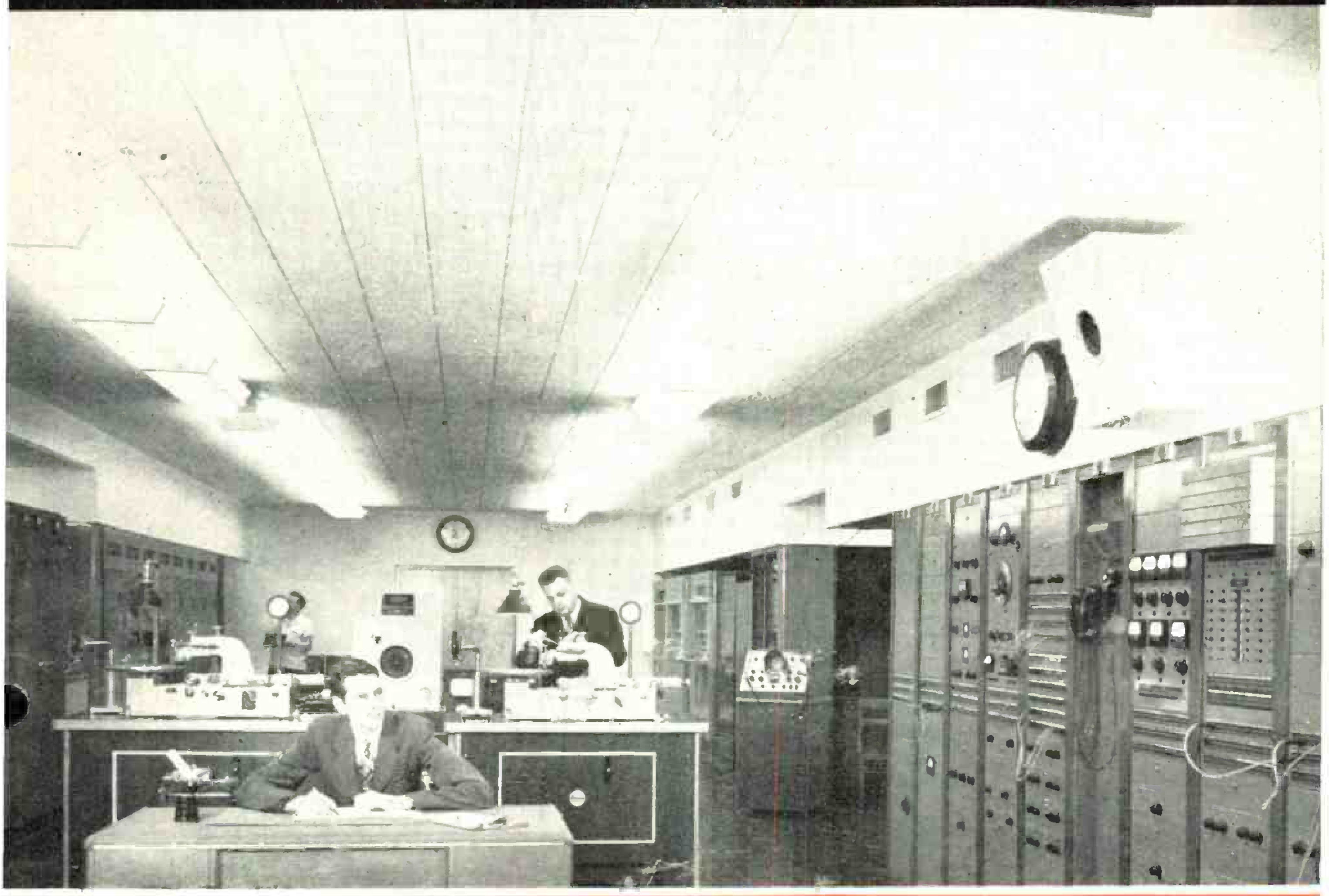
COMMUNICATIONS

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"



NOVEMBER

★ A REPORT ON HIGH-FIDELITY TAPE RECORDING

★ CAVITY RESONATORS AS FILTERS AT V-H-F

★ A-M/F-M/T-V FACILITIES AT WBZ-WBZA, WBZ-FM AND WBZ-TV

1948

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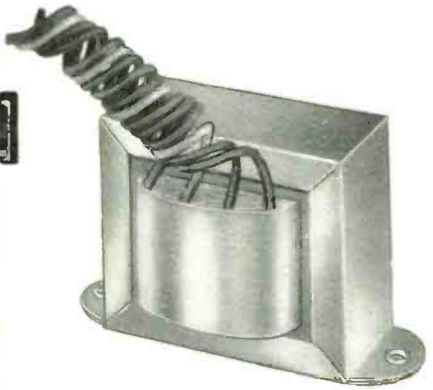

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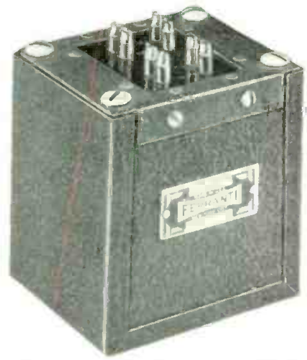

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We offer ample modern facilities and intensive experience in up-to-date practice, including the latest core material developments, and components for 400 cycle power supplies. Our large accumulation of patterns, tools and dies often makes it possible to supply your specific requirements from standard parts, thus cutting your costs without sacrifice of quality. Whatever the type of unit, our bid will meet your needs. Submit your inquiries.

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Ferranti Electric, Inc.

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NOVEMBER, 1948 VOLUME 28 NUMBER 11

COMMUNICATIONS

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COMMUNICATIONS *is indexed in the Industrial Arts Index and Engineering Index.*

COVER ILLUSTRATION

Main equipment room of the WBZ radio and television center in which are located the master control panel (right front) for WBZ-WBZA and WBZ-FM; twin recorders (center); 10-kw FM transmitter (right rear) and the TV transmitter (rear left) which provides erp of 7.5 kw audio and 15 kw visual.
(See pages 10 and 11, this issue, for further details)

ABC

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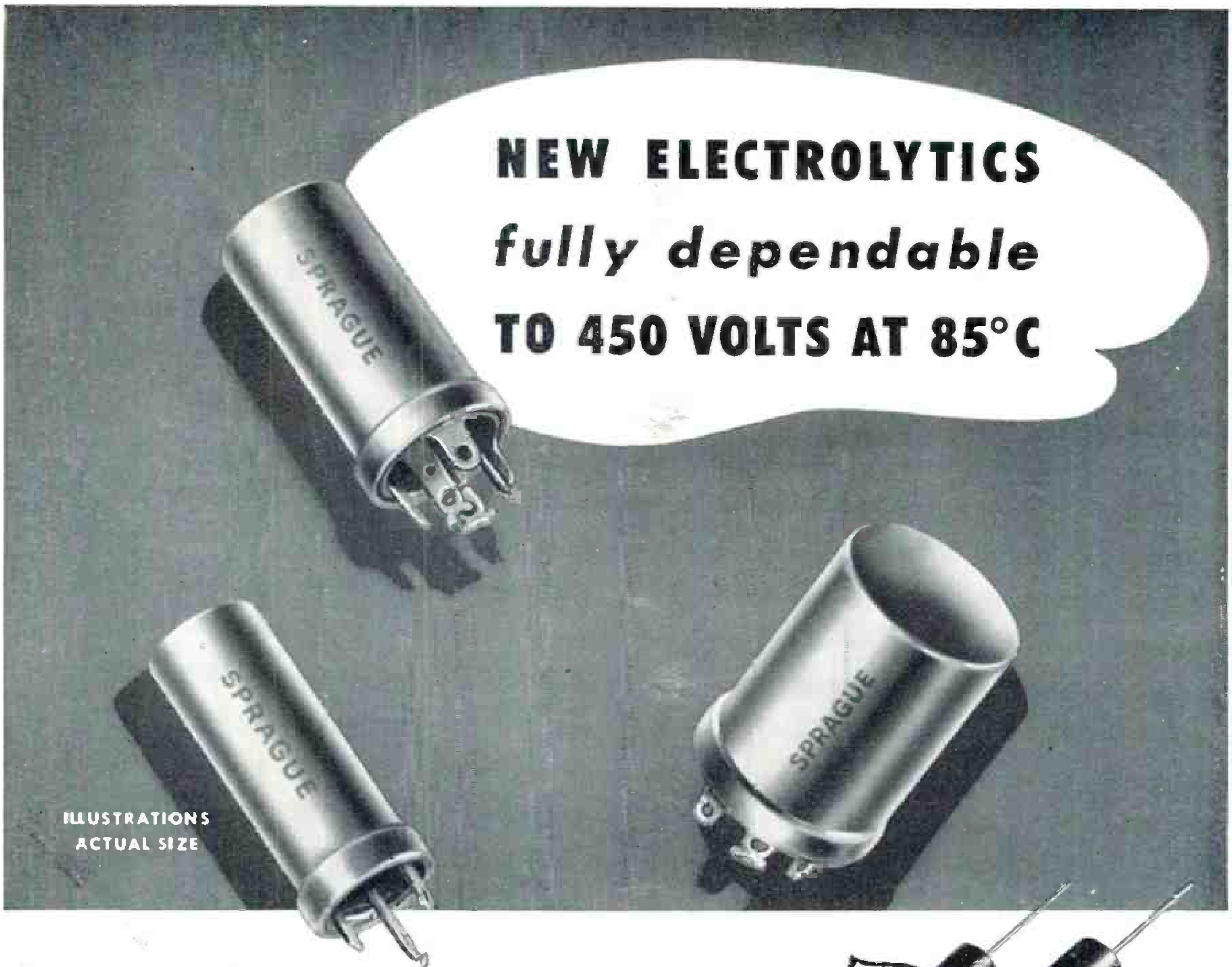

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Write for Engineering Bulletin 210A

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Capacitors
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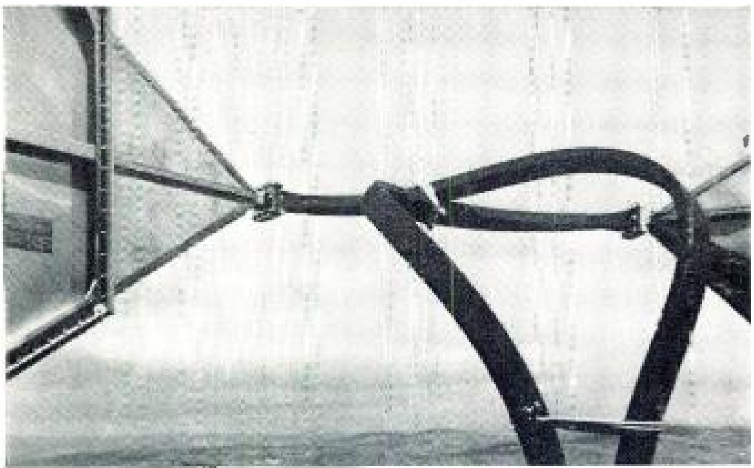
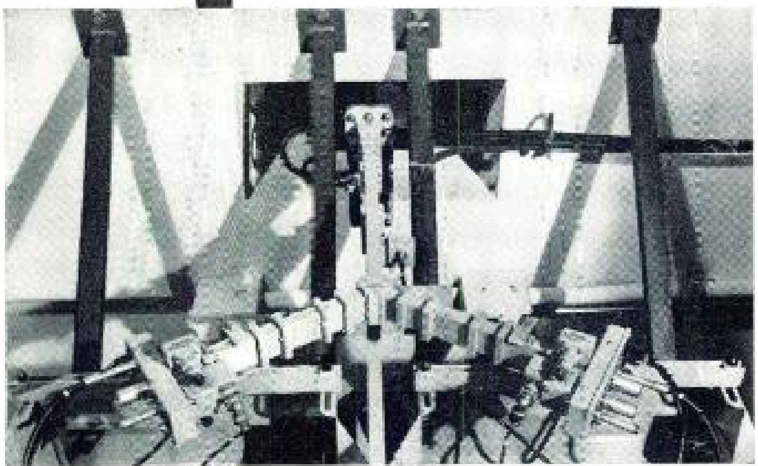
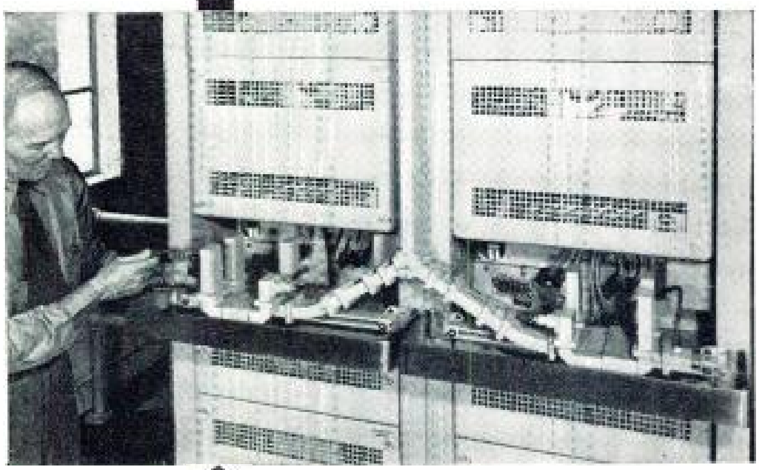


3 The waveguide connects with horn antennas which are pointed toward similar antennas at the next stations miles away.



2 Looking upward, the waveguide continues through the roof of the station toward the antennas.



1 Base of a waveguide circuit in a repeater station of the New York-Boston radio relay system.

Pipe Circuits

UNLIKE radio broadcast waves, microwaves are too short to be handled effectively in wire circuits. So, for carrying microwaves to and from antennas, Bell Laboratories scientists have developed circuits in "pipes," or waveguides.

Although the waves travel in the space within the waveguide, still they are influenced by characteristics found also in wire circuits, such as capacitance and inductance. The screw or stud projecting inside the guide wall acts like a capacitor; a rod across the inside, like an inductance coil. Thus transformers, wave filters, resonant circuits — all have their counterpart in waveguide fittings. Such fittings, together with the connection sections of waveguide, constitute a waveguide circuit.

From Bell Laboratories research came the waveguide circuits which carry radio waves between apparatus and antennas of the New York-Boston radio relay system. The aim is to transmit wide frequency bands with high efficiency — band widths which some day can be expanded to carry thousands of telephone conversations and many television pictures.

Practical aspects of waveguides were demonstrated by Bell Telephone Laboratories back in 1932. Steady exploration in new fields, years ahead of commercial use, continues to keep your telephone system the most advanced in the world.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.

For the best "look-in" on television programming and transmission . . . they are installing

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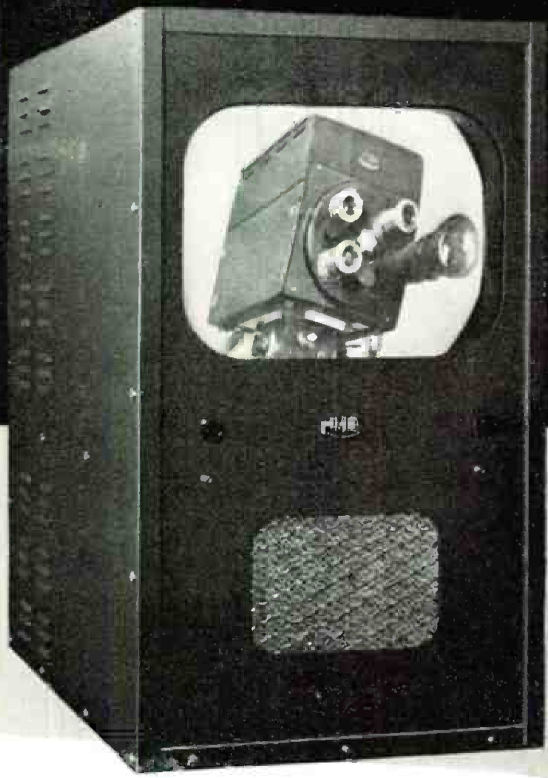

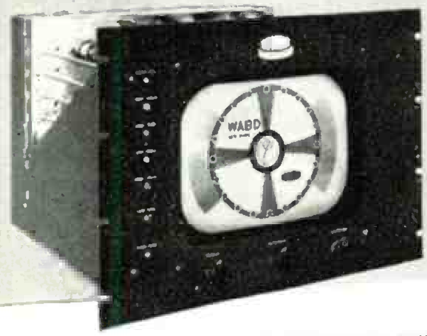

START AS SMALL AS YOU WISH, WITH THE DU MONT *Acorn Package*

TYPE 5108 12" PICTURE MONITOR

✓ Used in combination with companion unit, Type 5112-B Low Voltage Power Supply.

