Price 35 Cents

April '51

FM-TV RADIO COMMUNICATION

★ ★ Edited by ★ ★
Milton B. Sleeper

SIGNAL CORPS MINIATURIZED FM TRANSMITTER-RECEIVER

FEATURED IN THIS ISSUE:

Details of the FCC's Proposed TV Plan
Analysis of the Markets for TV Equipment
Further Progress in Radio Communication

11th Year of Service to Management and Engineering

MORE FOR YOUR MONEY

WITH BENDIX SCINFLEX ELECTRICAL CONNECTORS

MOISTURE PROOF

PLUS

- Pressure Tight
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Light Weight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

The importance of a completely moisture-proof electrical connector can scarcely be exaggerated. But in addition to this important characteristic, there are a host of other exclusive features that make Bendix Scinflex connectors outstanding for dependable performance. For example, the use of Scinflex dielectric material, an exclusive Bendix development of outstanding stability, increases resistance to flash over and creepage. In temperature extremes, from —67°F. to +275°F. performance is remarkable. Dielectric strength is never less than 300 volts per mil. If you want more for your money in electrical connectors, be sure to specify Bendix Scinflex. Our sales department will be glad to furnish complete information on request.

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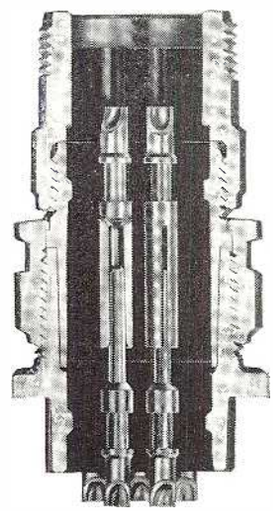

SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

CONTACTS
High current capacity . . . Low voltage drop.

SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

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SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

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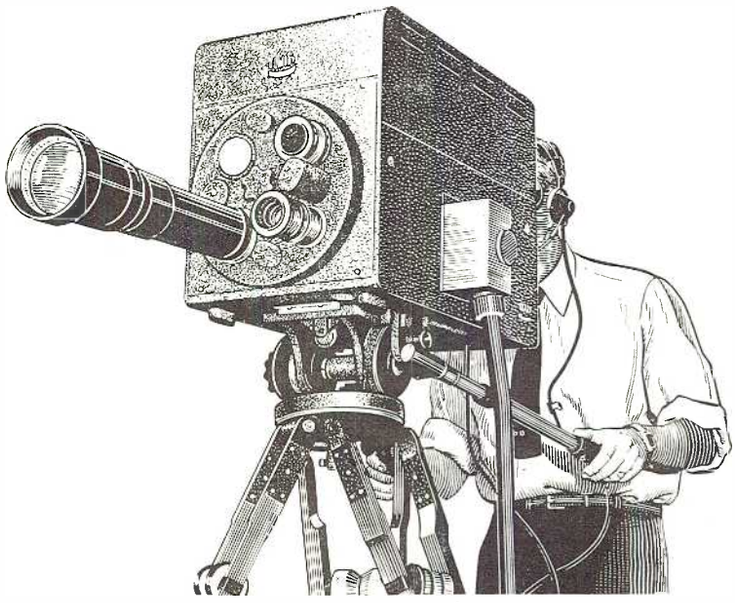


for telecasting... for research... for merchandising... for industry...

there's nothing finer than

DUMONT

television transmitting equipment

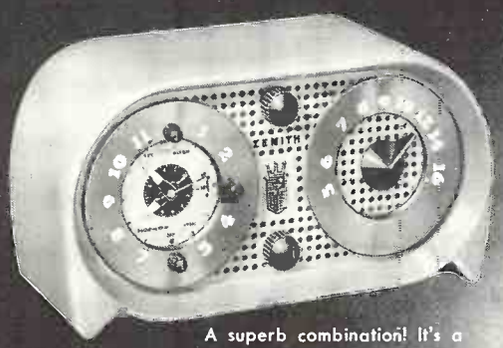
Wherever you wish eyes and ears to extend beyond their physical range . . . wherever you wish to have many eyes see a closeup . . . whether in color or in black-and-white TV — Du Mont equipment assures you of the finest in precise, dependable, economical performance.

DUMONT

YEAR AS PIONEER

ALLEN B. DU MONT LABORATORIES, INC.
TELEVISION TRANSMITTER DIVISION
CLIFTON, N. J.

Gift business is GOOD business!

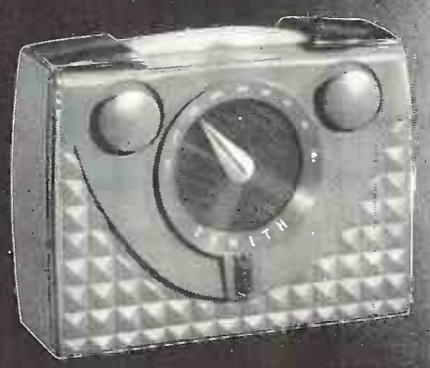


A superb combination! It's a "natural" gift item . . . the new Zenith Clock-Radio.

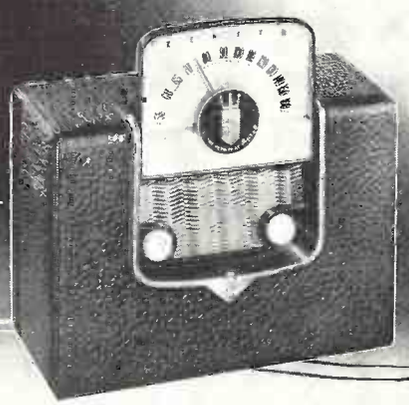
You're a SALES Headquarters on every gift occasion with ZENITH® QUALITY GIFTS

Gift Headquarters . . . SALES Headquarters, indeed! For in critical times like these your customers can't afford anything less than ZENITH Quality. Yes, people know that the radionic gift that they give may not be replaceable for years . . . and that the superb, advanced styling and engineering, the costlier parts and material in a ZENITH . . . is their guarantee of satisfaction and real pleasure. It's a gift of good sense . . . a gift of good taste!

Whatever occasion . . . weddings, birthdays, graduations . . . you'll realize what a terrific volume can be had in GIFT-SALES when you sell Zenith. There's a ready demand and a good profit for you in your ZENITH gift traffic. REALIZE your share of it . . . NOW . . . during this heavy gift-giving season!



IN TIME . . . as a graduation gift . . . Zenith's brilliant NEW portable . . . the "401".



Plays anywhere . . . a "perfect" gift all year round! It's Zenith's powerhouse-portable . . . the UNIVERSAL.

A big SELLER! But then it has Zenith's Cobra-Matic plus powerful DialSpeaker radio . . . the CARLETON.

there's a HARD SELLING package of special ZENITH® Promotional Material for your gift campaign . . .

RIGHT! Zenith wants this GIFT Campaign to be the biggest, most PROFITABLE Sales Drive that any dealer ever had. And it will be . . . with a tremendous NATIONAL ADVERTISING schedule, hard-hitting NEWSPAPER campaign that definitely "ties-in" . . . PLUS . . . a special package of dealer material. There's new GIFT FOLDERS, GIFT CERTIFICATES, special AD-MATS, bright, attention-getting DISPLAY MATERIAL . . . everything you NEED and WANT for a real promotion!

KEY YOUR GIFT CAMPAIGN TO THESE MAY-JUNE GIFT OCCASIONS

- Graduations
- Anniversaries
- Weddings
- Mother's Day
- Father's Day
- Servicemen

ZENITH RADIO CORPORATION

6001 DICKENS AVENUE CHICAGO 39 ILLINOIS

FM-TV RADIO COMMUNICATION

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

VOL. 11 APRIL, 1951 NO. 4

INDUSTRY NEWS

TELEVISION

APPARATUS DESIGN

COMMUNICATION

AUDIO SECTION

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CPA AUDIT

CIRCULATION AUDITED BY
HENRY R. SYKES
CERTIFIED PUBLIC ACCOUNTANT
SYKES, GIDDINGS & JOHNSON
PITTSFIELD, MASSACHUSETTS

JANUARY RTMA production data on audio and TV sets doesn't contribute much information as to the probable effects of limitations on materials, but certain significant information can be gleaned from this month's Production Barometer.

Television sets dropped 25% below the all-time high registered in December. That was probably in response to the sharp drop in retail sales since November 1. Strangely enough, dealers' stocks in some areas are at relatively low levels, but in New York City, for example, sets have been advertised at as much as 60% below list. Some of the larger manufacturers are offering special inducements to dealers, including payment of warehouse charges, as a result of current over-production.

AM sets were 30% below the December figure, but that drop was to be expected, because December hit the highest mark since October, 1947. Nevertheless, January was well above the '50 average.

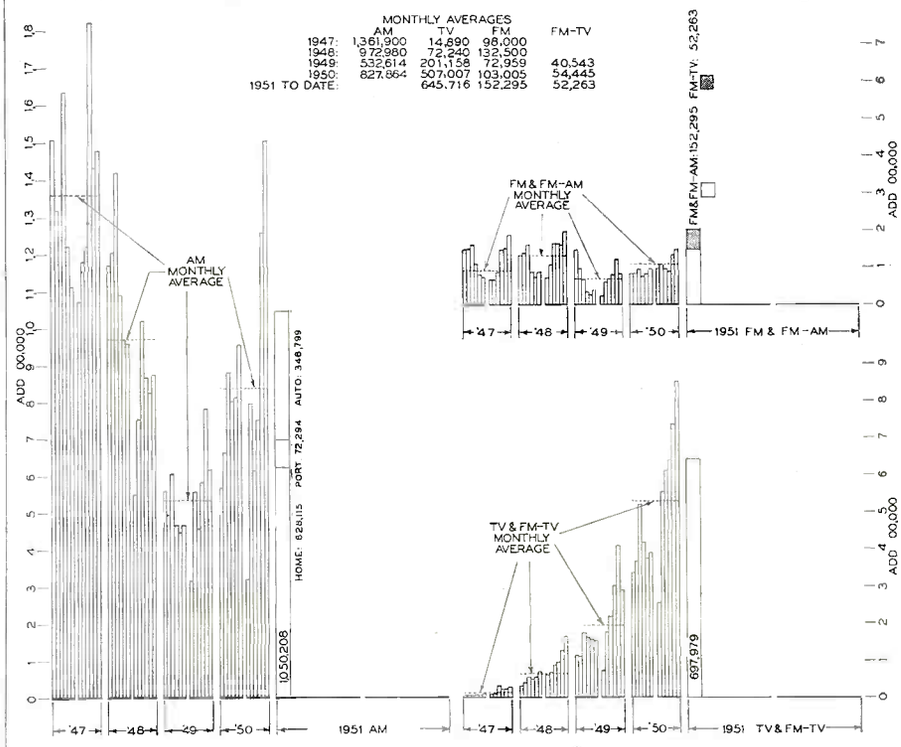
However, there is more to this story than is disclosed by the 1,050,208 total of AM production. Of these sets, only 628,115 were home types. That is only 4 times the number of FM models produced in January, and slightly less than the number of TV sets.

The remainder of AM production was divided between 346,799 auto sets and 75,294 portables. The former are bought as automobile accessories, and must be considered as separate from sales of portable and home models. Therefore, figures for each AM group will be shown hereafter in the Barometer.

FM figures certainly reflect the growing demand for better audio reproduction, and disclose the stability of the market for FM sets. In January, sales were above December, and nearly one-half of the 152,295 sets were radio-phonograph consoles. RTMA figures do not show the dollar volume of monthly shipments, but it is obvious that FM billings were substantially higher than for all AM home models! In addition, manufacturers' billings on custom FM chassis are running about $1 million per month.

Picture-tube shipments to manufacturers were 16% below December, totalling 508,317 units, valued at $16,272,654. Of these, 93% were 16 ins. or larger, and 78% were rectangular types.

Receiving tubes were down 3%, to 37,042,303. The breakdown shows that 27,595,483 were for new sets, 8,083,078 for replacements, 1,165,171 for export, and 198,571 for Government agencies.



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

RADIO COMMUNICATIONS *for* CIVIL DEFENSE!

Used by hundreds of Municipalities from Boston, Mass. to Alhambra, Calif.

In time of emergency, only Policalarm & Monitoradio can tune to any FM communications band!

This means that existing fire, police, taxi cab and other 2-way Radio Communications Systems can become, with advance planning, vital centers for the dissemination of messages to your civil defense personnel . . . Only Radio Apparatus Corporation makes available to you, at such low cost, rugged and dependable communications equipment of the type that tunes instantly to each and every emergency channel used by these presently established 2-way radio systems that are so important in your defense planning today . . . and Policalarm and Monitoradio are already proved through use by hundreds of municipalities throughout the country from Boston, Mass., to Alhambra, Calif. . . . To keep your official and volunteer civil defense personnel alert and informed, both at home and in cars, rely on Policalarm and Monitoradio—readily adaptable to most alarm signalling systems!

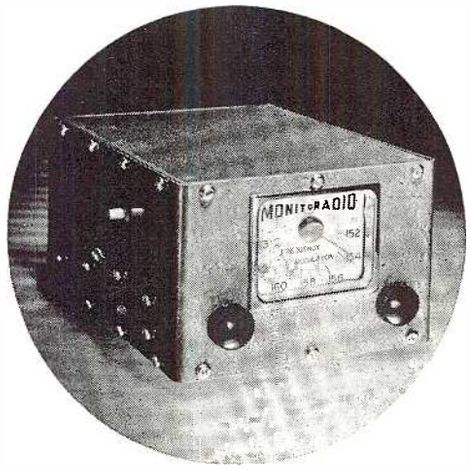
MONITORADIO

$72.50

A 6-VOLT MOBILE

Model M-51
30-50 MC

Model M-101
152-163 MC



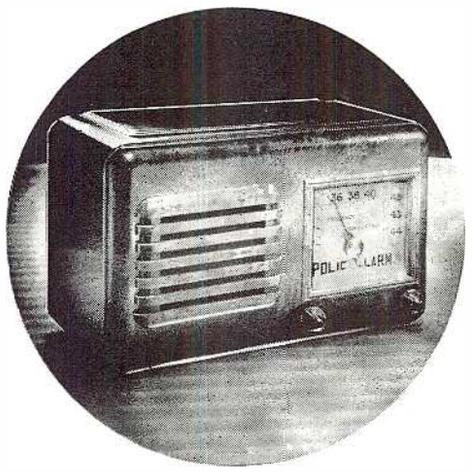
POLICALARM

$44.95

115 Volts AC-DC

Model PR-31
30-50 MC

Model PR-8
152-163 MC



RADIO-TELEVISION MANUFACTURERS ASSOCIATION RTMA EST. 1924

SEE YOUR PARTS JOBBER OR WRITE US TODAY . . .

RADIO APPARATUS CORPORATION, Indianapolis 3, Indiana
310 FOUNTAIN SQ. THEATRE BLDG. PHONE: FRANKLIN 1052

THIS MONTH'S COVER

This month's cover shows Major General Spencer B. Akin, Chief Signal Officer, with the first AN/PRC-10 to come off the RCA production lines. It weighs one-half as much as the World War 2 Walkie Talkie, has greater range, added operational features. Chart behind General Akin depicts RCA's remarkable feat of speeding delivery after the contract was placed. Original estimate was 55 weeks, later pared to 44 weeks. Actually, first units came from production in 37 weeks. Pilot model of this FM unit was engineered at RCA's Princeton Laboratories. A detailed description of the PRC-10 will appear in a forthcoming issue.

SPOT NEWS NOTES

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

Note on Movies Vs. TV:

Reports from our Business Manager, after seeing Fred Astaire in *Royal Wedding* at our local theatre: "The show was no better than some of the TV plays, and the sound was poor compared to that from my FAS system used for TV sound. The higher admission now charged at the movie theatre couldn't have made up for the very small attendance!"

Microwaves for Gas Line:

A 500-mile multiplex relay system is being installed by Philco for El Paso Natural Gas Company. Running between Fruitland, N. M. to the Arizona-California border, the cost of the initial installation is estimated at $500 to $700 per mile.

Non-Critical Permanent Magnets:

The development of permanent magnets, suitable for all radio applications and free of all critical material such as cobalt and nickel, has been announced by Sylvania Electric Products, 1740 Broadway, New York City. Pilot quantities are being produced, and it is expected that commercial production will be under way at an early date.

TV Reception on UHF:

A new announcement from Zenith restates the claim made previously that all Zenith sets can be adjusted to receive TV stations in the UHF band, and reports on successful field tests made in the Bridgeport area.

Grist from the Lawyers Mill:

It took us two letters and a phone call to Washington before we were straightened out on the latest bit of confusion created at the FCC. Now we can explain to you: A mobile radio station is one that is installed on a vehicle, and can be moved about. But a mobile relay station isn't mobile at all. It is a fixed station that picks up transmissions from mobile stations on one frequency, and repeats them on another frequency. (See Jeremiah Courtney's page in this issue.)

Next, a Free Armchair:

Latest price reduction on Muntz TV sets brings the retail price of their 17-in. table model down to $149.50.

WBEN-FM to Have 106 Kw.

Buffalo Evening News has been authorized to erect a 1057-ft. tower and to increase radiated power from 6 to 106 kw. The new station will be operating early in 1952. WBEN-FM is on 106.5 mc. from 1:15 p. m. to midnight. Its School of the Air programs are now used in more than 8,000 classrooms.

CBS to Enter Set Business:

Hytron stockholders are being asked to approve an arrangement under which CBS will acquire the business and assets of Hytron Radio & Electronics Corporation, and its subsidiary Air King Products, Inc. Columbia proposes to exchange 31 shares of CBS for 100 shares of Hytron. Looks as if CBS expects to win the color TV decision.

Those Directories Are Handy:

Note from W. L. Farmer of Mobile Radio Service Company: "We find those Communication Registries very handy to have in our shop. Recently, the local police department asked us to look up a mobile unit that had called the County station. We were able to pass on the information in about 5 minutes, even

(Continued on page 7)

SPOT NEWS NOTES

(Continued from page 6)

though they didn't have the call letters right the first time," The first Directory of Air-Ground Stations is now coming off the press.

FM Is Making Rapid Gains:

There's no doubt but what a definite shift to FM listening is under way in areas served by well-programmed FM stations. If you haven't seen the latest NAB survey, write to Edward Sellers, 1771 N Street, N.W., Washington, D. C., and ask him for a copy.

Data on Crystals:

A very comprehensive catalog, just issued by James Knights Company, Sandwich, Ill., presents mechanical and electrical data on new types of crystals and holders, as well as standard replacement types.

Dixie B. McKey:

Former Washington engineering consultant has joined RCA as field representative for microwave and mobile communication equipment. His headquarters are at the RCA offices in Dallas.

New Radio Factories:

Two factories at Elmira, N. Y., will become headquarters for the Westinghouse tube division and tube engineering laboratories, employing about 1,000 people. Sylvania will erect a tube factory of 100,000 square feet at Burlington, Ia., to employ about 800 people. A bulb and tube plant, of 270,000 square feet, will be built at Danville, Ky., by Corning Glass Works. Initially, 550 people will be employed. Philco has purchased three new buildings, totalling 175,000 square feet at Bedford, Ind. Employment for 800 people will be provided at a building of 158,000 square feet purchased by Globe-Union at 3410 W. Hopkins Street, Milwaukee, for its Centralab Division. Cannon Electric Company has opened a new plant at East Haven, Conn., with E. C. Quackenbush in charge.

How To Starve Slowly:

The increasing tendency to ask the group of men and women who comprise our Federal Government to assume our personal responsibilities is following the pattern established in England in 1905 by a group of 4,000 members of the Fabian Society, now expanded to the British Labor Party. Today, impoverished by the creeping paralysis of inefficient, wasteful, bureaucratic administration of the cradle-to-grave care that the people have been taught to demand of their Government, John Stratchey, Minister of Food,

(Continued on page 8)

SPOT NEWS NOTES

(Continued from page 7)

boasts that weekly rations allowed the English people are "all they ought to have." This is what they get per week: 1½ eggs, 3 ounces of butter, 6 of margarine, 1 of lard, 1 of cheese, 8 of sugar, 1 of bacon, 6 of meat, and 2 of corned beef. That's a week's nourishment in England. And we're going to come to it here unless we reverse the trend toward expanding Government planning and controls.

TV Profit and Loss:

FCC report for 1950 shows total TV broadcast revenue of $105.8 million, more than three times that of '49, with $7.9 million loss, compared to $25.3 million loss in '49. Of 107 stations reporting, 54 were in the black, with better than one-half showing income, before Federal taxes, of $100,000 or more. The 78 stations in interconnected cities showed total profits, before Federal taxes, of $5.7 million, while the 27 stations in non-connected cities had an aggregate of loss of $3 million.

Needham, Massachusetts:

Workshop Associates is now a wholly-owned subsidiary of the Gabriel Company, Cleveland, which also owns Ward Products. Under this arrangement, Workshop engineering facilities will be greatly expanded. Gardiner G. Greene will continue to head the company, which he founded in 1942.

General Dwight Eisenhower:

Note for those who expect security to be legislated by government: "Safety is a by-product of human vision, courage, and progress. If sought for itself, it cannot be found."

Radio Prices Frozen:

Office of Price Stabilization has frozen dealer price markups on all radio sets, components, phonographs, recorders, and records. Permitted markups range from 39% for TV sets to 58% for replacement parts, and 81% for tape and wire recorders.

William P. Short:

Named chief engineer of General Precision Laboratory, Pleasantville, N. Y. He will supervise production of TV equipment developed by the Company's research division.

TV Station for Peoria:

WMBD has signed a contract for the purchase of a 5-kw. Dumont installation, including a 5-bay antenna. Plan is to get on the air as soon as possible after freeze is ended.

(Concluded on page 9)

Special Services Directory

SPOT NEWS NOTES

(Continued from page 8)

Profitable Exchange:

Arthur Jones, until recently with Gray Research & Development, and now at Norden Engineering, clipped this classsified advertisement from the Farmington Valley Herald: "SWAP: Webster wire recorder plus two hours of wire for 8 loads of manure. Call Simsbury, Conn., 135-J."

Broadcast Station Buildings:

According to an NPA bulletin dated March 12, the construction of broadcast station buildings is specifically exempted from Government restrictions, and they can be started without the necessity of obtaining authorization.

FM for Railroads:

Diesel engines to be delivered by General Motors and Fairbanks-Morse to Milwaukee Railroad will have Bendix radio equipment installed at the locomotive works. More satisfactory installation is expected than if the work is done after delivery.

M. I. T. Communication Course:

A course in the theory of information and communication will be given at Massachusetts Institute of Technology from June 18 to July 6, comprising lectures daily from 9 to 12, discussion from 2 to 3, and Laboratory work from 3 to 5. Further information can be obtained from Prop. Walter H. Gale, Room 3-107, M. I. T., Cambridge 39, Mass.

Ductile Bismuth:

Is now available in wire and ribbon from Fitzpatrick Electric Supply Company, 44-4 Irwin Street, Muskegon, Mich. Bismuth has unique electrical properties, such as resistance change in a magnetic field and high change in resistance due to temperatures, and it is the most negative material for thermocouples. A booklet detailing these characteristics is available on request.

Facsimile Broadcasting:

Following the successful experiments carried on by Major Armstrong and John V. L. Hogan in multiplex facsimile transmission from KE2XCC, similar operations are now being carried out in a joint experiment conducted by Columbia University, Hogan Laboratories, and the Rural Radio Foundation.

