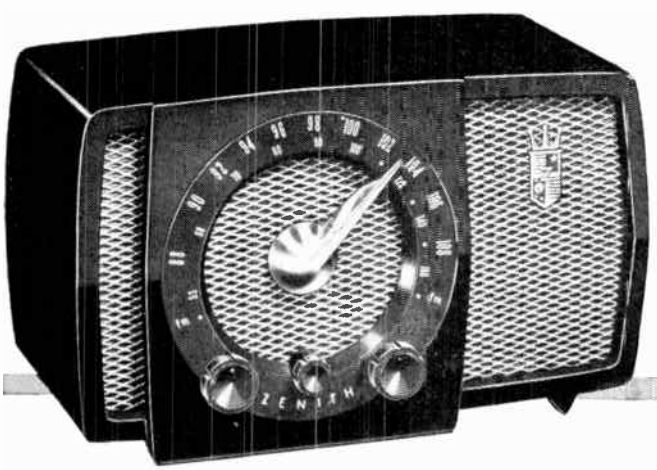
ZENITH ANNOUNCES

2 Super-Sensitive FM-AM Radios

with Performance Superiority that makes Sales!

Again Zenith lengthens its lead over the FM-AM field—with new and better versions of the Zeniths that were already the industry's two best sellers. With Zenith's unrivaled Super-Sensitive FM, they bring in a wealth of entertainment, static-free and real as only genuine FM can be. Their newly designed cabinets are the style highlights of the radio year. Of course, both have Zenith's famous Long Distance AM, big Zenith-built Alnico speakers and other Zenith advantages.



New Super-Medallion

Genuine Super-Sensitive Zenith-Armstrong FM plus Zenith Long Distance AM—automatic volume control—built-in Wavemagnet* and Light-Line Antenna—cabinet of beautiful maroon plastic with Roman Gold mesh grille and tuning indicator.

New Super-Triumph

The same Super-Sensitive FM and Long Distance AM as the Super-Medallion, plus new broad-range tone control—jewel-like on/off indicator—maroon plastic cabinet with "Flexo-Grip" carrying handle—Roman Gold embossed dial.

Zenith is No. 1 for '51!

ZENITH RADIO CORPORATION, CHICAGO 39, ILLINOIS

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"LONG DISTANCE" RADIO and TELEVISION
THE ROYALTY OF RADIO AND TELEVISION

FM-TV

Formerly, *FM* MAGAZINE, and *FM* RADIO-ELECTRONICS

VOL. 10 OCTOBER, 1950 NO. 10

CONTENTS

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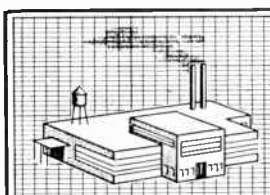


Set Production

JULY set production by RTMA members showed a radical shift in trend, as indicated by the Barometer chart below. The AM figure, after a steady rise to a 2-year high in June, dropped to the lowest point recorded since the beginning of 1947. AM home and portable models amounted to only 230,711. In addition, there were 90,255 auto sets.

TV receivers were down to 253,457, which is less than one-half the peak figure for last March.

FM sets, however, rose to a new high for the year with a total of 102,037 for the month. At the present average for 1950, this indicates that well over 1 million FM sets will be produced by the year-end. In addition, there were 45,284 TV sets with FM tuning.

July production does not reflect any appreciable effect of the military procurement program. However, we can already recognize two sharp trends. Set prices are beginning to climb and will be revised upward substantially by the year-end. Also, despite RTMA assurances to the contrary, components are in short supply to the point where set production schedules may fall below projected levels.

There's no telling now how TV will be affected, but the 7-month average so far gives a figure of 4.5 million for the year.

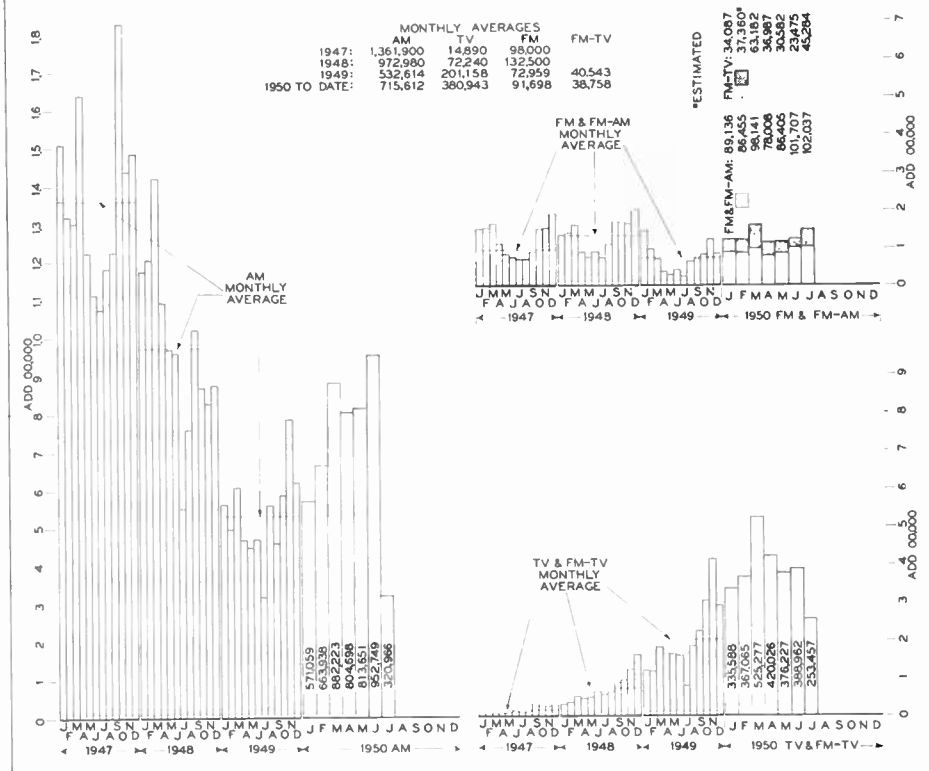
A comparison of July production with the same month of 1949 shows:

AM	320,966 sets, up	9%
TV	253,457 sets, up	219%
FM	102,037 sets, up	328%

It looks as if people are beginning to appreciate the static-free performance of FM receivers during the summer months. If that is so, the baseball broadcasts, many of which are carried only on FM, may be partly responsible for the fact that FM sales are continuing to climb at a faster rate than AM or TV.

Receiving-type tubes totalled 21,128,017, of which 14,600,533 went into new sets, 6,015,511 for replacements, 417,586 for export, and 94,387 for Government agencies.

The trend to rectangular picture tubes and larger tubes continues. In July, 47% of those sold to set manufacturers were rectangular types, and 84% were 16 ins. or larger in size, while 11% were 19 ins. or larger. Sales to manufacturers amounted to 341,940 units.



TV, FM, and AM Set Production Barometer, prepared from RTMA figures

THIS MONTH'S COVER

One thing is certain about the FAS audio system: its performance will stir up wide controversy among the experts. Whether majority opinion will be favorable or not, only time will tell. However, enthusiastic agreement is expected on one point. This system opens up a wide range of new ideas for the arrangement of speaker installations in custom radio-phonograph installations. Credit for this goes to Edmund Flewelling, whose picture appears on this month's cover.

SPOT NEWS NOTES

ITEMS AND COMMENTS, PERSONAL AND OTHERWISE, ABOUT PEOPLE AND COMPANIES CONCERNED WITH RADIO COMMUNICATIONS

TV Color at FCC Deadline:

Reaction to FCC undertaking to force immediate inclusion of bracket-standard circuits in TV sets had met with opposition ranging from passive resistance to vigorous protest. Plan has the odor of government planners' do-good ideology. Undercurrent of manufacturers' thinking: You can throw blue-books at the broadcasters, but radio research, development, and production are still run by private industry. Unless FCC backs down, it may find itself high and dry on both practical and legal difficulties, because the bracket-standards-or-else edict would force the public to spend $40 to $50 extra for receivers that would not give any improved performance, but only add degraded black-and-white reception of color programs they might not want if they were on the air, only they aren't, and there's no telling if or when they will be!

1951 NAB Conference:

Will open April 16, with engineering and management sessions to be held simultaneously. Plan will save considerable expense and time.

Height of Understatement:

Amphenol *Engineering News*, listing some of the things the public does not know, and is not being told: "That the advertisements for indoor antennas may not mean what they say."

Communication for Civil Defense:

Plans to coordinate broadcast and radio communication facilities are set forth in a 162-page book entitled United States Civil Defense. Copies can be obtained from the Government Printing Office, Washington, D. C., at 25c each. Release of this report has created a tremendous demand for our Registries of Common Carrier and Industrial, Public Safety, and Transportation Services, since these are the only complete listings of those systems.

Phonevision Tests:

Zenith has asked permission of FCC to delay start of phonevision tests until November 1, in order to obtain sufficient number of good films for the full 90-day period. Opposition by theatre operators has led to refusal by most producers to rent films for phonevision However, favorable developments have led to renewed negotiations for suitable films.

John J. Miller, Jr.:

Appointed chief engineer of television and radio research and engineering of Bendix television and broadcast receiver division at Towson, Md. He joined Bendix in 1947.

UHF Technical Session:

Kansas City section of the IRE will hold a two-day session on UHF applications and techniques at the President Hotel, Kansas City, November 3 and 4. Papers will cover transmitters, receivers, antennas, television, and test equipment. Conference chairman is J. H. Van Hern, Box 5837, Kansas City, Mo.

Management Changes:

W. D. Loughlin elected chairman of the board of Boonton Radio Corporation, with Dr. G. A. Downsbrough as president and Dr. D. M. Hill vice president in charge of research and development.

Chicago Parts Show:

The 1951 Show will be held at Hotel Stevens on May 21 to 23. During the three days, the exhibition hall and dis-

(Continued on page 8)

SPOT NEWS NOTES

(Continued from page 6)

play rooms will be open from 10:30 A. M. to 6:00 P. M.

TV Receiver Plant:

Westinghouse has purchased a 50-acre site at Metuchen, N. J., 27 miles from New York City, for the construction of a television receiver plant of 400,000 square feet. The factory is scheduled for occupancy by April 1, 1951. About 3,000 workers will be employed, of whom 60% will be women. Present receiver production at Sunbury, Pa., will be continued.

Editor's Face Was Red:

Imagine our dismay when we read on the cover of the September issue that an article on microwave facsimile was featured within! What happened was that the FCC announcement on color TV came when the September cover and all but one inside form were off the press. In order to get in that very timely report, we held up the two facsimile articles which appear in this issue! We are sorry that our front cover misled you, but we were glad that we could give you the full text of the FCC's announcement so long before it could appear in any other monthly publication.

Facilities Moved East:

Link-Vetric motorcycle communication equipment is now being manufactured in New York City. The plant at Alhambra, Calif., will be operated as a service center for the west coast area, under the direction of Johnny Rothrock.

FCC Commissioner Hennock:

Quoting from Dr. Harry Overstreet's book, The Mature Mind: "Radio has found its formula. Whereas the newspaper has found its vested interest in catastrophe, radio has found it in mediocrity."

10-Watt Educational Stations:

Will be relieved of the burden of maintaining a licensed operator at the transmitter when it is remote from the studio, under an FCC Rule proposed by the Commission. Comments on this proposal should be filed before November 13.

HF Measurements Conference:

Will be held at Washington on January 10 to 12, sponsored by IRE, AIEE, and the Bureau of Standards. Sessions will be held at the Department of the Interior auditorium, with Hotel Statler as conference headquarters. Program will include 25 outstanding papers, a spectacular demonstration, and inspection of scientific institutions. Papers will deal with

(Concluded on page 9)

Professional Directory

SPOT NEWS NOTES

(Continued from page 8)

bands from HF through EHF, and will include video measuring techniques. Chairman is Prof. Ernst Weber; chairman of the local arrangements committee, Dr. Harold Lyons; Dr. Frank Gaffney is chairman of the papers committee.

TV Network Expansion:

Added coaxial cable and radio relay facilities which went into operation on September 30 raise the total TV network mileage to 17,000 miles. Now included are Greensboro, Charlotte, Jacksonville, Atlanta, and Birmingham in the southeast; Indianapolis and Louisville in the central area; and Rock Island, Davenport, Ames, Omaha, Kansas City, Minneapolis, St. Paul in the west central area.

Stable Carbon Resistors:

Bell Laboratories has developed a technique for producing carbon film resistors of very high stability and low temperature coefficient. The element boron is added to the carbon in the pyrolytic process of depositing a film on the ceramic core. Temperature coefficients comparable with or smaller than those of wire wound units of the same resistance values have been obtained. Details of the pyrolytic process were described in *FM-TV*, February, 1949.

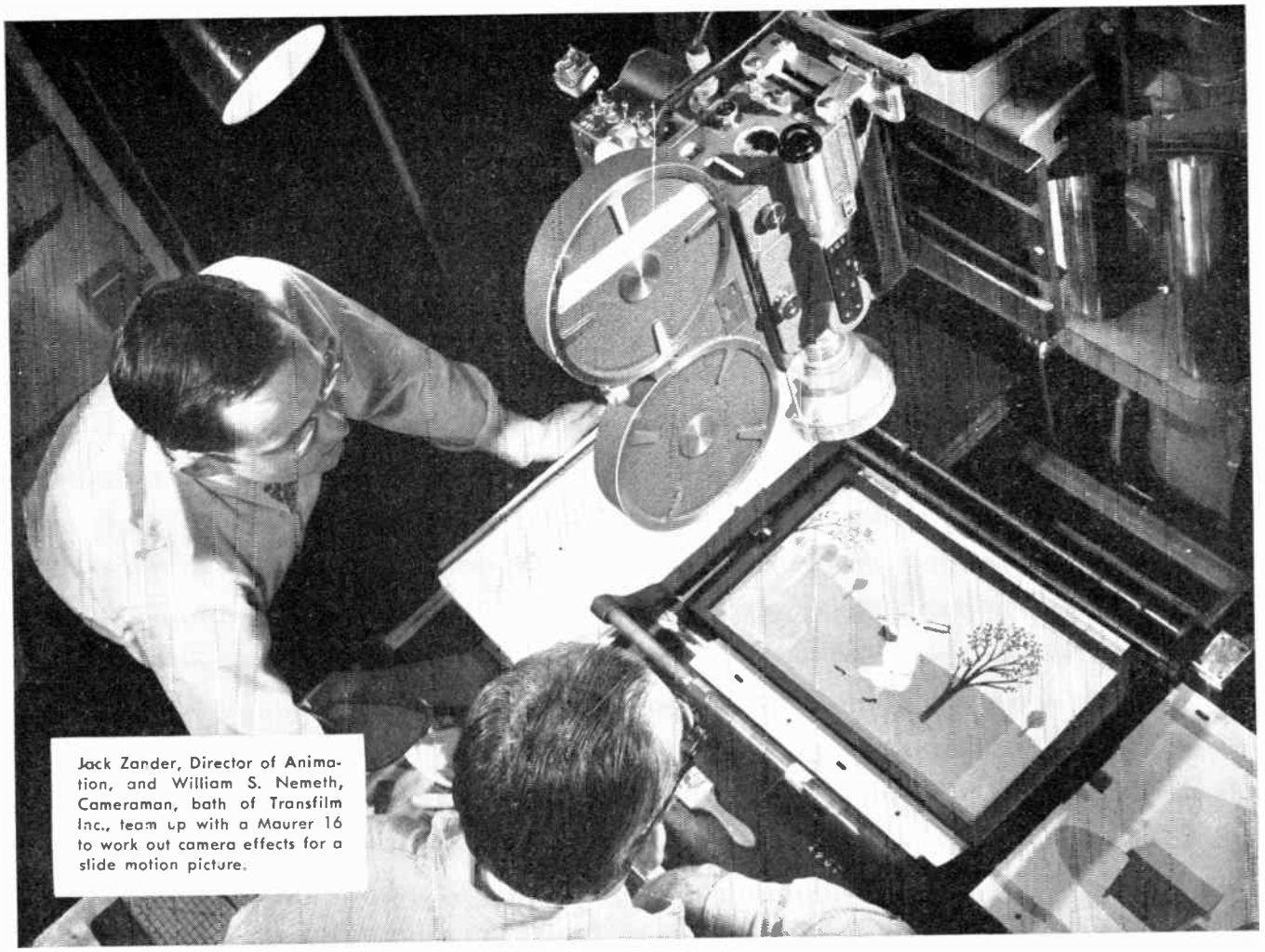
TV Equipment:

A very interesting line of TV and associated equipment is detailed in a new catalog from Polarad Electronics Corporation, 100 Metropolitan Avenue, Brooklyn 4. Units include cameras, camera chains, monitors, monoscope for receiver testing, distribution amplifier, and a radio cue system for studio use.

Comparison of TV on VHF & UHF:

Authority has been granted by the FCC for 90-day VHF-UHF tests at NBC's experimental station at Stratford, Conn. Station KC2XAK will transmit on UHF, and a temporary transmitter will be operated on channel No. 4.

Audio Equipment Directory



Jack Zander, Director of Animation, and William S. Nemeth, Cameraman, both of Transfilm Inc., team up with a Maurer 16 to work out camera effects for a slide motion picture.

Where hair-line ACCURACY counts..

At Transfilm Incorporated, where animated motion pictures and slide films are produced in volume, hair-line *accuracy* is of utmost importance. Inevitably, this leading commercial film company selected Maurer as the 16 mm. camera that best supplies this vital quality.

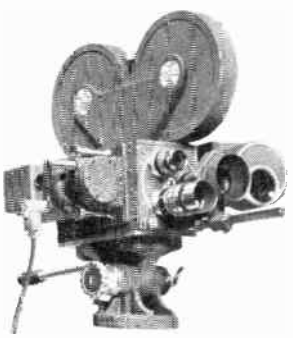
In Maurer **VERSATILITY** they found *accurate* registration of each individual frame, along with precise high-power focusing and large clear direct-through-the-lens viewing.

In Maurer **DEPENDABILITY** they found consistently *accurate* performance under all conditions, insured by years of rigorous testing by top industry technicians.

And in Maurer **EXCLUSIVE FEATURES**, such as the 235° dissolving shutter, they found fast *accurate* changes of exposure while shooting.

Because it meets so many varied needs, more and more producers like Transfilm are turning to the Maurer 16 mm. as the ideal camera for every phase of professional motion picture production.

For details on these and other *exclusive* Maurer features, write



The Maurer 16 mm., designed specifically for professional use, is equipped with precision high-power focusing and the finest view-finder made. Standard equipment includes: 235° dissolving shutter, automatic fade control, view-finder, sunshade and filter holder, one 400 foot gear-driven film magazine, a 60-cycle 115-volt synchronous motor, one 8-frame hasacrank, power cable and a lightweight carrying case.

J. A. MAURER, INC.

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CABLE ADDRESS: JAMAURER

WHAT'S NEW THIS MONTH

FCC DECISIONS NEED NOT BE TECHNICALLY RIGHT IF THEY ARE NOT LEGALLY WRONG - AD HOC GOBBLEDYGOOK - THE IMPORTANCE OF SOUND ENGINEERING

YOU may feel that the FCC hearings on television are so complicated with legal technicalities and political pressures that you might as well forget the whole affair until the Commission makes up its mind and announces its final decision.

And no wonder! FCC procedure is so complex and specialized that a lawyer, whatever his other qualifications, cannot represent a client before the Commission unless he is a member of the FCC Bar Association.

However, there is one basic aspect of the Communications Act, under which the FCC was created, that you can and should understand, because then you will see 1) why decisions involving highly technical matters are decided by the Commission's Legal Department and not by the Engineering Department, and 2) how it happens that these decisions are sometimes in conflict with facts well known to the radio industry.

This situation was explained for the first time in a simple and concise manner by Commissioner George E. Sterling in an address at the West Coast Convention of the IRE on September 15. To be sure, Commissioner Sterling's purpose was not to show why FCC decisions need not be sound or even factual from the engineering standpoint. We are sure that that was definitely not the intention, because we strongly suspect that his address was prepared in the Legal Department of the FCC. We hold that opinion because the full text is devoted to a labored justification of the involved procedure by which decisions are reached. But see what startling information comes out of Commissioner Sterling's address when it is boiled down to certain significant paragraphs. He said:

"Much as we might wish it at times, the Commission's decision is not the final word. The statute provides a specific method of appeal to the Court of Appeals for the District of Columbia. Review of the Commission's decision by that court is, however, limited to questions of law. Findings of fact by the Commission, if supported by substantial evidence, are conclusive unless clearly arbitrary or capricious."

The foregoing was taken from his introductory remarks. Now let us skip to the latter part of his address:

"While the limited appeal given to those adversely affected by our decisions is a flattering tribute to the Commission's technical experience and skill, it also imposes a higher standard of care upon us. If all fact questions could be reviewed in detail by the Court of Appeals, we might well toss off decisions with a lighthearted air, knowing that the Court was always there to hit the pitches we missed."

There, for the first time, we have an official explanation of the power of the FCC under which the Engineering Department can fabricate "substantial evidence" to support findings of facts which are not subject to appeal in any court!

In other words, as long as the FCC cannot be challenged as to questions of law, it is free to predetermine its conclusions, and then manipulate the conduct of hearings by accepting and rejecting testimony to produce the substantial evidence required, and still not cross the borderline of "clearly arbitrary or capricious" conduct.

At the same time, there is no arguing against Commissioner Sterling's statement that "If all fact questions could be reviewed in detail by the Court of Appeals, we might well toss off decisions with a lighthearted air, knowing that the Court was always there to hit the pitches we missed."

But there is nothing in the Commission's record over the last ten years to confirm the assertion that "the limited appeal given to those adversely affected by our decisions is a flattering tribute to the Commission's technical experience and skill." As we read it, it only confirms our opinion that the whole address was produced in the FCC's Legal Department. We don't believe that Commissioner Sterling could have written that, even with his tongue in his cheek!

IT isn't necessary to reach into history for an example of "substantial evidence" produced to meet the requirements of the Legal Department. Consider Volume II of the Ad Hoc Committee's data on propagation in the TV band, just released by the FCC.

