be uniform (no deviation) from 50 to 15,000 cycles. The lower limit shall be uniform from 100 to 7,500 cycles and 3 db below the upper limit; from 100 to 50 cycles the lower limit shall fall from the 3 db limit at a uniform rate of 1 db per octave (4 db at 50 cycles); from 7,500 to 15,000 cycles the lower limit shall fall from the 3 db limit at a uniform rate of 2 db per octave (5 db at 15,000 cycles).

3. At any modulation frequency between 50 and 15,000 cycles and at modulation percentages of 25, 50, and 100 per cent, the combined audio frequency harmonics measured in the output of the system shall not exceed the root-mean-square values given in the following tables:

Modulation Frequency	*Distortion*
50 to 100 cycles	3.5%
100 to 7,500 cycles	2.5%
7,500 to 15,000 cycles	3.0%

Measurements shall be made employing 75 microsecond deemphasis in the measuring equipment and 75 microsecond preemphasis in the transmitting equipment, and without compression

Fig. 13
Exciter block diagram indicating receiver coupling points.



Measurement Techniques

if a compression amplifier is employed. Harmonics shall be included to 30 kc.

It is recommended that none of the three main divisions of the system (transmitter, studio to transmitter circuit, and audio facilities) contribute over one-half of these percentages since at some frequencies the total distortion may become the arithmetic sum of the distortions of the divisions.

4. The transmitting system output noise level (frequency modulation) in the band of 50 to 15,000 cycles shall be at least 60 db below the audio frequency level representing a frequency swing of ±75 kc. The noise-measuring equipment shall be provided with standard 75-microsecond deemphasis the ballistic characteristics of the instrument shall be similar to those of the standard vu meter.

5. The transmitting system output noise level (amplitude modulation) in the band of 50 to 15,000 cycles shall be at least 50 db below the level representing 100 per cent amplitude modulation. The noise-measuring equipment shall be provided with standard 75-microsecond deemphasis; the ballistic characteristics of the instrument shall be similar to those of the standard vu meter.

Concluding Installment With Appendix Data Covering List of FCC Measurements Required, FCC Electrical Performance Standards, Bessel Zero System for Measuring FM Transmitter Frequency Swing and Diode Detector for Hum and Noise Measurements.

by F. E. TALMAGE

Transmitter Engineering Section
Engineering Products Department
RCA Victor Division, RCA

Appendix 3

(Bessel Zero System for Measuring FM Transmitter Frequency Swing.[10])

The purpose of the Bessel Zero System is to provide a means of checking FM transmitter swing, without a modulation monitor or for checking the modulation monitor if its accuracy is in doubt.

The Bessel Zero method of measurement is based on the fact that the amplitude of the center frequency component of energy, emitted from an FM transmitter, varies with the *amplitude* and *frequency* of the *audio* modulating voltage.

During modulation energy is distributed over the frequency spectrum. This diversion of energy to side current frequencies takes center frequency power. The amplitude of the center frequency component is proportioned to the zero order Bessel function ($J_0\ F_d/F_m$).

Figure 11 illustrates that the center frequency component becomes zero at several points as the audio modulating voltage, and hence frequency swing, is increased.

The point at which the center frequency disappears may be found by listening to the beat note (produced by the center frequency and a beat oscillator) in an AM receiver, as the audio modulating voltage is slowly increased. The deviation may be calculated from the following:

Modulation Index = 2.405
$F_d/F_m = 2.450$
$F_d = F_m \times 2.405$
$F_m = F_d/2.405$
At the first Bessel Zero
F_d = *rf* frequency swing to either side of the center frequency
F_m = audio modulating frequency.

Bessel Zero points may be located with the arrangement of equipment shown in Figure 12:

A superheterodyne receiver (with a cw oscillator), or a regenerative receiver is used.

(Note: A crystal filter on the superheterodyne receiver, or a sharp cut-off low pass audio filter in the regenerative receiver may be used to good advantage).

The receiver is tuned for a beat note of about 500 cycles with the transmitter unmodulated.

The transmitter is modulated with the desired audio frequency, by slowly increasing the audio input level (from zero), until the center frequency disappears.

(Note: Side frequencies will appear giving many beat notes and the pitch from the center frequency may change. The beat note due to the center frequency must be carefully followed by the ear).

In checking modulation percentage[11], the data in table A should be followed for the first *Bessel Zero*.

Rec. f	F_d KC	% MOD	F_m Cycles	
F/2	37.5	100	15,600	AM Rx
F/2	28.1	75	11,700	tuning
F/2	18.7	50	7,800	44-54
F/2	9.4	25	3,900	mc.
F/6	12.5	100	5,200	AM Rx
F/6	9.38	75	3,900	tuning
F/6	6.25	50	2,600	14.6-18
F/6	3.13	25	1,300	mc.
		$F_m = F_d/2.405$		

Table A

In making the check, the receiver should be tuned for low frequency beat note with unmodulated frequency indicated. Then the audio oscillator should be set on frequency indicated.

The audio input level should be slowly increased until the beat note disappears and then reappears. The percentage of modulation indicated occurs where the beat note disappears.

F = carrier frequency (transmitter output)
F_d = frequency deviation
F_m = audio modulation frequency

Appendix 4[12]

A diode detector suitable for making the AM hum and noise measurements which are required for FCC licensing can be readily constructed with a few parts, all of which are generally available.

The circuit used is shown in Figure 14.

In an AM transmitter, it is conventional so to measure noise level with respect to the amplitude of the modulating signal at 100% modulation. In an FM transmitter, however, the noise is measured with respect to the amplitude of the carrier itself. This is accomplished by providing a source of low frequency *ac* with the same amplitude as the carrier and then comparing it with the noise voltage.

The signal is fed into the diode detector. Across the potentiometer will be developed a *dc* voltage equal to the peak voltage of the carrier. Superimposed on this *dc* will be the noise voltage which is *ac*. The *dc* voltage is measured by the rectified type *ac* voltmeter, which is connected in such a manner that it will read the *dc* output of the diode.

On the opposite side of the equipment is a transformer which provides a source of low value 60 cycle *ac*. This voltage may be controlled in amplitude by a potentiometer, R_3.

It will be observed from the schematic that for any value of *ac* which is applied to the meter, only .707 of that value is delivered to the output. This is explained by the fact that the *dc* signal voltage is equal to the peak value of the carrier, and it is desired to generate an *ac* of exactly the same amplitude but of a low audio frequency. Since the comparing device is the rectifier type meter which reads effective values of *ac*, the meter will give the same reading for both *dc* signal voltage and *ac* voltage only when the *ac* is 1.414 times the *dc*. However, for the output, a peak *ac* which is exactly equal to the *dc* voltage is desired. We get this simply by tapping off .707 of the *ac* voltage on a voltage dividing resistor.

