TELE-TECH

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TELEVISION • TELECOMMUNICATIONS • RADIO

IN TWO PARTS • PART ONE

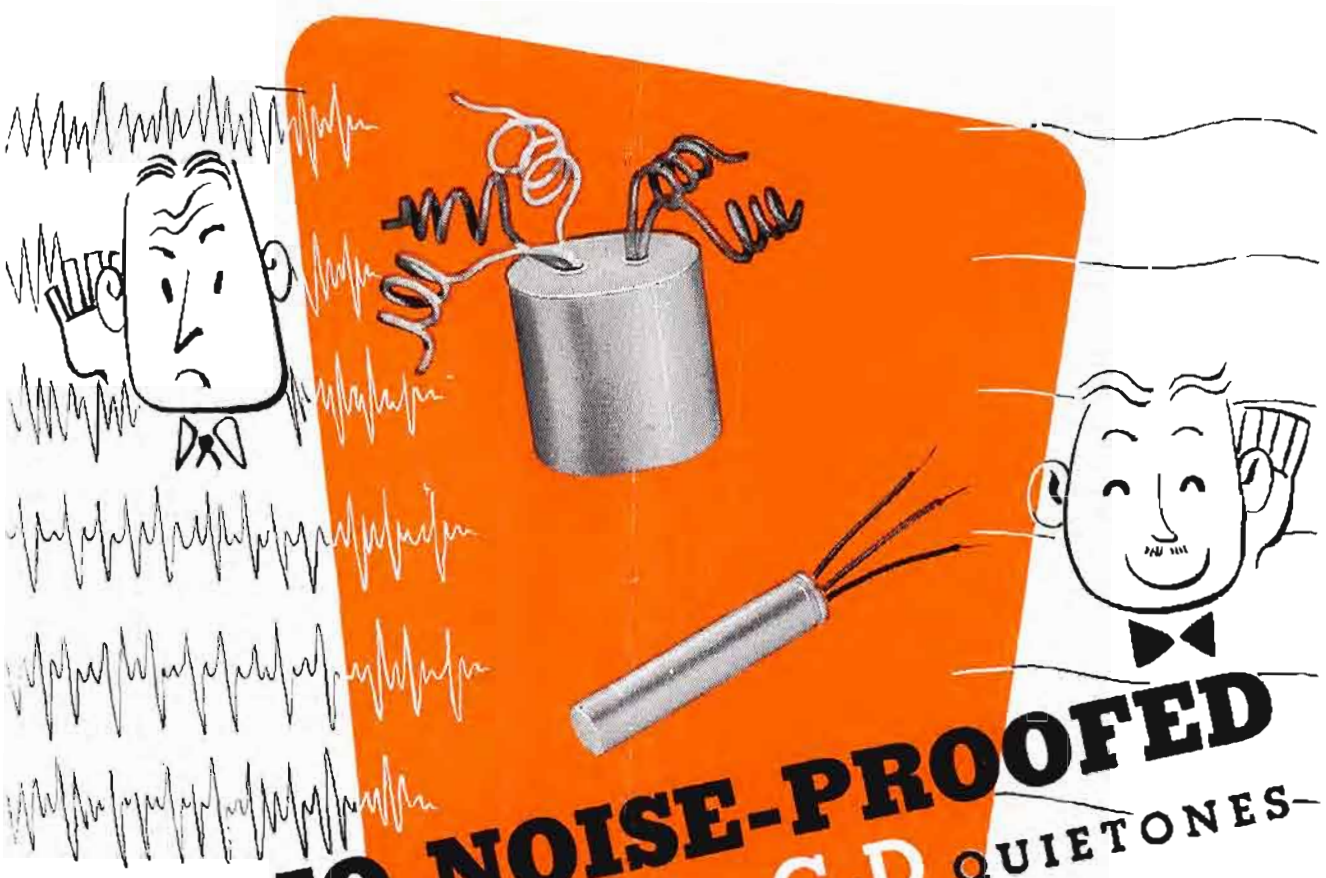
Sealex Machine at Western Electric's Allentown Plant — See pages 1 and 34

December • 1948

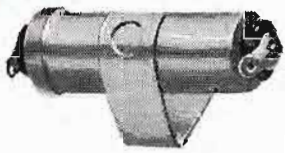
CALDWELL-CLEMENTS, INC.

Tele-Tech's 1949 TV Station and Network Timetable —See Part Two

Profit-Sharing Pay Plan at General Radio —See page 26



RADIO NOISE-PROOFED WITH C-D QUIETONES



More and more, electrical appliance customers are asking — "Will it cause radio interference?" And in the answer to that question lies the secret for many more sales of your products.

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TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

DECEMBER, 1948

Editorial Contents

PART ONE:

PART TWO:

CALDWELL-CLEMENTS, INC., Publication Office, Orange, Conn., Editorial and Executive Offices 480 Lexington Avenue, New York 17, N. Y., Tel Plaza 3-1340

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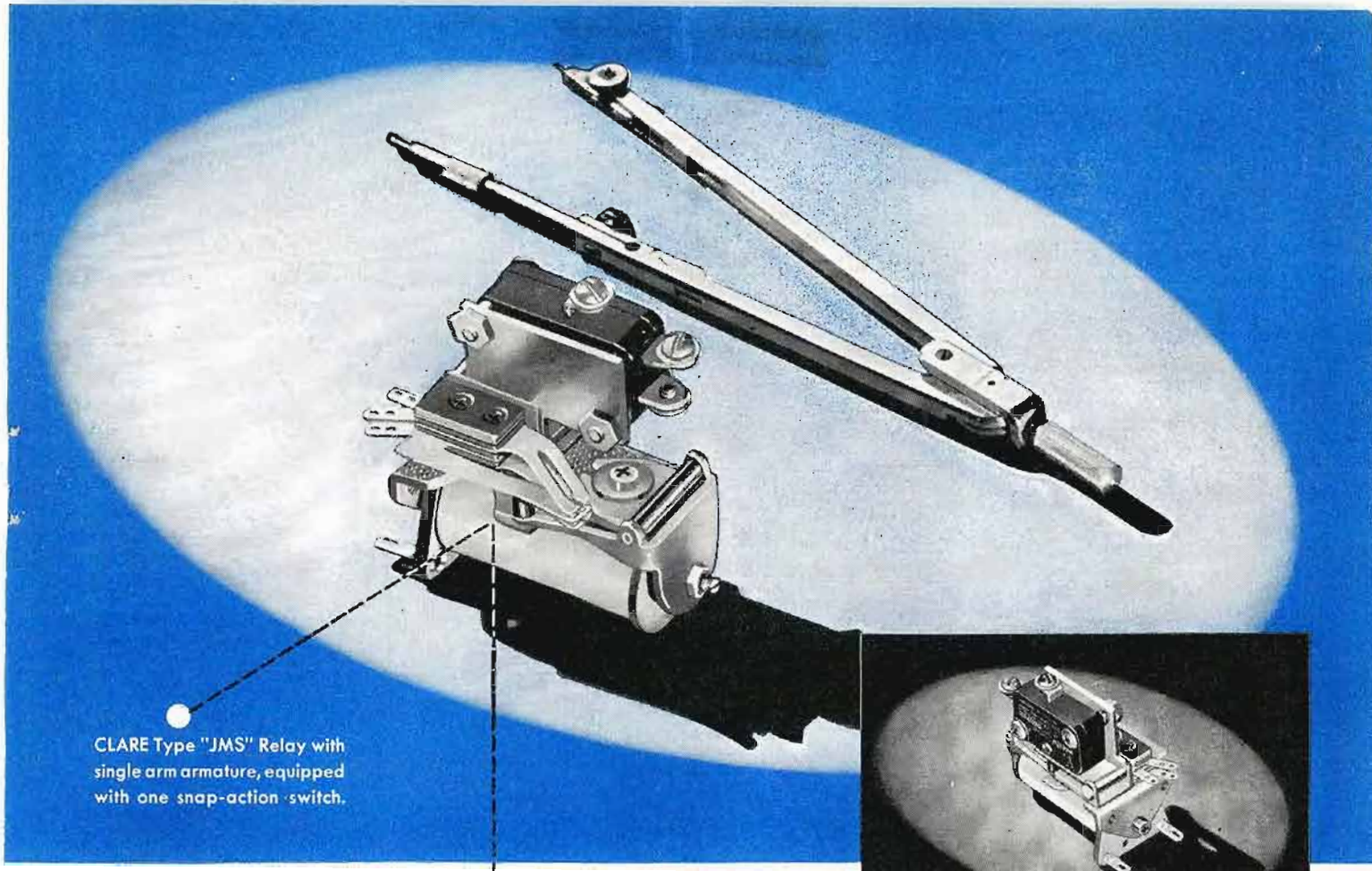
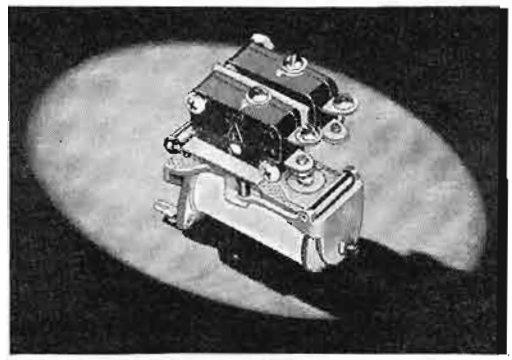


CLARE Type "JMS" Relay with single arm armature, equipped with one snap-action switch.

Showing mounting of snap-action switch on CLARE Type "JMS" Relay with single armature.



CLARE Type "JMS" Relay provided with double armature and two snap-action switches.

THIS SMALL, COMPACT CLARE RELAY

WILL SWITCH 1250 WATTS WITH AN INPUT OF 1 WATT!

This new CLARE Type "JMS" Relay is a sensitive relay for switching heavy a-c loads with small d-c controlling currents . . . as high as 1250 watts can be switched with a 1-watt input.

It combines the outstanding features of the larger CLARE Type "CMS" Relay with the small size and light weight of the CLARE Type "J" Relay and employs a new-type Micro precision switch of unusual efficiency and compact design.

The CLARE Type "JMS" Relay is especially suitable to locations subject to sudden jolts, constant vibration or tilting. It may be provided with either one or two Micro snap-action switches, or with one switch and a pileup of twin-contact springs. For installations where quick removal or replacement may be desirable, it may be fitted and wired to a standard radio type plug.

This new relay is a development of CLARE's unceasing effort to keep pace with every industrial relay requirement. Our engineers and sales representatives are constantly at your service to provide just the relay to meet your specific need.

For full information on the CLARE Type "JMS" Relay, look up the CLARE office in your classified telephone directory . . . or write for Bulletin 102 to C. P. Clare, 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address CLARELAY.

STANDARD SPECIFICATIONS

Contacts: Snap-action, enclosed. Varying capacity: 10 amperes at 125 volts; 5 amperes at 250 volts.

Residual: Lock Screw (Adjustable).

Mounting: May be mounted on relay bases or strips as well as mounting bays or individual mounting brackets.

Dimensions: Overall length: 2 1/4"; width: 1 1/8"; height: 2".

Weight: Net: 4 oz. (approx.); Shipping: 1/2 lb. (approx.)

Write for Clare BULLETIN 102

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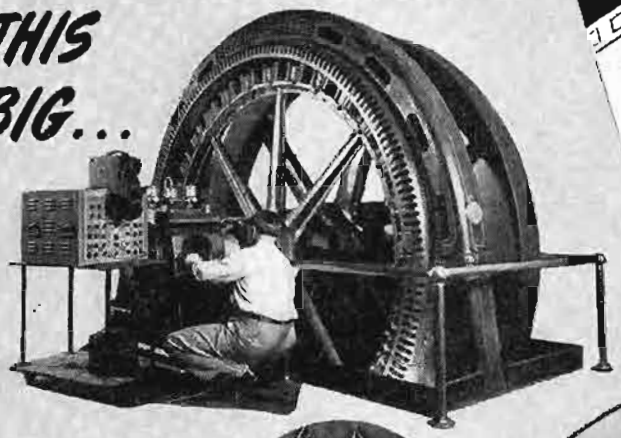

or this small...