European Audio Survey:

John K. Hilliard, Altec Lansing's chief engineer, left in March for London and the Continent to make a survey of foreign audio equipment, engineering, and potential sources of materials.

ACE HIGH

. . . for miniaturization, mounting, and temperature problems

Here they come, right off the top of the deck, to fill in what's been needed—new ways of mounting subminiature capacitors in military electronic equipment!

You'll find side stud, end stud, threaded neck, and two types of side bracket capacitors in Sprague's new 16 page Engineering Bulletin 213-B.

These new Sprague-pioneered designs make even broader the world's most complete line of solder-seal terminal metal-encased subminiature paper capacitors.

And they're now available as standard in a 125°C. temperature rating Vitamin Q® capacitor series. Voltage ratings range from 100 to 1000 volts in both inserted tab and extended foil constructions.

And remember, Sprague Capacitors are the standard of dependability for critical electronic circuits. Write for your copy of Bulletin 213-B which gives the complete Sprague Subminiature Story.

SPRAGUE®

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

SPRAGUE ELECTRIC COMPANY
NORTH ADAMS, MASSACHUSETTS

WHAT'S NEW THIS MONTH

MR. WILSON'S REPORT FOR THE FIRST QUARTER — ESTIMATES OF CONSUMER GOODS IN 1951 — A TRADE SHOW AT NEW YORK — LAWYERS VS. ENGINEERS

IN his April 1 report to the President, Defense Mobilization Director Charles E. Wilson summarized the progress since last June 25 in expanding our military strength and expanding production, and forecast the further task of "meeting the challenge of outright communist aggression" in these words:

The first nine months of the defense mobilization program have been — for the effort as a whole — a tooling-up stage.

The Congress has enacted the basic laws and the first big new appropriations. We have organized the necessary new agencies, planned the program, completed the specifications for much of the new equipment, begun ordering in quantity, and created the basic machinery for international collaboration.

In terms of military strength, we have achieved much since last June 25, but we are still far from achieving the strength we need. One year from now, with unflagging determination and effort, we and our allies will have achieved a formidable strength in many phases of modern warfare. Two years from now we should have military and economic strength sufficient to give us reasonable safety against aggression.

In terms of civilian standards of living, the impact of the defense program has hardly yet been felt. The coming year will be different. Shortages are bound to come for some civilian goods — particularly products made from metal.

The following year, if our program is successful in preventing war, shortages may begin to ease and we can probably begin to talk about taking off controls. In 1953, we should be in a position to maintain a high level of military expenditures on top of a healthy civilian economy — which, at that time, will be free to resume its upward trend.

But the production side of our task is in many ways the less difficult. A tougher test of our ability to survive the present crisis lies in the other side of the problem — stabilization.

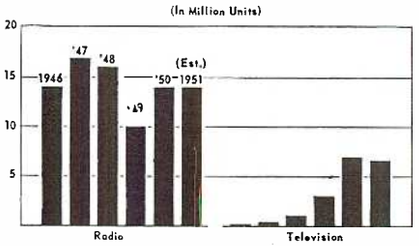
The success of our production effort demands that we win the battle against inflation. To win that battle calls for a subordination of selfish ends to the common welfare in a measure beyond what is commonly demanded in any period short of actual war. It calls for a fair presentation of its claims by every segment of society, an open and willing participation by all concerned, and a readiness to abide by decisions which are arrived at through fair and honest means. It calls for every organized group to consider the welfare and just demands not only of other organized groups but of the unorganized, the consumer, the public as a whole.

The nation demands, and must be given, the same degree of support by its citizens now, in a period of peace, that it would receive in a war. The times are no less challenging.

All of us must remember in the months ahead that it is vastly better to prevent a war, if we can, than to win one — and the surest course toward prevention of World War III is through building the might of America and with it the might and the security of the free world.

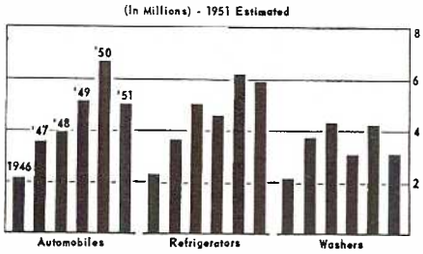
RADIO AND TELEVISION PRODUCTION

(In Million Units)



SELECTED CONSUMER DURABLE GOODS

(In Millions) - 1951 Estimated



THESE CHARTS ARE FROM MR. WILSON'S REPORT

MR. Wilson's report contains this significant information concerning the radio industry:

Up to now, the consuming public has scarcely felt the impact of Government controls over production and distribution. Production of most consumer items during the first quarter of 1951 actually exceeded production during the same period of 1950.

Because defense orders have been placed in large quantities only in recent months, and time is required to organize production, output of civilian goods has held to these very high levels. NPA orders have restricted the use of scarce materials for civilian consumption only to the extent that they were immediately required by the military, defense-supporting, and stockpiling programs.

While the production of the major consumer durables — radios, television, automobiles, refrigerators, and washing machines — will fall in 1951 below the all-time high of 1950, there will remain substantial output of these items. The accompanying charts show the comparison of 1951 production estimates with the output in recent years for certain key products. During the remainder of 1951, scarce materials going into non-defense production will be increasingly restricted, with the greatest over-all restrictions, under present schedules, occurring late in 1951 and early in 1952.

THE March IRE Radio Show was an outstanding success for the Institute, the exhibitors, and the record number of 23,000 engineers who attended it.

Although the show occupied three floors, it appeared that all available space had been taken. Surprisingly enough, the attendance seemed to be distributed evenly on all floors.

It is fortunate for the industry as a whole that this annual event is so capably managed and so widely supported by the manufacturers. Otherwise, competition would be encouraged, and conditions might prevail again, as in the 20's, when two shows were held the same week in New York City.

However, the IRE Show is organized strictly as an engineering event for engineers. By its success, it excludes the possibility of a trade show in New York. It has been proposed that the IRE Show be extended through Saturday, instead of closing down on Thursday, and that exhibitors have sales representatives on hand during the two additional days to consult with distributors and dealers. The Institute management has looked upon the idea with the disdain that engineers are inclined to display toward any activity related to traffic in the fruits of their labors. Nevertheless, there is a need for a trade show in New York, and the logical, economical way to hold it would be to tack it on to the four days of the IRE event.

RTMA board chairman Robert C. Sprague, delivering the principal address at the annual IRE banquet on March 21, voiced the resentment that

(Concluded on page 36)

ANALYSIS OF THE MARKET FOR TV TRANSMITTERS, BASED ON THE NEW FCC PLAN

This table lists all cities where one or more VHF assignments are proposed, and shows the number of VHF stations now on the air, the additonal VHF and UHF channels provided in the new plan, the population in thousands, and the number of AM and FM stations now operating.

	VHF on the air	VHF unassigned	UHF unassigned	Pop., add 000	AM & FM on the air
ALABAMA					
Birmingham	2	1	2	408	9
Dothan	0	1	1	17	3
Mobile	0	2	2	115	6
Montgomery	0	1	3	94	6
University	0	1	0		
ARIZONA					
Douglas	0	1	0	9	1
Flagstaff	0	2	0	5	2
Kingman	0	1	0	2	1
Mesa	0	1	0	7	2
Phoenix	1	3	0	121	7
Tucson	0	3	0	37	5
Yuma	0	2	0	5	2
ARKANSAS					
Blytheville	0	1	1	11	2
El Dorado	0	1	1	16	2
Fayetteville	0	1	1	8	1
Fort Smith	0	1	2	37	5
Hot Springs	0	1	1	21	2
Jonesboro	0	1	1	12	3
Little Rock	0	3	2	127	6
Pine Bluff	0	1	1	21	2
CALIFORNIA					
Alturas	0	1	0	2	0
Bakersfield	0	1	1	29	7
Chico	0	1	0	9	3
Eureka	0	2	0	17	3
Fresno	0	1	2	98	8
Los Angeles	7	0	3	2904	23
Monterey	0	1	0	10	1
Redding	0	1	0	8	2
Sacramento	0	2	2	159	7
San Diego	1	2	3	256	8
San Francisco	3	2	5	1428	16
San Jose	0	1	3	129	5
San Luis Obispo	0	1	0	9	2
Stockton	0	1	2	79	5
Visalia	0	1	0	9	1
Yreka	0	1	0	2	1
COLORADO					
Boulder	0	1	1	13	1
Colorado Springs	0	2	2	37	2
Denver	0	4	2	384	10
Pueblo	0	3	2	62	3
CONNECTICUT					
New Haven	1	0	1	308	7
New London	0	1	1	30	1
DELAWARE					
Wilmington	1	0	2	189	6
DIST. OF COLUMBIA					
Washington	4	0	2	908	15
FLORIDA					
Daytona Beach	0	1	0	23	4
Ft. Myers	0	1	0	8	1
Gainesville	0	1	1	14	3
Jacksonville	1	2	2	173	10
Miami	1	3	0	172	10
Orlando	0	2	2	37	6
Panama City	0	1	2	12	3
Pensacola	0	2	2	37	3
Tallahassee	0	2	1	16	3
Tampa-St. P.	0	4	0	210	11
W. Palm Beach	0	2	2	34	2
GEORGIA					
Albany	0	1	1	19	2
Athens	0	1	1	21	3
Atlanta	2	1	2	302	12
Augusta	0	2	0	66	4
Columbus	0	1	2	53	6
Macon	0	1	2	58	7
Rome	0	1	1	26	4
Savannah	0	3	0	96	8
Thomasville	0	1	1	13	2
Valdosta	0	1	0	16	3
IDAHO					
Boise	0	3	0	26	3
Caldwell	0	1	0	7	1
Idaho Falls	0	2	0	15	2
Lewiston	0	1	0	11	1
Nampa	0	2	0	12	2
Pocatello	0	2	0	18	4
Sandpoint	0	1	0	4	1
Twin Falls	0	2	0	12	4
ILLINOIS					
Centralia	0	1	1	16	2
Chicago	4	1	5	3397	29
Peoria	0	1	2	105	6
Quincy	0	1	1	40	4
Rockford	0	1	2	85	2
Rock Island (see Davenport)					
Springfield	0	1	2	76	5
Urbana	0	1	2	14	3
INDIANA					
Bloomington	1	0	2	21	2
Evansville	0	1	3	97	6
Indianapolis	1	2	2	387	5
Terre Haute	0	1	2	63	4
IOWA					
Ames	1	0	1	13	2
Cedar Rapids	0	1	2	62	4
Dav'p't, Rock Is.	1	1	3	175	4
Des Moines	0	3	2	184	10
Iowa City	0	1	1	17	2
Mason City	0	1	1	27	4
Sioux City	0	2	2	82	4
Waterloo	0	1	2	67	4
KANSAS					
Dodge City	0	1	1	8	1
Garden City	0	2	0	6	2
Hays	0	1	1	6	1
Hutchinson	0	1	1	30	3
Lawrence	0	1	1	14	2
Manhattan	0	1	1	12	2
Pittsburgh	0	1	1	18	2
Topeka	0	1	2	68	4
Wichita	0	2	2	115	6
KENTUCKY					
Bowling Green	0	1	1	15	3
Louisville	2	0	2	434	10
Middlesborough	0	1	1	12	1
Paducah	0	1	1	34	4
LOUISIANA					
Alexandria	0	2	0	27	5
Baton Rouge	0	1	3	35	7
Lafayette	0	1	1	19	3
Lake Charles	0	1	2	21	3
Monroe	0	1	1	28	4
New Orleans	1	3	3	540	17
Shreveport	0	2	0	112	7
MAINE					
Augusta	0	1	1	19	2
Bangor	0	2	1	37	4
Calais	0	1	1	5	0
Lewiston	0	1	1	58	3
Orono	0	1	0		0
Portland	0	2	2	106	4
Presque Isle	0	1	1	17	1
MARYLAND					
Baltimore	3	0	3	1047	12
MASSACHUSETTS					
Boston	2	2	3	771	14
MICHIGAN					
Alpena	0	1	1	13	1
Cheboygan	0	1	1	6	0
Detroit	3	0	3	2296	17
Escanaba	0	1	0	15	1
Flint	0	1	3	189	5
Grand Rapids	1	0	2	210	8
Hancock	0	1	0	6	0
Iron Mountain	0	1	1	11	1
Iron River	0	1	0	4	1
Kalamazoo	1	0	1	77	2
Lansing	1	0	1	110	2
Marquette	0	1	1	16	1
Sault St. Marie	0	2	2	16	1
Traverse City	0	1	2	14	1
MINNESOTA					
Austin	0	1	1	18	1
Brainerd	0	1	0	12	1
Duluth-Sup.	0	3	2	136	4
Hibbing	0	1	0	6	1
Intl. Falls	0	1	0	6	0
Minn.-St. Paul	2	3	2	911	14
Rochester	0	1	0	26	2
St. Cloud	0	1	1	24	3
MISSISSIPPI					
Biloxi	0	1	2	17	2
Clarksdale	0	1	1	12	1
Hattiesburg	0	1	1	21	3
Jackson	0	2	2	88	6
Meridian	0	1	2	35	4
State College	0	1	0		0
West Point	0	1	1	6	1
MISSOURI					
Cape Girardeau	0	1	1	19	3
Columbia	0	1	2	18	2
Hannibal	0	1	1	8	1
Jefferson City	0	1	1	24	2
Joplin	0	1	1	37	4
Kansas City	1	2	2	399	7
Kirksville	0	1	1		1
St. Joseph	0	1	2	76	2
St. Louis	1	3	3	816	9
Sedalia	0	1	1	20	0
Springfield	0	1	2	61	5
MONTANA					
Anaconda	0	1	0	11	1
Billings	0	3	0	23	3
Bozeman	0	1	1	9	2
Butte	0	3	0	37	3
Great Falls	0	2	1	30	3
Hardin	0	1	0	2	0
Havre	0	2	0	6	2
Helena	0	2	0	15	2
Kalispell	0	1	0	8	1
Lewiston	0	1	0	6	1
Miles City	0	3	0	7	2
Missoula	0	2	1	18	2
NEBRASKA					
Alliance	0	1	1	6	1
Grand Island	0	1	1	19	1
Hastings	0	1	1	15	1
Kearney	0	1	1	10	1
Lincoln	0	2	2	82	4
McCook	0	1	1	6	1
North Platte	0	2	2	12	2
Omaha	2	1	3	224	6
Scottsbluff	0	1	1	12	2
NEVADA					
Boulder City	0	1	0	3	0
Elko	0	1	0	4	1
Ely	0	2	0	4	1
Goldfield	0	1	0	.6	0
Henderson	0	1	0	7	0
Las Vegas	0	3	0	8	4
McGill	0	1	0	3	0
Reno	0	2	2	21	5
Tonopah	0	2	2	2	0
Winnemucca	0	1	0	2	0
NEW HAMPSHIRE					
Durham	0	1	0		0
Manchester	0	1	1	81	5
NEW JERSEY					
Newark	1	0	0	413	6
NEW MEXICO					
Albuquerque	1	3	0	35	4
Carlsbad	0	1	1	7	2
Clovis	0	1	1	10	1
Gallup	0	2	0	7	1
Roswell	0	3	0	13	2
Santa Fe	0	3	0	20	2
Silver City	0	1	0	5	1
NEW YORK					
Albany-Sch.-Troy	1	0	2	432	14
Binghamton	1	0	2	145	7
Buffalo-N. Falls	1	2	2	857	13
New York	6	0	3	11691	31
Rochester	1	1	3	412	8
Syracuse	2	0	1	258	7
Utica-Rome	1	0	2	197	6
NORTH CAROLINA					
Asheville	0	1	2	51	5
Chapel Hill	0	1	0		0
Charlotte	1	1	2	101	8
Durham	0	1	2	60	4
Greensboro	1	0	2	59	5
Greenville	0	1	0	13	1
New Bern	0	1	0	12	1
Raleigh	0	1	2	47	6
Washington	0	1	0	9	2
Wilmington	0	1	2	33	3
Winston-Salem	0	1	2	80	6
NORTH DAKOTA					
Bismark	0	2	2	15	1
Devils Lake	0	1	1	6	1
Dickinson	0	2	1	6	1
Fargo	0	2	2	33	2
Grand Forks	0	2	0	20	3
Jamestown	0	1	1	9	1
Minot	0	3	0	17	2
Valley City	0	1	1	6	1
Williston	0	2	1	6	1
OHIO					
Cincinnati	3	0	2	789	9
Cleveland	3	0	2	1214	14
Columbus	3	0	2	365	9
Dayton	2	0	2	271	6
Toledo	1	1	1	341	6
OKLAHOMA					
Elk City	0	1	1	5	1
Enid	0	1	2	28	3
Lawton	0	1	2	18	1
Muskogee	0	1	2	32	4
Oklahoma City	1	2	2	221	10
Tulsa	1	2	2	189	8
Woodward	0	1	0	5	1
OREGON					
Corvalis	0	1	1	8	2
Eugene	0	1	2	21	5
Klamath Falls	0	2	0	16	2
La Grande	0	1	0	8	1
Medford	0	2	0	11	2
Portland	0	4	2	406	14
Salem	0	1	2	31	2
PENNSYLVANIA					
Erie	1	0	2	134	5
Johnstown	1	0	1	152	5
Lancaster	1	0	1	132	4
Philadelphia	3	0	4	2899	18
Pittsburgh	1	2	2	1994	14
RHODE ISLAND					
Providence	1	1	2	712	11
SOUTH CAROLINA					
Charleston	0	3	0	71	7
Columbia	0	1	2	62	5
Florence	0	1	0	16	2
Greenville	0	1	2	35	8
SOUTH DAKOTA					
Aberdeen	0	1	1	17	1
Brookings	0	1	1	5	0
Huron	0	1	1	11	1
Lead	0	1	1	8	0
Mitchell	0	1	1	11	1
Pierre	0	1	2	1	1
Sioux Falls	0	2	2	41	4
Vermillion	0	1	1	3	1
TENNESSEE					
Bristol	0	1	1	14	1
Chattanooga	0	3	3	193	7
Jackson	0	1	1	24	4
Johnson City	0	1	1	25	3
Knoxville	0	2	2	152	7
Memphis	1	2	2	332	8
Nashville	1	2	2	242	8
TEXAS					
Abilene	0	1	1	27	2
Alpine	0	1	0	4	1
Amarillo	0	5	0	53	5
Austin	0	3	3	106	4
Beaumont-Pt. Ar.	0	2	2	139	7
Big Spring	0	1	0	13	2
Brownsville	0	2	0	22	2
College Station	0	1	1		1
Corpus Christi	0	2	2	71	5
Dallas	2	1	2	377	11
Denton	0	1	1	11	2
El Paso	0	4	2	116	6
Ft. Worth	1	1	2	208	7
Galveston	0	1	3	72	3
Houston	1	2	2	510	11
Laredo	0	2	1	39	0
Lubbock	0	2	2	32	3
Lufkin	0	1	1	14	3
Midland	0	1	1	9	2
Monahans	0	1	0	4	1
Odessa	0	1	1	10	3
San Angelo	0	2	2	26	2
San Antonio	2	2	2	319	11
Sweetwater	0	1	0	10	1
Texarkana	0	1	2	12	3
Tyler	0	1	1	28	3
Waco	0	1	2	71	2
Wichita Falls	0	2	2	45	4
UTAH					
Cedar City	0	1	0	5	1
Logan	0	1	1	12	1
Ogden	0	2	2	44	3
Price	0	1	0	5	1
Provo	0	1	2	18	3
Richfield	0	1	0	4	1
Salt Lake City	2	1	2	204	7
VERMONT					
Montpelier	0	1	1	8	1
VIRGINIA					
Lynchburg	0	1	1	51	4
Norfolk-Pts.	1	1	3	191	8
Petersburg	0	1	1	31	1
Richmond	1	1	2	193	11
Roanoke	0	2	2	69	6
WASHINGTON					
Pullman	0	1	1	4	2
Seattle	1	3	2	453	13
Spokane	0	4	0	141	6
Tacoma	0	2	2	156	3
Walla Walla	0	2	0	18	2
WEST VIRGINIA					
Charleston	0	1	2	68	7
Clarksburg	0	1	1	31	4
Huntington	1	1	1	79	5
Wheeling	0	2	1	61	5
WISCONSIN					
Eau Claire	0	1	2	31	4
Green Bay	0	1	0	46	4
La Crosse	0	1	2	43	3
Madison	0	1	3	67	7
Marinette	0	1	2		1
Milwaukee	1	2	3	587	9
Wausau	0	1	1	27	1
WYOMING					
Casper	0	2	0	18	2
Cheyenne	0	2	0	28	1
Laramie	0	1	0	11	1
Rawlins	0	1	0	6	1
Riverton	0	1	0	3	1
Rock Springs	0	1	0	10	1
Sheridan	0	2	0	11	1

ANALYSIS OF THE NEW TV PLAN

MARKET FOR TELEVISION EQUIPMENT — INCREASED OUTPUT POWER — UHF TRANSMITTER PROGRESS — IMPACT ON FM AND AM — *By* MILTON B. SLEEPER

NOW that the long-awaited revision of the FCC's schedule of allocations for television has been released, the industry has a basis for planning transmitter and receiver sales, and for predicting the probable effects of TV expansion on audio broadcasting.

Activities in equipment sales can be divided into four parts: 1) new VHF installations; 2) equipment for increasing the power of existing VHF transmitters, 3) additional studio facilities, and 4) new UHF installations. And of course, there is the matter of opening up additional and currently-needed markets for VHF receivers, plus the necessity of providing UHF sets.

All this calls for immediate planning on the part of manufacturers, present TV broadcasters who want to increase their power, and those who want to get into TV. This does not mean immediate orders and deliveries, however. Nor is it possible to work out any time-table now.

First, the new allocations plan must be finalized. Second, while the war clouds have not closed in on the manufacturers to the extent anticipated last fall, there is no assurance as to how long the present favorable conditions will continue. Also, if the Supreme Court upholds the FCC in the adoption of an incompatible color system, the whole TV picture will be thrown into confusion.

Changes in Radiated Power:

Two favorable changes in radiated output limits are contained in the FCC proposal. One is the plan to authorize the use of increased power. This opens up sales for high-power output equipment, since radiation up to 100 kw. on channels 2 to 6 will be allowed, and up to 200 kw. on 7 to 13, and on UHF channels.

The second, which may prove to be even more important, is the plan to authorize the use of lower power in less populated areas, down to 1 kw. radiation from an antenna 300 ft. above average terrain. This will make the installation of transmitters economically practical in the smaller cities. Further details of power requirements are presented elsewhere in this issue, and they can be related to the population data in the accompanying list of cities where VHF channels are planned.

New VHF Transmitters:

Since standard types of VHF transmitters have been manufactured in substantial quantities already, the initial sales effort will be made in cities where VHF allocations are planned. And the first new orders will come from those cities, because VHF receivers are available in quantity. There will be delays, however, for the reason that, in most cases, there are more applicants than channels. CP's cannot be issued until hearings are held, and final decisions rendered. It's anybody's guess as to when orders can be placed for equipment to be installed at any particular city; which will be first, and which last. But it is probable that deliveries can be made as fast as CP's are issued.

Actually, the delay may all work out for the best because, if a hundred CP's were handed out at one time, the resulting scramble for equipment and operating personnel would create devastating confusion.