The Ad Hoc Report is to be the cornerstone of VHF and UHF television allocation and is, therefore, essential to steps which must be taken to end the freeze. The success or failure of a projected multi-billion-dollar industry depends on the wisdom and foresight represented by this Report. Yet it was only endorsed without reservation by Committee Chairman Edward W. Allen, Jr. and six of the members. Seven members endorsed the Report with reservations and three declined to endorse it at all.

Raymond Wilmotte and Dr. Frank Kear stated in their reservation that "the presentation and the calculations are in our opinion so complex that too few practical engineers will be able to make correct use of the material."

Dr. Thomas J. Carroll, physicist at the Bureau of Standards, wrote: "Rarely have I had the occasion to try to study carefully such a mass of confused gobbledygook as Vol. II, purportedly relating to radio propagation."

It hasn't been mentioned publicly before, but Kenneth Norton, who was responsible for much of what Dr. Carroll called gobbledygook, based his work on certain references supplied by the Bureau of Standards. Dr. Condon, Director of the Bureau, repudiated those references in a letter to Edward Allen, Jr., dated July 19, 1950, and explained that the references used in the Ad Hoc Report are being reviewed and revised, and derive no validity from the Bureau until they have been published as public documents.

Paul deMars wrote: "In my opinion, the technical treatment of the subjects of these references is scientifically unsound, and contain assumptions of questionable validity."

How can the Federal Communications Commission accept such a document as a basis for national planning of TV frequencies when some of our leading propagation experts consider it so confusing that it will lead to "no results readily applied in practice"? Does the Commission expect to understand what the experts find confusing?

The answer is that the FCC can maintain that the Report constitutes "substantial evidence." The Report is not "clearly arbitrary or capricious."

Therefore, since it is definitely unclear and confusing, it is exactly what the Legal Department wants. If it confuses the experts, it can be interpreted to support decisions made in advance of any hearing. And that practice, we firmly believe, has been followed by the Commission on various occasions in the past.

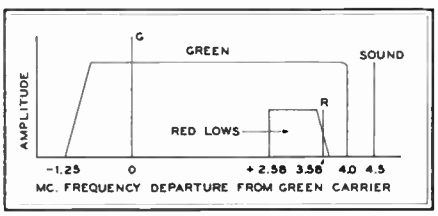
Now, preparing to allocate TV frequencies in the VHF and UHF bands, the Commission has in the Ad Hoc Report "substantial evidence" with a two-way stretch that can be adjusted to cover whatever position it chooses to take on any question of channel assignments.

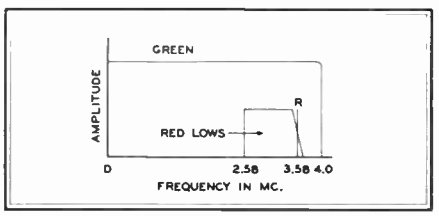
(Continued on page 37)

FREQUENCY-INTERLACE COLOR TV

REPORT ON A PROPOSED SYSTEM OF COMPATIBLE COLOR TELEVISION WHICH IS NOW UNDER DEVELOPMENT AT GENERAL ELECTRIC COMPANY—*By* R. B. DOME*

ANY system for the transmission and reception of images in natural color by television in the same frequency bandwidth as is employed in a monochrome system must in some way attempt to transmit up to three times as much information as is contained in the monochrome channel. This pre-





Figs. 1 and 2. Green and red signals as transmitted and at output of 2nd detector

mise is based upon the assumptions that at least three primary colors are employed in the color composition, and that substantially the same over-all picture definition or detail is to be portrayed at the receiver.

Since there are in effect three messages to be transmitted, some method of multiplexing must be devised if the objective is to be realized. There are in general but two means available for multiplexing, namely time-division multiplex and frequency-division multiplex. In a time-division multiplex system only one message is dealt with at any given instant. The rapidity with which messages, or colors, are switched in rotation may vary over very wide limits. The longest interval of time devoted to one color may be as long as one complete field of scanning. An intermediate interval corresponding to the length of time required to transmit one scanning line may be the next logical switching interval. Finally, a very rapid switching may be used wherein only a small portion of a line, such as a dot, forms the switching interval. Any one of these three choices may form the basis of a system of color television. Each of these systems has its own attendant problems. In general, however, it may be stated that all of these systems require a total elapsed time varying from two to three times the time required to transmit a monochrome picture of equal definition. A longer elapsed time, however, means that the flicker problem may become a serious limiting factor.

Viewed from the economic standpoint, time-division multiplex is not too attractive. The receiver must be equipped with suitable gating apparatus to switch the incoming information into the correct reproducing channels. Means must also be provided for identifying which of the three colors is being transmitted at any given instant so that at a given instant the correct color is reproduced. These two functions add to the complexity of the receiver and tend to make it less attractive as an article of merchandise because of increased price, less reliability, and greater difficulty of adjustment.

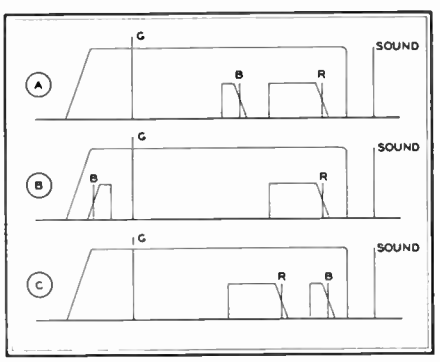


Fig. 5. Possible blue subcarrier positions

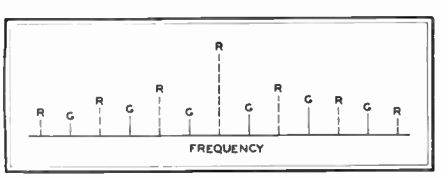
An examination of the possibilities of frequency-division multiplex therefore seems to be in order. If the bandwidth available for the television signals were arbitrarily divided into three equal segments, one for each message, or color, the rate of transmission of the entire information would have to be slowed down to one third that used in monochrome. This could be done, of course, but the flicker problem would enter and would be a serious limiting factor to commercial acceptance. A way should, therefore, be sought to transmit the three messages simultaneously in the same frequency spectrum. This method forms the basis of the system to be described, and which has been given the name "Frequency-Interlace Color Television System."

Nature of Frequency Interlace:

As the name Frequency Interlace implies, the frequencies employed by the three messages are sandwiched so as to be non-interfering. This can be done in scanned information systems such as in television because it has been found that the video frequencies associated with a television signal are bunched around harmonics of the line frequency and that a large part of the available spectrum is unused. It has been estimated that about 46% of the space between harmonics is not occupied[1].

Suppose the video frequency bandwidth available is 4 mc. Furthermore, let it be assumed that scanning frequencies compatible with monochrome television are to be used, namely, a vertical or field frequency of 60 per second, and a line rate of 15,750 per second. This results in the standard 525-line system employing two-fold interlace. Suppose that the three primary colors to be used in the system are green, red, and blue.

At the camera, the composite picture being televised is split by electro-optical means into three separate groups of signals associated with the three primary colors. Each channel may contain frequencies extending up to 4 mc. The signals associated with the color green may be regarded as the basic signals,



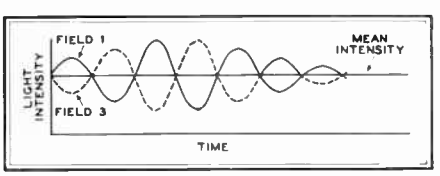


Fig. 3. Spectrum in red subcarrier vicinity. Fig. 4. Red in green signal cancels

*Electrical Consultant, Receiver Division, General Electric Company, Electronics Park, Syracuse, N. Y. In submitting this report to the FCC on July 24, G. E. vice president Dr. W. R. G. Baker said: "I recognize that it is rather late to submit for consideration a new system of color television. Unfortunately, however, research and development cannot be scheduled, otherwise we would have presented the system at the recent hearing. In any event, the frequency-interlace system of color television appears to have such outstanding potential advantages as to justify serious consideration even at such a late date."

[1] "A Theory of Scanning and Its Relation to the Characteristics of the Transmitted Signal in Telephotography and Television," Pierre Mertz and Frank Gray, *Bell System Technical Journal*, Vol. XIII, No. 3, July, 1934.

and can be used to modulate the picture carrier in the same manner as in a monochrome transmitter. Since the line frequency is 15,750 cycles, it will be found that the sideband energy is chiefly bunched at frequencies spaced from the carrier by 15,750 cycles, 31,500 cycles, 47,250 cycles, and so on out to 4 mc. It is planned to use the spaces between these harmonics to transmit the information associated with the two remaining colors.

Green and Red Interlace:

The video frequencies associated with a second color, for example red, can be utilized as modulating frequencies for a video frequency subcarrier. This subcarrier frequency is carefully selected to lie exactly midway between two harmonics of the line frequency or, in other words, at an odd multiple of half the line frequency. Half of 15,750 c.p.s. is 7,875 c.p.s., so that a frequency of 3,583,125 cycles, the 455th multiple of 7,875 cycles, may be selected. This subcarrier is modulated with video signals of the red channel, and the modulated wave is superimposed on the green channel signals. It is evident, then, that the red video signals will lie halfway between green signal line-frequency harmonics, in unused parts of the spectrum. The entire red spectrum is not used as modulating frequencies, since a number of investigators have found that acceptable color reproduction can be obtained by identifying only the lower video frequencies with their respective colors. The higher video frequencies can be transmitted either by green alone or by the mixed highs principle. Good reproduction will be obtained if red is transmitted as red out to only 1 mc. Furthermore, use can be made of vestigial side-band transmission of the red signal, so that the lower side-band is the dominant one. The spectrum of the combined green and red signals can, therefore, be as shown in Fig. 1.

This signal can be received by a conventional monochrome receiver insofar as the RF, IF, and 2nd detector are concerned. The video frequency spectrum out of the 2nd detector would then be as shown in Fig. 2.

A more detailed view of the frequency spectrum in the vicinity of the red subcarrier is shown in Fig. 3.

Visual Separation of Green & Red:

The way in which the signals associated with the two colors are interleaved is now clearly revealed. It is necessary to provide some means at the receiver for separating the signals for portrayal of the correct color on the picture tube. One way of accomplishing this would be to employ an elaborate wave filter having multiple passbands for the desired frequencies, and multiple elimination bands to exclude the undesired frequencies. Such a filter would probably be too expensive for home receivers because of the large number of sections indicated.

Fortunately a cheap natural filter is available in the form of the human eye. The satisfactory operation of the system depends to a considerable extent on the physiological phenomenon known as the persistence of vision. It will be observed that any one line of the green television picture will be modulated in intensity at the rate of the red subcarrier, but that two fields later in time, namely, in 1/30 of a second, the modulation effect will be 180° out of phase with the modulation of the first field. Thus a lighter dot on field No. 1 will appear as a darker dot on field No. 3, and vice versa, so that in the eye the mean illumination tends to average out.

This principle is illustrated in Fig. 4, in which are depicted light intensities along a single green line in field No. 1 and in field No. 3. The sine wave is the red subcarrier simultaneously present, and is shown here to be amplitude modulated by low-frequency red picture signals. If the eye were a perfect long-time integrator, the visual sensation would be given by the line marked *mean intensity* which corresponds in this case to the desired green signal. The repetition rates involved here are not fast enough to give perfect integration, but the practical result is believed to be sufficiently close to the ideal to be commercially acceptable. Moreover, the superposition of fields yields twice the number of dots per line as one field alone gives, so that a very fine dot structure results: its fineness is comparable to horizontal scanning line structure and disappears at substantially the same distance away from the picture tube that normal line structure disappears. Thus, although both the red and green signals appear on the green gun, the red is effectively filtered out by the eye and only the green remains.

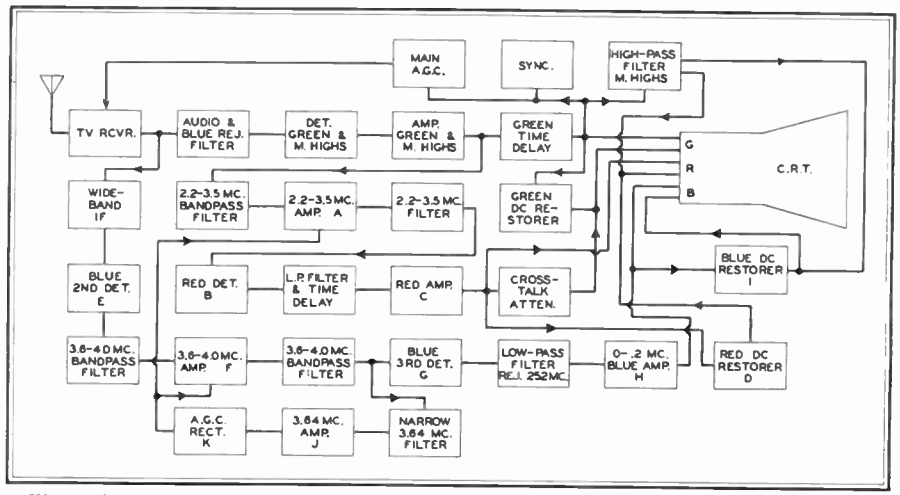


Fig. 7. Detailed diagram of a practical receiver for the frequency-interlace system

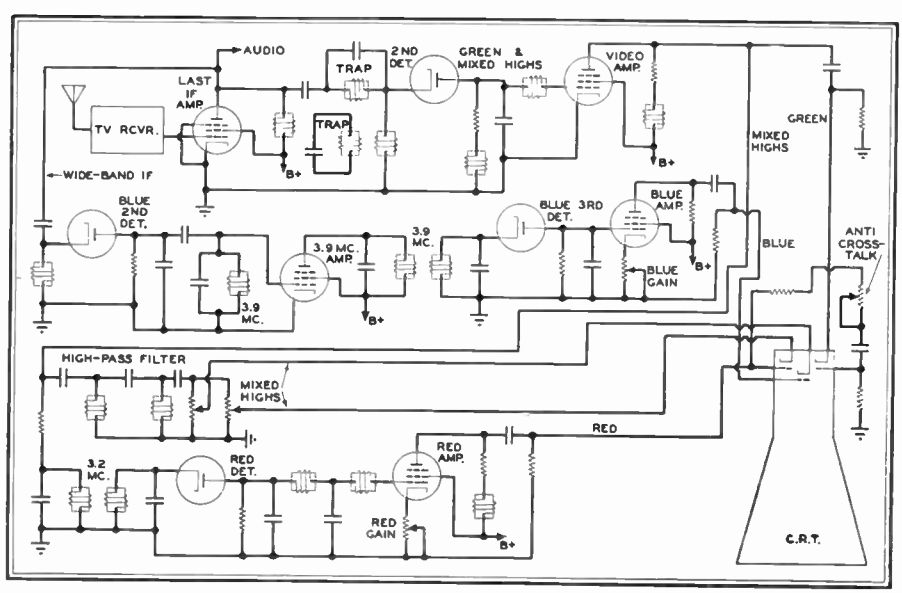


Fig. 6. Color section of simple receiver for use with frequency-interlace system

The information contained in the red camera signal above 1 mc. and up to 4 mc. can be superimposed on the green signal to yield a mixed-high signal above 1 mc.

Addition of Blue Signals:

The video frequencies associated with the third color, blue, can be transmitted as modulation on a second subcarrier. Again, as in the case of the red signals, only the lower blue frequencies need be transmitted, so that a comparatively narrow channel should suffice. A blue video band up to 2 mc. may be sufficient. Fig. 5 shows several alternative possible locations for the blue subcarrier. It is not known at this writing which one of these various methods is likely to provide the best all around performance. Consider, for example, the third alternative in which the red subcarrier is shown moved down to about 3.2 mc., or to 3.189375 mc., the 405th multiple of 7,875 cycles, while the blue carrier may be located just under 4 mc., at 3.898125 mc., the 495th multiple of 7,875 cycles. (The 3.189375-mc. signal can be derived from the 3.898125-mc. signal by dividing the latter by 11 and then multiplying the quotient by 9.)

Again, as was the case with red and green, the blue signal appearing on the green gun is effectively filtered out by the eye, as are the green signals appearing on the red and blue guns. The blue and red signals, since they do not overlap in frequency, do not exhibit this effect.

High-Frequency Video Components:

As stated before, the high video frequencies can be represented by the green channel alone. In order to avoid a greenish tinge to high frequencies, the green highs can be taken off the green video channel by the shunt connection of a suitable high-pass filter and added to the blue and red guns (as well as direct connection to the green gun) of the reproducing means to produce black-and-white fine detail. Alternatively, blue and red highs can be added to the green channel at the transmitter and taken off from the green video channel in the receiver to feed the blue and red guns as well as the green gun. The cutoff frequency of the high-pass filter would be selected at approximately the cutoff frequency of the red channel low-pass filter or, in the example given, at about 1 mc.

Simplified Receiver:

A schematic of the color section of a simple receiver for the reception of television transmission such as is shown in Fig. 5c appears in Fig. 6. The IF is kept wide-band at the plate of the last IF amplifier purposely, so that the blue channel will not be adversely attenuated before it is detected in the blue 2nd detector. Following this detector is an amplifier and tuned circuits centered around the blue subcarrier to remove effects of the sound carrier and the red subcarrier. The blue 3rd detector yields the blue low-frequency video signals which are amplified and fed to the blue gun grid.

Appropriate sound traps and, if desired, blue subcarrier traps, are employed before the green and mixed-highs 2nd detector. The output of this detector is amplified and fed to the green gun. Two shunt circuits leading from the plate of the green channel amplifier feed respectively the red detector through a 3.2 mc. bandpass circuit and the mixed-high filter for addition of mixed highs into the red and blue guns. The 3.2 mc. filter feeds a red signal detector, and the output of the detector feeds a red amplifier connected to the red gun.

The receiver as shown here employs 6 sets of tube elements over and above those a receiver would employ if designed to receive black-and-white pictures. By using available combination types of tubes, the actual number of envelopes may be as low as three. The polarity of the detectors can be reversed from those shown to produce the right phase of light intensity, i.e., a positive picture. Alternatively, the picture tube gun connections can be reversed to achieve the same result.

A mathematical analysis of the action of the green 2nd detector shows that some of the red low video-frequency modulation will appear as low frequency in the detector output because the system is single sideband. The presence of this low frequency spurious signal in the green channel may cause an undesirable cross-talk effect, making itself evident in a change in hue but not in geometrical design. This color shift cross-talk effect can be reduced to a small amount if desired by feeding some low-frequency red signals into the green gun in phase reversal to the cross-talk.

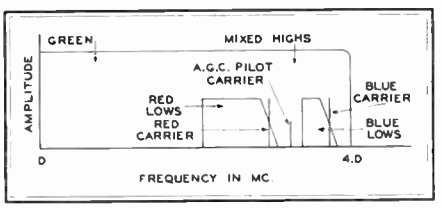


Fig. 9. Adder output frequency spectrum

Tube Requirements:

A block diagram of the color portion of a receiver incorporating some added features is shown in Fig. 7.

This receiver employs the following tube functions above what are required for a black-and-white television receiver:

A: 2.2-3.4 mc. red IF amplifier
B: red diode detector
C: 0-1 mc. red video amplifier
D: red restorer diode
E: blue 2nd detector diode
F: 3.6-4.0 mc. blue IF amplifier
G: blue 3rd detector diode
H: 0-.2 mc. blue video amplifier
I: blue restorer diode
J: 3.64 mc. AGC carrier amplifier
K: AGC rectifier diode

These 11 tube functions can, of course, be obtained by employing fewer than 11 separate tubes when use is made of double-purpose types. The following combinations are suggested:

A and B — 6SF7 tube
F and G — 6SF7 tube
D and I — 6AL5 tube
J and K — 6SF7 tube
C and H — 6SN7GT tube
E — ½6AL5 tube

The Transmitter:

The transmitter for the frequency-interlace color system would be a standard transmitter with some modifications. A block diagram is shown in Fig. 8.

(Continued on page 39)

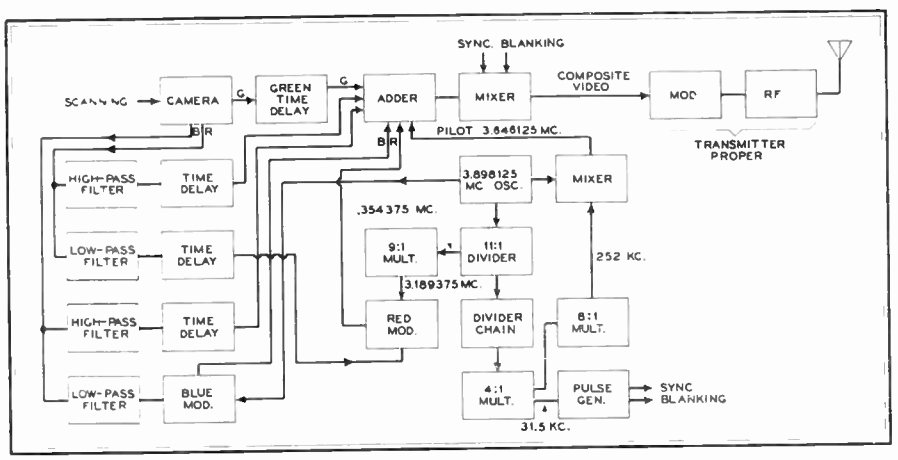


Fig. 8. Critical circuits and expensive components are located at FI transmitter

COLOR TV AS THE FCC SEES IT

CHAIRMAN WAYNE COY EXPLAINS THE COMMISSION'S THINKING WHICH LED TO ADOPTION OF THE COLOR TELEVISION REPORT RELEASED ON SEPTEMBER 1

Right or wrong, it looks as if the Commission will have to adopt the incompatible CBS color television standards or explain its way out of coming to no final decision at this time. Certainly the proposal that the manufacturers agree by September 29 to the adoption of bracket standards has met with no encouragement from individual companies or from the RTMA.

Up to the 29th, at this time of writing, no industry plan of opposition strategy has been revealed, but it looks as if the manufacturers will have no part in sharing responsibility for the adoption of the CBS system. Thus the FCC may be confronted with a very awkward situation.