The noise voltage is then compared with the amplitude of the *ac* voltage on the distortion meter.

Operation

To operate, an *rf* signal from the transmitter is introduced to the input connector. Output is then connected to distortion meter.

With switch in *signal* position, signal voltage

(Continued on page 32)

[10]Courtesy RCA Service Co.

[11]Using an RCA MI-7016 exciter.
[12]Courtesy RCA Test Equipment Design Section.

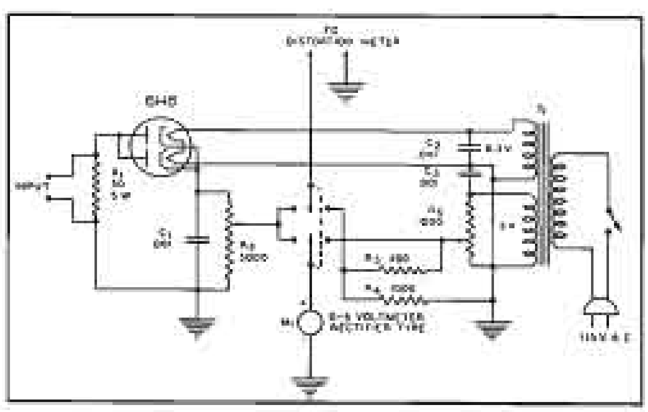


Figure 14
Schematic of a suitable diode rectifier circuit for measuring AM hum and noise.

TAPE RECORDER Time Clock Control

Left: Front view of the tape-recorder time-clock relay container. Right: Interior view of the relay unit.

Modified Tape-Recorder Control Unit Permits Automatic Recording of Air-Check Programs. System Can Also Be Applied to Other Remotely-Operated Tape Installations.

by WILLIAM MARSH

Chief Engineer
WHHM, Memphis, Tenn.

FREQUENTLY IN BROADCAST operation it is necessary to aircheck a program or announcement. Where a tape recorder is available, this has been found to be a very convenient and inexpensive facility for the purpose. However, it is usually necessary to assign an operator to the job of making the recording. Where control operators are not on duty at all times, this may involve shift changing, overtime payment, or personal inconvenience. To alleviate the problem, a time clock control device was evolved.

The unit operates from a householder timer[1] or similar timing device, the recorder[2] turned on for a fifteen or thirty-minute interval and then turned off. The modification required on the tape unit is quite simple and does not alter manual operation in any respect.

In the original tape-recorder control circuit, after the controls have been set on *forward*, *record*, and *record*, the recorder is started by pushing the *start* button.

It is necessary to hold the *start* button down long enough for the tape to

(*Continued on page* 34)

[1]Telechron 8H33. [2]Brush BK401.

Figure 1
Standard control circuit of the tape recorder with modified connections to accept an additional four-prong socket for the clock relay.

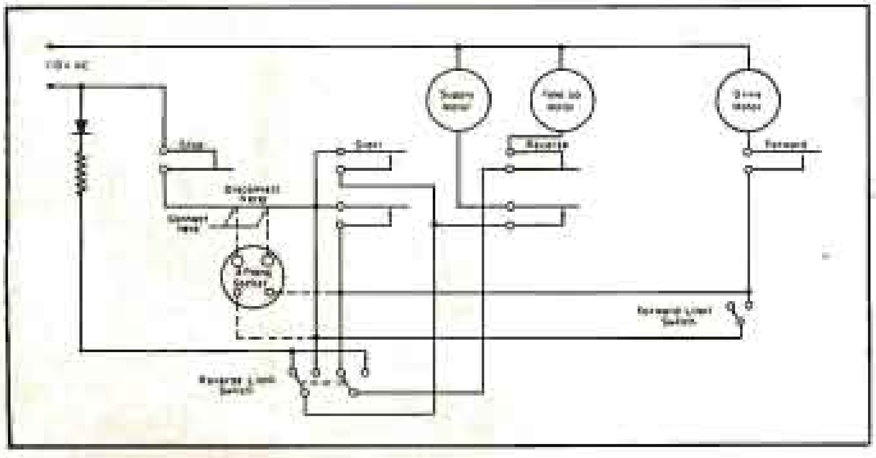
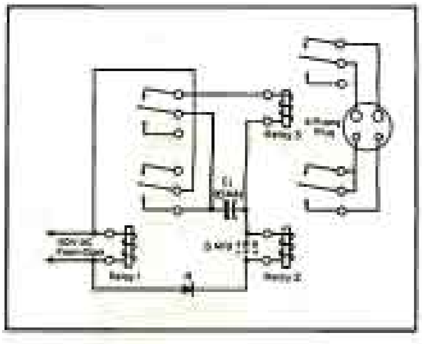


Figure 2
The clock-relay control circuit.



Civil Aircraft Radar

Part III . . . Design and Operational Features of Equipment.

by SAMUEL FREEDMAN

New Developments Engineer
DeMornay-Budd, Inc.

In describing the operation of the duplexer, used in the civil aircraft radar system in the wave guide to separate the transmitted and received signals, it was indicated that the duplexer consists of two gas switching tubes in a *tr* (transmit-receive) box and *atr* (anti-transmit-receive) box. Both of these tubes are of the broad-band type eliminating any tuning adjustment. The received signals go through the *tr* box into the crystal mixer where they are mixed with a local oscillator signal to produce a 60-mc intermediate frequency. The local oscillator is a reflex klystron tuned to operate 60 mc above the magnetron frequency.

Now these 60-mc signals are fed to a fixed tuned *if* strip of about 110 db gain. The radar signals are detected in the *if* strip and amplified in the video amplifier. The video signals are fed from the *transmitter-receiver-antenna* unit to the indicator via a coaxial cable and applied directly to the grid of the cathode-ray tube.

The sweep circuits for the *crt* are located in the indicator unit. They are triggered by a negative pulse obtained from the pulse line output in the modulator unit. The sweep circuit develops a sawtooth sweep and feeds it to the magnetic deflection coil around the neck of the *crt*. The magnetic deflection coil rotates and is driven in synchronization with the scanner by a positive flexible drive, giving a modified *ppi* pattern on the *crt*. The sweep length is automatically adjusted to give ranges of 5, 15, 50 and 150 miles. The *crt* is fed from an 8,000-volt supply located in the indicator unit. Controls on the face of the indicator have been reduced to a minimum for the pilot-operator. They consist of receiver gain, range switch and on-off switch.