New UHF Transmitters:

Some companies have already completed much of their development and design work on UHF transmitters. However, deliveries will proceed slowly, and no substantial number will be released for production until after the initial installations have been in service long enough to disclose all the bugs that may develop.

Thus, while the Commission may issue CP's for UHF transmitters in cities where there are no conflicting applications, it will be quite a while before any number of UHF stations are actually on the air.

In all probability, the first UHF transmitters will be in areas where there is only one VHF station. The reason is that people who now have a choice of VHF programs will not be particularly anxious to buy adapters or new all-channel sets, but where there is now only one VHF station, a second program source, even on UHF, will be important to them.

As the accompanying table shows, there are 13 cities where one VHF station is now on the air, and any additional stations which may be installed will have to operate on UHF. Still, with 904 UHF-only cities, it is possible that UHF will break out first where there is no VHF transmission.

Just what happens will be determined to a considerable extent by the degree to which UHF transmitter deliveries are coordinated with the promotion of suitable receivers. Probably companies which order UHF transmitters will benefit by the experience of FM broadcasters. It will be recalled that the principal manufacturers of FM transmitters did not undertake the production, distribution, and promotion of suitable receivers. The same disastrous results could be repeated in UHF television, but it probably won't, because the delivery of transmitters will presumably be coordinated with receiver production.

VHF-UHF Receivers:

Of the 335 cities where VHF allocations are planned, 237 have UHF assignments also. All the principal cities are in the latter group. Most of the 98 VHF-only cities are in sparsely settled areas. Therefore, in the principal markets, there will be eventually a huge demand for VHF-UHF receivers.

Two years ago, the development of UHF circuits looked like a remote possibility, but that was largely due to the fact that the industry was preoccupied with VHF engineering. Today, production of UHF receivers, or converters, does not seem such a formidable undertaking. We have no information on the subject, but it seems reasonable to expect that RCA has anticipated the need, on the part of its licensees, for UHF circuit data, and will probably have it ready for distribution well in advance of the first commercial UHF transmission.

The sale of receivers goes hand in hand with the installation of transmitters, and since the bulk of receivers will be sold in the relatively small number of cities of 50,000 population and up, the accompanying table and the following breakdown of cities and available channels show where the greatest TV activity will develop.

Cities of More Than 100,000:

VHF assignments are provided for 79 cities of more than 100,000 population. Of these, 6 have only VHF assignments, while 73 have both VHF and UHF.

At present, 58 out of the 79 cities have a total of 100 VHF stations, and channels are proposed for 62 more, plus 125 UHF stations.

In the remaining 21 cities that have no TV stations at present, 54 VHF and 40 UHF channels will be open for assignment.

This group, therefore, represents a market for 116 VHF and 165 UHF transmitters. At present, there are 731 AM and FM stations in these cities.

Cities of 50,000 to 100,000:

There are 39 cities of 50,000 to 100,000 population that have VHF assignments. Of these, 4 are VHF only, while 35 have both VHF and UHF assignments.

Only 3 of these cities, Kalamazoo, Greensboro, N. C., and Huntington, W. Va., have one station each at present.

Altogether, 54 VHF and 68 UHF channels have not been assigned. There are 188 AM and FM stations operating in this group of cities.

Immediate Transmitter Market:

While some cities of less than 50,000 population are so located that the coverage areas of TV stations would reach much larger markets than indicated by the population of the cities where they would be located, immediate prospects for transmitters might be considered as 108 cities of 50,000 population or more where VHF channels are proposed.

This adds up to a potential sales total of 170 VHF and 233 UHF transmitters (in addition to 103 VHF stations now on the air) in cities of 50,000 population or more, where 919 AM and FM stations are already in operation.

Total U. S. Assignments:

The remaining market represents a long-range campaign. One segment can be written off as far as any immediate activity is concerned. That is comprised of 79 cities, having 10,000 population or less, accounting for 93 VHF and 32 UHF assignments. These total more than the 83 AM and FM stations now operating in those cities.

Altogether, the FCC has provided for 557 VHF and 1,357 UHF assignments to 1,256 cities.

Therefore, deducting from the total above the 197 cities of more than 50,000 or less than 10,000 population, for which 366 VHF and 265 UHF assignments have been provided, there is a remainder of 1,059 cities having 294 VHF and 1,092 UHF assignments.

In tabular form, the figures on potential TV transmitter sales break down:

100,000 Population or More		
79 Cities	116 VHF	165 UHF
50,000 to 100,000 Population		
39 Cities	54 VHF	68 UHF
10,000 to 50,000 Population		
1059 Cities	294 VHF	1092 UHF
Less Than 10,000 Population		
79 Cities	93 VHF	32 UHF

Some of these VHF transmitters have been sold already, for delivery when the customers receive their construction permits, but the number is not large.

TV-Audio Competition:

About one-third of the audio broadcasters are now operating at a profit, another third are breaking even, and the others are losing money. Without competition from television, it might be expected that nearly one-half of the present number would go off the air within the next few years, either because of discouragement or inability to continue at a loss.

What, then, will happen when the 919 audio stations in 108 cities of more than 50,000 population are faced with the competition of 170 new VHF television stations, added to the 103 now operating, plus 233 UHF stations to be built subsequently?

It's certain that these 108 cities can't support 919 audio stations plus an eventual total of 506 TV stations. Something will have to give.

Some of the AM-only stations will have to quit, and some of the FM-AM operators will have to choose between the two methods of transmission. It has been obvious for a long time that one or the other must be dropped eventually. The number of FM sets and TV sets with FM tuning has been growing at a rapid, healthy pace. Still, it is doubtful if the FM figure will compare favorably with AM sets in use by the time TV competition begins to hurt the audio broadcasters. On that basis alone, it might be expected that FM will be dropped.

Demand for Music:

But it may very well happen that FM will win out in the end. FM is teaching people that the "perfect" reception they thought they had on AM was actually full of very objectionable noise. When the noise is eliminated, listening becomes much, much more entertaining. And there are many hours throughout the week when people can't watch television, but they can enjoy straight audio programs.

Something else is happening to strengthen FM's position. Fine music has become big business and very profitable business. FM broadcasters have an opportunity to capitalize on the demand for high-quality musical entertainment, now spreading at a fantastic rate. In that field, AM cannot compete.

Whether or not FM broadcasters will take advantage of their exclusive opportunity remains to be seen. There still isn't enough good music from FM stations and, through indifference, lack of engineering skill, or financial limitations, some FM transmitters are not doing justice to their program material. As a matter of fact, some of the best FM quality can be heard on the audio channels of TV stations. They aren't consistently up to par, but all FM broadcasting should be as good as the best quality heard on TV.

As time goes on, broadcasting should settle down to TV and FM service.

That would be a logical development, but it is not offered as a prediction because there are always conflicting interests in this business, and they are seldom resolved in a logical manner.

TV STANDARDS

A SUMMARY OF THE PROPOSED STANDARDS OF GOOD ENGINEERING PRACTICE FOR TV STATIONS

IN its proposed Rules and allocations for television broadcasting, released on March 22, the FCC announced that May 7 will be the final date for submitting written comments on its proposal, and that a hearing will be held before the Commission *en banc* on June 11 at Washington. The inference is that the Commission is prepared now to end the TV freeze with the least possible delay.

It is expected that the final Rules and Standards of Good Engineering Practice will be substantially in the form of the proposal. Accordingly, the following resume of the new TV plan deserves the most careful study.

Number of Channels:

In addition to the present twelve 6-mc. VHF channels, numbered 2 to 13, fifty-two 6-mc. UHF channels will be allocated to commercial and non-commercial educational broadcasting. If the band from 470 to 500 mc. is finally assigned to common carrier mobile service (the decision had not been reached at this time of writing) these 52 channels, No. 14 through 65, will extend from 500 to 812 mc., with 13 "flexibility" channels, No. 66 through 78, from 812 to 890 mc. If the 470 to 500-mc. band is assigned to television, the 52 channels will extend from 470 to 782 mc., and 18 "flexibility" channels, No. 66 through 83, will occupy the band from 782 to 890 mc.

At least initially, provisions have been made for assignments to non-commercial educational stations, although there was considerable difference of opinion among the Commissioners on that point. Presumably, channels reserved for that purpose, if not taken up within a reasonable

PROPOSED CHANNEL CHANGES

		Present Channel	Proposed Channel
WOI-TV	Ames	4	5
WSB-TV	Atlanta	8	11
WRBC-TV	Birmingham	4	6
WTTV	Bloomington	10	4
WBKB	Chicago	4	2
WLWT	Cincinnati	4	5
WKRC-TV	Cincinnati	11	12
WCPO-TV	Cincinnati	7	9
WXEL	Cleveland	9	8
WNBK	Cleveland	4	3
WLWC	Columbus	3	4
WLWD	Dayton	5	2
WHIO-TV	Dayton	13	7
WOC-TV	Davenport	5	6
WLAV-TV	Grand Rapids	7	8
WSAZ-TV	Huntington	5	8
WJAC-TV	Johnstown	13	5
WGAL-TV	Lancaster	4	8
WAVE-TV	Louisville	5	3
WHAS-TV	Louisville	9	11
WMCT	Memphis	4	5
WTMJ-TV	Milwaukee	3	4
WNHC-TV	New Haven	6	8
WTAR-TV	Norfolk	4	10
WKY-TV	Oklahoma City	4	7
WDTV	Pittsburgh	3	2
WJAR-TV	Providence	11	10
WHAM-TV	Rochester	6	5
WRGB-TV	Schenectady	4	6
WSYR-TV	Syracuse	5	3
WDEL-TV	Wilmington	7	12

time, will be made available to commercial broadcasters.

VHF and UHF Assignments:

The table appearing elsewhere in this issue lists all cities to which VHF allocations are proposed, and the additional UHF allocations. At the previous hearing, there was some opposition to assigning VHF and UHF channels in the same area, but "many witnesses favored intermixture on the ground that it was impractical to avoid it; that UHF stations would be constructed in cities located within the service areas of VHF stations, and television viewers would expect their sets to receive both signals; and that receiver manufacturers would be obliged to build combination VHF-UHF receivers for such areas. . . .

"It is reasonable to assume that if the entire UHF band is allocated for regular television broadcasting, television receivers will be built to receive VHF and UHF signals. If intermixture were avoided, it would be necessary to limit many areas to one or two VHF stations, even though UHF assignments were available for those areas, and additional stations could be supported financially."

Principles of Priority:

The allocation of TV channels was planned according to the following principles of priority:

1. To provide at least one television service to all parts of the United States.
2. To provide each community with at least one television broadcast station.
3. To provide a choice of at least two television services to all parts of the United States.
4. To provide each community with at least two television broadcast stations.
5. Any channels which remain unassigned under the foregoing priorities will be assigned to the various communities depending on the size of the population of each community, the geographical location of such community, and the number of television services available to such community from television stations located in other communities.

Grades of Service:

The new proposal specifies only two grades of service. "Grade A service is so specified that a quality acceptable to the median observer is expected to be available for at least 90% of the time at the best 70% of receiver locations at the outer limits of this service. In the case of Grade B service, the figures are 90% of the time and 50% of the locations."

The required median field strengths in db above 1 microvolt per meter are specified for three groups of channels as:

Grade	No. 2-6	No. 7-13	No. 14-83
A	68 db	71 db	74 db
B	47 db	56 db	64 db

The permissible co-channel ratios in db of median desired field strengths to 10% undesired field strengths are specified at

Channels No. 2-13

Grade	Non-Offset	Offset
A	51 db	34 db
B	45 db	28 db

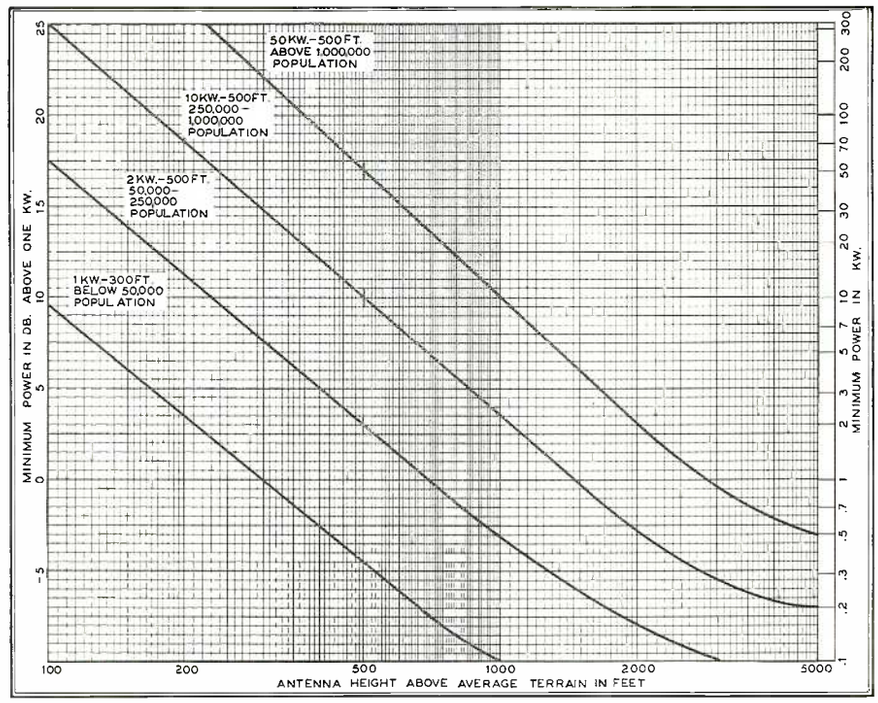
Channels No. 14-83

Grade	Non-Offset	Offset
A	53 db	36 db
B	45 db	28 db

The Commission has proposed the use of iso-service contours which express service in terms of the ratio between desired and undesired signals in db, or the minimum required signal levels in db above 1 microvolt per meter. This is to facilitate computation of service and interference field strength. The same terms can be carried over to the output of the transmitter, transmission-line loss, and antenna gain. Also, 1 db of power added at the transmitter produces 1 db increase in field strength.

The permissible adjacent-channel ratio of median desired to undesired field strength for both grade A and B services on all channels is 0 db.

Propagation charts for predicting service areas and interference have been worked out by the Engineering Department of the FCC, and are available on request. They are based only on propagation through the lower atmosphere. While it is recognized that interference at distances of 500 to 1,500 miles may occur, it is not practical to protect stations against F2 or sporadic E interference because of the limited number of channels available.



PROPOSED EFFECTIVE RADIATED POWER, AND ANTENNA HEIGHT ABOVE THE AVERAGE TERRAIN

Classes of Stations & Power:

Only one class of television station is proposed, with appropriate power ratings according to population or rural area coverage. This is a more flexible and practical plan than the original, rigid power requirements.

The minimum effective radiated power in db above 1 kw. is related to city population, exclusive of adjacent metropolitan areas, as follows:

Population	Min. Power
1,000,000 or more	17 db/500-ft. ant.
250,000 to 1,000,000	10 db/500-ft. ant.
50,000 to 250,000	3 db/500-ft. ant.
under 50,000	0 db/300-ft. ant.

FCC'S PROPOSED TV CHANNEL ASSIGNMENTS, MARCH 22, 1951

STATE	COM. VHF	ED. VHF	COM. UHF	ED. UHF	NO. OF CITIES	NO. OF STA.
ALA.	6	2	34	3	32	45
ARIZ.	12	2	15	0	22	29
ARK.	8	2	27	1	26	38
CALIF.	28	2	44	6	41	80
COLO.	7	3	25	1	23	36
CONN.	2	0	11	1	10	14
DEL.	1	0	2	1	2	4
D. C.	4	0	1	1	1	6
FLA.	18	5	29	4	29	56
GA.	13	2	35	3	37	53
IDAHO	14	1	12	1	22	28
ILL.	9	2	42	3	36	56
IND.	5	1	33	6	28	45
IOWA	10	2	42	4	38	58
KAN.	10	2	35	2	36	49
KY.	5	0	26	1	25	32
LA.	11	1	28	2	27	42
MAINE	8	1	18	2	20	29
MD.	3	0	8	1	7	12
MASS.	3	1	19	0	13	23
MICH.	17	0	42	6	40	65
MINN.	12	2	34	0	35	48
MISS.	7	1	27	4	28	39
MO.	14	3	34	2	30	53
MONT.	17	5	16	1	26	39
NEBR.	12	1	20	1	19	34
NEV.	13	1	7	1	16	22
N. H.	1	1	10	0	11	12
N. J.	1	0	8	0	8	9
N. M.	12	3	20	0	25	35
N. Y.	16	0	31	8	30	55
N. C.	11	1	32	7	36	51
N. D.	14	2	13	4	17	33
OHIO	13	0	37	7	35	57
OKLA.	9	2	39	4	38	54
ORE.	8	3	20	1	21	32
PENN.	8	1	40	3	31	52
R. I.	2	0	1	1	1	4
S. C.	6	1	18	2	20	27
S. D.	10	2	16	2	17	30
TENN.	11	2	36	2	33	51
TEXAS	43	7	115	11	114	176
UTAH	8	1	8	2	10	19
VT.	1	0	8	1	8	10
VA.	8	0	24	5	25	37
WASH.	10	3	27	1	24	41
W. VA.	6	0	13	4	16	23
WISC.	8	1	31	4	27	44
WYO.	9	1	17	0	23	27
TOTALS	**484**	**73**	**1230**	**127**	**1239**	**1914**
ALASKA	15	4	0	0	6	19
HAWAII	16	4	0	0	4	20
P. R.	8	1	0	0	5	9
VIR. IS.	3	0	0	0	2	3
GR. TOTAL	**526**	**82**	**1230**	**127**	**1256**	**1965**

Maximum effective radiated power proposed is:

CHANNELS	MAX. POWER
2 to 6	20 db/500-ft. ant.
7 to 83	23 db/500-ft. ant.

The accompanying chart, reproduced from the new proposal, shows values of effective radiated power and antenna height above average terrain. No minimum antenna height is specified.

Any station "may be authorized on appropriate application to increase its power to the maximum set forth above without the necessity of a hearing so far as interference to other stations is concerned. The use of antenna heights greater than 500 ft. above average terrain is encouraged as a means for improving the quality of service. If an antenna height greater than 500 ft. is used, the effective radiated power shall be limited to that value which will avoid interference within the Grade A service radius of any other station, either existing or provided for in the Table of Assignments, on the basis of operation of such station with the maximum power and antenna height of 500 ft. as set forth above."

Co-Channel Separation:

The 1949 proposal called for co-channel separation of 220 miles for VHF and 200 miles for UHF. It has been proposed that this could be reduced to 150 miles on VHF with offset-carrier operation. Now, recognizing that present propagation data is relatively meager, the Commission believes that a safety factor should be allowed to the extent of providing a separation between cities of 180 miles for channels 2 to 13, and 165 miles for channels 14 to 83, and a leeway in locating stations at a minimum of 170 miles on channels 2 to 13, and 155 miles on channels 14 to 82. This assumes offset-carrier operation.

Greater separations are provided in sparsely settled areas, and in the Gulf coast area and other sections where high levels of tropospheric interference may be encountered.

Adjacent-Channel Separation:

Under the present TV standards, adjacent-channel interference is considered objectionable when the ratio of desired to undesired signals falls below 6 db. It is now felt that it could be set at 0 db or −6 db. The Commission "is of the opinion that these separations should be based upon receiver performance which may reasonably be expected of manufacturers, and not on the characteristics of the poorer receivers."

Accordingly, the minimum adjacent-channel separation now proposed is 70 miles city-to-city or 60 miles station-to-station on channels 2 to 13, and 65 or 55 miles respectively on channels 14 to 83.

Receiver Interference:

It is proposed that an IF frequency of 41.25 mc. be used for both VHF and UHF receivers. This is now the RTMA standard for VHF. Accordingly, UHF stations 7 channels apart (42 mc.) are to be spaced by a minimum of 60 miles.

Intermodulation may prove more serious in the UHF band than has been the case on VHF channels. Thus, it is planned to space UHF stations in one city by 6 channels, and to separate stations by 20 miles if they are less than 6 channels apart.

To anticipate interference from sound and picture images on UHF, stations in the UHF band will be separated by 75 miles if they are 15 channels apart (90 mc.) in order to guard against picture image interference; and 60 miles, if they are 14 channels apart (84 mc.) to prevent sound image interference.

IF beat interference has been experienced when stations are 7 or 8 channels apart. Thus, UHF stations 8 channels apart will be separated by a minimum of 20 miles.

Offset-carrier operation has proved so successful in reducing co-channel interference that it will be used in the future on both VHF and UHF. On VHF, stations will be offset by plus or minus 10 kc., with a frequency tolerance of 1 kc. Specific values for UHF are to be determined at a later date.

From the foregoing, it appears that consideration has been given to practical matters in the new plan and, to that extent, it represents a substantial advance over the 1949 proposal.

MUSICAST STATIONS

While owners of radio sets are free to turn their sets off and on, stations must not sell time to people and then transmit signals that turn sets off and on so their sponsors won't have to do it manually. That, in effect, is what the FCC has told musicast stations WRLD Miami, WACE-FM Chicopee, WFMF Chicago, and KDFC Sausalito. Each station was told "to submit a statement showing how you intend to achieve compliance with all lawful requirements. The statement should be submitted on or before April 3, 1951." Further:

1. The Commission considers that musicast "arrangements must be considered to constitute an invalid abdication of your duty as a licensee to retain discretion, responsibility, and control, and to remain free to alter your service as the changing needs of the public in your area may require." It's hard to understand why selling time for musicasting is any different than for any other kind of broadcast programs.

2. Transmission of sponsorship and station identification announcements to the general public while eliminating them from reception by subscribers is in violation of the Communications Act, because it is contemplated that this information "will be transmitted to the station's entire audience; they admit of no discretion on the part of the licensees to introduce exceptions thereto for the benefit of subscribers to *special services* or other selected listeners."

Comment from one housewife who prefers musicast reception to most of the network programs: "The FCC must be trying to make itself as unpopular as our President!" Looks to us as if the Four Horsemen are riding again.

MINIATURIZED STEPPING SWITCH

DESIGN AND CHARACTERISTICS OF THE AUTOMATIC ELECTRIC SWITCH SMALL ENOUGH TO FIT A STANDARD RELAY CUT-OUT — *By* D. N. MacDONALD*

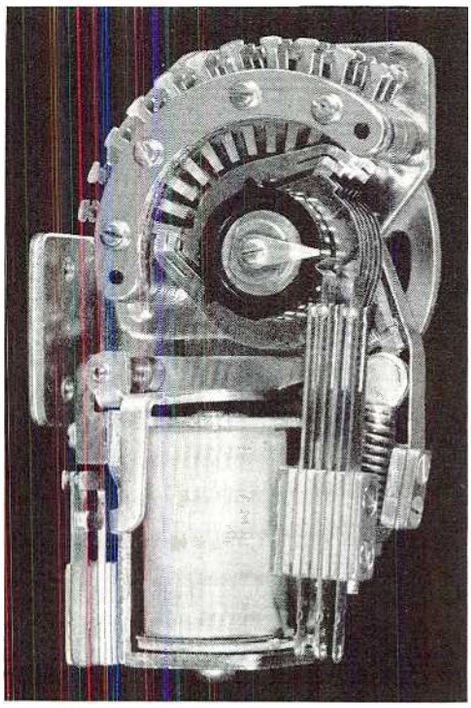


FIG. 1. THIS VIEW OF THE TYPE 44 STEPPING SWITCH IS A LITTLE LESS THAN FULL SIZE

THE trend toward miniaturization in electrical and mechanical equipment, so evident in recent years, has required an extensive study of methods for developing components which are not only compact but also capable of outperforming and outlasting their larger predecessors. As a result, it has now become possible to produce complex devices and mechanisms which would have been impractical heretofore due to physical size.