✓ Produces a comfortable-sized image on 12" picture tube for program monitoring of picture content.

✓ Operates from standard black negative composite picture signal with level in the range of 0.5 to 2.5 volts peak-to-peak. 1000-ohm input impedance.

✓ A 75-ohm input terminal is provided and is inserted across input terminal by means of toggle switch at rear.

✓ Type 5108-C fitted with 13⅜" x 17⅛" panel fitting into control consoles.

✓ Type 5108-D fitted with standard 14" x 19" relay rack panel.

✓ Overall dimensions, less panel: 12-11/16" h. x 16¼" w. x 18¾" d. Weight, 50 lbs.

Resolution exceeds that of usual commercial equipment.

TYPE 2116 20" PICTURE MONITOR

✓ Du Mont deflection system for better-than-usual focus.

✓ Full light output from 20" picture tube operated from 15KV supply. An excellent image thoroughly enjoyed even in lighted room.

✓ 215 square inches of picture. Excellent resolution — 450 lines.

✓ High voltage automatically removed should horizontal sweep fail, in order to protect picture tube.

✓ Monitor operates from a composite signal on a 75-ohm line with a level between .5 and 2.5 peak-to-peak voltage.

✓ Foolproof. Front panel carries brightness and contrast controls. At rear are the linearity, focus and other occasionally-adjusted controls.

✓ Type 2116-A includes a 10-inch high-fidelity speaker installed with baffle and grille assembly.

✓ Overall dimensions: 38" h. x 22" w. x 30" d. Weight, 300 lbs.

Superlative rendition — that accounts for the growing popularity of Du Mont large-screen picture monitors.

Two models: Type 5108, 12-inch tube, 72-square-inch screen. Type 2116, 20-inch tube, 215-square-inch screen. The direct-view images are brilliant, sharp, and pleasingly contrasty yet retain the full range of all the half-tone values so necessary for pictorial beauty.

The 12-inch model in combination with Type 5112-B Low Voltage Power Supply unit, is intended primarily for control functions. The 20-inch giant-image monitor is ideal for use on a dolly in the studio, for visual cueing of actors and studio personnel during a performance. It may also be placed in the lobby, in the studio manager's office, in other executive offices, and in clients' rooms.

• • •

For superlative monitoring, as in every other TV function from camera to transmitter and again to receiver, make it DU MONT for "The First with the Finest in Television."

Details on request. Submit your telecasting plans for that Du Mont "know-how" guidance.

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COMMUNICATIONS

LEWIS WINNER, Editor

NOVEMBER, 1948

The Rochester Fall Meeting

THE MOUNTING INTEREST in TV was dominant at the 20th Rochester Fall Meeting, fifty per cent of the papers being devoted to television involving new forms of TV circuitry, optical control and test setups for factory and lab.

Instruments[1] received banner attention. Two papers were offered on new test apparatus for TV receiver production work: a picture-and-sound modulated signal generator, and pulse-cross generator. The former unit, described by W. R. Stone, of Hazeltine, features a balanced modulator circuit in the sound channel in which FM sound carrier is produced. The in-phase input to this circuit is an r-f voltage of a frequency equal to the sound carrier plus 6.5 mc. This voltage is produced by a crystal oscillator and multiplier chain. The out-of-phase component applied to the balanced modulator is a 6.5-mc signal which is frequency modulated by either an internal 400-cycle *RC* oscillator or by an external source. A reactance tube produces the frequency modulation of the 6.5-mc oscillator and also acts as part of the center-frequency control circuit, the remainder of which is the limiter and discriminator. Deviation is determined by calibrating an a-c rectifier-type meter which is in the output of a cathode follower fed by the discriminator. The maximum output voltages are: picture, .5 rms; sound, .75 rms.

R. P. Burr, of Hazeltine, described the pulse-cross generator, a device for producing a pattern on the face of a normal picture tube which may be readily interpreted in terms of the time relationships existing between components of the composite synchronizing and blanking signal. This method, originally outlined by Loughren and Bailey of Hazeltine at a Fall Meeting in 1940, is very convenient for TV receiver testing providing a check on phase modulation of the sync information with respect to video detail. The pulse-cross pattern is a result of three modulations upon a video signal and its display system.

Another interesting TV signal generator was demonstrated at the meeting by Jerry Minter of Measurements Corporation. This generator, covering 20 to 250 mc, in eight ranges, is a wide-band device of the master oscillator, buffer-amplifier, modulated power-amplifier type, with the output circuits of the double-tuned over-coupled band-pass type, permitting modulation frequencies up to 5 mc. Video modulation is obtained from a built-in video modulator with a band-width of 5 mc. Continuous monitoring is provided by a built-in 'scope which displays the output of a keyed d-c potentiometer superimposed on the video for determination of modulation levels.

Next Year, Syracuse

IN '49 the Fall Meeting will be held in Syracuse sometime in November, Virgil Graham, chairman of the conference, announced at the annual banquet. It was reported that there would be no exhibits at this meeting.

The annual transmitter meeting, usually held in Syracuse in the spring, will, in '49, go to Philadelphia.

Fall Meeting Award To Israel

DORM ISRAEL, of Emerson, was awarded the eighth annual Rochester Meeting plaque, for his outstanding services on the RMA receiver committees. A well-deserved award!

Troposphere Reports

THE RESULTS of an exhaustive series of East Coast tropospheric and sporadic *E* field-intensity measurements on 47.1, 106.5 and 700 mc, released by the FCC Bureau of Engineering, reveals that higher signal levels are available on 106.5 than on 47.1 mc at distances of 45 and 68 miles from a 1-kw transmitter; tests were made from the WBAM FM transmitter in N. Y. City with separate half-wave horizontal dipoles for each frequency, with 10 kw on 47.1 and .725 kw on 106.5 mc, signals being directed to Princeton, N. J., Southhampton, Pa., Laurel, Md., and Powder Springs, Ga. At Laurel (186 miles away) the 47.1 mc fields were stronger during most of the time. Within 52 miles of the transmitter the lower frequencies had a greater fading range, while beyond this distance fading was greater on the higher frequencies. In Southampton, the 700-mc signals were found to increase considerably after sunset apparently continuing strong during the night and several hours after sunrise. The 700-mc transmissions were conducted by W2XCT of CBS with an antenna consisting of a square corner reflector, energized by a vertical half-wave dipole. Peak power radiated in the direction of the beam was estimated to be equivalent to 6.5 kw out of a half-wave dipole. The transmitter was pulse modulated at 300 cps, with a duty cycle of one to ten.

Generally as the distance from the transmitter was increased, tropospheric fading became appreciable first at the lower frequencies and on the higher frequencies at greater distances.

Abbreviations and Symbols

AT LONG LAST standards on abbreviations, graphical symbols, letter symbols and mathematical signs have been published. Prepared by four IRE committees, the standards cover graphical symbols for circuits; coax and waveguide and electron tube elements; subscript and superscript procedure; abbreviation formats; typographical details, etc.

While all of the standards are not completely satisfactory, they do, nevertheless, provide an effective approach to a complex problem. COMMUNICATIONS articles will, hereafter, follow the new look.

VHF and Washington

VHF will be put on the stand again in Washington on November 30, December 1 and 2, with FCC looking for the answers.

During this important three-day hearing there'll be testimony on *vhf* propagation standards, *vhf* telecasting and FM broadcasting. Every phase of the problems in these fields will be thoroughly analyzed to provide a sound basis for any revisions in the present standards.

The final results of these meetings are expected to set a mighty-welcomed long-term pattern of procedures in FM and TV broadcasting.—L. W.

[1] A complete report will appear in December COMMUNICATIONS.

The WBZ Radio and

The WBZ Radio-TV Center

RADIO BROADCASTING studio requirements have changed over a period of years from the rather simple beginning of WBZ, where a factory penthouse at the East Springfield works of Westinghouse was dressed up with monks cloth drapes for its initial broadcast, to the complex floating wall, elaborate acoustical-type studios recently completed.

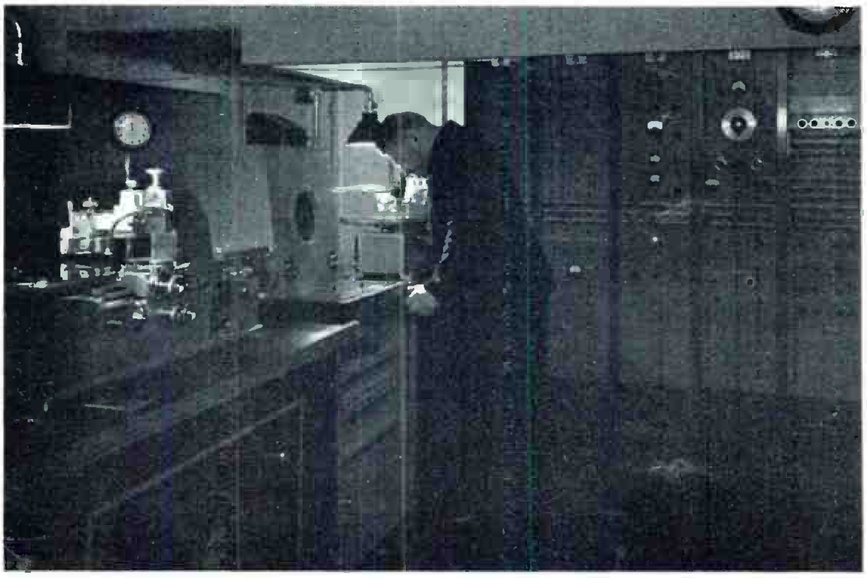
The art has grown swiftly from those early beginnings, and today the average metropolitan station requires a multi-studio layout with complex switching control equipment to satisfy station business and listening audience expectations.

WBZ has employed several studio locations since its founding. From the Springfield factory studio it moved progressively to more elaborate quarters in the Brunswick, Statler and Bradford hotels, all in Boston, and in June 1948 moved to its new WBZ radio and television center.

In 1947 when the FCC granted a television *cp* to WBZ, the manifold problems of selecting a transmitter site, providing adequate studio facilities, and modernizing our AM studio quarters had to be met. Preliminary plans were drawn, contemplating separate transmitter-studio sites. Hilltop sites located in the approximate metropolitan center were investigated for the obvious economical advantage of shorter tower height. In all these explorations, residential zoning restrictions on all the hilltops appeared to be an obstacle of major proportions, predicating delay and perhaps refusal.

Walter Evans, vice president of Westinghouse Electric, and president of its radio broadcasting subsidiary, proposed that a study be made of a building layout which would encompass all WBZ radio activities, with the exception of the 50-kw AM and international transmitters and their re-

Elmer Lantz, in charge of recording for WBZ, checking cutting grooves through microscope on the Scully recorders. Note recording and test bays (rear right) of master control racks, clearly visible for technician operating recorders.



Studio and control room used for WBZ-FM.

Television Center

Recently Completed Center, On Soldiers Field Road Along the Charles River in Boston, Houses 10-KW FM and 5-KW TV Transmitters and Studio and Audio Facilities for WBZ-WBZA, WBZ-FM and WBZ-TV.

by W. H. HAUSER

Chief Engineer
WBZ

spective antenna systems. A further stipulation was that such a building should be located in an area of the metropolitan district where the following conditions could best be met:

(1) Zoning restrictions must permit type of building required and permit erection of tower on site.

(2) Sufficient land for the erection of a two-story building and room for future additions or expansions.

(3) A site location approximately in the geographical center of the metropolitan area to be served by the television signal.

(4) Attractive frontage.

(5) Land of reasonable valuation, but with good prospects for future developments.

A site of more than 10 acres was located, fulfilling these requirements, on Soldiers Field Road along the Charles River in Boston, adjacent to Harvard Stadium, having a metropolitan parkway as frontage, and with another main thoroughfare in the rear providing surface trolley and bus lines for public transportation. There was more than sufficient land here for the type building we contemplated, and the location of a tower which would support TV and FM antennas. This plot of land was purchased in the fall of 1946 and consultations with our architect, Elisha Safford and D. A. Myer, technical field director for the Westinghouse station subsidiary began the building layout that same fall.

The new WBZ radio and television center represents experience gained in more than 25 years of operating broadcasting stations. The building and all associated equipment was planned with efficiency and flexibility of operations foremost in our thinking. With this in mind, a large equipment room was designed in which was installed the following major items:

A 5-kw television transmitter[1] with associated control console and input and monitoring units. A 10-kw FM transmitter[2] with associated input and monitoring equipment.

Audio channel amplifiers, switching and monitoring equipment installed in eight standard racks.

Recording equipment[3] with associated input apparatus.

The equipment room is of sufficient size to permit some expansion in the future if it becomes necessary. The transmitters and audio racks were enclosed by furring down the ceiling and partitioning so that their exhaust heat could be readily drawn off to the outside of the building, thereby decreasing the air-conditioning load. Fresh conditioned air is introduced to the equipment through air vents inside this enclosed space. Approximately 40 kw of heat load from the room was eliminated in this manner.

This equipment room may be observed by visitors to the building through a large glass window.

Immediately adjacent to the equipment room are three small studios used primarily for record and transcription programs, spot and call-letter announcements, discussions, and news programs. Three larger studios, including an auditorium studio, capable of handling the largest orchestral and choral groups which may be encountered, are located on the east side of the building on the first floor.

A spacious workshop for maintenance of technical equipment, news room, music library, transcription library, technical and program supervisors' offices are conveniently located near their respective fields of operation.

The acoustic design of all studios was furnished by Henry Gurin, an en-

(Continued on page 28)

[1]RCA TT5-A.
[2]Westinghouse FM-10.
[3]Scully.

The old and new: At left, the old "Little Trees" studio of WBZ, Springfield, Mass. At right, the new polycylindrically-shaped wall studio at the WBZ center. A two-story 40' x 45' room with seating capacity of 150, the studio is air-conditioned and possesses a clients' room directly above the technicians' control booth.

Figure 2
The completed revamped master control equipment racks.

Figure 1
View of the old two-bay speech input equipment with patch panels, auxiliary monitoring amplifiers, two line amplifiers and two microphone preamps plus bridges, pads, four-channel mixer, etc.

A Speech Input Installation For Two Stations

Faced with an *upcoming* FM station operation and some rather limited studio facilities, we found ourselves with quite a facilities problem. Our existing control facilities were very limited. Installed during the war when materials and equipment were almost impossible to obtain, we had been struggling along with hardly more than the bare essentials. If we were to attempt FM programming with any degree of program separation, a certain amount of additional equipment was necessary.

First, we surveyed our existing setup. Our engineering pattern included a consolette[1] arranged to feed three adjoining studios which were on the three sides of the control room. In addition to these three studios, an audition room and a news room in remote corners of the building had been wired with microphone outlets and could be patched in on a moment's notice. Speech input equipment included, in addition to the consolette and two playback tables,[2] two speech bays of auxiliary equipment.

Only a brief study of this setup was needed to convince us that it was not suitable for a two-station feed. The facilities would be adequate only at the expense of the equipment needed to feed regional networks, auditions, recordings, etc. It was necessary therefore that some arrangement be devised to feed the second station and it was highly desirable that it be made as flexible and serviceable as possible. Analyzing these requirements, it was found that: (*1*) Additional studios were not available; (*2*) space for an additional control room was not available: (*3*) added facilities should operate in conjunction with but independent of the existing facilities, and (*4*) any installation or construction work must be done without disturbing the *on-the-air* operation of the existing station.

Briefly, then, our situation was quite fixed and offered very little latitude in design.

We decided to add another consolette to feed the second station. It was not desirable to decrease the area of any of the existing studios, and therefore this new console could not be installed in a new booth adjacent to a studio. The present number of studios was no more than adequate and thus it would be impractical to reduce the number of studios available for the AM station by assigning one of them for the exclusive use of the FM station. With the somewhat unstable FM programming situation, it was highly desirable that the FM console be arranged so as to make possible the handling of programs from any one of the five studios, network, or playback tables, without affecting the operation of the other station's console. And all this installation work was to be done without interruption of the AM program in progress.