Meanwhile, the Commission is apparently undertaking not only to explain its position to the radio engineers and, through them, to the public, but to gain support for immediate adoption of CBS standards in case that should be their final decision.

This was indicated by Chairman Wayne Coy's address before the National Electronics Conference at Chicago. Space does not permit publication of his complete text, but his most significant statements and conclusions are presented here:

I am aware of the fact that there are those in the industry who sincerely feel that color is a "phoney" issue. Let me assure you that, in the judgment of the Commission, there is nothing "phoney" about the issue. Congress, through the Communications Act, commanded the Commission to "generally encourage the larger and more effective use of radio in the public interest." Certainly, the Commission has encouraged such a development for the past several years. Having reached the point in the development of a television service where the UHF band of frequencies was needed to provide a basis for a nation-wide competitive service, we were at a crossroads with respect to the past encouragement given to the development of color television. We could provide for color along with black-and-white in the VHF and UHF, or we could provide for black-and-white service only in both bands. We were aware, and I am sure that you are aware, that the latter course might foreclose the opportunity for the development of color television in the foreseeable future.

Action is Necessary Now:

Therefore, it seemed quite clear to us that the groundwork should be laid now for the joint use of both bands—VHF and UHF—for both black-and-white and color. . . If we did not now lay the groundwork for such joint use, it is obvious that when the Commission did get around to adopting a color system, we might not be able to choose the best possible color system, but would as a practical measure have to consider only such systems as might be compatible with black-and-white television.

Why CBS System Was Chosen:

Now for the report itself. There were three color systems proposed to the Commission: one by Color Television, Inc., one by Radio Corporation of America and the third by Columbia Broadcasting System. The first two systems are compatible systems, that is, present receivers without making any changes could receive a black-and-white picture from color transmission of such systems. The CBS system is not compatible. Some changes must be made in existing receivers in order to enable them to receive a black-and-white picture from CBS color broadcasts.

The Commission carefully analyzed the voluminous record of the hearing. We had to weigh testimony covering almost 10,000 pages of transcript and evidence that was submitted in 265 exhibits. We made detailed and specific findings concerning all three systems — findings approved by all seven members of the Commission. The care with which this work was done can best be indicated by the fact that while, as was to be expected, the particular result we reached was disappointing to some of the parties, there has been no intimation by anyone that the Commission's findings are not supported by the evidence in the record.

The Commission unanimously found that the CTI and RCA color systems were not suitable for adoption. . .

In the first place, the Commission found that the quality of the color picture produced by the two systems was not at all satisfactory. In the case of the CTI system there is a serious line crawl or jitter, and in the case of the RCA system there is a prominent dot structure and a marked loss of contrast.

Moreover, the colors are not true in either system. This is particularly true of flesh tones. . . Since the purpose of the hearing was to pick a *color* television system, it is obvious that no serious consideration could be given to a system that failed to produce true colors.

In the second place, the equipment required for the CTI or RCA system appears too complex for normal use. . . The Commission believes that any television structure must be so constructed that color television is available to all, and not merely the rich. The Commission knows that color television receivers will cost more than present monochrome receivers, but we expect the price levels to follow the pattern of the present receivers. . .

The Commission, of course, recognizes that both the CTI and RCA systems were comparatively new systems and that the equipment that was demonstrated was not commercial-type equipment. However, an analysis of the two systems showed to the Commission's satisfaction that the defects were fundamental. The equipment is complex because, by the nature of the systems, registration and color controls are extremely critical. CTI and RCA thus did not meet the tests of simplicity and economy. . .

For these reasons you can see that there was just no basis upon which the Commission could approve either the CTI or RCA system.

The CBS system did not labor under these handicaps. The quality of the color picture was of a high order . . . Broadcasts were made from studios and from outdoors. In all instances color rendition was of a high quality. The equipment utilized was easy to operate. . .

Limitations of CBS System:

The CBS system does have fewer lines per picture than the present system. However, the addition of color to the picture more than outweighs the reduction in lines so far as apparent definition is concerned. You only have to look at a scene in color and compare the same scene in black-and-white to be convinced that the addition of color increases several-fold the amount of information that can be transmitted by a picture.

True, a monochrome picture from color transmissions under CBS standards is not of the same good quality as monochrome pictures from transmissions under present television standards. But neither

(Continued on page 45)

*From an address by FCC Chairman Wayne Coy at the National Electronics Conference, Edgewater Beach Hotel, Chicago, September 25, 1950.

THE increasing complexity of allocations problems which confront operators of and applicants for radio communication facilities is requiring more and more study on the part of engineers and consultants in this field. This situation, and the pressure being brought to bear by those who need new or added frequency assignments have created a serious question of engineering policy in connection with testimony presented to the Commission.

When a lawyer undertakes to defend a client, it is presumed that the court and the opposing counsel are equally informed as to questions of law.

However, when engineering counsel testifies before the FCC, the Commissioners must weigh testimony on technical matters of which they may have only limited knowledge.

This creates a delicate question of ethics on the part of the engineer who undertakes to advise the Commission concerning engineering matters, on behalf of a client whose interest will be vitally affected by the final decision of the FCC.

Economics Vs. Engineering:

The position of the Commission in such instances was discussed at length by Commissioner Robert F. Jones in the 80-page Annex to his dissenting opinion to the recent Color Television Report. His comments are so directly applicable to situations which arise at hearings on communication matters that they deserve serious study by communication engineers and consultants.

Citing chapter and verse, Commissioner Jones showed why he, for one, has been obliged to take a dim view of the extent to which the Commission can rely on the advice of engineers engaged by partisan interests.

His conclusion on this point: "The 1949-50 hearing makes crystal clear that the industry's engineers were unsound analysts. . . . Their engineering testimony in 1946-47 is rendered so completely worthless by the 1949-50 record that the kindest thing that can be said in explanation is that their economic interest blinded their engineering judgment. In view of the position taken in both hearings by witnesses . . . there is grave doubt that any can be relied upon to predict the potential performance of any system whose adoption might prejudice their economic interests."

Service to the Radio Profession:

Regardless of the soundness or unsoundness of his substantive conclusions, Jones had certainly done the radio engineering profession a genuine service in the forceful expression of his views. For the subject is a tremendously important one. As the majority of the Commission expressly stated:

"The Commission is aware that of necessity it must rely to a great extent upon industry experts for data and expert opinion in arriving at decisions in the field of standards; our own facilities are too limited to gather much of the data."

Since the FCC, in the nature of things, must rely on the engineering experts of industry, the burden is upon these engineers to lean over backwards in arriving at their engineering judgments in those areas affecting their employer interests. Commissioner Jones' remarkable research job in bringing to light the inconsistent and shifting representations by industry engineers in the course of FCC hearings should serve as a guide to professional ethics in the future.

The majority of the Commission indicated they shared Jones' views to some degree at least when they rejected the majority of the expert testimony:

"The responsibility for decision is that of the Commission, and we cannot feel bound to accept recommendations and expert opinions when we find from a study of the record that the record supports different conclusions. Moreover, the testimony of many of the parties was not based on field testing conducted by them or upon an analysis of field testing made by others but were simply recommendations and expert opinions of a general nature. In weighing these recommendations and expert opinions we cannot overlook the fact that many of these same parties offered recommendations and expert opinions of the same kind as the basis of their advocacy in the 1946-1947 hearing of . . . a system which never survived field testing."

Effect on Communications:

The communication services are suffering today from a lack of frequencies primarily because the Commission in another proceeding — the general allocation proceeding of 1944 and 1945 — relied on the industry engineers' advice that the TV channels not assigned for use in a particular area could be used for mobile radio purposes. The inadequate exclusive assignments made to the mobile services were to be compensated for by sharing rights in the 6-mc. TV channels. It soon appeared, however, that the advice was a matter of opinion unsupported by tests or measurements.

Hardly had the allocations been finalized when this sharing plan was demonstrated to be impracticable, regardless of distance separation. This error resulted in the subsequent deletion of TV Channel No. 1 and its assignment to the mobile radio services. This could hardly compensate, however, for the lost rights of shared use in the 6-mc. TV channels. The band from 72 to 76 mc. was likewise reassigned and limited to fixed-circuit use only, to prevent mobile interference to the adjacent TV channels 4 and 5. Other restrictions were placed on the use of the band even for fixed-circuit purposes, as a result of which vast silences reign in that valuable area today.

If no other concrete results flow to the communication services from the Annex to the Color Television Report, certainly Commissioner Jones has added to the list of required reading for those who would take the Radio Engineers' Hippocratic Oath, at the same time demonstrating that his critical positions are formulated not only with courage but painstaking documentation as well.

Public Safety Amendments:

Proposed amendments to Public Safety Radio Rules were made finally effective as of October 2. Form of final Rules followed proposals outlined in *FM-TV* for June, with two exceptions:

1. Mobile station identification requirements were further relaxed. In cases where a licensee has several base stations and a group of separately licensed mobile units transmitting on the same frequency as the base stations, the mobile units need not identify themselves. Under proposed Rule, all separately licensed mobile units would have been required to identify themselves under all circumstances.

2. The point-to-point frequency for police use in Alaska was changed from 7805 kc. as proposed to 7480 kc.

(Concluded on page 45)

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How the U. S. Weather Bureau Uses
FAX & TELEMETERING

HOW FM EXPEDITES WEATHER DATA DISTRIBUTION

— *By* C. A. KETTERING AND G. F. MONTGOMERY*

WEATHER information is like news: it becomes valueless soon after it is issued. It must be gathered and distributed by the fastest means available. With improvements in telemetering and facsimile techniques, weather information pickup and distribution has been expedited greatly. In order to permit utilization of these techniques by the U. S. Weather Bureau, the National Bureau of Standards developed a country-wide VHF radio system which was completed in 1948. This paper describes the Weather Bureau's application of the new system to the transmission of weather maps by facsimile and the telemetering of weather data from remote points.

The radio system operates in the 160 mc. band, employing narrow-band, crystal-controlled FM transmitters with frequency multiplication of 36. The final amplifier and frequency-multiplier stages use type 2E30 vacuum tubes, with power output of approximately 5 watts. For use in locations where propagation conditions are difficult, or where receiving sites are especially noisy, a transmitter was developed using a 4-65A tetrode power amplifier, with an output of approximately 45 watts.

Receivers are of the double-superheterodyne type, crystal-controlled, with both audio output and carrier-operated relays for controlling external equipment.

The antennas used at both transmitting and receiving sites are five-element parasitic arrays, consisting of dipole, reflector, and three directors, fed with RG-8/U coaxial cable. Operation of the radio equipment has been reliable, requiring only routine maintenance.

Facsimile Transmission:

The system has been used to transmit weather maps and other graphic material from the forecasting center in downtown Chicago to the receiving terminals at the Chicago Municipal Airport since November, 1948. The Weather Bureau Airport Station and the Flight Advisory Weather Service now receive maps and charts more quickly and at lower cost than when messenger service or the simultaneous preparation of charts at the receiving terminals was required.

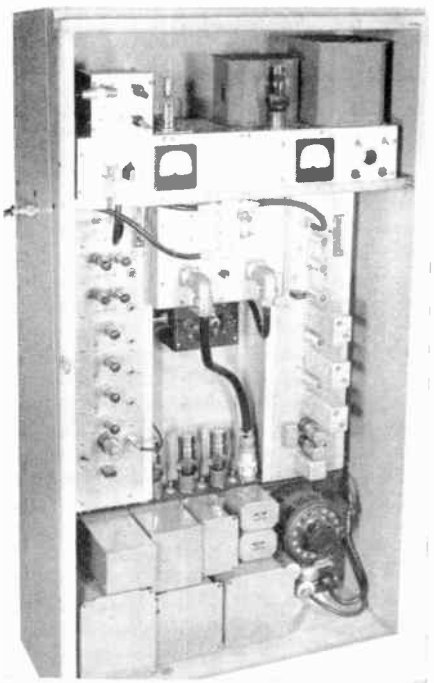

Fig. 2. Automatic telemetering equipment

Facsimile requirements include reliability and simplicity of operation, maximum practical speed and copy size, adequate detail, and unattended operation of the receiving equipment, with starting, stopping, and phasing operations being remotely controlled by the transmitter. These have been met satisfactorily by the facsimile equipment designed by Hogan Laboratories, Inc.[1], and shown in Fig. 1.

This is a view of the transmitting installation at the forecasting center. The transmitter is at the left. Two facsimile scanners and a monitor recorder are on the table at the right.

A scanning rate of 56.2 square ins. per minute provides a considerable increase in transmitting speed over systems previously used, without imposing undue frequency-bandwidth or mechanical problems. By employing vestigial side-band transmission, bandwidth requirements are limited to an acceptance flat within 1 db between 7 and 15 kc.

The maximum usable copy size is 8.2 by 11.5 inches. This size is adequate for all but the largest maps, for which two scanners are used. The larger maps are cut into quarters. Two scanners are loaded with the map quarters, and the paired quarters are transmitted sequen-

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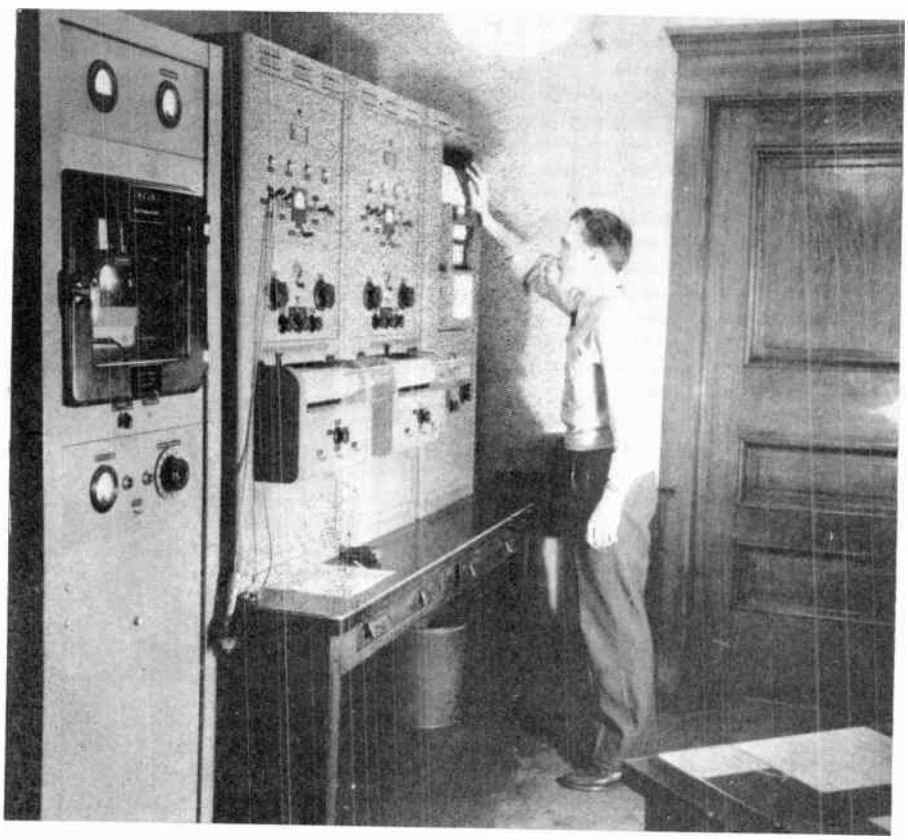


Fig. 1. Facsimile transmitting equipment at weather forecasting center in Chicago

* Respectively of the Instrument Division, U. S. Weather Bureau, Washington, D. C., and the Central Radio Propagation Laboratory, National Bureau of Standards, Washington 25, D. C.

[1] See "High-Speed FM Facsimile," by John V. L. Hogan and Carl V. Olson, *FM-TV*, this issue.

HIGH-SPEED FM FACSIMILE

MODERN FACSIMILE EQUIPMENT OPERATED AT THE CHICAGO WEATHER BUREAU HAS PROVED FAST AND DEPENDABLE—*By* JOHN V. L. HOGAN* AND CARL V. OLSON*

OUTSTANDING advances have been made in facsimile during recent years. Transmitting speed and flexibility of modern equipment have been increased markedly over that of installations used during World War II.

In November, 1948, equipment was installed for transmission of weather maps and other graphic material between the

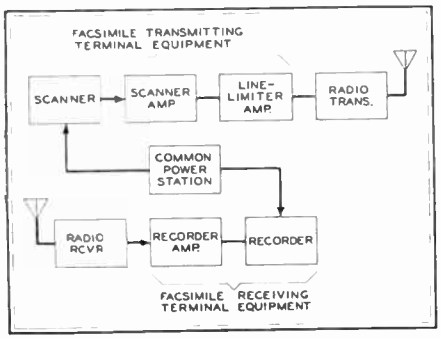


Fig. 1. Main units in facsimile system

U. S. Weather Bureau[1] forecasting center in downtown Chicago and the Chicago Municipal Airport. It has been in operation continuously since then. This paper describes the facsimile terminal equipment, designed and supplied by Hogan Laboratories, Inc.

General System Operation:

The entire system, with emphasis on the facsimile units, is shown in simplified form in Fig. 1. Video from a scanner unit amplitude-modulates a 13-kc. subcarrier in the scanner amplifier. This is converted to vestigial-sideband AM in the line-limiter amplifier and applied to an FM transmitter operating in the 160-mc. band. At the receiving end, the subcarrier from the FM receiver is applied to a recording amplifier. Here it is converted to video and fed to a facsimile recorder.

Front and rear views of a facsimile transmitting unit are shown in Fig. 2. The scanner is at the bottom of the rack. Above it are three panels containing the scanner amplifier, a control panel, and the line-limiter amplifier at the top. The receiving terminal rack, Fig. 3, contains the recorder amplifier, bottom; recorder, center; and take-up reel, top.

To send a map or other graphic copy, a sheet containing information within the dimensions of 8.2 by 11.5 ins. is wrapped around the scanner copy drum. The drum is rotated at 720 RPM, while a pickup head is moved longitudinally along the drum by a lead screw, advancing 1 inch in 105 revolutions of the copy drum. This provides a definition of 105 lines per in. The copy is scanned at the rate of 56.2 square ins. per minute, an entire sheet being scanned in 1.68 minutes. This corresponds to over 500 words per minute for single-spaced typewriting, or better than 1,000 words per minute for printed copy similar to text of *The Saturday Evening Post*.

At the receiving terminal, moist electrolytic recording paper about 9½ ins. wide is fed from a supply roll between a rotating helical electrode and a stationary linear electrode. Then, the recorded paper goes through a drier and is cut off in appropriate lengths or is wound on a take-up reel, as desired. The helical recording electrode rotates at 720 RPM, the same speed as the copy drum at the transmitting end. Since the transmitting and receiving equipments are supplied with 60-cycle AC power from the same central station power system, synchronism is maintained with synchronous motors without the necessity for special controls. This provides a major simplification in equipment.

Scanner and Scanner Amplifier:

Fig. 4 is a simplified diagram of the scanner and scanner amplifier. An exciter light on the scanner head illuminates a spot on the rotating copy drum. Reflected light from the copy is directed to a 931-A multiplier photocell. The electrical output from the photocell is a voltage varying in amplitude with the graphic density of the copy on the drum. This video signal is applied to a coupling tube to change from a high output impedance to an impedance of a few hundred ohms. It is then suitable for application to a ring modulator, which employs copper oxide rectifiers. The signal fed to the modulator is in the order of ±10 volts.

The output of a balancing amplifier is applied through a tone-scale switch

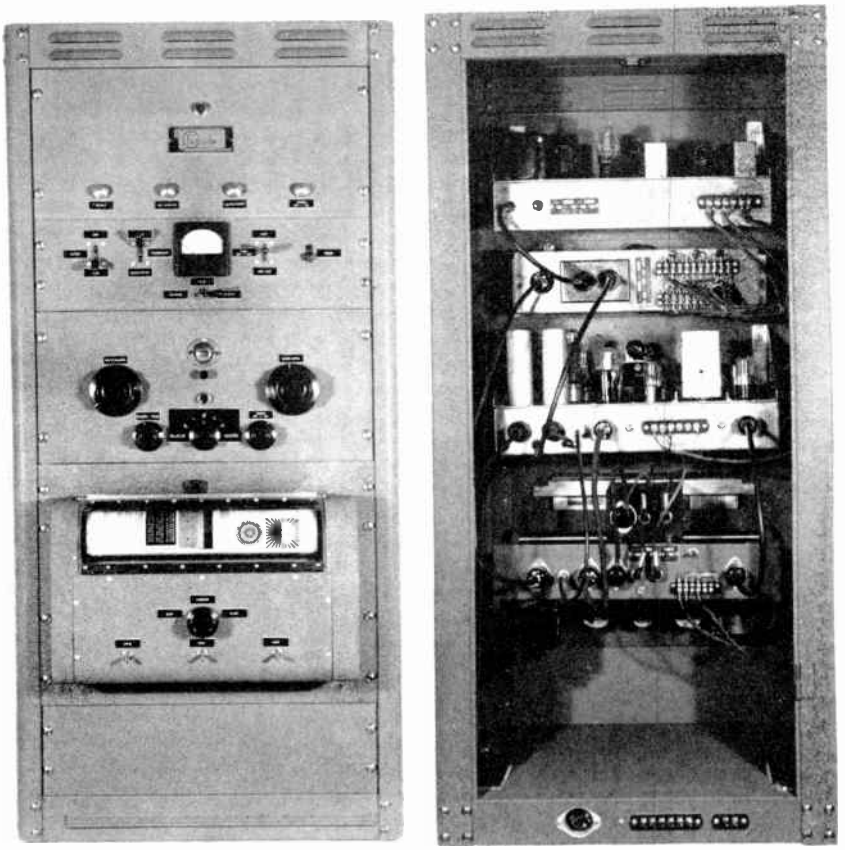


Fig. 2. Front and rear views of facsimile transmitting terminal equipment rack

* Respectively President and Engineer, Hogan Laboratories, Inc., 155 Perry Street, New York 14, N. Y.