A number of these devices are sequential in nature, and require switching between a group of circuits to obtain successive steps of operation necessary to achieve the end result. Others require storage of information, frequently for long periods which may extend through a temporary power failure. Telephone-type rotary stepping switches, with their ability to select circuits from a group, under electromagnetic control, are ideally suited to many new applications, including the requirements of radio communication circuits. Until recently, however, the use of these switches has, in many cases, been limited by their large size in comparison with the reduced size of the other components of this type of equipment.

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Now, with the introduction of the new Automatic Electric Company's Type 44 rotary switch, a very compact, fast, and rugged device is available for the first time to fill this gap. The type 44 switch is unique in several respects. A three level switch is small enough to mount in the same panel space as a telephone-type relay, yet the bank has eleven positions (ten active switching points plus a home or off-contact position). Individual parts are of ample size to insure reliability and long life. In addition to the bank and wipers for primary circuit switching, off-normal, and interrupter spring assemblies are available for secondary or auxiliary circuit control.

The Driving Mechanism:

Operation of the switch is under the control of a single self-protecting magnet, which drives the wipers from one position to the next through a ratchet mechanism of advanced design. Energization of the magnet causes the armature to operate, compressing a driving spring and lifting the driving pawl into engagement with the proper ratchet tooth, which is held stationary by a leaf type detent spring. De-energization of the magnet initiates the step, when the armature is restored to normal under pressure of the driving spring, causing the pawl to advance the ratchet wheel and wiper assembly one step. Teeth on the armature engage the ratchet teeth at the end of the stepping stroke, thereby locking the wipers in the correct position on the bank.

This type of drive, first introduced on the type 45 rotary switch, has distinct advantages. Since the downward position of the armature is determined by the ratchet mechanism itself, no adjustable stops are necessary to set this position. Earlier drive mechanisms locked the ratchet in position and prevented it from overthrowing by wedging the pawl into the ratchet teeth through the use of a pawl-stopping block, with subsequent battering of the pawl tip at each step. In the new switch, the elimination of the pawl block and armature stop, with the adjustments and wear which they entail, reduces the maintenance necessary, and increases the life of the switch.

The two-piece frame is arranged so that the switch parts are mounted on only one side. In this way, it is possible to equip the same basic frame with banks of various level capacities. The bank is assembled on a square bank plate, to which are fastened the motor magnet frame and the various switch mounting brackets. A slot in the bank plate receives and guides the hub of the wiper assembly (carried on the motor magnet frame) to its proper position with respect to the bank. Similar slots are provided under the mounting screws on the motor magnet frame so that the motor magnet assembly can be removed for maintenance without disturbing the mounting or bank wiring. In the same manner a motor magnet assembly can be added to an idle bank for expansion of facilities. The T-shaped mounting-screw slots allow the motor magnet to be rotated after assembly, to center the wipers on the bank contacts.

Two different types of standard mounting brackets are available. Shown on the switch in Fig. 1 is a shelf-mounting bracket, normally used for mounting the switch parallel to a panel. A relay-type bracket which mounts the switch at right angles is shown in Fig. 2. It is slotted to allow the switch to be swung away from the panel to provide access to the bank terminals from the front, and to adjustment points when the switch is surrounded by other equipment. These brackets are attached to the bank plate in the same manner as the motor magnet assembly.

New Design Features:

The motor magnet frame, shown at the top of Fig. 3, carries the complete driving mechanism of the switch — coil, armature, assembly, driving spring, and the ratchet and wiper assembly — maintaining these parts in permanently correct alignment. In addition, the frame serves as a heelpiece to close the magnetic circuit between armature and coil, producing the highly efficient relay type of magnetic circuit which contributes a great deal to the high stepping speeds obtainable. A three-level switch operating automatically through its own interrupter springs has a normal speed in excess of 80 steps per second, due to the efficient magnetic structure, the small mass of the moving parts, and the careful matching of the driving spring to the motor magnet and the wiper load for efficient power transfer.

The type 44 switch is characterized not only by high speed operation, but also by exceptionally long service life.

To reduce wear to a minimum, the ratchet wheel, armature teeth, and pawl are case-hardened, and the pawl is made of abrasion-resisting alloy steel. The use of a bronze alloy pin as the pawl bearing, turning in a hardened bearing hole, and a hard stainless steel pin and die-cast bronze alloy yoke for the armature bearing contribute greatly to long life. The wiper assembly bearing is a case-hardened steel tube rotating on a hard-drawn stainless steel pin, which is undercut to provide a cavity for grease. The low-temperature grease with which the bearing is filled at the factory is usually sufficient for the life of the switch. The ratchet teeth are lubricated with a graphite and oil mixture chosen for its ability to stay in place at high speeds and to withstand large unit pressures. The same light yet tenacious oil is used without graphite for the armature and pawl bearings.

This careful choice of lubricants, and the elimination of the pawl stopping block, with its tendency to bind the pawl, enable switches of this type to perform normally at temperatures of −30°F. and lower.

Frequently, the determining factor in the life of a rotary switch is the wear at the tips of the wipers due to mechanical friction and erosion caused by electrical arcing which increases with the magnitude of current in the circuit being made or broken. Although the wiper assembly can be replaced if necessary, and the life of the switch extended by this means, it is obviously desirable to extend the life of the wiper assembly itself, and thus minimize the need for its replacement. To attain this end, this switch is provided with three sets of wiper blades for each level, instead of the customary two, and the bank contacts are arranged to occupy an arc of 120°. This arrangement in itself provides 50% greater life, besides resulting in a more compact mechanism. As a result of careful balancing of the life of these various components, switches on test regularly operate in excess of 20 million 11-step cycles or 220 million steps, while carrying relatively heavy electrical loads.

Of equal importance is the number and frequency of adjustments required during the life of a switch. Extensive tests have shown that on both the type 44 and type 45 switches, the only two adjustments that normally require attention are the tension of the driving spring (margining) and gauging of the interrupter springs. The driving mechanism itself is adjusted at the factory and should require no further attention. Tension of the driving spring is controlled by a micrometer screw, while the interrupter spring adjustment is a simple gap-setting to obtain smooth, self-interrupted stepping. Armature stroke is held within very close limits by the use of high precision parts, and need never be adjusted in the field.

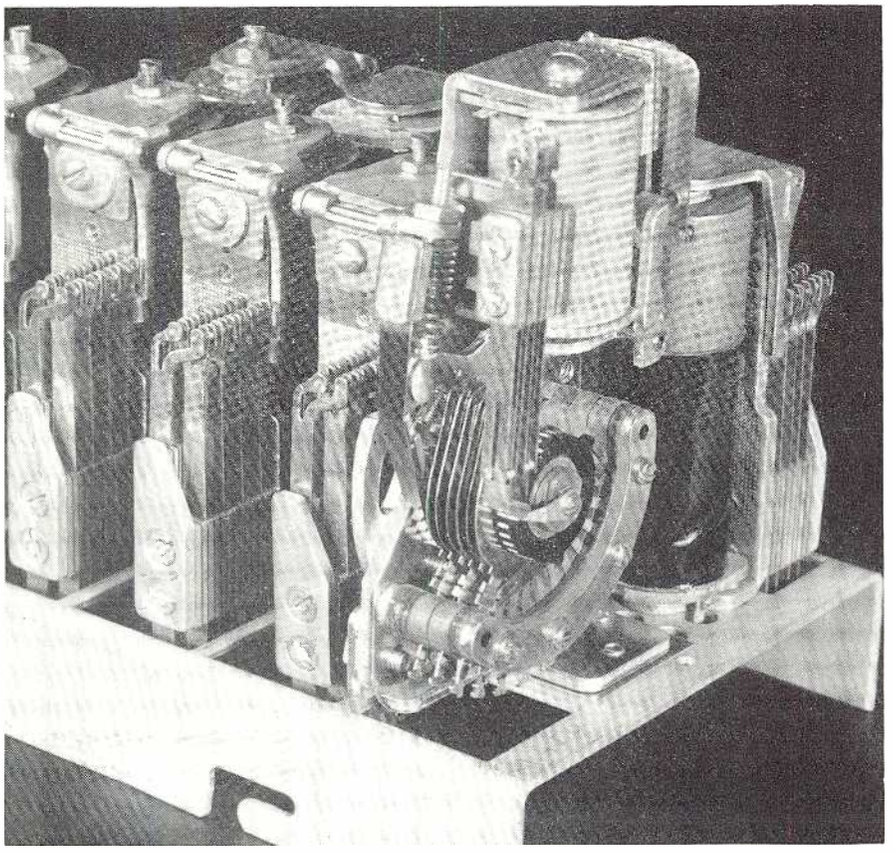


FIG. 2. SHOWING THAT THE SWITCH OCCUPIES ONLY THE SPACE OF A STANDARD RELAY CUTOUT

Bank and Wiper Assemblies:

To meet severe service conditions the bank and wiper assemblies are made up with spacers of a hard, moisture-resistant grade of laminated phenolic plate, coated with bakelite varnish. A baking and pressure cycle after assembly welds these parts together into a cemented unit structure. The number of components in these sandwich-type assemblies is held to an absolute minimum, and the tolerance on thickness of each held to especially close limits, so that all assemblies of the same number of levels are directly interchangeable with a minimum of misalignment.

These assemblies are designed to have a breakdown in excess of 1200 volts DC. The brush blades, which establish electrical connections with the wipers, are assembled as a part of the bank, and occupy the vacant or home position. Because the brushes contact the inside of the wiper blades directly, rather than a metal washer between levels, all the space between levels can be occupied by insulating material. This prevents high-voltage breakdown, while retaining the advantages of a considerably more compact assembly. The disadvantage of this construction in the past has been that while one set of wiper blades passed over the brushes, another was passing over the bank contacts. This resulted in a double load on the switch, producing uneven wear and operation of the driving mechanism and limiting the number of bank levels. The provision of a vacant bank position opposite the brushes has eliminated these difficulties. Electrically, such a home or off-contact position is usually desirable, but in order to provide circuit continuity over this position when necessary, the first two levels have home or 11th step contacts. The off-normal spring assembly, which operates in the 11th position, can also be used for this purpose.

Twin contacts are provided on all auxiliary spring assemblies, while on the wiper and bank circuits a total of 4 contacting points is provided for each connection, since the wiper blades have split tips, and each bank brush terminates in two contacting tips. The wiper springs have long, flexible trailing blades to eliminate bounce (with consequent undesirable circuit interruption) as the tips pass over the contacts at high speed.

The switch may have as many as 6 levels. A maximum of two bridging levels equipped with 11th step contacts may be assembled, adjacent to the ratchet wheel. The remaining levels are

non-bridging. Coils are available for operating voltages ranging from 6 volts DC. to 110 volts DC. They are self-protecting; that is, they can be energized continuously on rated voltage for any given period of time without overheating, and still operate the switch at the end of the period.

The high stepping-speeds attainable with the Type 44 switch are evident with both self-interrupted and external pulsing operation. Fig. 4 shows the operating range of a three-level switch on 46 volts DC. in response to external pulses. These curves correspond to an operate time of the armature of approximately 16 milli-seconds and a release time of approximately three milli-seconds, and show that speeds up to 30 to 40 pulses per second are possible, depending on the accuracy with which the pulse length can be held.

Performance and Application:

The type 44 rotary switch might well supplant the telephone-type minor switch and other switches with a limited number of contact points, in many telephone and industrial applications. Through the use of a uni-directional single-magnet rotary switch drive, it has been possible to eliminate the release magnet and mechanism of the conventional minor switch. This reduces the mounting space for comparable facilities to one-half that formerly required, and results in a more simple and rugged switch. The bank-level capacity is twice as great as that of the minor switch, which is limited to three levels, while the life expectancy is five or six times as great. The accompanying table gives comparative data on performance and life of the two switches, with some similar data for the Type 45 switch. The first five figures are obtained from the impulse range diagram 4, and are of interest in applications involving critical circuit timing. It should be noted that the maximum theoretical impulse speed is not a practical value because the pulse length cannot be held to the one critical value required, but it does provide a good performance index. This speed can be most closely approached by pulses of the ideal impulse ratio. The figures for the maximum time to home the switch represent the time required for the type 44 rotary switch to step self-interrupted from the 1st to the 11th or home position, and for the minor switch to be released from the 10th contact to its home position. As we have pointed out, any statement of life expectancy must be considered only as a guide, since the mechanical and electrical service conditions may radically alter the switch life. Furthermore, in most cases the useful life can be doubled or tripled by minor readjustment and parts replacement after the initial point of failure has been reached.

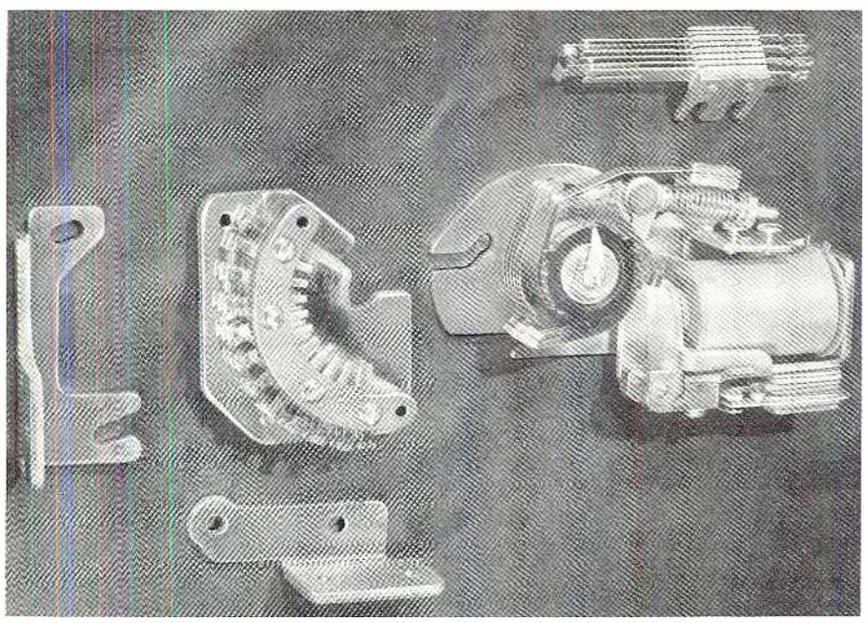


FIG. 3. COMPONENTS OF THE SWITCH. DISASSEMBLY DOES NOT AFFECT THE DRIVE ADJUSTMENT

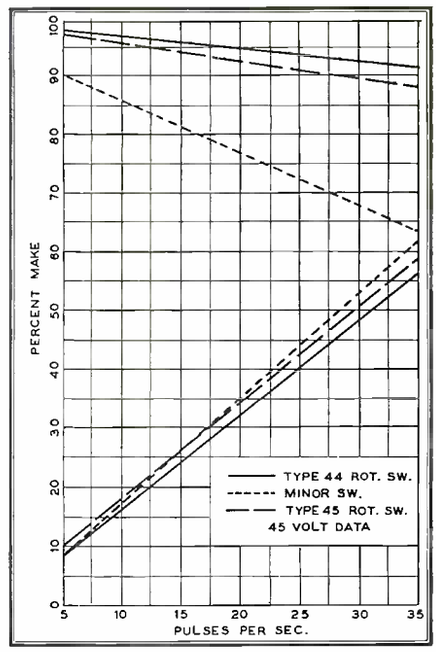


FIG. 4. OPERATING RANGE OF TYPE 44 SWITCH

Many mechanisms having the virtue of compactness are the result of reduction in size of component parts. For some applications such a technique may prove satisfactory. But where there are critical requirements of long life, rugged construction, and a high order of reliability, reduction of overall size must not be made at the expense of reduction in area of wearing and electrical contacting surfaces, rigidity of structural parts, or adjustment tolerances to the point where maintenance costs become excessive. This presents a much more difficult task. The type 44 rotary switch, based on a uniquely simple design, which is also the key to its exceptional performance, reconciles these apparently conflicting requirements.

PERFORMANCE CHARACTERISTICS OF STEPPING SWITCHES

Characteristic	Minor Switch	Type 44	Type 45
Motor magnet operate time	16 ms.	16 ms.	18 ms.
Motor magnet release time	11 ms.	3 ms.	5 ms.
Maximum theoretical impulse speed	35.5 pps.	53 pps.	43.5 pps.
Impulse range at 10 pps. in per cent make	74% make	80.5% make	77% make
Ideal impulse ratio	60% make	84.3% make	78.3% make
Average self-interrupting speed	not applicable	80 pps.	75 pps.
Maximum time for switch to home	58 ms.	110 ms.	334 ms.
46 volt motor magnet resistance	155 ohms	140 ohms	100 ohms
Minimum expected life	3½ million 10-step cycles	20 million 1/3 revolutions 11-step cycles	10 million ½ revolutions

MICROWAVE RELAY

Texas Eastern Transmission Corporation will have a Federal PTM multiplex relay system running from Shreveport, La., to Linden, N. J., a distance of 1,400 miles. Operating on 2,000 mc., the initial installation will provide 8 voice channels, with provisions for mobile radio communication, dispatching, telemetering, and supervisory services. If additional facilities are required, the system can be expanded to handle up to 23 channels.

JEREMIAH COURTNEY'S MOBILE RADIO NEWS AND FORECASTS

THE importance of the FCC's proposal to amend its industrial and land transportation radio service Rules so as to permit mobile relay stations, and the meaning of the limitation upon the use of these stations, are perhaps best outlined by specific illustration.

The ABC Canning Company (name fictitious, facts actual) harvests and packs peas grown in the rich foothills of the Oregon Blue Mountains between Pendleton and Milton. These peas must be moved to the packing plant within a few hours of vining in the field. Otherwise, an entire crop might be lost or, if saved, must be sold as an inferior grade. Vining equipment and trucks that break down in the field—and the roads in this country are not the Pennsylvania Turnpike or even the Boston Post Road—must therefore be promptly repaired. After vining, the flow of peas to the packing plant must be closely coordinated with the capacity of the plant.

A few hours' delay, in the field, at the packing plant, or en route between these points may wipe out a farmer's toil of an entire year. Two-way radio is naturally of high importance to such harvesting operations.

The ABC Canning Company operates in very hilly and uneven terrain. When it decided to use radio a year or so ago, it was necessary to locate the base station at a high elevation some distance from its offices at Milton and Pendleton. Accordingly, operational control stations in the 72-mc. band were constructed at Milton and Pendleton, this type of fixed circuit use being possible because of the absence of any interference to TV channels 4 or 5 in that remote agricultural area. An operational fixed repeater station was also located at the mountain-top location to relay mobile-unit transmissions to the two company offices. The specific frequencies used were 75.46 mc. for the Milton and Pendleton operational fixed control stations: 152.93 mc. for the mountain-top base station (actuated by the operational control stations) and the associated mobile units: and 72.10 mc. for the mountain-top operational fixed repeater station relaying the mobile transmissions to the packing plant offices at Milton and Pendleton.

*1707 H Street, N. W., Washington, D. C.

1950 was the first year the radio system was used throughout an entire harvesting period, and this was the first year the company did not have to destroy a single truck-load of peas. Operation without radio is unthinkable now. However, there is still a very serious limitation on the use of the present system: the hilly and uneven terrain seriously limits the car-to-car range.

The car-to-car radio range is an extremely important factor in pea-harvesting work, so important indeed that it controls the extent of the area the company can work. Pea-harvesting operations are compressed within a single month. The company field superintendents during this critical period, traveling from grove to grove, must be able to exchange information instantaneously. The information exchanged may lead to a transfer of equipment from one grove to another or to a decision to continue marginal harvesting at one location because of some special facts known to one field superintendent but not the other. The company's pea harvesting area of operation is thus economically confined to the area of its car-to-car coverage.

Proposed Radio Use:

The Commission's mobile relay proposal means that this particular company may now install a mobile relay station at the present mountain-top location which will repeat all car transmissions on a mobile frequency. The company will expand its territory of operations accordingly. In this particular case, the company's plans call for the retention of the operational control stations at the Milton and Pendleton offices on the present frequencies: transformation of the present base station to a mobile relay station operating on 154.49 mc. instead of the mobile frequency of 152.93 mc.; and deletion of the optional control repeater station. The mobile receivers will be changed from 152.93 to 154.49 mc., and the operational control receivers at the company offices from 72.10 to 154.45 mc.

General Effects:

Generally speaking, the Commission's mobile relay proposal means:

1. Operating or capital investment savings will not alone justify the use of a mobile relay station. Such stations will only be authorized upon a satisfactory showing of a substantial requirement for prompt mobile-to-mobile communication over ranges not now covered.

2. Only mobile units operating on frequencies above 47 mc. are eligible for mobile relay station use. This denies mobile radio station use to the inter-city bus, highway truck, and the urban transit radio services, all of which operate on frequencies below 47 mc. (The FCC proposal in terms denied mobile relay use to the low power industrial, taxicab, and automobile emergency services, as not applicable to the types of operation conducted by them.) The 47-mc. line of demarcation applies only to the frequency on which the mobile units transmit, and the mobile relay station receives. There is no prohibition against transmitting from the mobile relay station on a frequency below 47 mc. if the mobile service in question has a frequency assignment in that portion of the band.

3. Two mobile frequencies only will be assigned to any one user; one frequency for all the mobile units and the control stations of the system; and the second for all the mobile relay transmitters, attended or unattended.

4. The proposed Rules reflect no change in FCC policy on fixed relays. Users who now have operational fixed (control or repeater) stations are unaffected by this proposal. The next time it is necessary to renew or modify such an authorization, the FCC license section will change the classification of the authorization to that of fixed relay, the term henceforth to be used for the present operational fixed (control or repeater) stations. The term "central relay" is also dropped in favor of mobile relay.

5. The same station may operate in two classifications. For example, the office station may be a base station during the day and, by throwing a switch, a mobile relay station at night. Such a station would be classified as a mobile relay station.