This was quite an order!

It meant an entire rebuilding of the existing speech racks, replacement of the existing equipment in these racks replacement of the existing units in the control room, rewiring of the equipment now in the system units—all without program interruption.

First, we determined what equipment we would have to add and that was the new consolette. We decided on one just like the one we already had, since, because of its similarity of design to the unit being used for AM, our engineers could quickly adapt

[1]RCA 76B2.
[2]RCA 70C.

Additional FM Consolette Added, Without Disturbing AM On-the-Air Schedule, to Provide Handling of Programs From Any of Five Studios, Network or Playback Tables, Without Affecting Operation of AM Console.

by F. E. BARTLETT

Chief Engineer
KSO and KSO-FM

themselves to its control and thus avoid any operational errors during the transition stages. It was also decided that additional playback equipment would be desirable if not mandatory, first for general program flexibility and second to broaden the activities in which we might become engaged, without serious inconvenience. We also found that we should have wider latitude in patch board design to further the flexibility of the two-station setup, additional audition facilities, and some few new units to replace or supplement obsolete items, such as remote line-equalization facilities, sound effect filters, echo chambers, outside line switching, etc. We then proceeded to work out a tentative placement plan, for the equipment in the speech racks, thereby determining the number of additional racks and the amount of wire, blank panels, coils, pads, bridges, etc., which would be needed. An order was then placed for the basic and associated equipment and accessories.

In our next planning step, duplicate studio outlets for making studio pick-ups were considered and duplicate microphone circuits were planned for each studio, one set for each console. In this manner, by proper placement of microphones it would be possible for one station to immediately follow the other in a single studio with separate microphones and no complicated parallel connection would be necessary.

Next came the design of the entire speech rack and control setup. It was laid out in block form on paper. Figure 4 shows how this was arranged and how it was then laid out in the speech racks. We had determined that four bays would be required in place of our existing two and it was decided that bay *1* or *4* should actually be constructed first. Since these two would be identical, it was unimportant which we did first. We could then construct the bay and place it in operation thus releasing the equipment in old bay *2*, the existing audition bay, for placement in the other new audition bay. We chose to start with bay *4*. By this time some of the equipment ordered, including the additional racks for bays *1* and *4* had been received and we immediately started our construction work.

One of our technicians, who had displayed an exceptional mechanical aptitude, was thoroughly briefed on the project and turned loose. Close cooperation was maintained between the worker and the writer at all times throughout the conversion. All wiring was done in the shop, units were actually placed in the bay and wired in completely as desired. On completion of the bay in the shop, it was temporarily connected to the 110-volt power supply through a drop cord and thoroughly tested. A few bugs were found and corrected and some improvements in design were incorporated, after which all units were removed bodily from the frame to facilitate handling and the bay was moved into the control room and set in place. The units were reinserted in the bay, power connections made and it was ready for service. Since this bay was a complete unit in itself, with only power supply connections necessary to put it in operating order, this method was highly practical. By building in the shop, it was possible to work much faster and yet eliminate practically all of the confusion in the control room.

Bay *1* was then commenced and completed in the same fashion, all wiring, design, etc., being an exact duplicate of bay *4*. When completed and installed, this bay released all of the equipment from the original bay *2*, which was to become bay *3* in the new setup, but retained its original physical location. This new bay, now number *3*, which was to become the jack panel, could not be constructed in the shop since it was impractical to remove it from its physical location in

(*Continued on page 29*)

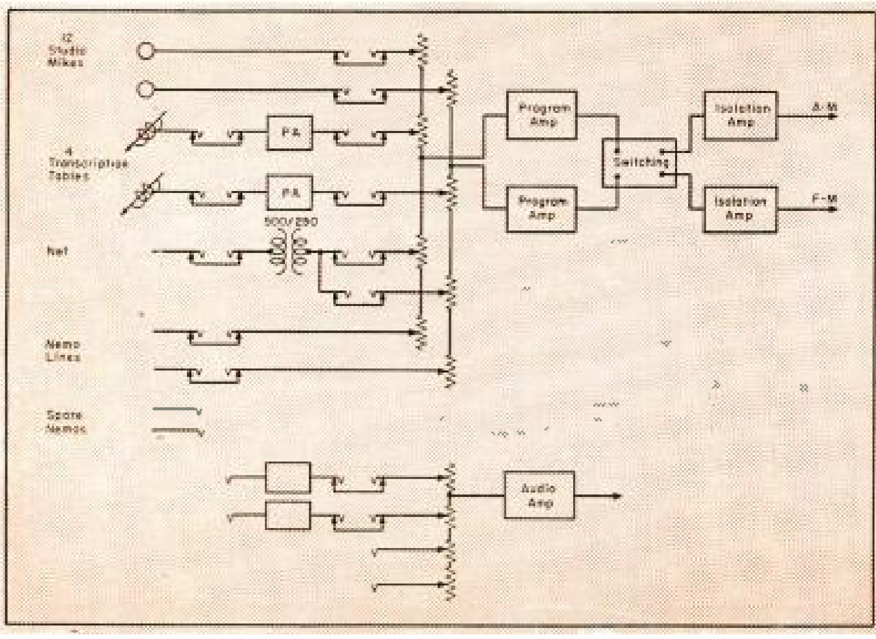


Figure 6
The speech layout setup for AM and FM at KSO.

Figure 4
Block diagram of the equipment bays now in use at KSO.

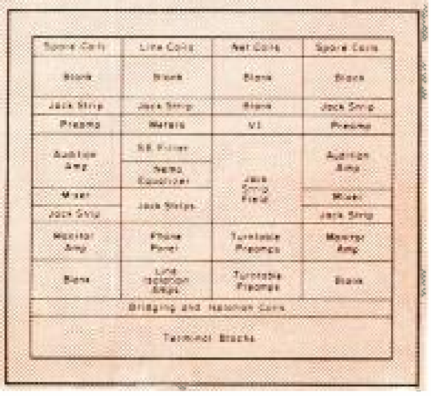


Figure 1a
A dual recorder setup at KCRG/KCRK.

Custom-Built Dual-

Dual Recorders Built Into Consoles Which Can Be Used in Two Single-Channel Recorder Work, Dual Recording of Same Program or for Continuous Recording Without the Necessity of a Break to Change Recording Blanks. Console Can Also Be Used as a Program Monitor, When Not Recording, or Receive the Cue and Monitor Program Being Recorded.

by A. S. KARKER

Audio Engineering Section
Engineering Products Department
RCA Victor Div., RCA

DUAL-RECORDING SYSTEMS are an extremely useful audio tool in the modern broadcast station, offering a variety of recording applications.

In an installation in WKJG, Fort Wayne, Indiana, a dual recorder,[1] of the type shown in Figure 1, was inserted in a setup with switching facilities to permit simultaneous or individual recorder operation as desired. In addition, continuous recording without breaks, program monitoring and cueing are possible; Figure 2.

The recording console and cabinet consists of two professional recorders which are mounted on each side of a turret installed at the top center of the cabinet. The turret panel contains the controls for operation of the left or right recorder, recording switching system, metering and monitoring. The recording and monitoring amplifiers are the plug-in type and are mounted on shelves in a compartment below the control panel. A recording (orthacoustic) filter[2] is also mounted in this section, as well as the a-c and audio terminal blocks, thus making it unnecessary to move the console for connecting additional lines and also permitting the cabinet to be placed against the wall in a convenient permanent location. An automatic recording equalizer[3] is mounted in a metal cylinder that is parallel to the tube housing the cutter head feed screw. As the cutter head moves on the feed screw towards the center of the record, a contact riding on the equalizer provides the proper amount of compensation. There is a large storage space under each recorder with shelves for recordings or blanks.

Operation

The operation of the right and left recording channels in the dual system are quite similar. After the recording and monitoring amplifier are adjusted to the proper levels, it is not necessary to change these adjustments, since all other control operations can be made directly from the control panel.

By operating the center selector switch (directly under meter on turret control panel), the operator has a choice of seven positions—three *off*, and four *recording* positions (left recorder, right recorder, both recorders and single recording). For the purpose of illustration, let us assume that this switch is in the *right* position. With the key switch (which is located above the right recorder controls) played on the center position, the recording amplifier[4] operates in a normal condition. If this key switch is operated to the right or orthacoustic position, the recording amplifier response will be the

(*Continued on page 30*)

[1]Two RCA 73-B professional recorders (MI-11825/11850-C): Recorder head impedance, 15 ohms nominal; frequency response, ±2 db, 30-10,000 cps; sensitivity (groove velocity 6.3 cm/sec., .0079") (peak to peak) at 1,000 cps + 30 dbm (1 watt); turntable diameter (handles blanks up to 18¼" diameter and up to ⅜" thick), 17½"; turntable speed, 33⅓ or 78 rpm.
[2]RCA MI-4916A.
[3]RCA MI-11100.
[4]RCA BA-4C (MI-11223-B).

Figure 1 (right, top)
Front view of WKJG dual recorder. Recording and monitoring amplifiers are located in center cabinet. In the top shelf are the left and right recording amplifiers. In the lower shelf, at the left, is the a-c terminal block, monitor amplifier (center) and at right is the audio terminal block and monitor amplifier gain control.

Figure 2 (right, bottom)
simplified block diagram of the WKJG dual recorder setup. At *A*, is the orthacoustic recording filter; *B*, 12-watt amplifiers; *C*, dual recorders, and *D*, automatic recording equalizer.

Figure 4 (right)
Recording equipment response curves. Solid line shows overall frequency response obtained with an orthacoustic filter; dashed line, NAB standard lateral response.

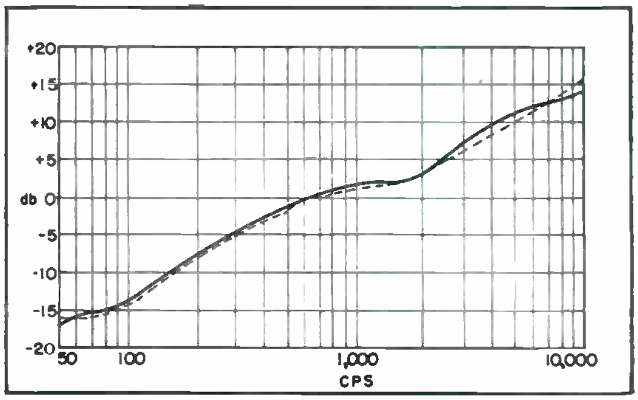
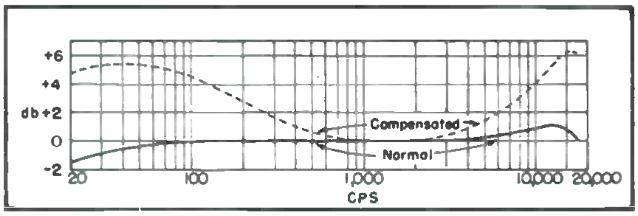
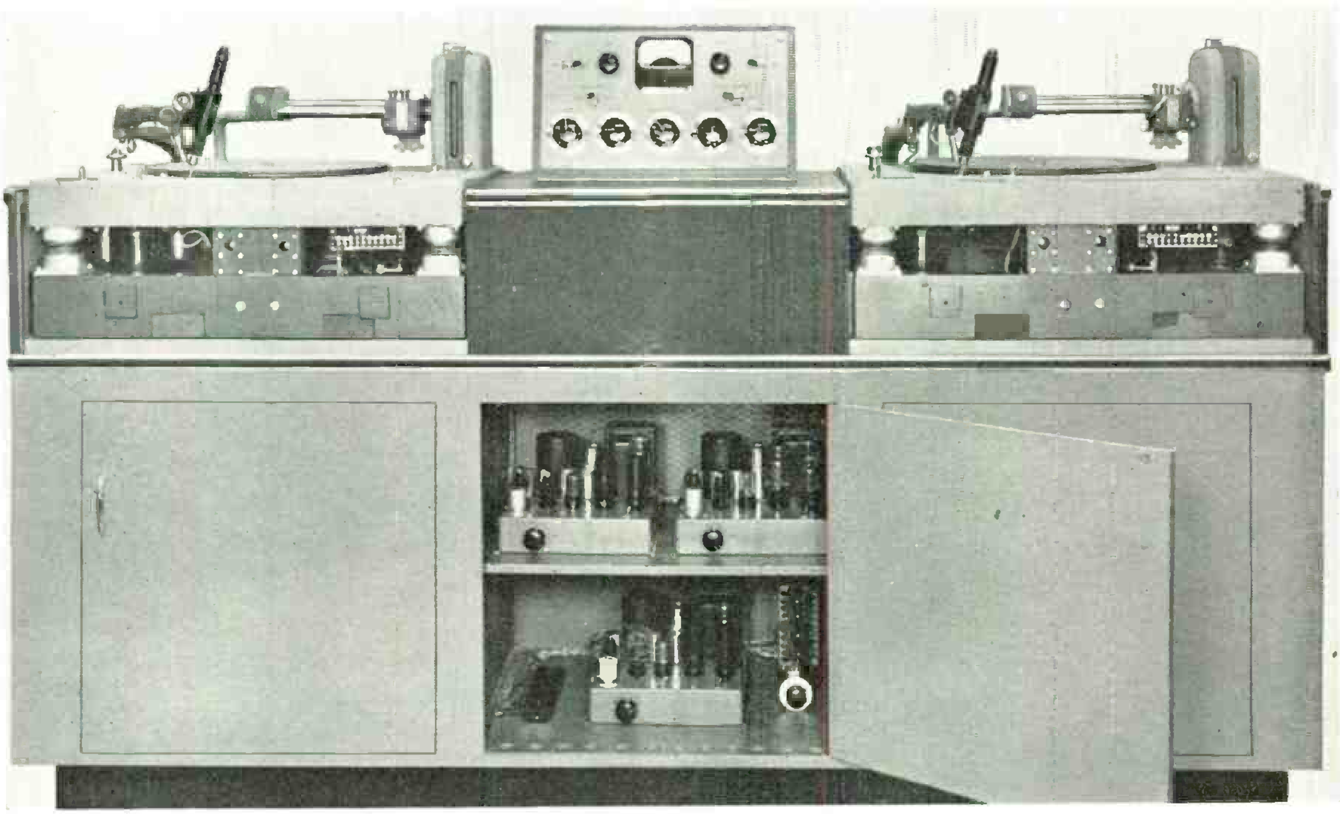
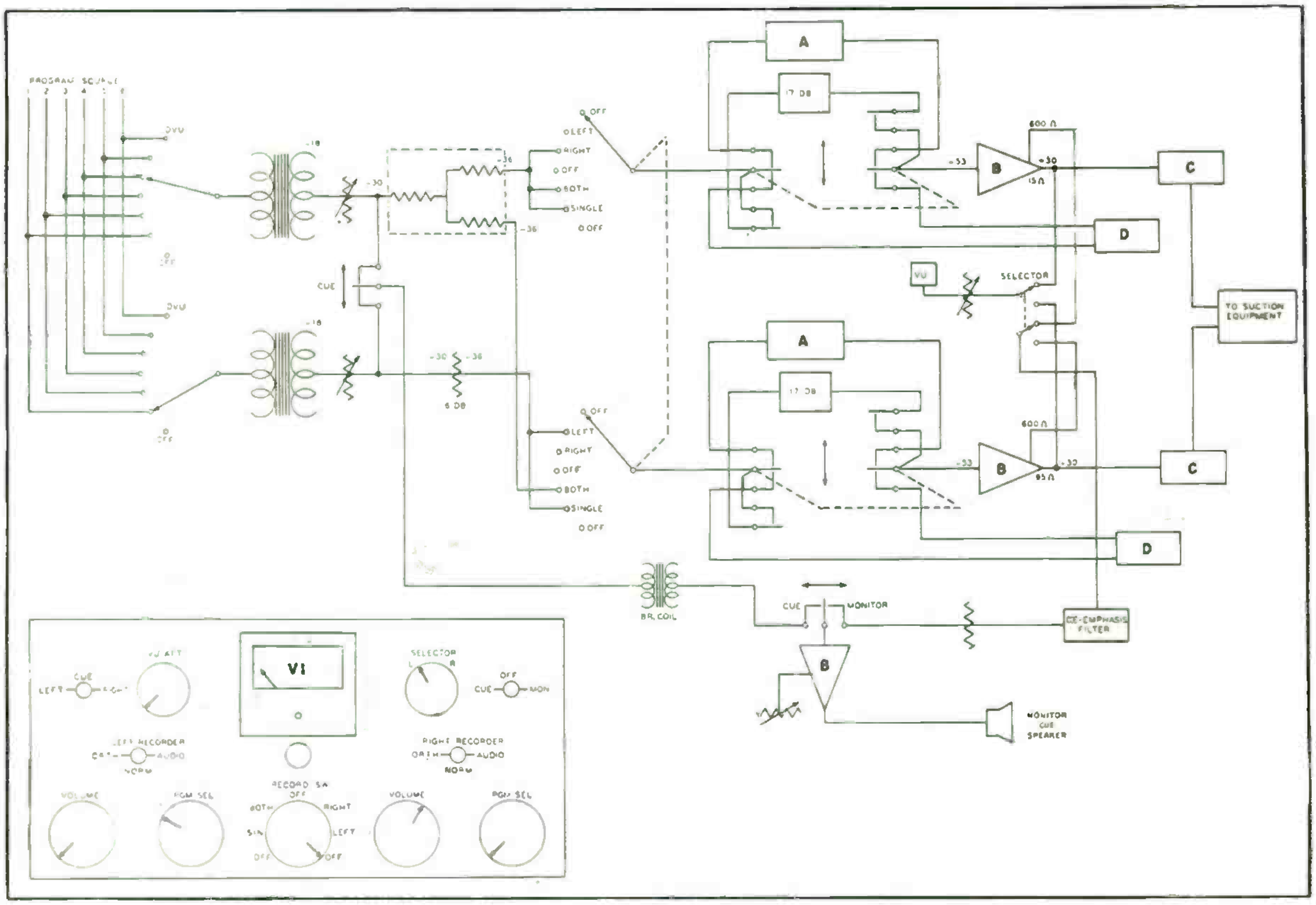