...use the

DU MONT Type 5 SP-

Dual-beam CATHODE-RAY TUBE

Both the concomitant electrical and/or *mechanical* characteristics of a piece of equipment may be conveniently examined and recorded with a Du Mont Type 5SP-Dual-beam Cathode-ray Tube. Especially so if used with a Du Mont Type 279 Dual-beam Cathode-ray Oscillograph.

For example: You can compare speed and vibration, velocity and acceleration. You can observe transient voltage and current; the input and output signals of amplifiers; related phenomena on different sweep frequencies; or again the complete signal and an expanded portion thereof. And for ease of recording, there is also available the Du Mont Type 314 Oscillograph-record Camera.

Indeed, the Type 5SP- is an unique cathode-ray tube since it embodies *two complete and independent* electron guns and deflection plate assemblies for the production of two entirely separate electron beams. The Type 5SP- *does not* produce a split electron beam. Rather it presents two separate traces on the screen. Intensifier electrodes are used for high light output at maximum deflection sensitivities. Type 5SP- is also available with any of four different screen phosphors.

And please remember this: The Du Mont Type 5SP- is the *only* dual-gun cathode-ray tube registered with the Radio Manufacturers Association.

Details on request.

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In addition, Revere takes full cognizance of the fact that OFHC Copper for radio purposes must have special qualities. In making anodes, it must be deep drawn, and for the feather-edge seal, it must be capable of being rolled or machined down to .002"/.010". By carefully controlling mill processing, grain size is kept at or below permissible limits. Freedom from oxygen, and from voids, is guaranteed by the method of casting the bars from which we roll the forms required. In addition, there is an operation which results in Revere OFHC Copper being not just commercially free but *nearly absolutely free* of internal and external defects. This great care in producing copper for radio and radar purposes probably accounts for the fact that Revere is a preferred source of supply.

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All Revere Metals are processed with the care and attention required to assure that they meet all metallurgical and physical specifications. Revere supplies mill products in non-ferrous metals and alloys, and also electric welded and lockseam steel tube. An important part of our service to industry is the Revere Technical Advisory Service, which will gladly collaborate with you on specifications and fabrication methods.

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the voice that

STEPPING-STONES TO PROGRESS IN MARINE RADIOTELEPHONY

The first ship-to-shore radiotelephone communications were established almost 30 years ago between land stations at Green Harbor, Mass., and Deal Beach, N. J., and the steamers "Ontario" and "Gloucester," operating between Boston and Baltimore.

The "Leviathan" was the first ship to handle radiotelephone messages as a public service to and from land telephones.

This selector set made it possible to dial ships at sea, and eliminated the need for constant monitoring by loudspeaker or headphones.

IT'S COMMONPLACE TODAY to pick up a telephone on shipboard and talk to a business associate on land. But little more than 30 years ago, this was just a dream.

Back in 1915, the spoken voice could travel to far places only by wire. Then telephone scientists developed the radiotelephone, and soon the spoken word was winging its way across the ocean. A further use of this new magic was soon proposed: could not the human voice be sent from shore to ships at sea?

Soon sub-chasers and other small Navy craft were talking to each other over equipment designed by Bell engineers. And in experiments starting in 1919, the men on two coastwise steamers talked through land stations to land telephones of the Bell System.

These early experiments covered fairly short distances. But in the meantime, telephone calls across the Atlantic by radio had become an ordinary occurence. So . . . why not 'phone calls to ships way out in *mid*-Atlantic?

Of course, long-distance ship-to-shore radiotelephony brought up problems of varying distances and directions—problems not encountered in point-to-point transmission. Bell Telephone Laboratories solved these problems with the design of the "Leviathan's" equipment. For the first time, long-range marine radiotelephony became a reality.

Later, Bell Laboratories scientists developed selective ringing, which made it possible to *dial* particular ships at sea. The basic elements of practical marine radiotelephony had now been developed.

BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communications.

links the ship and the shore

IN ADDITION TO producing radiotelephone equipment for the largest ocean liners, Western Electric for many years manufactured the 224, 226 and 227 type sets, which brought the benefits of radiotelephone facilities to coastwise vessels and small craft.

These sets provided power capacities ranging up to 100 watts. As the Bell System had tremendously expanded its chain of harbor stations, coastal craft were normally near a shore station. Hence these capacities were ample to maintain contact with land.

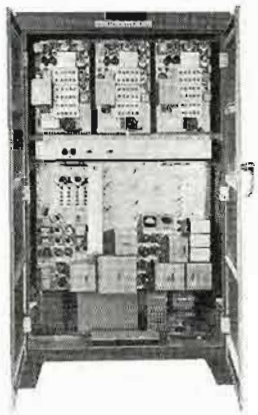
There still existed, however, no equipment specifically designed for tankers, freighters and smaller passenger ships plying the *ocean* lanes. This need has been filled by the introduction of the Western Electric 248A.

This new equipment provides 250 watts of transmitted radio frequency carrier power, resulting in greatly increased range. Provision is made for transmission and reception on the frequencies of the high-seas shore stations (as well as on the coastal harbor and ship-to-ship channels). Because of these two features, a ship equipped with the 248A, at practically any point on world trade routes, can establish contact with a land station.

The 248A combines this advantage with the compactness and simplicity of operation essential on smaller ships.

—QUALITY COUNTS—

THE NEWEST IN MARINE RADIOTELEPHONE EQUIPMENT



Left: Main cabinet of 248A mounting transmitter and three receivers.
Above: Remote control unit.

The long experience of Bell Laboratories and Western Electric in design and manufacture of marine radiotelephone equipment has culminated in the 248A—compact, powerful, simple to operate.

A single cabinet houses the transmitter and three receivers. Each of the three receivers can be tuned to any one of 10 pre-set frequencies; the transmitter to any one of 30. Transfer from one frequency to another is accomplished simply by turning knobs on the remote control panel.

Because three receivers are used, it is possible for the ship to monitor simultaneously on three different channels. The set is designed to permit easy installation of selective equipment to allow dialing the ship from shore stations.

Western Electric

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

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The new IRC Type BT resistor *meets* JAN-R-11 specs. At ⅓, ½, 1 and 2 watts, the *new* IRC Type BT is an *advanced* resistor in every respect.

You may specify this *advanced* IRC resistor immediately. It is in production now, with hundreds of thousands coming off production lines daily.

BT *means* **B***etter* **T***echnically* **BTS** *means* **B***eats* **T***oughest* **S***pecs* **BTR** *means*

BT resistor will change your standards of performance for fixed composition resistors

Get the full performance facts on this ADVANCED resistor

Standards for resistor performance set by this *new* IRC Type BT are so advanced, you need complete information to fully evaluate its significance. Test result charts will show you how this *advanced* resistor easily performs the rigorous requirements of television. Performance curves prove its excellence in every characteristic . . . particularly in high ambient temperatures.

Technical Data Bulletin B-1 gives the full story. We shall be glad to rush it to your desk or drawing board . . . or to have our representative review your requirements in the light of this *advanced* resistor. Use the handy coupon below.

IRC MEETS JAN-R-11

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☐ Have your representative call—no obligation.

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TELE-TIPS

UHF HEADACHES — Television experiments on the 510-mc channels now proceeding in Washington area have revealed that considerable more power is needed on the UHF channels for comparable locations and distances compared with present standard VHF channels. Noise from converter circuits also generates considerable "snow". UHF TV broadcasting in cities with high buildings seems bound to involve many sharp shadow difficulties.

WHY ONLY RADIO TOWERS?— Smokestacks, watertowers, or buildings to any height can be erected, and no requirement is imposed for red warning lights. But let a radio or television tower be run up even a couple of hundred feet in height, and at once strict CAB regulations are enforced for all-night marker lamps. By a roundabout play of authority, the FCC makes such lighting imperative before granting construction or operating permit, although such requirement is clearly outside the FCC's legal authority so far as radio is concerned.

TV DOMINATES ELX—Dr. W. R. G. Baker, vice-president GE Co., told IRE members at Rochester, N. Y. last month, that television has surged to dominance of the electronics industry. "TV Now Dominates Electronics Field" read headline covering Dr. Baker's statement that television is now moving into the mass markets.

DETROIT TV NOVELTIES—First radio station to duplicate AM and FM programs on TV audio is WJBK, Detroit. This newest television experiment, begun during November, enables WJBK-TV to present the feature attractions of WJBK-AM & FM simultaneously with its daily test pattern. During the initial weeks of test pattern, WJBK-TV also deviated from routine procedure by televising all transmitter equipment.

RADAR, SAND-BAR DETECTIVE, now helps clear sand bars from the paths of vessels on Lake Erie. The areas are usually marked in advance somewhere in the middle of the Lake by 50-gallon-drum buoy. For the radar application, a rod extending five feet into the air with a crossed screen on its top has been attached to buoys. This screen is picked up on the radar installed aboard the dredge.

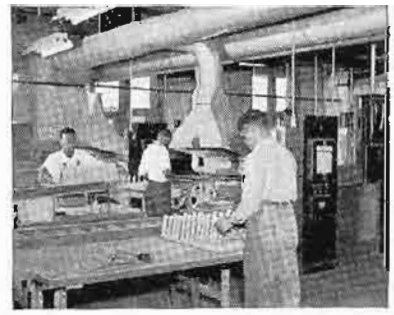
Do You Have A Copy of This MALLORY Booklet?

Up to the Minute Data on Vitreous Enamel Resistors

WHAT types of vitreous enamel resistors can you get from Mallory? What do they offer in quality and construction? What are their sizes and wattage ratings?

This newly published booklet tells you everything you want to know—tells it with charts, pictures, diagrams and specifications. It shows that the line is more complete than ever before, including standard fixed tab, adjustable and ferrule types.

Most of the resistors listed are available through conveniently located Mallory distributors, who can meet your requirements promptly. Special orders are handled by our plant in Indianapolis, where engineering assistance is available, too. Write direct for a copy of the booklet—ask for Form No. VER-1146.



Mallory Resistors Ovens are the most modern in this country. Here, where facilities are available for large scale production, enamel is applied in even thickness to insure maximum protection to winding elements and to guarantee uniform heat distribution.

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(FIXED AND VARIABLE)

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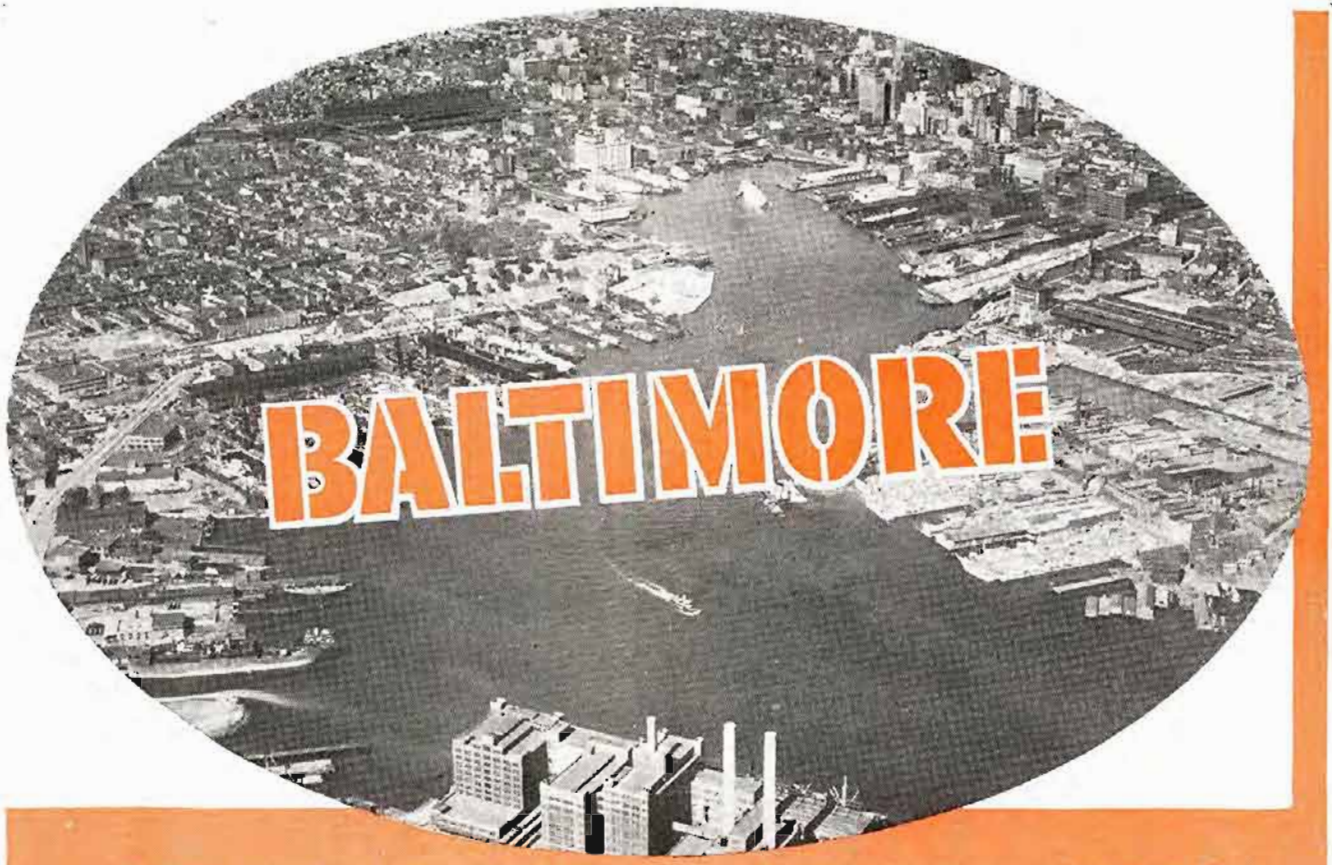


GREAT NEW "RADIO UMBRELLA" SAFEGUARDS CITY OF A MILLION

FEDERAL Equipment is used throughout one of the Largest FM Mobile Radio Networks in the United States

BALTIMORE – pioneer in police radio since 1932 – has replaced its AM system with new Federal FM Mobile Radiotelephone Equipment throughout. Change-over was expertly accomplished without interruption in 24-hour service. And now Baltimore has the advantage of clear, constant and static-free coverage everywhere in the city!