6. The mobile relay station must incorporate a signal device coded to the associated mobile units received to prevent the actuation of the mobile relay station by undesired stations operating on the same frequency. This requirement is mandatory for frequencies between 47 mc. and 50 mc., but may be waived for those on the higher frequencies (152 to 162 mc.) upon a showing that the proposed station location is in an area free of undesired signals on frequencies which would activate the proposed mobile relay transmitter. This protective signalling device for the

(Concluded on page 38)

1: B. OF S. MOBILE PROPAGATION LABORATORY 2: HUGH ROBERTSON BREAKS GROUND FOR ZENITH PLANT 3: FIRE RADIO EQUIPMENT FOR PHILADELPHIA

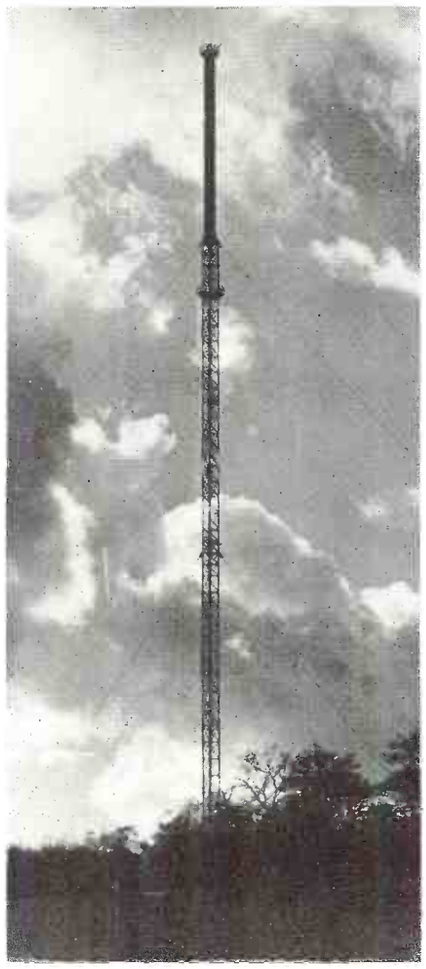
NEWS PICTURES

1. The Bureau of Standards now has a mobile propagation laboratory for use in conjunction with its ionospheric research program. It is being used to make soundings between the fixed stations engaged in this work, for which a world-wide chain of 60 observation points are being operated.

2. Executive vice president Hugh Robertson dug the first ground for the new 3-story plant that will add 453,000 square feet to Zenith's factory space in Chicago. When the building is completed next fall, about 1,000 people will be employed at this location.

3. Philadelphia has installed a very elaborate RCA radio system for fire control communication at the City Hall. In this picture, Edgar P. Grim, Chief of the Electrical Bureau is at the console. Left to right are RCA engineers Zappacosta, Culp, and Rammer; Frank O. Schierff, the Superintendent of Fire Alarm and Radio Systems; RCA representative Field; Anthony Repici, supervising radio technician of the new station; and communication equipment sales manager Reutter.

4. The British Broadcasting Company has erected this slotted VHF antenna for the comparative tests on FM and AM which are now in progress. Total height is 470 ft. Tests were made at low power by the BBC in 1945, but they were not considered conclusive. For the new project, an FM transmitter of 25 kw. output is being used, and an 18-kw. AM transmitter. The use of VHF broadcasting offers a solution to the bad interference from European stations.



4: BBC ANTENNA ERECTED FOR FM VS. AM TESTS

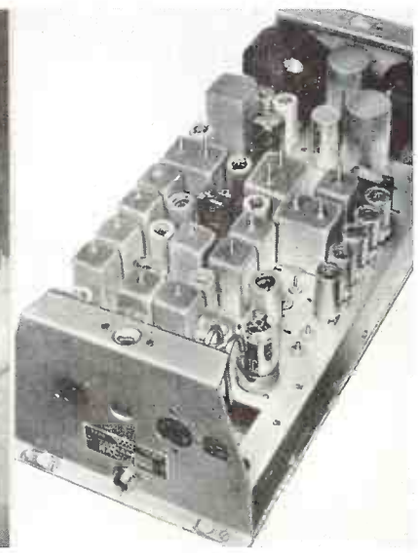
5. This very compact group of RCA equipment comprises a complete 250-watt AM broadcast station. The three racks contain a complete tape recorder, monitoring instruments and limiting amplifier, and the transmitter. The turntable and consolette are in the foreground. Together they make up a compact installation for a small station.

6. This industrial TV installation provides remote control of continuous steel billet casting at the Babcock & Wilcox Tube Company. Because the mold must be filled to an exact level, it was previously necessary to station a man at the mold, to signal the operator, 50 ft. away. This Utiliscope equipment, manufactured by Diamond Power Specialty Corporation, Lancaster, Ohio, enables the operator to observe the mold himself.

7. Polaroid Corporation, Cambridge, Mass., is producing 22½-in. Schmidt-type lenses for projection television. Cast from liquid plastic, they require no polishing or grinding.

8. Kaar Engineering Company, Palo Alto, Calif., has brought out this new mobile transmitter-receiver unit, rated at 10 to 12 watts output, and featuring low battery drain. Standby current is 6½ amperes at 6 volts, and 15 amperes during transmission.

5: PACKAGED AM STATION 6: TV MONITORS STEEL CASTING 7: GIANT PLASTIC LENS FOR PROJECTION TV 8: LOW-DRAIN MOBILE RADIO EQUIPMENT



FTB AIR-RAID ALERT ALARM

PART 3: DESCRIBING TWO TYPES OF AUDIO OSCILLATORS SUITABLE FOR GENERATING THE ALARM-CONTROL SIGNALS — *By* FREDERICK T. BUDELMAN*

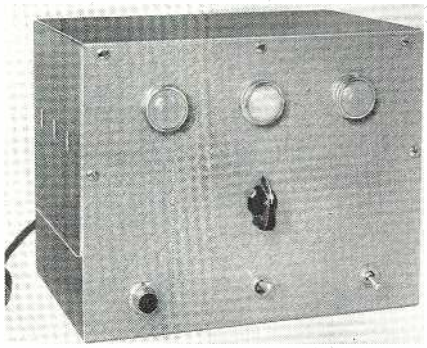


FIG. 1. COMPLETE OSCILLATOR AND CONTROLS

IN Part 1 of this series, the general method of operation of the FTB air raid alert alarm system was described in detail. The most complicated part of the system, the alarm indicator unit, was described in Part 2, with sufficient data to enable anyone interested to build the device and put it into service. The alarm indicator unit is really the heart of the whole system, because it contains the circuits which provide the all-important fail-safe features so essential to a dependable alarm system, and so lacking in the usual telephone and teletype warning nets.

*Vice President in Charge of Engineering, Link Radio Corporation, 125 West 17th Street, New York City.

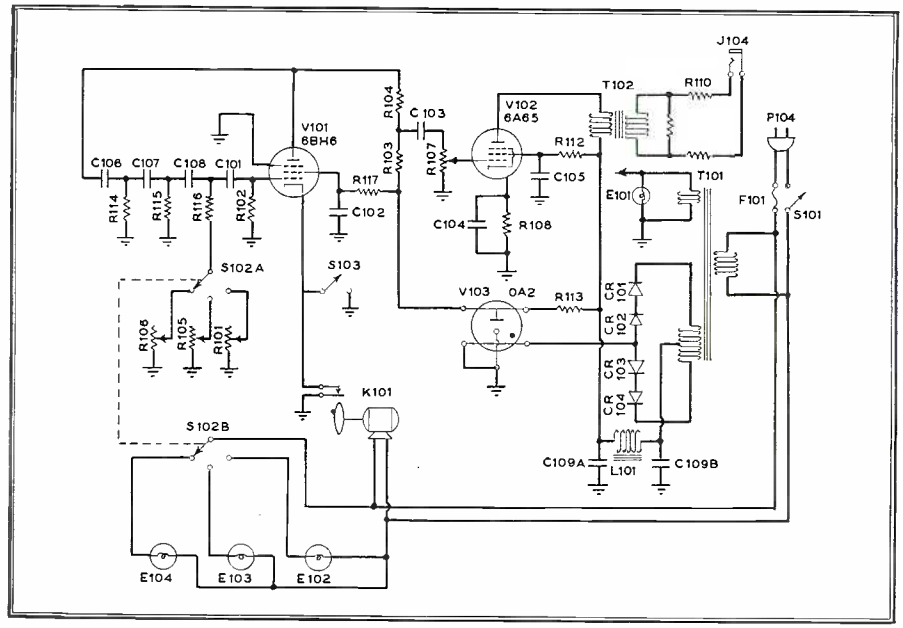


FIG. 4. A SIMPLIFIED VERSION OF THE OSCILLATOR FOR PRODUCING THE AUDIO CONTROL TONES

The remaining element of the system is an audio oscillator to generate the signals necessary for the proper functioning of the alarm indicator at the transmitting end of the circuit. Let us review, briefly, the requirements for the tone-generating unit.

1. It must be capable of generating, one at a time, three specific tone frequencies with an accuracy and stability of approximately 1%. These tone frequencies have been arbitrarily chosen, for the purpose of this description, as 2,600, 2,800 and 3,000 cycles, if the alarm signals are to be transmitted over a voice communication circuit, or 16,000, 18,000 and 20,000 cycles if the alarm signals are to be transmitted over an FM broadcast circuit.

2. The tone signals must be amplified to a sufficient level and at an impedance which will allow coupling into the radio transmitter audio circuits, or into a wire-line circuit without interfering with any other normal use of the communication circuit.

3. A timing device must be provided that will periodically key on one of the three tones, as selected, and at the same time key on the radio transmitter if it is not already on the air.

4. Provisions must be made for sending out alarm signals manually at will, to enable the transmission of an alert or all-clear signal without waiting for the automatic periodic tone transmission.

Figs. 1 to 3 show views of an experimental tone generator which fulfills all of these functions in a reliable manner. This unit was built to be as universal as possible and therefore utilizes three separate tone oscillators. Actually if the specific recommendations of this article are followed and 3 frequencies close enough together are utilized, only one

FIG. 2. REAR VIEW OF THE THREE-FREQUENCY OSCILLATOR, SHOWING THE MOTOR-DRIVEN SWITCH

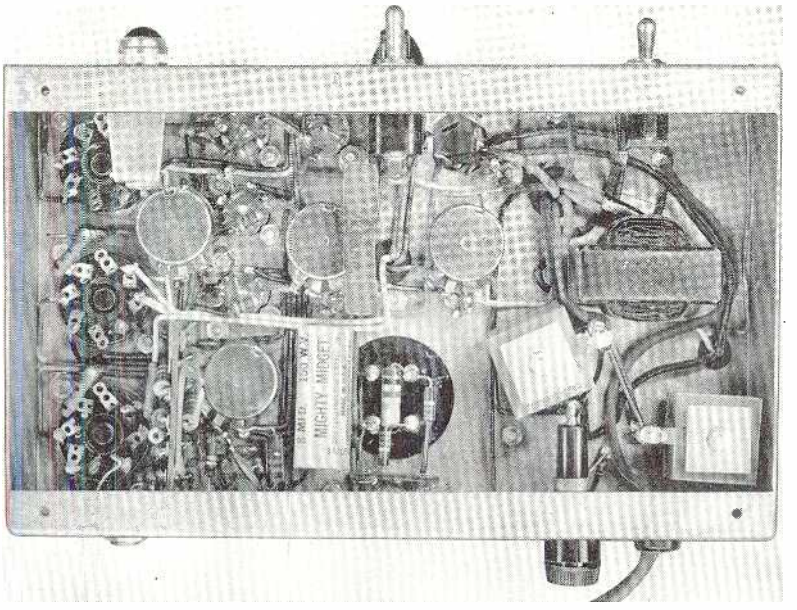


FIG. 3. BOTTOM VIEW OF THE CHASSIS. THE VARIABLE RESISTORS ARE ADJUSTED FROM THE TOP

tone oscillator tube need be utilized as shown in the schematic of Fig. 4.

Referring to the circuit diagram of Fig. 5, it will be seen that three separate tubes V101, V104, V105 are utilized in three separate R-C phase-shift oscillator circuits. For convenience and flexibility, the resistances and capacitances in the phase-shift circuits are assembled on an octal plug so that tone frequencies can be quickly changed or defective components easily replaced if desired. In the simplified version, Fig. 4, only one tone oscillator tube is utilized and the components are wired permanently into the circuit. Since the three frequencies under discussion (26,000, 28,000, 3,000 cycles) are relatively close together, the plug-in phase-shift components are the same for all three frequencies, the difference being taken care of by the vernier frequency adjusting controls R101, R105 and R106.

Only one tone frequency can be generated at a time, and this frequency is selected by rotary switch S102A, located on the front panel of the tone generator unit. This switch connects the cathode of the desired tone frequency oscillator tube to the manual (S103) and automatic (K101) keying circuit. At the same time it energizes one of the three colored lamps on the panel to provide a constant visual indication of the particular signal being transmitted and shown on all receiving alarm indicator units.

A portion of the sine-wave tone output from each of three tone oscillators is coupled to the master level control R107 and then to the grid of the tone output amplifier V102. The transformer T102 is designed for use between the plate and a 500-ohm line, and can be fed directly into a 500-ohm audio circuit if it is not being used for any other purpose, as, for example, if the tone generator unit were feeding a long two-wire circuit. Since it is expected that usually these tone signals are to be superimposed on circuits carrying, simultaneously, either speech or music, a bridging pad is connected in the transformer output circuit so that it may be connected across any 500 to 600-ohm audio circuit without necessitating any readjustments to that circuit. The resistor across T102 is of 500 ohms, providing a proper termination for the output transformer while the series resistors, of 2,200 ohms each, raise the bridging impedance to nearly 5,000 ohms. Sufficient audio capability is available to provide at least 2 volts across a 500-ohm circuit.

The power supply is straightforward except that selenium rectifier stacks of the readily available 75-milliampere type are shown in a full wave circuit connected so that at least 10 plates are in series on each side of the center. These are used for reliability and to reduce power drain, but any type of rectifier

(Concluded on page 31)

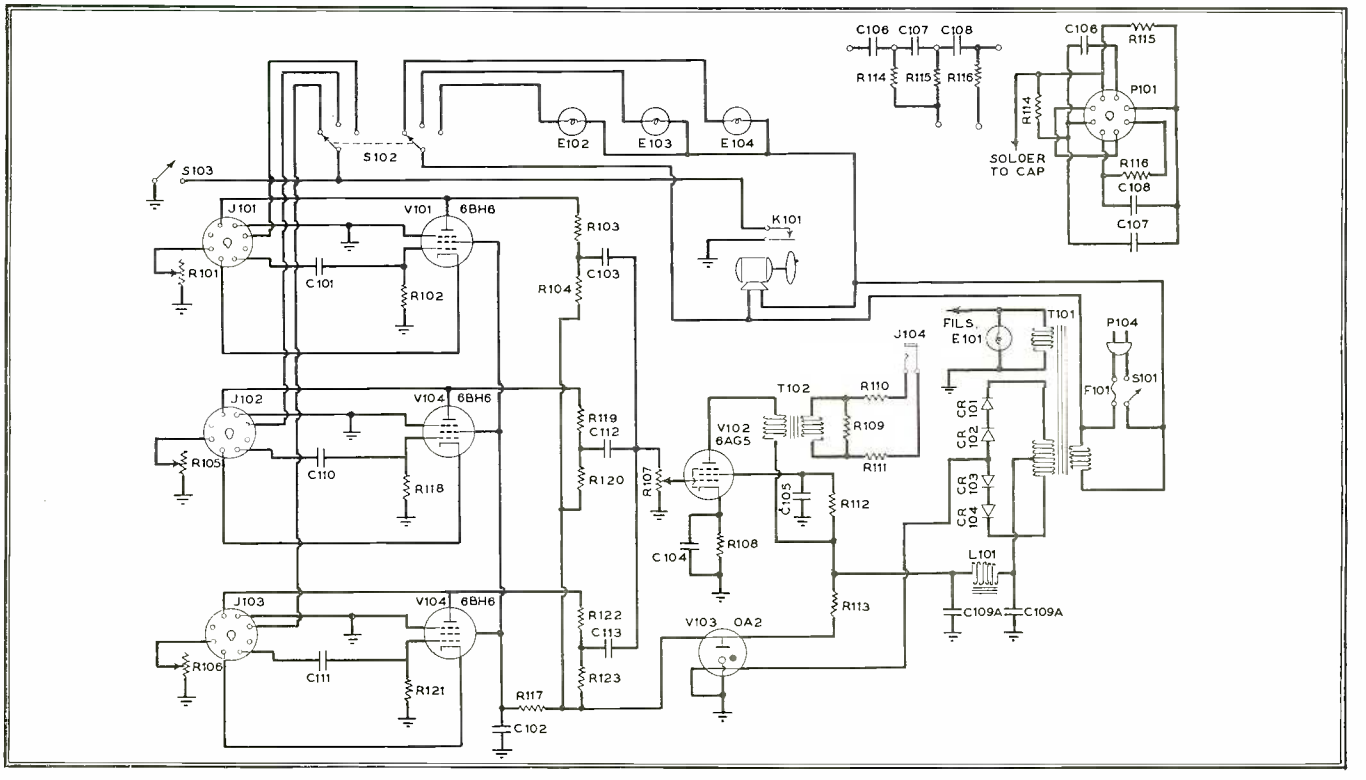


FIG. 5. A MORE ELABORATE AND FLEXIBLE TYPE OF CIRCUIT FOR THE AUDIO OSCILLATORS, IN WHICH THREE TUBES ARE EMPLOYED

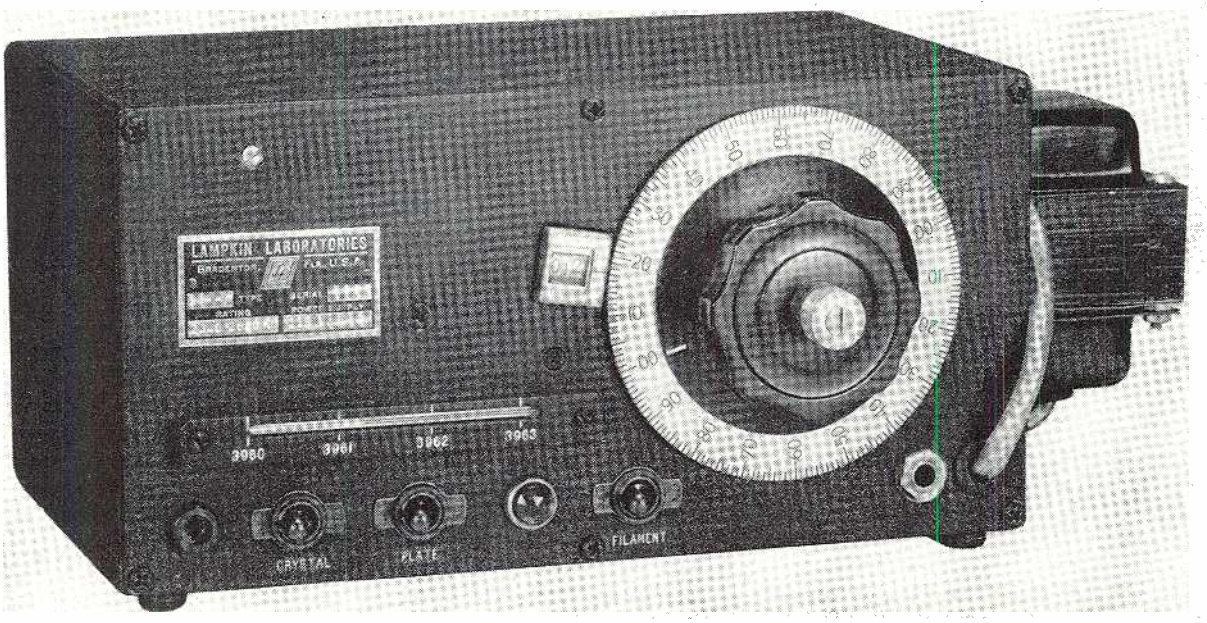


FIG. 2. THIS FREQUENCY METER HAS A THERMOMETER TO GIVE DIAL-READING CORRECTIONS FOR TEMPERATURE CHANGES AFFECTING THE CRYSTAL

MFM FREQUENCY METER

FREQUENCY METER, DESIGNED FOR THE COMMUNICATION SERVICES, WHICH INCORPORATES A NUMBER OF UNUSUAL FEATURES — *By* JAMES M. BROWN*

THE licensee of a mobile communication system can resort to several approaches in meeting FCC requirements for center-frequency measurement. If his system is large enough, he may have his own technical personnel, and all the equipment for installation and maintenance purposes. As an alternative, an engineering firm may be employed to do his installation and maintenance, and to make the periodic frequency checks, currently required every 6 months.

There are many small mobile radio systems in which expenditures for frequency-measuring equipment or for full-time technical personnel are not justified. The independent engineering firm fits very naturally into this picture.

Such organizations may be called on to measure any number of widely separated frequencies. For instance, police channels range anywhere from 1,600 kc. to 162 mc. Forestry assignments lie anywhere from 2,200 kc. to 172 mc.; aircraft from 278 kc. to 132 mc.; and marine installations from 100 kc. to 22 mc. Immediately it can be seen that the independent engineering organization has need for a frequency meter which is accurate, rugged, readily portable and, above all, versatile to the extent of measuring any number of frequencies in any part of the communication bands.

The Lampkin Micrometer Frequency Meter is designed to meet such requirements. Essentially, this instrument provides a continuously variable oscillator covering a small frequency range, and a highly precise, calibrated control. The oscillator is rich in harmonic output. Used with a wide-range, untuned detector, it covers a wide frequency range with high accuracy, but without the necessity of coil or crystal switching.

Indications are aural, with a heterodyne beat note heard in a set of headphones. A calibration chart can be made up for each frequency, reading directly in percent deviation from a specified frequency. There is no need to send a Micrometer Frequency Meter (MFM) back to the factory for additional calibrations. Calibration charts are a matter

*Lampkin Laboratories, Inc., Bradenton, Fla.

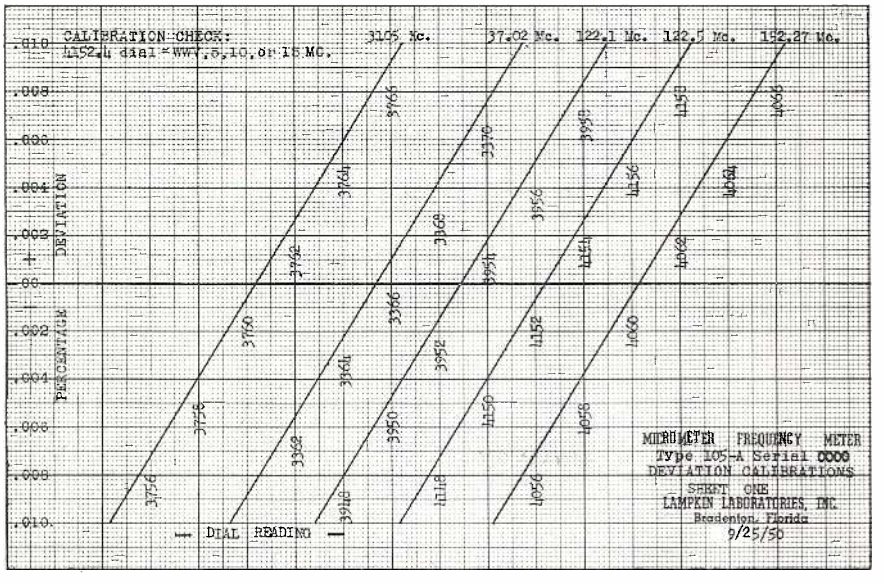


FIG. 1. DEVIATION CALIBRATION CHART, WITH CURVES FOR 5 SEPARATE OPERATING FREQUENCIES

of computation only; new ones can be made in the field, or obtained from the manufacturer. Fig. 1 illustrates a deviation calibration chart, having curves for five separate operating frequencies.

Fig. 2 shows the complete MFM. It is compact, measuring 5 by 10 by 6 ins. deep, and weighs approximately 12 lbs., including the built-in power supply. Because of these features, the MFM is readily adapted to portable usage.

Ratio-Coupled Oscillator:

Since the accuracy and performance of the MFM depends largely on the characteristics of the variable-frequency oscillator, it might be interesting to discuss it in some detail.