Automatic-frequency control is provided by sampling a small portion of the high-frequency power from the wave guide and running it through a 60-mc discriminator. The discriminator output is fed to the grids of two small gas tubes which, in turn, control the voltage on the local klystron oscillator.

In the case of the DC3 type of aircraft, a single indicator located midpoint is sufficient for both the pilot and co-pilot. In the case of larger aircraft such as the DC-4 and the DC-6, the pilot and co-pilot sit far enough apart so that it is advisable to provide two indicators, one on either side of the panel. This adds the weight of one more indicator.

Interpreting the Indicator Display

The main beam transmitted has a finite width of approximately 6° in the form of a cone. The beam rotates in azimuth or bearing. The greater the distance from the plane to the target, the greater will be the area covered by the beam. The beam width is approximately 500′ at one mile, 1,000′ at two miles, etc. Most of the target materials encountered will be land or water in nature. Water scatters nearly all of the incident energy sending little, if any, back to the 'scope. Land, on the other hand, sends back various amounts depending on such factors as smoothness, flatness, roughness or perpendicular character. Proper interpretation of the information becomes a function of experience. Typical indications are:

Target Material	Energy Returned	'Scope Response
Water	None	Dark 'scope
Airport runways	Slight return	Dark 'scope
Flat, smooth earth	Little return	Low intensity
Flat, rough earth	Normal return	Medium intensity
Surfaces approaching perpendicular	Large return	Bright

The indicator has five half-circles engraved on the face. These are equal to one-fifth separations of the range scale. For example, they may be 1, 3, 10 or 30 miles depending on whether 5, 15, 50 or 150-mile sweep rate is used. The bearing with respect to 90° each side of center is determined by the distance from center vertical line of the tube in either direction. If a bright spot is picked up from a mountain 45 miles away dead ahead, it will show up as a bright dot (the dot size and shape depending on the area of the earth occupied by the mountain) midway between the first and second circles at center, when the sweep is on the 150-mile scale. It could also show up between fourth and fifth circles on the 50-mile scale. If the mountain bears 45° relative either right or left, it would show up half way between center and the side of the picture tube in the appropriate range circles.

The best indications are from land and water. Water by dark spots exactly corresponding to a river, lake or coastline is easy to define. High land is defined by bright spots on the indicator tube. Various light intensities show up for other objects depending on their prominences above the earth and their reflective properties. Metallic structures show up extremely well, as do built up cities suddenly looming up over rural terrain. Thunderstorms and clouds show up ghostlike. They make possible the reception of information about themselves as well as the existence of denser objects beyond them. In effect, it is possible to see into a storm or cloud and also through it. Highways, railroad trackage and similar demarcations on earth also show up and well defined. Farm or ranch fencing may or may not show up depending on type of fencing and angle of energy arrival.

Many interesting applications for radar exist in mountainous terrain or during bad weather. Some examples cited by a member of many international aviation radio conferences are:

(*1*) In the case of a plane flying over mountainous and canyonous terrain, energy from the radar impinges on the slopes of ridges and is returned while that from the canyons is either lost or attenuated.

(*2*) In the Mediterranean and in the Indian ocean, it is sometimes unsafe to fly into clouds because of internal turbulences accompanied by huge raindrops capable of wrecking an aircraft.

(*Continued on page 32*)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

The VWOA Dinner-Cruise

CITATIONS for meritorious service and excellence in radiotelegraph operation were awarded to four ops during the recent dinner-cruise in New York City: Radio officers A. T. Newberg of the S.S. Gulfstream; Clarence H. Scruggs of the United Fruit steamer Junior, and Arthur E. Murray of the Bull Steamship vessel Suzanne (for their outstanding heroism during the rescue of the crew of the USCG Cutter Eastwind when it collided with the Gulf Oil Tanker Gulfstream on January 19, 1949); and Rouel E. Cowden of the Moore-McCormick steamship Mormacrey (for his meritorious service during the distress of the British Tanker Adellen early in January of this year). Cowden was highly commended by the U. S. Navy, British Marconi and other authorities for service beyond the call of duty during which he remained on watch aboard his ship for 72 hours continuously, handling distress messages for the disabled vessel.

Unfortunately the boys had to sail prior to the banquet. Representatives of the steamship companies accepted the awards for them.

Veteran VWOA members at the recent dinner cruise in New York City: Arthur Rebbein, John Lohman, Eugene C. Cochran, Willard S. Wilson and Walter Jablon.

Chicago Chapter Dinner-Cruise

THE CHICAGO CHAPTER held their annual cruise at the Adventurers Club with L. W. Bear as *chief purser*, ably assisted by G. I. Martin. A large group were present at the affair. Congratulations. . . . We learned via TV that Arthur Godfrey is now an honorary member of the Chicago chapter.

Personals

SORRY to learn of the death of Mrs. Cooke, wife of veteran member G. C. Cooke and the passing of Mrs. Stobbart, wife of Arthur J. Stobbart. Our deepest sympathy to both. . . . At the recent IRE convention in New York City, VWOA members Paul Trautwein, G. C. Cooke, Wm. C. Simon served on the hospitality committee under the chairmanship of Roscoe Kent, also a VWOA member. . . . We are glad to welcome several new VWOA members; E. C. Cochrane, Jonathan Eddy, and Arthur J. Stobbart. . . . Gene Cochrane, with the FCC in New York, began his wireless career in '07 when he was in the Navy as a second class electrician assigned as a radio (the Navy must have used that word in those days) operator. From that assignment he moved to the Navy wireless station in Boston, whose call letters were *P G*. When he left the Navy in '08 he worked as a civilian in the Navy Yard in Brooklyn, in charge of the radio test laboratory. In '22 he moved to the Department of Commerce as a radio inspector, and after ten years in this post went to the Federal Radio Commission. In '34 he joined the FCC, a post he still holds. . . . Old-timer Eddy started pounding in '18 and worked at the game until '25 with Independent Wireless, American Marconi and the U. S. Shipping Board. . . . Stobbart who was very active in the organization back in '37 and has re-affiliated as a full veteran member, has seen service on the S.S. Essex, Rochester, Dorchester, Hypathia, Gargoyle, Alleghany and Birkenhead. . . . Marvin S. Seimas, who now is chief engineer of WGNY, WHVA and WKIP, recently forwarded his application. MS began operating aboard ship in '26 sailing out of the port of Philadelphia for RMCA. In '30 he left the ships and started in broadcasting as an operator and in June '40 he was promoted to his present spot. In addition to his regular work MS acts as consultant for a number of other broadcasting stations. He has built a number of stations, delved in police radio and since '24 kept very active in the ham field. And if you have any television receiver problems MS can probably solve them for you, having designed and constructed a very good receiver for his home in Wappingers Falls, N. Y. . . . Walter Evans, vice president of Westinghouse, keeps very busy with his manifold duties. . . . E. J. Girard is looking after Mackey's interests in Washington. . . . L. O. Gorder now resides in Winnethe, Ill., and works in Chicago. . . . G. G. Greene is doing a good job as shift engineer at WSL. . . . A Barbabalate has a full-time job with RCAC as assistant to the coordinator of service and supply at New York. . . . F. P. Guthrie, who completed 25 years with RCA, was presented with a gold watch recently. He is assistant vice president of RCAC, in charge of their Washington office. . . . C. C. Harris, TRT's chief engineer and vice president, with headquarters at Hingham, Mass., sends best 73's to all.