This new network gives split-second police and fire department protection to more than a million people – and covers them like an umbrella. On land and water, 300 square miles of the great seaport of Baltimore are patrolled by 215 mobile radio units. And this network of security swings into action instantly – just dial "O" and ask for "Police Radio" from any telephone.

Communications crossroads for not only the city but the nation are the Radio Rooms in the Police Building in central Baltimore. Switchboards give access to all local telephones. Teletype machines give direct links to 12 states ... indirect links to all others. Two Federal 250-watt Transmitters – to insure uninterrupted flow of intelligence – are capable of handling MILLIONS of calls a year.

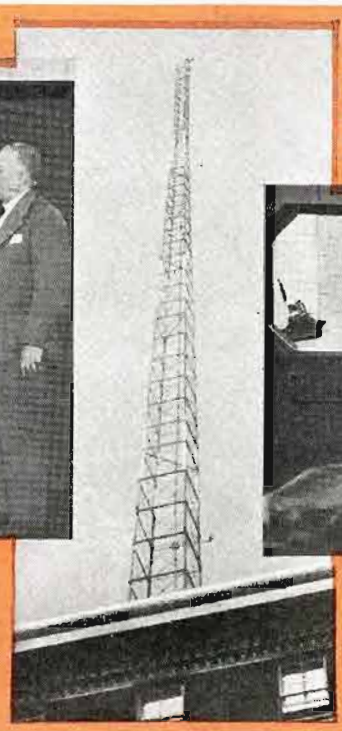
Equipped with Federal Transmitter-Receiver Mobile Units are scout, post-patrol, accident-investigating, vice-squad, detective, inspector and commissioners' cars; impounding trucks, patrol boats and district offices ... plus fire department units including 10 ambulances and 5 fire boats.

Federal is proud of this model municipal system that is demonstrating the advantages of its Mobile Radio Equipment ... equally proud of systems engineered for taxi companies, bus lines, pipe lines, utilities, lumber camps and other private accounts. For information, write to Department I-866.

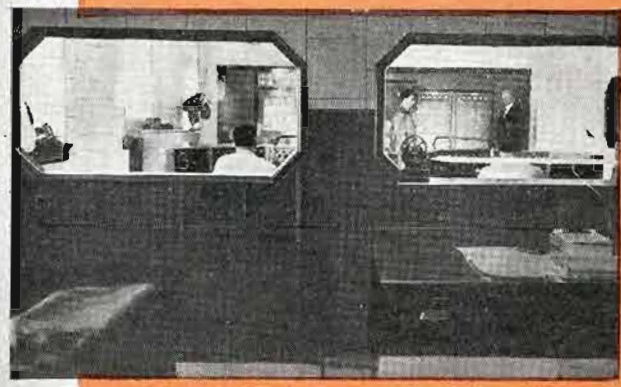
Federal

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

TWO FEDERAL 250-WATT TRANSMITTERS assure 24-hour service. One is in continuous service—the other stands by in case of emergency. Sgt. J. A. Stoltenberg, Police Radio Engineer (left) and Police Commissioner Hamilton R. Atkinson.



HIGH-GAIN ANTENNA rises 300 feet above ground. The low angle radiation pattern provides maximum signal strength throughout service area and assists in overcoming high noise level of central Baltimore.



RADIO ROOM is soundproof and air conditioned for top efficiency. In foreground are Remote Control Consoles for direction of police and fire department mobile units. Standing by Federal transmitters are R. E. Altoonian, Federal Engineer, (left) and Captain William E. Taylor, head of Baltimore's Communications Division.

Some of the various types of Public Safety vehicles equipped with FEDERAL Mobile Radio Units

Fire Boats

Police Cruisers

Accident Investigating Cars

Impounding Trucks

Municipal Ambulances

Telephone and Radio Corporation

100 KINGSLAND ROAD, CLIFTON, NEW JERSEY

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PLACE THE MIKE WHERE YOU WANT IT... *Instantly!*

Having a microphone with the proper pick-up pattern is one thing, but putting that mike in the *right place,* at the *right time,* is a problem that plagues you daily. Especially do you encounter it in table pick-ups, in dramatic and orchestral presentations, in any group broadcast where the mike must be shunted from one person to another.

It is here that you need the *flexibility* and *long reach* of a Dazor *Floating* Arm. For the mike, when attached to this fixture, may be raised, lowered, pushed, pulled, tilted or rotated in a circle with a touch of your fingers. It is held firmly and automatically in the position chosen, and at the exact angle placed, by a patented self-balancing mechanism. No locking necessary.

In radio broadcasting and studio recording the Dazor-floated microphone reduces set-up time, permits a wider working radius and easier, more complete control of background disturbances. It also makes possible livelier and more spontaneous programs . . . a *must* in night clubs, theaters and dance halls. Recommended for airport and railroad control towers, police radio networks—wherever microphone *flexibility, convenience* and *added working comfort* are sought.

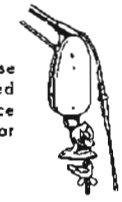
Phone Your Dazor Distributor for full details. For his name, if unknown to you, write Dazor Manufacturing Corp., 4481-87 Duncan Ave., St. Louis 10, Mo. *In Canada* address inquiries to Amalgamated Electric Corporation Limited, Toronto 6, Ontario.

MOVES FREELY INTO ANY POSITION AND STAYS PUT—*WITHOUT LOCKING*

CHOICE OF 2 BASES

UNIVERSAL

With this combination base the Dazor may be clamped or screwed to any surface—horizontal, sloping or vertical.

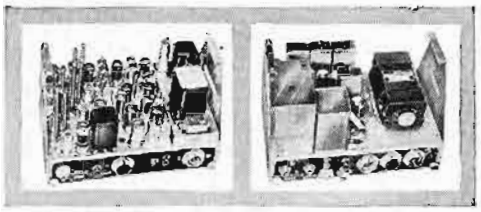


PEDESTAL

This base, a portable floor-type fixture, is equipped with rubber pads to absorb shock.

DAZOR FLOATING ARM FOR MICROPHONES

Greyhound Bus improves service, saves mileage, reduces delays with *Motorola* sets . . . .



and Sylvania Lock-In Tubes . . . . .

Dispatchers communicate directly with drivers to adjust schedules to changing load conditions.

BY MAINTAINING 2-WAY RADIO COMMUNICATION between dispatchers and buses on the road in the Chicago area, Greyhound has effected substantial operating economies – and *at the same time* has improved quality of its service to riders! Schedules are quickly readjusted, extra sections added, runs combined – as the dispatcher works with the up-to-the-minute reports coming in from drivers.

The 2-way communication is maintained by FM equipment built by Motorola, Inc., Chicago – using Sylvania Lock-In Tubes in the mobile units. These famous tubes stay put in their sockets, no matter how rough the road. They have no soldered joints, few welded ones. Short, direct connections reduce losses. Getter is located on top; separation of getter material from leads cuts down leakage.

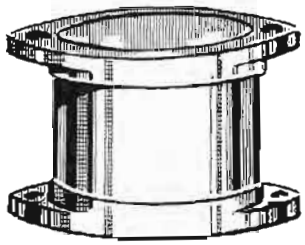
This electrical and mechanical superiority makes the Lock-In the ideal choice for equipment on the road, in the air, on the rails . . . for marine radar, FM, television. See Sylvania Distributors, or write Radio Tube Division, Emporium, Pa.

SYLVANIA ELECTRIC

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

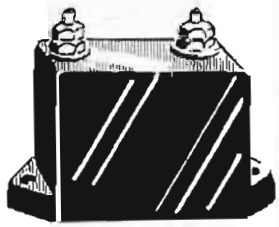
Driver can quickly report overloading or underloading, traffic conditions, weather hazards.

TRANSMITTING *Mica* CONDENSERS



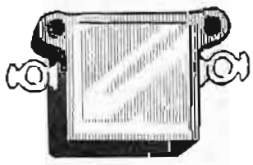
STYLE "A"

STYLE "AA"



STYLE "B"

STYLE "C"



STYLE "D"

SPECIAL LOW PRICES FOR IMMEDIATE SALE AND DELIVERY

We have literally hundreds of thousands of these top quality standard type transmitting mica condensers in stock for immediate delivery at a fraction of their original cost. Every condenser is brand new and carries the name of a fine nationally known manufacturer.

Despite the unusually low prices, these mica condensers, like all Wells Components, are fully guaranteed. Be sure to order sufficient quantities for your requirements.