[1] See "How the Weather Bureau Uses Facsimile and Telemetering," by C. A. Kettering and G. F. Montgomery, *FM-TV*, this issue.

to the other side of the ring modulator in order to provide a stable balance reference voltage. A 13-kc, RC phase-shift oscillator provides a subcarrier signal, which is fed through a driver and isolation stage to the modulator. When the video signal is equal to the reference voltage there is no output from the modulator. When the video signal voltage departs from the reference voltage the output is a 13 kc, subcarrier, modulated in amplitude according to the degree of departure of the video signal from the reference voltage.

Since the lightest shade of graphic copy varies with the type of paper used, the pickup head is directed to the whitest portion of the copy. With the copy drum stationary, the white balance control in the photocell power-supply circuit is adjusted to deliver a signal to the ring modulator which balances the reference voltage. White balance is indicated by an electron-ray tube indicator. In this manner, the modulator is always balanced, because the white output from the photocell is constant regardless of the maximum degree of whiteness of the particular piece of copy scanned.

When scanning photographic or halftone copy which is predominantly dark or predominantly light, adjustments can be made at the transmitter so that the recording made at the receiving end of the system can be an improvement over the original. This is accomplished by an electronic retouching circuit in the scanner amplifier, controlled by tone-scale switches. If the copy is dark, the circuit can be set to compress the light shades into a narrower density range and to expand the darker shades over a wider density range. As a result, the contrast and detail of the recording is improved. If the copy is light, the circuit can be set to correct in the opposite direction.

The output of the ring modulator is a 13-kc, subcarrier, amplitude-modulated according to the instantaneous graphic density of the copy scanned, and contains sidebands out to 7 and 19 kc. The signal is applied to an amplifier stage and then to a black-level control. This is a gain control for setting the maximum output level corresponding to the blackest part of the graphic copy. The adjustment is made with the scanner head directed to the blackest part of the copy on the scanner drum, in a manner similar to that described in connection with the white balance control. Thus, the signal extremes corresponding to black and white are set so that optimum contrast is obtained in the recording, despite contrast variations in different pieces of copy scanned.

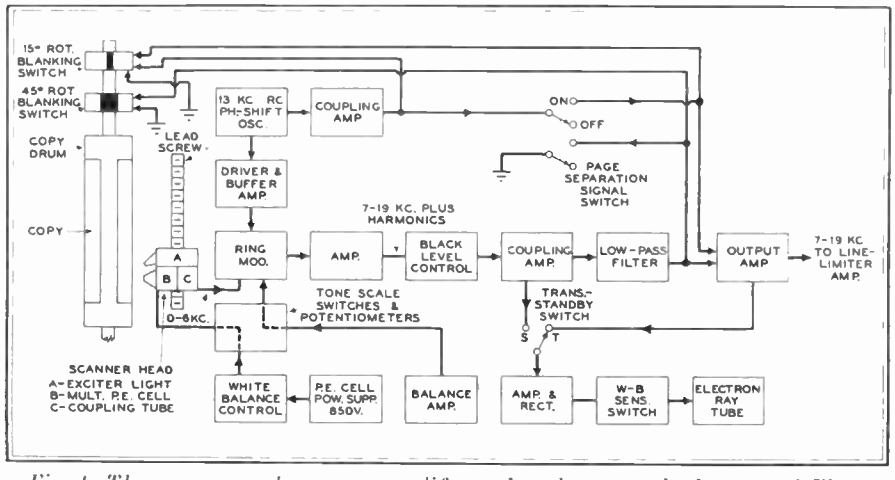


Fig. 4. The scanner and scanner amplifier units, shown at the bottom of Fig. 2

Harmonics of the carrier frequency, generated in the modulator, are removed by the low-pass filter. The white balance and black-level adjustment described previously can be made during conditions of transmission or standby. When the transmit-standby switch is in the transmit position, a sample of the signal is taken from the output amplifier. When in the standby position, it is taken from the coupling amplifier circuit since no video signal is then present in the output stage. The sample is amplified, rectified, and applied to the electron-ray tube indicator. The white-black sensitivity switch increases the sensitivity of the indicator tube circuits when set on white to facilitate making accurate null adjustment on the white portion of the copy, since white corresponds to zero signal.

As the copy drum rotates, the pickup head generates an undesired signal when passing over the copy-paper clamps. To remove this signal, and to provide a space between each line of copy scanned for a synchronizing and phasing pulse, the signal is blanked during 45° of each copy-drum rotation by means of a rotary blanking switch on the copy-drum shaft. The coupling amplifier stage following

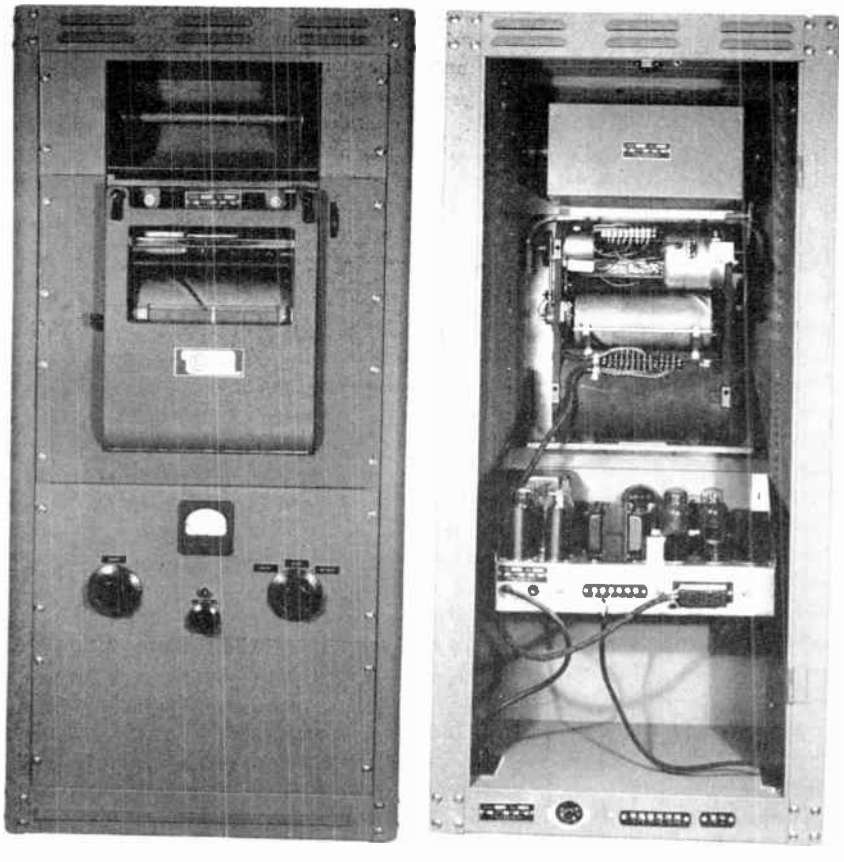


Fig. 3. This rack contains all facsimile receiving terminal equipment components

the black-level control provides a convenient low-impedance point in the circuit for this purpose. The signal is grounded between the low-pass filter and the output amplifier when contact is made between the brushes and the rotary switch. Thus, the video signal is broken up into lines equal in length to 315° of copy-drum rotation, and is blanked during the remaining 45°.

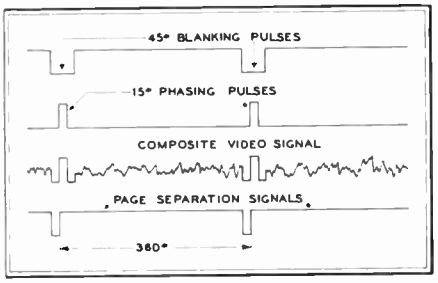


Fig. 5. Output signal time relationships

Part of the 13-kc. subcarrier oscillator output is applied to a coupling amplifier, and is used to provide 15° phasing pulses and 345° page-separation signals. The time relationships of these signals are shown in Fig. 5. Normally, the oscillator signal from the coupling amplifier is directed through brushes on the rotary pulse switch to the output amplifier. The pulse switch is oriented relative to the blanking switch so that the pulse occurs in the center of the notch made by the blanking signal.

To make certain that the recorder is in phase with the scanner, a page separation signal is transmitted for a period of about 10 seconds. This signal is sent when the page separation signal switch is closed, grounding the video signal going to the output amplifier and shorting the rotary pulse switch brushes. A third brush on the pulse switch is oriented in such a way as to ground the oscillator signal applied to the output amplifier during 15° rotation of the scanner drum at the relative time indicated in Fig. 5. The manner in which the recorder responds to the page separation signal is explained later.

It should be understood that the 15° phasing pulses, the video signals, and the page separation signals are represented in Fig. 5 by their envelopes. They are actually in the form of amplitude-modulated 13-kc. waves.

The Line-Limiter Amplifier:

The 7- to 19-kc. output of the scanner amplifier is fed to a switch in the line-limiter amplifier, Fig. 6. For the transmission of half-tone copy, the switch directs the signal through a coupling amplifier into a 3-section wave filter. This removes upper-sideband components from 15 to 19 kc. Thus, the signal is converted from a conventional double side-band AM signal to a vestigial side-band signal composed of frequencies between 7 and 15 kc., which is then passed through an amplifier to a push-pull output stage. In this case, the signal is used to modulate a radio transmitter. The signal could, of course, be sent over a wire line rather than a radio link.

When black-and-white copy is transmitted, the switch directs the output of the scanner amplifier through a driver stage, a peak and threshold limiter, and a coupling amplifier, after which it is fed to the same wave filter. The limiter passes no signal until the input reaches a certain predetermined level, which is adjustable by means of the limiter transfer control. Either full signal or no signal is passed.

In the transmission of weather maps containing penciled notations, best results are obtained with the switch in the photo position. The density of the recorded marks then conforms exactly to the density of the marks on the scanned copy.

Recorder Amplifier and Recorder:

The recorder amplifier, shown in Fig. 7, is connected to the output of the radio receiver. This output is a vestigial side-band AM signal, having frequencies between 7 and 15 kc. The signal is passed through an amplifier stage and is demodulated in a full-wave rectifier circuit. All carrier components are removed by a low-pass filter, whose output is a fluctuating DC signal having frequency components from 0 to about 6 kc. This video signal is essentially the same as the output of the phototube in the scanner.

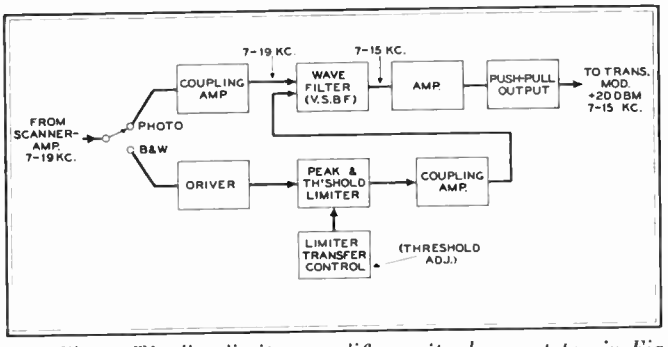
At this point the signal is applied to the grids of the marking tubes in a DC amplifier. The plate currents of the tubes pass through a slip ring, the helical recording electrode, and the electrolytic recording paper to the linear recording electrode. In order that the recording electrodes may be at ground potential, the plate supply for the marking tubes is at ground also. The recording point at any instant is determined by the point of junction of the helical electrode with the linear electrode on the opposite side of the recording paper.

Since the synchronous motor driving the helical electrode drum is powered by the same central power station which supplies the motor driving the scanner drum, there is no problem in getting the two drums to rotate in synchronism. However, provision must be made to insure that the drums will rotate in phase. That is, the helical recording electrode must be in the correct position to record the beginning of a line at the instant the pickup head is at the beginning of a line on the scanner drum. To this end, the page separation signal is sent initially from the transmitting end as described in the section concerning the scanner amplifier.

The RECEIVE-FRAME switch is put in the frame, or phasing, position at the beginning of a page. In this position, the signal passes through a relay coil to brushes on a 6° rotary switch on the shaft of the helical electrode drum. If the two drums are not exactly in phase, the page separation signal momentarily energizes the relay, opening the contacts and interrupting the power supply to the synchronous motor which drives the helical electrode drum. Each time the power is interrupted the motor slips one pole. The motor has ten possible locked-in positions, so that it soon falls into the desired phased position. The brushes then contact the 6° segment of the rotary switch during a time period centered in the 15° page separation notch.

Phasing takes about 10 seconds or less. Thereafter, the switch is thrown to the RECEIVE position, and the system is in readiness for the unattended trans-

(Concluded on page 40)



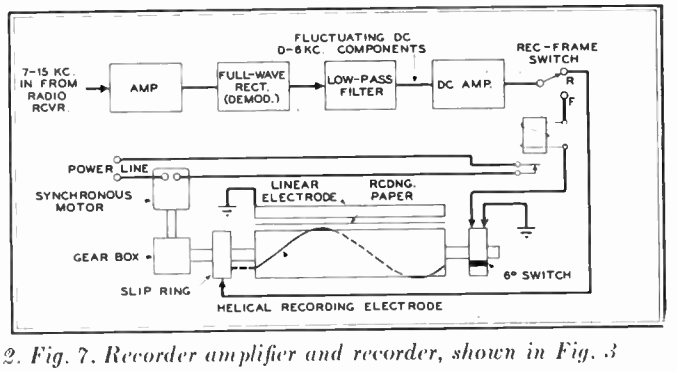
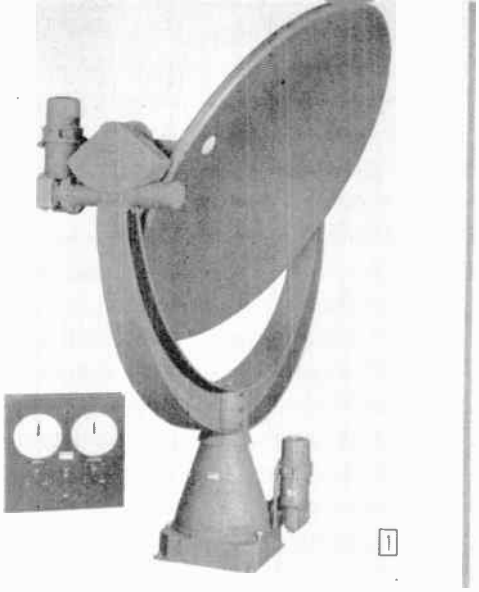


Fig. 6. The line-limiter amplifier unit, shown at top in Fig. 2. Fig. 7. Recorder amplifier and recorder, shown in Fig. 3



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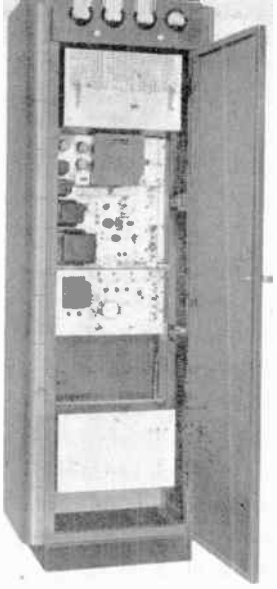

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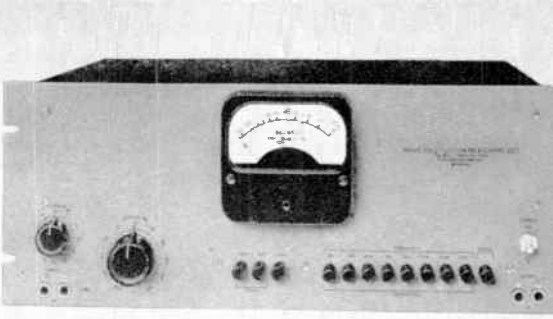

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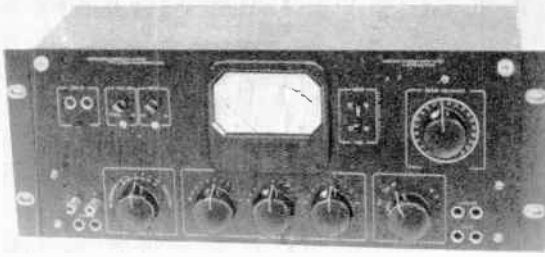

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NEWS PICTURES

1. Much hard work will be saved by this microwave reflector mount, made available recently by RCA Broadcast Equipment Section. Antenna can be rotated and tilted with the indicating remote control unit shown at left. Easy, fast, and accurate aiming of reflector results in reduced set-up time. Once set, antenna is held rigidly.

2. Two new fixed-station transmitter-receivers for 30- to 50-mc. communications systems are announced by RCA. Additions to the Fleetfone line, both 70-watt and 250-watt equipment are designed for adjacent-channel use. A single 84-in. cabinet houses transmitter, receiver, and power supplies for the 250-watt unit shown.

3. Distortion, noise, and hum level in audio equipment can be measured rapidly and accurately with the Daven 35-A Distortion and Noise meter. Necessity for making careful frequency and phase adjustments is avoided by the use of 8 fixed band-rejection filters, thus reducing the balancing operation to pushing a button.

4. This RCA type BI-11A Transmission Measuring Set provides direct readings of transmitter system measurements within FCC accuracy limitations. Intricate setups and lengthy calculations involved in checking broadcast transmitter audio gain or loss, frequency response, mismatch loss, and complex circuit readings are eliminated by this unit.

5. Measurements Corporation has developed this self-contained Intermodulation Meter, model 31, which can be mounted on a 19-in. rack panel. Output is two sinusoidal waveforms, one high and one low frequency, mixed at a 4-to-1 voltage ratio. These are applied to the instrument under test, the output of which is fed back to the meter. IM is read directly in distortion percentage.

6. This frequency shift keyer is produced by Northern Radio Co., Inc., 143 West 22 Street, New York 11. Unit replaces crystal oscillator in a transmitter and provides mark and space carrier shifts for teleprinter or telegraph signals.

7. General Radio Company's type 1303-A two-signal audio generator can be used to supply test signals for IM distortion measurements or as a laboratory BFO. Outputs are: 1) Single sinusoidal voltage adjustable from 20 cycles to 40 kc., 2) Two sinusoidal voltages, separately adjustable, one to 10 kc. and one to 20 kc., and 3) Two sinusoidal voltages with a fixed difference maintained as one is varied in frequency. Fixed difference frequency is adjustable to 10 kc., and lower frequency is adjustable to 20 kc.

8. An electronic pointer, either black or white, can be superimposed and moved anywhere on a TV picture with this simple unit developed by General Electric Company. Equipment consists of a rack-mounted chassis and the control unit shown at the lower right. Pointer is controlled by a device similar to an airplane joy-stick.

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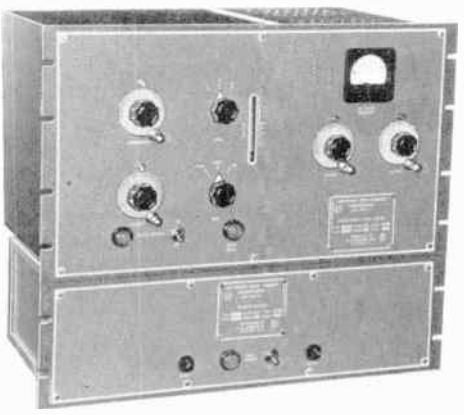

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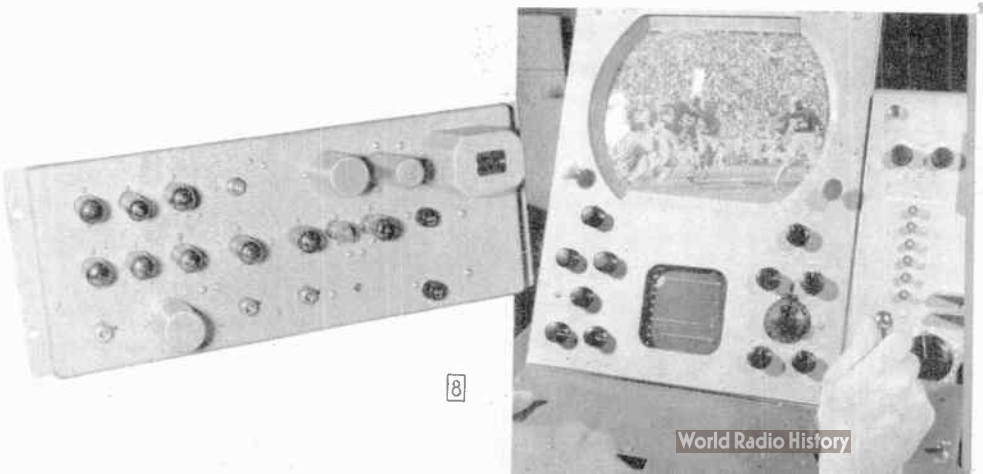

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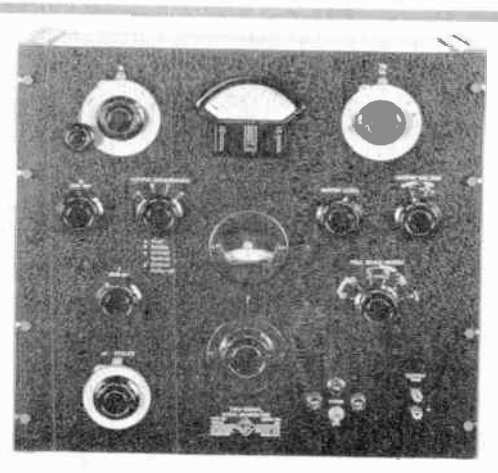

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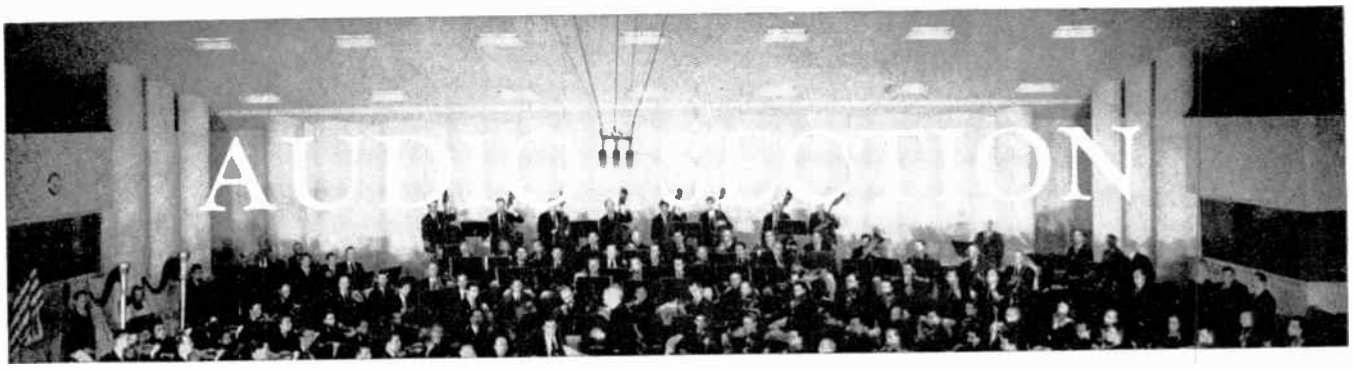


THE FAS AUDIO SYSTEM

PART 1 — DISCUSSION OF SOUND-POWER OUTPUT AT LOW FREQUENCIES — FAS SYSTEM CHARACTERISTICS — FAS AMPLIFIER DESIGN — *By* MILTON B. SLEEPER

EARLY in 1948, I began to hear about a marvelous and mysterious audio system built by Edmund Flewelling at his home. However, for all the enthusiasm expressed, the reports were not factual or really informative, because those who had heard the installation did not know how it worked.