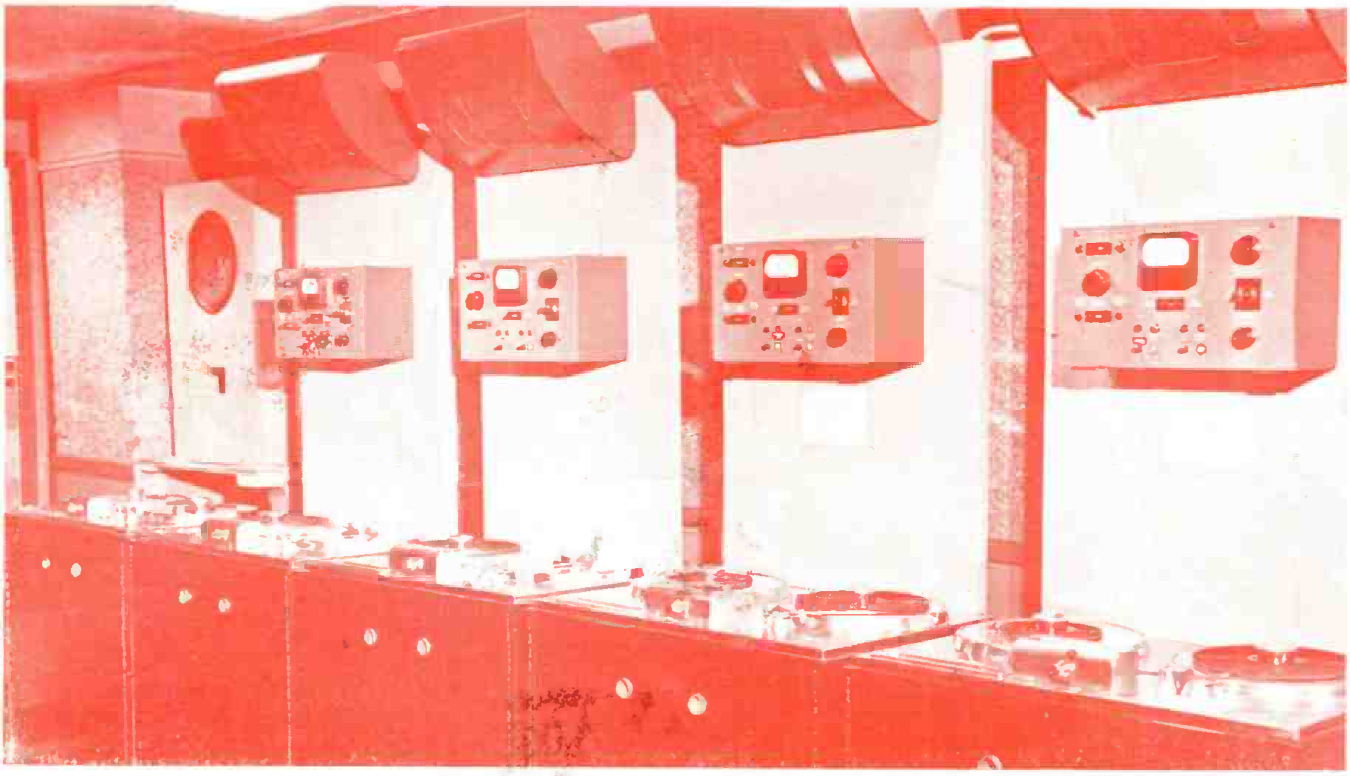
Figure 3 (below)
Response curve of the 12-watt amplifier.



Recording Console Systems







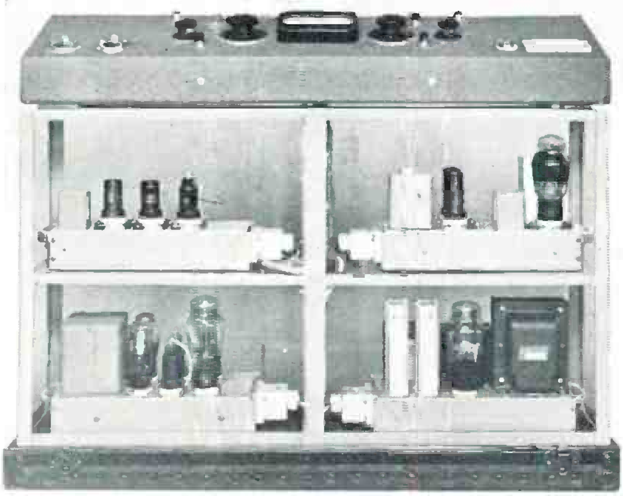
ABC tape recording setup in Chicago.

High Fidelity

by RALPH BARUCH

DURING THE LAST WAR magnetic tape was used extensively by the Germans with a recorder-playback known as the *Magnetophone*. Shortly after the war this machine, either in its original form or slightly altered, was used by Radio Luxembourg for recordings in Paris when direct broadcasts from its studios proved impractical. The program *L'Heure De Coca-Cola,* for example, was recorded on tape in Paris in several sections, edited and spliced there, and broadcast in Paris a few days later. The quality and the ease of editing of this recorder soon became known here. Bing Crosby, who had been using discs to transcribe his radio show, began using tape in 1947, and in the early part of '48 the Bing Crosby Show became one of the first programs to use an American-made high speed and high fidelity tape recorder. Soon thereafter two more programs, on the same network, began using magnetic tape. This network has since equipped its Chicago recording room with quite a few high speed tape recorders for delayed broadcast work.

The claimed frequency response of the professional type units is from 50 to 15,000 cycles within ±1 db. Distortion in the overall systems (from input to output terminals) does not exceed 4% intermodulation distortion using measuring frequencies of 40 to 2,000 cycles with the high frequency 12 db lower than the low frequency. The total *rms* harmonic distortion does not exceed 1% from 100 to 6.000 cycles and 2% from 30 to 100 cycles. Noise level is 60 db below 100% modulation, 100% modulation being the maximum input signal within the aforementioned distortion limits. This noise level incidentally was measured at the output of the playback amplifier



(Left)
Interior veiw of portable type tape recorder showing amplifier and power supply. (*Courtesy Rangertone*)

Consolette model tape recorder. (*Courtesy Rangertone*).

At top and below appear two closeups of the tape recorder shown in the ABC installation. Top view illustrates the interchangeability of units within the recorder and the bottom view illustrates the recording head assembly. *(Courtesy Ampex)*

A portable type tape recorder. *(Courtesy Magnecorder)*

Tape Recording

A Review of the Design and Application Characteristics of Professional Type Tape Recorders Now Available, Editing Practices and the Features and Drawbacks of the Systems.

thereby checking all sources of possible noise. The recording amplifiers will give 100% modulation with an input of up to 26 db. The playback accuracy is approximately the same as with disc recorders, namely ±.2 of 1%.

One recorder-playback unit,[1] being used at present by *ABC* in Chicago and New York, has a recording speed of 30″ per second. The rewind speed is 300″ per second, but this can be increased to 600″ if desired. The instrument is equipped with plug-in erase, recording and playback heads assembly to facilitate rapid interchange and repair service if and when necessary. Erase, recording and playback heads are separate. Tape is mounted on four-inch hubs which are locked on 14″ flanges for easy handling of the tape. These flanges can be removed for more economical storing purposes.

To thread the tape it is first inserted in the hubs and then passed through the heads. All operating controls are by relays which permits remote control of the recorder by installing an auxiliary push-button panel.

Chassis are of plug-in construction with all amplifiers, etc., readily interchangeable. The instrument will record 32 to 35 minutes of tape.

Instant monitoring has been made possible through the playback head, providing immediate control of the recording. Adjustments can be made with a screwdriver for high and low frequencies.

Another type,[2] developed by Col. R. H. Ranger, also has a recording speed of 30″ per second with a frequency response of 30 to 15,000 cycles. The speed can be changed, with equivalently more recording time, to 15″ per second with a response of 100 to 10,000 or 7½″ per second with a 100 to 6,000-cycye response. The rewind speed of the unit is variable up to 150″ per second.

The recorder-playback is equipped with a *vu* meter which checks input signal, output signal, bias current, and erase current.

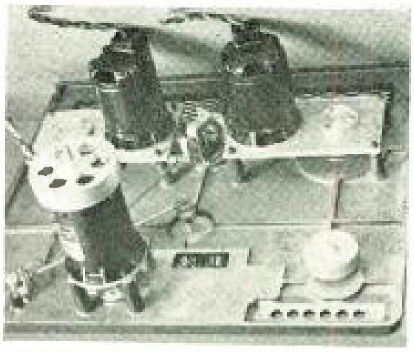
A third professional type tape device[3] has a recording speed of 15″ per second, with 15 minutes recording time or 7½″ with 30 minutes recording time. Frequency response is claimed at 50 to 15,000 cps at 15″ recording speed and 50 to 7,000 cps at 7½″ per second. This unit can be equipped with an additional spooling mechanism providing a total recording time of 30 minutes at 15″.

Delayed Broadcasts

Tape recorders are being used, in the main, for delayed broadcasts. In these recordings the program is recorded on tape from a high fidelity

(Continued on page 32)

High speed monitor assembly of Rangertone tape recorder.



[1] Ampex.

[2] Rangertone.

[3] Magnecorder.

A Report On

Adjusting position of the parabolic-type antenna at a test location near Barrington, Illinois, in connection with the laying out of the Chicago-Milwaukee microwave relay system. This system is designed for television, sound radio programs or long distance telephone calls.

Capt. Bill Eddy (left), formerly manager of WBKB, under whose direction the South Bend-Chicago 1900-mc microwave relay system was installed, and S. W. Pozgay of G. E. discussing the system in the WBKB laboratories.

(Below and Right)
Setting up 6800-7050 mc microwave equipment for remote TV work.

Each of the seven repeater stations in the New York-Boston link has four repeaters, two for each direction of transmission. Four antennas are mounted on the roof of the repeater station, two for north-to-south transmission and two for south-to-north transmission. Of the two antennas for one direction of transmission, one receives from the previous repeater and the other transmits to the next repeater. Each repeater provides a maximum gain of about 80 db, which when added to the gain resulting from the highly directive antennas is sufficient to make up for normal transmission losses plus additional losses due to fading to a depth of 20 db.

In the absence of satisfactory amplifier tubes to provide the required gain and bandwidth, it is necessary to use low-level amplification on frequencies less than 100 mc. Silicon rectifiers serve as fairly good modulators at microwave frequencies and are used to shift the signal band from 4,000 mc to an i-f centered at about 65 mc. After amplification at 65 mc, another silicon modulator is used to shift the frequency band back to the microwave range for high-level amplification. In the second modulation step, an additional shift of 40 mc is provided so that signals sent out by the repeater are higher or lower in frequency than those received, thereby simplifying the overall feedback problem.

In the two-channel circuit, operating in one direction at a repeater station, the signal may be visualized as a carrier with two sidebands extending 4 to 5 mc on either side. Received signals of 3,930 and 4,130 mc are indicated as the carriers of the two south-to-north channels. The 3,930-mc carrier is channeled through a waveguide from the receiving antenna to the proper converter by a waveguide branching filter. In the converter, the 3,930 mc is combined with an oscillator frequency of 3,865 mc to produce a difference frequency of 65 mc. This is amplified as it passes through the pre-amplifier and main i-f amplifier. An *avc* circuit maintains constant amplitude for application to the transmitting modulator.

In the modulator the 65 mc carrier is combined with a modulating frequency of 3,905 mc to produce a new carrier frequency of 3,970 mc. This is further amplified in the microwave amplifier and is then carried by waveguide to the transmitting antenna through a combining filter. The filter permits the combination of the two transmitted signals into one antenna with negligible interaction losses.

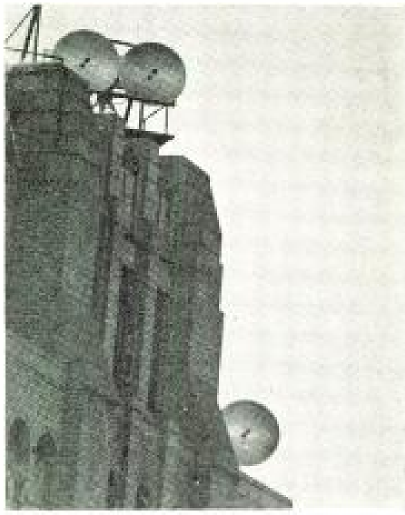
The two modulating frequencies, 40-mc apart, are provided by using a 3,905-mc highly stabilized reflex oscillator and a very stable 40 mc crystal oscillator. The former supplies the transmitting modulator directly, while the receiving modulating frequency is obtained by combining the output from the two oscillators in a modulator and selecting the difference frequency. Since the same microwave oscillator frequency is involved in the receiving

Microwave TV Networks

Part II . . . . Circuitry of N. Y.-Boston Net. Characteristics of Links Between Chicago-Milwaukee, N. Y.-Schenectady, South Bend - Chicago and Philadelphia - Washington. Features of Microwave Equipment, Including Design and Application Features of Tubes and Antennas Used in Link Systems.

by **SAMUEL FREEDMAN**

New Developments Engineer
DeMornay-Budd, Inc.



Western Union microwave relay reflectors at the Philadelphia terminus for handling communication and television channels. (*Courtesy Western Union Telegraph*).

and transmitting modulating steps, its absolute frequency is not a factor in determining the transmitted frequency. Should this oscillator be in error by some small amount, the intermediate-frequency carrier will be in error by the same amount. This error will be cancelled in the process of shifting back to the microwave range.

The overall frequency stability of the repeater system is thus determined only by the microwave oscillator at the transmitting terminal and the various crystal-controlled 40-mc oscillators in the repeater chain. Although the frequencies of both oscillators are controlled to the same percentage precision (about .005%), the possible variation in the absolute frequency of the microwave oscillator is 100 times that of the 40-mc oscillator because of the 100-fold difference in frequency.

The microwave amplifier uses four 402A velocity modulated type tubes. Each tube is mounted in a two-cavity assembly with an associated permanent magnet for focussing the electron beam. The cavities are tuned by threaded studs which project into the cavities and are adjusted externally. Another adjustment allows rotation of a small sheet of resistance material inside the cavity for loading purposes.