Cap Mfd	Wrkg. Volt.	Price Each
STYLE "AA" CONDENSERS		
.04	1000	$3.50
.02	3000	4.50
.002	35000	15.00
STYLE "A" CONDENSERS		
25 MMFD	10,000	$1.65
STYLE "B" CONDENSERS		
.0000425	5000	$0.80
.00005	3000	.75
.00007	1140	.70
.00003	3000	.75
.00004	3000	.75
.00009	3000	.75
.000091	3000	.80
.000107	3500	.85
.0001	3000	.85
.00015	6000	1.15
.00015	5000	1.05
.0001	5000	.85
.000175	3000	1.05
.0002	1430 AC	1.00
.0002	5000	1.05
.00027	5000	1.05
.00025	5000	1.10
.0003	3000	.95
.00036	5000	1.10
.0004	3000	.95
.0004	5000	1.10
.00047	3000	1.00
.0005	3000	1.00
.0005	5000	1.15
.00056	5000	1.15
.00056	3000	1.00
.00056	5000	1.15
.000625	3000	1.05
.0007	3000	1.05
.00075	5000	1.15
.0008	5000	1.15
.0008	3000	1.00
.00095	5000	1.15
.001	4500	1.25
.001	3000	1.15
.001	5000	1.30
.00125	2000	1.10
.0011	5000	1.35
.0015	3000	1.10
.0015	5000	1.40
.0018	2000	1.10
.002	3000	1.10
.002	5000	1.40
.002	6000	1.75
.0024	3000	1.15
.0024	5000	1.50
.003	3000	1.60
.003	5000	1.70
.004	3000	1.50
.005	2500	1.40
.005	5000	1.70
.0056	3000	1.30
.006	3500	1.45
.0068	3000	1.40
.008	3000	1.45
.01	2500	1.60
.01	5000	1.95
.0125	6000	2.00
.02	3000	1.70
.025	2500	1.60
.047	2500	1.75
STYLE "C" CONDENSERS		
.000005	2500	$0.40
.00005	2500	.40
.0001	2500	.40
.0001	1250	.35
.0001	600	.25
.00015	2500	.40
.00015	1250	.35
.000175	2500	.40
.000175	1500	.35
.0002	2500	.40
.0002	1500	.35
.0002	600	.25
.00022	2500	.45
.00022	1250	.35
.00024	2500	.45
.00025	2500	.45
.00025	1200	.35
.0003	2500	.45
.00039	2500	.50
.0004	2500	.45
.0004	1200	.35
.0005	2500	.45
.00051	2500	.55
.00056	2500	.55
.000575	1500	.60
.0006	1250	.45
.0007	1250	.45
.0008	1250	.45
.0008	1000	.35
.00085	1200	.40
.001	2500	.55
.001	1200	.40
.001	600	.35
.0011	2500	.55
.0012	1250	.50
.00125	1200	.45
.0015	1200	.45
.0018	1200	.50
.002	1200	.45
.0022	1200	.50
.0024	1200	.50
.0025	1250	.50
.0027	1250	.55
.00275	1200	.60
.003	1200	.55
.0035	2500	.60
.00375	2500	.65
.00375	1000	.45
.0039	1250	.55
.004	2500	.60
.004	1250	.45
.0043	2500	.65
.0045	1000	.45
.0047	1250	.55
.0048	500	.45
.005	2500	.60
.005	1250	.45
.005	600	.35
.0051	2500	.65
.0051	1200	.45
.0056	2500	.65
.0056	1200	.45
.006	2500	.65
.006	1200	.45
.0068	1200	.55
.007	500	.35
.008	1200	.45
.009	600	.50
.01	2500	.60
.01	1250	.45
.01	600	.40
.015	1250	.55
.015	600	.35
.0175	1200	.55
.02	2500	.65
.02	1250	.45
.02	600	.35
.025	1250	.55
.03	1200	.50
.04	1200	.55
.04	1000	.45
.04	600	.35
.047	1200	.50
.047	600	.40
.056	1000	.55
.06	1000	.50
.073	500	.40
.09	1000	.65
.09	600	.45
.1	1000	.60
.1	600	.45
STYLE "D" CONDENSERS		
.00004	600	$0.20
.0001	1250	.25
.0001	600	.20
.00015	1200	.25
.00015	600	.20
.000175	1000	.30
.0002	1200	.25
.0002	600	.20
.00025	2500	.35
.00025	1200	.25
.00025	600	.20
.0004	2500	.35
.0004	1200	.25
.0005	2500	.35
.0005	1200	.30
.0005	600	.20
.00051	2500	.35
.00052	2000	.35
.00055	2500	.40
.00056	1200	.35
.0006	2500	.35
.0006	1200	.25
.0006	600	.20
.00065	600	.25
.0007	600	.25
.0008	1000	.35
.00085	1200	.35
.001	2500	.40
.001	1250	.35
.001	600	.25
.0012	600	.30
.0015	1200	.35
.0018	1200	.35
.002	2500	.40
.002	1200	.35
.002	600	.25
.0022	2500	.40
.0022	1200	.30
.0022	600	.25
.0024	1200	.25
.0025	2500	.40
.0025	1200	.30
.0027	1200	.30
.003	1200	.30
.003	2000	.40
.00375	1000	.40
.0039	1200	.40
.004	2500	.45
.004	1200	.35
.004	600	.25
.0044	600	.25
.0043	1200	.35
.0045	600	.30
.0047	2500	.40
.0047	1200	.30
.005	2500	.40
.005	1250	.30
.005	600	.25
.0051	1200	.35
.0051	600	.30
.0056	1200	.35
.0056	600	.30
.006	1200	.35
.006	600	.25
.0068	1200	.35
.007	600	.30
.008	1200	.35
.008	600	.30
.009	600	.30
.01	1250	.40
.01	600	.30
.01	2500	.50
.015	1250	.40
.015	600	.30
.014	600	.35
.0175	600	.40
.02	2500	.50
.02	1200	.35
.02	600	.25
.022	1200	.35
.025	1200	.35
.025	600	.25
.03	1200	.35
.033	1200	.35
.04	1000	.35
.04	600	.30
.047	1200	.40
.047	600	.30
.056	1000	.35
.06	1000	.40
.073	500	.30
.09	1000	.45
.09	600	.35
.1	1000	.50
.1	600	.35

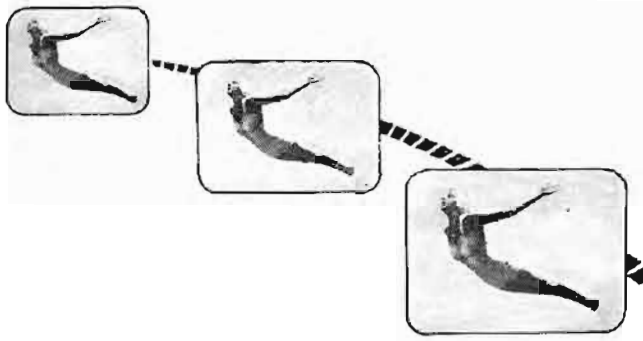
This is only a partial listing. Write or wire for information on types not shown and for receiving set micas and silver micas.

We advise distributors to order immediately from this ad. Our standard jobber arrangement applies.

Manufacturers and Distributors: Write for our complete Mica Condenser Listing No. 103A.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. T, CHICAGO 10, ILL.



The Pictures Arrive in PERFECT SHAPE Over ATV Lead-In Lines

LEAD-IN LINES play an important part in television and FM reception. To be sure of the best performance of your set, specify ATV* lines for your set.

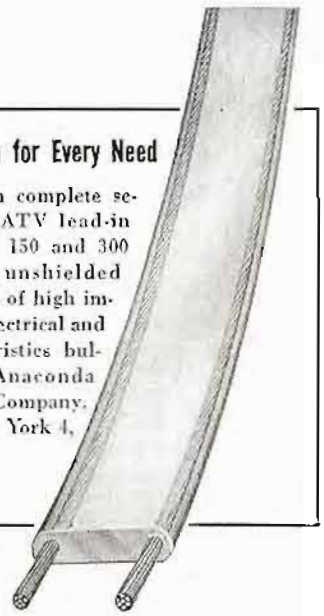
The effects of attenuation and impedance mismatch on FM and Television reception are minimized by Anaconda Type ATV lead-in lines.

The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion. Count on Anaconda to solve your high-frequency transmission problems—with anything from a new-type lead-in line to the latest development in coaxial cables.

13447

A Type ATV Lead-In for Every Need

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and shielded lines of high impedance. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.



*Reg. U. S. Pat. Off.

ANACONDA

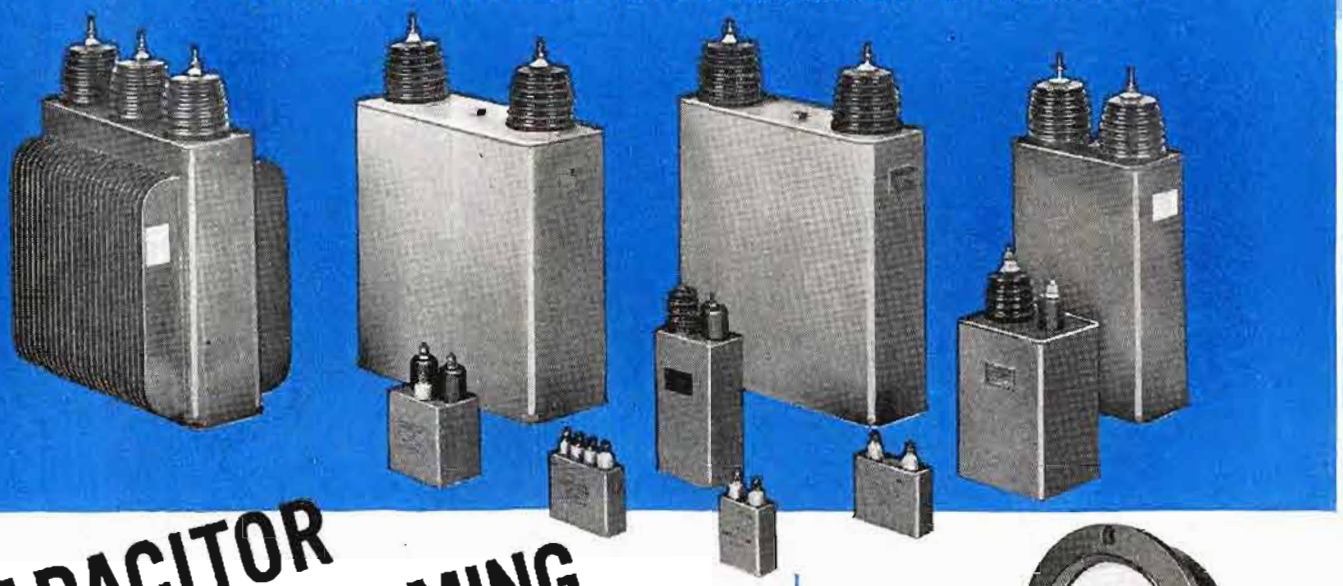
Anaconda Wire and Cable Co.

25 Broadway, New York 4, N. Y.

ELECTRONICS

Designers

NOW AVAILABLE FOR YOUR COMMERCIAL APPLICATIONS



CAPACITOR PULSE-FORMING NETWORKS

Developed by General Electric and proven by the thousands in the war, these compact units are now available for any commercial use. They find application in radar and industrial equipment where the normal capacitor discharge shape is not suitable and where an impulse having a definite energy content and duration is required. The network consists of one or more equal capacitor sections and the same number of inductance coil sections. Both capacitors and coils are hermetically sealed in the same metal container. Networks are treated with top quality mineral oil to provide stability of capacitance characteristics over a wide range of ambient temperatures. Sizes from which you can make your selection range from a 0.5-kw output rating to 4500-kw. Write for bulletin GEA-4996.

DESIGNED FOR BETTER READABILITY

General Electric's new line of 3½-inch thin panel instruments will save space and add to the appearance of your panels. They're dust-proof, moisture resistant, and vibrations normally encountered in aircraft and moving vehicles have no adverse effects. Especially designed for better readability, the scale divisions stand out by themselves. Lance-type pointers and new-style numbers mean faster reading. Available in square and round shapes, depth behind the panel is only 0.99 inches. Construction is of the internal-pivot type, with alnico magnets for high torque, good damping, and quick response. Check bulletin GEA-5102.

GENERAL ELECTRIC

Digest

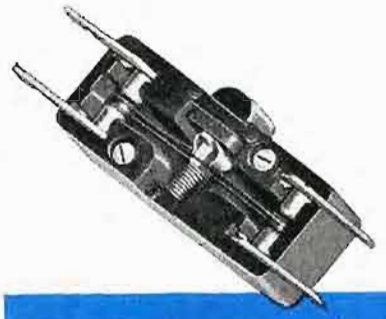
TIMELY HIGHLIGHTS ON G-E COMPONENTS

SIMPLIFY CONTROL WIRING WITH THESE TERMINAL BOARDS

Easy-action hinged covers protect control wiring, help give your product a neat appearance. Hook-ups are easy with the hard-gripping connectors. Simply strip the wire end, screw down the connector on the bare wire. Blocks are durable, too, constructed of strong Textolite with reinforced barriers between poles to insure against breakage. Marking strips are reversible—white on one side, black on the other. These terminal boards are available with 4 to 12 poles, 2 inches wide, 1¼ inches high. Send for bulletin GEA-1497C.

HOLDS OUTPUT VOLTAGE CONSTANT

This latest addition to G.E.'s line of automatic voltage stabilizers comes in 15-, 25-, and 50-va ratings. Output is 115 volts, 60 cycles. The small size of the unit makes it particularly applicable to shallow-depth installations in many types of equipment. You may have a job for this unit which will give you automatically stabilized output voltage at a low cost. There are no moving parts, no adjustments to make; long service is assured. Check bulletin GEA-3634B for more information about this and other G-E voltage stabilizers.



LOOKING FOR LIGHTWEIGHT SWITCHES?

Switchettes* are designed for applications which require a manually operated electric switch in a limited space. Though small, these switchettes are lightning fast in action and are built to withstand severe service. A wide variety of forms and terminal arrangements makes them particularly useful where special circuit arrangements are necessary. Switchette shown above has one normally open and one normally closed circuit, transferable when button is depressed. Check bulletin GEA-4888.

*Switchette is General Electric's trade name for these small snap switches.