The Great FAS Mystery:

Engineering-wise, it doesn't mean much to be told that the performance was "out of this world," or that "I heard more music from commercial pressings than I thought it was possible to record on wax." That didn't jibe with the description of the equipment, either, because it seemed to consist only of a 78-RPM turntable, a crystal pickup, some kind of an amplifier, a small speaker just propped up on a bookshelf, and an inexpensive 12-in. speaker on a plain board leaning against the wall!

Each one who had heard it was sure that there was a trick somewhere in the system, but no one knew what or where. They had run down the possibility of speakers mounted in the walls or in the hot-air register, or hidden behind furniture. Some had had an opportunity to inspect adjoining rooms, thereby eliminating the possibility of speaker enclosures hidden in some other part of the house.

Various theories were advanced but, as I learned later, not one came within a mile of the right answer. Finally, I went to hear the system. I listened to 78-RPM records hours on end during my first and subsequent visits. Then Charles Fowler and Roy Allison, of our *FM-TV* staff, heard it too. We agreed that we had never heard comparable reproduction from new transcriptions over a studio monitor system, but the only guess we could make as to the method of achieving such performance proved to be entirely wrong!

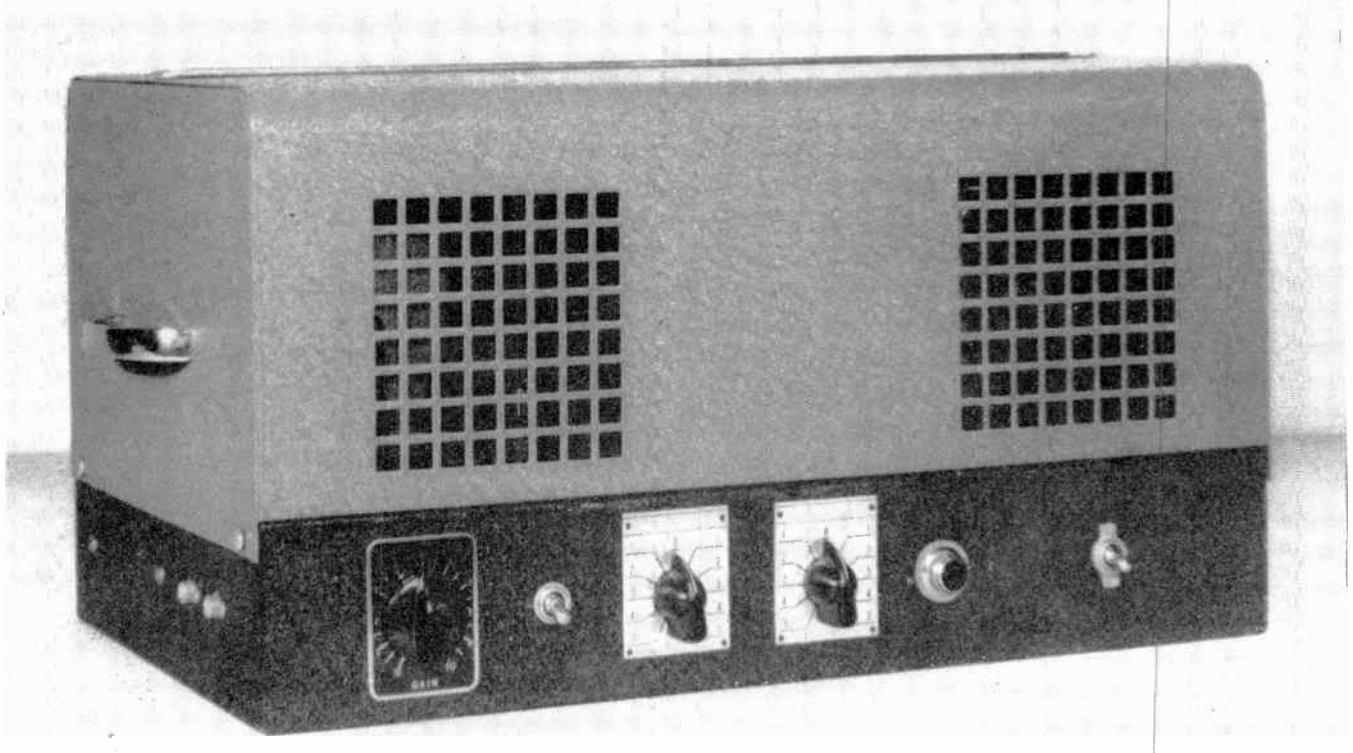


Fig. 1. The FAS amplifier, set up for demonstration purposes. Chassis-cover aids in carrying amplifier as well as shielding

Fig. 1. Correct parts layout helps to reduce hum level. If large chassis cannot be used, power supply should be separate

In fact, we didn't get the key to the mystery until after we completed arrangements to publish the complete information on his work.

Function of Sound-Power Output:

Our experience with the original equipment and our own work which led to the design to be described has been a liberal education in the problems of audio reproduction. We don't have all the answers yet, because we have discovered some missing links between electrical and mechanical design and listening reactions that have never come up before in technical papers or discussions. Moreover, the FAS equipment produces effects that we don't understand entirely and won't, therefore, attempt to explain. However, we have arrived at certain conclusions which can be summed up in this way:

We can criticize the one-note bass and the beer-barrel boom all we please, but there's no denying that people generally want some kind of substantial bass response. Maybe that is evidence of their having tin ears or juke-box tastes. Still, the feeling persists that so many can't be as wrong as are generally presumed to be.

Pursuing that thought, it must be admitted that the musical sound-power output of ordinary speakers from about 125 cycles down is in some inverse ratio to the power output of the musical instruments which produce those low notes. The problem of horn-loading is well recognized. At 30 cycles, an amplifier may produce a considerable excursion of the speaker diaphragm, but the sound emitted is barely audible. On the other hand, the power output from the piano, organ, bass drum, cello, tuba, or bass saxophone on low notes is enough to make the vibrations felt as well as heard, and to rattle objects in the room where the instruments are played.

In conventional audio systems, it hasn't been possible to approximate that sound-power output with a truly musical bass. Efforts to do so have produced only a one-note boom, due to speaker resonance at somewhere near 50 cycles. That seems to bring us around to the conclusion that most listeners want the substance that is supplied in music by the bottom end of the audio range, and they accept a phony bass effect because that's the only thing available to them.

Those with educated musical tastes, on the other hand, apparently prefer to supply the bass from their imagination, since they are disturbed by the lack of musical value in the one-note boom.

You may not agree with these observations, but they do explain the enthusiasm of both lay people and experts who have listened to the FAS equipment, and have described it as producing the most enjoyable and satisfying quality of music they have ever heard.

Now, the particularly distinguishing feature of the FAS is its ability to deliver sound-power output in about the same ratio as the power output of the original instruments. Moreover, the relation of the bass to the treble is maintained at any level from full volume to bare audibility! This is in contrast to conventional systems in which the sound-power output of the speaker drops steeply in the bass range, even though the amplifier is flat to 30 cycles. Also, as you have probably observed, demonstrations of bass response are always made at very high volume level, and much above the acceptable level for home listening. That is necessary because, as the volume is cut down, the bass drops out quickly.

In terms of conventional equipment, this would indicate that the FAS has 1) some method of getting a tremendous boost in amplifier output on low frequencies, and 2) bass compensation on the volume control. However, a study of the amplifier circuit will show that neither is employed. As to the amplifier output, two 6L6's loaf along at about 5 watts! But when you feel the vibration in the floor and in the air from deep pedal notes on the organ, you'd swear that it must take 150 watts or more.

Another interesting thing about the FAS is the dimensional effect on orchestral music. In a concert hall, you are conscious that the music shifts from one part of the stage to another. The FAS creates the same impression. In fact, it is almost equal to true stereophonic reproduction using two separate audio channels.

Further Development:

The FAS idea started with Edmund

Flewelling. But his equipment, as demonstrated to us, suffered from limitations which would make it well-nigh useless as a modern radio-phonograph system, because it could be used only with a crystal pickup and 78-RPM records! In our discussion with Mr. Flewelling, we suggested trying out his equipment with LP records and a reluctance pickup, and with an FM tuner. He insisted, however, that LP records were worthless, that the only place to put a reluctance pickup was in the ashcan, and that there was no music in FM broadcasting. At our last meeting, he proved his contentions by comparing reproduction of the same musical selections on LP and 78-RPM records. The LP quality was really terrible. On that occasion, he also had a good FM tuner, but the audio system that performed so marvelously on 78-RPM records just went to pieces on FM reception.

After we discussed the limitations of his equipment with Mr. Flewelling, he wrote us, "Any effort at this time to improve the job as I have laid it out simply means disaster." Since we felt that the best interests of our readers would not be served by describing a system for 78-RPM records only, we decided not to present the original Flewelling manuscript, but to accept his challenge that improvement was impossible.

Our own group at *FM-TV* has carried forward Flewelling's concept to create the completely flexible audio system to be described. Thus, FAS stands for Flewelling Audio System as well as the final Fowler-Allison-Sleeper designs for the amplifier, crossover network, and speakers. So the initials represent an audio system that is truly revolutionary in performance, and give credit to all those whose efforts are represented.

Thus, the Fowler-Allison-Sleeper project started where Flewelling had stopped.

First, we undertook to revise the amplifier for use with LP, 45-, or 78-RPM records and a crystal or reluctance pickup, as well as with a radio receiver. Then we had to work out a crossover network and speaker system that would give full-range response and full sound-power output down to 20 cycles under any conditions that might be encountered at a given installation. Finally, for the benefit of those who already own commercial types of expensive high fidelity amplifiers, we had to find out how to accommodate our speaker system to those units. All this information will be presented in the course of this series of articles.

THE FAS AMPLIFIER

Amplifier manufacturers publish frequency-response curves which show that their products provide, with various degrees of success, constant voltage-gain over the entire audio range.

It cannot be denied that constant voltage gain for all frequencies is desirable. But the term "frequency response" is misleading as normally used, for it implies that if an amplifier of flat voltage-gain characteristics is used in an audio system, a flat sound output will be obtained. This is quite wrong.

The quality of audio reproduction depends upon three critical elements: the amplifier proper, the output transformer, and the speaker system. The output of each element must be flat with respect to its input, but the criteria for flatness are different for each element.

It is not enough that the amplifier provide the same voltage gain at any frequency. The frequency characteristic of the output transformer must be flat at any input power level within its rated capacity. Finally, the speaker system must provide constant sound-power output at any frequency for any input level.

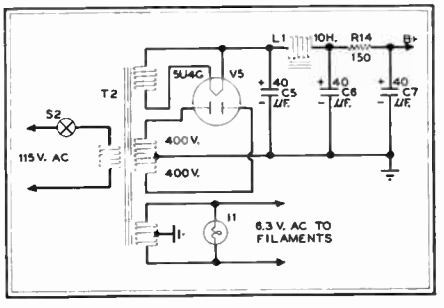


Fig. 3 Power supply has double-pi filter

Any reasonably good amplifier can be rated legitimately as flat from 20 cycles to 20 kc., but this has no relation to the performance of the output transformer and the speaker. That's why it is important to remember that you don't listen to the amplifier!

The FAS Amplifier Circuit:

The FAS amplifier, Fig. 1, was designed to meet all the requirements outlined above. The amplifier itself is capable of delivering essentially flat response from 20 cycles to 20 kc., and this flat characteristic is maintained by the output transformer at any level up to its full power rating.

With such performance, hum which would be inaudible in a conventional system could become objectionable. Therefore, an amplifier to be used in an FAS installation must have extremely low hum content.

A circuit diagram of the FAS amplifier is given in Fig. 2. The circuit is simple,

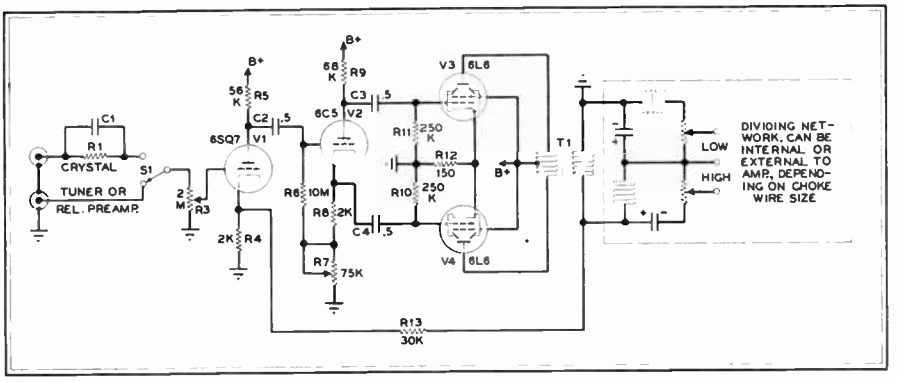


Fig. 2. Complete circuit of FAS amplifier, with one flat and one crystal input

straightforward, and conservative. Only three stages are used, with a complete feedback loop. The 6C5 phase-splitter circuit creates very little phase shift. As a result, the amplifier is so stable that a direct negative feedback connection can be made from the output transformer secondary to the 6SQ7 cathode without producing oscillations, although that is unnecessary and impractical. A feedback resistor of 30,000 ohms was found to be quite adequate.

The push-pull 6L6 output stage provides high power-sensitivity and adequate peak power with low distortion. Operated class A, a pair of 6L6's deliver 18.5 watts output at 2% distortion. The efficiency of the FAS speaker system is such that 5 watts produce ample sound power for any home requirements, and it is not likely that this maximum distortion figure would ever be reached. With the negative feedback provided, the distortion under normal operating conditions will probably not exceed .5%.

The 6SQ7 input stage has ample gain for a crystal pickup or a radio tuner, but not enough for a reluctanee pickup. Although the FAS is intended to operate with a reluctance pickup, no preamplifier was built into the chassis, on the theory that it is advisable to use the particular unit supplied by the manufacturer of the pickup. Also, it is customary to regulate the volume by the control in the associated tuner. Hence, a separate preamplifier simplifies the wiring.

For purposes of demonstration, two inputs were provided in this design, one

(Continued on page 29)

Fig. 1. This illustrates one of the basic advantages of custom-building — equipment can be installed in existing furniture

DESIGNS FOR INDIVIDUALISTS

CUSTOM BUSINESS BOOMS AS PEOPLE DISCOVER THE EXTRA PLEASURE AND SATISFACTION OF MADE-TO-ORDER INSTALLATIONS — *By* PHILIP C. KELSEY*

FROM time to time I am asked: "Are many people having custom radio-phonograph installations made in their homes?" And also: "How did you get into that kind of business, anyway?" It's just a matter of faith in people.

After twenty-five or thirty years of radio, measured from whenever you decided that radio was here to stay, it's not surprising that a great many people have decided not to put up with table models any longer because, however handy they are, their performance is decidedly makeshift. They have finally ruled out consoles, saying that cabinets are too ugly to be seen, and too big to hide. The feeling of an increasing number of particular people was summed up in this conversation, overheard at a radio store:

"That radio cabinet is not period furniture."

"That radio cabinet is not furniture, period!"

In the few well-made consoles of past years, part of the equipment usually became obsolete within a short time. This left the owner with a big piece of furniture of almost no practical value, even though it had actually cost him a considerable amount of money. This was even more disappointing than buying a cheap console.

Properly planned custom installations are designed so that individual com-

Fig. 2. Drawer below tuner is record file

*Philip C. Kelsey Company, 21 Whitfield Street, Guilford, Conn.

ponents which become obsolete can be replaced easily. This permits the owner to take advantage of equipment improvements quickly, and at minimum cost.

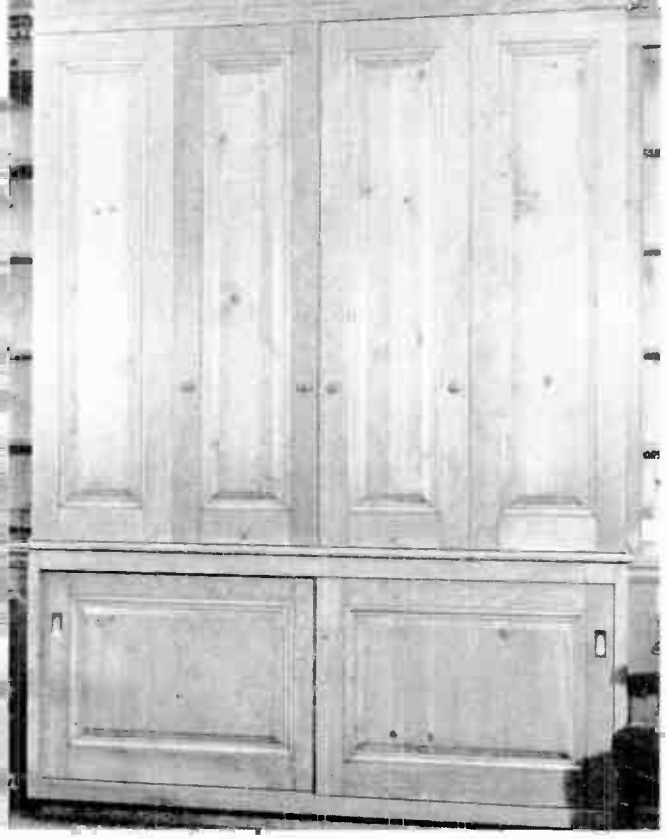
Demand for Custom Work: To show how particular people can be, consider an installation I made for a discriminating family living in a lovely old home on a hill above the Connecticut River valley. Every piece of their furniture reflected character and charm. They wanted a radio-phonograph that would give performance consistent with the quality of the surroundings. Any standard console was ruled out because, in the opinion of the owner, it would ruin the appearance of his living room. A preliminary study of the situation revealed that the electrical supply was a 32-volt lighting system.

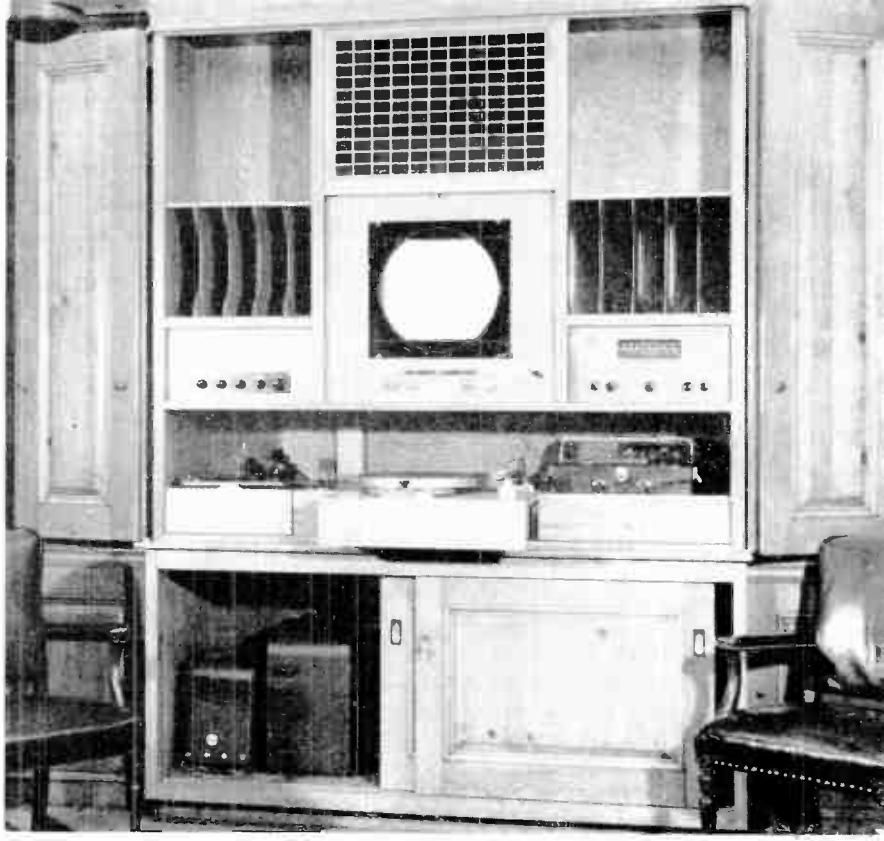
Fig. 3, above left. When new cabinets must be built, they can be designed for best use of floor space and to harmonize with other furnishings

Fig. 4, above right. Extra speakers can be provided in other rooms. This speaker was mounted inconspicuously above a built-in filing cabinet

Fig. 5, below. A cabinet planned for future expansion. A TV tuner will eventually replace the shelves between the two speaker enclosures

Fig. 6. Some like cupboard construction because equipment can be concealed completely, as shown in insert





Figs. 7 and 8. Another cupboard installation. Individual units can be replaced easily as they become worn or obsolete

The final plan which the owner approved worked out in this way: A mahogany Queen Anne lowboy was designed and built to house a tuner, amplifier, and turntable. The turntable was mounted in a drawer with a light and automatic switch. The drawer pull was used as a knob for the volume control. A nearby bookshelf was used to conceal the speaker. AC power came from a small motor-generator operating on 32 volts, which required the use of a governor-controlled turntable.