The Industry Offers

IRC INSULATED RF CHOKES

A line of molded phenolic chokes has been announced by International Resistance Co., 401 N. Broad St., Philadelphia 8, Penna.

Chokes available in two sizes, types CLA and CL-1. Q is said to be sufficiently high for broadband tuning in FM and TV regions; resistance low enough to enable use as filament chokes for moderately high power tubes.

Samples for testing and catalog data bulletin may be obtained from the factory.

• • •

HEWLETT-PACKARD HF SIGNAL GENERATOR

A signal generator for direct readings between 800 and 2,100 mc has been announced by Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Instrument, model 614A, is said to eliminate the need for charts and interpolations, since readings are made direct in either microvolts or db.

Has a constant internal impedance swr of 1 db, and accuracy is said to be ± 1 db throughout the frequency range. The rf output ranges are from .1 volt to 0.1 microvolt, and may be continuous, pulsed or frequency modulated at power supply frequency.

• • •

ALTEC MINIATURE MICROPHONE

A miniature microphone, 21B, weighing less than ½ ounce, and about ½" in diameter, adaptable to all types of stand mountings or overhead suspensions, has been announced by the Altec Lansing Corp., 1161 North Vine St., Hollywood 38, Calif (161 Sixth Ave., N. Y. 13). Microphone designed on the basis of electrostatic rather than magnetic principles. Moving element in the microphone is an extremely small diaphragm actually no larger than the human eardrum.

Feeds into a microphone assembly system which has an output level of —50 dbm in a sound field of 10 dynes/cm². Output impedances: 30-50, 150-250, 500-600 ohms.

Microphone is non-directional.

• • •

SYLVANIA TV RECEIVER TUBES

A line of receiving tubes for replacement service in TV receivers has been announced by Sylvania Electric Products, Inc.

Line includes miniature, GT, and *Lock-In* styles, including 1B3GT, 6AG5, 6AL5, 6BG6G, 6J6, 6K6GT, 7B4, 7B5, 7C5, 7F7, 7H7, 7N7 and 7Z4.

Tubes are identified by an orange branding, *Sylvania Television Tube.*

News Briefs

PERSONALS

W. L. Rothenberger, formerly manager of renewal sales, has been appointed assistant general sales manager of the RCA Tube Department; **William H. Painter** has been appointed manager of the merchandise division; **H. F. Barsche,** formerly manager of the renewal field force, succeeds Rothenberger as manager of the renewal sales section; **M. J. Carroll** has been appointed manager of the equipment sales section.


W. L. Rothenberger


H. F. Barsche

F. D. Meadows and **M. R. Paglee** have been appointed RCA field sales reps to handle television and broadcast sales in the West. Meadows, formerly in audio equipment sales at the Camden home office, will act as field rep for the territory south of Chicago, including St. Louis and Indianapolis, with headquarters in Chicago. Paglee has been assigned to the Dallas office.

Merchandising activities of the broadcast section of the RCA Engineering Products Department have been divided into two groupings, transmitter equipment and studio equipment.

Under the new organization setup, **A. R. Hopkins** continues as products manager of the broadcast section; **Dana Pratt,** former merchandise manager of broadcast transmitters, becomes merchandise manager of transmitter equipment; and **Merrill A. Trainer,** former merchandise manager of TV, becomes merchandise manager of studio equipment. **C. M. Lewis,** sales manager of the field sales group, and **E. T. Griffith,** supervisor of the commercial services group, continue in those posts.

Assisting Dana Pratt will be: **E. C. Clammer,** handling antennas, transmission line, towers, and associated measuring equipment; **A. H. Super** and **David Bain,** on AM, FM, and TV transmitters and associated monitoring equipment; and **G. E. Rand,** on phasing and associated monitoring equipment.

Reporting to Merrill A. Trainer will be **G. W. Tunnell,** on film equipment and kinescope recording activities; **J. P. McGrearn,** TV field equipment; **Henry Dussak,** on TV studio and measuring equipment; and **Wayne Babcock, H. J. Lavery,** and **H. W. Rhoades,** on custom and standard broadcast audio equipment.

W. Wesley Ballard has been appointed director of publicity and advertising for the communications division of Motorola, Inc., Chicago. **James Cody,** who formerly held this post, is now with the Professional Equipment Company, Chicago.

Nicholas Balas, formerly development engineer with The Tungsram Lamp Works and Electric Co. has been named chief engineer of Electronic Essentials Corp., 24 Cliff St., Jersey City, N. J., who will announce shortly a line of TV coils and antennas.

Walter F. Kean, formerly manager of Andrew Corp., broadcast consulting division, has opened consulting engineering offices at 114 Northgate Road, Riverside, Illinois.

Rear Admiral Thomas P. Wynkoop, Jr., U.S.N. (ret.), has been elected president of the Radiomarine Corporation of America.

Paul Ware has been named manager of the Electronic Parts Division of Allen B. Du Mont Laboratories, Inc., of Passaic and Clifton, N. J.

LITERATURE

The Illinois Condenser Company, 1616 North Throop St., Chicago 22, Ill., have released a catalog with detailed information on a line of capacitors for radio and TV.

Clarostat Mfg. Co., Inc., Dover, N. H., has released a catalog, No. 49, describing resistors, controls and resistance devices. For convenience in service work, the listings in catalog concentrate on universal numbers wherever feasible.

The Hickok Electrical Instrument Co., 10529 Dupont Ave., Cleveland 8, Ohio, have published a 4-page folder describing and illustrating a line of dynamic mutual conductance tube testers.