FOR YOUR COOLING FANS

Here's a fractional-horsepower fan motor suitable for many uses because of its compact design, low servicing requirements, and extreme quietness. Long, dependable operation is assured by sturdy, totally enclosed construction. These Type KSP unit-bearing motors are of shaded pole type design with low starting torque characteristics especially applicable to fans. A continuous oil circulation system furnishes good lubrication. You can use simple, hubless, low-cost blades with the special mounting arrangement. Write for bulletin GEC-219.

General Electric Company, Section A 642-19
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

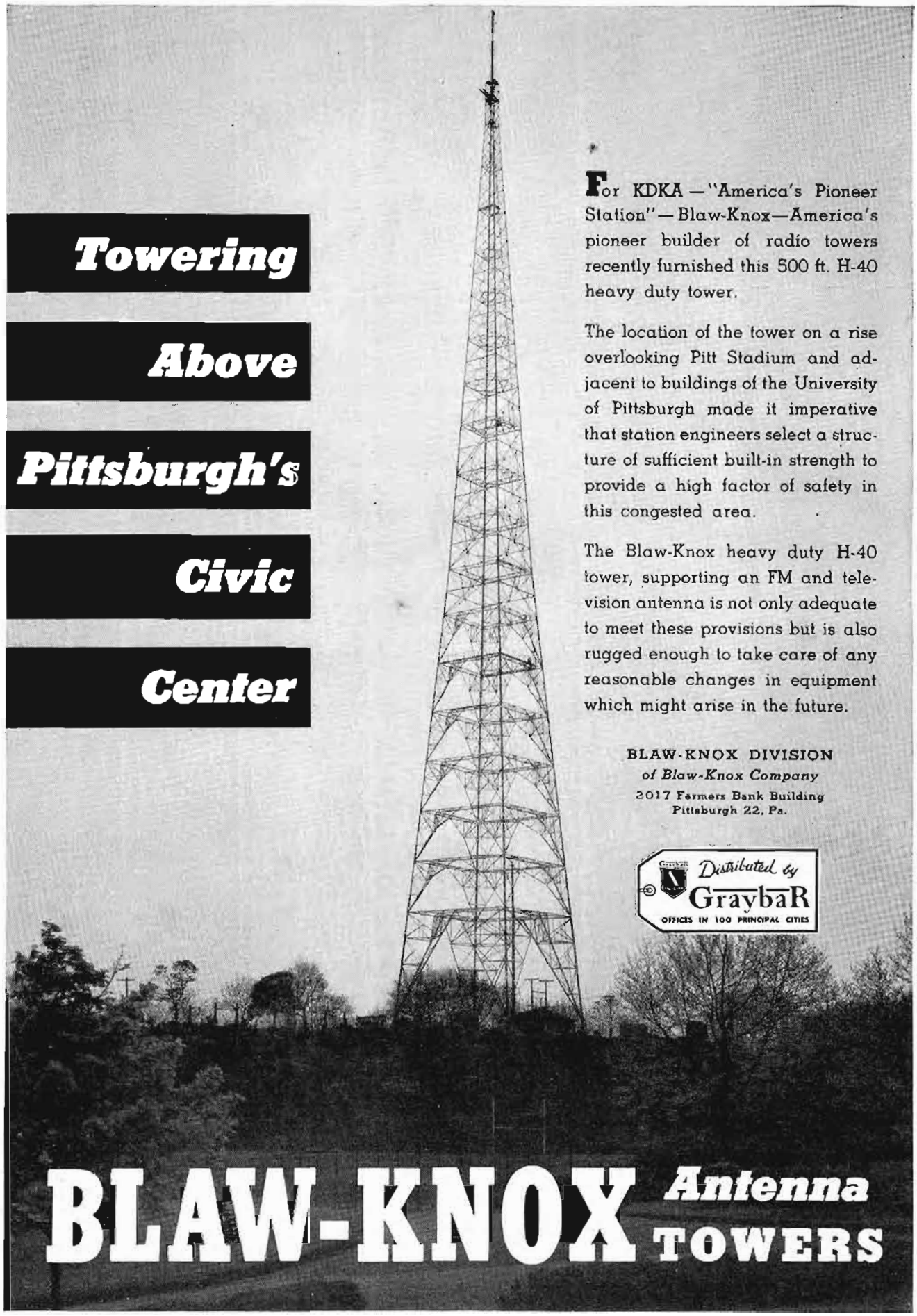
- ☐ GEA-4996 Capacitor Pulse-forming Networks
- ☐ GEA-5102 Panel Instruments
- ☐ GEA-1497C Terminal Boards
- ☐ GEA-3634B Automatic Voltage Stabilizers
- ☐ GEA-4888 Switchettes
- ☐ GEC-219 Unit-bearing Fan Motor

NAME.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....



F. S. Powell, of WIP, at the RD100 Program Dispatching unit (center panel) presets program connections to Western Electric 10 kw FM transmitter in background and to the 5 kw AM transmitter and Mutual Network.

The Western Electric RD100 *simplifies program switching for WIP*

Chief Engineer Cliff Harris of WIP says:

"Our Program Dispatching System was put into operation just before the political conventions last June. There was not a single hitch. Aided by the most complete and accurate installation data I ever saw, we simply put the equipment in and it worked perfectly. It gave us the needed solid support during one of the busiest periods in our history."

Distributed by GraybaR
OFFICES IN 100 PRINCIPAL CITIES

At WIP, Philadelphia, the Western Electric RD100 Program Dispatching System has provided an ideal solution to the ever-present problem of program switching.

By simply pushing one button, the operator simultaneously switches preset program connections between the seven studio program sources and the three output trunks to the AM transmitter, FM transmitter and Mutual Network. Circuit connections are preset at leisure in advance of station breaks.

Equipment is complete in WIP's unit for three additional inputs and three additional outputs whenever needed—a total of ten input and six output channels, which can be connected in any combination.

For further information on the RD100 Program Dispatching System, call your Graybar Broadcast Representative or write to Graybar Electric Co., 420 Lexington Ave., New York 17, N.Y.

Western Electric
—QUALITY COUNTS—

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

TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

PSYCHO-ACOUSTICS—It takes more than extended frequency range to give high-quality reproduction, points out C. J. LeBel, consultant and vice-president Audio Devices, Inc., in discussing the physiological and psychological aspects of high-fidelity hearing. For fatigue, he emphasizes, is an important and often-overlooked element in listener response,—that is, fatigue of the brain, not of the cochlea in the ear. Commercial effects of reduced fatigue designs have been demonstrated for several years in various sound-recording and sound-reproducing fields. In studying the objectives and limits of quality improvement, Mr. LeBel concludes that the point of diminishing returns is quickly reached. About 50% of the listeners, he declares, prefer a bandwidth of 8000 cycles or more, if a source sufficiently free from distortion is available.

CIVIL DEFENSE "MOBILE & TV"—Mobile and portable radiotelephone equipment and television receivers loom as a fertile field of equipping the Civil Defense centers and key points under the national program of that "missing link" in the country's defense plan which was issued in mid-November by Secretary of Defense Forrestal and Director of Civil Defense Planning Russell J. Hopley. In the other fields of communications, telephone, telegraph, standard broadcasting, amateur stations etc., Mr. Hopley and his staff visualized that in the planning for a pre-emergency civil defense the present equipment and facilities would be sufficient.

But Television has a major role of educating the public and conveying pertinent information in training of Civil Defense officials and staff aides so that Civil Defense centers and key points undoubtedly will have to be equipped with video receivers.

Mobile radio telephone equipment, together with portable units and "walkie-talkies", are all-important in the program to be utilized for emergency reports, search and rescue and directing of civil defense personnel. The National Military Establishment report on the Civil Defense Plan indicated definitely that a large amount of this apparatus would be necessary. In addition, the plan calls for a large expansion of fire departments' and police departments' radio systems and mobile units.

A TELEVISION LOOK AHEAD—In the opinion of FCC Chairman Wayne Coy there will be 1000 television stations in operation, seven or eight years from now; also that 400 TV outlets will be on the air by the end of 1950.

Chairman Coy, apparently predicating his forecast on the development of upper-band television, suggests that when the higher (500 mc) TV channels are utilized, "adaptors" at reasonable prices will be available which will enable present sets to tune to the new stations. Mr. Coy revealed that he is using an adaptor now to tune in the NBC high-band experimental station in Washington, D. C.

Cautioning that the television channel problem will not be an easy one to solve, Mr. Coy nevertheless pointed out that the best indication of the future to be traveled by TV is "the avidity" with which the public is now buying receivers. "By the end of this year, more than 1,000,000 American homes, clubs and public places will have television sets," he commented, adding that by 1955 there may be 17 million television receivers in use.

Coming Next Month, January, 1949 —

STATISTICS OF RADIO AND TELEVISION PRODUCTION

For many years the radio magazines published by Caldwell-Clements, Inc., have compiled and published the accepted basic radio-manufacture and radio-use figures of the radio-electronic industry. Collected and issued immediately at the close of the periods covered, these estimates have afforded prompt radio-industry yardsticks which time and again have been fully confirmed months afterwards when carefully-checked U. S. Census and organization figures become available.

TELE-TECH for January will continue these industry statistics of radio-TV production and use, for 1948 and for the opening of the new year.

Profit-Sharing Pay Plan for Engineers

"K" system used by General Radio Co. determines engineer's salary and gives professional employees a share in profits; dividends and bonus supplement "K" pay

By *FRANK L. TUCKER*, Treasurer, General Radio Co., Cambridge, Mass.

FLEXIBLE methods of compensation (particularly to engineers) are attracting more attention these days as a step towards the solution of some of the problems forced on business by fluctuating economic conditions. As in any new or rapidly developing field, there is a great variety of plans and ideas and considerable lack of standardization. These plans range from well-known incentive plans, such as sales commissions and factory piece rates to many forms of bonus plans, profit-sharing trusts and combinations of deferred income and retirement income plans.

Experience has been both favorable and unfavorable, and it is safe to say that in many cases too much has been expected of a particular plan or that a plan that worked very well under certain conditions was found to have serious disadvantages under changed conditions. An ideal plan would reward individuals in accordance with their individual accomplishments. It would attract and hold the type of employee the company required, and it would harmonize with and advance the objectives of the employer, particularly those having to do with profit and control of expenses. Even to approximate these advantages a flexible method of compensation would have to be worked out to fit a specific condition having due regard for the type of employee to be affected, the relationship between employee and top management, the normal range of fluctuation in the company's business and profits, and other such factors.

At General Radio we have developed over a period of years a number of different plans, and as might be expected in a company where a high percentage of its management personnal are engineers, we have experimented to a certain extent. Our monthly salaried group is composed of executive, administrative and professional personnel, most of whom are either engineers or have had engineering training. One of the basic policy objectives of the company is to maintain stable employment even if it means the loss of some business during the peaks and the loss of profits or even capital during depressions.

Value of "K" vs. Monthly Volume of Business (Expressed as % of Quota)

"K"	% of Quota
.50	22.50-26.25
.55	26.25-30.00
.60	30.00-33.75
.65	33.75-37.50
.70	37.50-41.25
.75	41.25-45.00
.80	45.00-48.75
.85	48.75-52.50
.90	52.50-56.25
.95	56.25-60.00
1.00	60.00-67.50
1.05	67.50-75.00
1.10	75.00-81.25
1.15	81.25-87.50
1.20	87.50-93.75
1.25	93.75-100.00
1.30	100.00-106.25
1.35	106.25-112.50
1.40	112.50-118.75
1.45	118.75-125.00
1.50	125.00

The various incentive features of the method of compensation that applies to engineers and others on monthly salary are designed to make this group continually conscious of the fact that they largely determine the overall success of the company. It is well established that stable employment is important to our success, and just as the shop employees in effect share the work during bad times, the monthly salaried group shares the pay. Conversely, in good times the shop has the advantage of overtime, larger piece rate earnings, and a larger semi-annual bonus; and the monthly salaried group participates in several ways on the up-side of the flexible method of compensation.

Monthly salary compensation at General Radio falls into the following categories:

(1) Monthly pay check that

Table I. History of "K"

		1940	1.167	1948	
1933	.864	1941	1.35	January	1.30
1934	1.005	1942	1.475	February	1.30
1935	1.033	1943	1.50	March	1.20
1936	1.08	1944	1.50	April	1.20
1937	1.06	1945	1.425	May	1.25
1938	.99	1946	1.1875	June	1.20
1939	1.07	1947	1.27	July	1.35

varies from month to month under the "K" system.