This may seem like going to extremes, but I can assure you there is an endless supply of customers with just as specific ideas as to what they want and how they want it done. Incidentally, that installation probably sounds more expensive than it was actually. Many people think that custom work runs into enor-

Fig. 10, below. This speaker is operated from amplifier at left. T-pad attenuators are desirable, permitting individual volume adjustments for each speaker used

Fig. 9, above. Cabinetry must harmonize with room decor. Perfect balance is achieved here for subdued effect desired

mous prices, so it's usually possible to give them better performance and more attractive appearance for less money.

Developing Business:

I find that some custom designers, notably engineers at broadcast stations, seem to have had little trouble in getting started. They have the advantage of an established reputation. I started the hard way. Back in 1921, I built myself an installation that my neighbors thought so wonderful that they asked me to do the same for them.

The receiver was a breadboard affair with a regenerative detector and two stages of audio, mounted in a bookcase. A door carrying three pairs of headphones concealed the radio set during periods of no earstraining. At the bottom of the bookcase was a lead-lined space

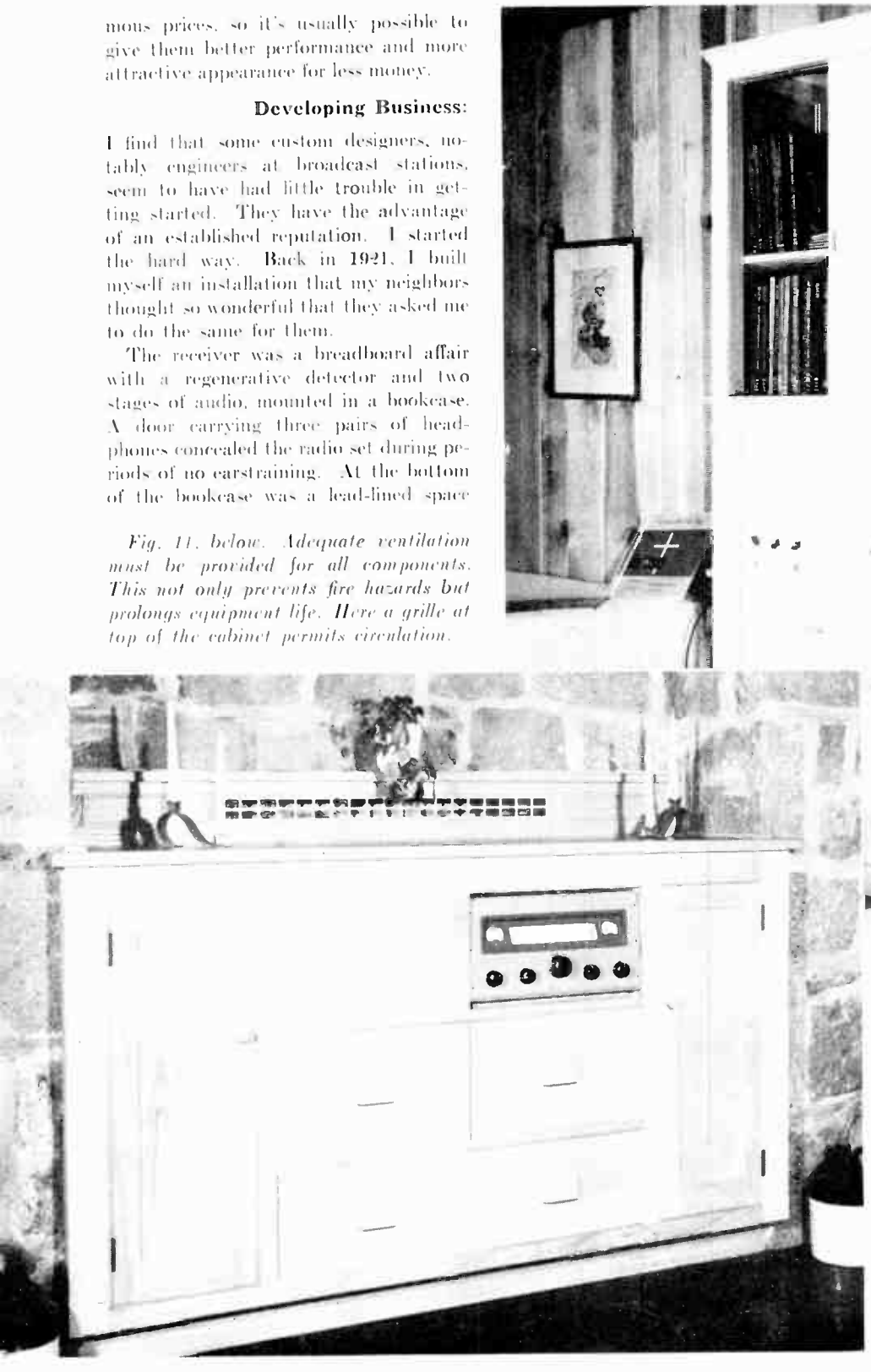


Fig. 11, below. Adequate ventilation must be provided for all components. This not only prevents fire hazards but prolongs equipment life. Here a grille at top of the cabinet permits circulation.

Fig. 12, above. This installation has a special high-power audio amplifier and an equalizer to regulate speakers in several rooms. A neat, careful layout prevents confusion among the many control knobs and switches required.

containing two storage batteries, a charger, rubber gloves, a jar of vaseline, another of distilled water, and two 45-volt B batteries. I learned a basic lesson from this job. It seemed that well-charged storage batteries gave off a considerable amount of hydrogen, and that poor connections tended to spark. The net result was that an explosion took place in that unventilated enclosure, accounting for the sudden removal of two lead-lined doors, and some damage to my skins.

Fortunately, that happened before I made any similar installations for my friends. Today, of course, there is no need to worry about storage batteries, but ventilation is of the utmost importance because of the heat generated in receiver, amplifier, and rectifier tubes. I pay equal attention to safety requirements for AC lines, and I go to great lengths to conceal all circuit leads not only for their protection but to protect grownups and children from tripping over wires which, if exposed, would come loose in time.

Equally careful attention to every other last detail pays in dividends of new customers. All the credit for the finest kind of a job can be lost by some little carelessness that becomes an annoyance to the owner. It's all right if a set stops working because some major fault develops, but an intermittent connection or a set-screw that won't stay tight may cost good will and business from the owner's friends.

Times have changed since I built my first display installation. What I have now is that four-section job illustrated at

(Continued on page 71)

THE FAS AMPLIFIER

(Continued from page 24)

equalized for a crystal pickup, and the other for a tuner or reluctance pickup.

Two input isolating resistors could not be tolerated with the amount of feedback used. The choice between reduced feedback and a switched input was settled in favor of the switch, Fig. 2. This was done on the assumption that most installations would utilize a single input, the signal sources being switched at some other point such as at the tuner control. In that case, both the input switch and the volume control on the FAS unit could be eliminated.

The Power Supply:

With the extended low-frequency response of the FAS system, the power supply must be filtered heavily to insure that hum will not be introduced. Fig. 3 shows the schematic diagram. Since no decoupling networks are employed in the amplifier, a double-pi filter is necessary.

It will be seen that the filament winding is center-tapped. With the center-tap grounded and the parts layout as shown, hum output is inaudible at full volume setting.

Crossover Network:

The original crossover network employed chokes wound with No. 26 enameled copper wire. This made the choke dimensions small enough that the entire network could be installed within the chassis, as can be seen in the lower left-hand corner, Fig. 5. However, the resistance of the relatively fine wire decreased the efficiency of the network somewhat. Better performance was obtained from an external network employing chokes of No. 16 wire. If space is available, it is recommended that the latter type be used.

Details of both types of crossover networks, together with instructions for winding the chokes, will be furnished in the section on the speaker system.

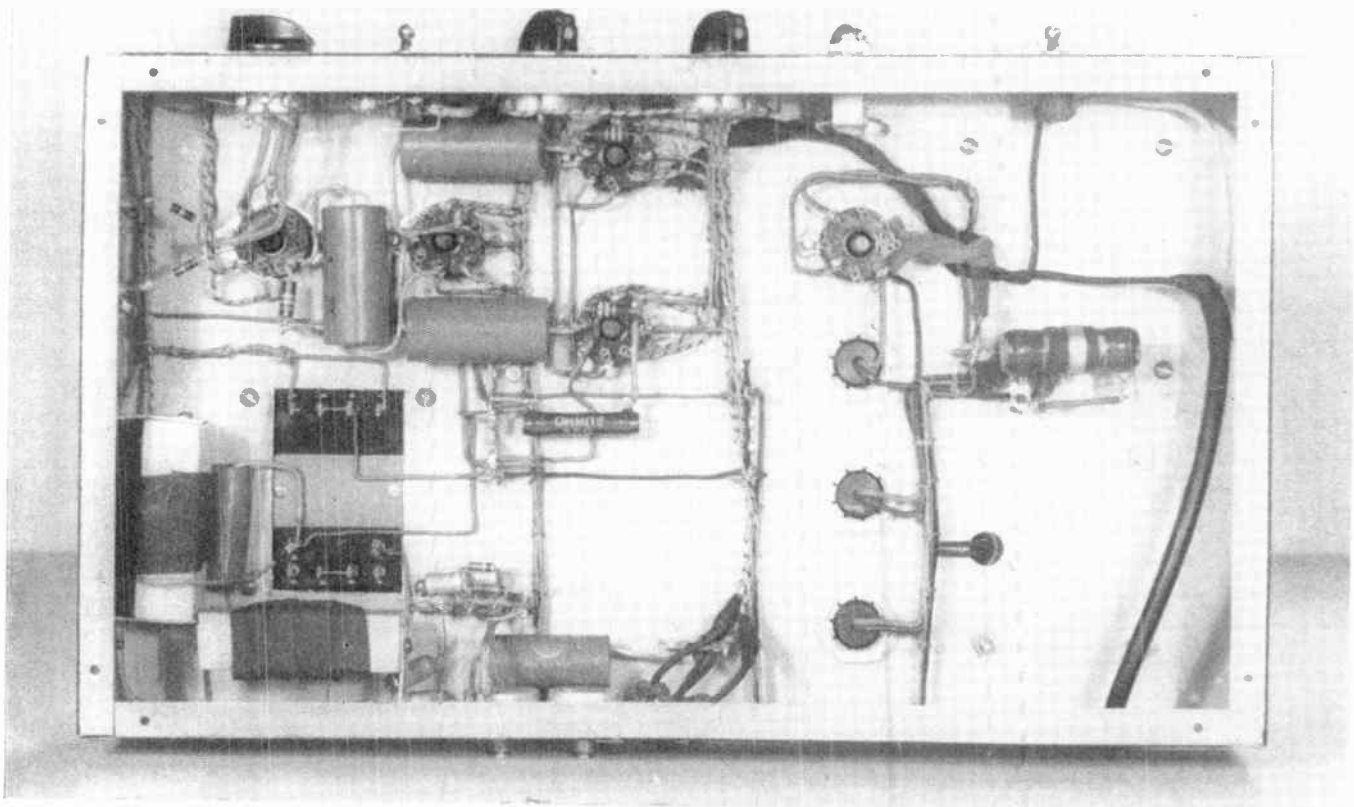


Fig. 5. Plenty of working room is provided underneath the chassis. Note extremely short AC leads from power transformer

Parts Required:

Following is a list of parts used in the amplifier and power supply. It should be possible to substitute parts of equivalent quality without sacrifice of performance. Particular attention should be paid to the selection of an output transformer, since it is this component which determines the power characteristic.

PARTS LIST

R3 2-megohm potentiometer, ½ watt
R4 2,000 ohms, ½ watt
R5 56,000 ohms, 1 watt
R6 10 megohms, ½ watt
R7 75,000-ohm potentiometer, 1 watt
R8 2,000 ohms, ½ watt
R9 68,000 ohms, 1 watt
R10 250,000 ohms, ½ watt
R11 250,000 ohms, ½ watt
R12 150 ohms, 10 watts
R13 30,000 ohms, ½ watt
R14 150 ohms, 25 watts
(R3 can be a fixed resistor if the volume is to be controlled externally)
C2 .5 mfd., 400 volts, paper
C3 .5 mfd., 400 volts, paper
C4 .5 mfd., 400 volts, paper
C6 40 mfd., 600 volts, electrolytic
C5 40 mfd., 600 volts, electrolytic
C7 40 mfd., 600 volts, electrolytic
V1 6SQ7 - V2 6C5 - V3 6L6 - V4 6L6
V5 5U4G
T1 Output transformer, Peerless S-230-Q
T2 Power transformer, Peerless R-560-A
Power supply choke, Peerless C-455-A

MISCELLANEOUS

Parmetal chassis 17 by 10 by 3 ins.
SPST toggle switch
SPDT toggle switch
2 phono input jacks
Pilot light assembly
Knobs and dial plates
AC cord and plug
5 octal tube sockets
3 terminal strips

NOTE: C1 and R1 make up the crystal equalization network. Optimum values vary with each type of crystal. Representative values are: C1 150 mmf., R1 1 megohm.

Construction and Wiring:

The parts layout for the FAS amplifier can be seen in Figs. 4 and 5. A chassis 17 by 10 by 3 ins. is recommended to ac-

(Continued on page 36)

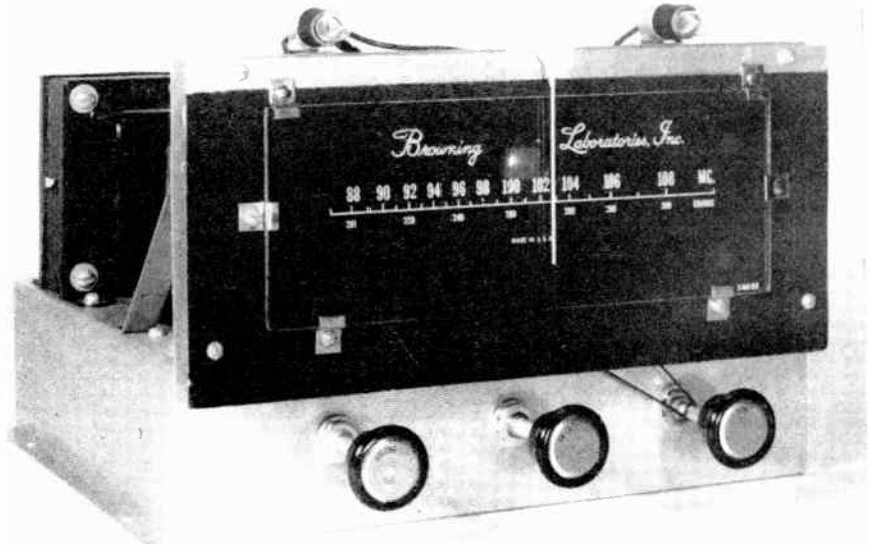


Fig. 1. Model RV-10A straight FM tuner. Selective AFC can be switched on or off

NEW TUNER DESIGNS

BROWNING MODELS PROVIDE SELECTIVE AFC AND EXTERNAL AUDIO SWITCHING — *By* F. A. SPINDELL*

AS one of our engineers put it: FM sets aren't hard to tune. They just seem so because AM sets are so broad. That isn't exactly true, because a 10-kc. AM channel at 1,000 kc. is relatively 5 times as wide as a 200-kc. channel at 100 mc. Moreover, automatic volume control in an AM receiver makes the tuning seem broad because it suppresses normal volume variation as the resonance point is approached and passed. FM signals, on the other hand, must be centered exactly on the discriminator response curve, since there is noise and distortion at each side of the correct setting.

More Listeners, New Problems:

It is interesting to look back over the ten years that we have been building FM and FM-AM tuners at Browning Laboratories to see the changing course of electrical and mechanical design during that period. In the beginning, most people thought of FM tuners as something to add to existing AM sets, so that the old amplifiers and speakers could be used. Now, practically all our FM and FM-AM tuners are used with high-fidelity audio systems in custom installations. That is why we now have three chassis designs, to meet individual requirements.

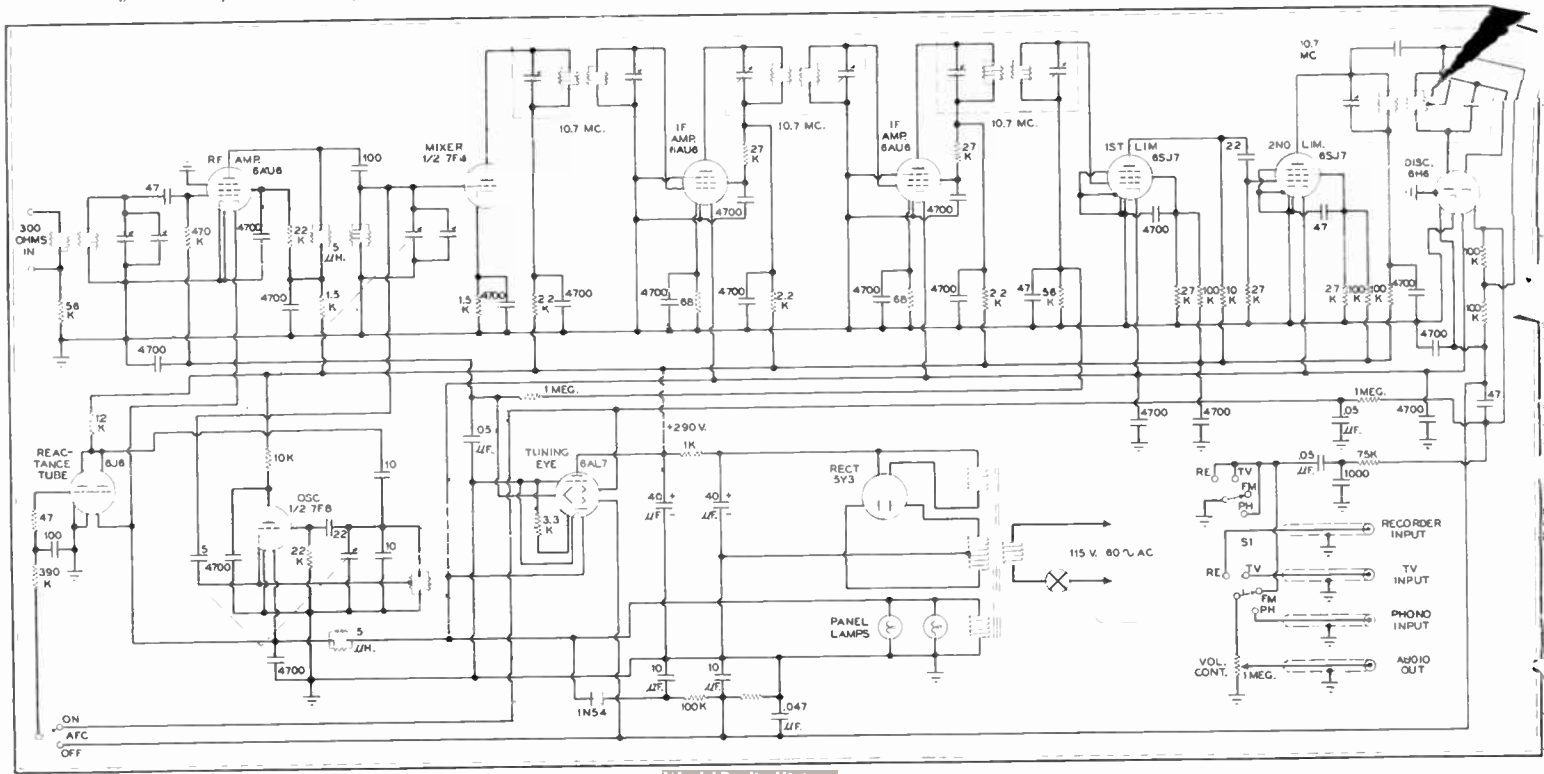
For a long time, the majority of our tuners were bought by engineering-minded people. They didn't mind the necessity of getting each station on the nose but they did complain about drift. Components for circuits operating on 88 to 108 mc. are so small in size that expansion due to heat from the tubes changes their electrical characteristic enough to cause detuning. That trouble was eliminated by changing the relative positions of critical circuit elements, and by using components with negative temperatures coefficients.

But as public interest in FM expanded, more and more of our tuners got into the hands of non-technical people who expected to get their favorite FM stations with no more attention to the tuning than they were in the habit of paying to their old AM sets. Thus we were confronted with the problem of satisfying the experts who like to seek out every new station they can log on the dial, and still satisfy Mr. and Mrs. John Public who, in increasing numbers, are switching from AM to FM listening.

The way to satisfy the latter group was to use automatic frequency control. So we undertook the development of an AFC circuit that would give a proper balance between broader tuning adjust-

* Chief Engineer, Browning Laboratories, Inc., Winchester, Mass.

Fig. 3. Complete circuit for RV-10A tuner. Each audio input, when switched in the circuit, is fed through volume control



Saving energy for better low-cost telephone service

Arrow points to tube containing a wire specimen under test for surface conductivity. The tube and wire are excited to resonance by microwaves from generator at extreme left. Conductivity is calculated from frequency values indicated by barrel-shaped wavemeter (top center) and resonance curves traced on an oscilloscope screen (not shown).

In the waveguides which conduct microwaves to and from the antennas of radio relay systems, current is concentrated in a surface layer less than 1/10,000 inch thick, on the inner surface of the waveguide. When these surfaces conduct poorly, energy is lost.

To investigate, Bell radio scientists devised exact methods to explore this skin effect at microwave frequencies.

Scratches and corrosion, they found, increase losses by 50 per cent or more. Even silver plating, smooth to the eye, can more than double the losses of a polished metal. Very smooth conductors, like electropolished copper, are best. An inexpensive coat of clear lacquer preserves initial high conductivity for many months.

