Price 25 Cents

Mar. 1948

FM AND TELEVISION

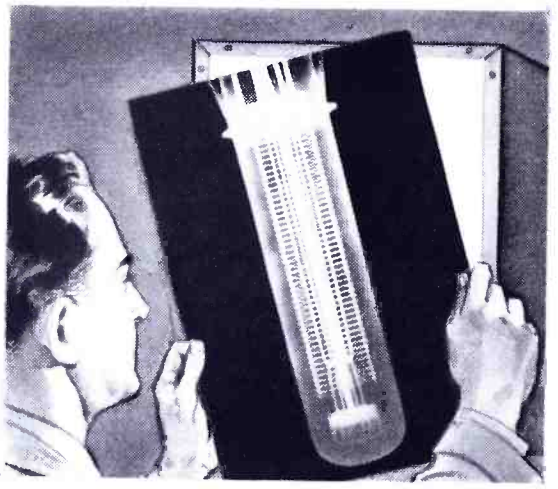
★ ★ Edited by Milton B. Sleeper ★ ★

DUAL ICONOSCOPE FILM PICKUP SYSTEM

(See pages 4 and 31)

8th Year of Service to Management and Engineering

HERE'S THE INSIDE STORY

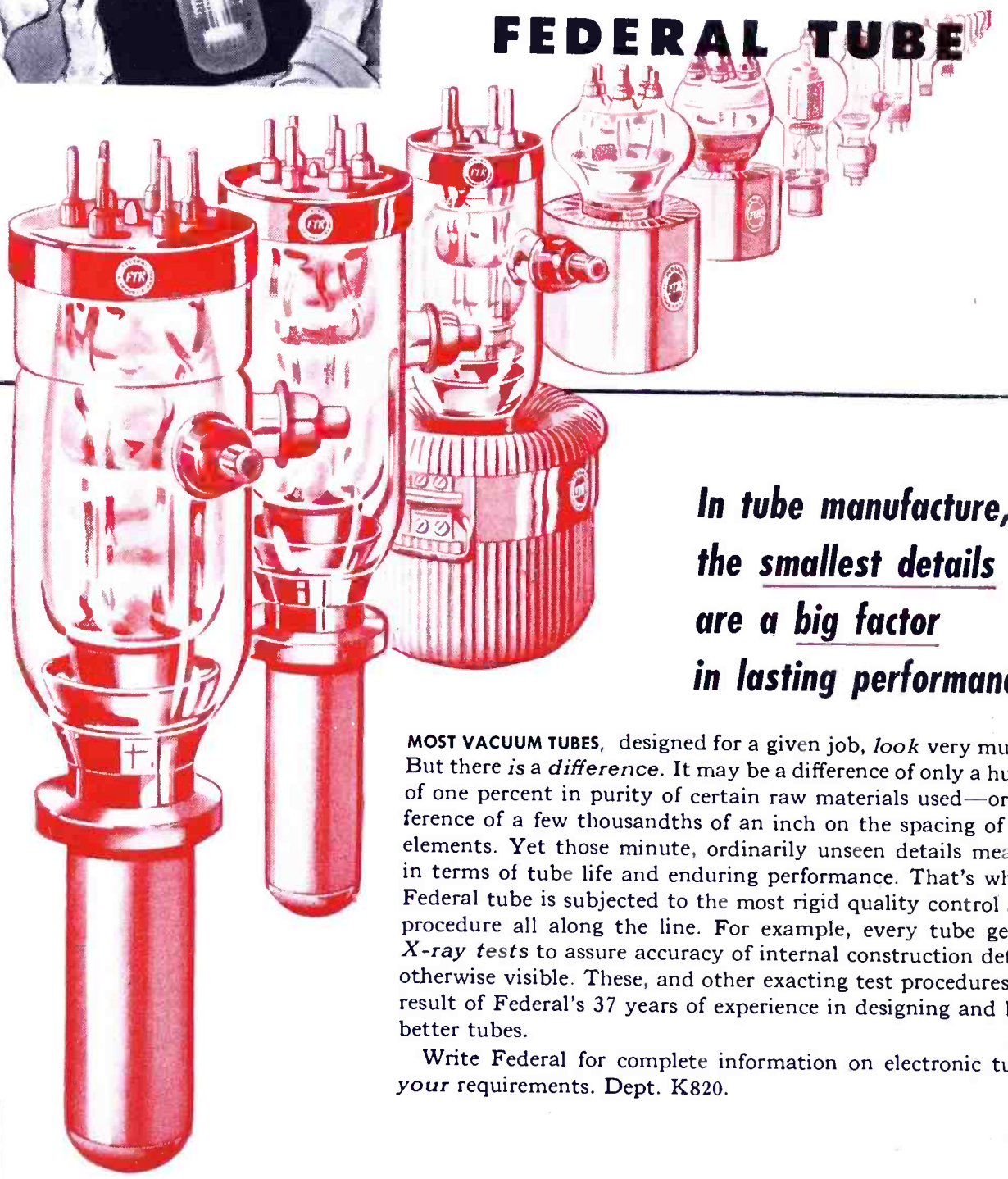


that means

Longer Life with Enduring Performance

for every

FEDERAL TUBE



In tube manufacture, the smallest details are a big factor in lasting performance

MOST VACUUM TUBES, designed for a given job, *look* very much alike. But there *is* a *difference*. It may be a difference of only a hundredth of one percent in purity of certain raw materials used—or the difference of a few thousandths of an inch on the spacing of internal elements. Yet those minute, ordinarily unseen details mean much in terms of tube life and enduring performance. That's why every Federal tube is subjected to the most rigid quality control and test procedure all along the line. For example, every tube gets three *X-ray tests* to assure accuracy of internal construction details not otherwise visible. These, and other exacting test procedures are the result of Federal's 37 years of experience in designing and building better tubes.

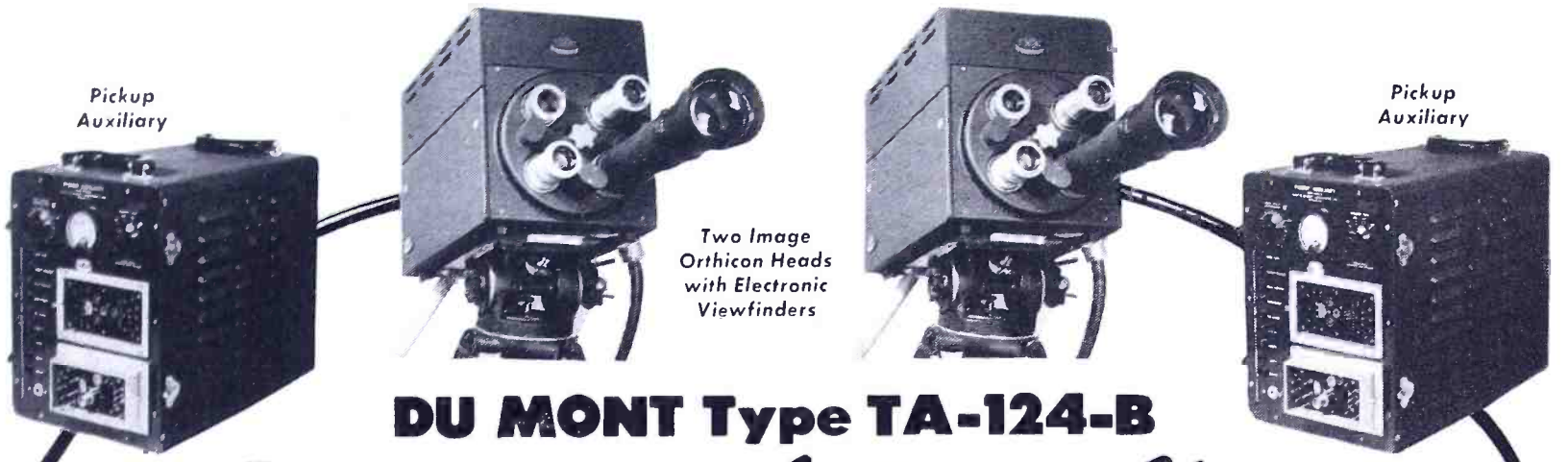
Write Federal for complete information on electronic tubes for *your* requirements. Dept. K820.

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

Federal Telephone and Radio Corporation

100 KINGSLAND ROAD, CLIFTON, NEW JERSEY

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors:—International Standard Electric Corp. 67 Broad St., N. Y.



DU MONT Type TA-124-B

Dual Image Orthicon Chain

Split-second action through quick setup and finger-tip controls; accessibility for time-saving inspection and immediate maintenance; superlative image pickup with precise electronic viewfinder checkup; handy matched units for all required power, synchronizing, amplifying and monitoring functions plus latest camera effects—such explains the popularity of the Du Mont Type TA-124-B Dual Image Orthicon Chain for studio and outdoor telecasts alike.

Whatever your telecasting plans or requirements —from modest start (Acorn Package) to most ambitious setup—whether local station or network—be sure to get the details of this oustanding camera equipment. From camera to antenna, it's DU MONT for "The First with the Finest in Television."

FEATURES...

Heavy-duty cables and "Jiffy" Connectors for trouble-free operation. Built in intercommunications.

Camera: Four-lens turret. Electronic viewfinder and camera integral assembly, but separately operable. Heater and blower for wide variation of ambient temperatures. Pan-handle operation of focus control. Remote iris adjustment from camera rear. No screwdriver controls. Factory-aligned peaking in video preamplifier.

Auxiliary: Pentode control of focus-coil current. Independent cable delay compensation for multiple camera hook-ups.

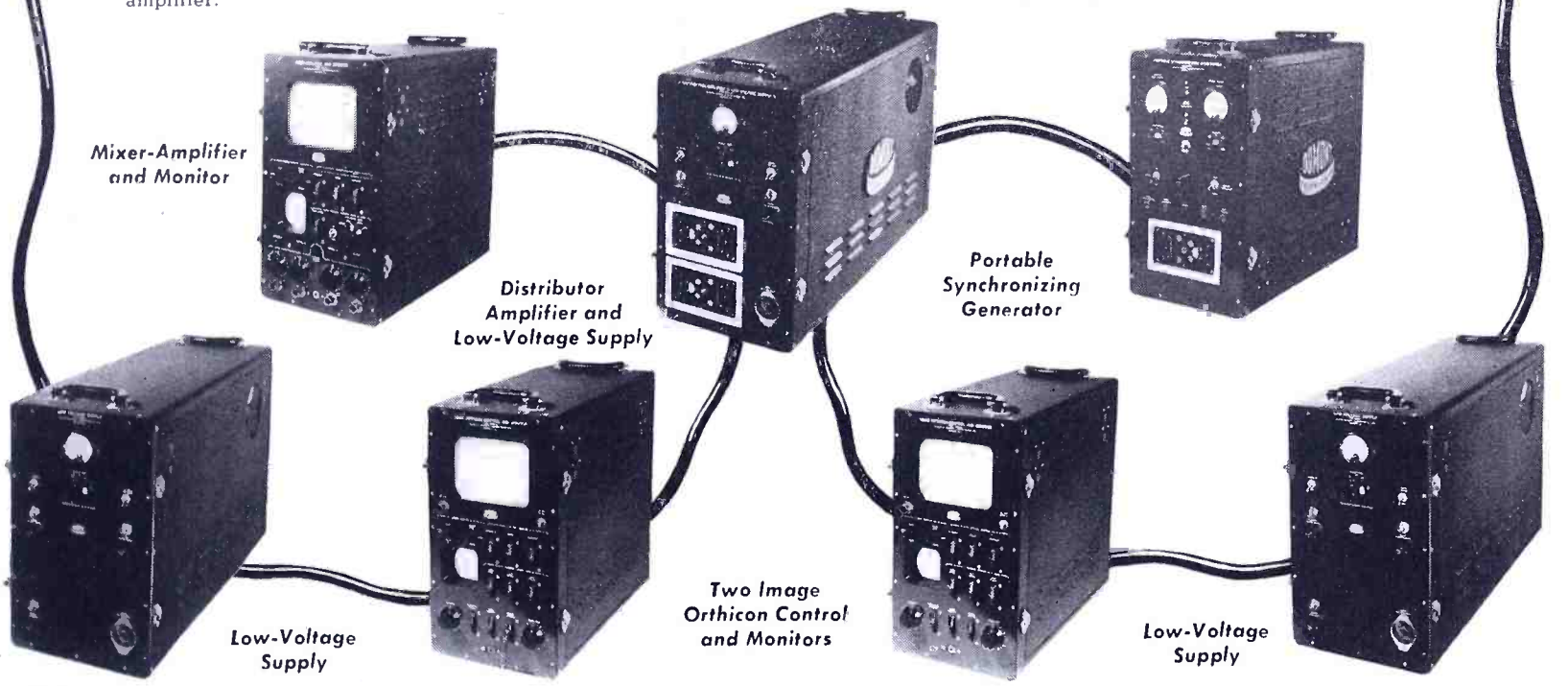
Power Supplies: Rugged construction. Super-regulating supplies for video circuits.

Control and Monitor: Thumb-wheel controls. Line-to-line clamp circuits. Single-camera chain operation if necessary.

Sync Generator: Smallest and lightest portable unit extant. Better rise time of pulses and freedom from adjustments than most studio type sync generators.

Distribution Amplifier: Equipment set up to handle up to four cameras without use of junction boxes.

Mixer Amplifier and Monitor: Automatic lap dissolve and fading circuits (four speeds) applicable up to four channels. Normal manual mixing and fading, also built in.



DUMONT *First with the Finest in Television*

ALLEN B. DU MONT LABORATORIES, INC. • TELEVISION EQUIPMENT DIVISION, 42 HARDING AVE., CLIFTON, N. J.
SEE OUR DISPLAYS AT BOOTHS 244–248, I.R.E. NATIONAL CONVENTION

.022 .0047 .15 .033 .068

Funny Numbers?

. . . perhaps, but they are more evidence of SPRAGUE LEADERSHIP!

New Phenolic-Molded Sprague Tubular Capacitors Produced in Decade Ranges and Color-Coded!

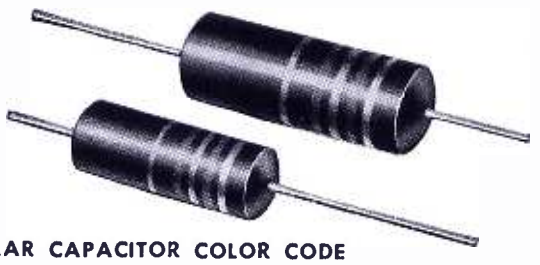
With the recent introduction of its sensational new *molded* tubular capacitors, Sprague now announces standardized capacities, and color-coding for ready identification of these new units. For example, starting with the number 1, the next numbers in the 20% tolerance decade are 1.5, 2.2, 3.3, 4.7, 6.8 and on back to 10.

Established decade ranges and color-coding have proved their efficiency and acceptability in the resistor industry over a period of years. Now, for the first time, this same practice will allow capacitor manufacturers the many advantages of standardized production—advantages which we feel will be cumulative through the years.

In the firm conviction that these steps toward standardization will prove mutually beneficial, Sprague Electric Company solicits your cooperation and invites your inquiries for information, samples and application data concerning the new SPRAGUE MOLDED TUBULAR CAPACITORS. WRITE FOR ENGINEERING BULLETIN NO. 210-A.

THE FIRST TRULY PRACTICAL PHENOLIC-MOLDED PAPER TUBULAR!

Highly heat- and moisture-resistant • Non-inflammable • Conservatively rated for —40°C. to 85°C. operation • Small in size Completely insulated • Mechanically rugged Moderately priced.



SPRAGUE MOLDED TUBULAR CAPACITOR COLOR CODE

			Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Gray	White
1st BAND	Capacity in MMFD	First Significant Number	0	1	2	3	4	5	6	7	8	9
2nd BAND		Second Significant Number	0	1	2	3	4	5	6	7	8	9
3rd BAND		Decimal Multiplier			100	1000	10,000	100,000				
4th BAND	TOLERANCE		±20%			±30%	±40%	±5%				±10%
5th BAND	RESERVED FOR ARMED SERVICES											
6th BAND	Voltage in Hundreds (x 100)	First Significant Number	0	1	2	3	4	5	6	7	8	9
7th BAND		Second Significant Number	0	1	2	3	4	5	6	7	8	9

SPRAGUE ELECTRIC COMPANY North Adams, Mass.

CAPACITORS **SPRAGUE** *KOOLOHM RESISTORS

*Trademark reg. U. S. Pat. Off.

PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS

FM AND TELEVISION

★ ★ Edited by Milton B. Sleeper ★ ★

FORMERLY, FM MAGAZINE and FM RADIO-ELECTRONICS

VOL. 8 | MARCH, 1948 | NO. 3

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THIS MONTH'S COVER

Experience with television programming is coming to emphasize the value of motion pictures as program material. Except for details of production technique and the sound quality, the audience is not conscious of any difference between film and live shows. And television has the advantage of eliminating the flicker that still characterizes theatre movies, projected on a screen.

To meet the need for adequate film pickup, monitoring, and transmission, DuMont Laboratories has developed and is producing the control console shown on this month's cover, and described by Messrs. Smith and Gregory in this issue.

Entered as second-class matter, August 22, 1945, at the Post Office, Great Barrington, Mass., under the Act of March 3, 1879. Additional entry at the Post Office, Concord, N. H. Printed in the U. S. A.

WHAT'S NEW THIS MONTH

1. JANUARY PRODUCTION
2. FM BROADCASTING

1. There's growing conviction that the number of set manufactures will be reduced substantially during 1948. The reason is not so much that the volume of business won't support the present number, but rather that FM and television have introduced such problems of development, design, production, and quality control that only companies with well-organized engineering and manufacturing departments will be able to hold their own.

Concerns who leaned on outside laboratories, and who merely revised designs copied from competitors are expected to find the going very tough this year.

In January, as would be expected, total set production by RMA members dropped. AM sets amounted to 1,173,240, off 311,000 from December, and 654,000 below the October record.

FM sets totalled 136,015 in January, off 55,000 from the all-time high in December. However, 65,166 FM table models were manufactured, a gain over the 58,225 December figure.

TV sets amounted to 30,001, a gain of 656 over December. This represents a slight rise in console models and a loss in table models.

In the accompanying Production Barometer, 1947 figures on FM, AM, and TV sets are shown so that 1948 figures can be compared by months.

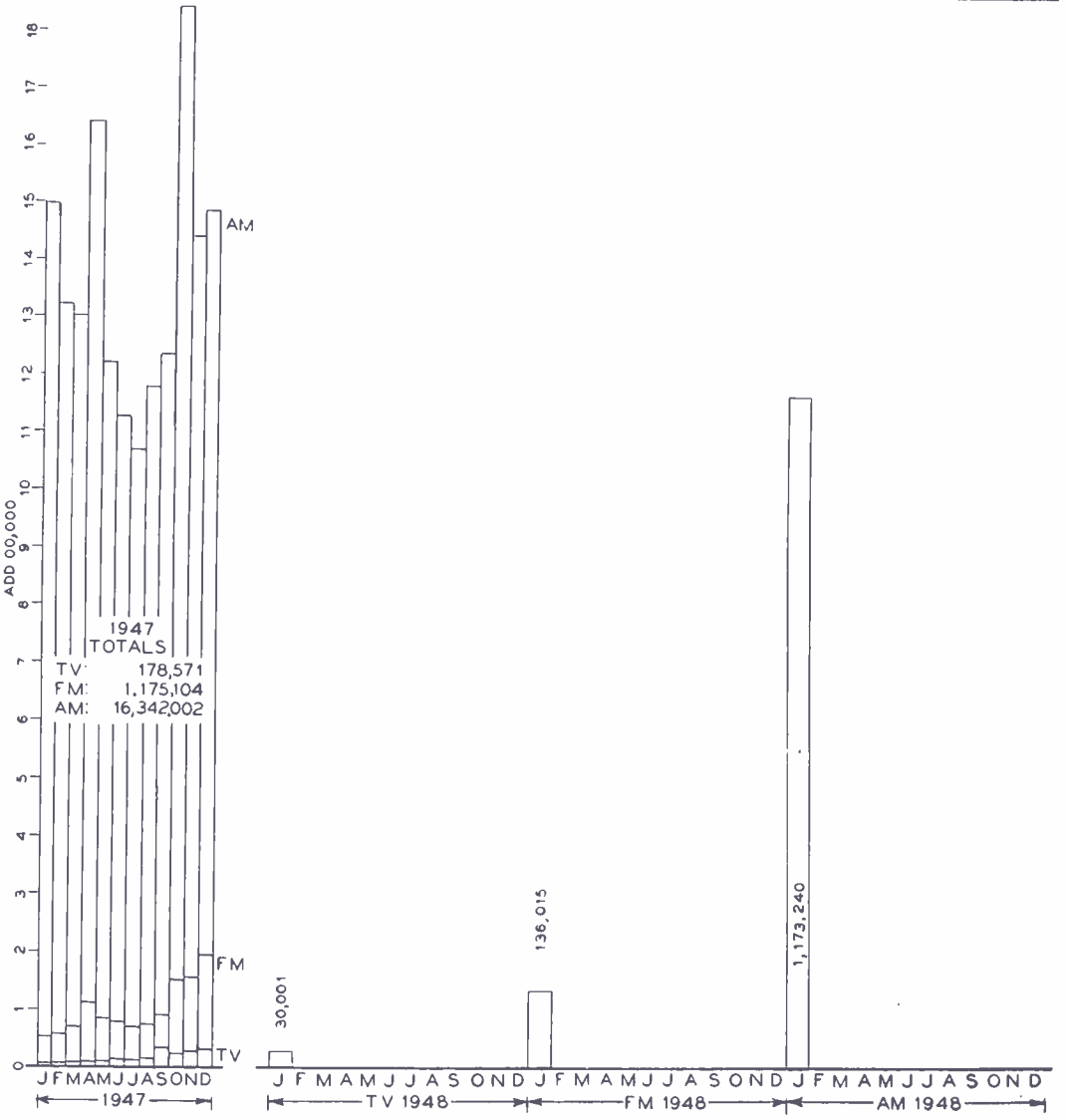
2. On February 19, Everett Dillard, president of FMA and of Continental FM Network delivered an address before the New York Radio Executives Club that is noteworthy as a factual, straightforward presentation of the relative positions of FM and AM broadcasting. Parts of this address to time-buyers and agency executives are quoted here:

I take my hat off to you men who have made AM radio what it is today, because AM radio has many limitations not known to you advertising people, largely because they are primarily technical.

I have on my office wall a small poster that states a truism which, I feel, is appropriate. This little bit of sage philosophy talks about the Bumblebee. It says:

"According to recognized aerotechnical tests, the bumblebee cannot fly because of the shape and weight of his body in relation to the total wing area. But, the bumblebee doesn't know this, so he goes

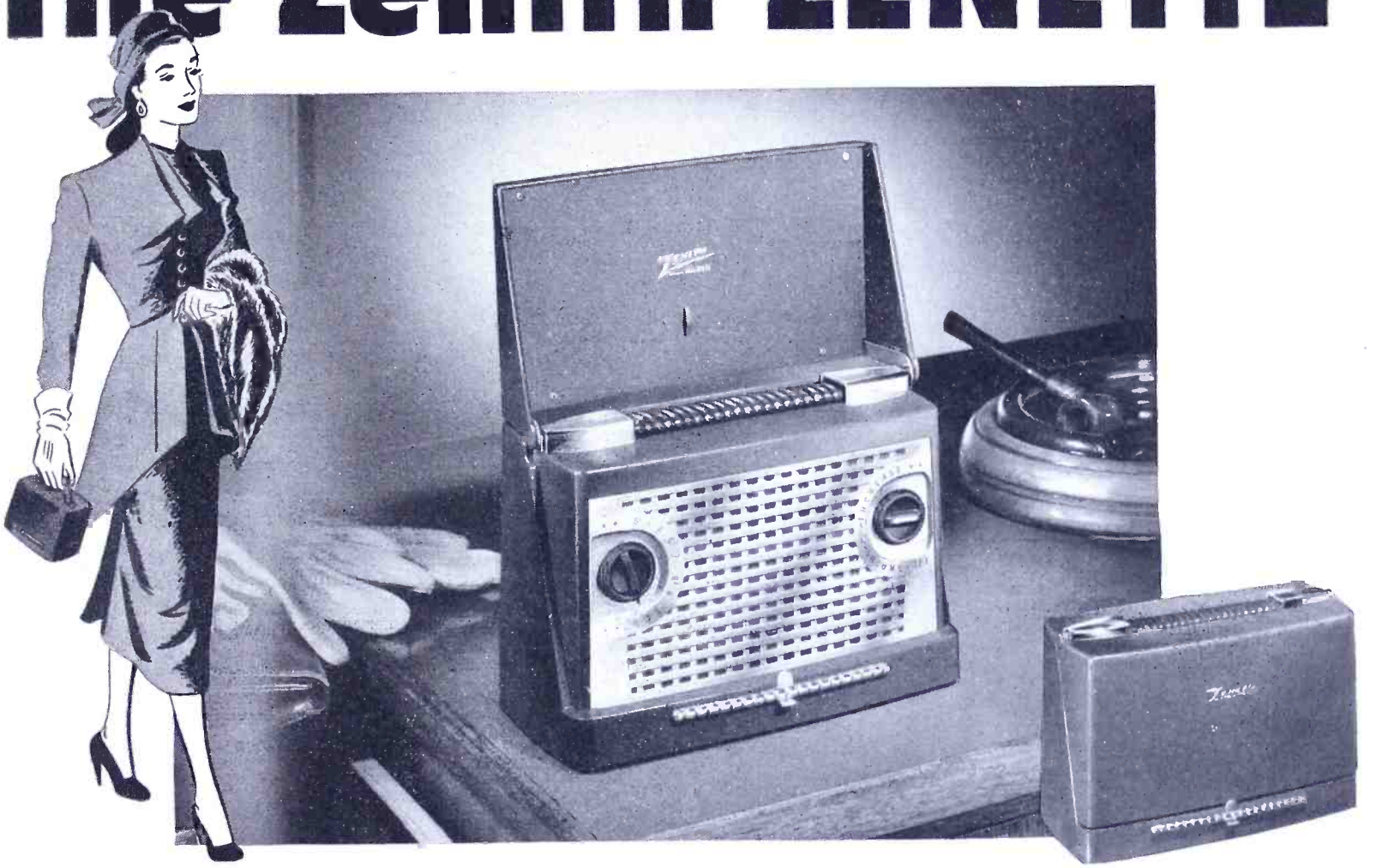
(CONTINUED ON PAGE 14)



TV, FM, AND AM SETS PRODUCED IN 1947 AND 1948 BY RMA MEMBERS

A Personal Portable Radio That Is "Out Of This World"...

The Zenith ZENETTE



It's Another Zenith Triumph

Here is the *Ultimate* in a Personal Radio—a tiny set that knows no compromise with quality, performance or value . . . a personal portable with *features.* "Zenette" is a brilliant presentation of the know-how gained by Zenith engineers in more than three decades of Radionics Exclusively.

Here, certainly, is a radio you will display proudly, for this is the *perfect* gift . . . the radio that will make a hit with the man or woman who "has everything." For this is a *beauty* . . . almost jewel-like in its sparkling elegance . . . amazing in its vigorous full tone and volume . . . and the most *convenient* radio ever built. It's a personal portable—it's an exquisite table model—it's the *new kind of radio* that will make sales aplenty for Zenith dealers.

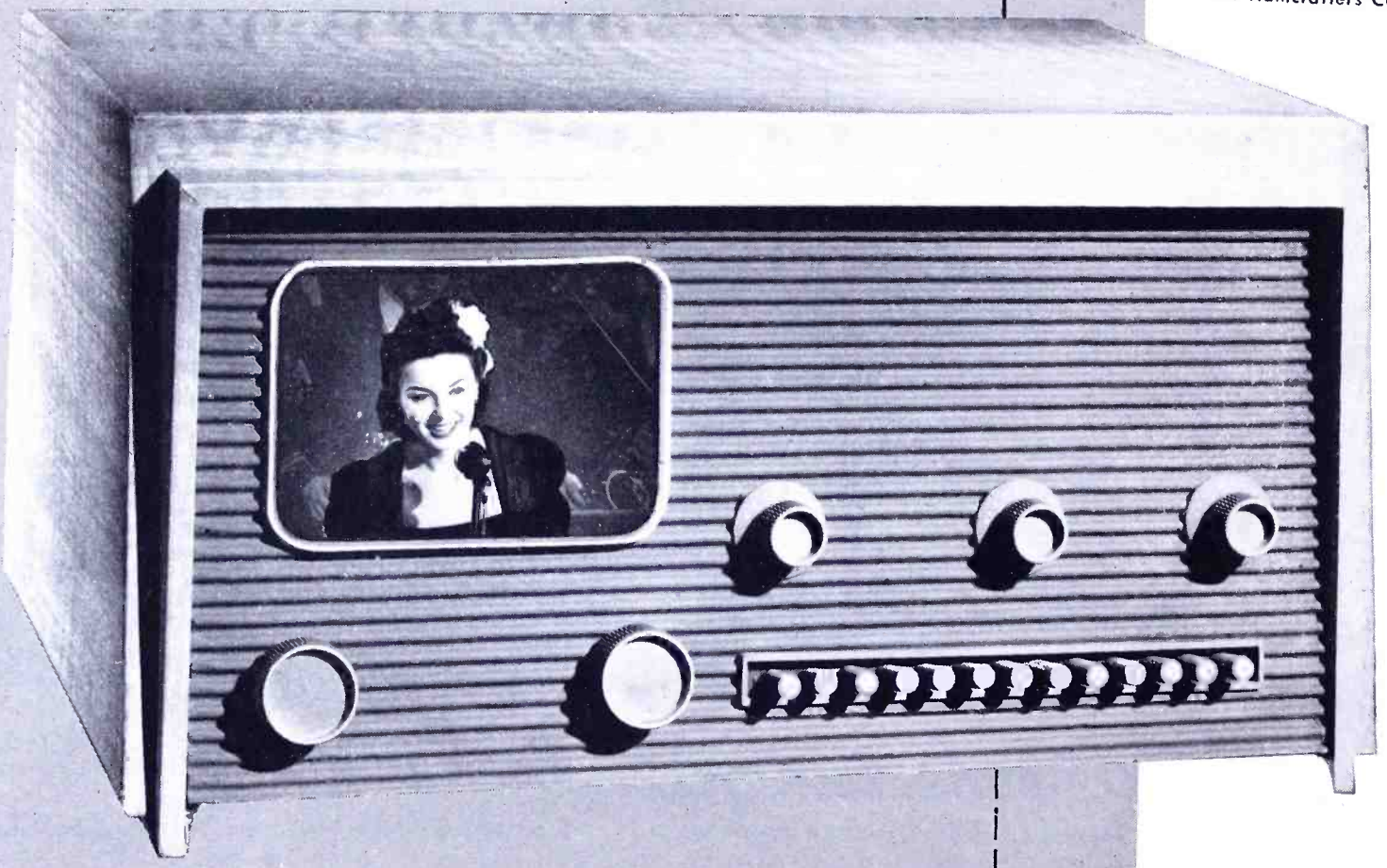
Suggested List Price (Zone 1) **$42.45** *Less Batteries*

With All These Features

- **AC/DC AND BATTERY POWER**—Will play practically anywhere.
- **QUICK BATTERY CHANGE**—Batteries slip into place in an instant without tools.
- **EXTRA POWER**—Full 90 volts on AC or DC.
- **STRIKINGLY BEAUTIFUL**—The perfect gift.