(2) Semi-annual bonus.
(3) Annual stock purchase bonus.
(4) Profit-sharing trust.

For the purposes of this article, we are primarily interested in the "K" system of pay for engineers which the company has used successfully for 15 years. Under the "K" plan, an engineer participates in the success of the company. He receives a base rate of pay comparable to similar positions with other companies. His actual monthly pay is this base rate multiplied by the value of "K" which is the same for all in any one month but which varies from month to month depending on the volume of business.

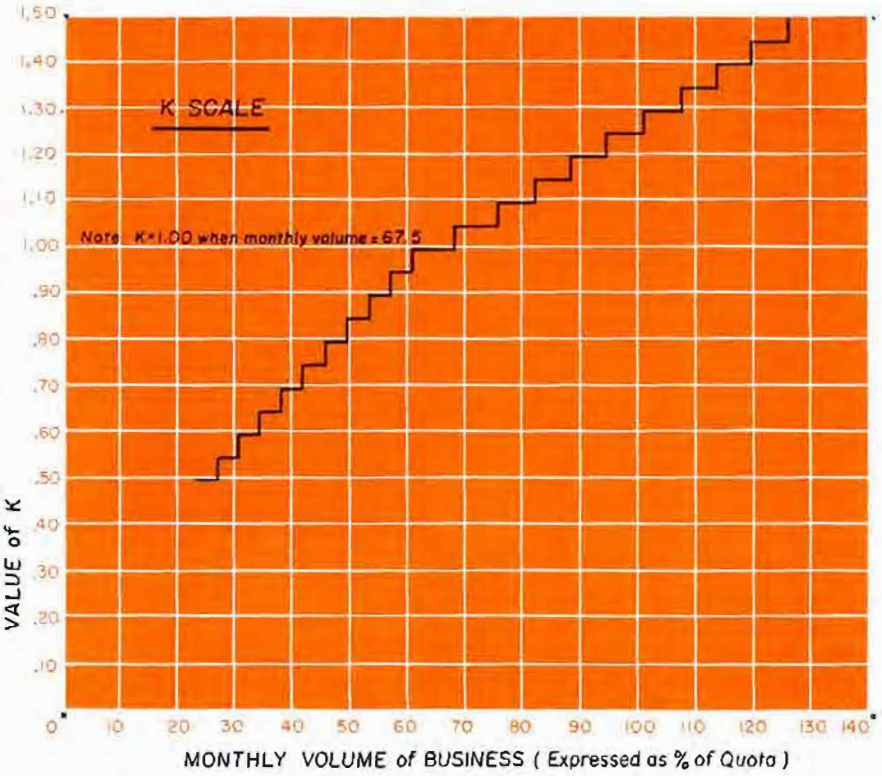
Factors Determining "K"

Thus if "K" is 1.25, a $500-a-month engineer would receive $625. Since "K" can be less than one as well as more than one, the same $500-a-month engineer would receive $425 if "K" were .80. Table I indicates the yearly average for "K" over the past 15 years. Note that it was below one in 1933 and 1938.

"K" is determined from three factors: new orders received, shipments, and factory production. The value of "K" is taken from a scale that ranges at the present time from .50 to 1.50 in bracket steps of .05. See "K" scale chart. The scale is reviewed at least once a year and is related, but not by a rigid formula, to our break-even chart and to the hours of work available to shop employees.

The "K" scale is based on an analysis of our over-all operating figures and the manner in which they vary with changes in volume. As a practical matter, it is more or less necessary to freeze all factors except volume and "K". This means that we make certain assumptions regarding material costs, efficiency, number of employees, hours of work per week and further assume that these assumptions will remain correct so long as any particular "K" scale is used. An ideal "K" scale probably would be continuously variable or perhaps operate like a complicated electronic fire control device, but not having such a complicated computing device to solve our problem for us, we review and revise the scale periodically.

The 100% of quota point on the scale is set by the Management Committee and revised as often as necessary. Perhaps it should not be called the *normal* volume of business but what the management considers to be the *optimum* volume of business under existing conditions, taking into consideration the number of employees, the size of the backlog, the rate at which orders are coming in, etc. It is not, strictly speaking, our ultimate capacity but it is what we assume our production capacity to be for the number of man hours available under the circumstances. In actual operation we do not use percent of quota but the actual dollar figures.



"K" scale showing relation of "K" value to monthly volume of business. Note that "K" is set at 1.0 for a business volume of 67.5. Any volume above 67.5 automatically increases value of "K" above 1.0 and implements bonus. See "Value of K" table opposite

Thus, for example, if we let 100% of quota theoretically equal $100,000.00, suppose that in the month of July production dropped to $50,000.00 because of vacations, shipments dropped to $75,000.00 for the same reason and orders amounted to $140,000.00. The average of these three figures equals $88,333.00 or 88.33%. Referring to the "K" scale this gives a "K" of 1.20. This July volume would determine "K" for August.

Immediately after the first of each month the Chairman of the Management Committee issues a "K" letter to all those on the "K" system. This letter gives the statistical figures on which "K" was based and the resulting "K" that will affect the size of the pay check to be received at the end of that month. The "K" letter is also used to call attention to any significant factors or developments that would be of interest to the monthly salary group, particularly when it is felt that a better understanding of the underlying facts by that group would lead to an improvement in the situation. This "K" letter is a rather important part of the "K" system since it is the medium through which the monthly salary group is continually reminded of the extent to which they and their efforts have an influence on "K" and therefore pay.

Determining Volume for "K"

In order to determine the business volume for "K" of 1.0 we developed a set of curves showing the variation of various costs with volume, using monthly salaries at base rates and omitting all bonus and profit-sharing trust estimates. This showed in graphic form the break-even point and the profit or loss at various volumes before "K" adjustments, bonus, profit-sharing trust or taxes. It is a matter of judgment whether "K" should be 1.0 at the break-even point or at some other point. It is also a matter of judgment as to how much of the available profit margin should be allocated to the monthly salary group

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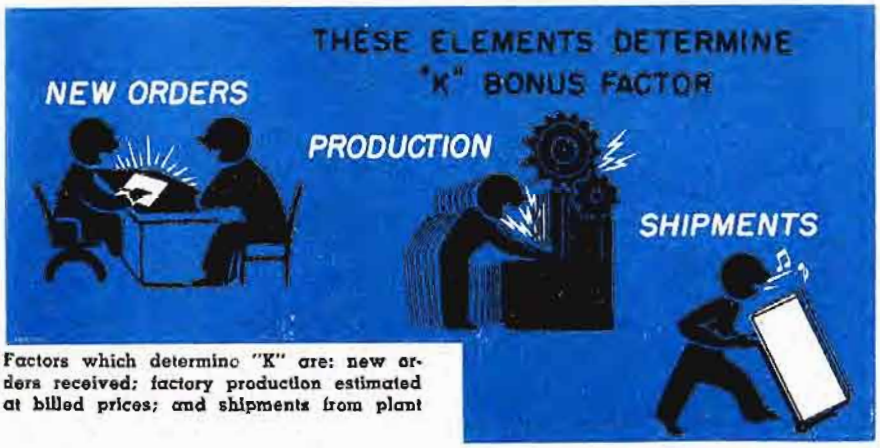
PROFIT-SHARING PAY PLAN (Continued)



Factors which determine "K" are: new orders received; factory production estimated at billed prices; and shipments from plant

in the form of extra "K," or conversely, to what extent the stockholders' losses when operating below the break-even point should be reduced by reductions in "K."

Share the Work Policy

In our own case, in addition to the consideration we give to such accounting and statistical estimates, we pay considerable attention to the probable hours of work available to the shop at each volume level. We do not have a hire-and-fire policy and it is generally understood that when business falls off we reduce hours of work for those on the shop payroll and reduce the pay of those on the monthly payroll instead of laying off personnel for either group. We believe it would be injurious to morale if the shop went on short time and monthly salaries stayed above base rates even though the engineers might actually be working overtime during that period in their efforts to develop new instruments to reverse our downward trend. For this reason there is a relationship between "K" and hours of work. It is not rigidly fixed since there are logical reasons for conditions affecting one group to be considerably out of phase with those affecting the other.

The hours of work available to the shop are based on production schedules that are set months in advance and are not changed until it is obvious that a change is necessary, which is rather infrequent. "K" on the other hand might change each month. Another point of difference is that theoretically there is a much more definite physical limitation to the amount of production a shop worker can turn out than there is to the value of an engineer's creative efforts. Here again the element of judgment is necessary in determining the extent the "K" scale is keyed to hours of work in the shop.

At the present time all of those on monthly salary participate in the "K" plan and it is automatically applied to all engineering personnel who are paid on monthly salary. Usually young engineers are rated by the hour and paid weekly. After they have demonstrated that they have the proper qualifications, usually after a period of several years, they are shifted to the monthly payroll. We consider all those on monthly salary as executive, administrative and professional employees, exempt from wage-hour overtime provisions. We treat all those not on monthly salary as subject to those provisions. At the time a person is eligible for transfer to monthly salary the system is explained. It is pointed out that he no longer is paid for overtime but shares in the overall risks and benefits of the monthly salary pay system and he is given the opportunity to stay on the weekly payroll. No one has declined the honor even though in certain cases there is a temporary loss of income for the reason that the individual may be working an unusual amount of overtime.

"K" Fluctuates With Business

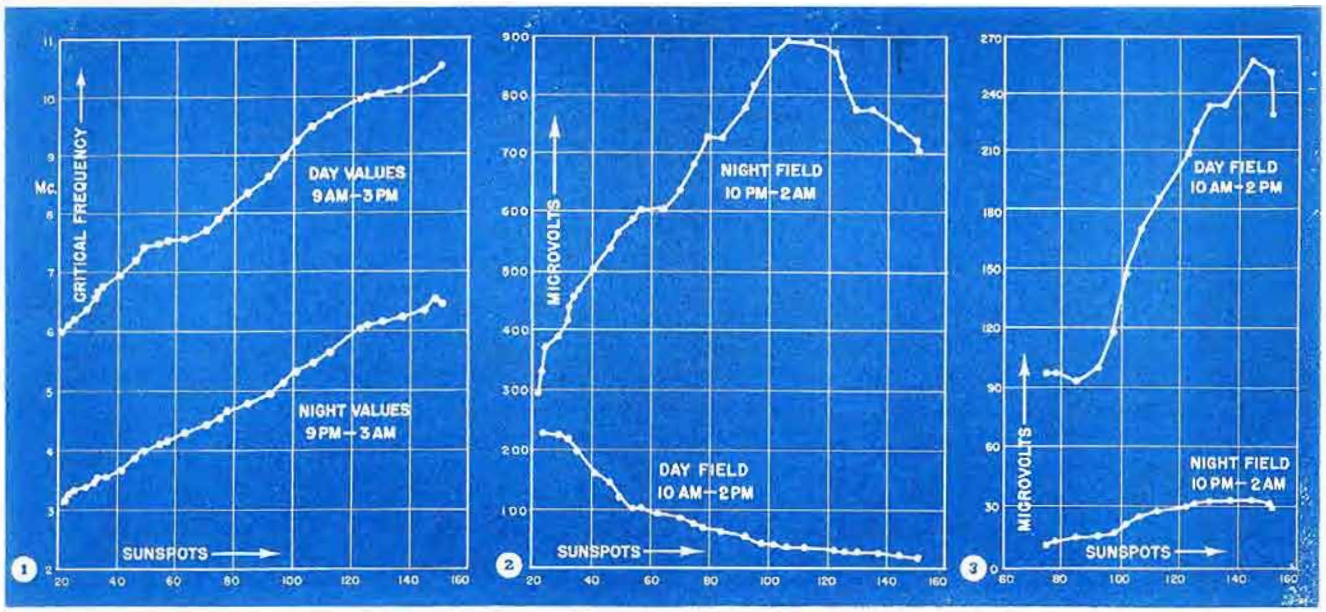
Under the "K" system the individual's pay is increased when business is good and vice versa. So long as the scale is kept on a sound basis the company gets the advantage of having all members of the management and professional groups keenly interested in the business facts of life. If some department or some group seems to be falling below par, thereby depressing "K", a very prompt reaction takes place in the direction of correcting the difficulty. Even though it may be difficult to see how certain individuals could through their own efforts change the picture, the interest they show and the very effective personal pressure they can apply somehow or other has the desired result.