The National Electronics Laboratories, Inc., Alexandria, Va., have prepared an 8-page bulletin describing a *vhf* two-way system for airport ground mobile application. Equipment operates on 121.7 or 121.9 mc, fixed tuned, crystal controlled.

The Andrew Corp., 363 East 75th St., Chicago 19, Ill., have released an 8-page bulletin, No. 48, covering type 737 (3/4 diameter) semi-flexible coaxial cable. Information includes data on 1700 series ceramic insulated terminals and 1600 series glass insulated terminals, as well as non-insulated cable cups, connectors for field splicing, adaptors, collar clamps, etc.

The Shallcross Mfg. Co., Collingdale, Pa., have prepared an 8-page catalog, *F*, describing kilovoltmeters, and accessories which include external meter and surge resistors, corona protected resistors, multipliers and hi-meg hi-voltage resistors.

Carter Motor Co., 2644 N. Maplewood Avenue, Chicago, Ill., have published a converter catalog, No. 349, which consists of 16 illustrated pages with electrical and mechanical specifications on Carter converters for television operation, as well as those for recording, sound projection, and mobile communications applications.

Included also is a *selector chart,* which shows the correct converter required to operate each make and model.

International Resistance Co., 401 N. Broad St., Philadelphia 8, Penna., have released a bulletin, 134, with data on deposited carbon resistors, which are produced in 2 sizes, types DCF and DCH.

16-Element FM

(*Continued from page 9*)

was brazed. Before the line was brazed to the lower two elements, the copper tubing matching stub had to be cut to length ($\frac{2880}{f_{mc}}$ for length in inches) and brazed to the inside ends of the lower two antenna elements.

This stub extended downward at right angles to the elements and parallel to the mast. A section of ¾" pipe was welded to the mast at a point just opposite the bottom of the stub. On this was screwed a pipe coupling, and in the other end of the coupling a piece of lucite rod was fastened. We were fortunate in locating a piece just the right size to screw into the coupling. If such size is not available most any size of rod could be fastened inside the pipe or the coupling by machine screws. This lucite rod was then secured to another piece of lucite and used as a spacer between the lower end of the stub lines. This prevented any movement of the stub and provided a good support for the transmission line. A coaxial line connector was soldered to the lower end of the stub for an efficient and convenient means of connecting transmission line to the stub.

The supporting mast was secured to the wall of a fire escape hatch on the roof of the hotel building, by means of clamps and ½" bolts through the wall and heavy iron plates on both sides of the wall.

The entire assembly could probably be built of lighter materials throughout, at some sacrifice of rigidity. In this case, since the antenna was atop a ten-story hotel building in the downtown area, we felt that the lighter weight construction might collapse.

The receiver was located inside the fire escape hatch directly below the antenna making it possible to use a relatively short transmission line, approximately 20'. A permanent telephone loop was already available in this location so no further expense was involved here. The receiver was set up for remote control from the studio, so that it could be used on very short notice.

A simple *ac* power supply was built by the staff for this receiver which was originally designed for 12 volt *dc* operation in mobile service.

This setup has been in service for over two months, on an average of four nights a week, without failure. It has made possible the greatly expanded sports coverage for WIBW-FM which we so greatly desired, and has contributed immeasurably to the increased interest in FM in this area.

Antenna Design

(Continued from page 28)

current maximum is at the ends of the dipole. Surrounding objects undoubtedly also distorted the field patterns somewhat.

An approximate check of the relations developed for the radiation resistance was found since changing the length of the tuning stub did not change the field pattern, but it did change the loading of the oscillator substantially. This relation was checked every quarter wavelength for the range zero to three wavelengths.

Conclusions

The close agreement of the field-strength patterns with the theoretical shape indicate that the method of solution used in the analysis predicted the correct results. Also experimental measurements affirmed that:

(1) For a given antenna length, the shape of the field pattern is independent of the length of the tuning stub and depends only on the length of the antenna,

(2) The radiation resistance referred to a current maximum will have a maximum value dependent upon the length of the antenna, and may be adjusted to any value from zero to the maximum value by changing the length of the tuning stub.

It should be noted that no differences were found in the directional qualities for the ordinary half wavelength dipole as compared to the general half wavelength folded dipole, but the range and ease of adjusting the radiation resistance of the general folded dipole make it very desirable. For the greater length folded dipoles, again the patterns have directional characteristics somewhat similar to the conventional antennas, but the radiation resistance of the dipole may be adjusted to help in matching any ordinary transmission line.

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[1]A. Alford and A. G. Kandoian, *Ultra-high-Frequency Loop Antennas*, AIEE Transactions, pages 843-8; Vol. 59, 1940.

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[3]W. van B. Roberts, *Input Impedance of a Folded Dipole*, RCA Review; Vol. 8, 1947.

[4]G. Glinski, *The Theory of Antenna Design for FM Broadcasting*, Tele-Tech; Oct., 1947.

[6]G. E. Hamilton and E. K. Olsen, *Load Characteristics of Television Antenna Systems*, COMMUNICATIONS; March, 1947.
[7]S. A. Schelkunoff, *A General Radiation Formula*, Proceedings IRE; Vol. 27, 1939.
[8]S. A. Schelkunoff, *Electromagnetic Waves* (1943), Chapter 9; D. Van Nostrand Co.
[9]S. Ramo and J. R. Whinnery, *Fields and Waves in Modern Radio* (1944), Chapter 11; J. Wiley and Sons.

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PRESTO MAGNETIC TAPE RECORDER

A magnetic tape recorder has been announced by the Presto Recording Corporation, P. O. Box 500, Hackensack, N. J.

Drive system employs three motors; one synchronous capstan motor and two reel driving induction motors. The latter are said to have the ability to exert a constant tension under varying rpm. Also, their torque may be altered by changing the applied voltage. Both reels are mounted *directly* on the motor shafts. Fast forward and rewind speeds are provided—16 to 1, or 32 to 1, respectively. Speeds, rewind and *fast forward*, may be reversed *instantly* with no damage to the tape or the recorder.

Recording speeds of 7½ and 15 inches per second are provided.

Provision is made to operate all sizes of reels up to and including 14" diameter (5400' of tape.)

Recording time varies with reel size and tape speed. A 7" reel with a 1200' length, at 15" sec. has a 16" recording time, while a 14" reel (5400' long) at 7.5"-sec. has a 146-minute recording time.

Frequency response said to be 30 to 15,000 cps ± 1 db; signal-to-noise ratio, over 60 db below max. signal.