Zenith Radio Corporation • 6001 Dickens Ave • Chicago 39, Ill.

hallicrafters
PRESS BOX



Hallicrafters Press Box is exciting in appearance, magical in performance and tremendously significant in its pricing. It is the forerunner in important developments to come, including projection type television in the great Hallicrafters Carnegie Hall series of console combinations.

Write for name of your local distributor.

$199.50

hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.
Sole Hallicrafters Representatives in Canada:
Rogers Majestic Limited, Toronto-Montreal

Presenting a whole new view of the radio-television business

Hallicrafters presents the "Press Box"—a high quality, high precision television receiver made—as only Hallicrafters can make an instrument like this—*to sell for $199.50.*

Sharp, clear, steady pictures that put you down front and center in the best seats in the house for the most exciting spectacles in the coming era of sight and sound.

Price and precision coupled with Hallicrafters character and quality make a combination that cannot be equalled. The "Press Box," an extraordinarily fine and sensitive instrument, is the direct result of Hallicrafters 15 years specialization in the development of advanced high frequency circuits.

Modernly designed cabinet of grayed bleached mahogany, perfectly adapted to the function of the receiver. 7" electrostatic tube provides a picture size 4" by 5⅞" with perfect, continuing clarity. Controls for contrast, brightness, volume, horizontal and vertical hold, fine tuning and 13 push buttons for channel selectivity. Uses inter-carrier modulation type FM sound system and a built-in 4" by 6" oval PM dynamic speaker.

A special automatic gain control circuit controls the I. F. system to maintain constant reception in spite of atmospheric or other variations in signal strength from the transmitting station. Sensitivity and distance reception of the "Press Box" is amazing and comparable to those in the much higher brackets. The set has three stages of I. F. using iron core I. F. Transformers. 22 tubes. Comes complete with cathode tube installed. No extra assembly required.

Hallicrafters "Press Box" is exciting in appearance, magical in performance and tremendously significant in its pricing. It is the fore-runner of important developments to come including projection-type television in the great Hallicrafters Carnegie Hall series of console combinations.

TELEVISION BY HALLICRAFTERS

TELENOTES

Warning: Has been sounded by Dr. Allen B. DuMont against cheap television receiver designs. This applies not only to cutting corners through the use of second grade components which invite failures, but to over-simplified tuning circuits which radiate powerfully, and cause serious interference at other receivers.

New Installation: Contracts for RCA television equipment have been signed by WMC Memphis, WCON Atlanta, WAVE Louisville, and WJAR Providence.

WATV: Newark, N. J. is already transmitting test patterns on channel No. 13. Meanwhile, studios are being rushed to completion in the Mosque Theatre Building.

Rodney Chipp: Formerly of ABC and NBC, has been appointed assistant engineer for the DuMont TV network.

WPIX: Regular transmission from the Daily News station on East 42nd Street, New York City, is scheduled to start June 15. The original plan to await the FM decision before starting TV construction has been abandoned.

Projection Receiver: Tradio, Inc., of Asbury Park, N. J., is offering a TV projection receiver for use in public places at a price of $2,600. This includes service for 1 year.

Television Optional: Offered by Admiral Corporation in matching cabinets for FM-AM-phono combinations, television picture-tube units, and record cabinets. Thus the purchaser of a radio-phonograph combination can add television at a minimum cost, with the assurance that the cabinets will present an attractive appearance.

Boston: Engineers at WBZ-TV are carrying out a training program in the use of the station's mobile television unit. The 2½-ton truck contains a complete field studio, and carries cameras and a microwave relay transmitter capable of beaming signals to the main station over a distance of 15 to 25 miles.

FM-TV: With AM network programs now available on FM, an increasing number of TV sets will provide only FM broadcast reception. Eliminating AM circuits effects a substantial saving in manufacturing costs, with a resultant reduction in list prices.

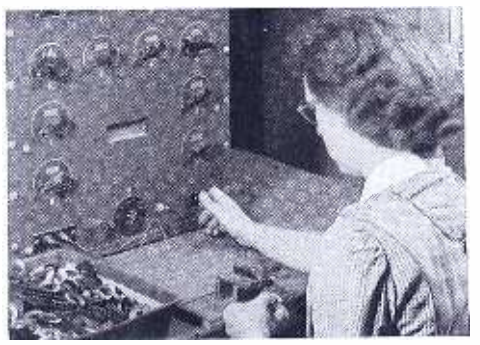
15-In. Table Model: Has been added to the line of TV receivers manufactured by U. S. Television. Price is $895.

Uniform Resistance

Mallory carbon controls are accurate in overall resistance value

You will find no variation in the resistance values of Mallory carbon controls. Frequent, critical inspections reject the imperfect, and pass only those carbon elements of the resistance values specified on the labels.

Recently dozens of controls from leading manufacturers were tested competitively for overall resistance value. Mallory controls averaged within 2% of specified resistance, the closest tolerance of any group in the test.



Every carbon element that goes into Mallory controls is individually inspected to be sure that its resistance value is the same as specified on the labels.

In volume controls you look for uniform resistance, accurate tapers, silent operation and long life. Mallory gives you all four, and more, too. The Mallory trade mark is your assurance that the volume control, vibrator or capacitor you buy is the finest that can be made.

The Mallory 1485 Control Deal

This attractive metal cabinet contains the 15 Controls and 9 Switches that will take care of 90% of your service calls. Its arrangement makes inventory control almost automatic — saves you frequent trips to the distributor's counter. It contains a rack for your Radio Service Encyclopedia. You pay only for the Volume Controls and Switches; the cabinet is included in the deal at no extra cost to you. Check your Mallory distributor on this special offer.

Visit us at Booths 84, 85, 86 I. R. E. Show Grand Central Palace New York March 22-25

P. R. MALLORY & CO. Inc.

MALLORY

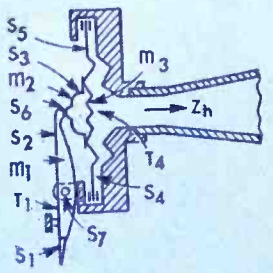
CAPACITORS . . . CONTROLS . . . VIBRATORS . . .
SWITCHES . . . RESISTORS . . . RECTIFIERS . . .
VIBRAPACK* POWER SUPPLIES . . . FILTERS

*Reg. U. S Pat. Off.

APPROVED PRECISION PRODUCTS

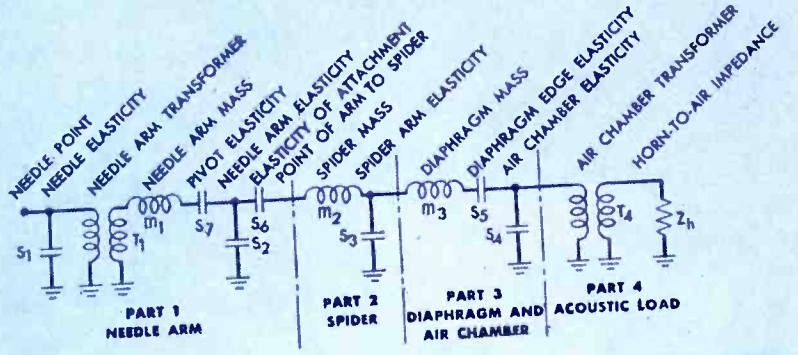
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

THIS IS THE REPRODUCER OF THE FIRST ORTHOPHONIC PHONOGRAPH



When the Orthophonic phonograph, developed in Bell Telephone Laboratories, was introduced in 1925, it represented an outstanding advance over previous acoustical types. Even more important to the progress in mechanical-acoustical and electro-acoustical systems, it represented the practical application of a basically new design tool—*the equivalent circuit.*

THIS IS THE SAME REPRODUCER WITH ITS MECHANICAL PARTS REPRESENTED BY ELECTRICAL COMPONENTS



Instead of time-consuming cut - and - try methods — involving experiments with mechanical parts of different sizes and shapes — Bell engineers tackled the design of the Orthophonic phonograph by representing each of its *mechanical* parts by an *electrical equivalent.* The effect of changing the mechanical specifications of any part of the phonograph could be predicted simply by changing the value of the corresponding electrical component, in accordance with the mathematics of electrical networks.

THIS IS THE CONCEPT OF THE "EQUIVALENT CIRCUIT"

An equivalent circuit is an electrical system in which each part is equivalent to a part in the corresponding mechanical system. The reaction of such an electrical system to electrical oscillations is identical to the reaction of the mechanical system to mechanical vibrations.

As a design tool, the equivalent circuit is particularly valuable in predicting performance of *transducers,* in which electrical energy is transformed into mechanical (and vice versa).

How the equivalent circuit came into being

The close analogy between elements in electrical and vibrating mechanical systems has long been recognized. Inductance corresponds to mass; capacitance to elasticity; electrical resistance to mechanical resistance, etc.

But it remained for the engineers of Bell Telephone Laboratories to integrate these facts into a practical design tool—to recognize and utilize the equivalance, not merely between *parts,* but between *systems.*

Once the fundamental idea of the "equivalent circuit" was applied, it quickly proved its merits as a practical, effective tool of transducer design. Employed in the design of the revolutionary Orthophonic phonograph, the equivalent circuit technique later became a standard procedure in transducer design.

The concept of the equivalent circuit is one of the many advances originating in Bell Telephone Laboratories that have contributed materially to progress in communications equipment.

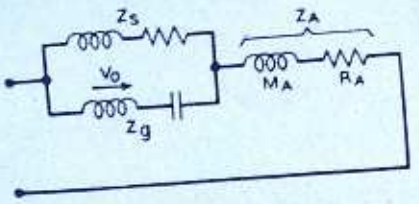
Why it means better quality in Western Electric equipment

In designing Western Electric microphones, crystal filters and recording and reproducing equipment, Bell Laboratories applies its long experience and thorough knowledge in the use of equivalent circuits.

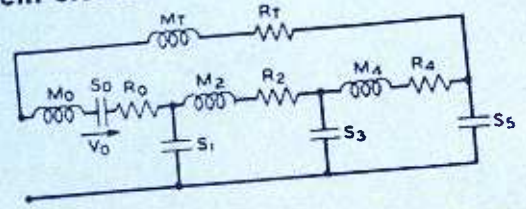
The results are twofold: *product designs* that mean greater dependability and improved performance, and *precise manufacturing information* that gives better control of quality during production.

The use of equivalent circuits is another example of the thorough research and careful manufacture which typify all Western Electric products—for radio broadcasting, radio communications, sound distribution and industrial uses.

THIS IS THE 639 MICROPHONE IN EQUIVALENT CIRCUIT FORM



Electrical equivalent of ribbon type pressure gradient element



Electrical equivalent of diaphragm type pressure element

These circuits were the starting-point in the design of Western Electric's popular 639 Type Cardioid Microphone. By changing the values of the electrical components, they provided extensive information on expected performance before the first model was built.

THIS IS THE MICROPHONE ITSELF

When the 639 was built, its outstanding performance—in quality and adaptability to various pick-up problems—bore out the predictions of the equivalent circuit.

—QUALITY COUNTS—

OTHER WESTERN ELECTRIC EQUIPMENT IN WHICH THE EQUIVALENT CIRCUIT IS A USEFUL DESIGN TOOL

LOUDSPEAKERS

Finest in the Western Electric line is the dual-unit 757A—handling 30 watts, giving uniform response from 60 to 15,000 cycles, having a 90 degree coverage angle.

CRYSTALS

This new line of crystals for oscillator control ranges from 1.2 KC to 50 MC. All are engineered for improved accuracy and stability.

REPRODUCERS

The 9A, specially recommended for vertical cuts, and the 9B used to best advantage on lateral cuts, have low distortion and provide maximum elimination of record noise.

Western Electric

Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.

Distributed by GraybaR
OFFICES IN 95 PRINCIPAL CITIES

DISTRIBUTORS: IN U. S. A.—Graybar Electric Company. IN CANADA AND NEWFOUNDLAND—Northern Electric Co., Ltd.

The BROWNING Sweep Calibrator is designed for use with oscilloscopes and synchroscopes, as a source of timing markers for measuring sweep intervals

BROWNING model GL-22 SWEEP CALIBRATOR

The BROWNING Sweep Calibrator expands the usefulness of any oscilloscope or synchroscope by adding the dimension of time, in the form of positive or negative markers. These markers are in groups of pulses, with time intervals between successive pulses of 0.1, 0.5, 1.0, 10, or 100 microseconds.

Pulse groups can be initiated from external positive or negative triggers, or from a built-in trigger generator, and applied to the blanking or vertical deflection circuits of the cathode-ray tube. The number of pulses per group and the amplitude of the markers are adjustable from front panel controls.

Also available is a gate pulse of either polarity and variable amplitude, the duration of which corresponds to the duration of the marker group. Width of the pulse can be determined by counting the number of pulses per group.

Additional details of the performance and application of this unique and highly flexible instrument are available on request.

Model OL-15A Laboratory Oscilloscope

The BROWNING OL-15A Oscilloscope offers special performance characteristics and added facilities intended for use in measurements on FM broadcast and communications equipment, and television, facsimile, and microwave apparatus. The coupon below will bring you complete technical literature.

Model OL-15A Laboratory Oscilloscope

Browning Labs., Inc.

750 Main Street, Winchester, Mass.

In Canada, Address:

MEASUREMENT ENGINEERING, Ltd.

Arnprior, Ontario

BROWNING LABORATORIES, Inc.
750 Main St., Winchester, Mass.

Please send me technical details and prices on the following Browning precision products:

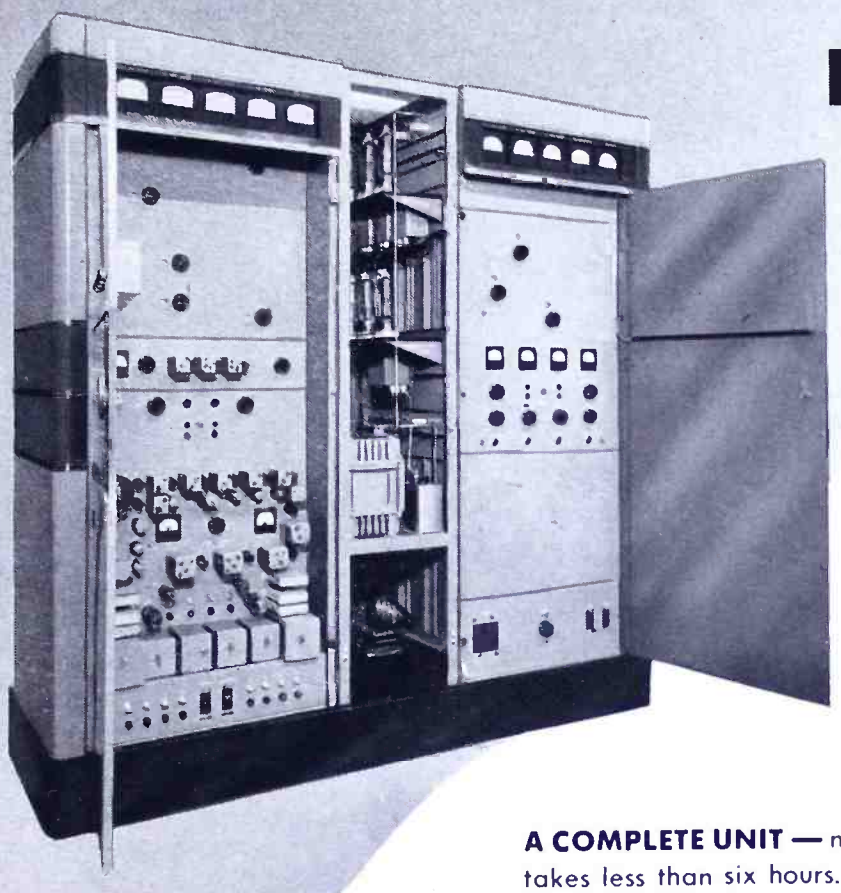
- ☐ FM Tuners
- ☐ FM-AM Tuners
- ☐ Frequency Meters
- ☐ WWV Frequency Calibrator
- ☐ Laboratory Oscilloscope
- ☐ Sweep Calibrator

Name.....

Address.....

Company Connection.....

EASY
- TO INSTALL
- TO OPERATE
- TO CONVERT TO HIGHER POWER



Front view of RF3 3KW-FM Transmitter with doors open showing convenient arrangement of controls for tuning driver and amplifier. Center lift-off panel has been removed to show accessibility of power supply.

RAYTHEON
250W — 3KW — 10KW FM TRANSMITTERS

A COMPLETE UNIT — normal installation takes less than six hours.

SIMPLIFIED OPERATION — by direct crystal control requiring no corrective circuits or mechanism.

NO SPECIAL TUBES — only standard low cost receiving-type tubes are used in the modulator.

NO SLIDING RF CONTACTS — standard amplifier techniques used in all RF stages. The amplifier maintains it settings *permanently*.

NO NEUTRALIZATION — the tetrode tubes used require no complicated tuning adjustments.

SINGLE POWER CONTROL — for full range adjustment of power output.

HIGH EFFICIENCY — exceeds 70% in all cases.

AUTOMATIC OVERLOAD RESET — returns transmitter to the air twice at full power and once at half power before locking out.

NO OBSOLESCENCE — Use the RF-3A amplifier in converting from 250 watts — use it later as the driver for a 10KW unit. Raytheon's integrated design policy eliminates obsolescence.

See your Raytheon Representative for complete information

. . . and no ice problem . . .

The new Raytheon Type RFW FM Antenna is highest in gain ratio but it's lowest in cost, lowest in height, lowest in wind loading. Get the whole story today.

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WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

ahead and flies anyway!"

I liken this to the aggressive men of radio who have put over the commercial success of aural broadcasting. AM may have a lot of engineering faults, but you, the commercial men didn't know it, so you made it the Fifth Estate anyway!

The technical limitations of AM broadcasting have always been with us — they will still be with us tomorrow. AM broadcasting is a deteriorating service because of them. This deterioration of coverage is rapidly accelerating as more and more AM stations come on the air. For over twenty years or more, AM broadcasting flourished and grew. As long as only 900 AM stations were on the air, interference could be controlled by technological development, up to the end of World War 2.

Do you know how many AM stations are now authorized? There are 1,969 AM stations either on the air or under construction — more than two times the number we had on VE-Day. An additional 350 applications for AM stations are yet to be acted upon by the FCC.

Technological development cannot keep up with this pace. Therefor, FCC operating standards have necessarily been reduced.

As a result, most AM stations are now operating under increased interference conditions which, in simple commercial terms, means less coverage and less listeners. This requires more stations and more advertising dollars to reach a given number of listeners.

Day by day, as the newer AM stations are crowding onto the ether waves, your advertisers are losing listeners at night in the outlying communities.

I don't ask you to accept this fact. Listen to your own car radio at night on a cross-country trip. You won't go far outside a city before you encounter cross-talk and interference. It is bad. It is serious. It is going to get worse as more and more AM stations go into operation.

Then there is the daytime AM station. All these stations would like nighttime hours of operation. It is not an economic limitation, it is a technical limitation. There are more than 400 daytime stations. These stations must operate when the audience is smallest and the competition greatest.

Let us consider for a moment the local 250-watt station. In many areas, he has been the backbone of your business, vitally important to your package deals. He has been your only available outlet. He has fared very badly in this interference problem. There are now more than 800 locals operating on the 6 local channels. His daytime coverage is chopped down from a service radius of 10 to 60 miles, depending upon operational factors, to a radius which in some cases is now less than 2

(CONTINUED ON PAGE 15)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 14)

miles at night. It is a known fact that in some of the larger cities, 250-watt stations serve only a small portion of the city itself after sunset.

You buy or sell AM on rates that are based upon watts: 50,000, 5,000, 1000, or 250 watts. I know the average agency does consider frequency in the rate structure, by a sort of rule of thumb policy. The lower the frequency, the better. But do you know the nighttime interference-limit of the station? Do you know whether the pattern of the nighttime directional antenna cuts off service from important nearby populations within the metropolitan area, or from nearby towns that should be served? Does the station adequately cover the city or metropolitan area at night? Only and until you know all these facts can you accurately compare time rates, and give the advertiser full dollar value. For no matter how good a program may be, it will not sell merchandise unless the listener can hear it.

It is true that AM coverage and service areas in most cases have been shrinking in alarming proportions.

To further complicate this picture, Mexico and Cuba are asking for more clear channel frequencies at the expense of the United States' allocations. Mexico wants 2 additional clear channels and wants to exchange 2 other channels. Cuba has asked for 12 frequencies for clear channel use. If these two requests are granted only in part, the United States broadcast structure must again undergo a major re-alignment as it did in 1941 when 777 U.S. stations shifted frequencies from 10 to 4 kc. It is reasonable to expect some compromise. The best result we can hope for can only mean further serious deterioration of our domestic AM broadcasting service. So you see, you *must* be interested in an escape from this situation if sound broadcasting is to be perpetuated. Frankly, I don't think any AM station operator, any time buyer, any agency, or any network can afford to ignore the storm warnings that are ahead in the AM broadcasting future.

There are 1,063 FM stations authorized as of February 11, 1947. More than 400 FM stations are on the air today and new ones are coming on the air in 1948 at an average of 50 per month. It is expected that 1,000 FM stations will be on the air by the end of this year. Moreover, FM service closely parallels existing AM service. Today, it is already nationwide! The 400 existing FM stations provide primary service to an area in which 60,000,000 people live. By the end of 1948 this will be increased to 117,000,000 people, or 84% of the population of the United States. These are FCC figures, not mine.

FM set construction did not begin until late in 1946 due to the change of bands.

(CONTINUED ON PAGE 49)

NOW AVAILABLE FROM STOCK!

109 TYPE REPRODUCER GROUPS

The time-tested units developed by Bell Telephone Laboratories — manufactured by Western Electric

They're back in stock again! Western Electric's famous 109 Type Reproducer Groups are now available for immediate delivery.

These practical, efficient reproducer groups for use with any transcription turntable are *complete* "packages" incorporating reproducer, arm and rest, equalizer and cable assembly and repeating coil.

They're available in two types: the 109AA, with 9A Reproducer, and the 109B, with 9B Reproducer. Both types of reproducers give excellent results on either vertically or laterally cut discs. The 9A, with a 2 mil radius diamond stylus tip, is particularly outstanding on verticals; the 9B, with a 2½ mil sapphire stylus tip, is especially good for laterals.

The improved equalizer switch provides a choice of 7 positions, 2 for vertical recordings, 5 for lateral. Careful, thorough design and production control assure the closest possible matching of present day recording characteristics. Choice of scratch equalization is provided.

The low intermodulation distortion and wide response of the Western Electric 9A and 9B Reproducers retain for these popular units their leadership in the quality field. *Prove it to your own satisfaction on a well cut disc and wide range system.*

Get the full story on the 109 Groups and the 9 Type Reproducers . . . better still, place your order right now for immediate shipment. Call your nearest Graybar Broadcast Representative, or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

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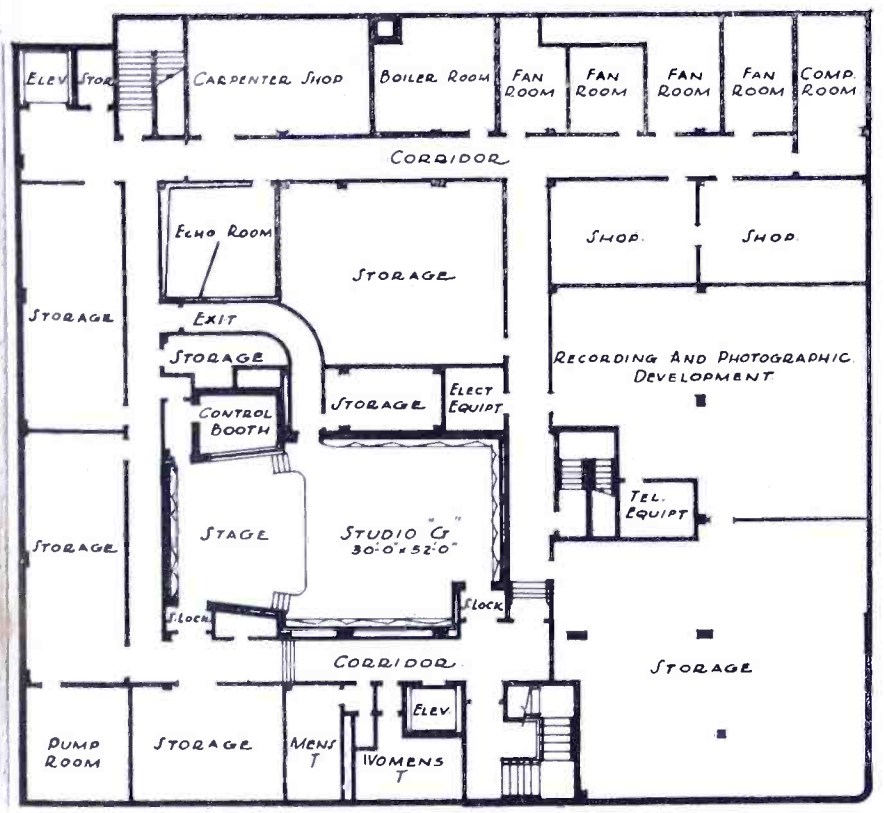


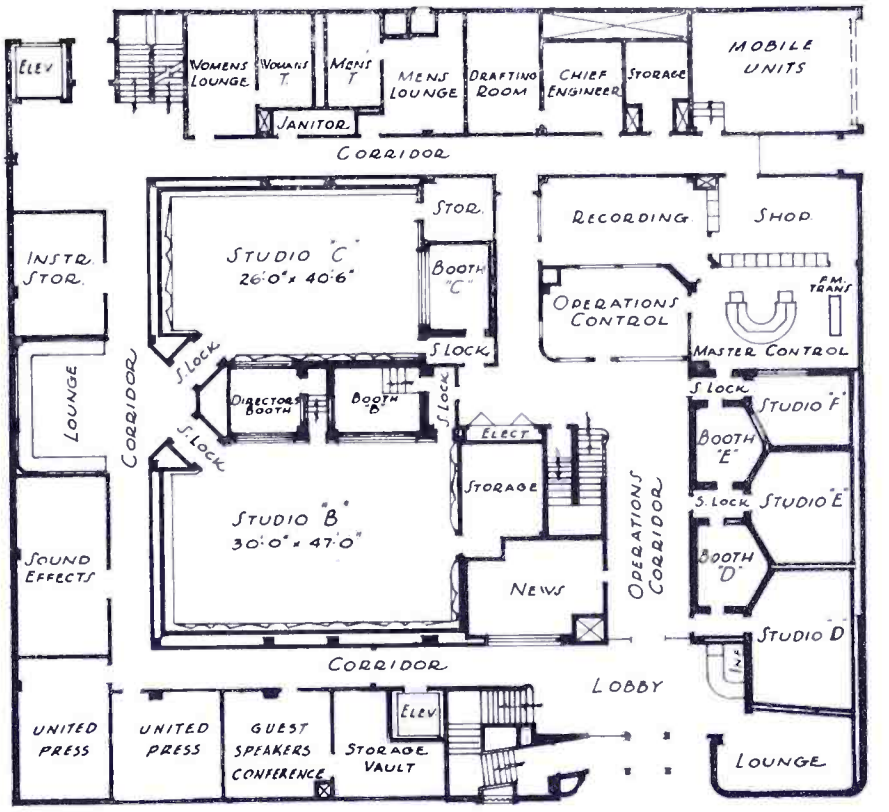


FIG. 1. BASEMENT, WITH STUDIO G, MECHANICAL EQUIPMENT, AND SHOPS. FIG. 2. STREET FLOOR IS THE MAIN OPERATIONS AREA

NEW IDEAS IN STUDIO DESIGN AND OPERATION

Seattle Station Sets Interesting Precedents in Plan and Facilities for FM-AM Broadcast Center

BY ROLLIN R. EIBER AND D. J. McNICOLL *

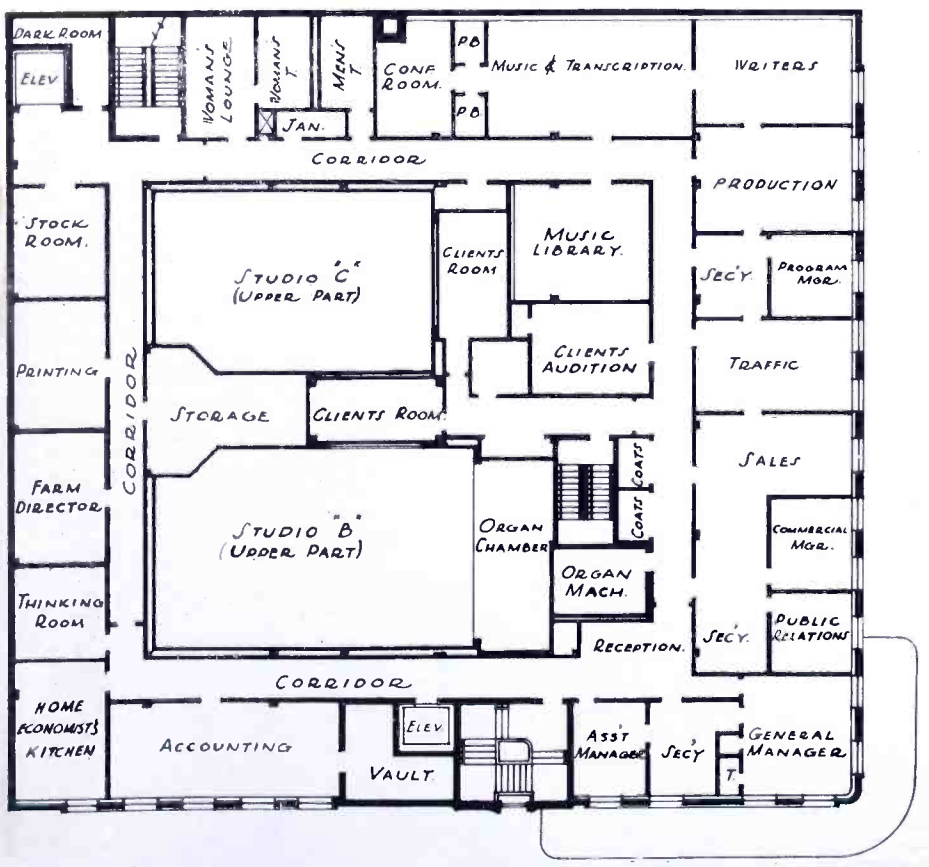
THE Pacific Northwest, where there's space to make things bigger and the urge to make them better, now has staked out a claim to the newest and finest FM-AM broadcast center. It is owned by Fisher's Blend Station, Inc., operators of KOMO and KOMO-FM, Seattle, Wash. The basic plan of the building, conceived by engineer-president O. W. Fisher, groups the whole operation of 6 studios and the news room around an operations control room in such a way that pedestrians on the street can follow the activities of announcers, celebrities, and engineers without crossing the threshold of the building.