Concerning the other three of our four methods of compensating employees referred to above, we have this to say: The total amount distributed as semi-annual bonus is determined by the Directors and is based on over-all company efficiency and the immediate outlook. The amount each individual receives is based on a method of rating by the Personnel Committee designed to provide the bonus in accordance with each individual's contribution during a six-month period.

Supplementary Bonuses

The annual stock purchase bonus is part of the company's long range ownership plan under which an effort is made to keep the distribution of controlling stock ownership approximately in accordance with the individual's active managerial and professional standing in the company. This bonus is paid in cash and carries with it the right to purchase a certain number of shares of stock. Although there have been exceptions, usually the amount of each individual's cash bonus exceeds the purchase price of the stock allotted to him by the amount of additional income tax he must pay. Eligibility to participate in this bonus is discretionary with the Directors. Practically all employees who have been on monthly salary for as long as two years have become stockholders under this plan.

The profit-sharing trust is qualified under Sec. 165(a) of the Internal Revenue Code. The company's total contribution is based on a formula incorporated in the plan. The company's contribution is divided up among those eligible to participate in proportion to their total compensation during the year. Distributions from this trust are at the discretion of the trustees and are not taxable to the individual until received. Our general idea is to make these distributions during periods of low income, primarily upon retirement but also during periods when pay has been reduced for other reasons.



Averaged F2 critical frequencies (left), with 5 mc (center) and 10 mc (right) field intensities observed during 1945-47 sunspot rise period

Changes in Radio Reception During Sunspot Period '45-47

By DR. HARLAN T. STETSON,
Director M. I. T. Cosmic Terrestrial Research Laboratory, Needham, Mass.

How coming reduced solar activity will affect day and night shortwave pickup

IT is generally recognized that electron density at the levels of maximum ionization in the earth's upper atmosphere is proportional to the square of the observed critical frequency; critical frequency being that frequency at which an electromagnetic wave arriving at normal incidence breaks through the layer.

If 12-months' running means of critical frequencies are taken to eliminate seasonal effects, a close correspondence exists between critical frequencies for both the E and F layers and sunspots. Curves are exhibited showing the relation of both daytime (9 am to 3 pm) and nighttime (9 pm to 3 am) values of F2 critical frequencies, determined at Washington, and sunspots based on observations during the sunspot rise between 1945 and 1947, Fig. 1. These curves show that the electron density at the F2 layer level increased in the ratio of 2.6:1 for daytime values and between seven and eight times for the night hours. Since the ultraviolet light of the sun is assumed to be the major ionizing agent, this increase in ionization with sunspots during the night hours presents some interesting cosmic problems as to the cause and the maintenance of ionization on the unilluminated half of the earth.

The field intensities at which radio waves are received over a given instance by way of the ionosphere depend both upon how well reflection takes place at the reflecting layer and also upon the amount of absorption introduced by the lower ionized layers through which the sky-wave must pass. Standardized measurements of field intensities of the Bureau of Standards standard frequency signal, WWV, have been recorded at the Cosmic Terrestrial Research Laboratory at Needham, Mass., during recent years for the 5, 10 and 15 mc frequencies. Curves of night fields of WWV 5 mc show that during the sunspot rise from 1945 to 1947 the average values recorded between 10 pm and 2 am rose from 300 microvolts to 900 microvolts when the Zurich sunspot number of 110 was reached; thereafter, field intensities decreased in value as sunspot numbers continued to rise to a maximum of 150, a value reached last year.

The decline in field strength with very high sunspot numbers is attributed to attenuation introduced by increased ionization of the lower layers. Day fields, representing averages of observations between 10 am and 2 pm showed a steady decline with increasing sunspots, a fact which again is explained on the basis of increasing absorption in the lower layers. The changes in the daytime field were from 225 microvolts when the sunspot number was 20 to about 15 microvolts when sunspot numbers were 150, as shown in Fig. 2.

For the 10 mc reception, for which observations began in October, 1945,

(*Continued on page 71*)

*Abstract from paper presented before recent meeting, American Astronomical Society at Pasadena, Cal.

Broadband Television Array

By E. C. HILLS,
Division Engineer,
Belmont Radio Corp., Chicago

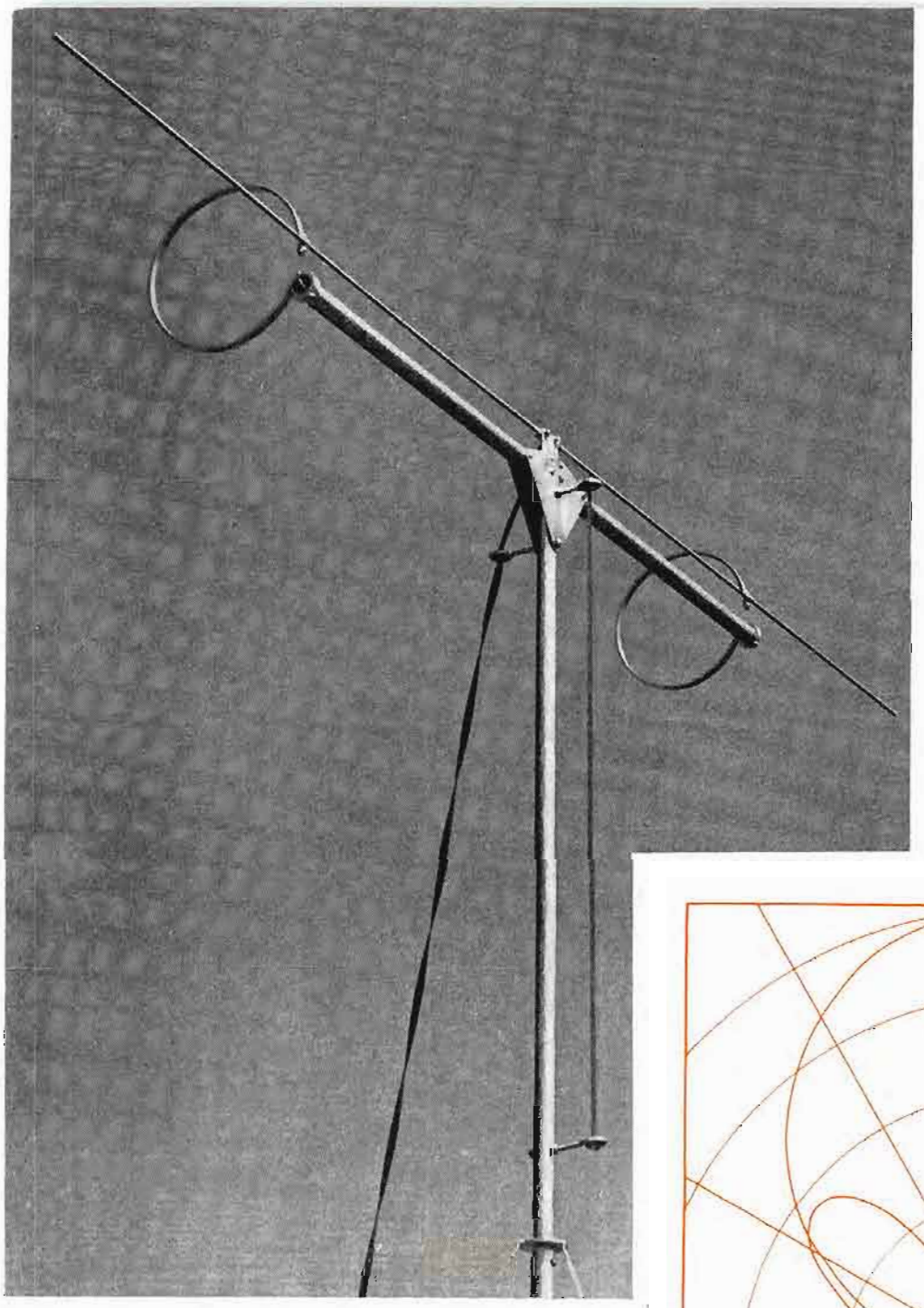


Fig. 2: Single broadband dipole with matching stub extending downward. The central short heavy dipole resonant to a mid-point in high range feeds the longer dipole at points well up on the voltage node through conductive impedance

Fig. 3: Ratio of input-to-self-resistances for two dipoles of the type shown in Fig. 2 when spaced six and a half ft.

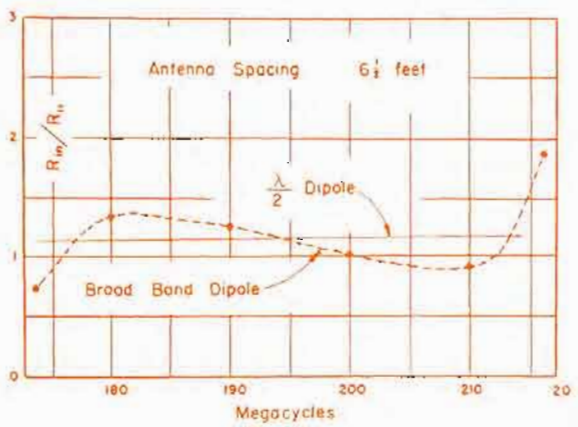
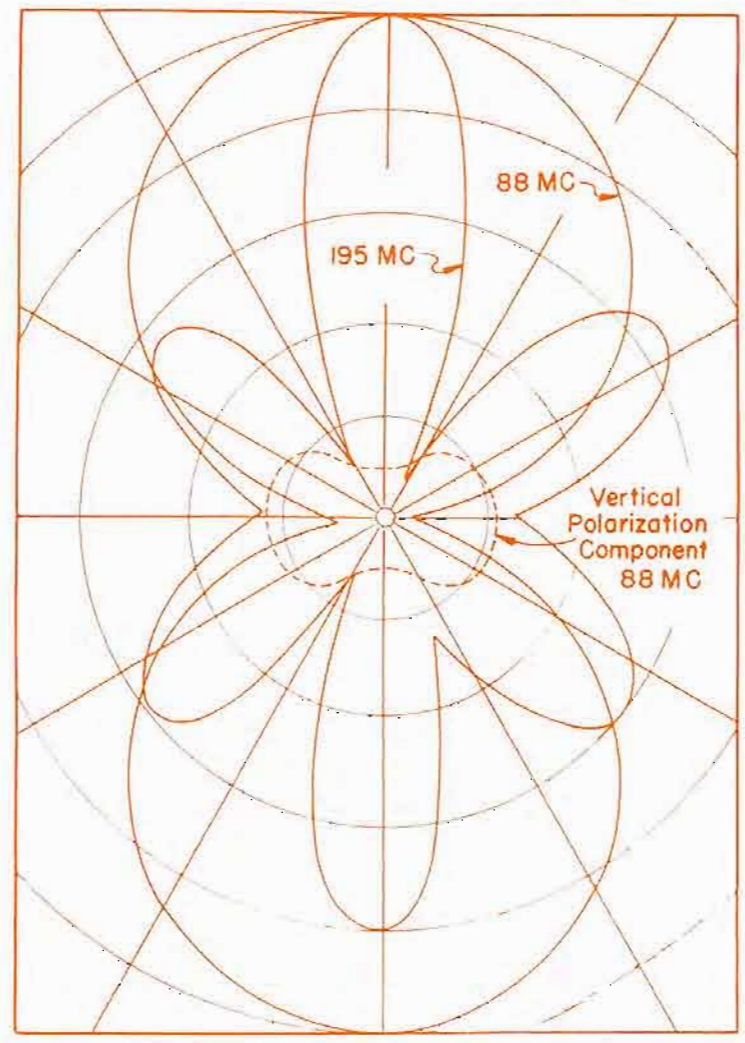


Fig. 1 (Below): Horizontal radiation patterns of the broad band dipole shown in Fig. 2 (left)



New method of gain measurement using Tricraft antenna shows advantages of two-element array; superior characteristics of two different size dipoles are cited

THE energy available from a receiving antenna depends upon signal field strength, directivity (or gain) and wavelength. As to signal output, the size is of no importance if the above three factors, together with heat losses, remain constant. The higher the frequency, (the gain remaining constant) the lower the available energy. Higher frequencies have their compensations, however, among which is the ease with which antenna directivity may be obtained.