Energy saved *inside* a microwave station is available for use in the radio-relay path *outside*. So stations can sometimes be spaced farther apart, and there will always be more of a margin against fading. Here is another example of the practical value of research at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES

WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE BIG IN VALUE AND LOW IN COST

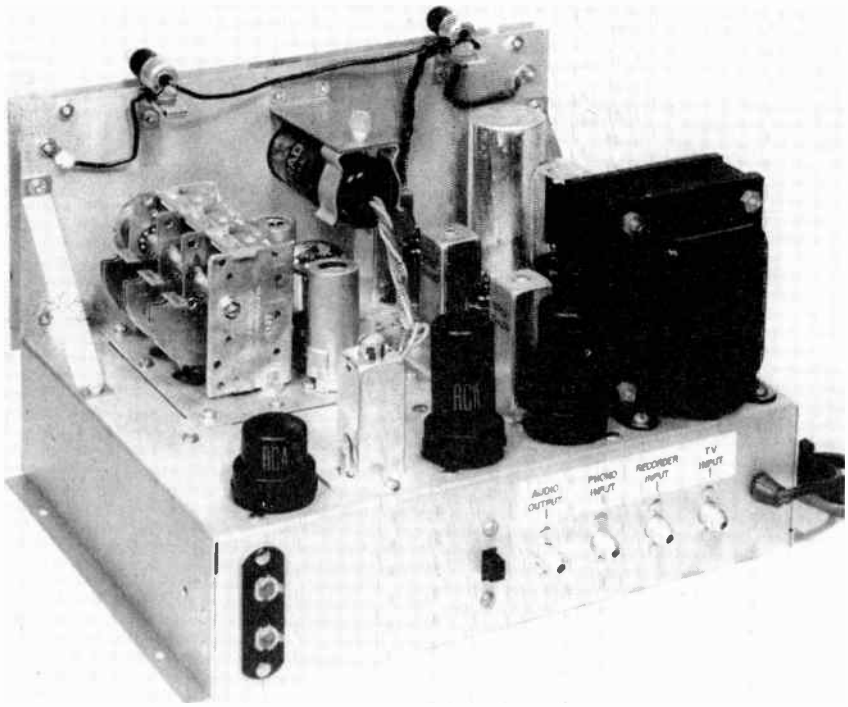


Fig. 2. Rear of model RV-10A. Note subchassis assemblies bolted to main chassis

ment and the tendency to jump over a weak station to bring in a strong one on a close-by channel.

Meanwhile, further circuit refinements were worked out to increase both sensitivity and selectivity for the benefit of those who want every last bit of performance that an FM tuner can produce.

There we had conflicting characteristics and, moreover, as we learned from field tests, conflicting requirements in different areas, because receiving conditions and the geographical distribution of FM stations vary to a surprising degree.

Finally, an obvious answer was found, so simple that no one else had thought of it before. We made a further change in the circuits so as to provide Selective AFC. Now, in all three tuner models, those who want non-critical FM tuning can get it by cutting in the AFC action, while those who prefer not to use it can flip the switch and cut out the AFC circuit.

We added another feature to meet the requirements of custom installations. This is a single, front-panel control to switch in a phonograph, television audio channel, recorder, FM, and AM for those models which include it. When the selector switch is turned to the phonograph, television, or recorder position, the proper input is selected and fed to the volume control. In these positions, FM and AM outputs are grounded.

Selective AFC Circuit:

The complete schematic diagram of the RV-10A tuner is given in Fig. 3, and a simplified diagram of the AFC circuit in Fig. 4. A 6J6 reactance tube is shunted across the local oscillator tuned circuit. Because of the high transconductance of the 6J6 triodes operated in parallel, the control range of the circuit extends to the peaks on the discriminator response curve.

With the AFC switch in the ON position, the grid of the reactance tube is DC coupled to the output of the discriminator. This output, at point X in Fig. 4, changes in polarity and magnitude as the signal carrier is moved across the IF center frequency by the tuning control. At exact center frequency, the point of correct tuning, the DC output is zero. At this point the reactance tube has no effect on the local oscillator frequency.

When the local oscillator has not been tuned so that the IF center frequency falls exactly at the center of the discriminator response curve, a DC voltage is developed at point X. Its polarity and magnitude depend, respectively, on the direction and amount of mistuning. This control voltage is applied to the 6J6 grid so that the tube shifts the local oscillator frequency in the proper direction, and the discriminator DC output is reduced. Thus, a signal is held automatically in correct tune over a considerable range on the tuning dial.

This AFC circuit is unusual in that the phase-shifting network, composed of C and R, employs the grid-to-plate capacity of the tube as the capacitive element.

When the AFC switch is in the OFF position, the grid of the reactance tube is returned to ground, which in effect removes the tube from the circuit. Tuning action is then normal. In the actual circuit, Fig. 3, it can be seen that in the AFC OFF position the grid is returned to a bias source rather than directly to ground. However, the effect is the same.

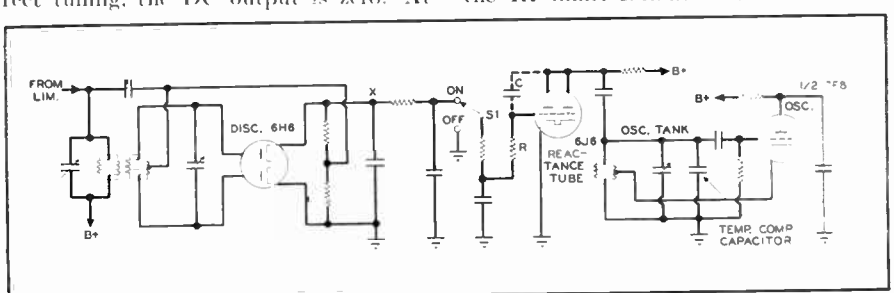


Fig. 4. Simplified diagram of AFC circuit, which employs only one additional tube

Improved IF Section:

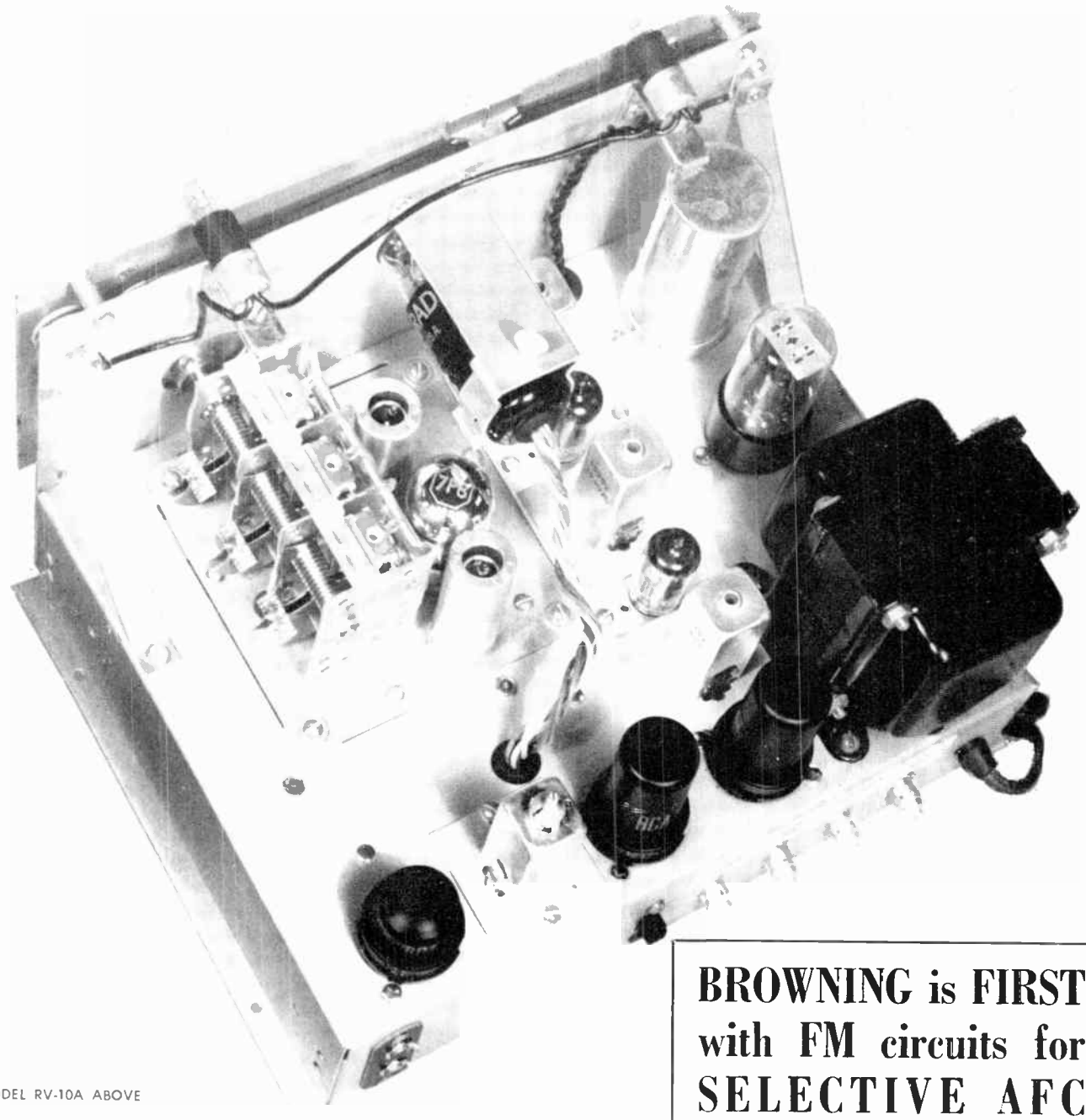
The basic circuitry of the new tuners is similar to that of previous models, with some notable improvements. Late developments have made possible the design of 10.7-mc. IF and discriminator transformers of quality equal to the 8.25-mc. transformers formerly used in Browning tuners. These have been adopted in order to eliminate images in the tunable range.

The discriminator transformer has 370 kc. separation between peaks. This, with the wide-band IF system, provides an amplifier and detector with nearly ideal characteristics.

In the RJ-12B, triple-tuned IF's are employed for AM, resulting in a response curve 13 kc. wide and with steep sides. Bandwidth is adjustable from 9 to 18 kc. in the RJ-20A. This feature is desirable in urban areas where strong signals from high-fidelity AM stations are available.

Mechanical Notes:

Pre-assembling groups of components has many real advantages. Sections such as the RF-mixer-oscillator tuner deck and the IF transformers are assembled on small plates, and critical wiring and soldering done with ample working room. These sub-assemblies are then bolted over chassis holes of appropriate size, through which the pre-assembled components protrude. The interwiring is then done within the chassis. This practice, employed in the new Browning models, saves time in assembly and reduces rejections due to faulty wiring. It makes the performance of the tuners more dependable because of the more uniform wiring arrangement possible.



MODEL RV-10A ABOVE

BROWNING is FIRST with FM circuits for SELECTIVE AFC

Before you buy ANY type of tuner, Check the Performance of These New Browning Models

How do YOU think an FM set should tune? Do you like the feel of high sensitivity and sharp selectivity that lets you explore each channel as you go along the dial?

Or do you want to be casual about it, and get your stations without having to lean forward in your chair?

Either way, you'll be happy with any of the three new BROWNING FM and FM-AM models because they all have Selective Automatic Frequency Control. By a flick of the switch you can have sharp FM tuning to bring in a weak station between two adjacent strong ones, or smooth AFC action on FM as non-critical as the tuning of an AM receiver.

Ask your dealer to let you try this new feature on the FM model RV-10A, and FM-AM models RJ-12B and RJ-20A. If you visit the Audio Fair, see and hear them at the Browning display in Room 645 or at the exhibits of Arrow Electronics, Harrison Radio, Hudson Radio, Leonard Radio, Milo Radio & Electronics, and Sun Radio & Electronics. For technical bulletins, address:

Browning Laboratories, Inc.

700 Main Street, Winchester, Mass.

In Canada, address Measurement Engineering Ltd., Arnprior, Ont.

DESIGN DATA for AF AMPLIFIERS — No. 5 Phase Inverters

PURPOSE OF PHASE INVERTERS — METHODS COMMONLY USED TO OBTAIN PHASE INVERSION — ADVANTAGES AND DISADVANTAGES OF EACH METHOD

ALMOST invariably, a push-pull stage is employed in the output of a good audio amplifier. Among the advantages of a push-pull power amplifier stage are increased peak power-handling ability and cancellation of all even-order harmonic distortion. However, the tube or tubes on each end of a push-pull stage must be operated 180° out of phase, the plate current at one end increasing while that of the other decreases. Also, the stage must be balanced; that is, for alternate half-cycles of an input signal of given amplitude, the increase in plate current above average must be identical at each end of the stage. Thus to drive a push-pull stage, the signal from the voltage amplifier section must be converted to two signals which are 180° out of phase (opposite in polarity) and of equal amplitude. That is the purpose of the phase inverter.

Method 1: Probably the simplest way to achieve phase inversion is by the use of an interstage transformer with a center-tapped secondary, Fig. 1. The center-tap is grounded or returned to a

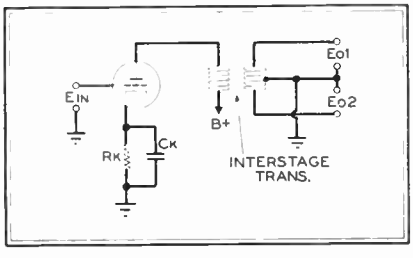


Fig. 1. Interstage transformer phase inverter

bias source, and the ends of the secondary are connected to the push-pull grids. Since current in the secondary can flow in one direction only at any given time, there is a linear gradation of voltage from one end to the other. Suppose that the potential at the top of the secondary is +10 volts with respect to the bottom. Then it must be at +5 volts with respect to the center-tap, which in turn is at +5 volts with respect to the bottom of the secondary. However, this is another way of stating that the bottom is at −5 volts with respect to the center-tap. Since the AC reference point for the push-pull grids is ground, and the center-tap is grounded, then the push-pull grids are fed with signals equal in amplitude and opposite in polarity.

Advantages of the transformer phase-inverter are relatively high gain, simplicity, and stability. Balance is determined by the transformer and is

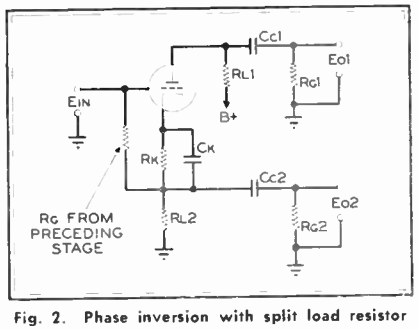


Fig. 2. Phase inversion with split load resistor

unaffected by the tube. Disadvantages are those inherent in transformer coupling, limited and uneven frequency response, and considerable cost.

Method 2: Fig. 2 shows a circuit often employed. Half the load resistance is used as a plate load, and the other half as a cathode load. As always, the signal developed across R_{L1} is 180° out of phase with the grid voltage. However, the signal across R_{L2}, in the cathode circuit, is in phase with the grid signal. Thus, the two output signals are 180° out of phase, and of equal amplitude providing that R_{L1} and R_{L2} are equal and the coupling networks similar.

This is a low-gain circuit, and the load resistors must be made small to minimize high-frequency loss. Typical values for a 6J5 or ½ 6SN7 are 50,000 ohms. However, there is remarkably little phase shift. Components are inexpensive, there is no balancing problem, and excellent results can be obtained.

Method 3: The circuit of Fig. 3 can be used where maximum gain is required. V1 is a

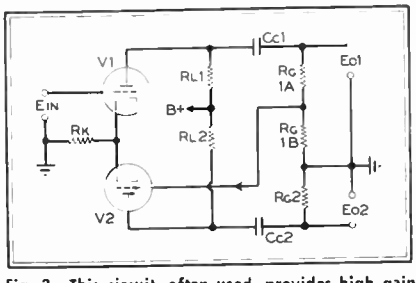


Fig. 3. This circuit, often used, provides high gain

straightforward RC-coupled amplifier stage, providing full gain. Its output, E_{o1}, feeds one push-pull end. The grid resistor is divided, however, into two unequal parts. Part of E_{o1} is used to feed the phase-inverter tube V2. The plate voltage of V2 is of opposite polarity to the grid voltage, and this is coupled to the other end of the push-pull stage as E_{o2}.

R_{G2} should be equal to the sum of R_{G1A} and R_{G1B}. In order that the two outputs may be equal, the percentage of E_{o1} fed to V2 should be the reciprocal of the gain of V2. For example, if the gain of V2 is 15, then R_{G1B} should be 1/14 the value of R_{G1A}.

Disadvantages are that two tube sections are required, and the balance is affected by the particular tubes used. It is difficult to obtain in practice the precise relation required for the two parts of V1's grid resistor. Finally, there is considerable phase shift engendered in the circuit.

Method 4: Fig. 4 shows a different but less desirable method of phase inversion. Here V1

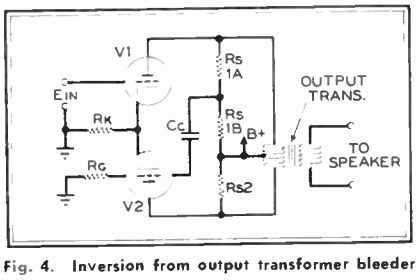


Fig. 4. Inversion from output transformer bleeder

and V2 make up the push-pull output stage. A dividing network, composed of R_{S1A}, R_{S1B}, and R_G, is shunted across the upper half of the output transformer primary, which is fed by V1. This voltage is 180° out of phase with the input signal, and part of it is used to feed V2. Thus, polarity reversal is obtained. The proper ratio of dividing-network resistances is determined as before by the gain of V2. If the voltage gain of V2 is 5, then R_{S1B} and R_G in parallel should be ¼ the resistance of R_{S1A}. R_{S2} is added to balance the loading effect on the output transformer, and should be equal to the total resistance on the other half of the primary.

This circuit is not generally recommended. It has all the disadvantages of Fig. 3 except that no additional tubes are required. However, it provides no gain. In addition, it imposes a load on the output transformer that is seriously detrimental to the performance of the amplifier.

THE FAS AUDIO SYSTEM

(Continued from page 25)

commodate all components comfortably. If space is not available for a large amplifier chassis, it is advisable to construct the power supply on a separate chassis in order to avoid hum pickup.

As can be seen in Fig. 4, the 6SQ7 tube is at the left of the chassis, close to the two input jacks on the left side. The 6C5 is next on the right, followed by the two 6L6's. Directly behind the 6SQ7 is the output transformer.

Components of the power supply are all at the right, Fig. 4. The power transformer and filter choke are at the extreme right-hand end of the chassis, as far away from the input stage as possible. The choke is just visible above the 5U4G rectifier. Three filter capacitors are aligned in back of the rectifier.

Controls on the front panel from left to right are the gain control, input switch, bass and treble level controls, pilot light, and the AC ON-OFF switch. The level-control potentiometers are components of the crossover network, Fig. 2. Their resistance values depend on speaker impedances, as will be explained in the section on the FAS speaker system. When an external crossover network is used these controls will be external also, and can be used as operating controls or as fixed balancing adjustments.

The filter resistor, R14, is mounted on a terminal strip, Fig. 5, which also provides tie points for the other power supply components. Two other terminal strips, located below and to the right and left of the lower 6L6 tube, carry the ground and B+ buses. All ground connections should, of course, be made to the ground bus, which is joined to the chassis at one point only. Shielded leads should be used for all wiring up to the 6SQ7 plate.

Two potentiometers can be seen on the back panel just to the right of a crossover network choke. One of these is R7, Fig. 2. Its purpose is to adjust the total resistance in the cathode circuit of the 6C5 phase splitter, so as to equalize the drive to the 6L6's. The other potentiometer and the components on the terminal strip above it were used in developmental work on the amplifier, and should be disregarded.

Use of Standard Amplifiers:

The use of the FAS amplifier design is recommended because it was worked out specifically for the crossover network and speaker system to be described. However, several of the standard high-fidelity amplifiers have been tried with the FAS speaker system and modified networks. In A-B tests, the difference in audio performance was found to be a matter of

personal and somewhat uncertain preference. Accordingly, in the course of this series, data will be given on crossover networks suitable for use with several of the standard amplifiers.

EDITOR'S NOTE: *Part 2 of this series will describe the FAS speaker system.*

WHAT'S NEW THIS MONTH

(Continued from page 11)

COMMISSIONER JONES may be correct in saying that engineers employed by commercial interests have attempted to mislead the FCC on technical issues, but the most ethical and able engineers have no chance to prevail when they are confronted with evidence manufactured to the specifications of the FCC's Legal Department. In his remarks about the industry's radio engineers, Commissioner Jones said "that their economic interest blinded their engineering judgment."

We'd like to observe that public interest, convenience, and necessity would be served to much better advantage if the FCC were not so top-heavy with lawyers, and so lacking in engineers of intellectual ability and integrity.

The effect of this state of imbalance, and its threat to the future of the radio industry, was brought out in a letter discussing radiation from FM and TV receivers which Major Armstrong wrote on August 1, 1950, to Dr. W. R. G. Baker, RTMA's Director of Engineering.

Major Armstrong cited specific examples of FM receiver design from which radiation is acceptably low, and others which caused interference over a radius of one-half mile. Radiation trouble is now growing to serious proportions because in both FM and TV, well-established engineering rules are, he wrote, "now being flagrantly violated by a large part of the industry, perhaps to their immediate profit, but certainly to the ultimate detriment of the public."

"In governmental circles," Major Armstrong continued, "the grade of engineering is little better. In fact, the present situation is due as much to FCC engineering incompetence as to unsound commercialism in the manufacturing industry. The discredited Norton and Allen theories (see Proceedings, IRE, February, 1947), which moved FM to its present wave band, brought about the interference which, without the move, could not have existed. That is not, however, the major error in judgment. The major error is the allocation of the frequencies of an air navigation service to a place within the interference range of FM and television sets where, with a large number of sets scattered about the country, the chance of something going wrong,

(Concluded on page 38)

WHAT'S NEW THIS MONTH

(Continued from page 37)

even with properly designed sets, must be considered. Why some of the non-vital types of air communication services were not assigned there to serve as a buffer region, so that all services adjacent to safety-of-life channels could be under CAA supervision, is something in need of much explanation.