Exterior construction is of simple functional character, entirely without ornamentation except for the curved wall facing of Roman brick at the main entrance, and horizontal ribbing in the gray concrete to set off the tall stair tower from the rest of the structure.

The accompanying floor plans and photographs show the studio facilities, business offices, and operating machinery provided in the building; and how they are arranged to function with smooth, time-saving coordination. The final result is an unusual example of collaboration between the station engineers, headed by chief engineer F. J. Broot, and The Austin Company, known to broadcasters for

* Broadcast Station Designers, respective of the Chicago and Seattle offices of The Austin Company, Engineers & Builders.

FIG. 3. UPPER FLOOR HAS ACCOMMODATIONS FOR ARTISTS, PRODUCTION AND BUSINESS DEPARTMENTS. FIG. 4. ENTRANCE LOBBY



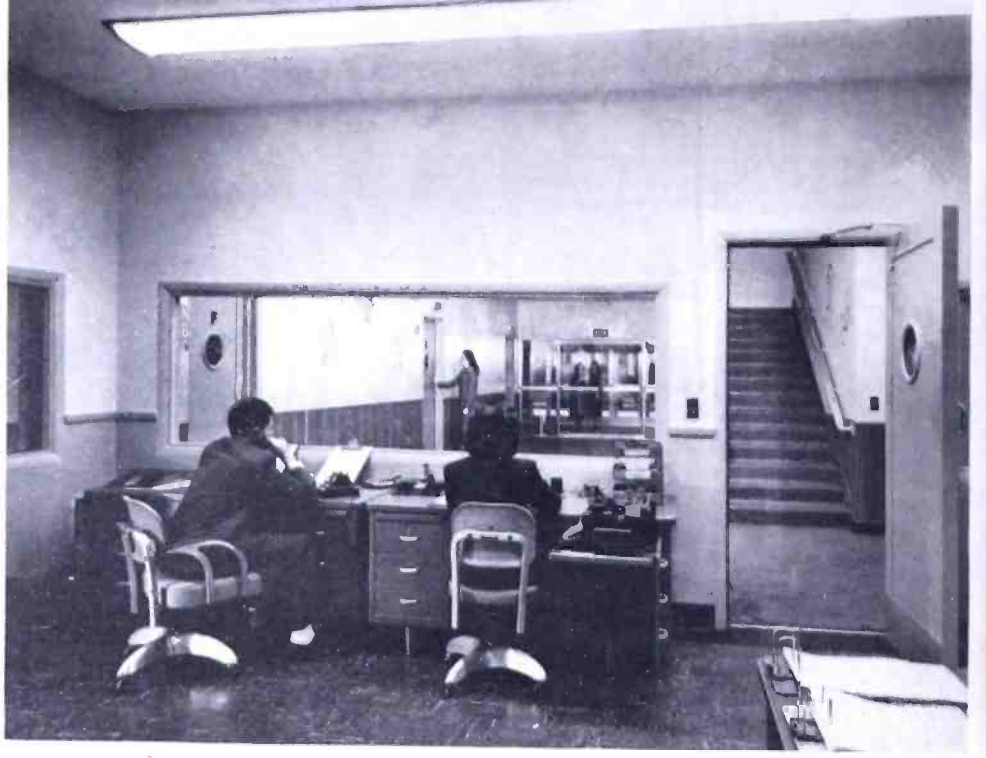
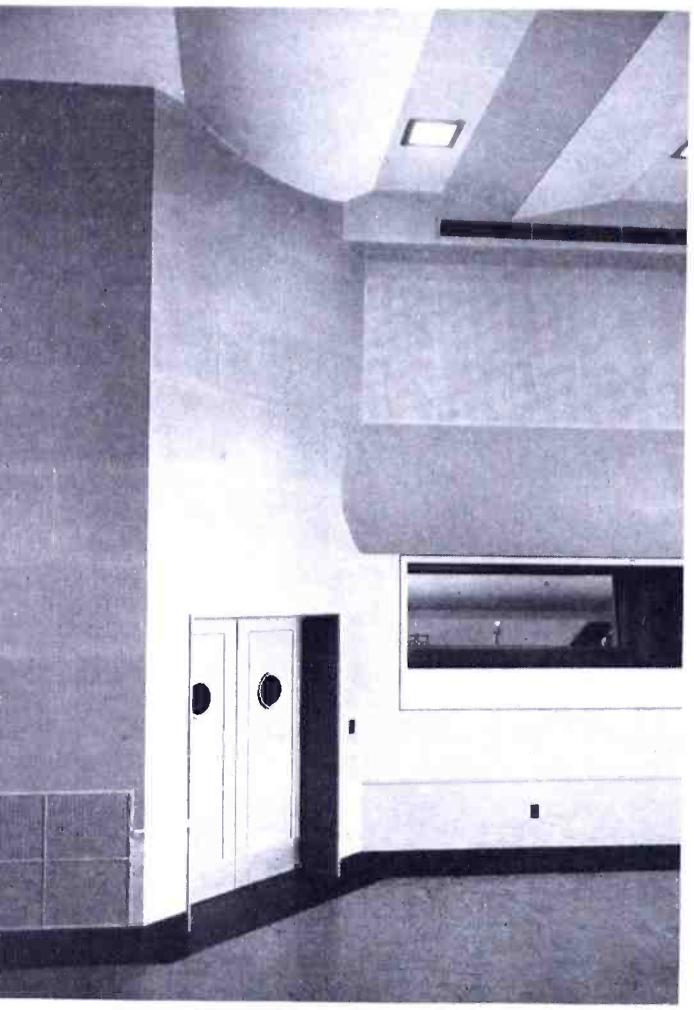


FIG. 5. OPERATIONS CONTROL AS SEEN FROM LOBBY. RECORDING ROOM IS AT REAR. FIG. 6. OPERATIONS CONTROL FACES LOBBY



many contributions to studio design and construction.

Figs. 1, 2, and 3 show the layout of the basement and the two upper floors. The entire street floor, except for a corner office leased to UP, is devoted to studio activities. Three intimate studios D, E, and F, and two group-accommodation studios B and C, all of different floor areas, are arranged along a central operation corridor in such a way that the maximum distance from the master control console and the individual studio control booths is approximately 50 ft.

This permits visual supervision of all traffic to and from the studio entrances from the operations control desk, at which point there is an unobstructed view of master control room, the recording department, and the lobby.

Fig. 4 shows the entrance lobby, decorated by a Grigware mural which combines radio portraits and symbolic figures. Wood paneling is used in the reception lounge and operating corridor, with caricatures of NBC stars painted in silver on soft gray-green upper walls. Floors are covered with rich red pile carpeting.

The rest of the operations area is decorated in various combinations of muted blues, greens, coral, tan and yellow. Adjoining rooms, and in some instances single walls, are painted in shades which contrast with surrounding areas from which they are visible, in order to enhance the interior perspectives. This is particularly advantageous where large windows open up vistas in several directions.

The operations control room, Fig. 5, faces the main lobby, with the recording room visible through a window in the background. Fig. 6 shows the view from the control room, looking toward the lobby. The window at the extreme left opens into the master control room. Down the corridor on the left are entrances to studios D, E, and F, while entrances to the news room and studios B and C adjoin the corridor on the right. Through this window there is also a direct view of stairs leading to the clients' booths and other second-floor areas, and stairs going down to the working end of studio G, on the lower level.

Audience traffic to studio G, however, is handled over a stairway leading directly down from the entrance lobby.

Fig. 7 is a view of the master console as seen from the operations control room. The window at the right looks into studio F. Thus the engineer at the master console can handle programs in studio F.

FIG. 12, ABOVE: CONSTRUCTION IN STUDIO B. FIG. 9. CONTROL FOR E AND F. FIG. 10. DIRECTOR'S ROOM BETWEEN B AND C

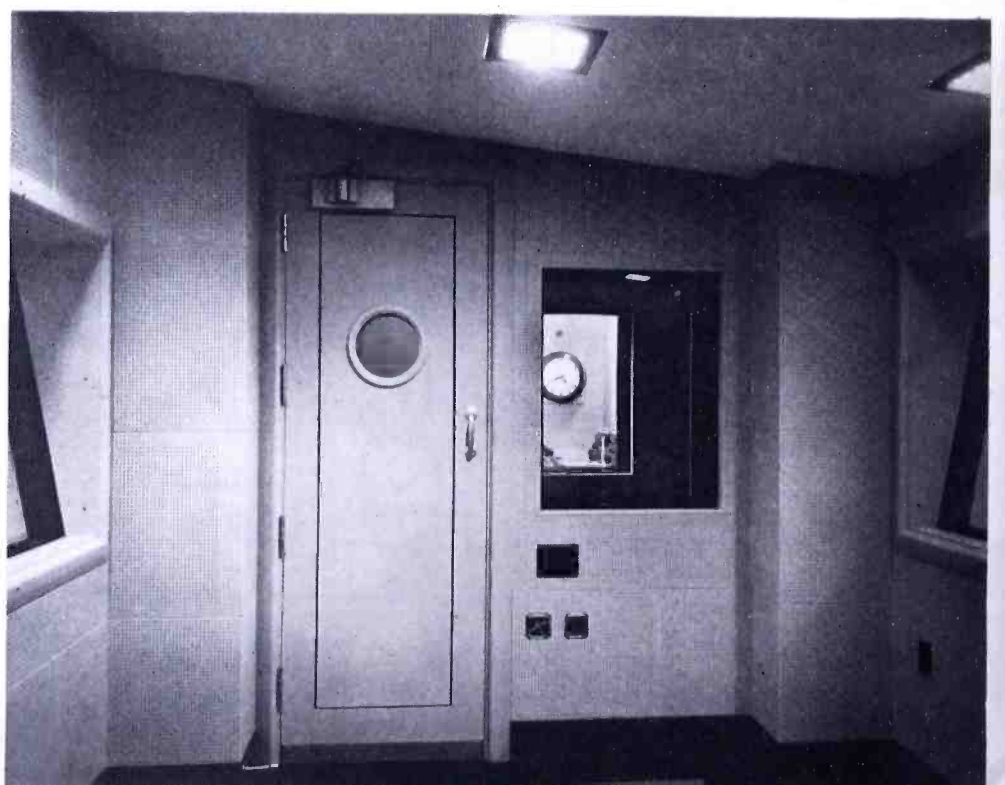


FIG. 7. MASTER CONSOLE AS SEEN FROM THE OPERATIONS CONTROL ROOM. FIG. 8. STUDIO D, LOOKING TOWARD THE CONTROL ROOM

At the far end is FM transmitter, with the speech equipment panels on the left, and a battery of monitor speakers at the right, above the window.

A high degree of economy in construction and operation has been achieved by the grouping of studios D, E, and F. Fig. 8 shows studio D, looking toward the control booth which also handles studio E.

The control booth in Fig. 9 opens on studios E at the right and F at the left. This view, in which the FM transmitter can be seen through the far window of studio F, explains how studio F can be handled directly by the master console engineer, or from the booth in Fig. 9. Walls of these studios combine plywood and perforated Transite to give the live and dead surfaces required for effective acoustic control.

Studios B and C are two stories high, as indicated in the plan drawings Figs. 2 and 3. These studios are located in parallel, with a director's booth between them. In this way, it is possible for a single musical director to conduct a symphony orchestra in the larger studio, and a chorus in the smaller one. Each studio has its own control booth, but they are at right angles to each other, so that both operators can see the conductor's booth. When the studios are used in combination, they are controlled from the booth in studio B.

Fig. 10 shows the musical director's room, with the two windows. Here, all walls and the ceiling are of perforated Transite to give a distinctly dead effect. Studio C, Fig. 11, is the larger of the pair. It measures 30 by 47 ft., while studio B is 26 by 40 ft. A close-up of the acoustic treatment is shown in the view of studio B, Fig. 12. This combines plywood for the cylindrical areas, and perforated Transite for the splayed area. The former are painted a soft blue, while the latter are warm gray.

Largest of all is studio G, Fig. 13, located below the street level. This is intended particularly for audience-participation shows.

All the studio units are built on the room-within-a-room principle. That is, the ceilings are suspended from structural members, and the floors are floated by steel isolators on concrete floor slabs. All walls and partitions stand free of the structural walls and columns, while glass panels, door sills, air ducts, and the like are mounted with isolating materials so the vibration cannot be transmitted to the studio enclosures.

(CONCLUDED ON PAGE 40)

FIG. 11. STUDIO C, DIRECTOR'S ROOM AT RIGHT. FIG. 13. AUDIENCE PARTICIPATION STUDIO G. FIG. 14, ABOVE, BUSINESS OFFICES

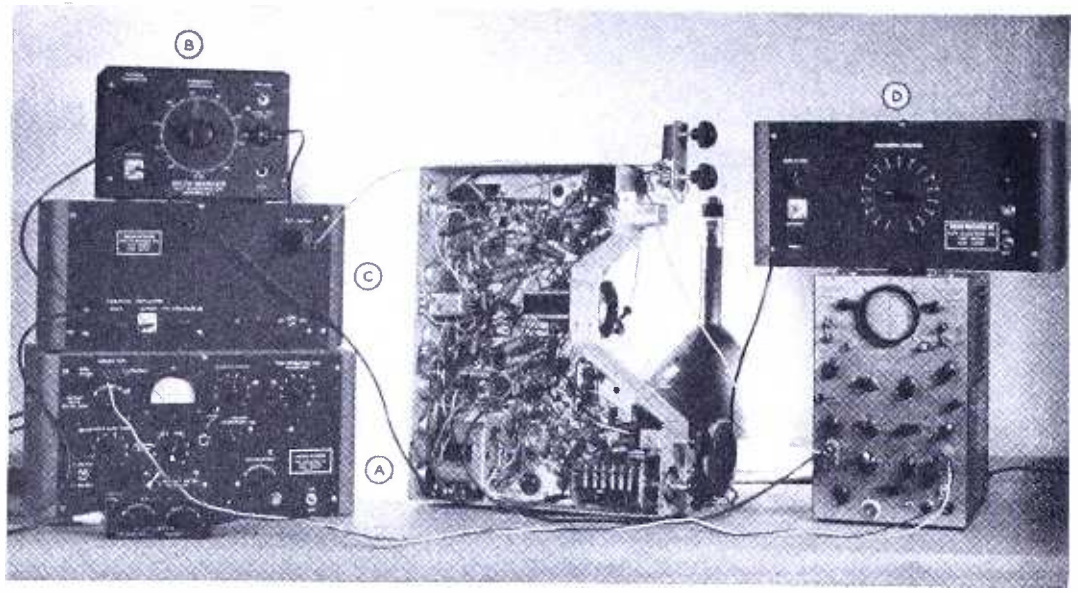


FIG. 1. THE FOUR INSTRUMENTS DESCRIBED HERE FOR USE WITH AN OSCILLOSCOPE

VISUAL FM AND TV ALIGNMENT

There Are Big Profits in FM and TV Service, but New, Precision Instruments Are Required

BY LESTER L. LIBBY*

THE rapid strides being made in the development and sales of FM and television receivers make it virtually mandatory that the progressive radio servicemen and technicians be familiar with visual alignment techniques for these sets. The circuit complexity and precisely-engineered operating conditions required throughout these receivers make the use of point-by-point methods with conventional signal generators and pointer-type meters virtually obsolete. New types of instruments, specifically designed for these new receivers, must be adopted by servicemen in order to keep pace with modern developments.

Two new elements confront servicemen who want to handle FM and TV work. These are 1) entirely new frequency ranges, and 2) a degree of accuracy and precision far greater than is needed for AM receivers. That is why AM equipment and methods cannot be applied to FM and TV service. This difference is emphasized in the new and complete line of instruments developed by Ohmega Laboratories and manufactured by Kay Electric Company. These instruments are unique in that they incorporate the latest micro-wave techniques, and introduce a number of features originated for radar use. Fig. 1 shows a combination of four instruments in a typical arrangement for aligning and servicing a modern television receiver.

* Chief Engineer, Ohmega Laboratories, Inc., Pine Brook, N. J.

Description ★ The primary instrument in this new group is the Mega-Sweep, Fig. 1A, a wide-range sweeping oscillator having an output frequency range of 50 kc. to 500 mc., with a sweep frequency excursion up to 30 mc. at any output frequency. This wide output frequency range, plus the wide sweep, anticipates future developments. Thus the instrument will not become obsolete when the citizens' radio band and the upper television band come into general use.

The next instrument in this new group is the Mega-Marker, Fig. 1B. This is a dual oscillator unit, combining a precision variable marker oscillator with a range of 19 to 29 mc. for the television IF band, and a crystal-controlled 10.7-mc. marker oscillator for the FM IF band. It is designed to operate directly from the tube-regulated power supply of the Mega-Sweep, thus insuring a very high degree of stability and precision. A special mixing circuit is provided for combining the output of the Mega-Marker and the Mega-Sweep in the output cable feeding the receiver under test. This circuit also has provisions for adjusting the amplitude of the marker birdie with respect to the response pattern amplitude.

By use of these two instruments, it is possible to mark, one at a time, the frequencies on the IF amplifier response pattern at which the various traps are to be aligned, and the frequency at which the response pattern should be 6db down for the IF picture carrier.

The third instrument in the group is the Mega-Pipper, Fig. 1C. This unit is designed to replace the Mega-Marker in those applications where more rapid and precise alignment of television receiver IF amplifiers is required, since it delivers 4 simultaneous crystal-controlled marker pips to the alignment oscilloscope. These pips simultaneously mark the IF picture carrier point, the IF sound carrier point, the adjacent-channel picture carrier IF point, and the adjacent-channel sound carrier IF point. The Mega-Pipper has a self-contained power supply, and requires no adjustments for frequency control aside from plugging in a crystal of the particular intermediate frequency for which the receiver is designed. The 4 marker pips are delivered to the alignment oscilloscope independent of the receiver under test, so that the marker indications are not lost at the trap points.

The fourth instrument is the Mega-Marker Sr., Fig. 1D. This is a 13-channel crystal-controlled television frequency marker generator. It provides a marker birdie at each of the 13 television sound carrier points, for the precise alignment of the receiver local oscillator. It has a self-contained power supply, and can be used with or without the Mega-Sweep, as desired.

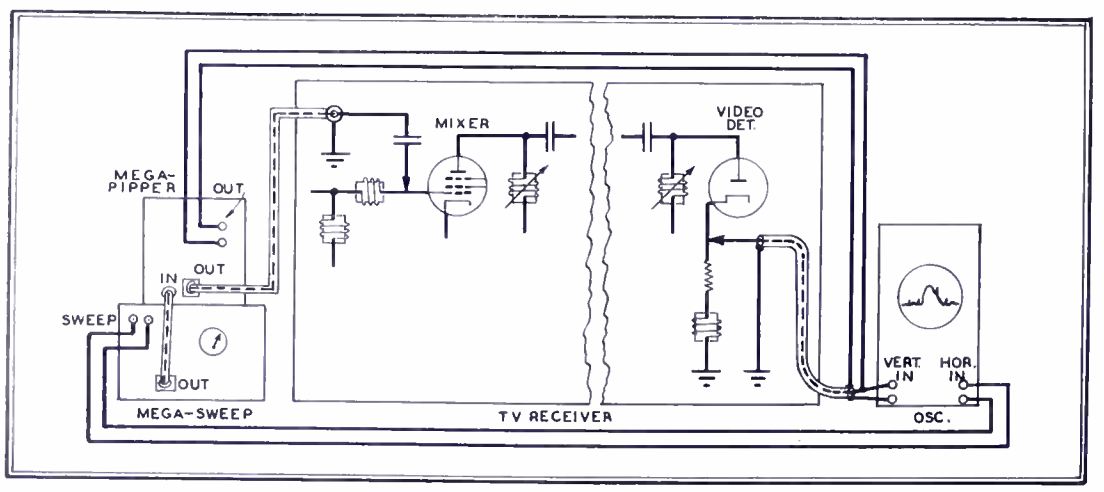


FIG. 2. SETUP FOR THE MEGA-SWEEP AND MEGA-PIPPER FOR VIDEO IF ALIGNMENT

Design of the Mega-Sweep ★ Returning for a moment to the Mega-Sweep, it is interesting to note that this instrument utilizes a pair of 3CM reflex Klystron oscillators in a special wave guide arrangement employing the latest radar design techniques. The outputs of the two Klystron oscillators are combined in a micro-wave silicon crystal mixer circuit, and their beat frequency difference is coupled directly from the crystal mixer to the coaxial output jack. This direct connection between the microwave silicon cyrstal mixer and the output jack insures that the output impedance will remain fixed at its

50-ohm value over the whole output frequency range, with no spurious resonances or dead spots. It is therefore desirable to exercise care, when using the instrument, that the output cable is not connected across a point in a circuit where an e.m.f. of more than about 1 volt exists, unless a 100-mmf. blocking condenser is inserted in series with the center conductor at the point in question. One of the Klystron oscillators is designated as the signal oscillator. Its output is coupled through a variable resistance-card attenuator in its section of wave guide to a broad-band directional coupler leading to the second wave guide section. The other Klystron is the local oscillator. Its high-level output is fed directly through the second wave guide section to the crystal mixer where the two frequencies are combined.

The low-level signal oscillator is fixed-tuned to a frequency in the neighborhood of 9,500 mc., whereas the high-level, local oscillator is tunable from 9,500 mc. down below 9,000 mc. The difference frequency is thus adjustable from about 50 kc., the approximate lock-in frequency difference of the two Klystrons, to over 500 mc.

A saw-tooth voltage of variable amplitude is applied to the repeller electrode of the high-level, local Klystron oscillator to produce the sweep frequency deviation. This sweep-frequency width is adjustable from about 30 kc. to over 30 mc. Since the low-level signal oscillator amplitude remains fixed for any particular setting of the microwave attenuator card, and is always small compared to the amplitude of the local oscillator, the beat frequency output undergoes very little change in amplitude while sweeping over its frequency excursion. Hence, a true picture of the response characteristic of the receiver under test is always insured.

Typical Alignment Applications ★ Fig. 2 is a diagrammatic representation of a typical setup of the Mega-Sweep and Mega-Pipper for the alignment of the video IF amplifier in a television set. The sweeping oscillator signal is fed into the Mega-Pipper and thence to the grid of the receiver mixer tube, as shown, for checking the overall IF response characteristic. The vertical input of an oscilloscope is connected by shielded cable to the video IF detector, while the horizontal input is connected to the saw-tooth sweep-voltage output terminals of the Mega-Sweep. The 4 output pips from the Mega-Pipper are also applied to the vertical input of the oscilloscope. Then the resultant composite picture of the response characteristic and the marker pips is displayed on the oscilloscope screen as depicted in the diagram. The Mega-Sweep is adjusted to a center-frequency output of about 24 mc., with a sweep width of 10 to 15 mc. The various alignment and trap adjustments can be made in compliance with the receiver manufacturer's specifications in a matter of a few minutes, and any departures of the response characteristics from the standard values can be observed and remedied instantly.

Fig. 3 shows a typical set-up of the Mega-Sweep and Mega-Marker for aligning the IF amplifier of an FM receiver, or the sound IF amplifier of a television set. The output of the sweeping oscillator is fed into the Mega-Marker mixing circuit, and thence to the grid of the receiver mixer tube, as shown in the diagram. The vertical input of the oscilloscope is connected by shielded cable to the discriminator output, to show the discriminator response curve. The horizontal input of the oscilloscope is connected to the saw tooth output of the Mega-Sweep, as before. The Mega-Sweep oscillator output is adjusted to a center frequency in the neighborhood of 21.5 mc. for the television set (or whatever the manufacturer specifies for sound IF frequency), or at 10.7 mc. for the FM set, and the sweep width set at 1 to 2 mc. The discriminator characteristic will then be displayed on the oscilloscope screen.

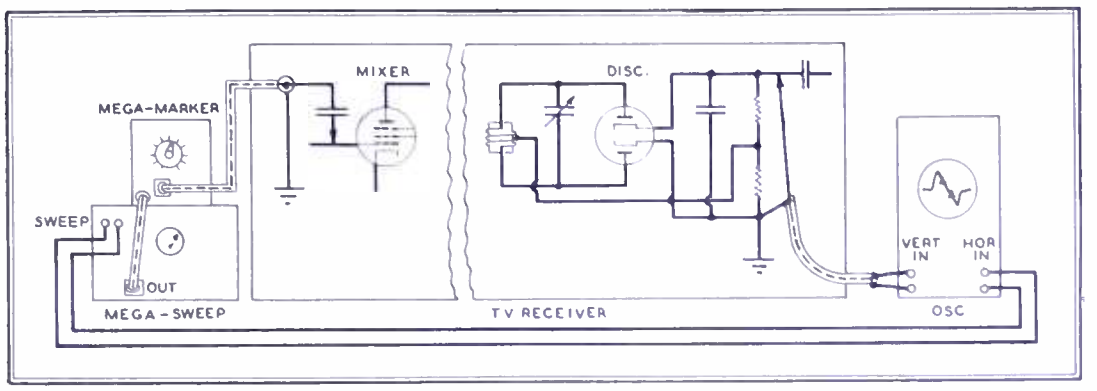


FIG. 3. MEGA-SWEEP AND MEGA-MARKER FOR ALIGNING IF OF FM SET, OR TV SOUND IF

For television receiver applications, the variable oscillator of the Mega Marker is used to introduce a birdie marker signal in the response pattern, whereas for FM receiver applications the 10.7-mc. crystal oscillator is used. It should be noted that the marker signal will tend to disappear when it is at the center or zero point of the balanced-discriminator pattern, since that is the nature of this type of discriminator circuit. By swinging either the Mega-Marker signal or the discriminator transformer primary tuning adjustment to either one side or the other, the marker signal becomes visible, and the center point can be identified quickly. For checking the alignment and response curve of the IF amplifier stages ahead of the discriminator, the vertical input of the oscilloscope is connected across the primary of the discriminator transformer (if a ratio detector is employed, or if no limiters are used) or else across the grid circuit resistor of the first limiter, or of the last IF amplifier stage. Then the normal tuning adjustments can be made to achieve the manufacturer's recommended response curve, with the marker birdie (visible even at the center frequency) acting to identify the proper frequency.

Fig. 4 shows a representative setup of the Mega-Sweep and Mega-Marker Sr. for testing and aligning the 13 RF input circuits of a television receiver, and particularly for the precise setting of the local oscillator frequency for each channel. The Mega-Marker Sr. provides a crystal-controlled marker frequency for each of the 13 channels, selected at will by means of a multi-position switch.

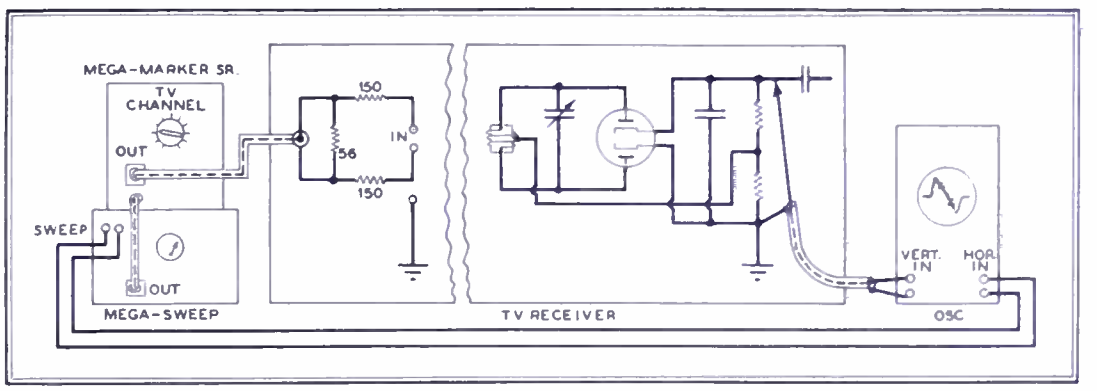


FIG. 4. 13-CHANNEL TV INPUT CHECK, USING THE MEGA-SWEEP AND MEGA-MARKER, SR.

The marker frequency is mixed with the signal from the Mega-Sweep, and this mixed signal is then applied to the receiver input circuit as shown in the diagram. The vertical input of the oscilloscope is connected to the output of the sound IF detector, so that the normal discriminator characteristic is displayed. (Alternatively, the oscilloscope can be connected to the video IF detector to observe the overall picture response curve.) The Mega-Sweep is adjusted to sweep through the desired sound-carrier frequency, and the local oscillator in the set is adjusted until the marker birdie disappears into the center of the discriminator curve displayed on the oscilloscope.

(CONCLUDED ON PAGE 40)

THE MICROWAVE HANDBOOK

Chapter 3: How Waveguides Carry Energy at Microwave Frequencies, Part 1

BY SAMUEL FREEDMAN

3.1 Waveguide Transmission Lines ★ In the preceding chapter, section 2.2 explained the skin-effect phenomenon encountered when currents at microwave frequencies flow in solid conductors. A more practical and useful type of conductor is the waveguide. This is merely a pipe of rectangular, square, or round cross-section.

Any discussion of waveguides has to do with electromagnetic waves internal to the conductors. As always, these electromagnetic waves have an electrical component (*E* field) and a magnetic component (*H* field). These fields represent an electrical see-saw, with the *H* field maximum corresponding to the *E* field minimum, and vice versa.

Waveguides can be of any material having an inner surface of high electrical conductivity. If the material itself is not a good conductor, it can be plated with silver, gold, or copper. A plating of a few ten-thousandths of an inch is adequate to provide the path necessary for the high-frequency energy to travel in a waveguide. The internal composition does not affect the electrical characteristics appreciably.