One part of the heart of the MFM is the ratio-coupled oscillator.[1] The general idea is to provide loose coupling between the tuned circuit and the oscillator tube. This can be accomplished inductively, as in the ratio-coupled circuit; capacitively, as in the Clapp circuit[2]; or through mutual inductance.

The important advantage of loose coupling is that the oscillation frequency is chiefly determined by the constants of the tuned circuit, and is influenced less by the variables of the oscillator tube. The tuned circuits can be made stable to a few parts per million, through mechanical design. By loose coupling to the oscillator tube, all changes in tubes themselves, in tube electrode voltages, in tube temperature or interelectrode capacity, and in socket or wiring capacity have 10 to 20 times less effect on frequency than in more conventional oscillators. For instance, the ratio-coupled oscillator in the MFM shifts frequency less than 1 cycle per megacycle for 1 volt change in line supply, anywhere from 100 to 130 volts.

Micrometer-Capacitor:

The other part of the heart of the MFM, and the component from which it derives its name, is the micrometer capacitor. This element, stripped of the dial mechanism, is shown in Fig. 3. The parts, starting from the inside, are: a machinist's micrometer head and spindle, a conically-tapered rotor, a stator, a pad ring, and a support ring which holds the pad ring and stator in place. The stator is electrically hot, supported on Isolantite beads through holes in the pad ring. All other parts are grounded.

It requires over 40 turns of the micrometer spindle to move the rotor from a fully engaged position to a fully disengaged position. Rotation from one extreme to the other causes a change in capacity of 1.32 to 1, maximum to minimum. This change is reflected in a 1.15-to-1 frequency range. Coupled to the micrometer spindle is a 4-in. dial, etched with 200 divisions around its circumference. The dial readings are spread out over more than 42 ft. of scale length, since the dial goes through 40 revolutions, tallied on a Veeder counter at the side. With this scale length it is possible to reset to a given frequency to within 5 parts per million, or 0.0005%.

The pad ring and the heavy support bars are composed of brass and steel sections, copper-plated to prevent corrosion. The differences in thermal expansion of brass and steel act to give very nearly a zero temperature co-efficient.

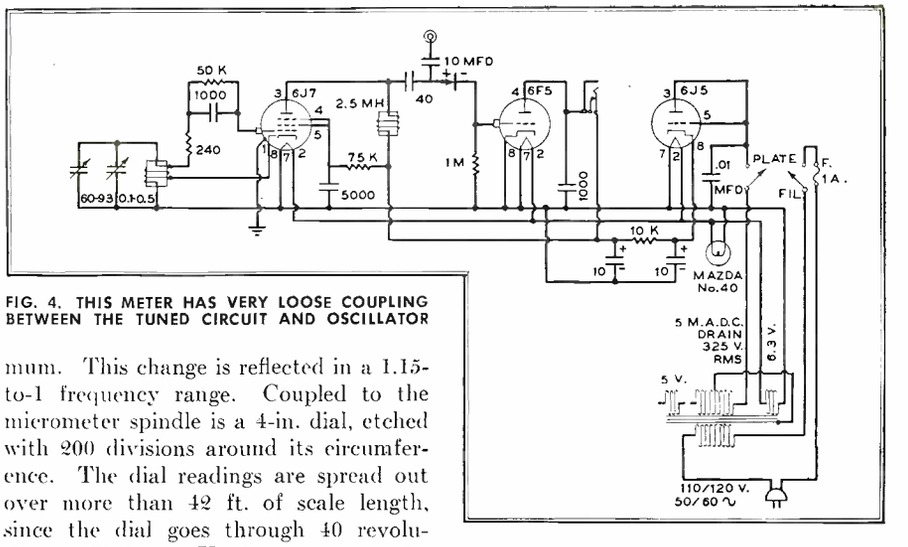


FIG. 4. THIS METER HAS VERY LOOSE COUPLING BETWEEN THE TUNED CIRCUIT AND OSCILLATOR

Oscillator Inductance and Detector:

The oscillator inductance is wound on a 6-ribbed polystyrene form. When wound, the wire takes on a form part way between a hexagon and a circle. Radial and axial thermal expansion of the coil form, coupled with linear expansion of the wire, serve to vary the effective diameter of the coil, and thus produce a very low temperature coefficient of inductance. The overall VFO coefficient is less than 4 parts per million per degree Centigrade over normal room-temperature range.

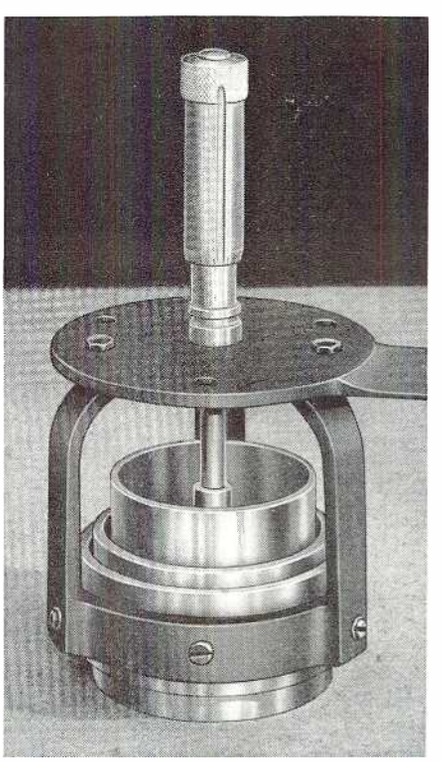


FIG. 3. CONDENSER AND THE MICROMETER DRIVE

The output of the VFO and the signal to be measured (picked up from an antenna) are fed into a conventional triode grid-leak-type detector. As shown by the diagram in Fig. 4, there is no attempt to tune the input or output of this detector, and for this reason it has a wide effective operating range. A pair of headphones are connected directly into the plate circuit of the detector for aural indication.

Crystal Calibration:

The crystal calibrator circuit is quite conventional, using the crystal in parallel with an oscillator tuning condenser as described by W. G. Cady.[3] In most crystal oscillators where accuracy is required, an oven is employed to minimize the effects of frequency drift due to temperature variation. In the MFM, no attempt is made to keep the crystal at a constant temperature. Thermal drift is compensated for in a unique manner.

The alcohol thermometer mounted on the front panel is used to standardize an MFM with a crystal calibrator. The reading of the thermometer, whatever it may be, is given in dial divisions. The procedure is as follows: Set the VFO dial at the observed reading, turn the crystal switch on, and adjust the VFO for zero beat against the crystal by means of a small trimmer capacitor. Next, turn the crystal switch off, and the standardization is complete.

The panel thermometer, calibrated in dial divisions, is mounted in thermal contact with the crystal. When a temperature change occurs, there is an accompanying change in the crystal-oscillator frequency. The thermometer automatically gives this new frequency in dial divisions, rather than in degrees Fahrenheit or Centigrade.

This simple technique eliminates both

[1] "An Improvement in Constant Frequency Oscillators" by G. F. Lampkin, *Proc. IRE*, March, 1939.

[2] "An Inductance-Capacitance Oscillator of Unusual Frequency Stability" by J. K. Clapp, *Proc. IRE*, March, 1948.

the original cost and the maintenance expense of a crystal oven. It has the additional advantages of being fool-proof, space-saving, and weight saving. The overall calibrator accuracy is within 0.0005%, or five parts per million.

Frequency Range:

The fundamental range of the standard MFM models is centered on 2,500 kc. The type 103 and 103-A meters do not contain a crystal calibrator, but are designed to be standardized at the same point by means of a radio receiver tuned to WWV. Either WWV or the internal crystal-controlled oscillator can be used to calibrate the types 105 and 105-A.

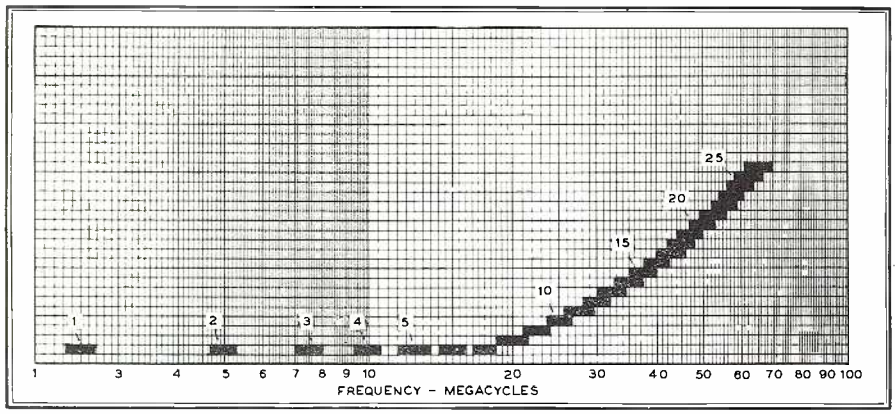


FIG. 5. SHOWING HOW THE TUNING RANGES OF THE HARMONICS BEGIN TO OVERLAP AT 16 MC.

While the fundamental-frequency range is restricted to 2,330 kc. to 2,670 kc., the harmonics begin to overlap at about 16 mc. and up, as can be seen by Fig. 5. This does not mean that the MFM is useless below 16 mc., however. By utilizing the harmonics of the transmitter which is to be measured, the lower limit of operation is 100 kc.

For instance, let us say a transmitter is operating on 450 kc. The 11th harmonic of the transmitter occurs at 4,950 kc. and will beat with the 2nd harmonic of the MFM when the MFM fundamental is set at 2,475 kc. At this point it would be wise to consider the fact that the 11th harmonic of the transmitter is not radiated into space to any appreciable extent. For this reason the MFM has continuous coverage only in the immediate vicinity of the transmitter. Signals picked up on a receiver can be measured when they fall within the fundamental or harmonic range of the MFM.

The upper frequency limit is governed chiefly by the harmonic output of the ratio-coupled oscillator. Harmonics as high as the 70th are readily used, which puts the upper limit at 175 mc.

Accuracy of Measurement:

In an instrument such as the MFM, there are many factors which must be investigated to achieve high accuracy. As a corollary, many factors contribute to the net error.

One of the possible sources of error in the MFM is that of tracking. The mid region of the dial is highly accurate, since the center is standardized against WWV or the crystal calibrator, but the error at the far ends of the dial may approach as much as 0.005% in extreme cases.

By restricting operation to within 50 kc. either side of the 2,500-kc. check point, this error is effectively minimized. This restriction can be met on all transmitters whose frequencies lie above 70 mc., because the MFM harmonics begin to overlap at this frequency; and the restriction can be met on about one-half of all frequencies below 70 mc.

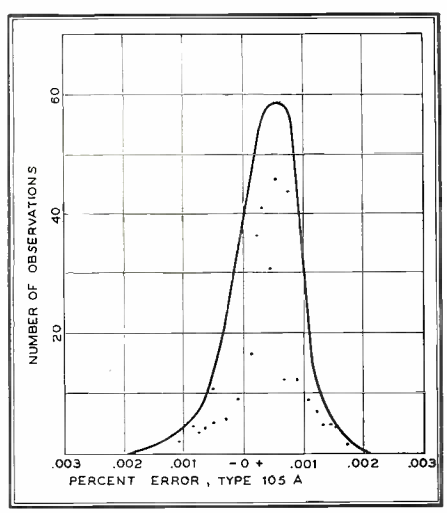


FIG. 6. PLOT OF ERRORS IN 500 OBSERVATIONS

Extensive tests were performed under actual field conditions, to provide data on which to base a guarantee of accuracy. Over 500 separate observations were made, covering several months time, on several different meters, in different parts of the country, and by six different observers, three of whom were skilled, and three unskilled. The results of all these tests are given graphically in Fig. 6. The horizontal scale represents the actual error of a particular reading, and the vertical scale indicates the number of measurements which showed that value of error.

By this chart it can be seen that the worst error recorded was 0.0017%, and that 90% of all measurements were accurate to within .0010%. In view of these tests, the accuracy of all MFM models is guaranteed better than 0.0025% when the fundamental falls within 50 kc. of the check point, and 0.005% when it falls within 100 kc. of this point.

Frequency Measurements:

Because of its inherent characteristics, the MFM is used in some very interesting applications. For example, Clair Watson, whose picture appeared on the front cover of RADIO COMMUNICATION last November, has occasion to work on many varied frequencies in the northern Pennsylvania area. Some of them are 2,118 kc., maritime mobile; 2,182 kc., Great Lakes marine calling frequency; 4,422.5 kc., ship-to-shore; 30.58 mc., special industrial; 155.01, 155.13, and 155.61 mc. police; 158.13 mc., electric power; four taxicab frequencies from 152.27 through 157.65 mc.; and others, for a total of 25 channels.

The police department of a major city on the West Coast operates an MFM with calibration curves for 29 frequencies. These range from 1,730 kc. radiophone, into the zone and interzone telegraph frequencies from 2,804 to 7,935 kc., through seven phone channels in the 30 to 50-mc. band, one in the 70 to 72-mc. band, and a dozen or so between 152 and 162 mc.

Until recently, the record number of frequencies for an MFM was held by one of the large petroleum companies, with 42. The lowest frequency is 388 kc., for aeronautical navigation, and the highest is 153.50 mc. for checking an industrial power service. Now one of the large scheduled airlines has stolen this record, with an MFM having 55 curves from 212 kc. to 131.3 mc.

Noteworthy also are other applications of the MFM. It is used as the modulating oscillator in microwave frequency standards, and to span the gap between discrete crystal frequencies, producing, after multiplication and filtering, output voltages of 100 mc. to 10,000 mc.

Another application, important to service engineers, is receiver alignment. While the FCC has tried in the past not to make alternate-channel assignments in any one geographical location, the number of requests for operating channels precludes such practice in the future. To solve this problem, manufacturers are tending to more selective receiver design. The receivers are crystal-controlled,

(Concluded on page 30)

[a] "The Piezo-Electric Resonator" by W. G. Cady. *Proc. IRE*, April, 1922.

Radio TOWERS

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★ TV-FM SUPPORT TOWERS
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SIOUX CITY 6, IOWA, U.S.A.

FIG. 3. ONLY THE TUNING MECHANISM AND RF INDUCTORS HAVE BEEN MOUNTED IN THIS VIEW

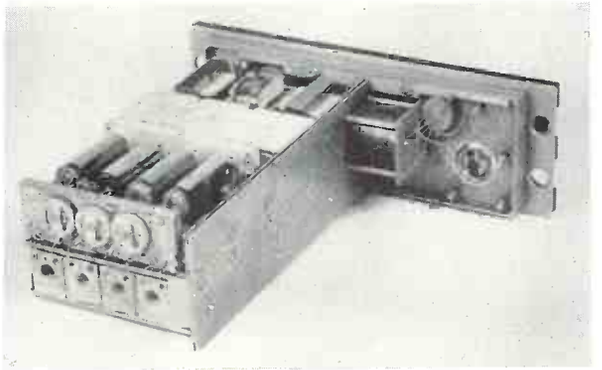
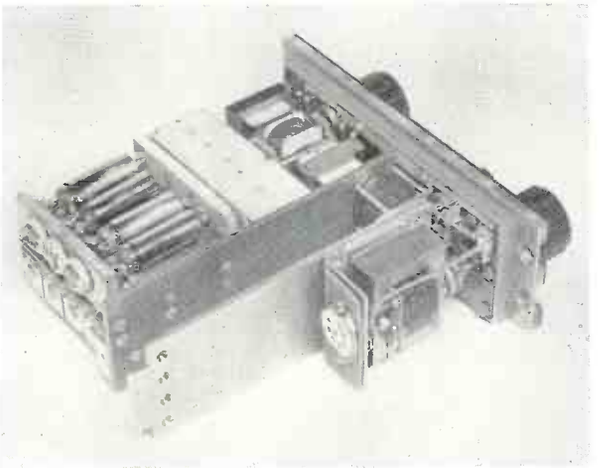
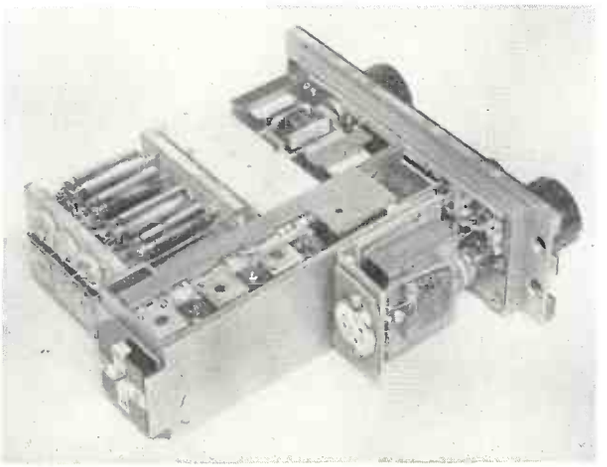


FIG. 4. THE RF AMPLIFIER SECTION AND THE POWER FILTER ASSEMBLY HAVE BEEN ADDED



FIGS. 5 AND 6. THESE SHOW SUBSEQUENT STEPS IN ASSEMBLING THE SUBMINIATURE RECEIVER



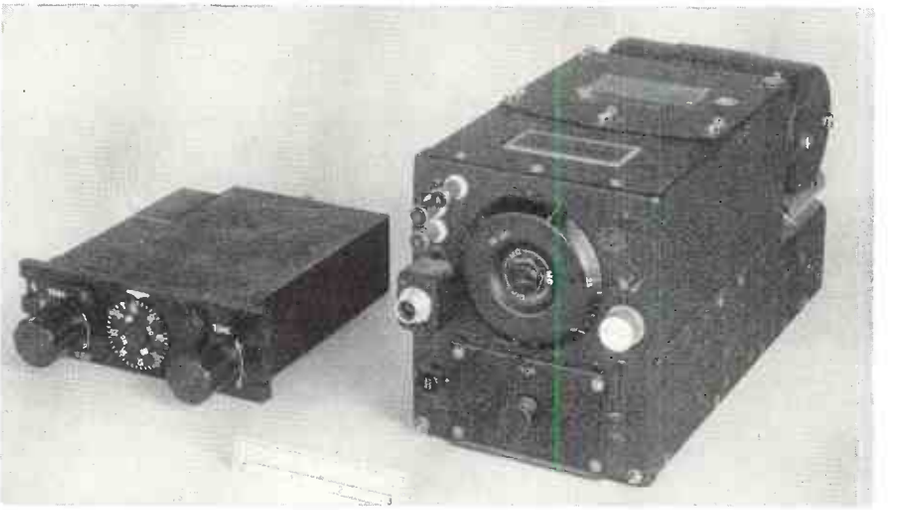


FIG. 1. THE SUBMINIATURIZED RANGE RECEIVER, AND THE EARLIER MODEL WHICH IT REPLACES

Size of Radio Range Receiver is Cut 78% by

SUBMINIATURIZATION

DESIGN TECHNIQUES ADAPTABLE TO COMMERCIAL EQUIPMENT ARE REPRESENTED IN THIS NBS UNIT

MINIATURE and subminiature radio design practices, stimulated by the space and weight limitations of military ground and aircraft service, are introducing new features that are just now coming to be reflected in commercial communication equipment. An example of what has been done for the Signal Corps is illustrated in the photograph of the AN/PCR-10 equipment, on the front cover of this issue. Another is the 12-tube radio range receiver shown here, developed for the Navy Bureau of Aeronautics at the National Bureau of Standards by Gustave Shapiro and his associates.

Fig. 1 gives a comparison of size between the new model, occupying 55 cubic inches, and its predecessor, of 300 cubic inches. The front panel is 5¾ by 1⅞ ins., and the case is 5⅛ ins. deep. Within that space are the complete components for a receiver with continuous tuning from 190 to 550 kc., having a sensitivity of 5 microvolts for 6-db signal-to-noise ratio, and a power output of .1 watt.

The circuit, shown in Fig. 2, is comprised of 2 tuned RF stages, a mixer, local oscillator, 2 IF stages on 135 kc. with a bandwidth of about 2 kc., detector and AVC diodes, beat-frequency oscillator, an audio stage, and a push-pull parallel audio output. All stages operate with 26 volts DC on the heaters, screens, and plates. That explains the use of four subminiature tubes in the audio output stage.

Details of the internal construction can be seen in Figs. 3 to 6. The receiver is made up of 7 separate sub-assemblies, an arrangement which speeds factory production and simplifies servicing. In Fig. 3, the mechanical tuning assembly and the RF inductors are in place. The RF amplifier and power-filter units are added in Fig. 4. Next come the output transformer, potentiometer, switch, and associated hardware, Fig. 5. Finally, the IF assembly and input-output connector, Fig. 6, complete the receiver up to the point where it is put in the case, the air pumped out and replaced with nitrogen, and the case is sealed to the front panel by a soldered copper band. When necessary, the band can be peeled off with a key, just as coffee cans are opened.

The hermetic seal not only provides protection against moisture and contamination, but it permits the elimination of protective coatings on the components. The latter is a space-saving consideration in miniaturized construction, while the use of nitrogen prevents oxidization.

Of course, it is necessary to have the shafts of the two front-panel controls sealed hermetically. This proved to be a serious problem, but in the end it was solved by the simple expedient of using commercially available rotary seals of the wobbling-bellows type. They were too large to go inside the unit, but they could be recessed under the control knobs, since the latter are large enough for an operator to manipulate them

(Concluded on page 30)

Don't Underestimate the Growing Opportunities in

RADIO COMMUNICATION

Here Are Some Facts about This New Business:

A considerable part of the letters we receive at the Cleveland Institute of Electronics comes from men now engaged in servicing home radio sets, who want to know about getting into radio communication work. Here is a typical inquiry:

"I have about reached the limit of what I can earn from installing and servicing radio and TV sets. It looks to me as if I must make a change if I'm ever going to increase my income by any substantial amount. Can you tell me about the opportunities in radio communication, and how I can get into it? I've had plenty of experience with radio circuits and basic service and testing. What more do I need?"

Looking for a Chance to Capitalize on Your Ability?

Getting into the communication field is a logical step of advancement for an experienced serviceman. Competition is keen in the home set business. A man may earn a little more if he can work faster, but there is a practical limit to the number of jobs he can do in a day.

Exceptional skill isn't greatly appreciated and there is not much chance to broaden out and gain added experience when you stick to work which, over the years, is a repetitious grind.

Opportunities Unlimited in Radio Communication

When you think of making a change, you naturally wonder: "Am I too late? Sure, the men who got in early are doing well. But what are my chances of getting ahead rapidly *now?*"

Here are some facts about the radio communication field: You *can't* be too late in a business that is *just starting*. Many men think of radio communication only as a police service. To be sure, that is where its possibilities were first demonstrated. But imagine having charge of the system that the Yellow and Checker Cab Companies are preparing to install in Chicago, with 8 fixed stations and mobile units in 3,600 taxicabs!

Think of the pipeline relay systems, now under construction, with 6 to 20 multiplexed channels operating over distances of 500 to 2,000 miles. And the railroads, currently erecting hundreds of wayside stations and installing thousands of mobile units on locomotives and cabooses.

These are only part of an expansion so great as to swamp the FCC under a daily flood of applications for new systems and added facilities for truck fleets, big construction projects, telephone companies, logging operations, and gas and electric power companies.

How to Make a Fast Start

Men who have been pushed up the line into high-salaried jobs as supervisors of big radio systems nearly all started on installation and maintenance work. They were able to start that way for just one reason: They *already* had their FCC tickets as licensed radiophone operators. Otherwise, they wouldn't have had a chance, because no man can do installation and maintenance work involving frequency adjustments until he has passed the FCC exam, and has received his operator's license.