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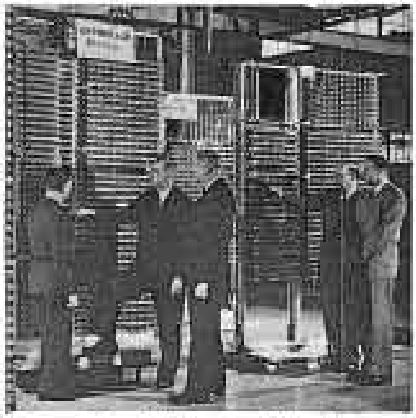
ALASKA-BOUND EQUIPMENT



Left to right: William A. McCracken, works manager, Kellogg Switchboard & Supply Co.; Donald R. Wilson, city manager, Anchorage, Alaska; W. D. Burke, Kellogg sales engineer; E. W. Miller, manager of Kellogg apparatus sales, and William Connolly, manager of the Anchorage telephone division, examining part of nearly $1,000,000 worth of dial *Relaymatic* switchboards and related outside equipment at the Kellogg Chicago plant prior to rail-and-water shipment to Anchorage.

Proof-of-Performance

(*Continued from page 23*)

is increased until meter reads in the neighborhood of 3.5 to 4 volts.

Switch is then thrown to the ac position and ac increased until meter reads same value as in *signal* position. Distortion meter is then set up to read zero db at this level. The switch is then thrown to the *signal* position and the noise level read on the distortion meter.

•

Aircraft Radar

(*Continued from page 25*)

Radar can anticipate this condition and minimize such hazard.

(*3*) In some parts of the world such as Turkey, maps have been found useless, with errors in mountain positions. Radar alone can avert disaster, particularly in the absence of ground aeronautical aids.

(*4*) In the Himalayan mountains such as *over the hump*, pilots have reported spotting protuberances seemingly higher than Mount Everett. No one has been able to deny these conditions, though they have not been fully verified. Some think altimeter errors might account for it. Radar is needed to avoid accident or disaster by avoiding flight into such areas.

In any event, *radar* offers the best protection against errors in maps or charts, as well as confirmation when they are accurate.

•

BROWNING FIXED FREQUENCY FM TUNERS

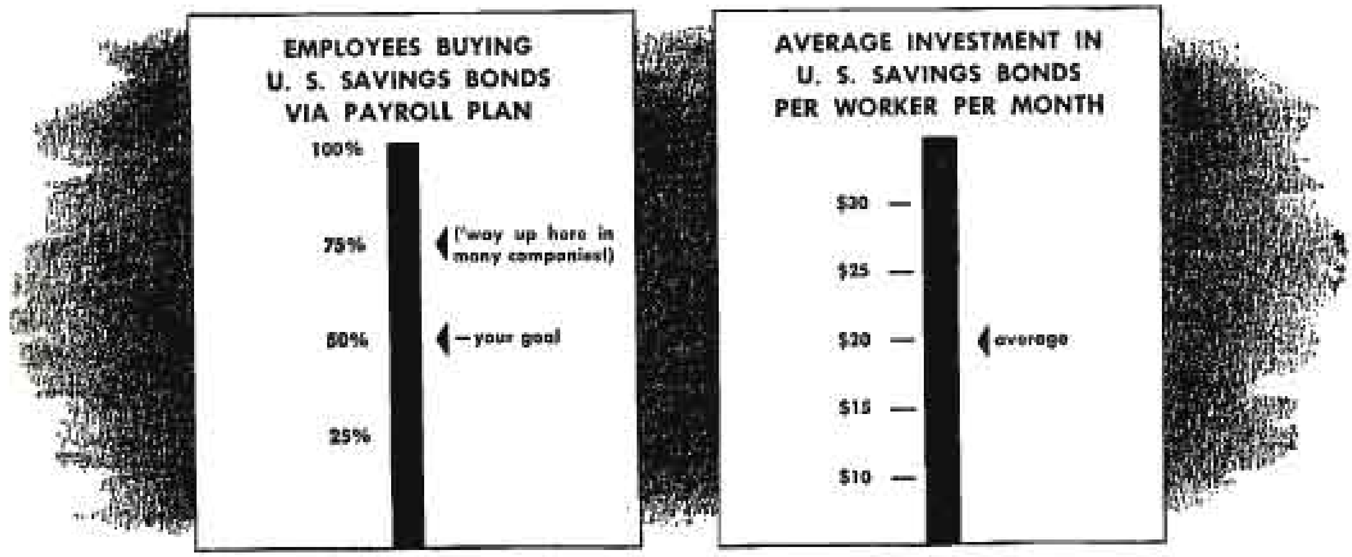
Fixed frequency FM Tuners for use in the 88-108 mc band have been announced by Browning Laboratories, Inc., Winchester, Mass. Available in three models, the tuners are crystal controlled and are adapted to relay reception, storecasting installations, or monitoring purposes.

Model RP-23 is a straightforward FM tuner using the Armstrong circuit with dual limiters. Signal input for 20 db quieting is 10 microvolts with response within 1 db from 30 cycles to 17 kc. Audio stage provides 1 volt RMS output with quieting signal. Antenna input is 72 or 300 ohms.

Model RP-24 consists of the same tuner as RP-23 plus relay circuits which operate on tones of from 15 to 20 kc received from the transmitter and which select in sequence two preset audio volume levels which may be manually adjusted from zero to full output.

Model RP-25 utilizes the same tuner as the RP-23 but has two relay circuits permitting audio level selection as in the RP-24 and also permits turning the audio *on* or *off* as required. In this unit, the two relay operations are controlled by transmitted tones of different frequency and are, therefore, independent. In the RP-24 and RP-25, the relay circuits are preset to operate at 15, 17¾, or 20 kc as specified.

How is YOUR company doing in this "EVERYBODY-BENEFITS" plan?



Compare your employee participation with others who have Payroll Savings

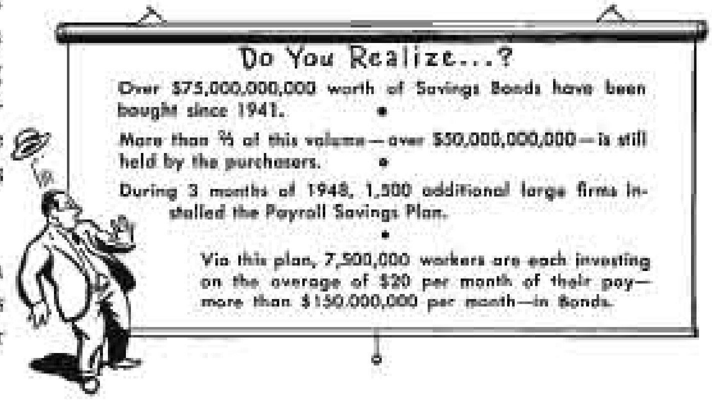
If the figures for your company fall below those shown above, you're missing your share of benefits of the Payroll Savings Plan! These benefits are described below. Nation-wide experience proves that when top management puts the "OK" on the Plan, its benefits rise sharply.