Waveguides can be formed by plating on paper, wood, plastic, or glass. In practice, they are usually made of brass, copper, or aluminum tubing because these materials offer advantages in cost, fabrication, rigidity, weight, or availability.

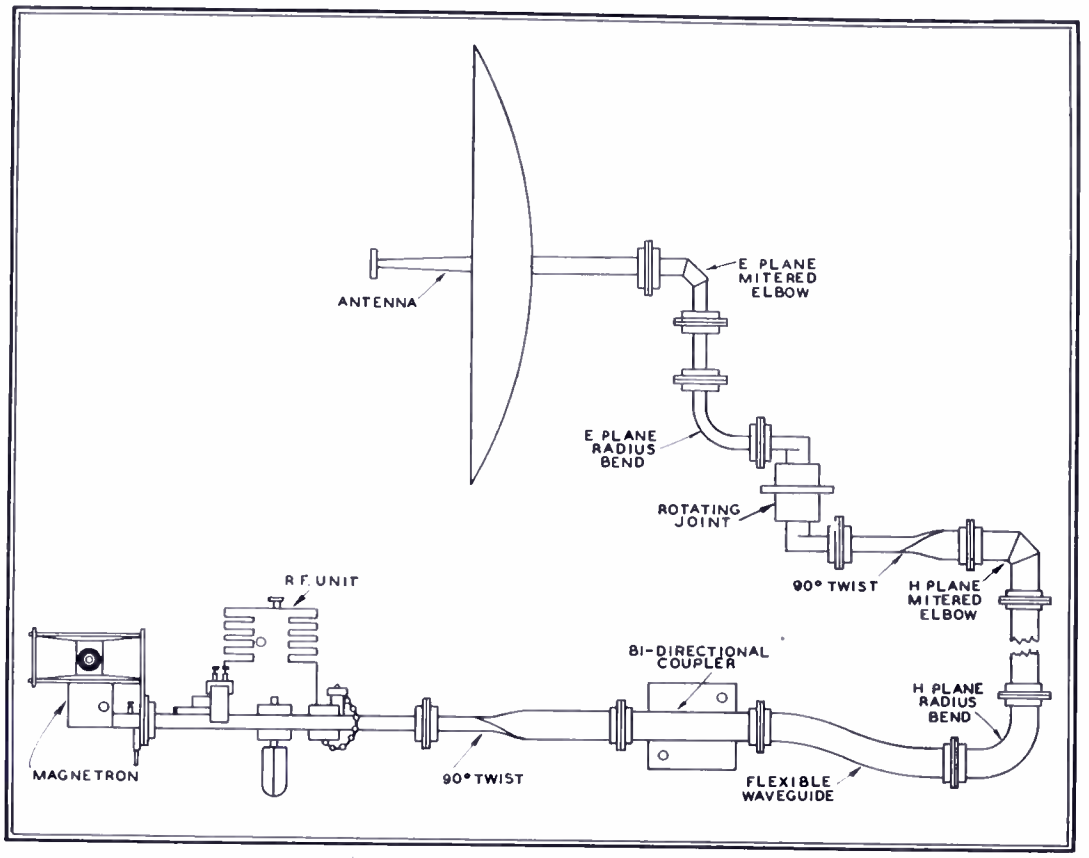


FIG. 9. ILLUSTRATING A COMBINATION OF UNITS IN A TYPICAL MICROWAVE CIRCUIT

Special plating is not required, but where cost is not a controlling factor, such metals are gold-plated for precision test equipment, or silver-plated for routine applications. Standard practice is to apply the plating at about 50 milligrams per sq. in.

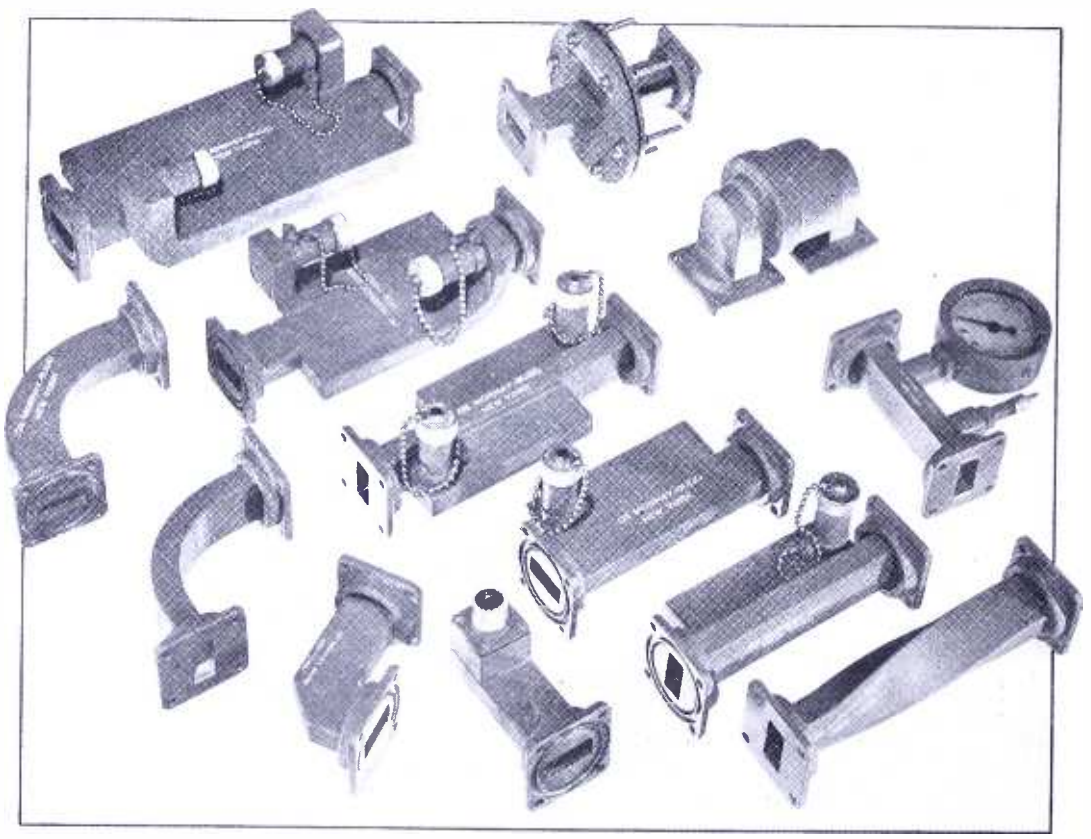


FIG. 8. TYPICAL MICROWAVE CIRCUIT ELEMENTS, MANUFACTURED BY DE MORNAY BUDD

Experimental waveguides can be formed of fine-mesh copper screen if the holes are not of appreciable size with respect to the wavelength. Waveguides can be made of dielectrics, also, such as solid polystyrene rod, without plating. Polystyrene has characteristics that compare closely with free space. Known as dielectric waveguides, they are used as dielectric antennas.

Waveguides are normally hollow, containing air as a dielectric. However, they can be of pressurized construction, and filled with a gas to increase their power handling capacity. They are also pressurized to reduce flashover at the very high altitudes encountered in military aviation service. Waveguide tubing is sometimes filled solidly with polystyrene or other plastic material. The length of an electromagnetic wave of a given frequency is different in free space than inside a waveguide. The type of dielectric employed inside the waveguide (free air, air under pressure, gas, or solid dielectric) alters the wavelength corresponding to the given frequency because the velocity changes.

Waveguides, by their shape, construction, dimensions, openings, enclosures, internal constrictions, flaring, operating frequencies, point of introducing energy, point of removing energy, couplings, twist, and taper, offer innumerable and

fascinating possibilities for designing such devices as:

1. Tunable cavities
2. Simulated inductance, capacitance and/or AC resistance
3. Wave or frequency meters
4. Standing wave detectors
5. Power terminations
6. Polarization changers
7. AC transformers
8. Fixed or variable attenuators
9. Directional couplers to sample outgoing or reflected energy, or both
10. Impedance bridges
11. Tunable loads
12. Transmission lines
13. Antennas (electromagnetic horns)
14. Mode or multi-frequency transmission means
15. Coupling devices

Fig. 8 shows a few items of so-called microwave plumbing, as manufactured by DeMornay Budd, Inc. Although these units will be discussed in detail later and their purposes explained, it is interesting to see, at this point, how the use of microwave frequencies has added entirely new techniques to radio circuit design.

In the left hand diagonal row, from top to bottom, these units are:

1. A 90° H-plane elbow with choke flange showing
2. A 90° E-plane elbow with cover flange showing
3. A 90° H-plane mitered elbow
4. Crystal-mounting assembly for rectifying microwave energy and coupling it through a coaxial cable to test equipment or intelligence device

The center row shows:

1. Bi-directional coupler with choke flange and coaxial fittings, used to sample outgoing and reflected energy simultaneously
2. Narrow-band bi-directional coupler
3. Broad-band bi-directional coupler
4. Narrow-band uni-directional coupler for sampling energy in one direction
5. Broad-band uni-directional coupler
6. A 90° twisted waveguide used to change the polarity

In the right hand row are:

1. Bulkhead flange assembly, used where the waveguide passes through a wall
2. Rotating joint for connection to a rotating antenna. A rectangular waveguide is converted into a circular section, and back again to a rectangular waveguide
3. Pressurized waveguide section with a gauge and air valve

One of the many combinations of units employed for microwave transmission is illustrated in Fig. 9. Some of these units can be omitted or others added, depending on the specific requirements of the installation. In this particular combination, a Magnetron tube and RF unit provide a signal of several thousand megacycles. The polarization is changed at the first 90° twisted section. It then feeds into a bi-directional coupler. The center of this coupler represents the primary waveguide, inside which the energy flows in the direction of the antenna. Holes or slots of special size, number, and spacing on the top and bottom of the primary waveguide permit small samples of the outgoing and the reflected energy to be analyzed in the top and bottom auxiliary waveguides. These are connected by a short coaxial cable in each case to an analyzing device.

From that point, a flexible waveguide

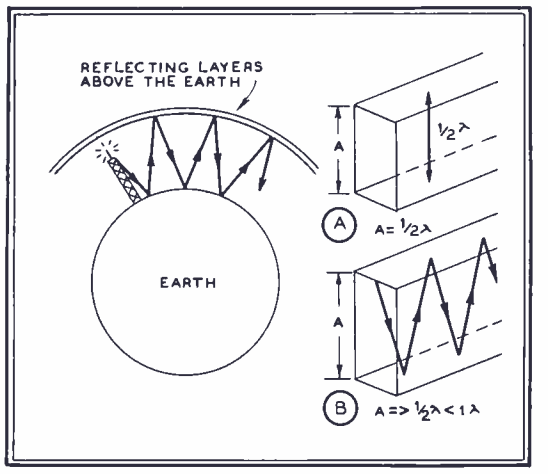


FIG. 10. SIMPLE WAVEGUIDE PRINCIPLES

is used to overcome vibration between portions of the antenna system, as in the case of aircraft installations. Next is a 90° H-plane radius bend in the broad side of the waveguide. It would be an E-plane bend if the narrow side of the waveguide were shown in the illustration. Mitered elbows are used in special cases in place of radius bends. If polarization has changed en route, it can be restored by another 90° twist. The rotating joint indicates that the antenna is rotatable as required in radar applications, radio signal search, or beacon work. The system continues with bends made necessary by physical considerations. The waveguide ends at the focal point of a parabolic reflector. Energy emerges from the waveguide to strike the reflector in a manner comparable to the focused filament in an automobile headlight. A sharply defined beam of high energy concentration is directed into space by the reflector.

Waveguides are necessary because of the extremely high inductive and extremely low capacitive reactances existing at microwave frequencies. They are further necessary because the lateral dimensions of any 2-wire line or of the spacing between the inner conductor and sheath of a coaxial cable are too great with respect to the operating wavelengths.

3.2 Natural Waveguide Conditions ★ Fig. 10 illustrates nature's low-frequency waveguide as compared to a fabricated microwave waveguide. The analogy is identical except for the difference in consistency, magnitude of dimensions, and cutoff frequency.

Ignoring the groundwave component in free space, it may be said that low frequencies make propagational progress after leaving the transmitting antenna by bouncing back and forth between the earth and the ionosphere. Nature's waveguide is unstable, since its dimensions are non-uniform and are changing constantly because:

1. The earth is not a uniformly smooth surface.
2. The earth is of non-uniform conductivity.
3. The ionosphere is of non-uniform conductivity.
4. The ionosphere is made of several layers, constantly changing in degree of ionization, height and number of layers. These changes occur to varying degrees during the night and day, winter and summer, and multi-year sunspot cycles.

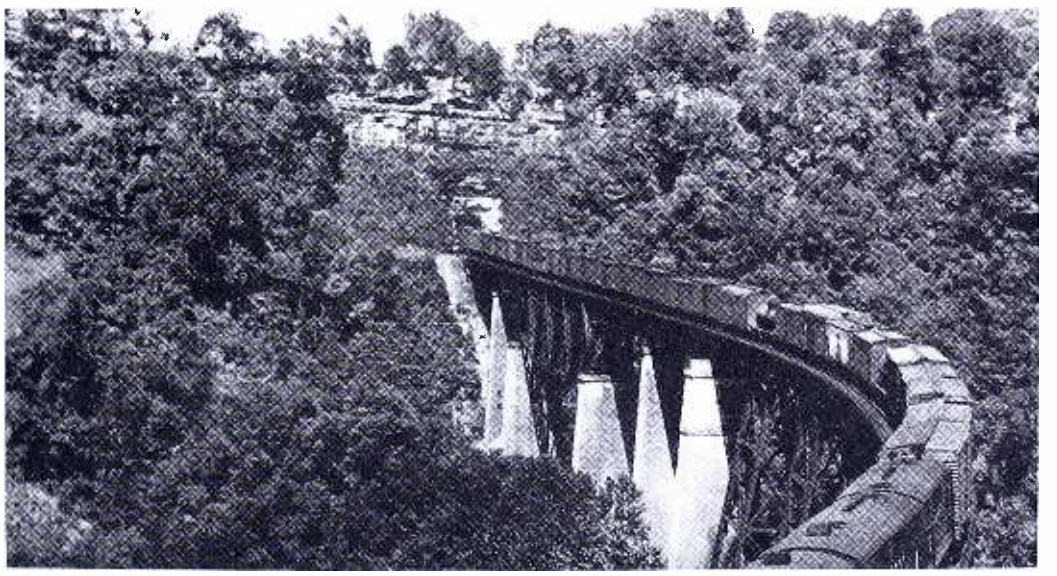


FIG. 11. HERE A TUNNEL "WAVEGUIDE" IS CHANGED IN SIZE BY PRESENCE OF CARS

In addition to non-uniformity, nature's waveguide has one outstanding difference with respect to fabricated waveguides. Its height is so great that it is unlikely to be reduced to cutoff for any frequency of radio communication, no matter how low. A fabricated rectangular waveguide only begins to function when its maximum dimension at right angles to the length exceeds one-half wavelength. A cylindrical

(CONTINUED ON PAGE 44)

SPOT NEWS NOTES

Items and comments, personal and otherwise, about manufacturing, broadcasting, communications, and television activities

15,000-Cycle Line: Carrying Army Air Forces orchestra from WASH Washington to W2XMN and W2XEA Alpine is giving listeners the highest quality of musical entertainment ever heard on the air. Listening at Great Barrington, we can detect no difference between direct reception from Alpine and twice-repeated relay station WACE-FM Chicopee, Mass. Tests and measurements on the line are still in progress. We expect to publish a report on the performance of the line in a forthcoming issue.

Klystron Tubes: One of Sperry Gyroscope's wartime developments is coming into wide use for microwave relays. Until now a hand-made job, preparations are under way for quantity production.

New York: Contract for Daily News TV station WPIX has been awarded to Turner Construction Company, with A. D. Crosett & Associates as architects and engineers. Two-story addition of 22,000 square feet will be erected on the News building. A 200-ft. tower will carry an 80-ft. antenna mast, making the total height 754 ft.

1,530-Ft. Tower: World's tallest man-made structure, topping the Empire State by 280 ft., will be erected for Cowles' KRNT-FM at Des Moines, Iowa. Westinghouse will supply the transmitter. Radius of primary coverage is estimated conservatively at 120 miles.

Boston: Yankee Network TV station, when completed, will carry CBS programs on an experimental basis. Presumably, network operation will be over AT & T New York-Boston relay.

U. S. Broadcast Stations: FCC data released February 11 lists authorizations as follows:

	AM	FM	TV	Total		AM	FM	TV	Total
Ala.	55	20	1	76	Nev.	12	3	—	15
Ariz.	24	2	—	26	N. H.	10	7	—	17
Ark.	28	7	—	35	N. J.	18	22	1	41
Cal.	129	87	12	228	N.M.	20	1	1	22
Col.	33	3	—	36	N.Y.	89	79	10	178
Conn.	24	19	1	44	N.C.	86	45	1	132
Del.	5	4	1	10	N.D.	15	2	—	17
D.C.	7	10	4	21	O.	53	66	9	128
Fla.	66	29	1	96	Okla.	40	21	—	61
Ga.	68	32	3	103	Ore.	35	15	—	50
Ida.	21	6	—	27	Pa.	98	80	6	184
Ill.	63	55	4	122	R.I.	8	8	1	17
Ind.	39	33	3	75	S.C.	31	14	—	45
Ia.	41	25	1	67	S.D.	15	1	—	16
Kan.	32	11	—	43	Tenn.	52	26	1	79
Ky.	36	15	1	52	Tex.	153	66	4	223
La.	38	17	3	58	Utah	17	3	1	21
Me.	14	5	—	19	Vt.	7	—	—	7
Md.	23	15	3	41	Va.	44	28	1	73
Mass.	42	39	3	84	Wash.	43	8	1	52
Mich.	56	38	3	97	W.Va.	33	15	—	48
Minn.	34	11	2	47	Wis.	46	31	1	78
Miss.	33	6	—	39	Wyo.	12	1	—	13
Mo.	38	23	2	63	Alas.	8	—	—	8
Mont.	25	—	—	25	P.R.	23	3	—	26
Nebr.	18	6	1	25	T.H.	9	—	—	9
						1969	1063	87	3119

Charles F. Adams, Jr.: Former executive vice president of Raytheon Manufacturing Company has been elected president, succeeding Laurence K. Marshall, who was made chairman of the board of directors.

Something Slipped: The FM-AM chassis shown on page 34 of our February issue was mistakenly described as a Meissner design. It is manufactured by Radio Craftsmen, Inc., 1341 S. Michigan Avenue, Chicago 5.

TV Service Preparations: Electric Association of Kansas City and the vocational training division of the Board of Education will shortly open a 50-hour course in TV service. First class will be limited to 50 students. Cost of course will be $5.

21- City LCC System: Most extensive limited common carrier system to date is projected by U-Dryvit Auto Rental Company, Cambridge, Mass., now operating in Boston. Application has been filed with FCC for headquarters transmitters in 21 cities spread over Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, and New York. U-Dryvit now serves doctors, salesmen, towing and repair services, and trucks in the Boston area.

IMSA: Annual meeting of the International Municipal Signal Association will be held October 4 to 7 at Hotel Statler, Buffalo, N.Y. Joint chairmen are Chester Kern, Supt. Police Signal System, and Lee O'Hara, Supt. Fire Alarm, Buffalo. Exhibits chairman is Everett Zeh, Supt. and Police Telegraph, Schenectady.

WGHF: Finch FM station at 10 E. 40th Street, New York, is on the air again after installing a 10-kw. Western Electric transmitter which now gives the full authorized radiation of 20 kw. Station will also resume facsimile broadcasting schedule. Chief engineer is Veikko K. West.

Speed: Fire broke out on Sunday, 4:00 A.M. at Annapolis station WANN, and burned the transmitter building to the ground. At 9:30 that night, a truck-load of replacement equipment left the Raytheon plant at Waltham, Mass., and pulled into Annapolis Monday afternoon. WANN resumed operation at 9:30 Tuesday morning!

Dr. Alfred N. Goldsmith: Writing in the *IRE Proceedings*, March, 1948: "The more closely the words of a man approach the truth, the more sturdily they endure, without erosion or erasure, the rude buffeting of time and criticism. It follows that only the most thoughtful and accurate statements of men survive."

Boston: A showroom display of Raytheon broadcast equipment has been set up at 1124 Boylston Street by Broadcast Equipment, Inc., formerly Chris F. Brauneck Company. Telephone is Kenmore 6–1364.

J. G. Crost: Former counsel of the Small Business Committee of the House of Representatives has joined Finch Telecommunications, Inc., as assistant to the president. Capt. Finch, we hear, is devoting himself to Colorfax, which provides facsimile reception in color.

10-Kw. FM Transmitters: REL reports the following installations on the air: WRAL-FM Raleigh, N.C.; WMNE Mt. Washington, N.H.; WNBF-FM Binghamton, N.Y.; WINX-FM Washington, D.C.; WMFR-FM High Point, N.C.; WHAD Madison, Wis.; WGBR-FM Goldsboro, N.C.; WGBG-FM Greensboro, N.C.; WHKX Cleveland, Ohio.

N.Y. City: Municipal station WNYC-FM, on the air since early in 1943, went to full power on February 13, using a 10-kw. W.E. transmitter and 4-bay cloverleaf antenna.

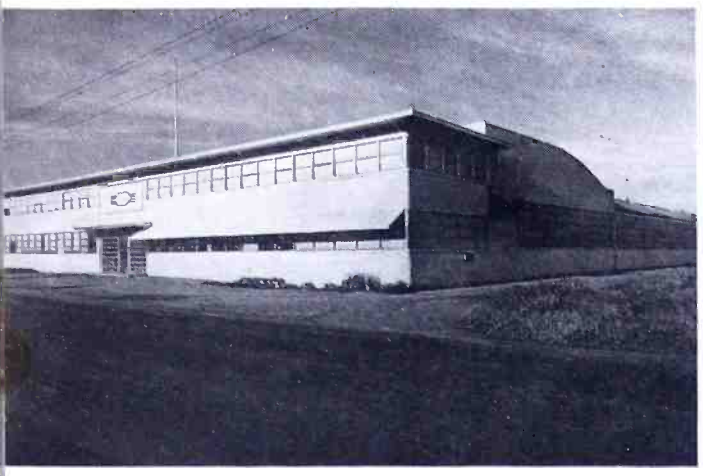
George Koch: Secretary, director, and sales manager of Simpson Electric Company, and one of the most highly regarded executives in his field, passed away at Chicago on February 15, after a brief illness. His association with Ray Simpson began at the old Jewell Electrical Instrument Company, in 1922.

Ernest A. Marx: General manager of Du Mont TV receiver division, addressing N.Y. Master Brewers Association: "Those in the television industry feel that, within 3 years, the radio industry will have suffered a very severe decline, and in its place, television will have taken over."

Johnstown-Northville Relay: Upstate Telephone Corporation of New York has installed a 26-mile multi-channel VHF link over the rugged Adirondack mountain country, to handle toll calls. Radio equipment was supplied by Link Radio.

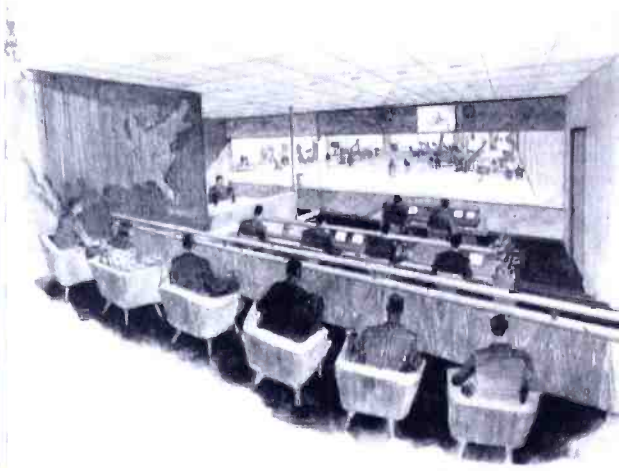
San Francisco: With KSBR moved to Mt. Diablo, and almost ready to radiate 250 kw., the operating company, Radio Diablo, Inc., has opened time sales offices at 582 Market Street, San Francisco. Clay Crane is in charge.

Honolulu: Mutual Telephone Company has installed a mobile FM system using a 250-watt transmitter and 3 remote, fixed receivers, operating in the 152- to 162-mc. band. Over 40 installations have been made in automobiles already. Equipment was supplied by Federal Telephone & Radio Corporation.



1. NEW KAAR ENGINEERING PLANT.

2. POLICE RADIO ROOM AT WASHINGTON, D. C.



3. CBS BUILDS HUGE TELEVISION STUDIOS

NEWS PICTURES

1. Indicative of the expansion of FM mobile communications is the recent completion of Kaar Engineering Company's new plant on a 2½-acre site on the outskirts of Palo Alto, Calif. Already rated as the largest western manufacturer of radio-telephone equipment, the new building provides for doubling past production of mobile units and marine direction finders. Also, Kaar equipment will now be made in Canada under an agreement just consumated with Measurement Engineering, Ltd., Toronto.

2. Police radio communications at Washington, D.C. have been speeded up by revising the method of processing calls. Formerly, calls received at the Headquarters Central Complaint Room were relayed by telephone land lines to the transmitter location, where they were repeated on the radio. Now, Federal remote control consoles have been installed, so that the transmitter can be turned on and off from either position, and all messages handled directly from the Complaint Room. In the accompanying picture, Lt. Frank M. Beall, police radio engineer, is standing at the left.

3. CBS is building what is described as the nation's largest television studio plant in the Grand Central Station Building, New York City. The artist's sketch reproduced here shows the sponsor's gallery, with the control consoles in the foreground, and the television stage beyond. There will be two studios 55 by 85 ft., equipped with elevated catwalks for lighting and sound technicians.

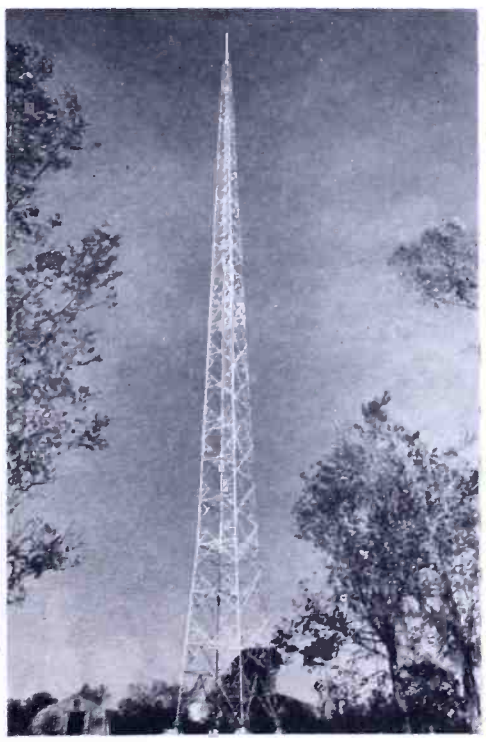
4. What appears to be boards piled in a frame are actually sections of a metal lens for focusing transmission of microwaves. This is a development of Bell Telephone Laboratories. In one design, metallic spheres are used in an arrangement based on the theories of light transmission through atomic and molecular structures. Radio waves, passing through the lens, set up electric currents in the spheres, and thereby produce the same effect on the radio waves that the molecular lattices of a glass lens produce on light waves.

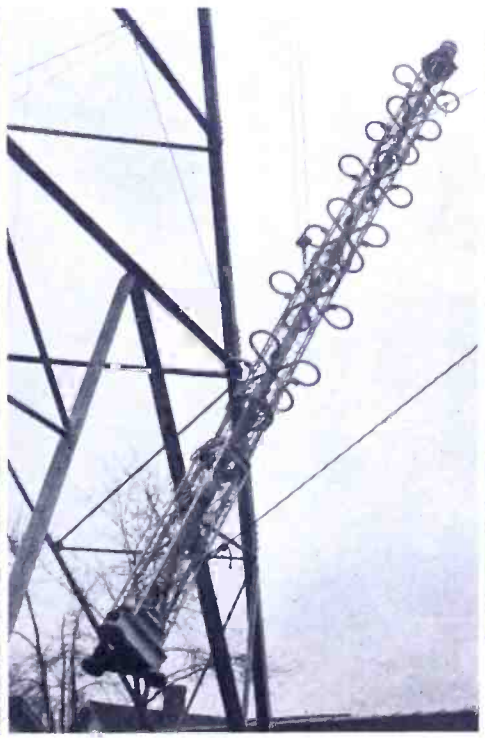
5. Tallest structure in Louisiana has been erected by *The Times-Picayune* for WTPS and WTPS-FM New Orleans. Total height is 607 ft. The antenna was put in operation on February 16. Present FM schedule is from 10 a.m. to 10 p.m., at 95.7 mc. The tower is located at Gretna.

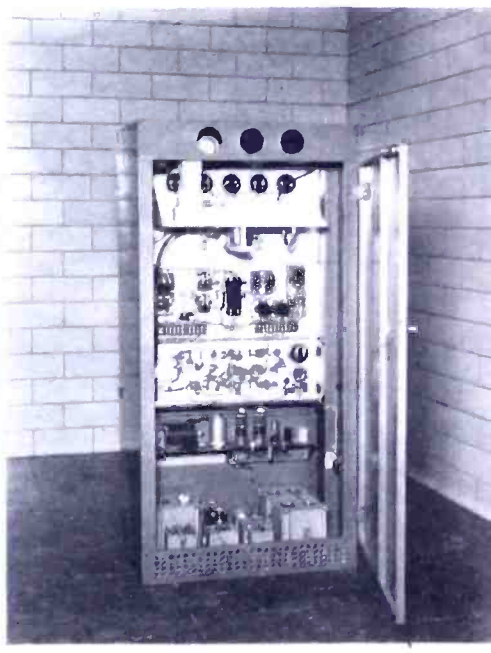
6. The *Greensboro* (N. C.) *Daily News* sent us this interesting photograph of a 6-bay Western Electric FM antenna, on its way up to the top of their 450-ft. Ideco tower. The 40-ft. antenna section was assembled on the ground, and raised to the top of the tower in one piece. Station WFMY will represent a total investment of $160,000.

7. G. E. has a new S-T relay transmitter, operating on 920 to 960 mc., the band permanently assigned to this service. It is described as having an output of 10 watts, with a stability of .005%.