Once you have that ticket, you can start quickly and move ahead fast, because the demand for men licensed to handle the installation and maintenance of communication equipment far exceeds the supply now, and it is growing day by day.

Having taken that initial step, you'll find that this field is truly Opportunity Unlimited.

Preparation Is as Easy as It Is Inexpensive

The Cleveland Institute of Radio Electronics will furnish you with the instruction necessary to pass the FCC examination. The cost is $89.75 in money, and 2¼ hours a day of your time for 12 weeks, or 3½ hours for 8 weeks. You may be able to reduce the time, but that has been the rate for most CIRE students.

Now, suppose you don't pass the exam the first time? That rarely happens, but if it should, CIRE guarantees to give you whatever further instruction you need to take the exam and pass it *with no additional expense to you!*

The only way you can lose is by passing up the opportunities available to you now in radio communication. Your first move is to fill out and mail the coupon below.

Cleveland Institute of Radio Electronics
Communication Desk No. 7
4900 Euclid Ave., Cleveland 3, Ohio

Please forward enrollment application for CIRE Course preparatory for FCC 2nd class radiophone operator examination. My deposit to the amount of $10 is enclosed. If you reject my qualifications, you will refund this amount at once. If you accept my application, I will send you the balance of $79.75 to cover the total cost of the Course, subject to the guarantee that:

1. My total remittance will be refunded in full if, for any reason, within 5 days after receipt of the first group of study material, I am not completely satisfied.

2. If I do not pass the FCC examination after completing the course, CIRE will provide additional instructions, without further charge, until I do pass the FCC examination.

Name .....

Address .....

.....

Note: This CIRE Course is approved for Veteran Training under the GI Bill.

MFM FREQUENCY METER

(Continued from page 26)

fixed-tuned, and selectivity can be such that the response is down 6 db at 15 kc. either side of center frequency. Such selectivity, while it helps solve the problem of adjacent-channel interference, provides a headache for the operating personnel who must keep the receivers in alignment, since mistuning by more than 5 kc. (0.0033% at 150 mc.) from the transmitter, can cause noticeable degradation in system performance.

Under this set of conditions, the MFM is a very useful tool. It provides a highly accurate weak-signal source of unmodulated RF power, which can be used to match the receiver exactly to the transmitter frequency, after rough alignment has been accomplished. Tuning indication for this fine adjustment is obtained by measuring the DC current in the limiter or discriminator circuit with a microammeter.

A very important feature is the fact that the MFM can be checked easily in the field against WWV. The very fact that the MFM can be checked with WWV, and corrected if need be, allows it to be used in ascertaining the accuracy of other types of frequency meters, particularly the fixed-frequency, crystal-controlled types, which cannot be checked against WWV in the field.

MINIATURIZATION

(Continued from page 28)

without removing his gloves. One knob is for tuning, while the other as a combined gain control, power switch, and on-off switch for the beat-frequency oscillator.

Tuning requirements called for frequency variation proportionate to the tuning control angle. This was difficult to accomplish in such limited space. Since slug tuning was to be employed, a variable-pitch screw drive was found to be the best method of adjustment. These screws were readily produced on a standard lathe fitted with a cam attachment devised by Robert O. Stone, of the NBS staff.

Because of the high temperature inside the sealed case, it was necessary to depart from conventional practice in many respects. The newly-developed ferrite-base material was used for the tuning slugs because it is more stable at high temperatures than powdered iron. Since it was expected that production control of this new material might present a difficulty, mechanical means were provided in the tuner to compensate for any non-uniformity of the core material.

Capacitors of the tantalum electrolytic type are used for the large values, and glass dielectric capacitors for bypassing. Both steatite and silicone-impregnated fibre glass serve as insulating materials. The two AF transformers and two line-hash filter chokes are wound with ceramic-insulated wire, insulated with high-temperature materials, and are impregnated with silicone varnish.

The miniature gain control has a high-temperature, adhesive-tape resistor, developed by the NBS. The tape is applied around a glass cylinder 3/16 in. long and 1/3 in. in diameter, on which 120 axial lines of silver paint were deposited to form commutator segments. A precious-metal brush makes contact with the projecting ends of the silver lines.

To facilitate replacement of the four output tubes, and to reduce the generation of heat inside the case, these tubes are made up into a unit that plugs into a setback outside the case.

Double-tuned IF transformers measure only ½ by ½ by 1⅜ ins. They have permeability-tuned inductors of about 2.8 millihenries, with Q's of 70 at 135 kc.

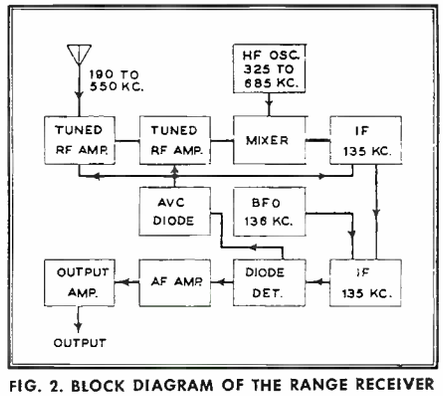


FIG. 2. BLOCK DIAGRAM OF THE RANGE RECEIVER

Washer-shaped resonating capacitors are mounted in the ends of the transformers. The RF coil structures resemble the IF transformers, so that similar parts can be used in both.

Aside from its inherent usefulness as an ultra compact piece of airborne communication equipment, the new range receiver has also served as the focal point for the development of several novel components and fabrication techniques. These components, engineered to meet the rigorous size and temperature requirements of subminiature equipment, may well afford superior permanence and reliability when used in commercial equipment of more conventional and less compact design.

FAS AUDIO SYSTEM

The next article in the FAS series is scheduled for publication next month. In the meantime, reprints of the first three installments, published in October, November, and December, are still available at 10c each. We still have a small supply of the subsequent magazines.

FTB AIR-RAID ALARM

(Continued from page 23)

would be satisfactory. Voltage regulator tube V103 is used to maintain a constant voltage supply to the tone oscillators in spite of line voltage variations, since variations in plate voltage tend to vary the oscillating frequency of this type of circuit.

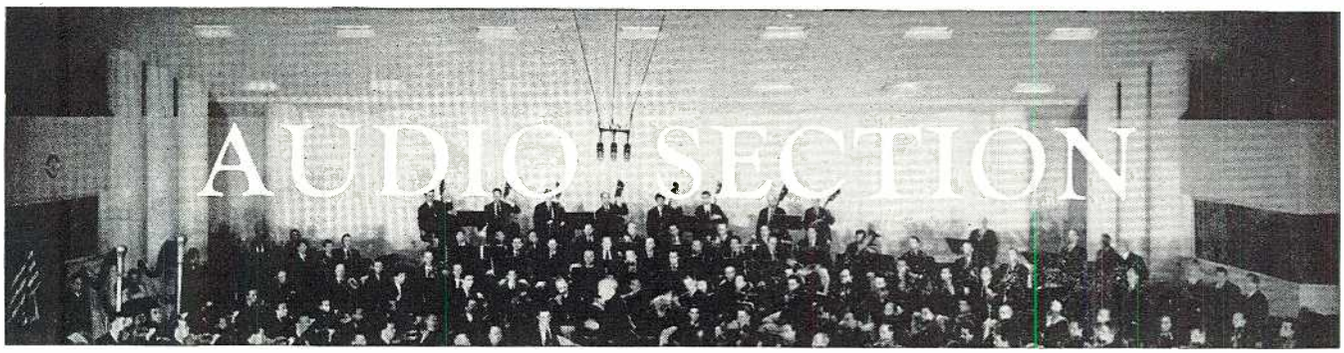
The timing switch K101 provides the automatic feature of the equipment. A synchronous clock motor drives, through a gear train, a cam which rotates at ¼ revolution per minute. The Hayden unit used in the model has an adjustable feature so that the microswitch contacts are made for an adjustable length of time once each 4 minutes. Since only a short tone transmission is needed the cam should be adjusted for the shortest possible ON period, which seems to be about 4 seconds. Additional switch contacts, not shown, may be used to turn on a transmitter at the same time the tone oscillator is energized.

Operation of the tone generator and the master station alarm facilities is very simple. The first step is to adjust the oscillator circuits by means of the controls R101, R105, R106, so that all three tones are on the correct frequencies by comparison with a good standard audio oscillator. Next the tone levels are adjusted by means of the master level control R107 for proper tone level or modulation level of the transmitter.

The rotary switch on the front panel is placed in the position corresponding to the state of alarm to be transmitted. The timing unit sends out a tone pulse every 4 minutes in order to keep the receiving alarm indicator units operating. When changing to a new state of alarm, however, it is not desirable to wait until the next automatic transmission. Thus the spring-return toggle switch S103 is provided on the front panel and should be depressed for several seconds every time the state of alarm is changed so that the receiving stations will receive an immediate warning.

PARTS LIST FOR THE FTB ALARM GENERATOR

	CAPACITORS
C1, C4	Silver, Mica, 1,000 mmfd, ±3% (2-500 mmfd in parallel)
C2, C5, C7, C8, C11, C14, C15	Ceramic, 10,000 mmfd
C3, C18, C19, C20	Variable, Air, 100 mmfd
C6, C9	Ceramic, 50 mmfd, +10%
C10	Paper, Oil Filled, 10,000 mmfd, 600 V.
C12, C13	Silver, Mica, 500 mmfd, +3%
C16, C17	Electrolytic, Dual, 2x10 mfd, 450 V. in parallel
	RESISTORS
R1, R4	Carbon, 2 megohms, ±10%, ½ Watt
R2, R3, R5	Carbon, 100,000 ohms, ±10%, 1 Watt
R6	Carbon, 68,000 ohms, +10%, 1 Watt
R7, R9	Carbon, 1 megohm, ±10%, ½ Watt
R8, R10	Carbon, 1,000 ohms, ±10%, ½ Watt
R11	Carbon, 6,800 ohms, ±10%, 1 Watt
R12	Wire Wound, 2,500 ohms, ±5%, 10 Watts
R13	Carbon, 50,000 ohms, +10%, 1 Watt
R14	Wire Wound, 15,000 ohms, +5%, 10 Watts
R15	Wire Wound, 7,500 ohms, ±5%, 10 Watts
R16	Carbon, 22,000 ohms, ±10%, ½ Watt
R17	Variable, Carbon, 100,000 ohms
R18	Carbon, 220 ohms, ±10%, ½ Watt
R19	Carbon, 22,000 ohms, +10%, 1 Watt
R20	Carbon, 528 ohms, ½ watt
R21, R22	Carbon, 2,375 ohms, ½ Watt
	RECTIFIER
CR1	Selenium (FTR Type 402D3728A)
	FUSE
F1	Cartridge Type 3AG-2
	RELAYS
K1, K2, K3	Clare, Type C Frame, 6,500 ohms, 2A
	CHOKE
L1	Chicago Transformer, Type 2060-AB-N
	CONNECTOR
P1	Male, Flush Motor Base
	SWITCH
S1	Toggle, S.P.S.T.
	TRANSFORMERS
T1	Output (Chicago 6226-N)
T2	Power, 6.3 Volts @ 3.8 Amps. 285-0-285 Volts @ 75 M.A.
	TUBES
V1, V2, V5	6AG5
V3	6BE6
V4	OD3/VR-150
	CRYSTALS
Y1, Y2, Y3	Quartz bar
Y4	Quartz bar, 100 kc.
	FILTERS
Z1, Z3	Link Radio Type 1710-844
Z2	Link Radio Type 1710-845
	MISCELLANEOUS
E1	Fuse Holder Type HKP
E2	Terminal Strip — 6 terminals



LOUDSPEAKER PERFORMANCE

ACHIEVING OPTIMUM REPRODUCTION IN SMALL ROOMS — COMPARATIVE ADVANTAGES OF OPEN-CONE AND HORN-LOADED SPEAKERS — *By* JAMES MOIR*

OF the many letters I have received a large proportion are concerned with the problems of loudspeaker performance. As this is too big a subject for adequate discussion in letters, I felt that it would justify a contribution devoted solely to the relative merits of loudspeakers suitable for use in small rooms.

Loudspeaker Requirements:

First of all, what are the essential requirements of loudspeakers that can be included in the short list of "best" types? This is a point discussed in greater detail in the July, 1950 issue of RADIO COMMUNICATION, so only a brief summary will be given here:

1. A frequency range of 40 cycles to 10,000 cycles, with some little extra credit for any extension of this range.

2. Peaks and dips in the frequency response should not exceed 5 db. Any claim to this or better performance should be accompanied by details of the test techniques employed, as there are large differences between the results of a frequency run taken with a single microphone on the axis of the speaker, and the average of three or more runs at various angles to the axis, and averaged to produce a single curve.

3. Distortion at power levels of about 1 watt should be below 1% over the entire frequency range.

4. The flux density over the working length of the magnet gap should be at least 14,000 gauss, preferably higher.

5. The transient response as measured by the method outlined in the September, 1950 issue of RADIO COMMUNICATION should show no marked peaks at delay time up to 40 milliseconds.

6. The polar diagram should not vary widely over the frequency range.

Somewhat surprisingly, attention seems to have been concentrated on the frequency response aspect, few manufacturers making any claims to outstanding performance in respect to distortion, though once a frequency range of 70 cycles to 6 kc. is genuinely achieved, it seems probable that attention to the other points will produce greater improvement in listenability than striving to extend the frequency range by another 2,000 or 3,000 cycles. Smoothing and extending the frequency response has not proved easy, and as many different methods are employed in currently available commercial speakers, a brief survey will be made of the advantages and disadvantages of the main methods in use.

Extended Frequency Range:

Attainment of response flat to 10 kc. on a single cone of paper or similar fibrous material has proved to be a difficult problem. Two separate diaphragms have proved to be a very much simpler proposition, though there is a wide diversity of opinion as to how the two diaphragms should be used.

The earliest and most straightforward method is to mount in fairly close proximity a large cone speaker (12 to 18 ins.) intended to deal with a low-frequency range, and a small cone (3 to 6 ins.) generally of hard paper, to deal with the high-frequency range, the crossover frequency being chosen anywhere in the region between 500 and 4,000 cycles. Once popular, this combination is losing ground, and as one weakness is common to all two-speaker installations, it justifies some further explanation.

Referring to Fig. 1, S1 and S2 are speakers necessarily separated by at least the radii of the cones, and often separated by a greater distance. At any listening point in space, the distances from the point to each speaker differs by a small amount which is a function of the angle between the listening point and a line passing midway between the speakers. Thus, in the overlap region where both speakers are radiating, sounds reach the listening point from the two speakers with a slight time difference due to the path-length difference.

At any particular frequency, the two outputs either add or cancel because of the time difference. In the overlap region, two speakers, each with perfectly smooth response, produce a total response, which displays a series of peaks and dips, and sounds rough in consequence. This is fundamental to all spaced-speaker equipments. It can be minimized, but not eliminated by increasing the rate of cutoff of the changeover filters, a solution that introduces other troubles. Apart from sounding rough, the resulting sound can have a peculiar disembowled character, the ear apparently recognizing the positions of the individual sound sources.

These difficulties have led designers to associate the high-frequency and low-frequency speaker units more closely than is possible when separate units are employed. And so the majority of current high-quality speakers consist of two separate units, the HF unit being mounted inside the LF cone. Thus, in the overlap region where both sound sources are radiating, they are almost coincident in space. The simplest combination speakers are those of the double paper-cone type, both cones being driven by a single voice coil, though in some examples a compound coil is used, both sections of the voice coil moving at low frequency; a mechanical compliance between the two coils sections making it possible for the HF section to move alone at high frequency.

The use of two cones makes it possible to choose the optimum material for each cone, generally resulting in a choice of a thick soft paper for the LF cone and a

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hard shiny material for the HF cone. Absence of a supporting surround at the outer edge of the HF cone makes the cone resonant modes more prominent and boosts the HF output. Careful design is required to prevent the upper register being over-prominent. While the use of two cones in this way extends the HF response and reduces the spaced-speaker effect considerably, some difficulties still exist in the overlap region, as the centre cone is slightly in front of the outer cone.

Some designers have taken the further step of combining the HF and LF cones, the HF cone of hard paper extending for 2 or 3 ins. and being sewn or stuck to the LF portion of the cone which extends for another 6 to 8 ins. This eliminates the trouble from double sound in the overlap region, and has the further merit of providing some damping for the powerful resonant modes of the HF cone, but may not provide a speaker response extending to 12 or 14 kc. as demanded by some high-fidelity enthusiasts.

Another approach to the problem consists in using a large and a small cone, the small cone being mounted inside the large cone and driven by a separate voice coil moving in its own gap. This ensures coaxiality, and nearly solves the spacing problem, but it does make it difficult to balance the HF and LF output and introduces the problem of isolating the large LF cone movements from the small HF cone.

Open paper cones of any kind have not yet been developed to the stage where they can provide a response as smooth and well damped as that obtained by a small horn-loaded diaphragm and, in consequence, some designers have sought to replace the HF speaker using a conical paper diaphragm by a horn-loaded unit. Earlier designs employed a separately mounted horn, but more recently it has become fashionable to mount the HF unit inside the centre pole of the LF unit, the short horn emerging into the centre of the LF cone. This artifice reduces the spaced-speaker effect but, due to space restriction, requires that the changeover frequency be raised in order to keep the HF horn of reasonable dimensions. While making the HF and LF sound sources coaxial, it does result in putting the HF diaphragm at the rear of the speaker where it is several inches behind the apex of the LF cone. Unless the rate of changeover is fairly high, the peaks and dips indicated in Fig. 2 can be serious in the overlap region.

Horns and Enclosures:

Extended HF response is of little value without an equivalent extension of the LF end of the range, a top response flat to 10 kc. requiring an LF response down to 40 or 50 cycles for reasonable overall balance. The basic requirement for good HF response, a small light weight mechanism, does not result in good LF response where large diameter cones and voice coils of corresponding dimensions and weight are essential, this being the main justification for the tendency to use two separate mechanisms for the HF and LF speakers.

However, something more than a cone of large diameter is required for good LF response. The mounting is of equal importance. The basic job of the mounting is to prevent air circulation between

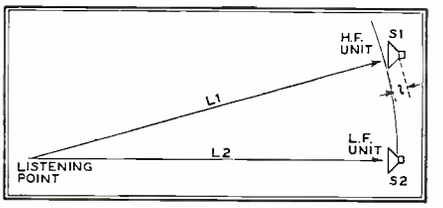


FIG. 1. EFFECT OF USING TWO SPEAKERS

back and front of the cone. The simplest solution is the use of a large, flat baffle, but as the length of each side needs to be at least 5 to 8 ft., it is not a very practical solution, particularly in a small room. Loudspeakers mounted in a hole in the wall have complete isolation between front and rear, but are rarely practical, and in any case do not make the best use of the available sound power. A loudspeaker cone radiates equal amounts of power (at low frequency) from both front and rear of the cone. While the infinite, flat baffle uses one-half the total power, a vented cabinet or labrynth, when designed correctly, serves to reverse the phase of the radiation from the rear of the cone and thus makes use of the sound power radiated from both sides. A detailed analysis of the vented cabinet or labrynth mounting indicates that the power gain may be even greater than 2 to 1, as the air loading of the cone may be increased appreciably over the lower octave of the frequency range. As usual, the advantages are not to be obtained without difficulty and both vented cabinets and labrynths may produce transient hangovers which lead to flabby LF reproduction, the danger increasing as the cabinet gain is increased.

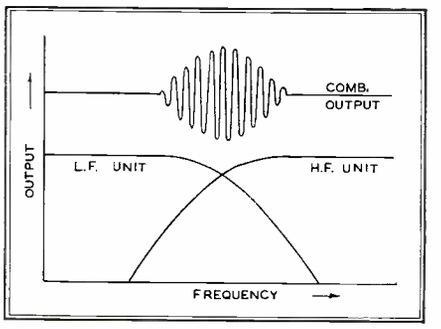


FIG. 2. EFFECT OF SPEAKER RESPONSE OVERLAP

There is one possibility that does justify further thought. This is the use of horns, a solution that has all the technical advantages, but the disadvantage of large size in small rooms. The advantages are considerable. There is no other way in which the motion of a loudspeaker cone can be as well damped over such a wide frequency range. Good damping over a wide band results in firm, solid reproduction that is most impressive, particularly in a large room.

Unfortunately it is impossible to design a loudspeaker that covers a wide frequency band and is simultaneously free from amplitude distortion. That is one of the main reasons for the use of two separate sets of loudspeakers in motion picture sound installations. This is a limitation peculiar to horn speakers, and presents another difficulty in attempting to meet the conflicting requirement of good HF and LF response simultaneously in one mechanism.

Good LF response necessarily involves the use of a relatively large horn and, as a consequence, the HF and LF openings must be more widely spaced than would be possible if open cone-type units are used without horns. Folding the LF horn to economize on space, a measure that cannot be used with the HF horn, produces additional fore and aft misalignment of the HF and LF sources. Overlap troubles are therefore more serious than with open cone units, and to achieve the same reduction of overlap roughness, the distance between speaker assembly and listener must be appreciably greater than with open cone speakers. Apart from the question of mere size, therefore, the horn speaker combination tends to be more suitable for a larger room. Given the larger room, its performance is superior to that of an open cone assembly.

Smooth Tone Quality:

Discussion so far has centered on the question of extending frequency response, but it is firmly believed that smoothness of response is at least as important, and once the essential flat response from 70 cycles to 6 kc. is achieved, it may be wise to concentrate on smooth response within that band rather than expend effort on extending the band an additional 2 or 3 kc. Smoothness of response is difficult to evaluate from published response curves once the departure from a straight line gets down to something around ± 6 db.

While there is an IRE standard on speaker testing, it is doubtful whether all the published response curves are taken under IRE conditions. A single frequency run taken on the axis at some fixed distance may show a flat response but, due to the increase in sound focus-

ing at the higher frequencies, the total sound-power may be falling off, *i.e.*, the real frequency response may fall at high frequency. On the other hand a rather ragged axial response curve may be smoothed by averaging the response at each frequency for three positions, say on the axis, and 30° and 60° off the axis. Without any of these artifices, and with the best will in the world, it is still extremely difficult if not impossible to obtain the same measured frequency response curve from three different test setups using the same loudspeaker. Response curves should therefore be taken as a guide rather than a conclusive answer.

In a general way, horn-loaded speakers will produce the most uniform response curve, but this should not be interpreted to mean that all horn response curves are smooth. As the frequency response of a loudspeaker is improved, it becomes more and more necessary to concentrate on reducing amplitude distortion if full advantage is to be taken of the extended response.

Amplitude distortion in a loudspeaker arises from two main causes, a non-linear force/deflection relation for the surround and centering spider, and non-uniformity of the flux distribution along the air gap. It is fairly obvious that if a voice coil current of 100 milliamperes produces a cone deflection of .01 inch, twice the current should produce a deflection of .02 inch. In practice, a linear relation holds over a rather limited range of deflection only, leading to appreciable harmonic distortion if this limit is exceeded. Non-uniformity of flux distribution in the axial direction along the gap leads to a deflection increment due to a coil-current increment that is a function of the mean current in the coil, instead of being independent of the mean current. Neither of these sources of non-linearity is easily checked when purchasing a speaker, and a listening test is about the only thing possible. In general, loudspeakers having cloth or thin leather surrounds and high gap densities are less likely to exhibit these defects than types having paper surrounds and low gap densities.