BENEFITS TO EMPLOYEES: Every $3 invested in Savings Bonds pay $4 at maturity. Workers gain a 33⅓% return on their money—enabling them in the future to buy more of the things they will want—plus the peace of mind that goes with regular saving.

BENEFITS TO *EMPLOYERS*: The feeling of security that goes with participation in Payroll Savings makes workers more contented. Worrying less, they work better. Among the more than 20,000 large companies with Payroll Savings, records show that—following installation of the Plan—production increased, absenteeism and accidents decreased!

BENEFITS TO THE *NATION*: The Payroll Savings Plan is a powerful deterrent to inflationary forces. Every Savings Bond dollar built up in the Treasury withdraws a dollar from the swollen spending stream. The Plan thus contributes to national security—which affects *your* security!

WHAT CAN *YOU* DO? If your company has the Payroll Savings Plan, make sure it's being adequately promoted—backed by your top executives—to bring your company its full measure of benefits. If you haven't yet installed the Plan, why pass up its benefits any longer? All the help you need is available from your State Director, Savings Bonds Division, U. S. Treasury Department. He is listed in your telephone book. Call him now!



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

COMMUNICATIONS

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council.

Tape Recorder Control

(*Continued from page 24*)

pull tight past the forward limit switch. As may be seen in Figure 1, one section of the *start* button is in parallel with the forward limit switch. However, the *start* button, having a spring return, does not bypass the forward limit switch during operation. The limit switch must retain its ability to turn the recorder off if the tape were to break. Pressing the *stop* button breaks the motor circuit for an instant. This allows the tape to loosen on the forward limit switch, thus stopping the drive and takeup motors.

Thus in an external control circuit it is essential that a *start* relay, which must make a connection, hold this connection briefly, and then release. Then we must have a *stop* relay which will break the motor circuit, hold this break briefly, and then reconnect the circuit for subsequent operation.

In the circuit, Figure 2, relay *1* is a slave relay to the clock, the clock's sole function being to turn the *ac* power on and off at a given time. When relay *1* is energized, relay *2* operates while capacitor C_1 (80-mfd) charges through a selenium rectifier, *R*. After C_1 has been fully charged, current ceases to flow in relay *2* and the relay returns to its off position. The duration of closure of relay *2* varies with the capacitance of C_1. The large capacity unit used causes relay *2* to close for about two seconds. A pair of *make* contacts on relay *2* are connected in parallel with the *start* switch.

When relay *1* is deenergized one pair of its contacts connects C_1 across the coil of relay *3*. This energizes relay *3* for the duration of discharge of C_1, in this case about two seconds. A pair of break contacts on relay *3* are then connected in series with the motor circuit. Hence this circuit is broken for an instant, and then restored for another operating cycle.

Connections from the control unit are made by means of a cable and a four-prong plug and socket. When the control unit is not in use, the recorder is restored to normal by means of a dummy plug which replaces the control unit cable plug. The dummy plug contains a jumper which restores the break in the motor circuit.

Relay Circuit Construction

Selenium rectifiers and electrolytic capacitors are both rather high in leakage. For this reason relay *2* may chatter unless it is an *ac* relay. A 5-mfd capacitor placed across the coil of relay *2* will generally result in completely quiet operation. All capacitors used are 150-volt, and all relays used are 110-volt type.[3]

Although the unit was designed for broadcast airchecks, the essentials of the circuit can be applied to other remotely-operated-tape recorder applications.

[3]Guardian.

G-R RF CAPACITANCE METER

An *rf* capacitance meter, type 1612-A, designed for measuring and testing small capacitors (up to 1200 mmfd) such as are used in *rf* equipment, has been announced by the General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Measurement is made by a substitution method in which the capacitance of a calibrated air capacitor is reduced to reestablish resonance after an unknown capacitor is connected. Resonance is indicated by maximum deflection of a meter. Two ranges are provided, 0 to 80 mmfd and 0 to 120 mmfd and range switching is accomplished automatically as the dial is rotated. Measurements are made at a frequency of 1 mc.

FAIRCHILD EQUALIZERS

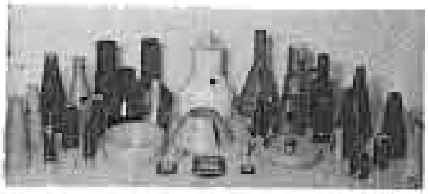
NAB type and diameter type equalizers have been announced by the Fairchild Recording Equipment Corp., 154 St. and 7th Avenue, Whitestone, N. Y.

The NAB units, 626-A1 and B1, are designed for insertion in a 500-600 ohm system in which the power level does not exceed ½ watt (insertion loss at 700 cycles is 22db) and for installations in which a 22 db insertion loss cannot be tolerated.

Diameter equalizers, 628, are used to apply equalization necessary to compensate for loss in *hf* reproduction which occurs as a result of decreasing groove velocity while cutting at 33⅓ rpm.

MILLEN METAL SHIELDS

Magnetic metal shields, using both Mu-metal and Nicoloi, for cathode-ray tube and other shielding problems, have been announced by James Millen Manufacturing Co., Inc., 150 Exchange St., Malden 48, Mass.



RCA REGULATED POWER SUPPLY

A regulated power supply, WP 33A, has been announced by the RCA Tube Department.

Supplies a *dc* voltage which is said to be continuously adjustable from 0 to 300 volts, and which remains virtually constant regardless of line-voltage fluctuations and the varying load currents encountered in development work.

Primarily intended as an extremely stable *B* supply, the unit is also said to be useful as a low-impedance *C* bias source.

Supply is said to offer regulation better than 1½ per cent with line voltage variation from 105 to 125 volts; 60 ma over output voltage range from 0 to 60 *dc* volts; 80 ma from 60 to 120 volts; and 120 ma, from 120 to 300 volts; unregulated output of 400 *ac* volts at 120 ma; ripple voltage less than 8 RMS millivolts.

Last Minute Reports...