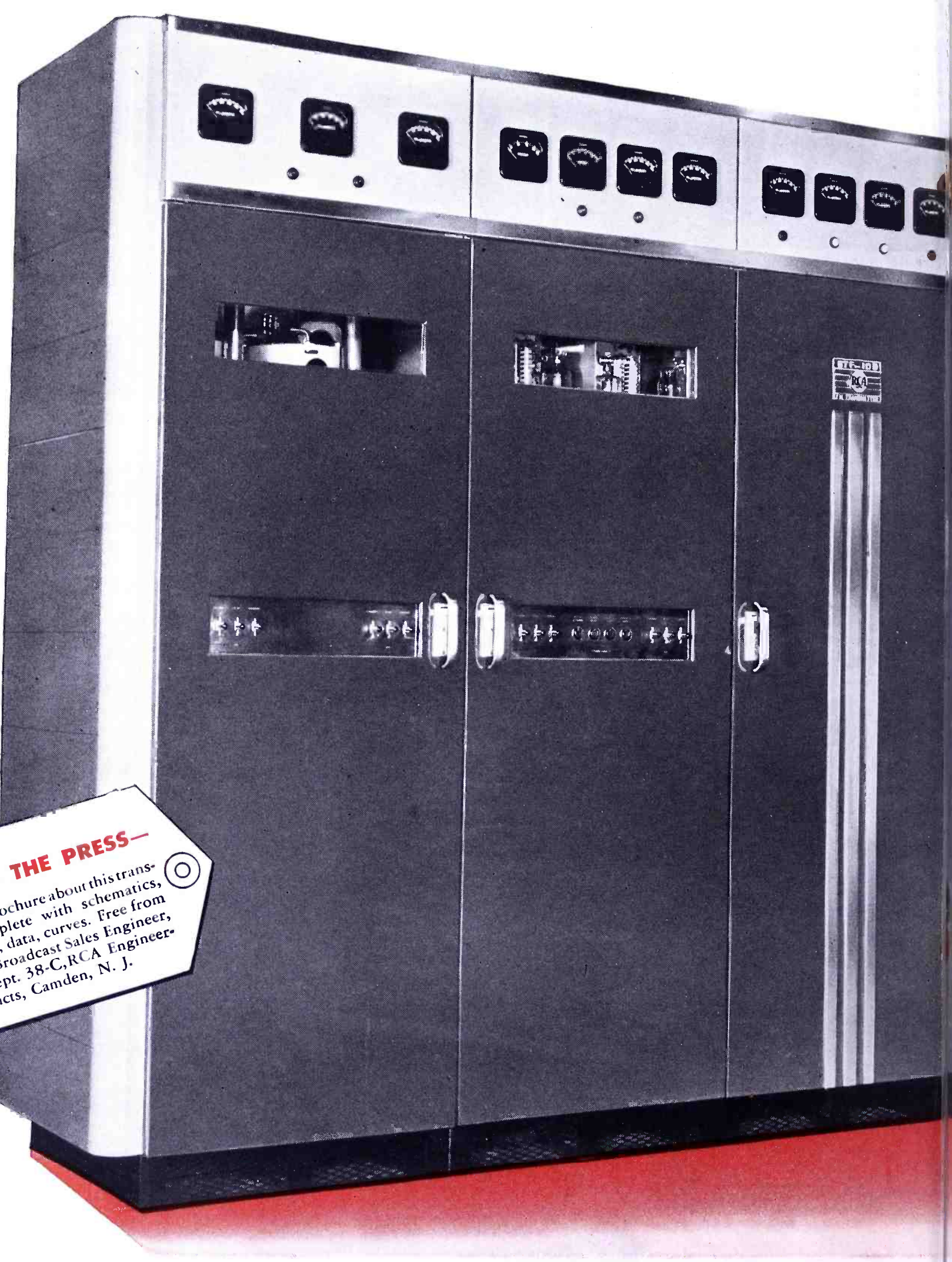
4. MICROWAVE RELAY ANTENNA. 5. FM-AM ANTENNA FOR WTPS. 6. CONSTRUCTION AT WFMY. 7. ST RELAY LINK TRANSMITTER







The revolutionary new 10-KW



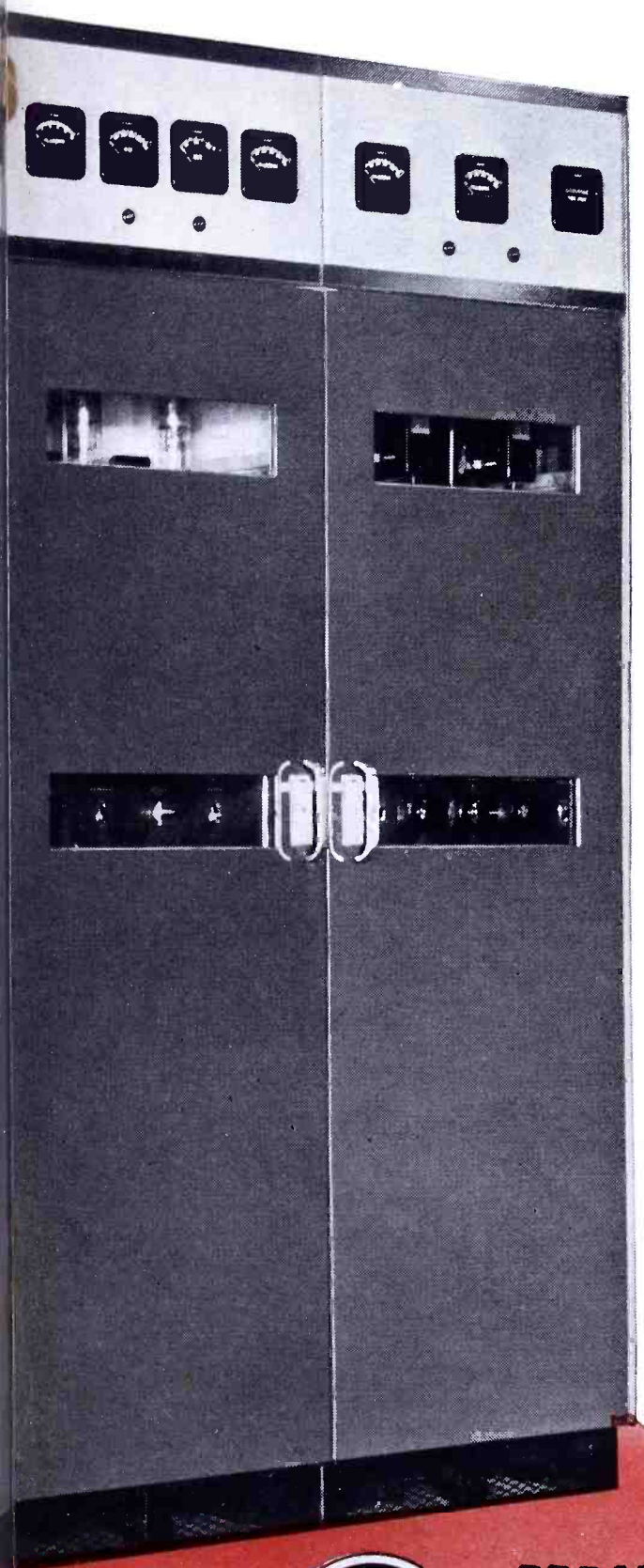
JUST OFF THE PRESS—

—a 16-page brochure about this transmitter. Complete with schematics, illustrations, data, curves. Free from your RCA Broadcast Sales Engineer, or from Dept. 38-C, RCA Engineering Products, Camden, N. J.

FM transmitter —

that saves you up to $1500 a year

Four important reasons why the BTF-10B costs less to run



Reason No. 1 . . . It Uses Smaller, Less-Expensive Tubes. Because Grounded-Grid circuits are used throughout . . . in driver stages as well as final, the extra power of the driver stages (ordinarily wasted) automatically adds to the output of the power amplifier. Thus, the final power amplifier is not required to furnish as much power—and smaller, less-expensive tubes can be used in it.

Reason No. 2 . . . It Uses Fewer Tubes. Because "Direct-FM" circuits are used in the exciter . . . and because one main rectifier supplies all high voltages, the BTF-10B uses substantially fewer tubes than most 10-kw designs. There are only 39 tubes, total. And only 23 of these are required for emergency operation. (The other 16 are control tubes whose failure will not take the transmitter off the air).

Reason No. 3 . . . It Takes Less Power. Because it uses fewer tubes, because the final amplifier tubes are smaller (use less filament power), and because the amplifiers all operate at high efficiency, *the power consumption of the BTF-10B is only 22.5 kilowatts.*

Reason No. 4 . . . It Requires Fewer Spares. Because the last three stages of this transmitter use the same type tube, the RCA-7C24, and because the overall number of tubes used is relatively small, the total *number of tube types required is only 14.* This greatly reduces the number of spares you must keep on hand.

Ask the RCA office nearest you to give you the figures which prove these claims

New York 20, New York
36 W. 49th Street,
Telephone: Circle 6-4030

Cleveland 15, Ohio
718 Keith Building,
Telephone: Cherry 3450

Chicago 11, Illinois
666 N. Lake Shore Drive,
Telephone: Delaware 0700

Atlanta 3, Georgia
502 Citizens & Southern Bank Bldg.,
Telephone: Walnut 5946

Dallas 1, Texas
1907-11 McKinney Ave.,
Tel.: Riverside 1371, 72, 73

Los Angeles 14, California
621 S. Hope Street,
Telephone: Mutual 1103

San Francisco 3, California
1355 Market Street,
Telephone: Hemlock 8-300

Kansas City 8, Missouri
221 W. 18th Street,
Telephone: Victor 6410

Washington 6, D. C.
1625 K. Street, NW,
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BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

AN AMPLIFIER AND NOISE-SUPPRESSOR UNIT

Characteristics of the H. H. Scott 210-A Amplifier, Designed with a Built-in Dynamic Noise Suppressor

BY H. H. SCOTT AND E. G. DYETT, JR.*

SINCE the original announcement of the Dynamic Noise Suppressor [1] there has been an insistent demand for a small unit which would allow full advantage to be taken of the combination of wide frequency range and low noise level made possible by this method of noise reduction in equipment for playing phonograph records and reproducing radio programs in the home. True, the dynamic noise suppressor is featured in many of the finest radio-phonograph combinations, but many hobbyists, experimenters, and music lovers enjoy the fun and also the saving in cost effected by selecting their own amplifiers, speakers, and tuners, and assembling custom-built sound-reproducing systems.

While the dynamic band-pass method of noise suppresssion is inherently adaptable to practically any sound-reproducing system, it has been featured mainly in connection with systems capable of unusually high quality musical reproduction, and it has become associated in the public mind with this type of reproduction. However, the mere addition of the noise suppressor to a system cannot improve the performance of the system itself except to lower the noise level. For that reason, it has been felt desirable to supply the noise suppressor in conjunction with a completely engineered reproducing system, in order to provide best possible results. There are also certain economies effected when the noise-suppression circuits are designed as part of the complete amplifying system, so that the total cost of an amplifier and noise suppressor is less than the cost of a separate suppressor and an equivalent amplifier.

FIG. 1. COMPACT DESIGN OF THE 210-A AMPLIFIER FACILITATES MOUNTING

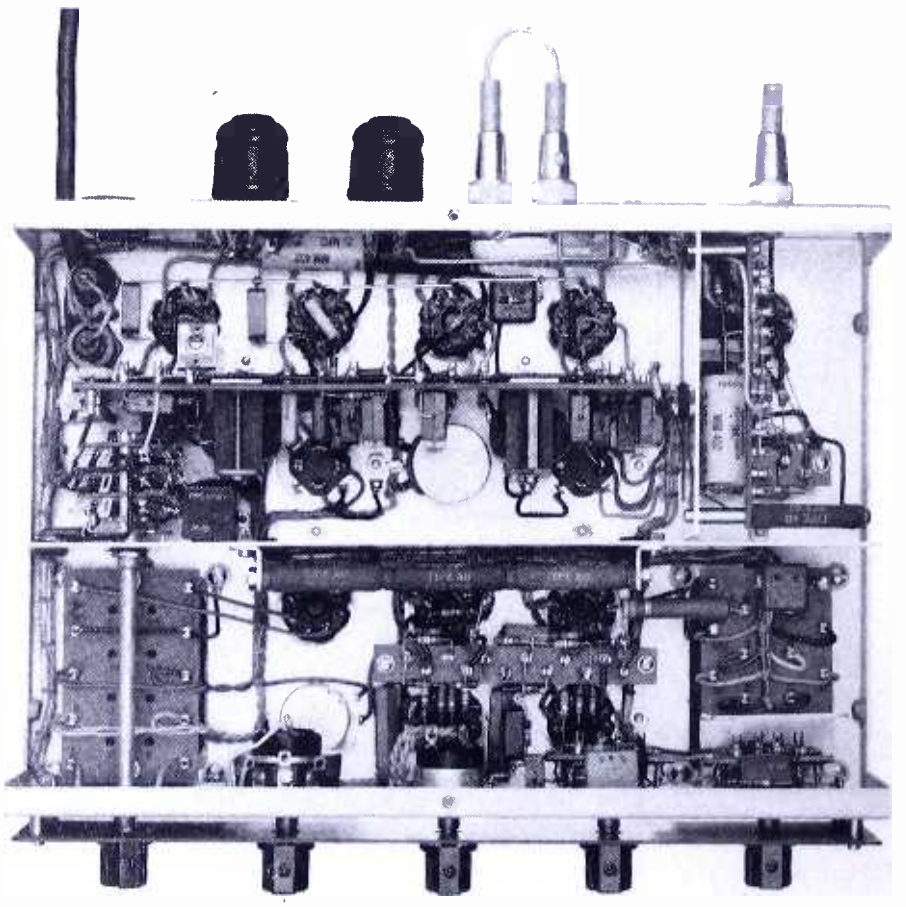


FIG. 2. UNDER SIDE OF CHASSIS SHOWS CARE GIVEN TO MECHANICAL DESIGN

Design Considerations ★ The H. H. Scott 210-A laboratory amplifier, which includes a built-in dynamic noise suppressor fills this particular need. As its name implies, the amplifier is designed and constructed to laboratory standards and includes, of course, an advanced version of the dynamic noise suppressor [2] utilizing four tubes, one of which is a double-purpose tube. Not only was an improved suppressor circuit developed specifically for this amplifier, but the amplifier itself was carefully designed to provide the best possible balance between all desirable operating factors. Totally aside from the noise-suppressing feature, therefore, the 210-A laboratory amplifier is worthy of note as an amplifier alone.

There are many factors to be considered in the design of an audio-frequency amplifier, and with the ever-improving standards of recordings and broadcasts, it is essential that no single factor be overlooked in an endeavor to exaggerate

* Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass.

[1] "Dynamic Suppression of Phonograph Record Noise" by H. H. Scott, *Electronics*, Dec. 1946.
See also "Dynamic Noise Suppressor for Recordings" by H. H. Scott, *FM* AND TELEVISION, October 1946, pages 27, 60 and 65.

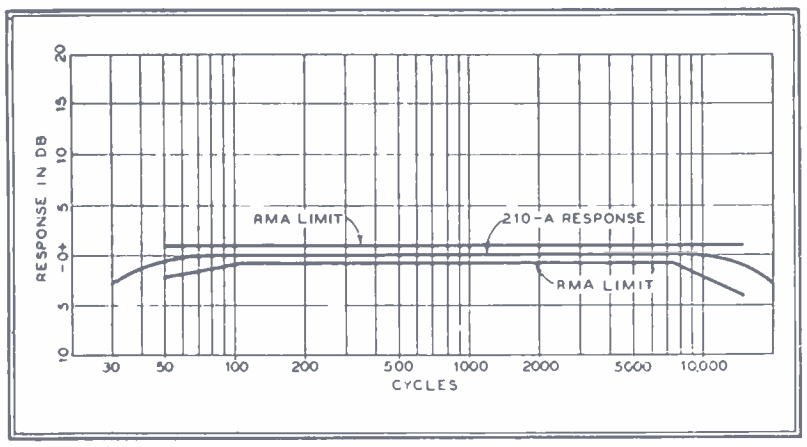
[2] Principles of dynamic noise suppression were discussed in "Dynamic Noise Suppressor" by H. H. Scott, *Electronics*, Dec. 1947.

other performance factors. Among the important factors, for instance, are the over-all frequency response and power-handling capacity without noticeable distortion or intermodulation. To these should be added the transient characteristics, the performance of the amplifier under overload conditions (which are more frequently encountered than is generally realized), effects of changes of load impedances, stability and freedom from parasitic oscillations, and the general cleanness of reproduction which results from a proper balance among all operating factors.

Some of the above factors are readily measured and presented in graphical form. On others there are no accepted standards or no satisfactory correlation between available methods of measurement and actual aural tests. The final performance of any amplifier should, therefore, be judged only on the basis of listening, but complete graphical data covering the more familiar performance factors is of considerable interest and help in the selection of an amplifier. The various performance factors of the 210-A amplifier are presented, therefore, with this in mind.

Frequency Characteristic ★ The frequency response of an amplifier can be made anything desired, subject only to economic or other practical limitations. Many amplifiers have been designed, therefore, with excessive extension of the low- or high-frequency ranges beyond any reasonable limits which may be present in the signal to be reproduced. As a practical matter, there is a very serious disadvantage to this type of amplifier design. Excessive high-frequency response above the audible range is generally accompanied by peaks in the region above 20 kc. which contribute to a type of instability or high-frequency *singing* which, while it occurs at a superaudible frequency, nevertheless produces, through intermodulation effects, considerable distortion and noise or hash. For this reason, it is definitely desirable to roll down the high-frequency response of an amplifier above the usable operating range at a definite predetermined rate.

A similar situation exists at the low-frequency end. Through direct coupling or other methods, the low-frequency response of an amplifier can be carried to almost any lower limit desired. Amplifiers have actually been encountered in which the low-frequency signal, slightly over 1 cycle per second, generated by the eccentricity of a commercial phonograph disc, actually overloaded the amplifier at normal levels of the desired signal. Furthermore, amplifiers with excessive low-frequency response tend to block on sudden transients either in the signal or as caused by clicks in a phonograph record, or static in radio reception. This blocking causes a muddy quality which is definitely objectionable. In the interests of the cleanest possible reproduction, therefore, the response curve of the 210-A amplifier was definitely selected to match the requirements of the signals to be amplified.



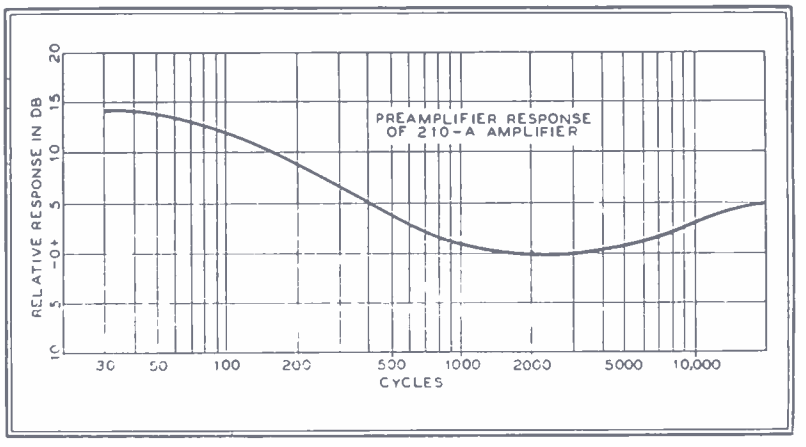
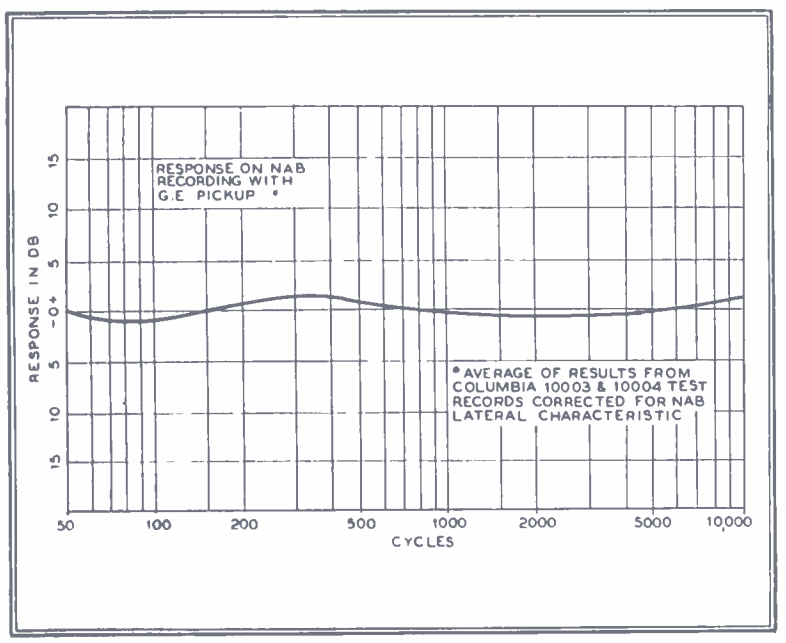


FIG. 3. PROPOSED RMA LIMITS FOR AM AND FM AUDIO FACILITIES. FIG. 4. RESPONSE OF THE PREAMPLIFIER IN THE 210-A UNIT

Fig. 3 shows the proposed RMA limits for the audio facilities and broadcast systems, either AM or FM. These limits include only the audio circuits between the microphone and the transmitter, and represent but a fraction of the total allowable limits in the entire broadcast system which must of necessity include the transmitter itself and the studio-transmitter link. Between these limits for the audio facilities is drawn the over-all response curve of the 210-A. It will be noted that this amplifier is well within the standards set for the broadcast equipment itself.



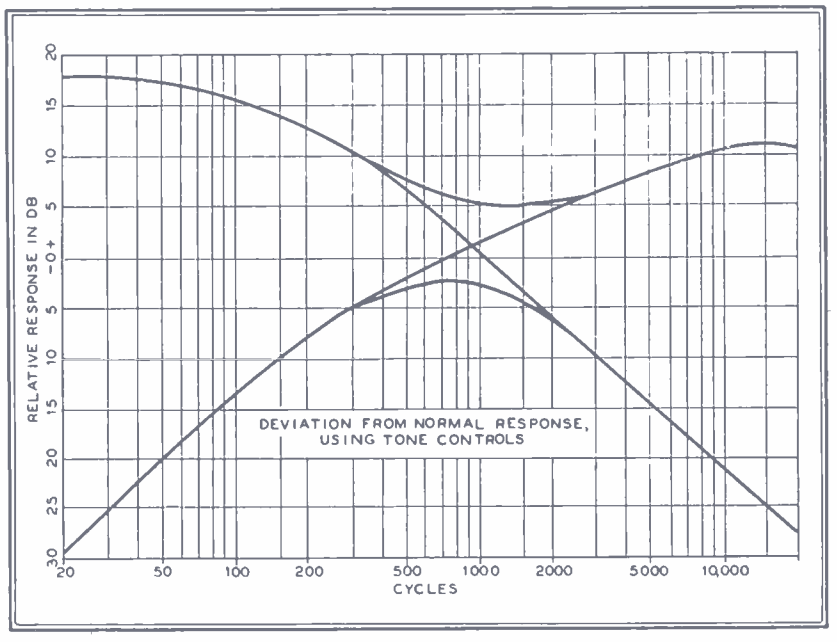
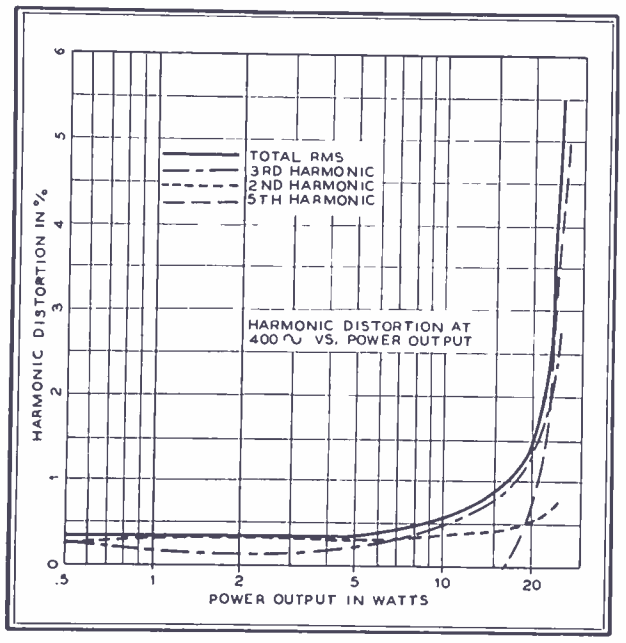


FIG. 5. OVER-ALL 210-A RESPONSE, INCLUDING PREAMPLIFIER AND PICKUP. FIG. 6. CHARACTERISTICS OF THE TONE CONTROLS

It is a reasonable assumption that the performance characteristics of recording systems used in making commercial phonograph records will not be of a different order of magnitude from those of the broadcast stations. Actually, in both broadcasting and recording systems,



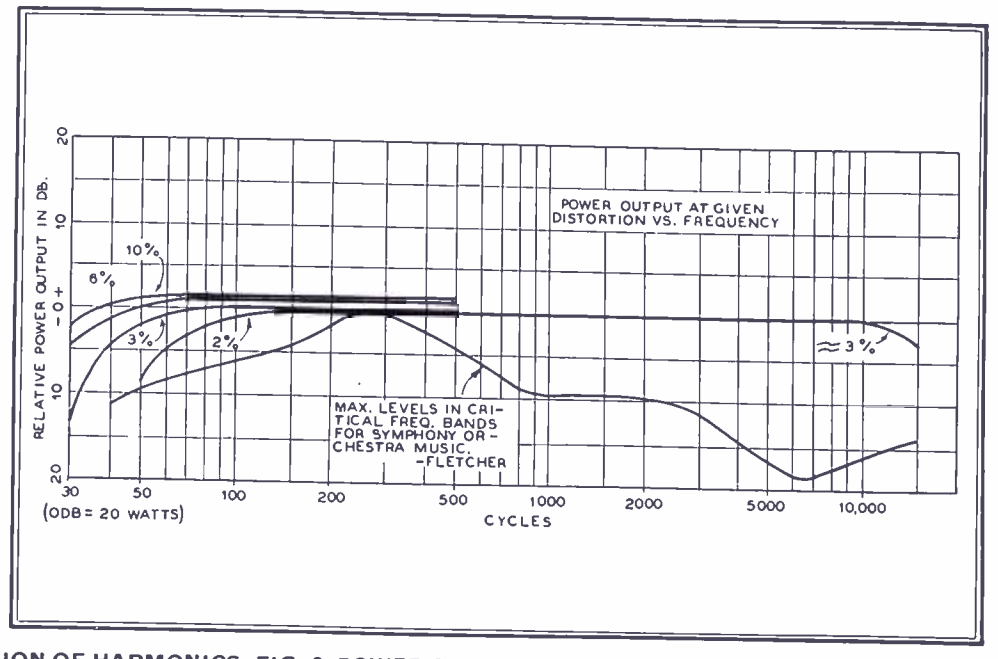


FIG. 7. DISTORTION IN TERMS OF THE GENERATION OF HARMONICS. FIG. 8. POWER AVAILABLE WITH NEGLIGIBLE DISTORTION

limiting amplifiers are quite generally used to compress the volume range somewhat. To avoid thumps resulting from the operation of these limiters, the low-frequency response of the systems are purposely attenuated below 50 cycles. As far as the high-frequency limits of phonograph records are concerned, it was not many years ago that 4 kc. or 5 kc. were considered entirely adequate. Until recently, most large recording companies have recorded through low-pass filters, cutting off around 8 kc. Now, 15 kc. are considered the top usable limit in FM stations. It is apparent, therefore, that the response characteristic of the 210-A amplifier, portrayed in Fig. 3, fits almost exactly the requirements for which it was designed. The actual response can, of course, be increased or reduced at either end of the frequency spectrum by means of the flexible tone control system provided. The curve shown in Fig. 3 is with the tone controls set at the center position.

Response on Records ★ The preamplifier built into the 210-A as an integral part of the circuit is particularly equalized for use with magnetic type (constant velocity) pickups, as indicated in Fig. 4. The heater of the double triode in this preamplifier is heated by DC to avoid any hum from this source, thus eliminating one of the usual difficulties attendant upon the use of a low-level pickup.

The correct frequency response on a phonograph record is a matter open to considerable conjecture and difference of opinion, since there is as yet no standardization among manufacturers of commercial phonograph discs. On the other hand, the trend among such manufacturers has been to approach the standard NAB lateral transcription characteristic, which provides a certain amount of pre-emphasis on the higher frequencies. It has been assumed, therefore, that the standard NAB playback curve would be a suitable average for commercial records. The user can vary the overall characteristic considerably in either direction in either the high-frequency or the low-frequency ranges by means of the tone control circuits.

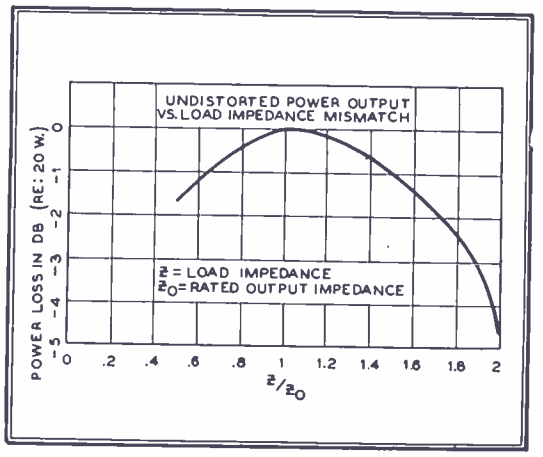
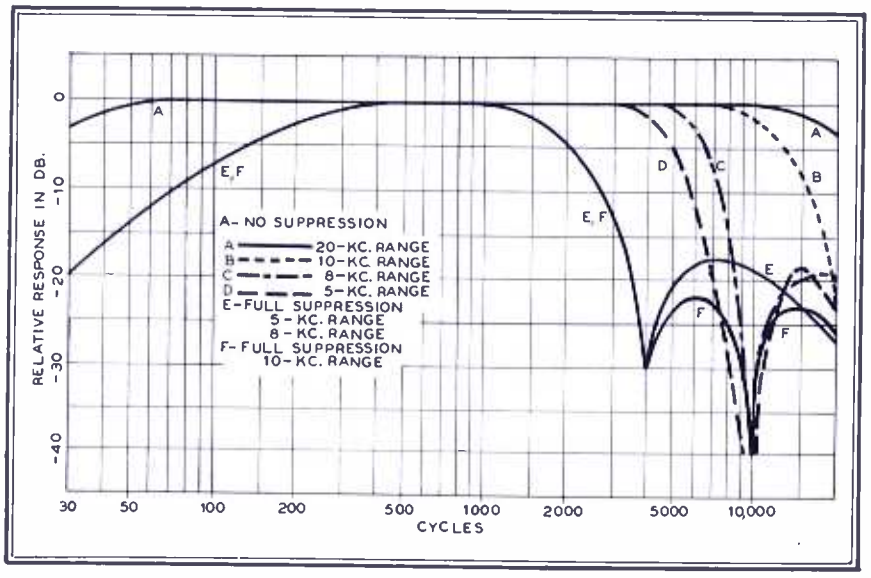


FIG. 9. EFFECT OF IMPEDANCE MISMATCH

Fig. 5 shows the overall response of the 210-A amplifier, including the preamplifier and an average General Electric variable-reluctance pickup. This curve was plotted by averaging results obtained on two commercial test records and correcting for their departure from the standard NAB lateral recording characteristic.