Automatic Recycling

Since the repeaters are designed for unattended operation, it was necessary to include an automatic recycling or restoring mechanism which will replace the high voltage if the overload relay should operate because of a momentary overload. If the overload condition is not of a permanent nature, automatic restoring circuits will make a maximum of five consecutive attempts to restore the repeaters to service at approximately one-second intervals. If the overload condition is not removed during this recycling period after five attempts, all plate power will be removed. An alarm will be sent to the control center indicating that the repeater is shut down.

The terminal equipment converts the television video signal to a FM carrier for radio transmission through the repeaters. From the time video signals leave the television studio until they go out in space as a modulated microwave signal at a terminal station antenna, the sequence of events may be summarized as follows:

(*1*) Video from television studio is received by coaxial cable or a balanced pair of telephone wires. It is limited to a bandwidth of 2.7 mc.

(*2*) Video amplification follows.

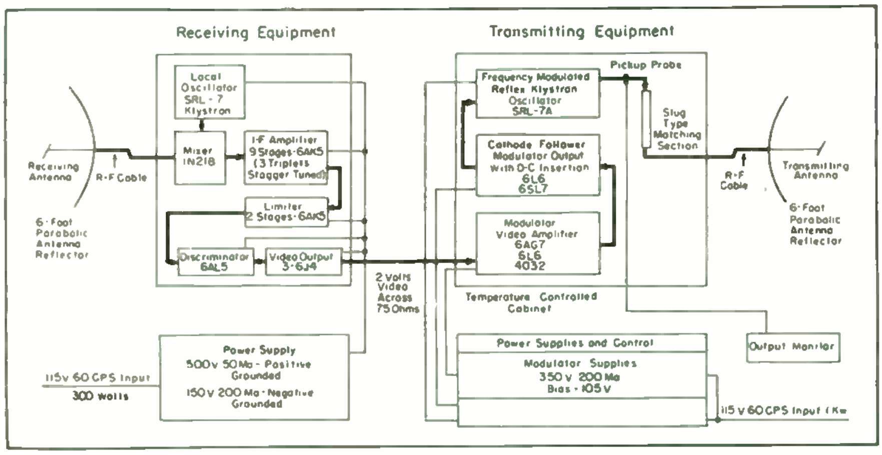
(*3*) The amplified video signal then encounters a reactive network so that variations in amplitude cause variations in reactance of an oscillator having a mean frequency of 65 mc.

(*4*) The transmitter, phase modulated at that frequency, is fed to a balanced crystal modulator. An FM signal from the microwave oscillator is also injected so as to step the 65 mc up to the microwave frequency.

(*5*) The signal then leaves the balanced modulator and passes through four r-f amplifier stages to the antenna.

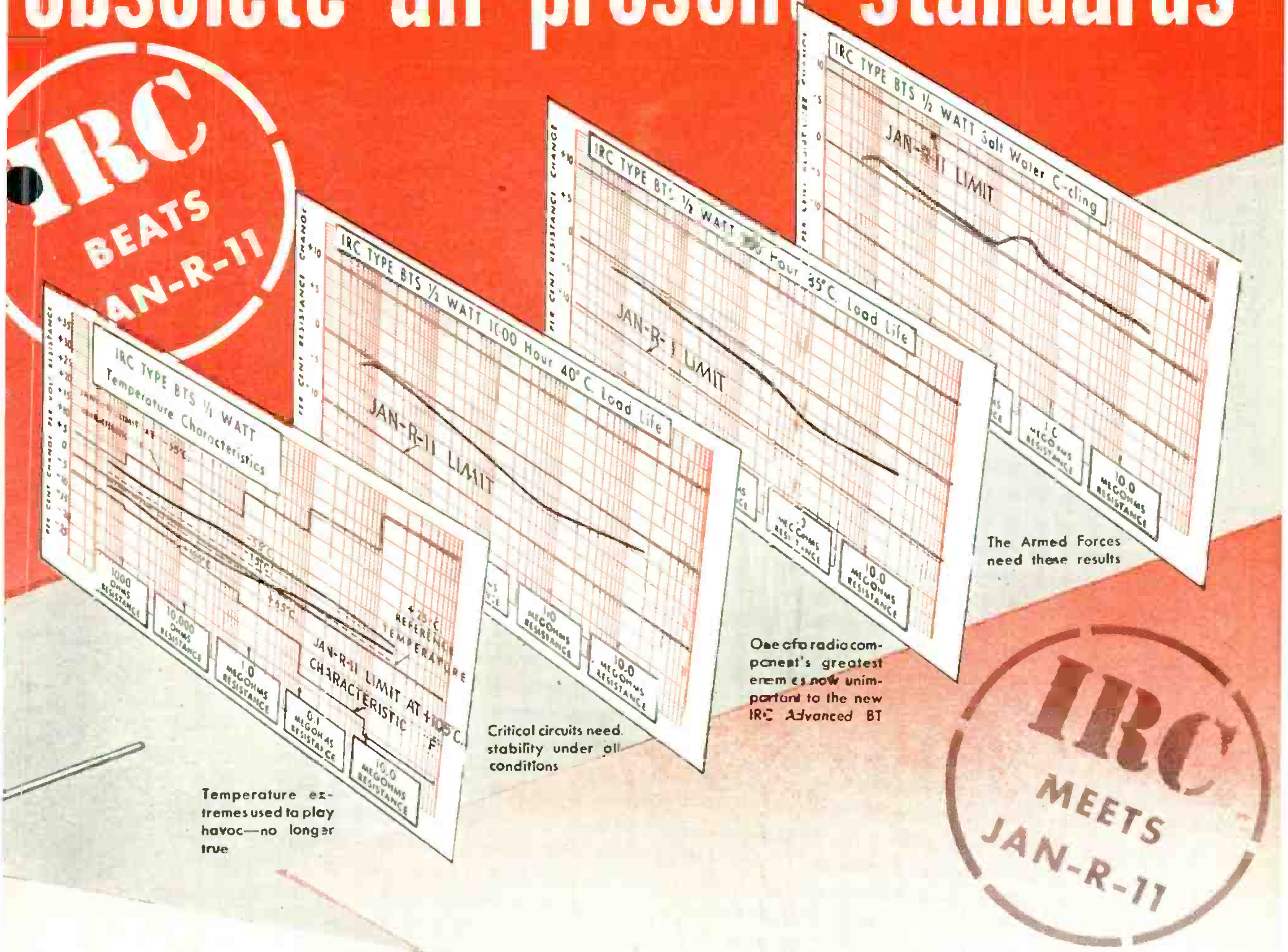
From the time a signal from a repeater station arrives at the antenna

(*Continued on page 36*)



Block diagram of the G. E. microwave relay setup.

obsolete all present standards



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The Impedance

Resistance and Reactance Measurements of Center-Fed *V*, Off-Center-Fed *V*, Fore and Aft, Vertical or Whip and Trailing Wire Antennas, Providing Series of Graphs, Can Be Used to Facilitate the Design of Transmitter Output Circuits, When Directly Measured Values Are Not Available.

by SIDNEY WALD

Aviation Equipment Engineering
Engineering Products Dept., RCA

The electrical characteristics of an antenna are determined mainly by its size, shape, and location with respect to other objects. It is difficult to calculate these characteristics; they usually are measured on each individual antenna. To minimize the problem, a series of measurements on several common types of aircraft antennas were made, and a set of graphs of antenna resistance and reactance prepared.

Five aircraft type antennas were covered: *(1)*, center-fed *V* antenna; *(2)*, off-center-fed *V* antenna; *(3)*, *fore and aft* antenna: *(4)*, vertical or *whip* antenna; and *(5)*, trailing wire antenna.

The first set of three charts, Figures 1, 2 and 3, gives the quarter-wave resonant frequency of the antenna, when the antenna type and dimensions are known. This latter information can be obtained from the antenna itself, as actually installed on the plane.

In applying the chart data, it is first necessary to find the chart for the type of antenna installed. Then on the horizontal, or *L* scale, we find the point corresponding to length of the antenna, and follow a vertical path from this point to where it intersects the slant line on the chart. If two types are on the same drawing, it is necessary to use the slant line nearest the drawing of the antenna type. From the intersection of the vertical line and the slant line, a horizontal path over to the *D* scale is followed. The number arrived at on this scale is the quarter-wave resonant frequency, or (for short) the resonant frequency.

The operating frequency is the frequency on which transmission from the equipment concerned is to take place. To make use of the remaining sets of graphs, it is necessary to divide the operating frequency by the resonant frequency.

When the operating frequency has been divided by the resonant frequency, a low number (probably between 0.1 and 2.0) will be obtained. The point corresponding to this number is found on the *F* scale of the chart of the type of antenna installed: Figures 4, 5 and 6. In use, the vertical path is followed from that point to the curve, and then the horizontal path from the curve to the *G* scale. The value of ohms at this point on the *G* scale is the *r-f* antenna resistance.

[Data on the antenna reactance plot and typical examples will be presented next month.]

Figure 1
Plot of quarter-wave resonant frequency of *V* antenna (center-fed and off-center fed).

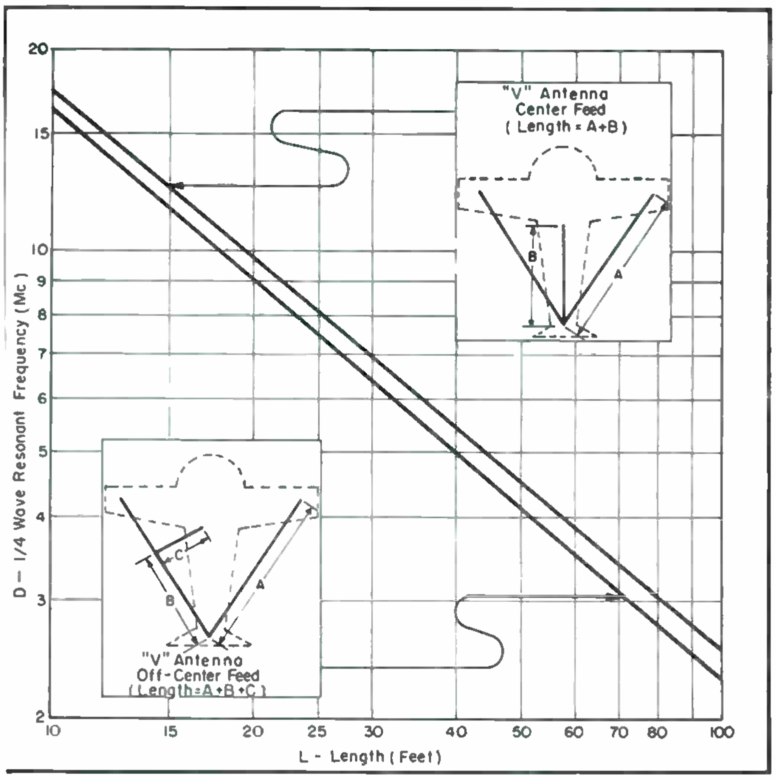
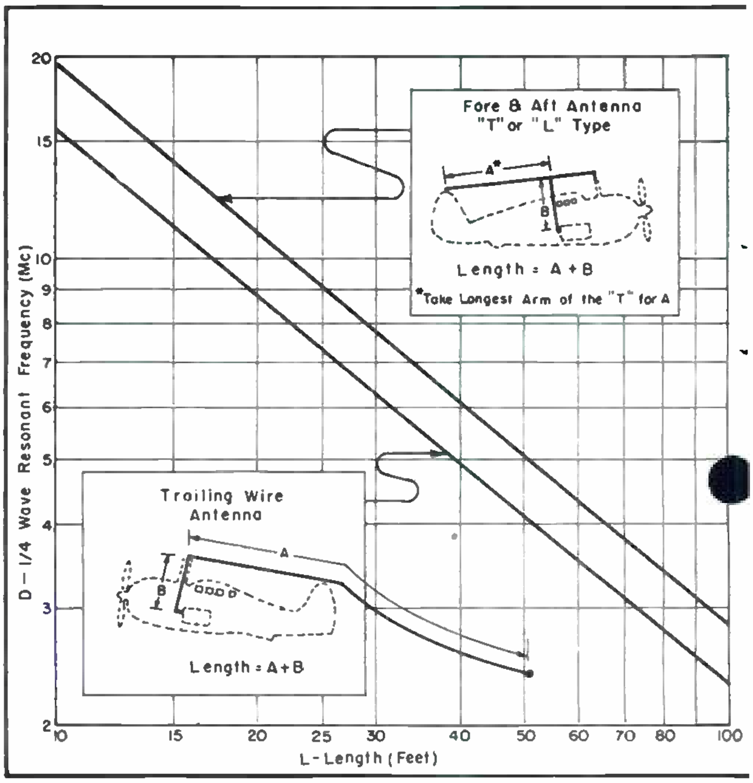


Figure 2
Plot of quarter-wave resonant frequency of trailing wire, and fore and aft antennas (*T* or *L* types).



# of Aircraft Antennas

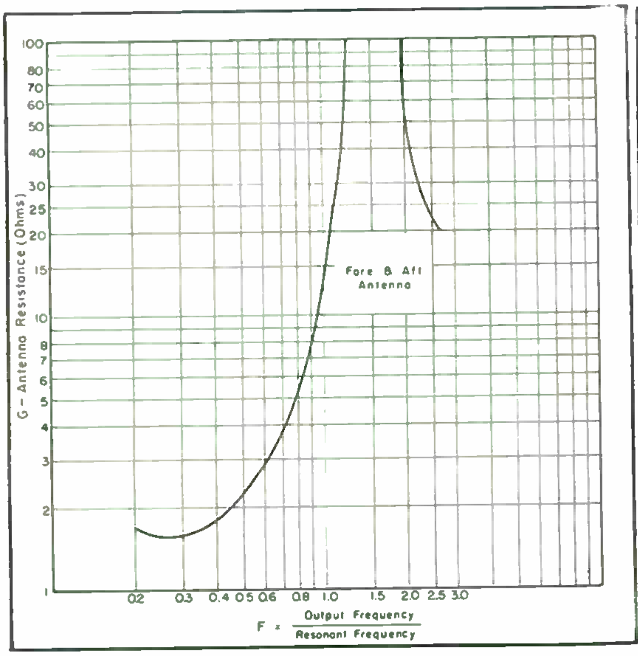


Figure 6
Another frequency ratio versus resistance plot for the fore and aft antenna.

Figure 4 (below, right)
Chart to be used for a *V* antenna when the output frequency has been divided by the resonant frequency.

Figure 5 (below)
Plot, similar to that of Figure 4, for the vertical and trailing wire antennas.