Transient distortion is another type of distortion that is difficult to evaluate by instrumental measurements, and recourse must be had to listening tests. Generally speaking, horn-loaded types having high gap densities will have the best transient response. In the plain open-cone type, units having high gap densities are likely to have the best performance. Good transient response is indirectly indicated by a smooth, wide frequency range and an absence of sharp peaks, dips or rapid cutoff at either end of the range. The speaker should be driven by an amplifier having an output impedance not higher than roughly 20% of the DC resistance of the speaker.

Polar Diagram:

Few manufacturers publish data on the distribution of sound energy with frequency over the listening area in front of the speaker, although it is of considerable importance. If acceptable results are to be obtained over a fairly wide area, and not restricted to one particular seat in the room, the distribution of energy over the listening area should be the same at 50 cycles as it is at 1,000 or 5,000 cycles. That is, the polar diagram should not vary with frequency.

Now, this is a result that no loudspeaker cone can manage, a typical performance being somewhat as shown in Fig. 3, where it will be seen that low-frequency energy is uniformly distributed over the whole hemisphere in front of

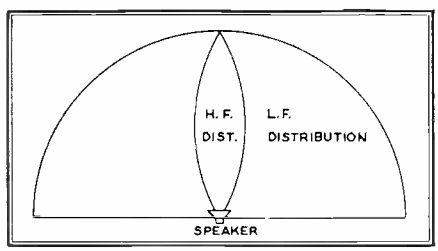


FIG. 3. DIFFERENCE IN HF-LF DISTRIBUTION

the speaker, whereas the high-frequency energy is confined to a relatively narrow angle around the speaker axis. Careful arrangement of the corrugations in a cone can give a valuable improvement in uniformity, but not the ideal performance. Once again, the horn speaker has the advantage and can be designed to give a more uniform response than the cone type, though it is fair comment that in the absence of care the polar diagram of a horn speaker can be worse than that of a cone speaker.

Personal Preferences:

This general survey of speaker types indicates that there is no single type of unit with *all* the advantages, a situation that is common in many other fields. Each type represents a different compromise with nature, and each purchaser has to make his own personal choice.

During the last few years, I have had an opportunity to discuss this subject with the engineers of three broadcasting systems. All the engineers had considerable experience in high-quality monitoring. Within reason, price was of little account to them, and all had adequate test facilities at their disposal. Yet they chose three different speakers as being the best available in England, though each engineer had heard the speakers chosen by the others. In conversation I gathered that one engineer had been impressed by the cleanness of the top response of one model, and made that his choice; another had been impressed by the absence of bass colouration in the model he chose; while the third had selected a unit with a particularly extended frequency range.

This sort of experience should be some comfort to the high-fidelity enthusiast who tries to make up his mind largely from advertising claims. There is however, one external factor that has an important bearing on speaker performance. That is the quality of the input signal to the speaker. Common experience backed up by careful test, indicates that wide-range loudspeakers require low-distortion driving signals if the results are to justify the expenditure. On a signal with 5% distortion, a wide-range speaker will sound worse than a narrow-range commercial unit, so it is wise to make certain that the radio receiver, phonograph pickup, and amplifier combine to deliver adequate power at low distortion before investing in a wide-range speaker. Or, if you buy the speaker, do not be too disappointed if it does not come up to your expectations when it is first tried on the old amplifier.

With most enthusiasts, the choice is complicated by at least two non-technical points: the space required for a high-fidelity speaker and the price of the top ranking products. Thus, in most cases, the problem is not "Which is the best speaker?" but rather "Of the speakers that will fit my installation, can I afford the one I think sounds best?" The number of possible answers to this question is indicated by the number of manufacturers claiming to sell the "best" speaker.

LIVE FM FOR BOSTON

Fine-music broadcasting will be given added impetus with the erection of a 20-kw. FM transmitter at Great Blue Hill, to be operated as a non-commercial station by the Lowell Institute Cooperative Broadcasting Council, 28 Newbury Street, Boston. The transmitter is a gift from Major Armstrong.

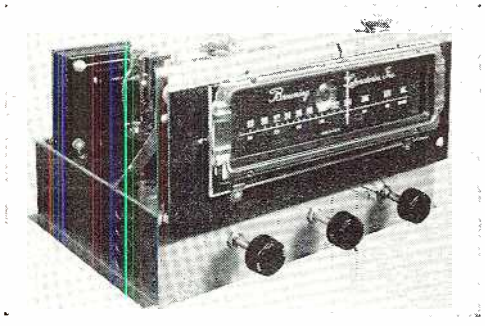
The Boston Symphony Orchestra has joined with Boston University, Harvard, and Northeastern, Boston College and Tufts, and M. I. T. to broadcast live-talent music and plays, and to present leading public figures to the eastern Massachusetts FM audience.

Main studios and offices will be at Symphony Hall, Boston, with additional studio facilities at the cooperating universities and colleges. Nearly 1½ million families are located within the area to be served by the new station.

CUSTOM SET BUILDERS' FIRST CHOICE

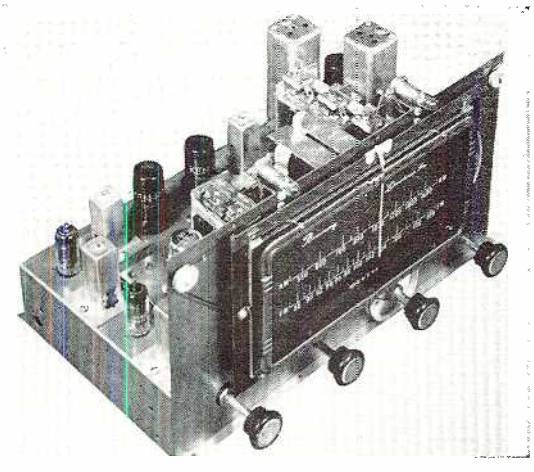
Check the sensitivity, effective noise limiting, and the many special features of BROWNING tuners such as the centralized switching control. Remember, too, that every BROWNING tuner now has *selective* automatic frequency control and a switch for PHONO—TV—RECORDER. Then you will understand why the three models illustrated here are the custom set builders' first choice.

The increasing demand for BROWNING performance is now beyond our current production capacity. We are doing our utmost to make shipments as fast as possible, however, and are allocating deliveries to give each distributor his fair share. Meanwhile, we are maintaining strict quality control, because we want you to say: "I'm glad I waited to get the real BROWNING performance."



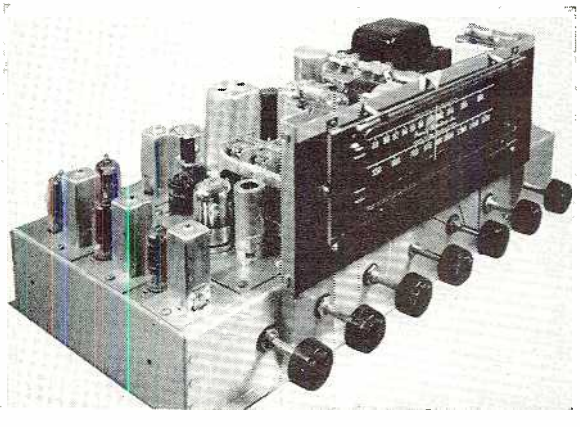
BROWNING RV-10A FM TUNER

High-sensitivity FM reception can be added easily to any AM receiver. The moderately-priced BROWNING RV-10A tuner is designed for that purpose. A tuned RF stage with an Armstrong dual limiter and discriminator produce complete noise limiting with signals of less than 10 microvolts. This is the same FM section as in the RJ-12B and RJ-20A. Controls: phono switch, radio-phono volume, and tuning. Tubes: three 6AU6, one 7F8, two 6SJ7, one 6H6, one 6J6, one 5Y3 rectifier, and 6AL7 tuning eye. As illustrated, or on a 19-inch rack panel.



BROWNING RJ-12B FM-AM TUNER

This model combines high-sensitivity FM reception from an Armstrong circuit that limits noise completely on signals of less than 10 microvolts, with the best reception of AM broadcasting. FM and AM circuits are completely separate. FM audio response is flat within 1½ db from 15 to 15,000 cycles. No drift after 2-minute warming. AM is flat within 3 db from 20 to 6,600 cycles. Tubes: three 6AU6, one 7F8, one 6SK7, one 6SG7, two 6SJ7, one 6H6, one 6SA7, one 6J6, one 1N34 dectector, one 6AL7 tuning eye. Operates from separate PF12 power supply with one 5Y3GT. As illustrated, or on a 19-in. rack panel.



BROWNING RJ-20A FM-AM TUNER

The RJ-20A is intended particularly for those who require superlative reproduction quality on both radio and records. Armstrong circuits, incorporating every refinement, deliver the full promise of FM's interference-free performance with maximum receiving range. Variable IF bandwidth allows AM selectivity adjustment from 4 to 9 kc. A 2-stage audio system is built in to provide separate treble and bass boost up to 20 db for record reproduction. Tubes: Five 6AU6, one 7F8, one 6SG7, one 6SA7, one 6SK7, two 6AL5, one 6SN7, one 6J6, one 6AL7 tuning eye, 5Y3GT rectifier. As illustrated, or on a 19-in. rack panel.

For Complete Technical Data on These FM and FM-AM Tuners, Address:

BROWNING LABORATORIES, Inc.

700 Main Street, Winchester, Massachusetts

WHAT'S NEW THIS MONTH

(Continued from page 11)

radio engineers have felt toward the FCC in general, and Commissioner Jones in particular, for their official remarks in which they questioned the "good faith, truth, and veracity" of the radio engineering profession.

It is unfortunate that the administration of the FCC is almost entirely in the hands of lawyers. There is very little area for a meeting of legal and engineering minds. The lawyer is trained to take a position and to sustain it against opposing opinion and evidence. The engineer is trained to seek the truth, and to avoid prejudgments which so often lead to false conclusions.

Speaking at the Indiana University School of Law on March 31, Chairman Coy said that the powers of the FCC "are usually described as quasi-judicial, quasi-legislative, and quasi-administrative." Obviously engineers have very little chance with an agency so empowered by Congress.

Chairman Coy also said: "I am not a lawyer." Then he doesn't have much of a chance, either, what with those Four Horsemen of the FCC's legal department running the show to the extent that the reality of scientific facts is denied in official decisions because they have not been written into the record. Such decisions, concurred in by the Commissioners, of whom Robert F. Jones is one, do not express "good faith, truth, and veracity."

Sooner or later, the administration of the FCC must be put into the hands of men who recognize that the service of public interest, convenience, and necessity is not a quasi-responsibility.

Up to now, and to an increasing extent, the arrogant attitude of the legal department toward industry executives and engineers has been expressed by such gleeful washroom remarks as: "Well, have I got that fellow tied in knots, or have I got him tied in knots? And watch me finish him off when I get him back on the stand!"

Thomas Jefferson expressed an opinion on this very point in 1801. There was no need for an FCC then. As Chairman Coy said: "Our founding fathers did not envision any such agency." Yet it is clear that the basic philosophy of sound administration has not changed, for Jefferson wrote: "Of the various abilities, no one excited more anxious concern than that of placing the interests of our fellow citizens in the hands of honest men, with understanding sufficient for their stations."

The necessary changes in the FCC will never be brought about by a Chairman who is a lawyer. But it might be attempted by Chairman Coy, who isn't.

MOBILE RADIO NEWS

(Continued from page 20)

mobile relay station, if required, will entail modification of all existing associated mobile units at a cost estimated at 4 to 15% of the cost of the mobile unit.

7. No mobile relay system applications will be accepted for filing during the pendency of the rule-making proceeding. Original comments on the proposed Rules were due March 21, and reply comments are due April 2. This means that applications for mobile relay stations will probably not be accepted until May or June, when it may be expected that the proposed Rules will be announced in final form.

Miscellaneous Notes:

Disaster communications service Rules have been finalized with a number of liberalizing amendments including: 1) tolerance of stations operating in 1,750 to 1,800-kc. band were relaxed from .005 to .015%; 2) one additional radiotelephone channel assigned from radiotelegraph channels; 3) definition of disaster expanded to encompass train or airplane wrecks and to include occurrences which affect a small segment of the public; 4) operating procedures and priority of messages rules made discretionary with activating or controlling authority, including civil defense officials; 5) provision made for use of repeaters and automatic signalling devices. Applications are to be made on FCC Form 525.

Suggestion of various mobile radio services, including taxi, that their present Rules be amended to permit the use of their stations for drill purposes and for communication with other stations in time of actual emergency was not adopted because: "For the most part, rules governing the various services provide for such communication in times of actual emergencies, and amendment of the various rule parts to permit such drills is under study. Hence, such suggestions are not properly a part of this proceeding."

In first action of its kind, FCC has had the Federal District Court for Southern District of New York issue an order to show cause why the Yonkers Cabinet Company of Yonkers, N. Y., should not cease the use of a dielectric heater causing interference to radio reception by the U. S. Coast Guard on the latter's aeronautical frequency of 7,530 kc. Action followed failure of company to remedy interference, as requested by FCC, in accordance with Part 18 Rules.

The FCC proposes to request Congress for amendment of Section 319 of the Communications Act to eliminate the requirement of obtaining a construction permit as well as a license.

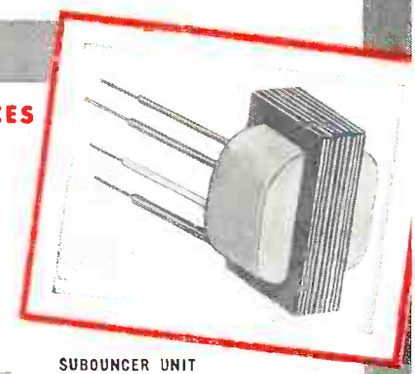
INDEX OF ADVERTISERS

FOR YOUR CONVENIENCE, TELEPHONE NUMBER OF EACH COMPANY IS SHOWN HERE

MINIATURE COMPONENTS FROM STOCK...

SUBOUNCER UNITS

FOR HEARING AIDS...VEST POCKET RADIOS...MIDGET DEVICES



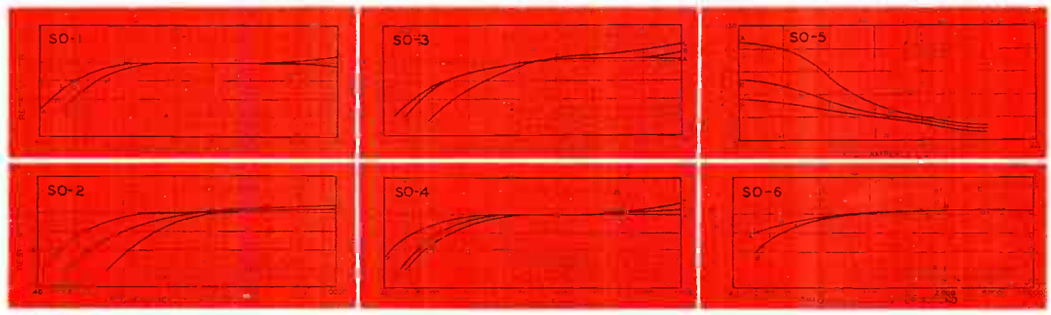
UTC Sub-Ouncer units fulfill an essential requirement for miniaturized components having relatively high efficiency and wide frequency response. Through the use of special nickel iron core materials and winding methods, these miniature units have performance and dependability characteristics far superior to any other comparable items. They are ideal for hearing aids, miniature radios, and other types of miniature electronic equipment.

The coils employ automatic layer windings of double Formex wire . . . in a molded Nylon bobbin. All insulation is of cellulose acetate. Four inch color coded flexible leads are employed, securely anchored mechanically. No mounting facilities are provided, since this would preclude maximum flexibility in location. Units are vacuum impregnated and double (water proof) sealed. The curves below indicate the excellent frequency response available. Alternate curves are shown to indicate operating characteristics in various typical applications.

Type	Application	Level	Pri. Imp.	D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.	List Price
*SO-1	Input	+ 4 V U	200 50	0	250,000 62,500	16	2650	$6.50
SO-2	Interstage/3:1	+ 4 V.U	10,000	0	90,000	225	1850	6.50
*SO-3	Plate to Line	+ 20 V.U.	10,000 25,000	3 mil. 1.5 mil.	200 500	1300	30	6.50
SO-4	Output	+ 20 V.U	30,000	1.0 mil.	50	1800	4.3	6.50
SO-5	Reactor 50 HY at 1 mil D.C. 3000 ohms D.C. Res.							5.50
SO-6	Output	+ 20 V U.	100,000	.5 mil.	60	3250	3.8	6.50

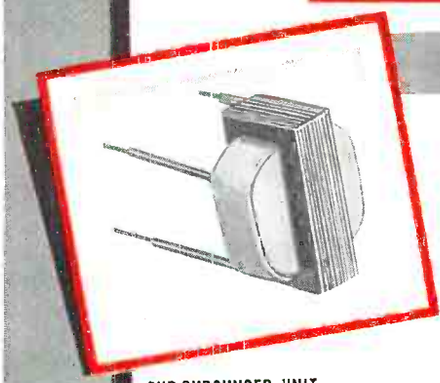
*Impedance ratio is fixed, 1250:1 for SO-1, 1:50 for SO-3. Any impedance between the values shown may be employed.

SUBOUNCER UNIT
Dimensions....9/16" x 5/8" x 7/8"
Weight .....03 lb.



SUB-SUBOUNCER UNITS

FOR HEARING AIDS AND ULTRA-MINIATURE EQUIPMENT

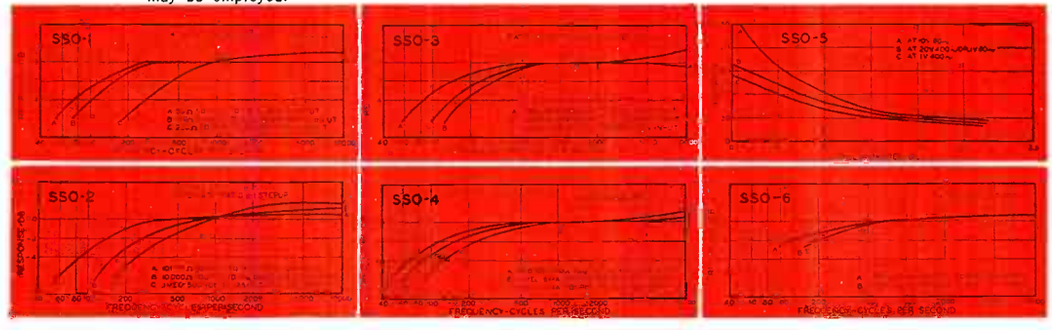


UTC Sub-SubOuncer units have exceptionally high efficiency and frequency range in their ultra-miniature size. This has been effected through the use of specially selected Hiperm-Alloy core material and special winding methods. The constructional details are identical to those of the Sub-Ouncer units described above. The curves below show actual characteristics under typical conditions of application.

Type	Application	Level	Pri. Imp.	D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.	List Price
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700	$6.50
SSO-2	Interstage/3:1	+ 4 V.U.	10,000	0	90,000	750	3250	6.50
*SSO-3	Plate to Line	+ 20 V.U.	10,000 25,000	3 mil. 1.5 mil.	200 500	2600	35	6.50
SSO-4	Output	+ 20 V.U.	30,000	1.0 mil.	50	2875	4.6	6.50
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.							5.50
SSO-6	Ouptut	+ 20 V.U.	100,000	.5 mil.	60	4700	3.3	6.50

*Impedance ratio is fixed, 1250:1 for SSO-1, 1:50 for SSO-3. Any impedance between the values shown may be employed.

SUB-SUBOUNCER UNIT
Dimensions....7/16" x 3/4" x 5/8"
Weight .....02 lb.



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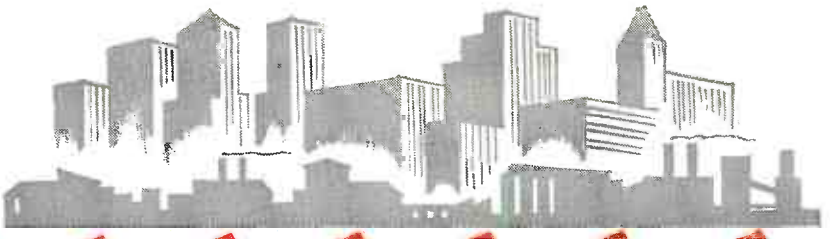

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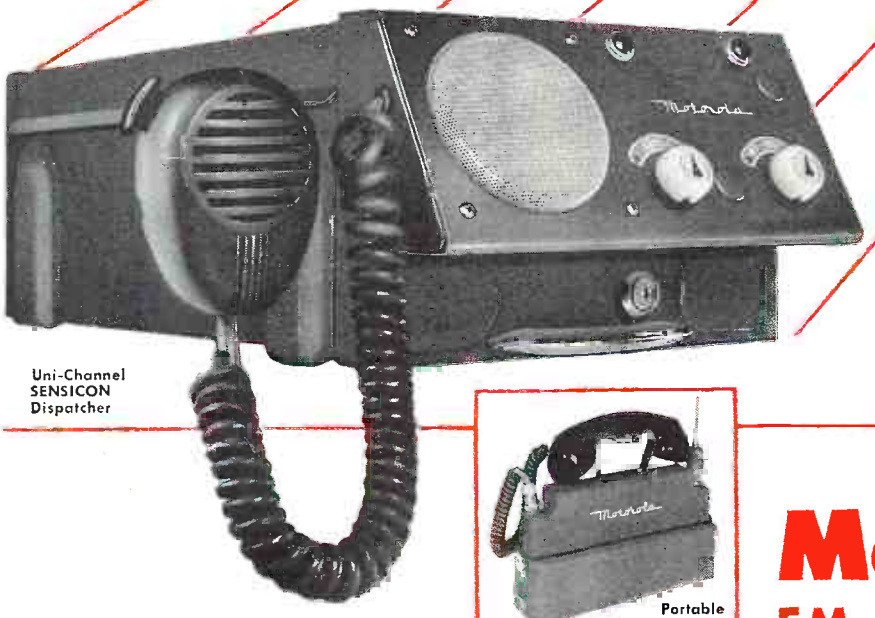


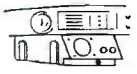
Uni-Channel SENSICON Dispatcher

Portable "Handie-Talkie"

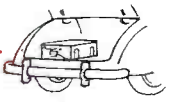
Motorola FM 2-WAY RADIO

USE AS PORTABLE BASE STATION

USE AS MOBILE DASH MOUNT



USE AS MOBILE TRUNK MOUNT



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Engineered for your specific communication problem . . . whether it be safety, protection, maintenance, repair, supervision, control — or any of the countless uses that modern industry requires.

Motorola's powerful *Uni-Channel SENSICON Dispatcher* is industry's top performer in low-cost FM 2-way radio. It gives you permanent selectivity, voice dominance over noise, greater freedom from interference, longer life and freedom from obsolescence. The *"Handie-Talkie"** radiophone houses a complete FM transmitter-receiver and power supply in a single compact unit . . . for vital communication liaison in thousands of industrial applications.

It will pay you to investigate the possible application of Motorola FM 2-way Radio in *your* operations . . . for you'll soon find that it *pays for itself* by providing greater control, more economical use of precious manpower and equipment.

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