"There is likewise a second question which required answering: Why is the guidance of a ship and its passengers entrusted to a transmitter having the peanut-like power of 200 watts — just about a quarter horsepower, when thousands of horsepower are employed in the other part of the transportation problem; that of keeping the ship in the air? Sound engineering judgment would dictate the use of sufficient power from ground transmitters to override even chance radiations from damaged FM or TV sets or diathermy machines out of control. Equal lack of foresight came to light a few years ago when planes were provided with superheterodynes for instrument landing operation with insufficient image rejection against FM transmitters in the center of the band.

"The list of mistakes that should not have been made could be continued, but sufficient instances have been given to make the point. Chairman Coy of the Federal Communications Commission is to be commended for bringing into the open a problem which both the Commission and the industry have been aware of for at least two years. This Commission, however, would inspire more confidence were it to admit the mistakes of the former Commission, in whose actions the basic responsibility lies. The present Commission is now face to face with the laws of Nature; it will find that they are as immutable as the laws of the Medes and Persians. A refusal to recognize that a bridge is improperly designed will not prevent the future collapse of that bridge.

"I suggest to the Radio and Television Manufacturers Association if it expects to continue to do its own engineering that it take the steps necessary to see either that that engineering is done properly, or that the facts about sound engineering be so plainly presented that responsibility for their violation can be squarely placed. If it does not do this it will find its engineering being conducted for it by some government bureau, perhaps on a lower plane of competence, but none the less being conducted for it."

Yes, that certainly can happen to an industry regulated by a government agency against whose decisions no appeal can be taken, even though they are technically wrong, as long as they are legally right.

FREQUENCY-INTERLACE

(Continued from page 14)

An adder is shown in this diagram into which may be fed:

1. Green video signals
2. Red lows on a subcarrier
3. Red highs direct
4. Blue lows on a second subcarrier
5. Blue highs direct
6. A.G.C. pilot signal

The adder output frequency spectrum would then look like that shown in Fig. 9.

Time-delay networks may also be required in the transmitter and if so would probably go into the green and red channels since once again the blue channel will be retarded the longest inherently because of the relatively narrow bandwidth devoted to blue low-frequency components. Time-delay networks may also be required in the red high and blue high circuits as indicated in Fig. 8.

Relaying and Propagation:

The video signal is capable of being transmitted over cable and radio relay networks without loss of fidelity providing the characteristics of the network are such as to provide good transmission up to 4 mc. If the cable or radio link has a band pass of only 2.8 mc., the picture is still usable as a black-and-white picture but not as a color picture because the blue and red would be missing.

Anomalous transmission vagaries at UHF are rare. Hence it is not anticipated that any difficulties will be encountered which would temporarily blot out a portion of the radiated band thereby removing a blue or a red carrier and the sidebands. Instead, it is to be expected that a continuous flow of all of the information would be received, with no significant variations.

Compatability:

This color system is compatible in that present black-and-white receivers, regardless of video bandwith, can be used to receive color transmissions in black-and-white. The green picture would constitute the signal employed in reception. Cross-talk would cause no trouble because it is geometrically in the same position on the screen as the green signal itself. If the polarity of modulation is chosen carefully, the black-and-white tube may actually be aided by the cross-talk to give lights and shadows even when the green component is considerably weakened.

Operational Tests:

As yet the system has not been completely set up, and color pictures as such transmitted and received. This is due to

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FREQUENCY-INTERLACE

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the relatively short time available. Preliminary laboratory tests have been made, however, to verify some of the basic principles. For example, a continuous-wave oscillation frequency representative of a red carrier has been superimposed on a black-and-white picture, and it has been determined that the best frequencies for it are any of those lying between line-frequency harmonics. When the injected frequency coincides with a line-frequency harmonic, vertical black and white bars are visually evident. When the frequency of the injected wave is shifted to lie midway between harmonics of the line frequency, two effects are noticed: 1) a dot pattern replaces the vertical line pattern, and 2) the intensity of light variations is reduced.

HIGH-SPEED FM FACSIMILE

(Continued from page 20)

mission and reception of a page of graphic material.

Conclusion:

The equipment described herein provides a modern facsimile system. At the Weather Bureau in Chicago, in more than twenty months of service, it has provided fast and inexpensive communication with minimum maintenance demands. Since November, 1948, the system has been out of operation only one day. That interruption was caused by antenna icing.

Facsimile transmitters and receivers are operated and maintained by personnel of the Weather Bureau. Specially-trained operators are not necessary.

FAX & TELEMETERING

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tially. Because the recorded copy is continuous, the map is received in two sections rather than four which, when joined with plastic tape, provide a map 16.4 by 23 ins.

The maps are not specially prepared for facsimile transmission, and certain areas contain high concentrations of small figures and symbols. For adequate resolution, a minimum advance of 105 lines per in. is used. Normally, ten shades can be transmitted from full black to white, and the transmitter operator can emphasize either the lighter or darker shades of the transmitted copy.

VHF receivers feeding the facsimile recorders operate continuously and unattended at the receiving terminals. A recorder operates only when the carrier-operated receiver relay is closed by a transmitter signal. Automatic phasing is effected by transmission of an audio phasing signal.

Telemetering Weather Data:

The Weather Bureau also operates a number of scattered, unattended weather stations which measure automatically such variables as temperature, wind velocity, and barometric pressure, and transmit signals proportional to these quantities to central pickup stations. There are many unattended sites where telephone lines are practically or economically unsuitable, and at these sites the signals must be transmitted by radio.

Fig. 2 is an interior view of the equipment installed at Rollins Pass, Colorado, 40 miles west of Denver. The vertical chassis at the left is the basic FM transmitter; the chassis at the right is the superheterodyne receiver. The unit mounted above these two is the 4-65A power amplifier and power supply. A control panel in the center contains a coaxial relay which shifts the antenna from receiver to transmitter.

This equipment is arranged to transmit a series of weather data from adjacent meteorological instruments once each hour. In addition, the equipment can be activated by transmitting an interrogating carrier from the central station at Denver. The interrogating

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FAX & TELEMETERING

(Continued from page 40)

carrier causes the receiver to switch on the transmitter, which then transmits the data in the normal fashion.

Various circuit arrangements are possible for the telemetering operation. One method which has been tested consists of assigning a keyed audio frequency to each variable to be transmitted and separating the different modulating frequencies at the receiver with selective resonant relays. The method currently used transmits each variable in sequence, by means of a coded signal whose pattern depends on the magnitude of the corresponding variable.

CUSTOM DESIGNS

(Continued from page 29)

the bottom of page 16 in *FM-TV* for June, 1950. It is very useful because so many people don't know that all kinds of equipment not found in factory-built sets can be included in custom-built designs. For example, when Mr. Smith sees what I put in for Mr. Jones, he may wish he could have a similar system but with other added features. Yet he may not know that those features are readily available until I invite him to see my demonstration setup.

How does a custom designer get new customers? Most new business comes from the satisfaction of clients previously served. People live in groups. A family that appreciates fine audio reproduction from an attractive system probably belongs to a group of families with similar tastes.

So the business grows. It takes root in work well done. It is nurtured by good will and confidence. Other means of promotion are very limited. The custom designer is in much the same position as a doctor or a lawyer. They succeed or fail according to their reputations. One very useful selling tool available to the custom designer, however, is a book of photographs of installations he has made, and any other pictures he can collect to show prospects how systems in other homes might be adapted to his particular needs.

Typical Installations:

The accompanying illustrations show some of the various types of installations I have made recently. Figs. 1 and 2 illustrate a conventional arrangement that meets a wide range of requirements. Sometimes it is necessary to furnish the entire bookcase construction. In other instances, only a modification of existing shelves is necessary. This system is made up of an FM tuner and an amplifier and noise-suppressor in the two upper sections, with a filing space for LP records and a changer below. The loudspeaker enclosure was built into the upper shelves, on the left.

Fig. 2 shows how the front of the changer compartment is hinged across the center. It is a small matter, but it permits the use of a deep drawer, and gets the front out of the way when records are being put on the changer. Cool air enters the equipment section from the open space at the bottom, and moves out through slots cut in the back of the shelf directly above the receiver and amplifier.

Although the cabinet shown in Fig. 3 is of rather large dimensions, its corner location involved no loss of useful floor space. Equipment comprises an FM-AM tuner, amplifier and noise-suppressor, a drawer-mounted changer, and a speaker on the opposite side of the room. A second speaker, Fig. 4, is in another room used as a study. Since no floor or wall space was available, a mounting was built over the filing cabinet.

Fraternity houses and clubs need good radio reception for sports events and for dancing. Here custom installations show up to good advantage because standard radio-phonographs generally aren't adequate, and they don't stand up under the rigors of such service. Fig. 5 shows a unit built for the Theta Chi House at the University of Connecticut.

There is an FM-AM tuner, amplifier, and record-changer at the top, with filing

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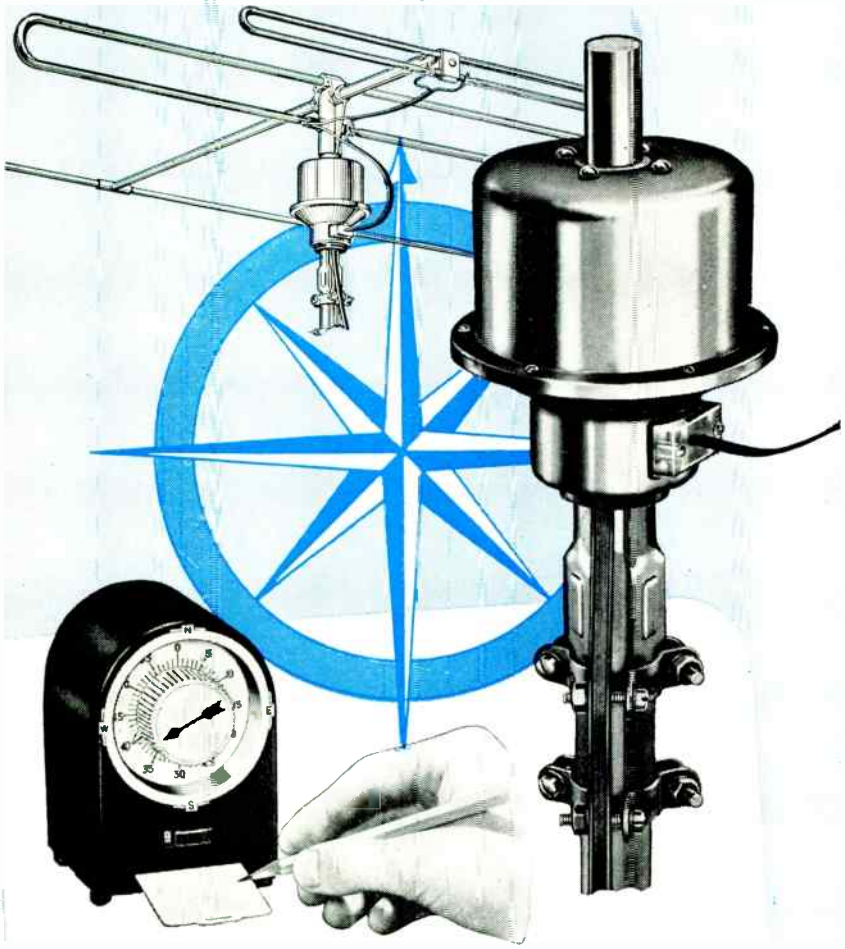

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AMPHENOL takes pride in announcing the new "Auto-Dial" TV Antenna Rotator. It features an entirely new and different principle of rotator control called "automatic travel action," and represents the greatest single advance in antenna rotators.

There are no tiresome buttons or switches to hold while the antenna is turning. An effortless turn of the knob to the correct setting and "Auto-Dial" takes over. Automatically—just like magic—the antenna follows to point directly at the TV station—then stops!

So accurately does it perform that even a child can "log" antenna positions, accurately returning to them time after time. Rotation is in steps of 6 degrees, accurately calibrated on the indicator. Because of this important feature, servicemen can now determine whether an antenna is functioning properly, whether it has the required front-to-back ratio and whether it is properly located for the best possible picture.

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NOS. 1 & 2 CROSSOVER NETWORKS: Components for the complete speaker system, designed for use with the Air-Coupler, a medium-range speaker, and a tweeter. Consists of 4 inductors, 4 capacitors, and 2 variable resistors for impedance matching.
Item No. 4: $15.00

12-IN. ALTEC 600-B SPEAKER: For use in the Air-Coupler and as the medium-range speaker. Impedance is 8 ohms.
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RACON CHU-2 TWEETER: The improved driving unit with a divided horn. Impedance is 15 ohms. . . . . Item No. 6: $22.50

COMPLETE FAS SPEAKER SYSTEM: Comprising items 2, 4, 5, and 6 above.
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General Apparatus Co.

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CUSTOM DESIGNS

(Continued from page 41)

space for LP records in the drawers below the speakers, and ample room for albums behind the sliding doors at the bottom. Toe-space is provided across the front so that the cabinet will not be marked.

One of the two speakers is mounted at a 45° angle, to direct its output toward the foyer. Space between the speakers will be used subsequently for a TV set.

A favorite plan of mine is to use cupboards for mounting radio equipment. Fig. 6 illustrates a typical design. The insert shows the appearance when the doors are closed. TV unit, amplifier, and tuner are of coordinated design, greatly simplifying the arrangement.

Figs. 7 and 8 show a job for an advertising agency that posed some unusual problems. It is in the General Electric Building, New York City. The antenna is 43 stories above the receiver, necessitating the use of 780 ft. of RG-11U cable run down through ducts and conduits. In addition to audio and television reception, the varied uses of this equipment call for a sound motion picture projector and plug-in connections to the amplifier. When that equipment is in use, a screen is hung in front of the speaker. There is also a tape recorder which can be pulled out, disconnected, and carried off wherever it is needed. Later, the tape can be played over the amplifier and speaker system.

Frequently people want extra speakers, as in Figs. 9 and 10. Here, the equipment is in the library, with a speaker in the living room. T-pads, mounted under the FM-AM tuner, provide individual volume controls. Also in that space is the control for an antenna rotator. Ventilation is obtained from an inlet at the bottom cut through to the cellar, and an outlet slot in the shelf directly above the tuner and amplifier.

The old chestnut cabinet, Fig. 11, is a particularly handsome piece. It was finished to match the existing woodwork exactly. The record-changer is in a drawer below the FM tuner, with record-storage space behind the end doors. Ventilation is provided by the grille at the rear. No speaker can be seen, as it is mounted inconspicuously at the other end of the game room.

Fig. 12. shows a radio-phonograph system with a special amplifier and equalizer to handle speakers mounted in several different rooms.

Notes on Details:

A study of these illustrations will reveal the careful attention given to every last detail of equipment, appearance, and

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CUSTOM DESIGNS

(Continued from page 43)

finish. The cabinet work for most of my installations is done by Irving H. Beckwith and his son. Frequently, molding and trim must match existing woodwork, calling for making up special cutters. Sometimes existing hardware has to be matched, even if copies must be cast, machined, and finished.

I very often mount speakers on angled baffles, so that the sound is directed to best advantage. Of course, this cannot be seen through the grille cloth. I always mount the grilles with spring clips, so they can be removed easily. A small space is left between the grille and the cloth because, if they are in contact, the cloth will wear, due to vibration.

As a rule, I use Workshop antennas with RG-11U cable, which can be run in conduit when necessary, or adjacent to metal. It is mechanically tough, can be painted, and does not seem to deteriorate.

Usually, installation work is fairly simple and straightforward, but occasionally there are real complications. One, for example, called for the services of a carpenter, two cabinet-makers, a painter, an electrician and helper, and an air-conditioning contractor. Also a 10-ton crane, manned by a crew of six, was needed to erect a 4,800-lb., 105-ft. mast, and telephone and power linemen had to remove and replace obstructing wires. That mast was put up without damaging a tree or a shrub.

AM and TV Reception:

As you can see from the illustrations, AM reception is a rather minor consideration in custom jobs. Many do not provide for AM at all. The whole purpose of these installations is to produce high-quality reproduction, and AM doesn't fit into that kind of a picture.

The television situation is a different matter. When a customer wants TV reception included, my concern is whether or not he can get absolutely top-quality images. I know from experience that dissatisfaction over one part of the equipment can spoil an owner's enjoyment of the part that works perfectly.

Therefore, if there is doubt about the signal level or the interference at a given location, I say so very frankly. It isn't wise to furnish any equipment that may be uncertain in operation, nor do I want any uncertain operation associated with one of my installations. It is much better for me to persuade the customer to get a TV set from someone else, and to install it separately. But when I do supply television, every effort is made to provide performance as good or better than he will see anywheer else.

MOBILE RADIO NEWS

(Continued on page 16)

Miscellaneous Notes:

The State Guard Radio Service is to be restored under a proposed amendment issued by FCC which would add a new Subpart K to Public Safety Radio Service Rules. Some thirty authorizations were issued during World War II in this Service, deactivated on July 1, 1948.

FCC has decided to hold hearings to determine which applicants will receive regular licenses as miscellaneous common carriers in Los Angeles, New York and Houston. Hearing dates have not yet been fixed and probably won't be until FCC decides two-versus-four-channel question of allocations in the same area for this service.

COLOR AS THE FCC SEES IT

(Continued from page 15)

were the monochrome pictures from color transmissions under the RCA or CTI proposals. . .

You have undoubtedly heard the CBS color system described as a mechanical system. . . The Commission pointed out in its report that the CBS system is not limited to the mechanical disc. A projection receiver was shown which did not require a disc. Also, if a direct-view tricolor tube is successfully developed, all the expert witnesses agreed that it can be utilized on the CBS system. . .

All of the Commissioners agreed that it would be desirable to have a compatible color system if that were possible. However, the Commission was forced to conclude that no successful compatible color system had been demonstrated. . .

Bracket Standards Plan:

All of the Commissioners are of the opinion that if a decision must be made now, the CBS color system would be adopted. However, five of the seven Commissioners are willing to postpone a decision, if certain conditions are met, in order to see a demonstration of a tri-color tube on the CBS system, to receive further evidence concerning horizontal interlace and long-persistence phosphors, and to look into certain developments in so-called compatible color systems which have occurred since we closed the hearing record, to see if they meet the requirements of a color television system as set forth in the report. . .

The Commission has given the manufacturers until September 29, 1950, within which to tell the Commission whether they will manufacture receivers incorporating bracket standards. If we receive adequate assurances on that score,

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COLOR AS THE FCC SEES IT

(Continued from page 45)

we will postpone a color decision and look into the developments I have already referred to. If we do not receive such assurances, we will adopt a final decision and designate the CBS system as the standard color system. . .

But, you may ask, why is it necessary for manufacturers to adopt bracket standards in the meantime? For, you may say, if a new compatible system is developed, the brackets will have been unnecessary.

These are fair questions and I will give you frank answers. In the first place, no successful compatible color system has been demonstrated.

In the second place, the Commission recognizes that it is entirely too easy to invent a new compatible system every time the Commission appears to be ready to adopt an incompatible system. If a lengthy hearing is held each time, then the number of receivers in the hands of the public becomes so large that, as a practical matter, an incompatible system cannot be adopted.

In other words, if the Commission were to postpone making a decision on color at the present time and proceed with a further hearing, without having assurances as to brackets being incorporated into receivers, we would be inviting a situation where, at the end of such hearing, fundamental defects might still be present in the compatible system but the incompatible system could not be adopted because the number of receivers in the hands of the public would have increased tremendously. . . We are unwilling to postpone adopting the CBS system if the manufacturers do not build receivers with bracket standards, for, in that event, we would be inviting the risk that if the compatible system failed again, we would probably not be able to adopt the CBS system.

In the third place, two developments were demonstrated during the hearing that hold real promise for improving resolution in black and white pictures. There are horizontal interlace and long-persistence phosphors. More work is needed before a final answer can be given concerning these techniques. If they are successful, a change in line or field scanning rate, or both, might be desirable in order to take advantage of the improvements. By building receivers with bracket standards at the present time we will not be confronted at a later date with the vexation of not being able to improve resolution in black-and-white pictures because so many sets would be outstanding and incapable of operating on the new standards. . .

ADVERTISERS INDEX

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AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR
Class AB_1 (Sinusoidal wave, two tubes, unless otherwise specified)

DC PLATE VOLTAGE	3000	4000	Volts
DC SCREEN VOLTAGE	750	600	Volts
DC GRID VOLTAGE (approx.)*	-136	-116	Volts
ZERO SIGNAL DC PLATE CURRENT	160	130	Ma
MAX. SIGNAL DC PLATE CURRENT	620	510	Amp
ZERO SIGNAL DC SCREEN CURRENT	0	0	Ma
MAX. SIGNAL DC SCREEN CURRENT	28	10	Ma
EFFECTIVE LOAD PLATE TO PLATE	9200	16,000	Ohms
PEAK AF GRID INPUT VOLTAGE (per tube)	136	116	Volts
DRIVING POWER	0	0	Watts
MAX. SIGNAL PLATE POWER OUTPUT	1100	1280	Watts

*Adjust to give stated zero-signal plate current.

A pair of Eimac 4-400A tetrodes provides the ideal answer for a one-kilowatt AM or FM broadcast power amplifier stage. The 400-watt plate dissipation rating of these tubes allows extremely conservative operation at the 1-kw level, thus assuring long, trouble-free tube operation.

In AM service, the 4-400A is FCC rated for 500 watts output per tube in high level modulated amplifiers. In FM applications, the superlative performance of the 4-400A at VHF allows an easy 1-kw of useful power output from a pair of tubes.

The low driving-power requirement of these tetrodes allows the driving equipment to be reduced to simple low power stages employing low cost tubes. The rugged construction of the 4-400A, plus a Pyrovac plate and the use of other time-proven materials and manufacturing processes, contributes to the tube's long life and ability to withstand both physical and electrical abuse.

To simplify transmitter design, an Eimac air system socket and chimney assembly is available for the 4-400A. This assembly provides a balanced flow of cooling air to the tube with minimum air waste, as well as completing the shielding between input and output circuits.

The low driving-power required by the 4-400A makes it an ideal choice for audio as well as r-f application. High audio power at low distortion can easily be obtained with zero driving power. (See accompanying data.)

For tube economy in one-kilowatt equipment, consider the service-proven 4-400A developed by America's foremost tetrode manufacturer . . . Eimac. Complete technical data are available . . . write today.

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