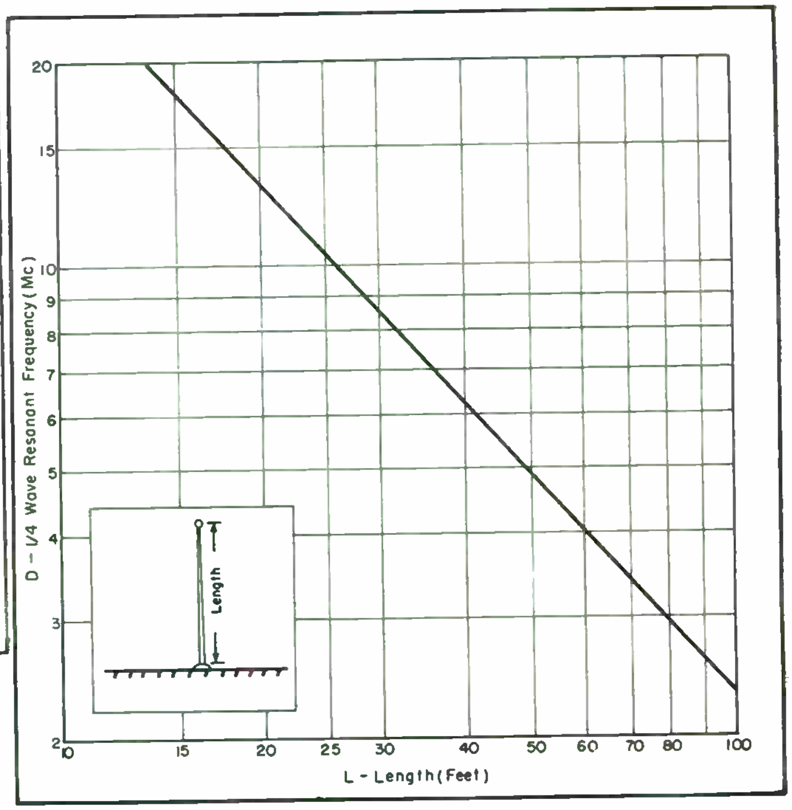
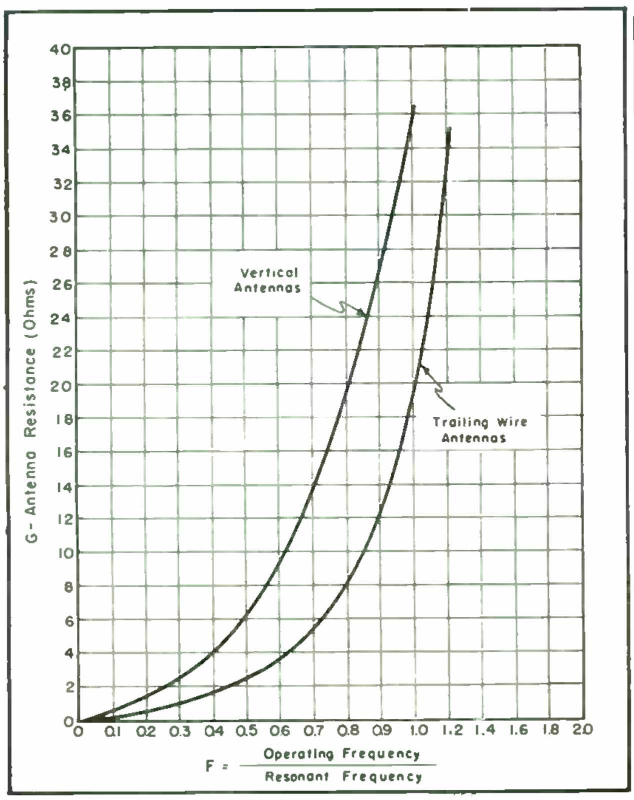
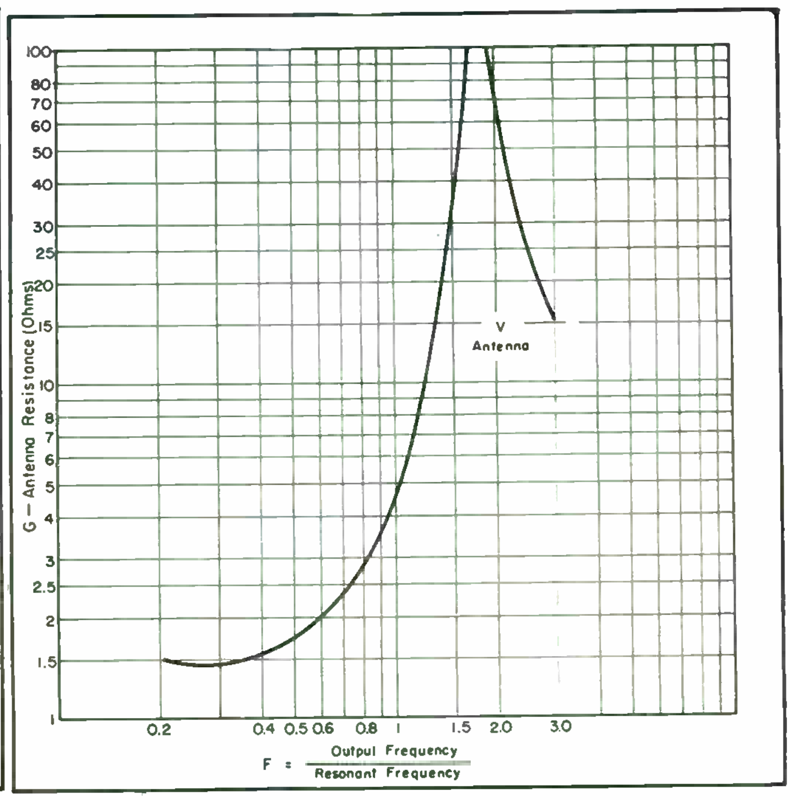


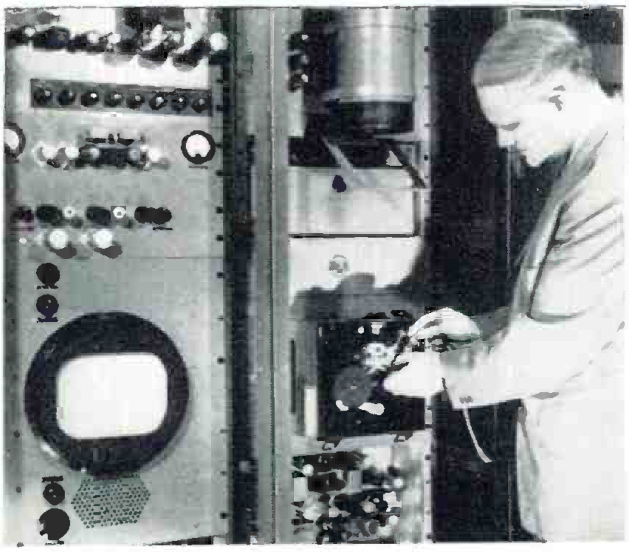
Figure 3 (above)
A quarter-wave resonant frequency plot for a vertical or whip antenna.



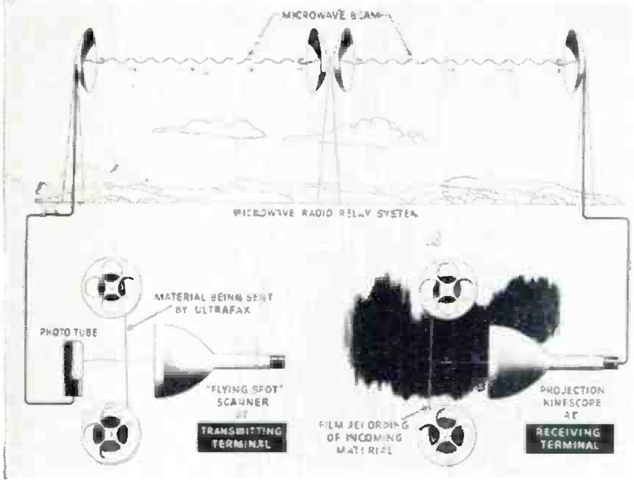


TV Developments

High-speed (*Ultrafax*) transmission via *TV* was demonstrated recently by RCA in Washington. At left, Donald S. Bond of RCA Labs. placing a strip of film containing outgoing messages in the scanning units of the newly developed system. As the film runs at constant speed through this unit, a pinpoint of light generated in *flying spot* scanner (lower left) is focused on the film and sweeps across it thousands of times a second. The resulting light impulses are converted into corresponding electrical impulses which are then transmitted.

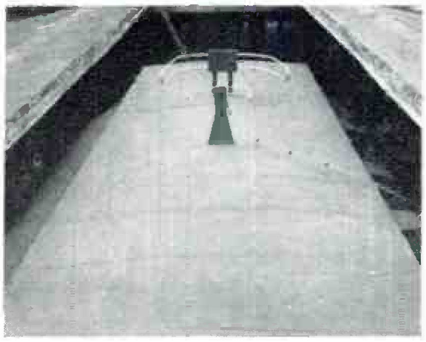


Above: Messages transmitted are reconverted to original form at receiving terminal shown above with C. J. Young of RCA Labs. adjusting the receiving camera. The messages are reproduced as TV images on a kinescope tube in the cylinder at upper right and are copied on film by the camera directly beneath the cylinder. Exposed film is then processed in 45 seconds. Below: Simplified operational schematic of Ultrafax system.



Above: Miss Frieda Hennock, FCC Commissioner at the controls of the train TV receiver, with J. H. Wallis, communications engineer for the B & O and F. R. Norton, Bendix, who played a major role in developing the set, looking on. Below: Photo of WCBS-TV image from screen of train receiver.

The Baltimore and Ohio Railroad, in cooperation with Bendix Radio, conducted an interesting experiment with a TV receiver aboard a speeding train a few weeks ago, picking up signals while en route from Washington to Jersey City. The receiver, using fast *agc* and a direct coupled video amplifier, was connected to a pair of omnidirectional antennas, shown at right.



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VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

Fall Meeting

THERE WAS quite a turnout at the annual VWOA fall meeting, which was held in the Marine Room of the Fireplace Inn in New York City on October 21.

Highlight of the evening was a talk by a veteran wireless operator, Edward Dros, who in World War 1 was a 2nd Class Radioman on the Destroyer 208, and is now Warden of Hart's Island Penitentiary and Workhouse. He told of his experiences as a key pounder, during his war days, activities in the South China Patrol and with his present ham station, W2PVR.

Among those at the meeting were VWOA secretary W. C. Simon. . . . Paul K. Trautwein, Mirror Record Corp. . . . R. H. Pheysey, United Fruit Company . . . ye prexy, W. J. McGonigle. . . . J. T. Maloney and A. F. Rehbeim of the American-Hawaiian Steamship Company. . . . V. Villandre, Radiomarine Corporation of America. . . . Sam Schneider, Oscar's Radio. . . . J. J. Michaels, RCA Communications, Inc. . . . Captain Fred Muller, U. S. Navy. . . . Lt. Comdr. R. L. Fischer, U. S. Navy . . . J. Flood, RCAC. . . . J. F. Rigby, McElroy Manufacturing Corp. . . . R. K. Davis, Tropical Radio. . . . G. N. Mathers, Tropical Radio. . . . L. C. Brown, RCAC. . . . R. J. Iversen, New York Times. . . E. N. Pickerill, RCAC. . . . Peter Podell, Podell Motor Sales Company, Inc. . . . Ben Beckerman, who listed himself as being retired. . . . C. D. Guthrie, USMC, retired. . . . H. T. Hayden, Jr., Ward Leonard Electric Co. . . . A. Barbalate, RCAC. . . . Clarence Seid, Attorney-at-Law. . . . Kenneth Richardson, Kenneth Richardson Labs. . . . Herman H. Parker, Consolidated Edison Company. . . . F. McDermott, AT&T. . . . A. C. Tamburino, New York Navy Yard. . . . George H. Clark. . . . Donald McNicol. . . . Charles Cooke. . . . Edward Ballentine. . . . F. Orth, CBS. . . . Roscoe Kent. . . . Eric L. Bisbie and Joseph L. Sarick.

Captain Fred Muller, who is on the VWOA board, disclosed at the meeting that he is now on his fourth term with the U. S. Navy and at present is on duty at the U. S. Naval Shipyard in Brooklyn. FM's career began a way back in 1908 and he says that he will probably be doing something in radio for many more years to come. . . . Ye prexy reported that he, his wife and five offspring, have left Brooklyn to take up a new residence in the Bellrose section of Queens County. At the present Mac is quite a busy man, directing the installation and repair of the new car radiotelephones for the New York Telephone Company in Brooklyn. . . . VWOA assistant secretary Henry T. Hayden, Jr., who acted as chairman of the meeting, reported that he now has an inside sales job with Ward Leonard. HTH is quite an active ham with his two-meter phone transmitter W2FO. . . . Lt. Comdr. R. L. Fischer disclosed, at the meeting, that he was ordered to active duty on April 4, 1941, and was given a coding assignment, then shipped to Washington and finally to New York. He served as assistant to the Communications Officer at 90 Church Street and was then transferred to the Commanders post, Mediterranean Forces. RL returned to these shores in the fall of '44 and was assigned to the Commandant of the Twelfth Naval District. He served one year at the Oakland base and was later transferred to the Brooklyn Navy Yard where he is now Matériel Officer in Charge of Procurement. . . . A very interesting old-timer's record was revealed by J. T. Maloney, who reported that he had a ham station in 1913 and was on the air for four years. In 1917 he joined the United Fruit Company as a commercial operator and in 1918 became a Navy operator for the Atlantic convoy. From 1919 to '24 he pounded brass for the Shipping Board vessels and from '24 to '30 he was in business for himself as a Service Man. In 1930 he joined Warner Brothers Theaters as a sound engineer and served in that capacity for two years. He then decided to return to servicing and was quite active in this type of work until '41 when he joined the

(Continued on page 35)

At the VWOA Fall Meeting in New York City (left to right): VWOA assistant secretary Henry T. Hayden, Jr.; Edward Dros, who was guest of honor; ye prexy W. J. McGonigle and VWOA secretary Wiliam C. Simon.

WBZ Center

(*Continued from page 11*)

gineer on the staff of NBC. Acoustic design incorporates polycylindrical and non-parallel surfaces. The reverberation point is calculated for approximately .75 sec. The auditorium studio, seating 160 with a clients' balcony and 16-mm projection room, is 35′ x 68′ x 18′ high. The stage dimensions are 22′ x 30′. This studio has camera outlets and lighting receptacles for future television use.

The television studio, control room, projection room and production offices are located in the southeast section of the building, and are contiguous to each other. The television studio is 45′ x 50′ x 23′ high, and is to be acoustically deadened by 2″ of rock wool bats over the four walls, and 4″ of this treatment on the ceiling. The rock wool bats are held in place by chicken wire fastened to nailor strips, except the lower 6′ along the sides which, for protective purposes, will have perforated transits. The basic lighting is to be slim line fluorescents augmented by incandescent scoops and spots mounted on a peripheral catwalk about 13′ off the floor. These lighting fixtures may also be fastened to a pipe grid which suspends from the ceiling.

The television control room is directly above the projection room and along the east wall of the TV studio.

The site of the new station is well identified from a distance by the antenna system, the height of which is 649′ above ground. A beacon lamp tops the steel pole on which is mounted a three-section super turnstile TV antenna.[4] This pole is supported by a two-section heavy-duty pylon FM antenna.[5] The total length of these radiating systems is 76′.

This combined antenna system weighs 7,442 pounds, and this weight is supported by a 573′ heavy-duty steel square section self-supporting tower.[6] The top of this tower is 29″ square and expands to 75′ on a side at the base. The 75′ square base rests on four buried concrete piers. Each pier is constructed to support a down load of 375,000 pounds.

In addition to the radiating systems, beacon and obstruction lamps, and illuminated call letters, this tower carries three r-f transmission lines:[7] 3⅛″ lines, one of which is required for FM

[4] RCA.
[5] RCA.
[6] Blaw-Knox type H-40.
[7] Andrew Corp.

and the other two for TV. These lines and tower lighting conduit are supported 18′ above the ground on an 80′ bridge which runs between the building and one tower corner base. The total length of the FM line is 697′ and each TV line is 687′ long.

Our first few months of operation have introduced no unusual technical problems indicating that the original planning was sound. There have been incorporated in this installation certain developments and techniques which have proved to be of value to other Westinghouse stations. These details will be covered in two articles in the December issue of COMMUNICATIONS by Charles Vassall, technical supervisor of WBZ, and Sidney V. Stadig, WBZ-TV technical supervisor.

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Speech Input

(Continued from page 13)

the control room. Since, however, it was to contain the jack panel and all the equipment associated with the outside lines, it could be built up in units and then placed in the bay. This was done, each jack strip being completed, the wires laced into preformed cable and the strip placed in its proper position.

Coils were mounted on panels, wired, etc., and then mounted in the rack. When completely set in place, all the connecting pairs which had been identified with numbered wraparounds were then connected to their proper terminal and terminal blocks. All of the jack connections for this bay were formerly made in the old bay *1*. Those now required were to be transferred to the new jack strip setup. The transfer was made at the terminal blocks and bid to become a slow and tedious process. Since it was essential that there be no program interruptions, it was necessary to make the transfer pair by pair, being extremely careful not to disturb a *hot* circuit. It was finally completed and with *no* program cuts. Judicious selection of pairs, some night work, a liberal use of double drops, coupled with a lot of mighty good luck, made this possible.

The old bay *1* was now ready to be cleared and converted into the new bay *2*. This was a repetition of the work done on the other bays; building the layout in units, installing them and gradually cutting them over. When completely installed, a chart of cross

(Continued on page 30)

Speech Input

(*Continued from page 29*)

connections was made up, showing all cross-connections from terminal to terminal on the same block, from block to block in the same bay, and from bay to bay. This then was made up into a preformed cable, all ends properly marked and slipped into place.