The circuit can be adapted easily for use with various other magnetic pickups now available. In general, the main difference between the response of different types is in the slope of the high-frequency characteristic. Since most of the other magnetic pickups have more high-frequency response than the General Electric, the overall response can be modified for such pickups by a simple

(CONTINUED ON PAGE 40)



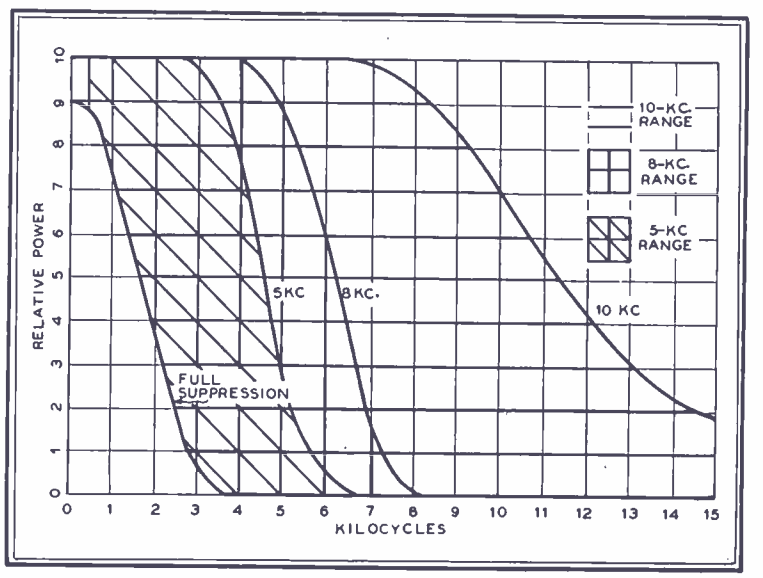


FIG. 10. CHARACTERISTICS OBTAINED FROM USE OF FREQUENCY-RANGE SWITCH. FIG. 11. OBTAINABLE NOISE REDUCTION

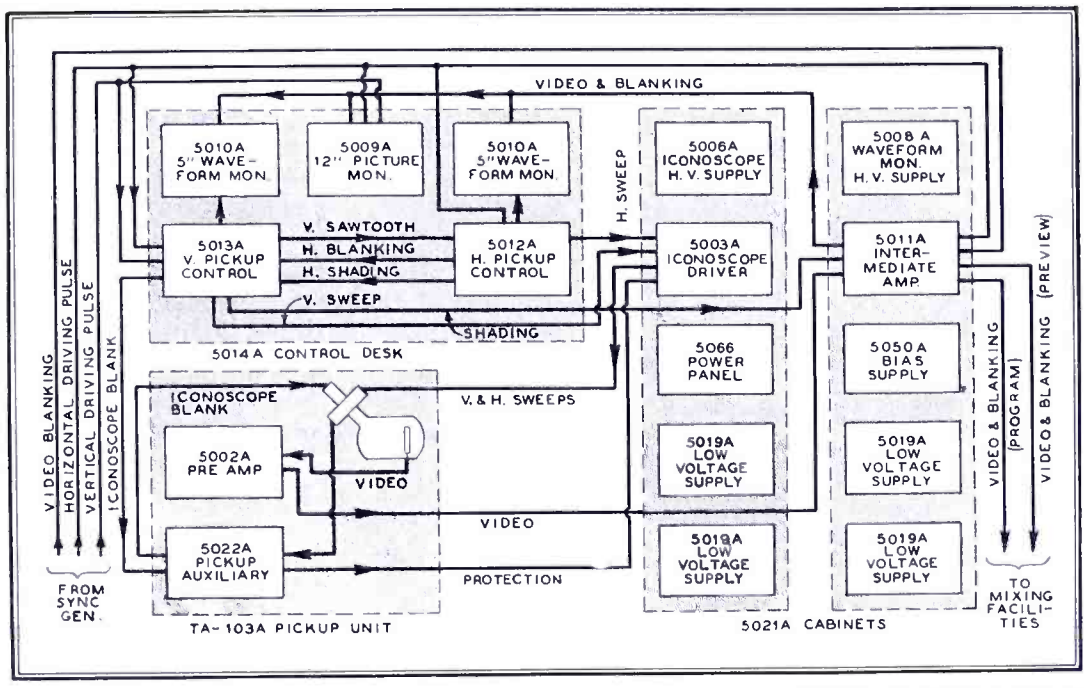


FIG. 1. BLOCK DIAGRAM OF THE ICONOSCOPE FILM PICKUP SYSTEM, SHOWING ONLY ONE SECTION OF THE CONTROL DESK DESCRIBED HERE

FILM PICKUP SYSTEM

An Engineering Description of DuMont Equipment for Handling Motion Pictures, Slides, and Test Patterns

BY HARRY R. SMITH AND GORDON S. GREGORY*

A CONSIDERABLE portion of the programs presented by television stations is originated by means of both fixed slides and motion picture film. Entertainment films, commercial films, sign-off and sign-on announcements, commercial slides, and test patterns, all make use of film pickup equipment. The system described herein performs the important function of converting the pictures obtained from slides and motion picture film into the video waveform required for the program mixing facilities of standard television stations.

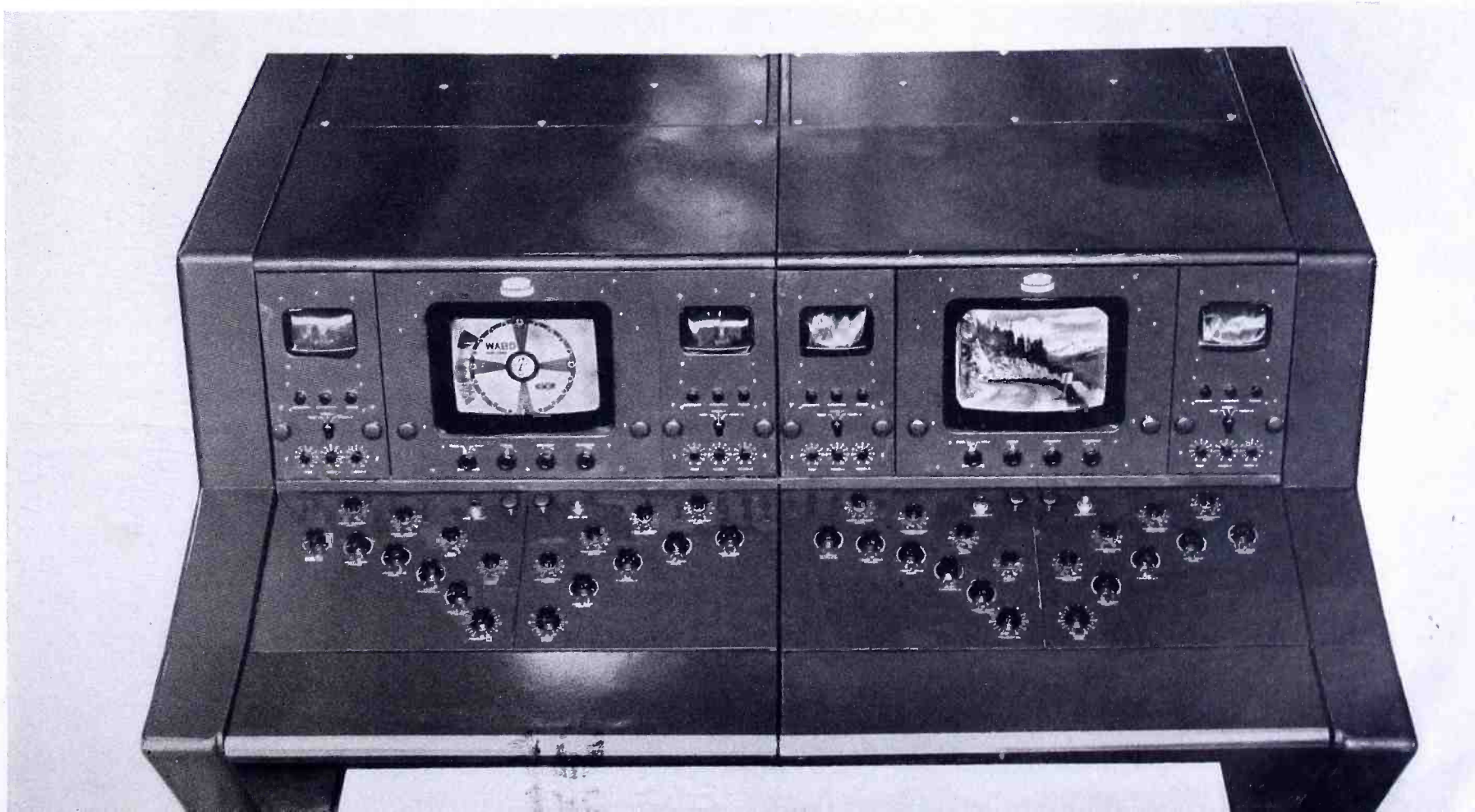
* Respectively, Senior Electronic Engineer, and Senior Mechanical Engineer, Transmitter Division, Allen B. DuMont Laboratories, Inc., Clifton, N. J.

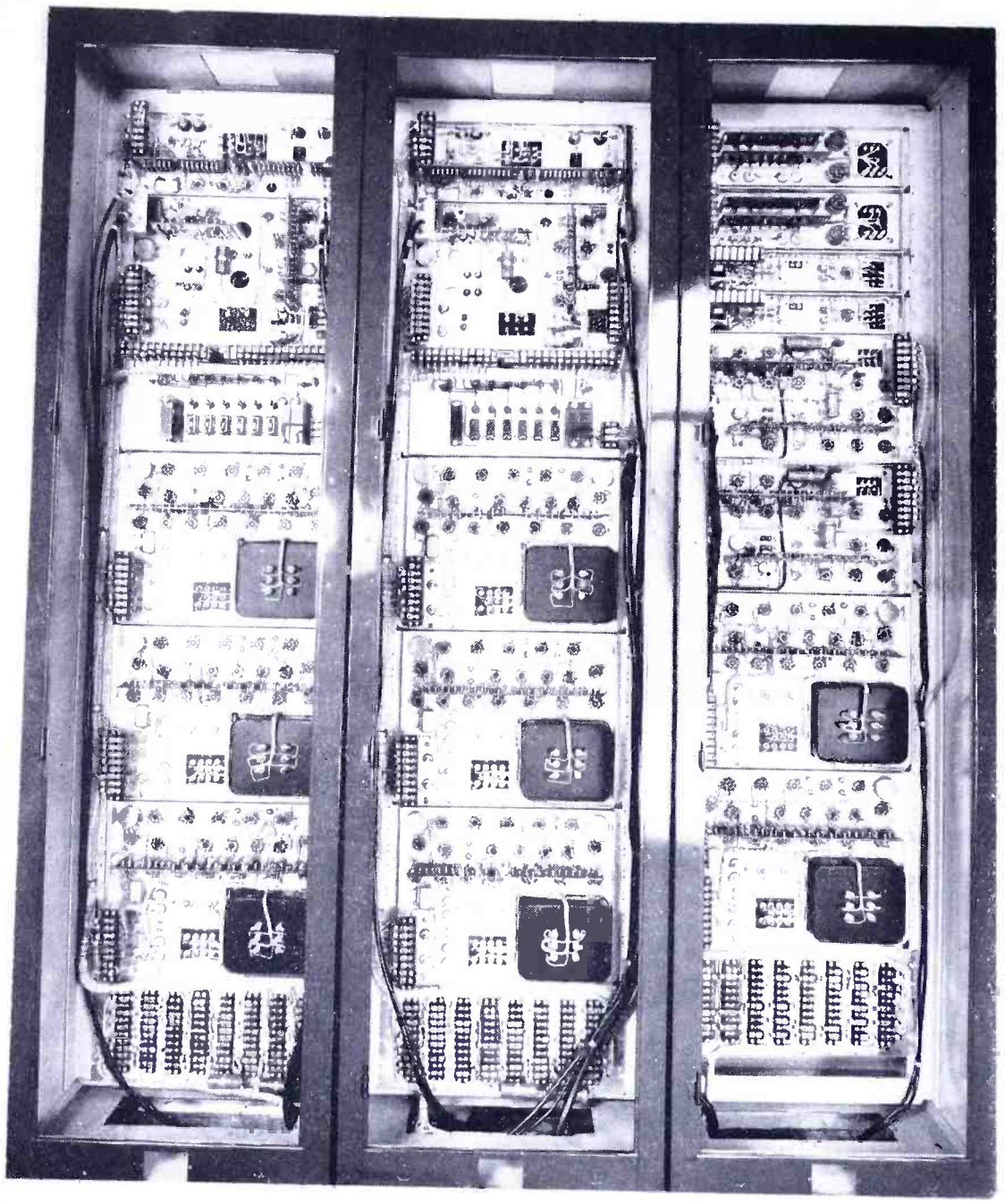
Arrangement ★ Associated with each film pickup tube is the film chain equipment, housed in three separate sections. One complete assembly, comprising a pickup unit, control desk, and the equipment cabinets, is represented by the block diagram in Fig. 1. In order to provide uninterrupted film programs, it is usually found necessary to employ at least two pickup tubes in a so-called dual film chain. Each additional pickup duplicates the equipment shown in Figure 1. The control desks and equipment cabinets of multiple film chains can be combined to give the equipment a unified appearance, as in Fig. 2, where two control desks are combined to form the operating console for a dual film chain. An existing system can be expanded by inserting more sections between the removable end bells.

The problems involved in operating and maintaining studio equipment have been given careful consideration in the design of this system. In addition to the normal operating controls, the important screw driver adjustments (such as sweep linearity and keystone amplitude) have been located in the control desk so that the operator can critically observe their effect on the picture and waveform monitors when the chain is being set up.

As far as practical, units have been located in the equipment cabinets, Fig. 3, where all their components are completely accessable for maintenance and service. Where circuit considerations such as lead lengths in high impedance circuits make necessary the location of units in the console, the units are mounted on sliding tracks for accessability as shown in Fig. 4. Stable circuits, and circuit components with large factors of safety have been chosen in an attempt to obtain long continuous service with a minimum number of component failures. Electrolytic condensers, which are liable to deteriorate with time, are for the most part of the plug-in variety and can be replaced easily. Test points have been located at strategic places throughout the system to permit rapid trouble shooting.

FIG. 2. TWO IDENTICAL FILM PICKUP CONTROL UNITS ARE COMBINED IN THIS CONSOLE, TO PROVIDE UNINTERRUPTED OPERATION

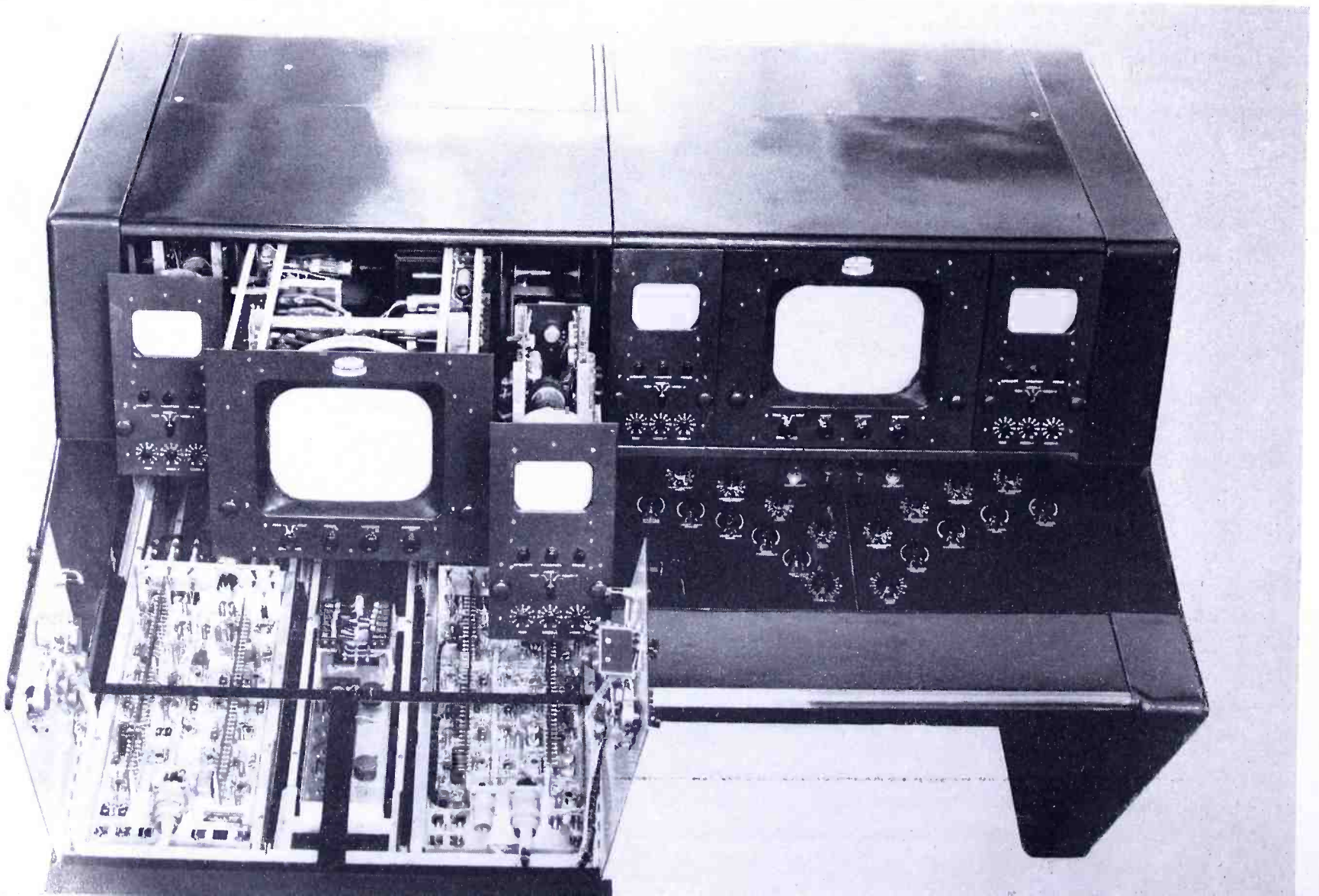




The type 1850-A Iconoscope was chosen as the pickup tube because of its ability to reproduce the gray shades in the picture. This tube is capable of good resolution with relatively high signal-to-noise ratio, and its lack of sensitivity at low light levels is counteracted by the fact that in this type of service adequate light is available. The most serious short-coming of the Iconoscope is its inherent spurious signal, which necessitates shading correction. This situation is considerably improved, however, by the use of adequate rim and back lighting, and by the use of a line-to-line clamping circuit. The shading correction controls on the console are located for most convenient operation and the need for shading can be quickly recognized on the two 5-in. waveform monitors which present the video waveform simultaneously at line and field sweep rates. Beside reducing the need for vertical shading correction, the line-to-line clamp avoids the need for low-frequency compensation in the video amplifiers, eliminates hum pickup, and reduces microphonics.

The deflection yoke for the iconoscope employs low impedance vertical and horizontal windings which allow the horizontal and vertical sweep output tubes to be located in the equipment cabinet, at a considerable distance from the pickup unit. The low impedance yoke has the additional advantage of simplifying the shielding in the pickup unit, since the amplitude of the voltage which is developed across the yoke during flyback is much less than that developed across the higher-impedance yokes. Hence, it is less

FIG. 3, ABOVE: CIRCUITS ARE RACK-MOUNTED IN CABINETS. FIG. 4, BELOW: DRAWER CONSTRUCTION GIVES ACCESS TO CONSOLE SECTIONS



liable to cause interference in the nearby low-level video circuits.

Pickup Unit ★ The pickup unit contains the pickup tube, pre-amplifier, and pickup auxiliary as indicated in Fig. 1. The unit is designed for mounting on either a fixed pedestal or a platform which moves on tracks. With a fixed pedestal, the unit can operate with only one optical projector, unless mirrors or prisms are used. The moving platform permits one unit to be operated with several optical projectors.

Fig. 5 shows the pickup unit with the shield cover removed. The Iconoscope tube is mounted in a cradle which can be positioned by means of various mechanical adjustments. The tube can thus be moved readily so that the photo-sensitive mosaic is centered on the projected image, and lies in a plane normal to the center line of projection. All mechanical adjustments are provided with locking screws. The back light, situated directly behind the Iconoscope, is contained in a small housing at the rear of the unit. Illumination of the back and side walls of the tube envelope reduces the spurious signal, and increases the sensitivity of the iconoscope.

Each rim light consists of three flashlight bulbs mounted in a small, wedge-shaped box. Collimating baffles and a machined knife-edge at the front of the box cause a well-defined band of light to be cast. The rim light assemblies are mounted with adjustments so that the light bands can be positioned accurately on the right hand side and bottom of the metal frame surrounding the iconoscope mosaic. The function of the rim lights is to reduce the spurious signal generated by the pickup tube, by causing the illuminated parts of the metal frame to emit photo-electrons and change the electric field distribution in the area where the scanning beam starts to fly back. The intensity of the rim and back lighting are separately controlled at the control desk.

Mounting for the low-impedance deflection yoke provides all the necessary adjustments for aligning the yoke on the tube neck, and can accommodate the various possible positions of the Iconoscope tube. The offset metal plate on which the rim light boxes and yoke support are mounted acts as a shield, and reduces electrical interference which might be coupled to the low-level circuits associated with the iconoscope signal plate.

The preamplifier unit mounts in a separate compartment directly above the signal plate of the pickup tube, allowing a short connecting lead to the input grid. This can be seen in Fig. 5. The amplifier employs 3 gain stages, a compensating stage, and an output stage, using miniature tubes. The gain stages use simple shunt-peaking, with fixed peaking inductances. Compensation for the attenuation of the high frequency components of the picture signal, resulting from the inherent capacity shunting the input load resistor, is accomplished by a variable series combination of inductance and resistance in the compensating stage. When this stage is properly adjusted, the overall frequency response of the pre-amplifier is flat within 5% up to 6 mc. The output stage feeds the coaxial cable which carries the video signal to the intermediate amplifier in the equipment cabinet. A video phase-reversing switch in the pre-amplifier output stage makes possible the projection of negative film. This feature avoids the need for making a positive film when it is desired to project a recently-filmed event in the shortest possible time.

The pickup auxiliary mounts in the bottom of the pickup unit Fig. 5, where both tubes and components are readily accessible when the cover is removed. This unit contains the filament supply for the Iconoscope and preamplifier, a regulator for the preamplifier B supply, and an amplifier for the Iconoscope blanking signal. Included also are two protection diodes which peak-rectify the flyback pulses appearing across the vertical and horizontal windings of the deflection yoke. Their DC outputs are fed to the Iconoscope driver unit in the equipment cabinet where they control relays which remove the high voltage from the Iconoscope in the event of sweep failure, and prevent accidental damage to the Iconoscope mosaic.

Control Desk ★ The control desk, as indicated in the block diagram, Fig. 1, contains two 5-in. waveform monitors, one 12-in. picture monitor, a vertical pickup control unit, and a horizontal pickup control unit. Each unit is mounted on sliding tracks and can be withdrawn while the system is in operation. As can be seen in Fig. 4, when a unit is withdrawn, all components are readily accessible for testing and maintenance. The control panel on each desk contains all the controls necessary for operating the associated pickup unit. The panel is divided in two parts, hinged to make their under sides accessible.

The controls in the upper row, Fig. 2, reading from the left, are: vertical sweep amplitude, vertical sweep positioning, rim light brilliance, back light brilliance, iconoscope beam focus, beam intensity, horizontal sweep position, horizontal sweep amplitude. The controls in the lower row, reading from the left, are: master shading, vertical sine wave phase, vertical sine wave amplitude, vertical parabola, vertical sawtooth, pedestal am-

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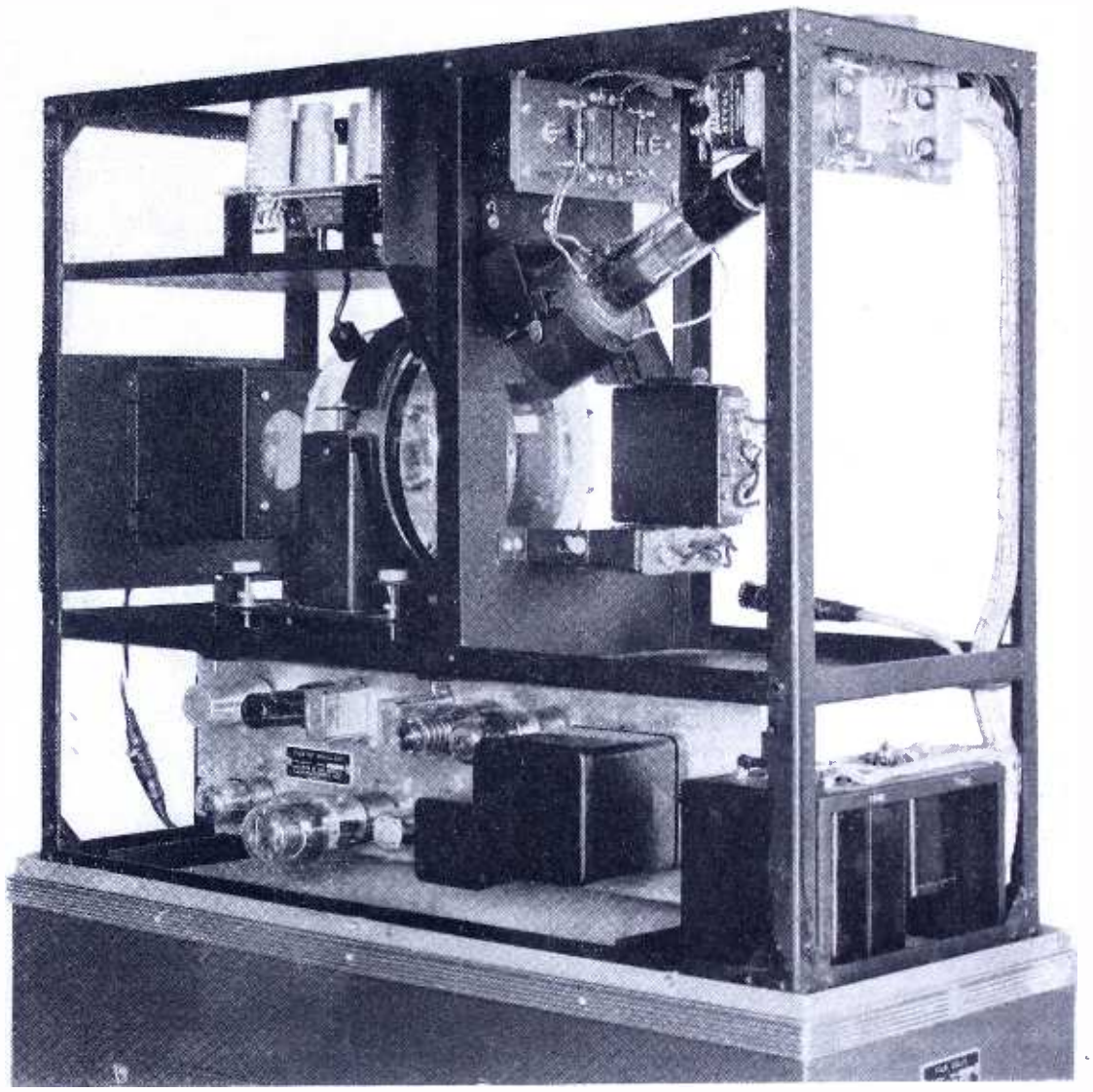

FIG. 5. THE COMPLETE ICONOSCOPE PICKUP UNIT WITH THE SHIELD COVER REMOVED

FIG. 3. CONTROL CONSOLE FOR THE STUDIO LAYOUT SHOWN LAST MONTH IN FIG. 2, OF PART 1

DESIGN OF STUDIO SPEECH INPUT SYSTEMS

Plans Which Strike a Balance Between First Cost, Flexibility, and Maintenance Expense—Part 2

BY JOHN A. GREEN

Console ★ The studio speech input console selected is a Collins 212B-2, shown in Figs. 3 and 4, with a block diagram in Fig. 6. It is a 7-channel unit with provisions for 4 low-level microphone inputs, 2 low-level transcription inputs, and one high-level or remote input channel. An improved telephone type of push button, a section of which is shown in Fig. 5, allows connections normally for 9 remote lines or combinations of 9 high-level inputs.

Loud speakers for all the studios, control room, and reception room are fed from the console by the self-contained monitor amplifier. Interlocked relay control circuits afford program protection in the studios and control room, as well as controlling studio warning lights. The Collins system of selective talkback to the studios and the remote lines is included in the equipment. The 409U power supply and the 274D relay unit are shown in the rack assembly, Fig. 7, although they are also furnished for wall mounting.

The mechanical design of the console is most interesting. It is so designed that the unit can be placed directly against the wall or the control room window, and there is no need to move it forward when maintenance is required. Fig. 4 shows the unit in the open position, giving access to the under side of the chassis.

Frequency response of the console is within 2 db total variation from the microphone to the line, or from the microphone to the speaker. Harmonic distortion is less than 1% RMS at the normal output of the line amplifier, and less than 2% RMS harmonic distortion at a power output of 8 watts from the monitor amplifier. Noise level of the unit is at least 65 db down.

Fig. 6 shows the block diagram of the 212B-2. An audition channel is provided by using the monitor amplifier included in the console. The selective talk-back system makes use of the control room microphone preamplifier and the monitor amplifier. Talk back can be directed to either of the studios or to the remote lines. Further details of the facilities provided will be apparent from a study of Figs. 2 and 6, and the following description of the units on the equipment racks.