THE 540-kc band has again become a headline topic in broadcasting with the pending FCC frequency proposals for the Fourth Inter-American Radio Convention. It appears as if the FCC has proposed that the entire band of 385 to 550 kc be considered as a unit for discussion at the convention. A statement filed with the FCC by the NAB stated that the 540-kc problem is a channel subject to negotiations at the forthcoming NARBA conference. NAB declared it is not the responsibility of FIAR to allocate, assign or classify the 540-kc channel, but their duty to clear this channel of other services, leaving the appropriate disposition of 540-kc band to NARBA. NAB also added that since 540 kc is a broadcast frequency, it should certainly be the broadcaster's prerogative to have a voice in its allocations. . . . The City of Long Beach, California, has received the first experimental authorization to construct a non-military shore-based radar station. The municipality stated that its purpose for the request was to study the value of radar as an aid in the movement of ships in periods of reduced visibility in the San Pedro Bay area. . . . The Acoustical Society of America will hold its twentieth anniversary meeting at the Statler Hotel, in New York, May 5 to 7. Dr. Harry F. Olson of RCA Labs will summarize developments for each of the sessions. . . . A new plant is being built in Marion, Indiana, for the mass production of RCA 16" metal picture tubes. . . . Describing the metal picture tube at the recent IRE meeting, H. P. Steier, who presented a paper prepared by himself in association with J. Kelar, C. T. Lattimer and R. D. Faulkner, declared that the metal cone is made of high chromium steel alloy and the face plate in sheet glass 3/16" thick. The tube was said to weigh eleven pounds, the same approximate weight of a 10" glass tube. . . . The East Providence Town Council recently approved a contract for the installation of sixteen Motorola FM two-way units for the police and fire departments of the city. . . . Ed Hamilton, formerly with the Allen B. DuMont Laboratories and a frequent contributor to COMMUNICATIONS, is now with the television department of ABC as a station engineer. . . . An airborne television antenna using a balloon 6½' long and 3½' in diameter and operating with a coaxial transmission line with a characteristic impedance of about 57 ohms was tested recently in New England. According to an announcement by Ralph Powell, the antenna provided excellent reception of TV and FM stations far beyond the theoretical range of transmitters.

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS INDEX

APRIL, 1949

INPUT VOLTAGE RANGE: 1,000,000 TO 1

SPECIFICATIONS

- **FREQUENCY RANGE:** 20 to 16,000 cycles
- **SELECTIVITY:** About 4 cycles flat-top band width. Response is down 15 db at 5 cycles, 30 db at 10 cycles, 60 db at 30 cycles from peak
- **VOLTAGE RANGE:** 300 microvolts to 300 volts full scale. Over-all range is divided into four major ranges, each of which is divided into seven scale ranges.
- **VOLTAGE ACCURACY:** Within ±5% on all ranges
- **HUM:** Suppressed by at least 75 db
- **INPUT IMPEDANCE:** 1 megohm for direct voltage measurements; 100,000 ohms with input potentiometer
- **ACCURACY OF FREQUENCY CALIBRATION:** ± (2% + 1 cycle)
- **BUILT-IN CALIBRATORS:** For both voltage and frequency
- **PRICE: TYPE 736-A WAVE ANALYZER $920.00**

This analyzer offers the simplest, most accurate and most direct method of measuring the amplitude and frequency of the components of any complex electrical waveform.

In its essentials it consists of a heterodyne-type vacuum-tube voltmeter with a highly selective i-f filter using three quartz bars. At only 60 cycles from resonance the attenuation is down by 75 decibels, yet tuning is very easy by virtue of the 4-cycle flat-top characteristic at resonance. Standards for both voltage and frequency are built into the analyzer and can be used to check its calibration at any time.

The Type 736-A Wave Analyzer is ideally suited for hundreds of types of harmonic-distortion measurements on any type of audio apparatus, broadcast receivers and transmitters, telephone and public address systems, oscillators, amplifiers and other vacuum-tube circuits; hum measurements on a-c operated communications equipment; harmonic induction studies on telephone lines.

WRITE FOR COMPLETE DATA

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

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

NEW -hp- 430A MICROWAVE POWER METER

$250.00

F.O.B. PALO ALTO

Automatic operation! Instantaneous power readings! No tedious calculations or adjustments! Read direct in mw. or dbm! Use at any microwave frequency!

To measure an unknown microwave rf, just connect the new *-hp-* 430A Microwave Power Meter to the 200-ohm barreter in your system. This one compact power meter does all the rest! No tedious calculating or knob-twisting. Except for initial range selection and zero set, operation is *entirely automatic!* You can make direct power readings *instantly* in milliwatts from 0.02 to 10 mw, or dbm from −20 to +10 dbm. Higher powers may be measured by adding attenuators or directional couplers to the microwave system. Any of 5 ranges are quickly selected by a front-panel switch. Power is read on an open-scale, 4″ square-face meter mounted on a sloping panel.

The new *-hp-* 430A Power Meter is an ac bridge, one arm of which is a 200-ohm barreter. This bridge is in precise balance with zero rf power across the barreter. When rf power is applied, an equivalent in audio power is *automatically removed.* The bridge remains balanced, but the change in audio power level indicates on the vacuum tube voltmeter. This meter thus measures the unknown rf directly and instantaneously.

The *-hp-* 430A is designed for use with any 200-ohm barreter and mount, and may be used over any microwave frequency for which the mount is designed. The meter incorporates the famous *-hp-* resistance-tuned oscillator principle, and is ruggedly built for long, trouble-free service. There are no delicate components to get out of adjustment.

For Complete Specifications, Write to

HEWLETT-PACKARD CO.

1830E Page Mill Road • Palo Alto, California

BRIEF SPECIFICATIONS

Power Range: 0.02 mw to 10 mw, 5 ranges, 5 db intervals. Scale also reads dbm continuously from −20 dbm to +10 dbm. (0 dbm = .001 Watt).

External Barreter: Frequency range depends on barreter and mount. (Must be 200 ohms at power level of approximately 15.3 mw.) (Barreter and mount not supplied.)

Accuracy: ±5% of full scale reading.

Size: 12″ wide, 9″ deep, 9″ high. 4″ Square-Face meter.

Power: 115 v., 50/60 cps, 60 watts.

hp laboratory instruments

FOR SPEED AND ACCURACY

Power Supplies · Audio Signal Generators · Amplifiers · Electronic Tachometers · Frequency Meters · UHF Signal Generators · Square Wave Generators · Audio Frequency Oscillators · Attenuators · Frequency Standards · Noise and Distortion Analyzers · Wave Analyzers · Vacuum Tube Voltmeters