In the meantime, the second console had been received and there were several other problems to tbe solved. Installation of the second console, which meant moving the original console without disturbing its *on-the-air* operation was one of them. The matter of console output switching and monitor speaker channeling was another. Each of these was a problem in itself and will be covered fully in subsequent articles, which will appear soon in COMMUNICATIONS.

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Dual Recording

(*Continued from page 14*)

same as that of the recording filter, or should this key switch be operated to the left, the automatic recording equalizer is placed in the circuit.

The meter switch is placed in position marked right, which will place the volume level indicator across the output of the right recording amplifier to adjust the gain control for the proper audio level to supply the cutter head. A *vu* meter has an attenuator which is adjustable by means of the switch on the left side of the meter.

Operation of the selector switch directly under the meter permits the selection of the left or right recorder, or each recorder operating independently for transcribing different programs simultaneously. In the *both* position, it is possible for the two recorders to be on the same program line. By operating the left recorder gain control, it is possible to regulate the input level to both amplifiers. The volume-level indicator meter may be placed across the output of either the right or left recording amplifier, as desired, by means of a meter selector on the right side of the meter.

The monitor system is very flexible, since it may be used for monitoring or cueing. When the key switch, located in the upper right-hand corner of the control panel (center position is *off*), is operated to the left or cue position, the input of the monitor amplifier is bridged across the left or right recording channel ahead of the recording amplifier. The desired channel is selected by the operation of another key switch which is located in the upper left corner of the control panel. The placing of the monitor amplifier in this circuit position does not vary the recording level.

When the key switch is placed in the monitor position, the operation of the meter-selector switch connects the input of the monitor amplifier across the output of the left or right recording amplifier. The output is taken from a separate output source and does not affect the recording level. The high-level audio is attenuated by means of a fixed pad so that the cue and monitor audio power levels are about the same at the input of the monitor amplifier. A deemphasis filter is employed in the monitor input to level off the audio response contributed by the insertion of the orthacoustic filter in the recording channel. All low-level audio power fed to the amplifiers is isolated and run in a separate cable from that of the high-level audio circuits, thus eliminating cross talk.

Recording Equipment

The recording equipment consists of a high-fidelity recording head,[5] carriage and lead screw mechanism, turntable assembly which includes a dual motor with rim drive mechanism, turntable platter with rubber mat, microscope lamp and a suction nozzle. Suction generating and hose equipment[6] is not normally supplied, but is available as accessory equipment.

The orthacoustic recording filter[7] employed in the dual-recorder system, is designed to provide the most desirable recording characteristic as set forth by NAB standards for lateral transcriptions.

Recording Equalizer

The automatic recording equalizer was developed to compensate for the variation in reproducing levels due to changes in surface speed of the recording blank relative to the stylus. Without this compensation, the recorded and reproduced level due to speed change would be of a lower level at the higher frequencies near the center of the record, than would be experienced near the periphery of the record.

Recording Amplifier

The amplifier,[4] a high fidelity 12-watt amplifier, with 105 db gain, is

[5] RCA MI-11850-C
[6] RCA RS-1A
[7] RCA MI-4916-A

(Continued on page 32)

Dual Recording

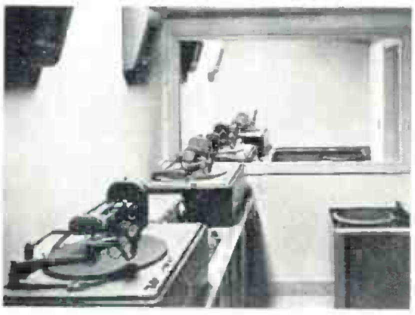
(*Continued from page* 31)

suitable for both recording and monitoring use. The unit has a plug-in type chassis using multi-conductor plugs.

Typical Station Installations

Custom-built dual recorders similar to WKJG's equipment are used by many broadcast stations, viz., KCRG (AM) and KCRK (FM) of Cedar Rapids, Iowa; KUTA, Salt Lake City, Utah; and *Radiocentro*, CMQ, Havana, Cuba.

Figure 5
Duplex dual-recording installation at CMQ, *Radiocentro*, the Radio City of Cuba.



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Tape Recording

(*Continued from page* 17)

line, when that is possible, and broadcast at any time desired with the same quality as the original program. This quality, however, will remain excellent only if the rebroadcast is made directly from the tape.

For recording studio work the tape can be used to record all cuts made in the studio for a certain purpose. Later a good cut or *take* can be selected or spliced together from five or six partly good takes without any loss of quality. After this procedure at least one set of the tape could be erased and used again.

Editing of tape is simple. The equipment needed is a pair of scissors and some *Scotch* tape. The best way to make a patch inaudible to the human ear is to cut off the ends of the tape wanted, diagonally, not vertically, and making the ends fit together. Then a piece of *Scotch* tape is placed on the reverse side of the ends of the magnetic tape to be spliced, the sides of the *Scotch* tape protruding cut off and the operation is completed.

Surface noise on tape does not ap-

The article: *Cavity Resonators As Filters at VHF*, originally scheduled for this issue, will appear in December.

pear to constitute as big a problem as on discs.

To date tape has not shown any susceptibility to climatic changes and can be stored indefinitely, recorded or blank, without any loss of quality. The loss of quality which often appears on the inside of a certain diameter of discs does not present itself with tape. Tape passes the recording head at the same speed throughout the recording and the quality remains constant. With tape, the operator is not faced with possible jumps of the pickup and consequent disc scratch. Tape can also be played a very large number of times without acquiring any noisy surfaces.

Recording is simple, too. There is no depth of groove to watch and no chip or thread comes off tape.

Drawbacks of Tape Systems

Tape as it exists today still has many drawbacks. One of the principal hurdles, the lack of standardization, will probably be overcome soon, thanks to the efforts of the NAB industry committees.[4] Another problem which, however, has not been solved completely is the duplication process. In the case of platters a *master* is recorded, processed and pressings can be obtained from this *master*. This is not the case with tape. One company[5] has, in the development stage, a machine capable of making a large number of copies.

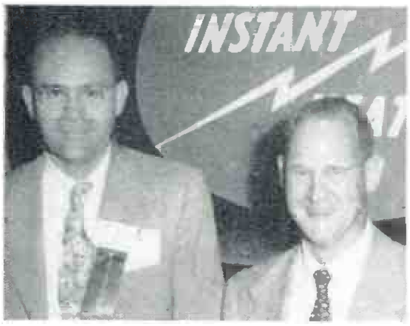
The next hurdle is the *cost* factor. We are told that 5,000′ of tape, enough to make a little more than a half-hour of recording, cost approximately $18. This compares with discs costing between $2.40 and $3.50 (for two) which, when double faced, can record up to a full hour.

A final disadvantage, which is seemingly minor but an important item to the professional, is the difficulty of spotting or locating the exact point in the recording on tape without any great loss of time. With discs it is only necessary to move the pickup from one groove to another across the record to the point desired with instant monitoring. The technician using tape is forced to stop the machine, switch to rewind, start rewinding, stop rewinding, move the tape forward again to play and check whether the wanted part has been reached. If he has gone too far, or not far enough along the tape the whole procedure will have to be repeated. Various devices, such as turn indicators, time in-

(*Continued on page 37*)

[4] Editorial, COMMUNICATIONS; September, 1948.
[5] Minnesota Mining and Manufacturing.

At The '48 IRE-WCEMA Pacific Electronic Exhibit



Left to right: John A. Kaar and C. J. Soderquist of Kaar Engineering Co.

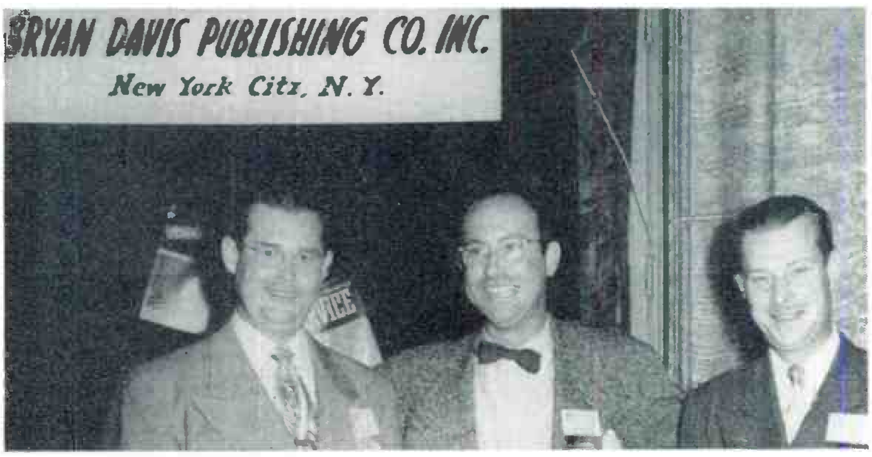
Left to right: Doc Power and Art Davis of Cinema Engineering Co.

Left to right: Noel Eldred, David Packard, and Noel Porter of Hewlett-Packard and B. S. Angwin of General Electric.

Left to right: Jack McCullough and O. H. Brown of Eitel-McCullough

James Lansing (left) and Robert Newcomb (right).

During a visit to the COMMUNICATIONS and SERVICE booth at the IRE-WCEMA show which was held in the Biltmore Hotel, Los Angeles, left to right: Norman Neely, Eddie Brand (Bryan Davis Pub. Co. Pacific Coast rep.) and Frank Kessler, associated with Neely as Pacific Coast reps.



VWOA

(Continued from page 27)

U. S. Navy and became an assistant to our own Captain Fred Muller, a post he held for three years. From '44 to '46 he was assistant to C. D. Guthrie and at present is assistant to A. E. Rehbeim, at the American-Hawaiian Steamship Co. . . . Donald McNicol told the boys that he spent his vacation months in Canada surveying the radio and electronic activities of our northern neighbors.

New VWOA Members

THREE MORE old timers have joined our ranks: Howard A. Crowe, Weldon M. Vogt and E. K. Price. . . . Crowe began keying in 1919, and worked on the S.S. Virginia, John Adams, Halway and others. . . . Vogt, now with Mackay Radio, started coding away in 1924. . . . Price, vice president at Mackay, was in radio service in 1913 with the U. S. Navy.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933, OF COMMUNICATIONS

Published monthly at New York, N. Y., for October 1, 1948.

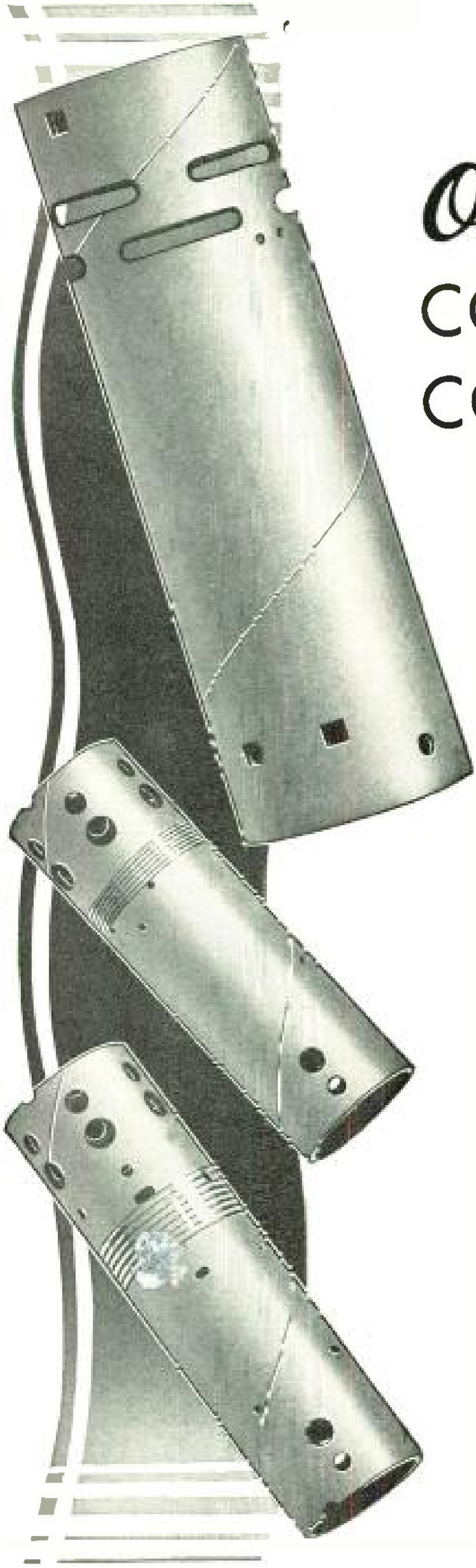
State of New York } ss:
County of New York }

Before me, a notary, in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of COMMUNICATIONS, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York 17, N. Y.; Editor, Lewis Winner, New York, N. Y.; Managing Editor, None; Business Manager, B. S. Davis, Ghent, N. Y.; 2. That the owners are: Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York 17, N. Y.; B. S. Davis, Ghent, N. Y.; J. C. Munn, Union City, Pa.; A. B. Goodenough, Port Chester, N. Y.; P. S. Weil, Great Neck, N. Y.; F. Walen, Union City, N. J.; G. Weil, Great Neck, N. Y.; L. Winner, New York, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities, are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock, and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me, this 25th day of September, 1948.

(Seal) EVELYN M. ROLLINS,
Notary Public
Commission expires March, 1949.



TV Networks

(Continued from page 19)

of a terminal station until it arrives at the television studio, we have the following sequence of events:

(1) The signals are picked up by the antenna and fed through waveguide filters.

(2) Signals then pass to balanced crystal converter.

(3) A local oscillator is set to operate in an i-f frequency of 65 mc.

(4) A preamplifier provides a 20-db gain at i-f.

(5) A main amplifier provides a further gain of 50 db at i-f.

(6) Signal then feeds through the FM receiver limiter and discriminator network.

(7) Output goes through the video amplifier and feeds into local video cables to television studios or it may be transferred to a coaxial cable network continuing on to other cities.

Chicago-Milwaukee Relay Setup

A Chicago-Milwaukee microwave relay system is being built at a cost of about $500.000 for the 80-mile distance between those two cities. It has been designed to handle television, sound programs or long distance calls.

The Chicago terminus will be in the Franklin building and will continue via relay stations located near Barrington, Illinois; Wilmot, Wisconsin and Prospect, Wisconsin, terminating in the long distance building of the Wisconsin Telephone Company in Milwaukee, Wisconsin. It will be possible to link this net with coaxial cable from Chicago to the east coast or any existing microwave relay facilities.

N. Y.-Schenectady Link

Between New York and Schenectady there is a three repeater station link[2] for rebroadcasting programs of WNBT through the Schenectady station.

Notre Dame-Chicago Relay

A 71-mile microwave link, similar to the N. Y. -Schenectady setup, is also being used to link the Notre Dame stadium in South Bend, Indiana, and station WBKB atop the Lincoln Tower in Chicago, Illinois.

In this system video is fed into the transmitter from the receiving equipment, in the case of a repeater station, or taken off a television receiver fed through a three-stage video preamplifier in the case of the New York terminus. It then goes through a modulator video amplifier comprising a 6AG7, 6L6 and 4D32 into a 6SL7 d-c insertion and a 1616 or 6L6 final

[2]G. E.

modulator to operate the repeller of a SRL7 or SRL7A reflex klystron tube. The SRL7 operates with −200 to −700 volts on the repeller, −1,000 volts on the cathode and +1,000 volts on the grid.

Philadelphia-Washington Links

Philadelphia has been linked to Washington, D. C., via a 4.5-mc Western Union microwave relay system. This system is at present laid out for a New York-Washington-Pittsburgh triangle, and is being expanded to Chicago and may become eventually nationwide. It can handle television programs in addition to teletype and telegraph channels.

Equipment

Several types of equipment have been developed for microwave application. In one system[3] the setup is complete and transportable and consists of a transmitter, parabolic antenna mounted on a rotatable unit and transmitter control unit, plus a relay receiver with a parabolic antenna. System, operating between 6,800 and 7,050 mc, was primarily designed for field pickup, but can be used in other microwave-link work.