Equipment Racks ★ Fig. 7 shows one of the many ways in which the rack mounted gear may be put into two cabinet racks. These racks should be located so that the operator can reach them easily from his operating position. The left rack carries all the units operating at the lower levels, while all the equipment operated at the higher levels is at the right. This separation makes for better performance of the overall system. Some extra panel space is available, so that new units can be added later. In the base at the rear of each cabinet are terminal assemblies which provide 96 telephone-type terminals for low-level and control circuits, and 60 heavy-duty terminals for power, AC, and high level audio. There are many, many ways in which equipment can be arranged in cabinet racks, and every engineer has his own particular reason for his preferences. The important thing is to have circuits segregated properly so that overall performance is not affected.

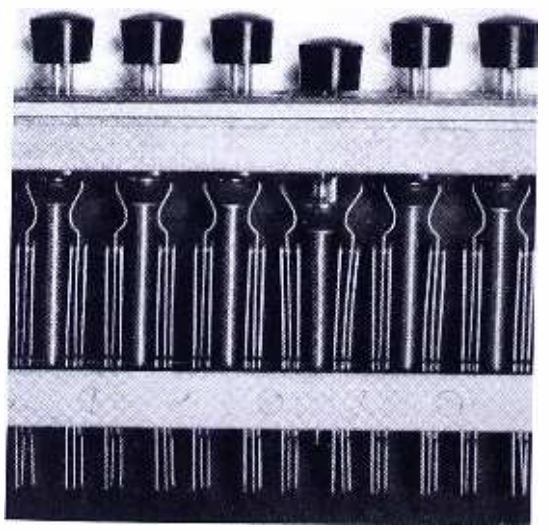

FIG. 5. SECTION OF PUSH BUTTONS

Included in the equipment racks, Fig. 7, are repeat coil panels 117N-4 and 117N-2, 62E-1 volume indicator panel, 6X monitor amplifier, 6R isolation amplifier, 82T-1 metering panel, and a Presto 88A recording amplifier.

The 117N-4 repeat coil panel contains 4 high-quality repeat coils. Two of these transformers are 600-ohm primary to 600-ohm secondary units, used for connection between the console output and a telephone line input to the transmitter. A third coil has a single 600-ohm primary with three 600-ohm secondary windings for special multi-feed requirements. The fourth coil is a bridging or isolation transformer with a bridging input to a 600-ohm secondary isolation or bridging transformer.

The 117N-2 repeat coil panel is a utility panel in which only 2 transformers have been specified. These are 600-ohm primary and 600-ohm secondary units, provided for isolation purposes. Space is afforded in the unit so that 2 additional transformers can be added at a later date.

The 62E-1 volume indicator panel incorporates a selector switch and a model 30 Weston VU meter, along with a variable multiplier so that levels from O dbm or 1 milliwatt to plus 40 dbm, in steps of 2 db, can be metered accurately. There is also a vernier screw adjustment which permits ± .5 db variation for coordinating readings with this meter and other meters. The 4 lines into this equipment are used as follows:

1. Output of the 116F equalizer system for checking levels on a remote line, and adjusting for proper equalization.

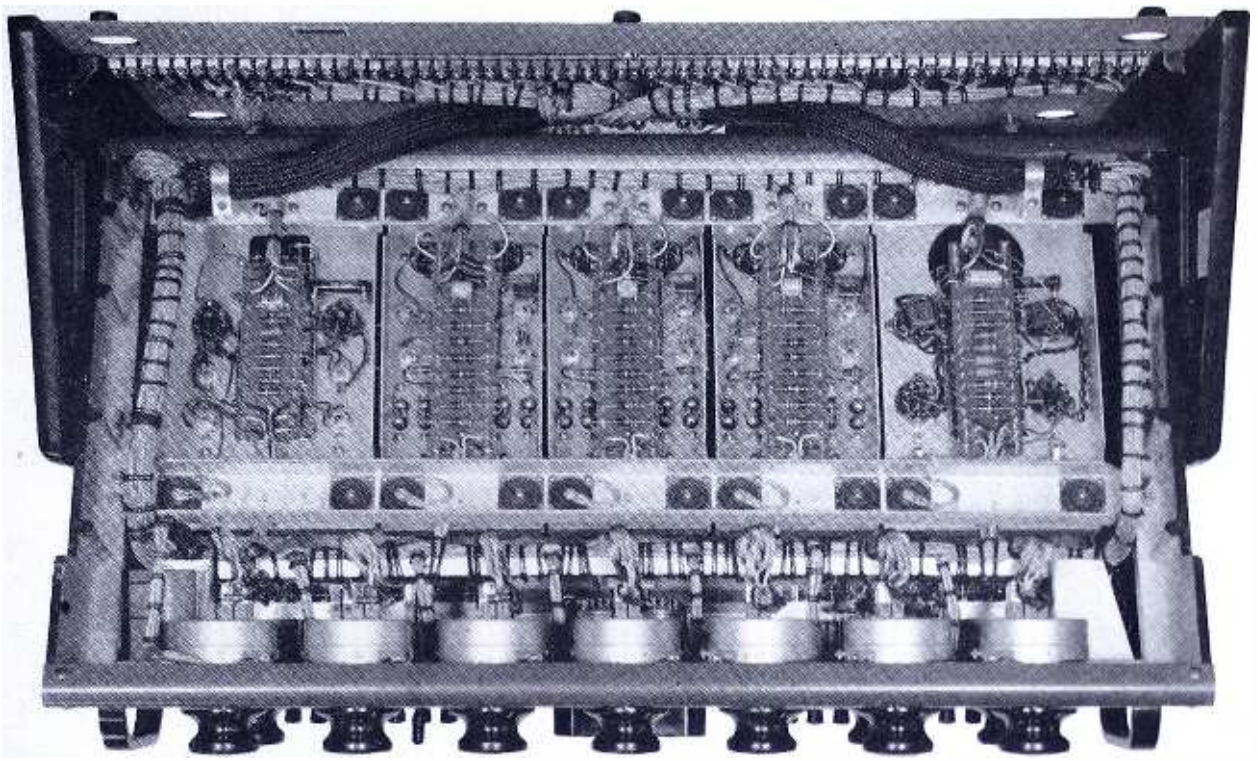

FIG. 4. ALL INTERNAL CONSOLE WIRING IS ACCESSIBLE WHEN FRONT PANEL IS DROPPED FORWARD

2. Output of the monitor amplifier in the 212B-2 console, offering an external volume indicator so that both a program and an audition can be metered as required.

3. Input to the recording amplifier to meter the input to the recording system.

4. This position is terminated in the jack panel, so that it can be patched into any circuit in which metering might be required.

The recording amplifier is a Presto 88A. It is suggested that in choosing a recording amplifier, the amplifier selected be designed to work with the associated recorders. This will assure the best recording and smoothest operation.

The 6R amplifier is included in the equipment for utility and isolation purposes on any of the special jobs which will arise from time to time. For example, there may be an occasion when the continuity department would like to time some special records or transcriptions. By using the third transcription turntable, one of the 6P preamplifiers, and the 6R isolation amplifier, properly patched together and to a loud speaker in the continuity department, the operator need not be bothered with the record cueing and timing.

The 82T metering panel offers a quick method of checking the average operating characteristics of the 6P preamplifiers, 6R isolation amplifiers, and the 6X monitor amplifiers, as well as the line voltage.

The 6X monitor amplifier is an 8-watt unit of excellent response characteristics and low distortion. It feeds the loudspeakers in the sales office, continuity department, manager's office, program director's office, music library, and the chief engineer's office. In this way, all these offices and departments can monitor the program on the air with absolutely no interruptions from talk back and cueing.

Several spare jack pairs and transfer circuits are indicated in Fig. 2, between the rack cabinets of this speech input system. These are always handy, and at the same time the spare jacks allow for additions of new equipment as the operations change over a period of time.

It is not necessary to go into detail concerning the choice of microphones, speakers, transcription turntables, or recorders. These accessories to the main equipment are just as important functionally, but are not as important perhaps to the whole picture as they are less permanent, and can be much more easily replaced than consoles or rack-mounted equipment.

Following is a typical check list of the equipment needed for this complete installation. Many variations could be suggested in choosing the equipment, but this list will serve as a guide in designing any specific speech input system.

Check List for Equipment Called for in Figs. 1 and 2

Studio A

1 Microphone with desk stand, 30-ft. cord, and plug
1 Microphone with floor stand, 30-ft. cord, and plug
1 Monitor speaker with cord and plug
3 Microphone receptacles
1 Speaker receptacle
2 Warning light assemblies

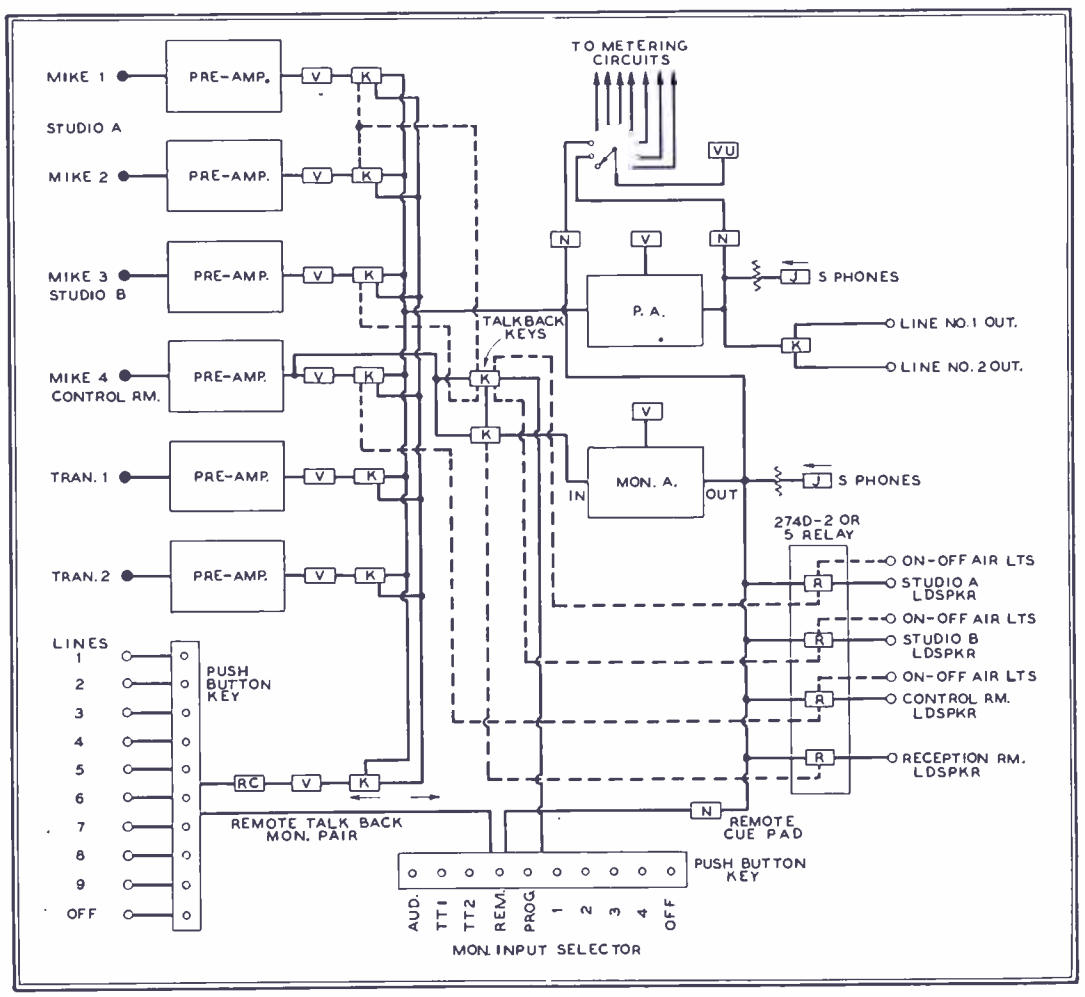

FIG. 6. BLOCK DIAGRAM OF THE CONSOLE CIRCUIT ELEMENTS AND CONTROLS

Studio B

1 Microphone with desk stand, 30-ft. cord, and plug
1 Monitor speaker with cord and plug
2 Microphone receptacles
1 Speaker receptacle
2 Warning light assemblies

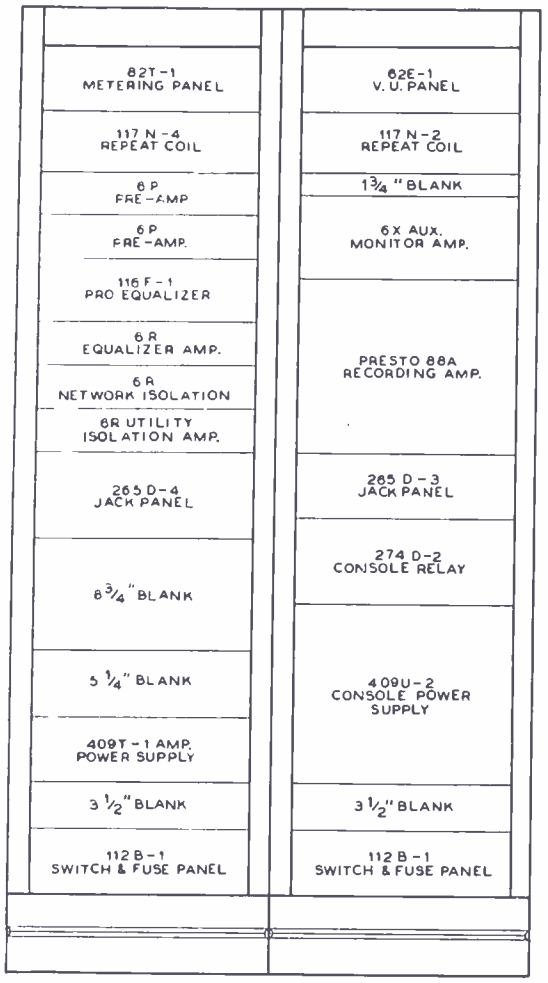

FIG. 7. RACK-MOUNTED AUDIO UNITS

Control Room

1 Microphone with desk stand, 20-ft. cord, and plug
4 Low-level receptacles
2 Speaker receptacles
2 Monitor speakers with cords and plugs
3 Transcription turntables
1 Speech input console
1 Desk for console

Units in Cabinet Racks

2 Cabinet racks
2 Terminal assemblies
2 Switch & fuse panels
1 48-pair jack panel
1 72-pair jack panel
2 Preamplifiers
1 Equalizer
3 Isolation or booster amplifiers
1 Power supply
1 Repeat coil panel with 4 coils
1 Repeat coil panel with 2 coils
1 VI panel
1 General monitor amplifier
1 Metering panel
1 Recording amplifier
2 Recorders
6 Warning light assemblies

looked in designing a studio speech input system is that many commercial models of consoles and speech input gear are available, each designed for a certain job. If your requirements do not really fit the design of standard commercial units, you should buy special equipment which is an adaptation of the standard gear. Such special gear does not cost as much as custom built equipment. Most manufacturers can modify existing equipment or furnish equipment similar to the standard which will do your job without fault.

Remote Pickup Amplifiers ★ Selection of remote pickup amplifiers should be made with extreme care. They are the secret of success for remote control shows. A Collins 12Z 4-channel remote pickup amplifier is shown in Fig. 8, and the block diagram in Fig. 9. This unit operates on both batteries and AC. Batteries and the AC power supply are contained in the unit. A special changeover relay in the power supply unit allows automatic cutback to DC operation should the power cord be disconnected or should the AC source fail. This insures continuity of operation at all times. Four input channels allow pickup of most types of shows produced outside the studio. An illuminated meter helps greatly where the operator must work in a small, dark corner off stage, a condition encountered quite frequently. Two telephone lines can be

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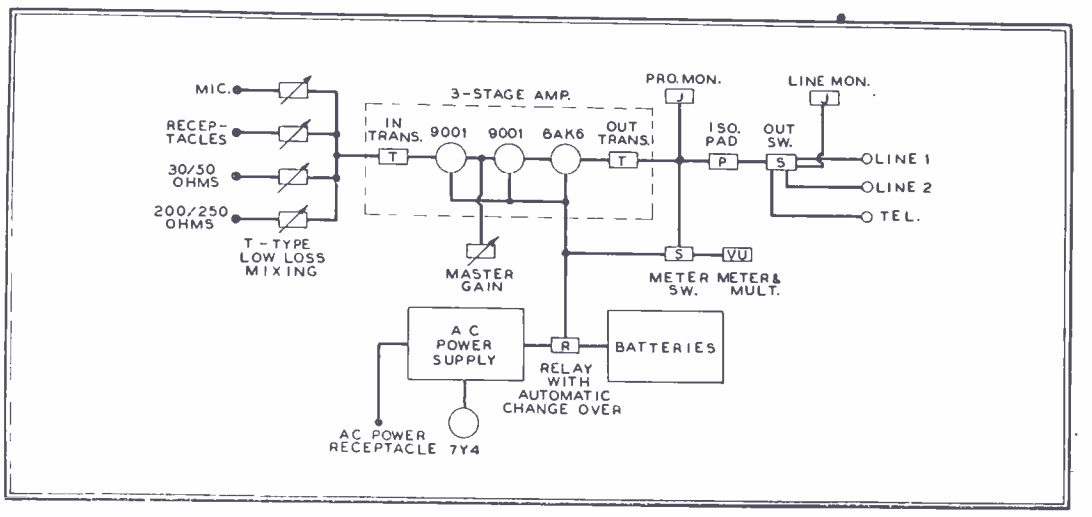


FIG. 9. BLOCK DIAGRAM OF THE 4-CHANNEL 12V COLLINS REMOTE PICKUP AMPLIFIER

Microphone Equipment for Remote & Studio Use

6 Microphones
1 Boom stand
3 Floor stands
2 Portable stands
2 Desk stands

Office Speakers

4 Extra-quality monitor speakers
4 Standard monitor speakers
8 Speaker plugs
8 Speaker receptacles

Remote Pickup Equipment

1 4-channel remote pickup amplifier
1 2-channel remote pickup amplifier
1 Single-channel remote pickup amplifier
3 Pairs headphones

One fact that should never be over-

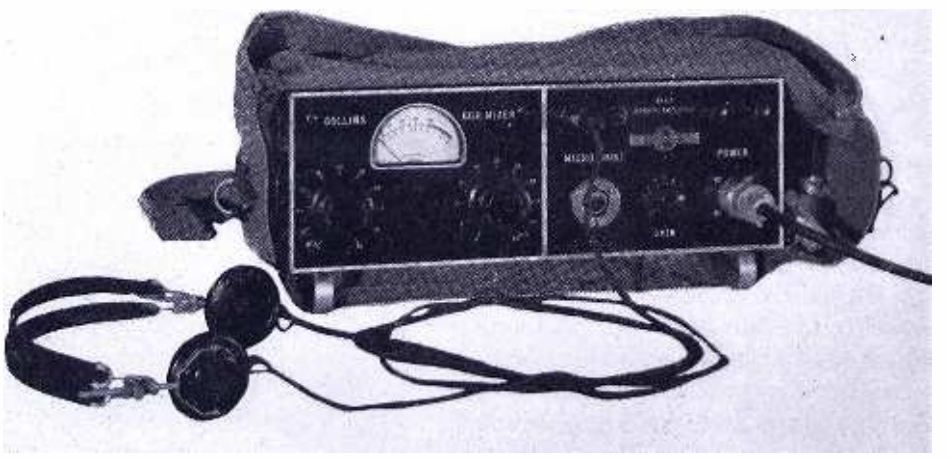
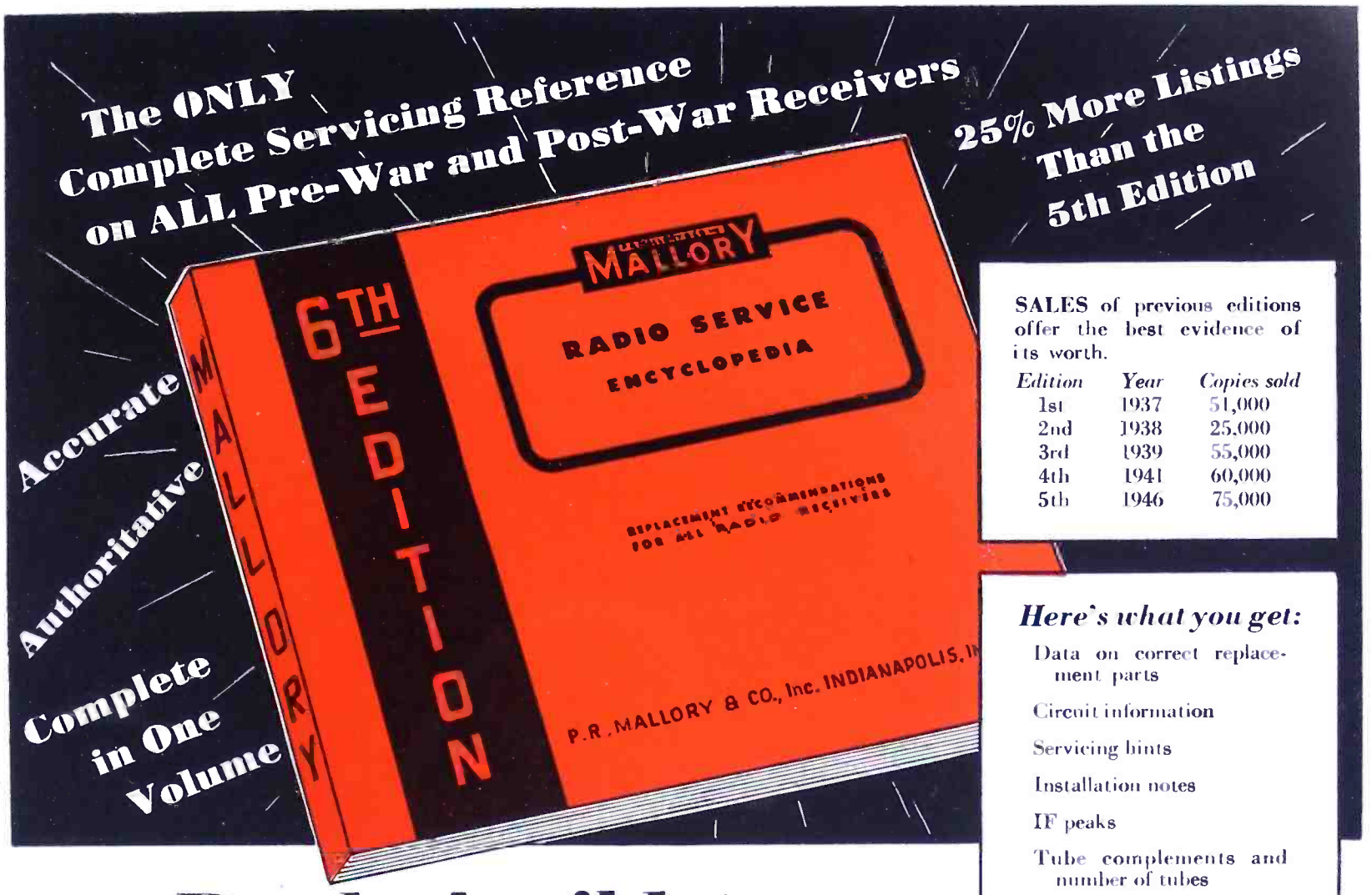


FIG. 8. 4-CHANNEL REMOTE PICKUP AMPLIFIER FOR AC OR BATTERIES. FIG. 10. 2-CHANNEL UNIT, WITH MIXER AND VU METER



SALES of previous editions offer the best evidence of its worth.

Edition	*Year*	*Copies sold*
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3rd	1939	55,000
4th	1941	60,000
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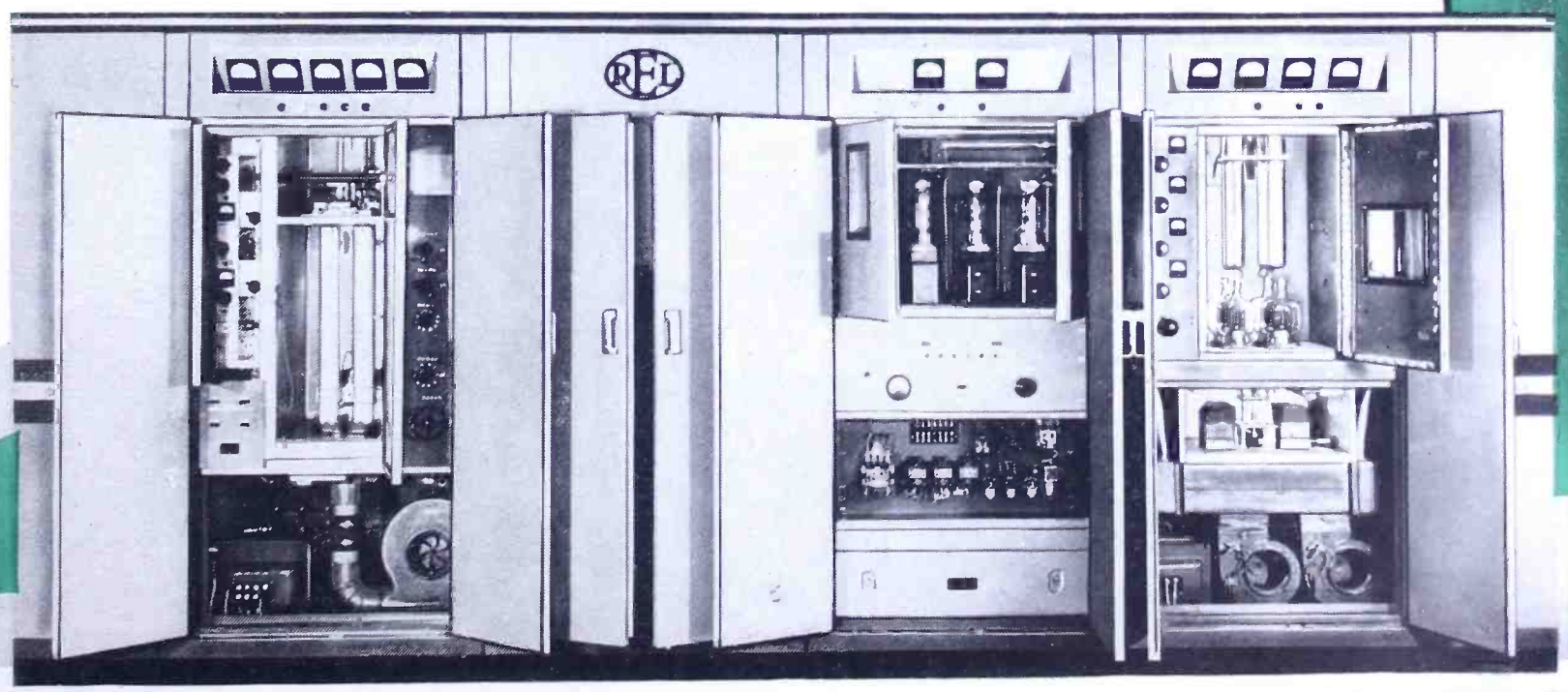

RADIO ENGINEERING LABORATORIES • INC

SPEECH INPUT SYSTEMS

(CONTINUED FROM PAGE 36)

connected to the amplifier and the program switched to either line. The telephone line not used for program transmission is switched automatically to the telephone set, for order-wire purposes.

Many times remote pickups call for the use of only one microphone. This requirement is met in the 212Y remote pickup amplifier. It is the answer to the engineering problems, and to the front office pocketbook. The unit is so arranged that it normally operates from 110 volts AC. Battery operation is provided for, however, by a special battery box and connecting cord which are available for the unit. The amplifier utilizes the new Cannon XL connectors, but adaptor cords are available for stations using other types.

A third type of remote amplifier to round out the complete equipment for remote pickups is a 2-channel unit, such as the Collins 212U Fig. 10. Basically, this is the same amplifier as the 212Y equipment, plus a 601H mixer unit and VU meter. There are many occasions where two microphones serve as a comfortable minimum, and offer excellent facilities for the pickup.

Design of a speech input system flexible enough to handle all program loads requires much engineering thought. The use of miscellaneous equipment which makes every job a compromise offers no economy, and is usually extravagant in the end. No matter how good the engineering staff is, unless it has tools, and this means equipment, it cannot carry out its duties in a manner satisfactory to the station management, sponsors, or listeners.

In the next part of this series, a more complete set of studio speech input equipment will be described, with block diagrams and pictures of the equipment. The conclusion will deal with the problems of dual programming for two stations.

FM-AM STUDIO DESIGN

(CONTINUED FROM PAGE 19)

Fig. 14 shows a section of the second floor offices. Walls are painted in two shades of tan, contrasting pleasantly with the moss green carpet. Holophane units in the ceiling combine incandescent lamps with 3-tube fluorescent units, controlled by separate switches.

The offices are heated and ventilated by a system which combines radiant heating and ventilation in hollow wall construction.

There are 10 separate air conditioning systems, all served by a 50-horsepower central Carrier refrigeration compressor. Hot water for heating is supplied by a cast iron sectional boiler. Fan systems serving the various sections of the building are set in operation from a central panel, and automatic zone controls maintain the temperature and humidity precisely.

Needless to say, KOMO's broadcasting center has been planned with an eye to public relations, and hearty welcome is extended to visitors who would like to see this latest radio plant in operation.

FM AND TV ALIGNMENT

(CONTINUED FROM PAGE 21)

If the oscilloscope is connected to the video detector, the local oscillator is adjusted to cause the birdie to coincide with the sound trap point on the overall response characteristic. Since the output frequencies of the Mega-Marker Sr. are crystal-controlled to within 0.01% of the desired sound-carrier frequencies, the adjustment of the local oscillators in the television receiver can be made with a degree of precision far in excess of that possible with conventional signal generators.

Other Uses of the Mega-Sweep ★ In addition to the applications described above, the Mega-Sweep is ideally suited to testing video amplifier circuits, adjusting video peaking coils, and the like. It can be used also as a high-frequency CW signal source of good stability at all frequencies above about 20 mc. By use of the built-in precision microwave frequency meter, it is possible to measure output frequency to an accuracy within about 1%, which suffices for most applications.

These and other uses which will suggest themselves make the Mega-Sweep an invaluable tool for a great many general laboratory, production, and service applications.

AMPLIFIER DESIGN

(CONTINUED FROM PAGE 30)

network at the input of the amplifier or, if desired, by reducing the setting of the treble control somewhat.

Tone Controls ★ Because of the wide variations in recording characteristics, loudspeakers, possible acoustical listening conditions and, above all, in personal preferences, it is desirable that any amplifier have a flexible tone control system allowing the response to be increased or decreased in either the high- or the low-frequency registers independently. In this connection, tone controls which merely attenuate or cut off are of little practical value. Generally it is desirable to boost either or both the low- and high-frequency ranges, particularly when listening to wide-range, noise-free programs at low levels. In this connection it may be noted that only in a system with a dynamic noise suppressor is it feasible to boost the high frequencies when reproducing phonograph records. Most record reproducing systems attenuate the high frequencies under all conditions in order to reduce noise, with the unfortunately attendant loss of musical quality and definition.

Fig. 6 shows the flexible tone control system provided. With this circuit, the response is inherently flat in the normal or mid-position setting of the tone controls, without the need for bucking one circuit against another. Either the high- or the low-frequency response can be increased or decreased independently. The maximum amount of extreme high- and low-frequency boost or attenuation is probably more than will ever be used under ordinary listening conditions. The actual maximum and minimum limits of the overall response of the amplifier alone or of the complete phonograph system will be obtained by adding Fig. 6 to Figs. 3 or 5, respectively.

Distortion ★ Clean reproduction is inseparably associated with low distortion. Methods have been suggested for measuring distortion in order to provide the best correlation with listening tests, but so far there has not been sufficient agreement between the proponents of various methods to warrant standardization. The 210-A was designed specifically to provide a high useful output power with minimum audible distortion.[3] Great attention was paid, therefore, to keeping intermodulation at a minimum, particularly the first-order intermodulation components (difference frequencies) which are generally responsible for the growling, discordant sounds, and high-frequency hash due to distortion or overloading.

While intermodulation is probably a more sensitive method of detecting audible distortion than mere harmonic measurements, intermodulation is associated with the same phenomena which causes the generation of harmonics. It is a truism, therefore, that if the harmonic distortion is very low, the intermodulation will also be low. In order not to burden this paper, therefore, with a discussion of the advantages of one type of intermodulation measurement over another, the distortion characteristics in Fig. 7 are presented in terms of the generation of harmonics.

Much has been written regarding the performance of various types of output systems including triodes, tetrodes, pentodes and, more recently, the space-charge-grid type of output tube.[4] Of all of these types of output tubes, the beam-type tetrode is admittedly the most efficient. That is, for a given amount of plate-supply power, it delivers more audio-frequency power, the actual efficiency in this respect approaching 60%. A typical efficiency value for a triode is 45%, while the space-charge-grid output tubes provide only about 31%. These figures are for ultimate power output.

[3] "Audible Audio Distortion" by H. H. Scott, *Electronics*, Jan. 1945.

[4] "Advantages of Space-Charge Grid Output Tubes" by Norman C. Pickering, *Audio Engineering*, October 1947, pages 20–21, 45.

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AMPLIFIER DESIGN

(CONTINUED FROM PAGE 40)

The usual criticism aimed at tetrodes and, to a lesser degree, at triodes, is the amount of distortion generated. It has been shown,[5] however, that with properly designed circuits including feedback, the performance of the tetrodes can be made to surpass even that of triodes. In the 210-A amplifier, the performance of the tetrodes is even better than that claimed for the space-charge tubes.

Fig. 7 shows the typical distortion characteristic of this type of amplifier. It will be noted that at the rated output of 20 watts, the actual total harmonic distortion is well under 2%, and that it does not exceed ½% below 10 watts output. At all normal operating levels, high-order harmonics are entirely negligible in amplitude. The low value of second-harmonic distortion and other even-harmonic distortion, even under conditions of severe overload, indicates a very low level of first-order intermodulation; that is, the generation of difference frequencies.

It will be noted in comparing these characteristics with published information on the space-charge-grid tube that, in spite of the greatly increased efficiency and output power of the 210-A, the harmonics are actually lower in terms both of actual power output and relative power output. Data for this amplifier includes losses in the output transformer, and thus represents actual power available to drive the loudspeaker.

In broadcast transmitter practice, it is generally considered that a leeway of at least 10 db should be allowed between the actual average signal level and the overload level of the equipment because of the peak-to-average ratio of music. In other words, unless the average operating level is 10 db below the overload point, an undesirable amount of clipping of the waveform peaks will occur. For this type of operation, with the 210-A conservatively rated at 20 watts, the normal average output level would be approximately 2 watts, under which condition the distortion is well under ½%. This results in an extreme clarity of reproduction impossible in systems with higher distortion. Also, this signal level provides a fairly high acoustical level with modern high-grade, high-efficiency speakers.

However, there are always some listeners who wish to push the equipment to the limit, and operate at as high an acoustical level as can be tolerated. Under these conditions, the performance of this amplifier is even more outstanding, since the freedom from strong first-order intermodulation products and spurious

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[5] "High-Quality FM Reproduction" by John K. Hilliard, *FM* AND TELEVISION, January, 1946.

AMPLIFIER DESIGN

(CONTINUED FROM PAGE 41)

parasitic or transient oscillations allows operation at considerably higher power levels than conventional amplifiers of similar power rating before the distortion becomes objectionable. In other words, the amplifier overloads gracefully, merely clipping the positive and negative peaks cleanly and symmetrically. The operating biases are not sufficiently disturbed under overload conditions to cause a noticeable shift in the operating characteristics.

Power Output vs. Frequency ★ Another factor in amplifier performance often overlooked is the requirement that sufficient *undistorted* power be delivered at extremes of the frequency range to allow correct reproduction of applied signals. Fig. 8 shows the power available with negligible distortion and, for purposes of comparison, the power-handling requirements for the reproduction of symphonic music. This latter data was first presented by Fletcher.[6] It should be pointed out that the curve represents the effective values of the peak intensities. A curve of most probable levels is lower at both ends of the frequency range.[7]

Theoretically, of course, if it were possible to trade power-handling ability in one portion of the frequency range for increasing the undistorted output in those ranges where the need is the greatest, amplifiers would be designed with an overall power-output-vs.-frequency characteristic shaped somewhat like the curve of maximum levels encountered in music, and would have maximum power-handling capacity in the neighborhood of 200 to 300 cycles. As a practical matter, it is not possible to increase the output in this region by sacrificing output in other frequency ranges. Accordingly the resulting characteristic shows considerable excess power-handling ability in the extreme high- and low-frequency ranges.

It should be noted that the performance curves of Fig. 8 represent actual available power at low distortion, and are not merely response curves measured without regard to harmonic content.

Output Impedance & Speaker Damping ★ It is generally considered that, for correct damping of the loudspeaker, the source impedance from which it is driven should be somewhere between the speaker impedance itself and one-half that value. Too high a source impedance exaggerates speaker resonances, particularly in the low-frequency register, causing booming and hangover. Some speaker manufacturers definitely advise against too low a source impedance which, with some speaker designs, may cause excessive damping. The feedback circuits of the 210-A have been so adjusted that the actual output impedance at any particular transformer tap is approximately two-thirds of the rated load impedance, thus providing optimum damping, and also rendering the exact impedance match to the loudspeaker relatively uncritical. Fig. 9 shows the effect on maximum undistorted power if the amplifier is terminated in a load other than the exact rated value. It will be noted that variations of $\pm 50\%$ make only a negligible difference.

The output transformer is wound with two secondaries which can be connected in series or in parallel, and with various taps, thus providing efficient matching to a wide range of speaker impedances between 2 ohms and 500 ohms.

Dynamic Noise Suppressor & Whistle Filter ★ The dynamic noise suppressor in this amplifier is combined with a whistle-filter feature, and includes an unusually flexible control system, as shown in Fig. 10. Curve A shows the maximum overall response of the amplifier, while the broken lines B, C, and D indicate respectively

(CONTINUED ON PAGE 43)

[6] "Hearing, the Determining Factor for High-Fidelity Transmission" by Harvey Fletcher, *Proceedings of the I.R.E.*, June 1942, pages 266–277.

[7] "Frequency Range and Power Considerations in Music Reproduction", Technical Monograph No. 3, Jensen Radio Manufacturing Company, 6601 S. Laramie Ave., Chicago.

AMPLIFIER DESIGN

(CONTINUED FROM PAGE 42)

the overall maximum transmission characteristics obtained for the 10-kc., 8-kc., and 5-kc. settings of the frequency-range switch. In the last two positions, a resonant circuit in the suppressor is tuned to 10 kc. exactly, to provide whistle-filter action when listening to AM broadcasts. This provides an extremely sharp high-frequency cutoff on these positions. The 10-kc. position, on the other hand, rolls down only gradually, having significant response as high as 16 kc. Curve E shows the overall frequency characteristic of the system under conditions of maximum noise suppression on the 10-kc. range. F shows a similar curve for the 8-kc. and 5-kc. ranges. In actual operation of the dynamic noise suppressor, the instantaneous transmission characteristic is a function of the applied signal, and may be anything between the extremes shown. The shape of the cutoff curves does not vary appreciably as the cutoffs move back and forth. The principle of operation is further described in the articles mentioned in Footnotes 1 and 2.

The suppression control on the amplifier determines the amount that the gate circuits close in the quiet passages, and hence the degree of noise suppression. It also controls the sensitivity of the control circuits and, consequently, the signal conditions required for complete opening of the gate circuits.

The actual amount of high-frequency noise-energy reduction obtained with the dynamic noise suppressor is shown graphically in Fig. 11, plotted with a linear frequency scale since high-frequency record noise with standard de-emphasis circuits tends to be white in character; that is, to have equal amounts of power in equal frequency bands. The total area between the full suppression and the 10-kc. curves represents the amount of noise eliminated by the dynamic noise suppressor when operating on the 10-kc. range. Similarly, the areas between the full suppression and the 8-kc. and the full suppression and the 5-kc. curves indicate the amount of noise reduction on these respective frequency ranges. Low-frequency noise reduction for a similar system is shown graphically in the article mentioned in Footnote 1.

Connection to Tuners ★ The 210-A has all electrical equipment required between the phonograph pickup and the loudspeaker to provide high-quality reproduction of phonograph music. It can be used also with any high-grade FM or AM tuner, for provision is made for connecting such a tuner between the preamplifier output and the high-level input of the amplifier.

The radio-phonograph switching should be such that, on the phonograph position, the preamplifier output is connected directly to the suppressor input, with no intervening volume control or other network. Generally, the switching provided in the tuner can be utilized to accomplish this result.

When the amplifier is used with a tuner, the volume control on the tuner itself is seldom necessary, but this depends somewhat upon the AVC or limiting characteristics of the tuner. Normally, the tuner volume control is set for approximately the same signal level as obtained from average phonograph records. On very weak signals, the level will naturally be somewhat lower, so that the suppressor gate circuits will not open as wide, thus automatically providing more noise-suppressing action.

High-frequency loss on phonograph operation due to cable capacity on the preamplifier output can be offset by increasing the value of a condenser in the preamplifier.

Listening ★ Listening is the final test of any amplifier, since the ear judges and integrates all performance factors. Currently, a decided change in listening habits is under way. It is evident in the astonishment of those who, before hearing one of the new amplifiers, were emphatic in

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AMPLIFIER DESIGN

(CONTINUED FROM PAGE 43)

saying that nothing could offer an improvement over the "high-fidelity" equipment they had been using. The difference lies in the fact that the owners have become conditioned to the *simulated* speech and music produced by older types of amplifiers. In contrast, such an amplifier as the 210-A described here delivers actual *reproduction*, limited only by the source which feeds the amplifier. Thus, slowly, because personal habits do not change quickly, but definitely, since reproduction is real and simulation is artificial, the new audio circuits are gaining public favor.

MICROWAVE HANDBOOK

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waveguide compares with a rectangular waveguide if the center of the waveguide is considered as the opposite wall with respect to the actual wall of the round pipe. The lowest frequency or maximum wavelength which the waveguide can accommodate is known as the cutoff point.

Fig. 10A shows the condition at exact cutoff. Here the "A" dimension of the waveguide is equal to ½ wavelength, and the energy bounces back and forth without making any longitudinal progress.

Energy at the same frequency, or wavelength, will travel in a large waveguide, however, as indicated in Fig. 10B, where dimension A is greater than ½ wavelength, but somewhat less than 1 wavelength.

Attenuation is reduced, and power-handling capacity is increased as the A dimension of the waveguide is increased beyond ½ wavelength until A approaches about 1 wavelength, at which point double-moding starts. This causes 2 electromagnetic patterns to form in the waveguide. Increasing the size of the waveguide still further for the same wavelength caused the attenuation to increase slowly for that particular electromagnetic pattern or mode.

The narrow or B dimension of the rectangular waveguide should be below the cutoff wavelength. Otherwise, it will usurp the function of the A dimension. The usual practice is to keep it at one-half or less of the A dimension.

Waveguide effects explain why motorists can not receive standard broadcasting on their radio receivers while driving in tunnels or on bridges having overhead and side lattice or solid construction. It is because the tunnel is a waveguide with a maximum dimension less than one-half wavelength for that frequency. For example, to receive a 1,000-kc. signal, the diameter of the tunnel, overpass aperture, or mountain gorge must exceed one-half wavelength, or about 500 ft. The same tunnel or comparable condition can receive microwave signals if the tunnel

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MICROWAVE HANDBOOK

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diameter exceeds one-half wavelength. This is particularly apparent on the mobile radio bands where communication may be as good or better on bridges than elsewhere, even though the standard broadcast reception is poor or impossible. An exception might be where long-wave or low-frequency signals are brought into the tunnel or bridgeway by guided carrier or induction paths.

Fig. 11 is a typical example where low frequencies cannot be used for communication in a railroad tunnel. Communication is either impossible or erratic, even if the tunnel height exceeds one-half wavelength, because the freight cars fill most of the clear space. Even 30- to 40-mc. waves would have difficulty in getting through in the amount of clearance shown by this photograph. It is generally agreed both by prediction and by actual tests that microwaves are the only dependable frequencies for use in tight tunnels and subways.

Waveguide effects also explain why communication is possible behind physical barriers or down canyon-like streets having obstructed horizon paths with respect to the transmitting point. The building walls on the two sides of the street behave like a waveguide. Similar conditions exist when traveling in valleys, since the hillsides or mountains act as the two sides of a waveguide. A waveguide actually need comprise only two walls. In the case of fabricated rectangular waveguides, the other two walls serve only as their support to maintain the critical dimensions.

The modern concept is to consider tunnels, canyons, and valleys as natural waveguides. As long as they exceed one-half wavelength in width, and are suitably contoured to permit reflections in desired directions, communication is possible without regard to the horizon. Furthermore, communications are thus made possible even beyond theoretical horizons, independent of the antenna elevations at the transmitting and receiving points.

It is also possible to consider the two boundaries of any medium, densification or stratification of the atmosphere as a waveguide. If the microwave energy penetrates such an atmospheric waveguide, it may travel fantastic distances. This will become better known in the future as the microwave spectrum is more fully utilized by a larger number of stations located all over the world.

The attenuation is least when the waveguide, either natural or fabricated, has the following characteristics:

1. Uniform A dimension
2. Reflecting walls of high uniform electrical conductivity
3. Dimension A is well above the ½-wavelength cutoff, but less than 1 wavelength.

To be continued next month

FILM PICKUP SYSTEM

(CONTINUED FROM PAGE 33)

plitude, video gain, horizontal sawtooth, horizontal parabola, horizontal sine wave amplitude, and horizontal sine wave phase. In general, only the controls in the bottom row need be used during a program. Two signal lights at the center near the top of the control panel indicate when the film pickup is on the air, and when the high-voltage is applied to the Iconoscope.

The two waveform monitors normally present the vertical and horizontal video waveforms at the output of the intermediate amplifier. Two additional inputs are provided, one of which permits the monitor to be used as a test scope for checking wave forms in the nearby units, and the other permits the monitoring of an additional signal such as an off-the-air signal.

Any one of the 3 input signals can be selected by a selector switch on the front panel of the unit. The other controls on the front panel are C.R.T. brightness, focus, vertical positioning, and 3 calibrated gain controls for the 3 inputs. The vertical deflection amplifiers in the waveform monitors are DC-coupled to the C.R.T. deflection plates, and the input grid is DC-restored in order that the bottom of the pattern will remain fixed with respect to a line marked on the tube face, regardless of changes of pedestal and video gain settings. This aids the operator in maintaining a given video level with changes in scene brightness, since he only needs to observe the upper part of the waveform and compare it to a second line marked on the tube face. The distance between the two lines can be made to represent a given level by means of the input gain control and the vertical position control. The video amplifiers in the waveform monitors have uniform response within 3 db from 30 cycles to 4 mc., and are capable of full-scale deflection with .5 vpp. input.

The picture monitor, using a 12-in. magnetic deflection cathode-ray tube, is capable of fully showing the four corners of the raster without reducing the picture size beyond a point where the operator can view the picture critically at a comfortable operating distance. The sweeps in this unit can be driven either from external driving pulses or from a self-contained sync separator. In this application, the former method is used since the synchronizing pulses are not added to the video signal in the control section. Four controls are provided on the front panel of the monitor. These are: focus, contrast, brightness, and a sweep-speed switch which causes the monitor sweeps to operate at one half normal speed. This latter feature is found convenient in observing conditions during the vertical and horizontal blanking intervals. The frequency response of the monitor video amplifier is uniform within 3 db from 30 cycles to

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FILM PICKUP SYSTEM

(CONTINUED FROM PAGE 46)

at least 5.5 mc., making the unit capable of considerably better resolution than can be transmitted over the air according to present day standards.

The vertical pickup control unit mounts at the left hand side of the console, directly beneath the control panel. As its name implies, this unit contains the control circuits which operate at the 60-cycle, vertical-sweep rate. The vertical driving pulses from the synchronizing signal generator trigger a blocking oscillator whose output drives a capacitance-discharge type of sawtooth generator. Since the sawtooth voltage is required primarily for the vertical sweep of the Iconoscope, an exactly linear sawtooth is not generated, but rather one whose rate of rise decreases as its amplitude increases. This requirement is brought about because the mosaic in the Iconsocope is inclined with respect to the center line of the electron beam. If the sweep were exactly linear, the horizontal scanning lines would be too widely spaced near the end of the sweep since, at this time, the beam is sweeping an area which is farther away from the yoke than it is at the beginning of the sweep. A close approximation of the required curvature of the sawtooth wave is obtained if the condenser which develops the sweep voltage is allowed to charge more than it would be for a linear sweep. The sawtooth wave thus generated is amplified and fed to the Iconoscope driver over coaxial cable. The sawtooth wave is also used for the vertical waveform monitor sweep, for keystoning purposes in the horizontal pickup control unit, and for shading purposes. Beside driving the sawtooth generator, the output of the blocking oscillator is used to trigger 2 multivibrators.

The output of one multivibrator is filtered and used as the 60-cycle sine-wave shading signal. The output of the other is used for vertical iconoscope blanking. It is mixed with a similar signal from the horizontal pickup control unit and sent to the pickup auxiliary unit over a coaxial cable. The vertical shading signal, which is a combination of a 60-cycle sine wave, a parabolic wave, and a sawtooth wave, (the wave shape of the combination depends, of course, on how the shading controls are set) can not be merely added to the video waveform. If this were done, the desired shading signal would be clamped out by the line-to-line clamp in the intermediate amplifier in the same way that hum and tilt, arising from poor low-frequency response, are removed by the clamp. This difficulty is avoided by modulating horizontal driving pulses with the desired vertical shading waveform, and adding this modulated waveform to the video waveform.

This amounts to inserting into the video signal a 15,750-cycle pedestal whose am-

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FILM PICKUP SYSTEM

(CONTINUED FROM PAGE 47)

plitude varies in proportion to the desired vertical shading wave, and clamping this varying level to a fixed reference. The horizontal shading signal is first mixed with the modulated horizontal driving pulse in the vertical pickup control unit. Then the combination is fed to the intermediate amplifier.

The horizontal pickup control unit mounts directly beneath the control panel at the right hand side of the control desk, as shown in Fig. 2. As its name implies, this unit generates the required signals for the system which reoccur at the 15,750-cycle horizontal sweep frequency. Horizontal driving pulses from the synchronizing signal generator trigger a blocking oscillator whose output is coupled to a sawtooth generator. The sawtooth wave is used for horizontal iconoscope sweep voltage, shading signal, and waveform monitor sweep. The Iconoscope, having an inclined mosaic, requires a keystoned horizontal sweep. In other words, the horizontal sweep amplitude must decrease as the vertical sweep moves the beam of the Iconoscope toward the bottom of the picture. Keystoning is accomplished in this unit by modulating the horizontal sawtooth with a vertical sawtooth wave which is obtained from the vertical unit.

The horizontal shading waveforms (saw, sine, and parabola) are generated in this unit as well as horizontal Iconoscope blanking signal. Both of these signals are fed to the vertical pickup control, where they are mixed with their vertical counterparts and sent to their respective destinations.

Equipment Cabinets ★ Units mounted in the equipment cabinets are the DC power supplies for the system as well as the iconoscope driver, intermediate amplifier and power switching panel, as indicated in Fig. 1. The power supplies include 4 low-voltage supplies which provide well-regulated + 350- and + 250-volt DC power for the various units; a regulated high-voltage supply of − 1000 volts for the Iconoscope; and a high-voltage supply of + 1,800 and − 1,000 volts for the type 5CP1 cathode-ray tubes in the waveform monitors. A − 150-volt bias supply is also included. The power panel provides a central switching and fusing point for filament and plate power to all units.

In the Iconoscope driver unit there are both horizontal and vertical deflection amplifiers for the Iconoscope sweeps, and two DC control-amplifiers which operate the protection relays. The vertical sweep section employs current feedback to insure good vertical sweep linearity. The horizontal sweep current is coupled to the low-impedance yoke circuit by means of a shunt-fed deflection transformer with a

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FILM PICKUP SYSTEM

(CONTINUED FROM PAGE 48)

diode damping tube connected in its primary.

The intermediate amplifier amplifies the video signal from the preamplifier, inserts the shading signal, clamps the video wave to a constant reference level, inserts the blanking pedestal, and makes the resulting video signal available at 3 separate output terminals. Four stages of video amplification are used, the first of which has a remote gain control, marked video gain, on the control panel. The shading signal has been described already as a combination of horizontal shading waveform and modulated 15,750-cycle pulse whose amplitude depends upon vertical shading waveform. It is added to the video signal at the first video stage. The grid of the fourth video stage is clamped to a DC reference level at the end of each horizontal line by means of a 4-diode clamp, actuated by horizontal driving pulses obtained from the sync generator. Since the modulated vertical shading pulses occur at the same time that the clamp operates, each line in the picture is clamped to a level determined by the original vertical shading waveform. The video blanking is mixed at the plate of the fourth video stage.

The blanking pedestal amplitude, which determines the average brightness of the picture, is controlled remotely from the control panel by varying the bias on a series diode clipper. This clipping process also removes the modulated shading pulses from the signal. Then the combination of video and blanking signal is fed to 3 cathode-follower output stages where it is distributed to the waveform and picture monitors in the control desk, and to the mixing facilities on program and preview lines.

Performance ★ Operating tests on this system, conducted over a considerable period of time, have indicated consistent, trouble-free operation. Excellent picture quality is obtained with a 16-mm. movie projector of the type generally used for television service. With a high-definition test pattern projected on the iconoscope mosaic by a standard slide projector, the picture monitor shows the limiting horizontal resolution of the system to be in excess of 550 lines. Such resolution is considerably better than that which can be transmitted over the air according to the presentday standards for video transmitters.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 15)

186,000 FM sets were made that year. In 1947, 1,175,000 sets were produced. Estimated production for 1948 will fall between 4,000,000 and 5,000,000 FM sets.

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WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 49)

Audiences are already sizeable where FM stations are located, and the audiences relatively larger than production figures would indicate.

Duplication of AM programs on FM *recaptures the loss of service due to deterioration of AM coverage*, and replaces it with a new, superior service. This applies to both independent and AM-FM network program duplication. AM-FM duplication has placed the top AM network shows on the FM band. These constitute a time-proven attraction to the radio public. Duplication will increase the traffic on the FM dial and will, thereby, improve the status of the independent FM stations.

Duplication does not mean, however, that you are getting FM free. What is happening is that already you are paying *less* for AM and *something* for FM. This is the theory of the networks in seeking duplication on the basis upon which the deal was made with AFM. It will not take as long as most people think for the FM portion of the rate to equal the AM portion, as the number of sets increases. This is due to the fact that the FM station covers a wider area at night during peak audience hours.

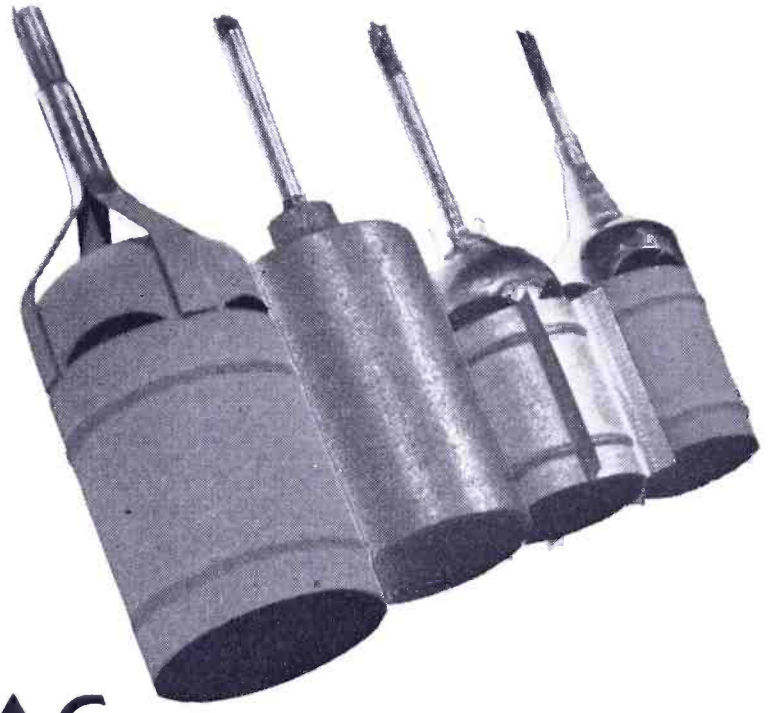
The Continental FM network is an excellent example of a wide-area FM regional network operation. It has been in existence one year. The first program was carried by 4 stations: Washington, Baltimore, New York, and Schenectady. The first 3 stations were connected by wire lines. Schenectady received its program by FM radio relay from Alpine. Last month, the Continental Network provided its shows to 41 stations, extending from South Carolina to the Canadian border, and from Boston to Niagara Falls. Only 873 miles of 8,000-cycle common carrier circuits were used to connect 9 stations.

FM is particularly adaptable to regional network operations. In most cases, it is not necessary to use expensive intercity wire-connecting circuits. The programs are transmitted by the stations themselves to one another. The high-fidelity, low-noise characteristics of FM provide a better intercity transmission circuit, at practically no expense, than can be obtained from the highest-fidelity common carrier circuits.

At the beginning of this talk, I mentioned that I would give you facts, not fiction. I sincerely hope that you will double-check every statement that I have made, and I further hope that because of our meeting today, you who have made sound broadcasting the Fifth Estate will put your own energies actively behind FM sales and promotion. America has always been a land of opportunity. Now, although AM coverage is deteriorating, aural radio will still forge ahead, thanks to FM.

ADVERTISERS INDEX

there IS a difference.



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4. **COSTS** . . . Pyrovac plates in Eimac tubes cost you no more, yet since they enable longer life you actually get more for your vacuum-tube-dollar.

5. **PROVEN IN SERVICE** . . . Pyrovac is the result of millions of hours of life tests. The universal acceptance of the 4-125A and the 4-250A in all fields of electronic endeavor can, in part, be attributed to Pyrovac for contributing overload resistance, life, and a general ability to "take it."

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EIMAC TUBE TYPES	PLATE DISSIPATION watts
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4-65A	65
4-125A	125
4-250A	250
4-400A	400
4-1000A	1000
TRIODES	
25T	25
3C24	25
35T	50
35TG	50
75TH	75
75TL	75
100TH	100
100TL	100
152TH	150
152TL	150
250TH	250
250TL	250
304TH	300
304TL	300
450TH	450
450TL	450
750TL	750
1000T	1000
1500T	1500
2000T	2000

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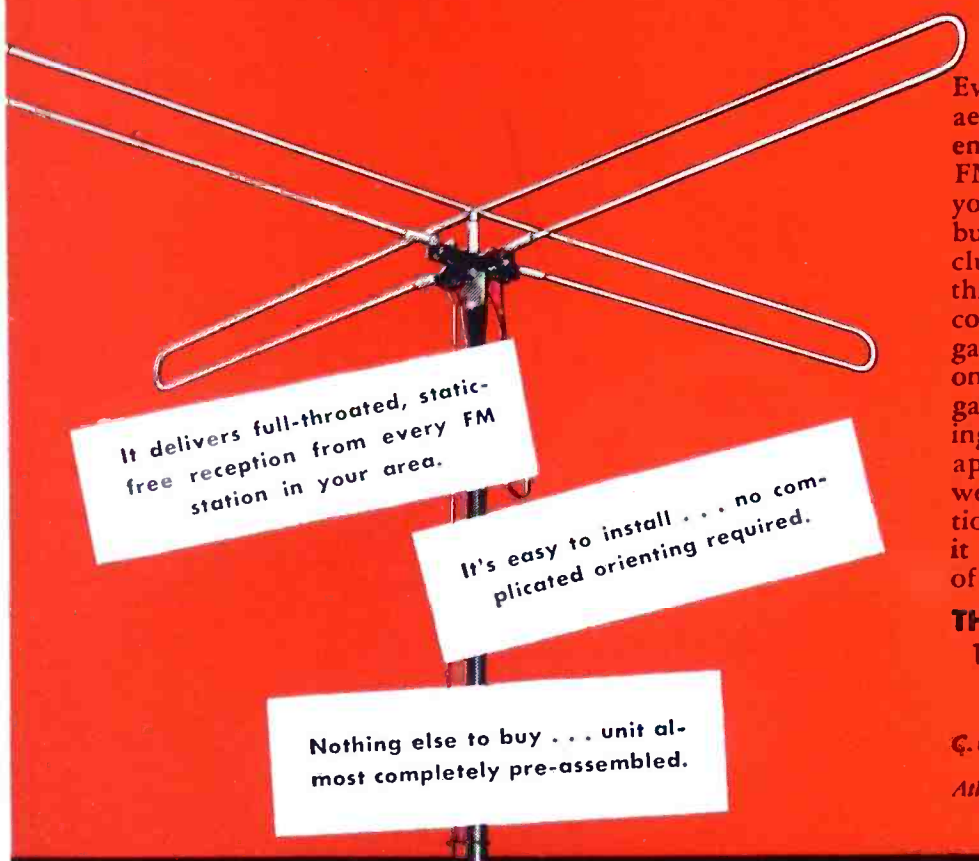

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