The transmitter is rigidly attached to the back of a parabolic antenna reflector making possible a very short transmission line (waveguide) thereby minimizing all matching and loss problems between the equipment and the antenna. The oscillator is a 2K26 reflex klystron with its compartment temperature-controlled. After a warm-up period of 15 minutes, the oscillator will hold its *center* frequency within 2 mc and deliver a power output of about 100 milliwatts. This initial power is equivalent to 500 watts with a 4′ reflector or 1,150 watts with a 6′ reflector in the 7,000-mc region.

The oscillator is frequency modulated by varying the reflector voltage at video frequency. Normal deviation is approximately 8 mc with polarity such that video signals in the white direction causes an increase in transmitter frequency. A 6AG7 modulator tube receives its input voltage from one of the coaxial lines in the connecting cable. A peak-to-peak input signal of .65 volt from the transmitter control unit is sufficient for normal modulation of the transmitter. A wavemeter coupled into the waveguide provides a reference for transmitter frequency calibration. This wavemeter is made of invar to minimize temperature effects and is sealed to eliminate possible humidity effects.

The companion receiver is similarly attached to a parabolic reflector. A 2K26 reflex klystron local oscillator beats against the incoming signal in a crystal converter or first detector to produce an i-f frequency of 110 to 130 mc. Four stages of i-f amplification follows the detector. This is fed to the receiver control unit where it is amplified sufficiently to operate the limiter and discriminator circuits.

[To Be Concluded in December]

[3] RCA TTR-1A.

Tape Recording

(*Continued from page 33*)

dicators and others have been developed in an effort to overcome this handicap. These aids do help the engineer but have not completely solved the problem.

There is no doubt that the aforementioned difficulties will be overcome and extremely soon, to expand the many possibilities which tape recording appears to afford.

News Briefs

PERSONALS

Leslie J. Woods has been elected vice president of the Industrial Division of Philco Corporation.

The division handles the development and sale of Philco automobile radios to the motor car industry and also sales of aircraft radio and radar equipment to the armed forces.

Colonel George P. Dixon, vice president of I. T. & T. and chairman of I. T. & T.'s Military and Naval Committee, recently completed two weeks of active duty training with the Signal Corps.

Kenneth W. Jarvis has been named manager of the new electronics department of the Automatic Electric Co., 332 S. Michigan Ave., Chicago 4, Ill.

Jay H. Quinn has resigned as sales manager of Gray Research and Development Corp. to become director of sales and advertising, for the recently formed Fairchild Recording Equipment Corp., 30 Rockefeller Plaza, N. Y. 20, to manufacture a new professional studio quality magnetic tape recorder as well as the line of professional disc recording and sound equipment of Fairchild Camera and Instrument Corporation. **C. V. Kettering**, in charge of recording equipment sales at Fairchild heads a sales division specializing in educational and industrial applications; **Theodore Lindenberg,** the inventor of the Fairchild dynamic pickup, heads the instrument laboratory; and **Gordon Mercer,** for many years in charge of manufacturing for Recordisc Corporation, then engineer of Musicraft Records, Inc., later with the Gray company, and recently with Fairchild, is in charge of the electronic laboratory.

J. H. Quinn

William L. Everitt, head of the University of Illinois Department of Electrical Engineering since 1944, will become dean of the University's College of Engineering next September.

He will succeed Dean Melvin L. Enger, head of the College of Engineering since 1934, who is retiring Sept. 1, 1949. Dean Enger's post as director of the University's Engineering Experimental Station, also will be taken over by Dr. Everitt.

Oden F. Jester has been named General Sales Manager of the Ross Manufacturing Co., at 2241 S. Indiana Ave., Chicago, Ill.

Henry Yates Satterlee is now on the sales engineering staff of Cannon Electric.

Arthur A. Berard, executive vice president and general manager of Ward Leonard Electric Co., since 1944, has been elected president and general manager. **Dawson J. Burns,** who resigned as president is now chairman of the executive committee.

John T. Thompson has been appointed sales manger, replacement tubes, for G. E.

Formerly tube representative at the Atlanta, Ga., office, Thompson succeeds the late Russell W. Metzner, who died suddenly last July.

G. V. "Vince" Rockey died recently. He was associated with the Daven Co., the P. R. Mallory Co., and from 1932 to 1945, with the Meissner Manufacturing Co. as vice president and sales manager. Since 1945 he had been with the British Industries Corp., N. Y. C.

Donald B. Sinclair, assistant chief engineer of General Radio and **Frank D. Lewis,** G-R engineer, have been awarded Presidential Certificates of Merit.

Industry Offers..

IRC DEPOSITED CARBON RESISTORS

Deposited carbon resistors, DCF and DCH, for applications up to 1 and 2 watts, respectively, have been announced by International Resistance Co., 401 N. Broad St., Philadelphia, Pa.

Resistors are made by depositing pure crystalline carbon film on specially compounded ceramic rods. Multiple layers of insulating varnish protect each unit, and soft copper leads are securely anchored to silvered brass caps.

Resistors are designed to provide high stability and low voltage coefficient, and to assure low capacitive and inductive impedance in h-f applications. Available in 3 tolerances: 1%, 2% and 5%.

Resistance ranges are DCF, 200 ohms to 5 megohms; DCH, 500 ohms to 20 megohms.

Comprehensive data are contained in bulletin B-4.

• • •

STANCOR HIGH-FIDELITY A-F TRANSFORMERS

A series of high fidelity audio transformers, types *HF* and *WF*, has been announced by the Standard Transformer Corp., Elston, Kedzie & Addison Streets, Chicago 18, Ill.

The *HF* series, except for the HF-65 output transformer, is said to have a frequency response of ± 1 db from 20-20,000 cps; HF-65, a response of ± 1 db from 30-20,000 cps. The *WF* series, except for the WF-21, is said to have a frequency response characteristic of ± 2 db from 30-20,000 cps; WF-21 input transformer, a response of ± 2 db from 50-10,000 cps.

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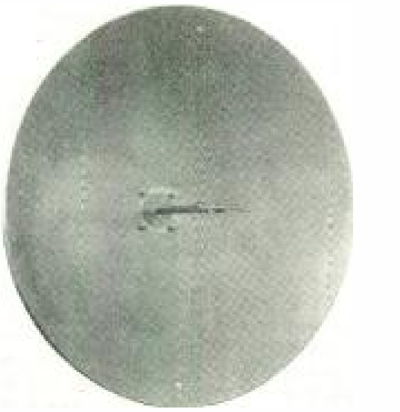
ANDREW STL PARABOLIC ANTENNAS

Parabolic antennas designed for use in the 920-960 mc FM relay band, with dish diameters of two, four or six feet, have been developed by Andrew Corp., 363 East 75th St., Chicago 19. Field gains of these models over a half wave dipole are said to be 10, 15 and 20 db, respectively.

The two-foot model mounts on a 2" support pipe. The larger models require a 4" support. All models include a mechanism for directing the beam through a 20° included angle both vertically and horizontally.

Input impedance of the antennas is a nominal 51.5 ohms and ⅞" air dielectric cable is recommended as a feed line. The maximum voltage standing wave ratio over the band is 1.4.

Bulletin 902 contains complete information.



DAZOR MICROPHONE ARMS

Flexible arms for microphones, for desk and stand application, have been announced by the Dazor Manufacturing Corp., 4481-87 Duncan Ave., St. Louis 10, Mo.

COLE DECADE RESISTANCE BOXES

Decade resistance boxes, model 1900, with ranges of 11 ohms up to 111, 110 ohms have been announced by Cole Instrument Co., 1320 So. Grand Ave., Los Angeles 15, Calif.

Resistors are said to be adjusted between their terminals to within .1% of their stated value.

Resistors are wound with low temperature co-efficient wire.

Each decade assembly is shielded from the adjacent decade assemblies by partitions cast directly into the metallic instrument case and the decades are mounted upon a metallic panel which completes the shielding.

• • •

FTR AUTO ANTENNA LEADIN

A low loss, low-capacitance auto antenna leadin has been developed by Federal Telephone and Radio Corporation, East Newark, N. J. Cable, designated K-109, employs a crimped center conductor. Capacitance of 8 mmfd per foot.

AN ENTIRELY NEW *Dependable* AUTOMATIC DEHYDRATOR

BY *Andrew*

For pressurizing coaxial systems with dry air

WRITE FOR BULLETIN 85

Now, for the first time, here is an automatic dehydrator that operates at line pressure! This means, (1) longer life, and (2) less maintenance and replacement cost than any other automatic dehydrator.

Longer life because the compressor diaphragm operates at only 1/3 the pressure used in comparable units, vastly increasing the life of this vulnerable key part.

Reduced maintenance and replacement costs because new low pressure design eliminates many components.

Operation is completely automatic. Dehydrator delivers dry air to line when pressure drops to 10 PSI and stops when pressure reaches 15 PSI. After a total of 4 hours' running time on intermittent operation, the dry air supply is turned off and reactivation begins, continuing for 2 consecutive hours. Absorbed moisture is driven off as steam. Indicators show at a glance which operation the dehydrator is currently performing.

Output is 1¼ cubic feet per minute, enough to serve 700 feet of 6⅛" line; 2500 feet of 3⅛" line; 10,000 feet of 1⅞" line or 40,000 feet of ⅞" line. Installation is simple, requiring only a few moments.

Important! Not only is this new differently designed Andrew Automatic Dehydrator completely reliable, but it is available at a surprisingly low price.

Andrew CORPORATION

363 E. 75th STREET, CHICAGO 19

Eastern Office:
421 Seventh Avenue, New York City

ANDREW

TRANSMISSION LINES FOR AM, FM, TV. DIRECTIONAL ANTENNA EQUIPMENT. ANTENNA TUNING UNITS. TOWER LIGHTING EQUIPMENT. CONSULTING ENGINEERING SERVICE.

MAIL COUPON NOW!

MAIL COUPON NOW!

ANDREW CORPORATION, 363 E. 75th St., Chicago 19

Please send me Bulletin 85 describing the new Type 1900 Andrew Automatic Dehydrator.

Name__________

Title__________

Company__________

Address__________

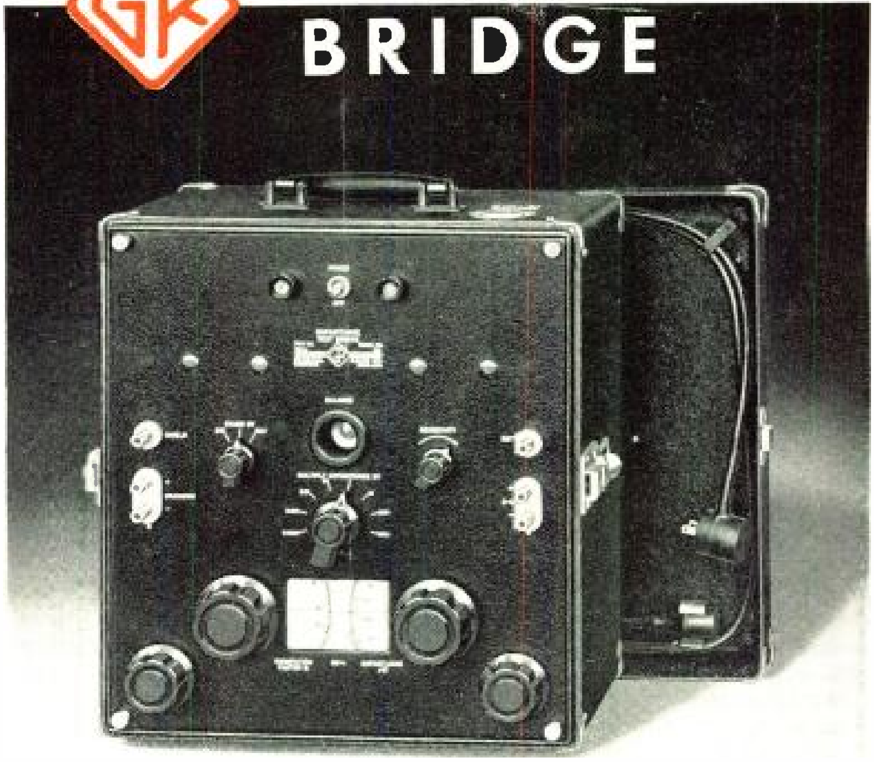
City______ Zone___ State_____ Com. 11-48

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS INDEX

NOVEMBER, 1948

NEW CAPACITANCE BRIDGE



with a range of TEN BILLION to ONE

Higher Accuracy • Greater Sensitivity • More Operating Conveniences

For Measuring Electrolytic Condensers • Testing Dissipation Factor of Transformer Bushings and Insulators • Measuring Dissipation Factor and Dielectric Constant of Solid and Liquid Dielectric Materials • General Electrical Machinery Insulation Testing • Product Control and Uniformity Production Checks on Materials Sensitive to Variable Electrical Properties

This new Type 1611-A Capacitance Test Bridge has many circuit and operating conveniences which make it highly adaptable to all sorts of capacitance and dissipation-factor measurements. Its enormous range of 1 micromicrofarad to 11,000 microfarads is achieved with the unusually good accuracy of ±(1% + 1 micromicrofarad) over the whole range. For dissipation factor measurements the range is 0 to 60% at 60 cycles, with an accuracy of ±(2% of dial reading + 0.05% dissipation factor).

The bridge detector is composed of a single stage amplifier and an electron-ray visual null indicator. The detector is designed to be very sensitive when the bridge is at or near balance, but relatively insensitive when off balance.

A new zero-compensating circuit has been developed to provide marked improvement over previous bridges of this general type when making measurements below 1000 micromicrofarads.

For measurements on electrolytic condensers, a polarizing voltage, up to 500 volts, may be applied, from a grounded power supply if desired. Terminal capacitances of the power supply do not affect the accuracy of the bridge.

The bridge and its accuracy are unaffected by temperature and humidity variations over normal room conditions (65 deg. F. and 0 to 90% RH).

The ac-voltage applied to the capacitance under test varies from approximately 125 volts at 100 micromicrofarads to less than 3 volts at 10,000 microfarads.

This bridge combines all of the principal operating features of our popular Type 740-B and Type 740-BG bridges but improves the performance of each in most of their important characteristics.

TYPE 1611-A Capacitance Test Bridge . . . $375.00

WRITE FOR COMPLETE INFORMATION

GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 — 920 S. Michigan Ave., Chicago 5 — 950 N. Highland Ave., Los Angeles 38

RCA Field-Intensity Meter Type WX-1A

50 to 220 Mc

NEW *field-intensity meter*

—for the television and FM bands

SPECIFICATIONS

Freq. Range ...... 50 to 220 Mc

Sensitivity ...... 5 microvolts to 20 microvolts/meter, depending on frequency

I-F Bandwidth .... 150 kc

FM Adjacent Channel Selectivity .... 65 to 1

FM Band Image Ratio .. 130 to 1

Power Supply ...... Built-in 6-v, voltage-regulated (a-c power supply also available)

Weight
Meter .... 43½ lbs.
Antenna (including tripod) ..... 15 lbs.

Size ..... 19"L × 14½"H × 13" D

THE WX-1A meets the strict requirements of FM and TV engineers for a field-intensity meter of laboratory accuracy covering television, FM, and AM services between 50 and 220 Mc. Its high sensitivity permits minimum readings ranging from as low as 5 microvolts per meter at 50 Mc, to 20 microvolts per meter at 200 Mc.

Completely self-contained, the WX-1A includes a very stable superheterodyne receiver. Selectivity characteristic is down 65 to 1 on adjacent FM channels. Image ratio is 130 to 1 at 100 Mc. A 2-stage audio amplifier drives a built-in loudspeaker for continuous audio monitoring of the signals being measured.

Separate output terminals provide for convenient use with the standard Easterline-Angus recorder. The built-in vibrator power supply includes its own voltage regulator. The antenna . . . furnished with each WX-1A...is adjustable for horizontal or vertical polarization.

For accurate data on the service area of any TV, FM, or AM station in the uhf—and for authoritative coverage information for FCC proof-of-performance—the WX-1A is second to none. Complete details are available from your RCA Broadcast Sales Engineer. Or from Dept. 23K, RCA Engineering Products, Camden, N. J.

The One Equipment Source for Everything in BROADCASTING—is RCA

RCA

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

In Canada: RCA VICTOR Company Limited, Montreal