If a uniform broadside array of half-wave dipoles perfectly matched to its line were many wavelengths across, the power it could extract from an incident wave would be roughly that of the array area. As this area decreases its gain also decreases almost linearly with area until only a single half-wave dipole is left. If the dipole is shortened, however, the gain remains nearly constant.[1]

Unless one can erect a huge antenna with an effective area greater than that of a half-wave dipole, on the basis of gain alone, he may be as well off to use one so small that it will fit in his receiver cabinet.

In television reception on the other hand, he can benefit by the advantages of a high-gain antenna, such as: (1) more signal pick-up in desired direction and (2) less noise and reflection signals (ghosts) from other directions. In the first case there is nothing that greater antenna gain will do that adding more stages to the receiver will not do, as long as the tube noise in the set does not exceed received noise, (usually true in television bands).

Noise and ghost reduction is another thing. If received noise comes equally from all directions an S/N improvement equal to the antenna gain can be expected. If from one direction, differing from that of the desired signal, S/N improvement equal to the ratio of the antenna pattern intensities in the two directions can be expected. Only when all the noise comes from exactly the same direction as the desired signal will a highly directive antenna give no S/N improvement.

If we assume that "ghost" signals are just as likely to come from one direction as another the most probable signal-to-ghost ratio improvement for the average installation due to having a high-gain antenna is equal to the antenna directive gain.

Just as it is possible (and probably even cheaper) to obtain greater sensitivity by adding stages to the receiver than by adding elements to an array, it is also theoretically possible to improve signal-to-ghost ratio by means other than the receiving antenna — use of delay lines in the receiver, for example. The alternative to this is the continued and expanding use of antenna arrays.

If two antennas were erected so far apart that they had no effect on each other the two would receive twice as much *energy* as one, so there would be a 41% output voltage increase for the same matched load impedance. As the antennas are brought near each other their individual impedances change because of the mutual impedance between the elements. Assuming the two elements form a symmetrical broadside array, their input impedances will always be equal because of the mechanical and electrical symmetry, regardless of mutual impedances.

If the elements were connected in series, (still with matched load), the voltage would be twice that for a single matched antenna (E), and the power would be:

$W_1 = E^2/R_m$ for a single antenna and

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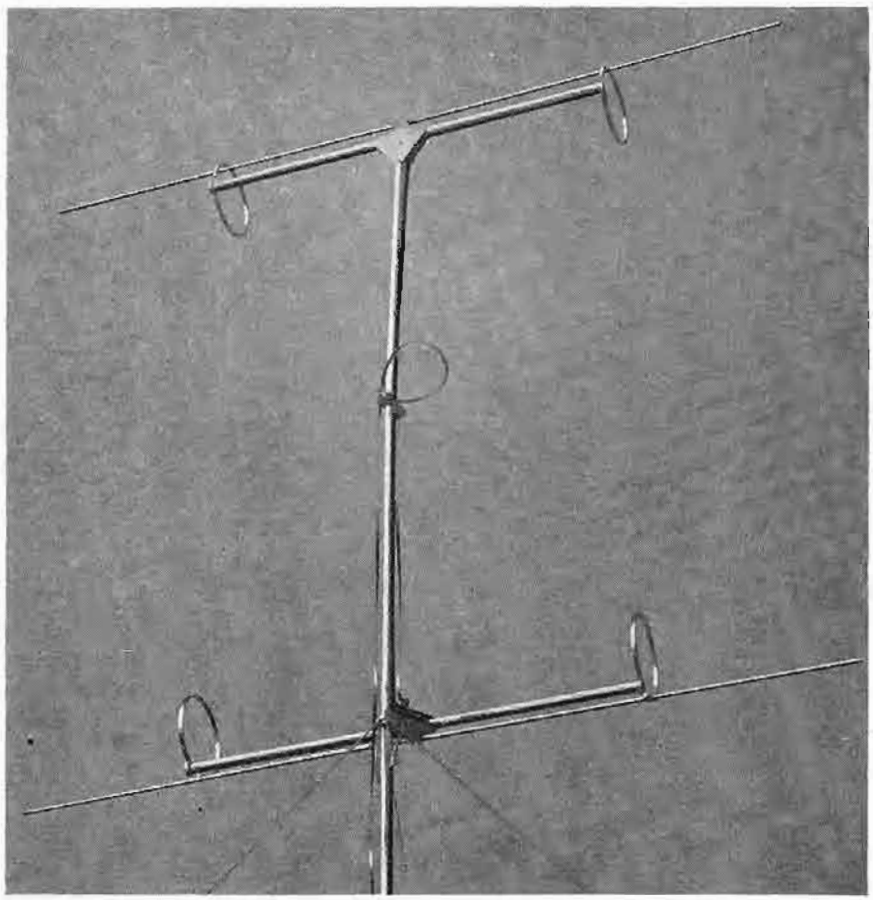
Fig. 4: A two element broadside array. Measurement of the impedance of this array facilitated calculation of mutual resistances of the dipoles in Fig. 3



[1] H. T. Friis, Transmission Line Formula, Proc. I.R.E. vol. 34, No. 5, May 1946, pp. 254-256. Theoretically, the gain of a dipole of zero length is only 0.39 db less than that of a half-wave dipole.

BROADBAND TELEVISION ARRAY (Continued)

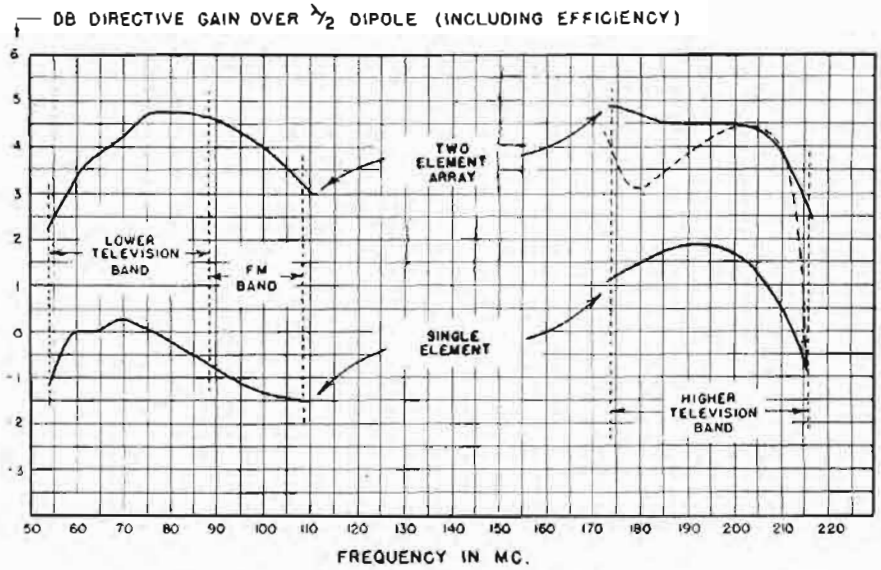


Fig. 5: (above) Gains of single element and array. Dotted curve shows gain in high band

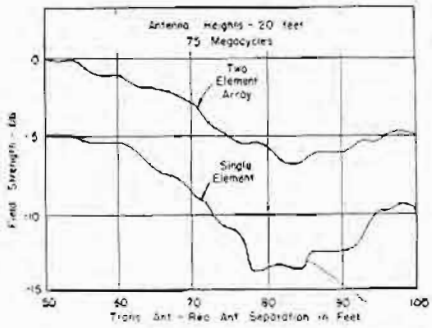


Fig. 6 (left) Signal-distance curves. Plot of Fig. 4 array against one element of array

$W_2 = (2E)^2/2R_{11}$ for a double antenna. Here R_{11} is the self-resistance of a single isolated antenna. The gain of two equals the ratio of these powers, equivalent to three db.

With spacings where the mutual impedances alter the input resistances greater or less gain than this can be expected because the doubled voltage of the two elements is applied across a lower (or higher) load resistance when matched. Neither the self or mutual reactances affect the gain since the latter appear at the element feed points as self reactances for identical element currents and the resultant reactance can be tuned out in the impedance matching process. The input impedance of an element near a second one that is carrying an identical current is:

$Z_{1a} = Z_{11} + Z_{12}$ from which

$R_{1a} = R_{11} + R_{12}$ where R_{12} is the resistive component of the mutual impedance.

Then:

$W_2 = (2E)^2/2(R_{11} + R_{12})$ and

$W_2/W_1 = 2/(1 + R_{12}/R_{11})$.

For two identical elements maximum gain is obtained with the spacing for which R_{12} has its greatest negative value. Parallel non-staggered half-wave dipoles spaced .67λ show a gain of approx. 5.6 db over a single dipole.[2] This is not necessarily the spacing or maximum gain for two antennas other than half-wave dipoles. Schelkunoff[3] shows (for two highly directive elements) that as the directivity of the individual elements increase they must be set further apart to retain a given increase in gain. Thus the mutual resistances of the radiators must depend on spacing and exist even though the radiation patterns are such that in the far zone one radiates no energy in the direction of the other.

Fig. 1 shows radiation patterns of the broad-band dipole[4] of Fig. 2 in the center of each television band. While in the lower band the radiation pattern follows that of a half-wave dipole, in the top television band the patterns differ considerably, as in Fig. 3. Here also is shown the same ratio for half-wave dipoles spaced the same distance. The mutual resistances of the former dipoles were obtained by measuring the input impedance of the array shown in Fig. 4 and referring one-half this input impedance (as measured at the series transmission line junction to the lead-in) back to the elements themselves. The dotted curve in Fig. 5 shows the gain of the array in the high band computed from the mutual resistances of Fig. 3 and the measured gain of a single dipole. The dotted curve is probably the more accurate because of a considerable spread obtained between different direct gain measurements of the array (not noted in the gain measurements of a single element).

Antenna Gain Losses

As there is actually a loss with the single element at the high end of the low band compared with a half-wave dipole, a pattern was taken to see if part of the energy was being lost as a vertically polarized component. The vertically polarized component of the antenna radiation (the dotted curve in Fig. 1) is probably due to the inductive rings at the ends of the short dipole member of a single antenna. There is little vertically polarized energy received so the low gain shown must be due either to antenna heat losses or to errors in gain measurements.

The latter were made by plotting the signal received by a half-wave dipole (adjusted for the frequency of measurement) against the distance between transmitting and receiving antennas, as the distance was varied and then repeating the plot with the half-wave dipole replaced by the antenna under test. As can be seen from the curves in Fig. 6, more than a five db gain variation could have been observed if only two single measurements had been made at two different distances. An average gain for the antenna was taken from the curves and a correction made for the fact that neither the standard half-wave dipole nor the antenna under test were perfectly matched to their transmission lines. In the measurements, an unbalanced receiver was connected through a line balancer and resistive pad to the antenna under test. The pad insured a receiver impedance of 300 ohms at all frequencies. The folded half-wave dipole used as a standard was made of copper tubing and such that its length could be adjusted for each frequency of measurement. It was connected to the same resistive pad, balancer and receiver used with the antenna under test.

This directive gain comparison considered the ratio of the transmitted signals from a distant point

[2] P. S. Carter, Circuit Relations in Radiating Systems and Applications to Antenna Problems. Proc. I.R.E. vol. 20 p. 1004 June 1932.
[3] Schelkunoff, Electromagnetic Waves Proc. I.R.E.
[4] Hills, All-Wave Television FM Antenna, Radio News, Oct. 1947 p. 49.

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DECEMBER, 1948

TELE-TECH

IN TWO PARTS
PART TWO

TELEVISION • TELECOMMUNICATIONS • RADIO

RCA -World Leader in Radio ...FIRST IN TELEVISION

FIRST IN DIRECT-VIEW RECEIVERS

RCA Victor television receivers are the acknowledged standard of the industry. They are the most successful, the most sought after, and the most copied receivers ever produced. Just recently the famous RCA Victor 8TS30 was replaced by a still better design, the 8T24 series. With this new series RCA Victor continues to lead in television receiver design.

RCA Victor also is first in television receiver production, having manufactured more television receivers than any other firm in the industry.

FIRST IN PROJECTION RECEIVERS

RCA engineers pioneered in the adaptation of the Schmidt optical system for use in television receivers, designed the first projection model receivers, and have led in the further development of projection optics.

RCA Victor produced the first commercial projection receivers to be built in large quantities—and has continued to lead in the production of projection receivers for use in the home.

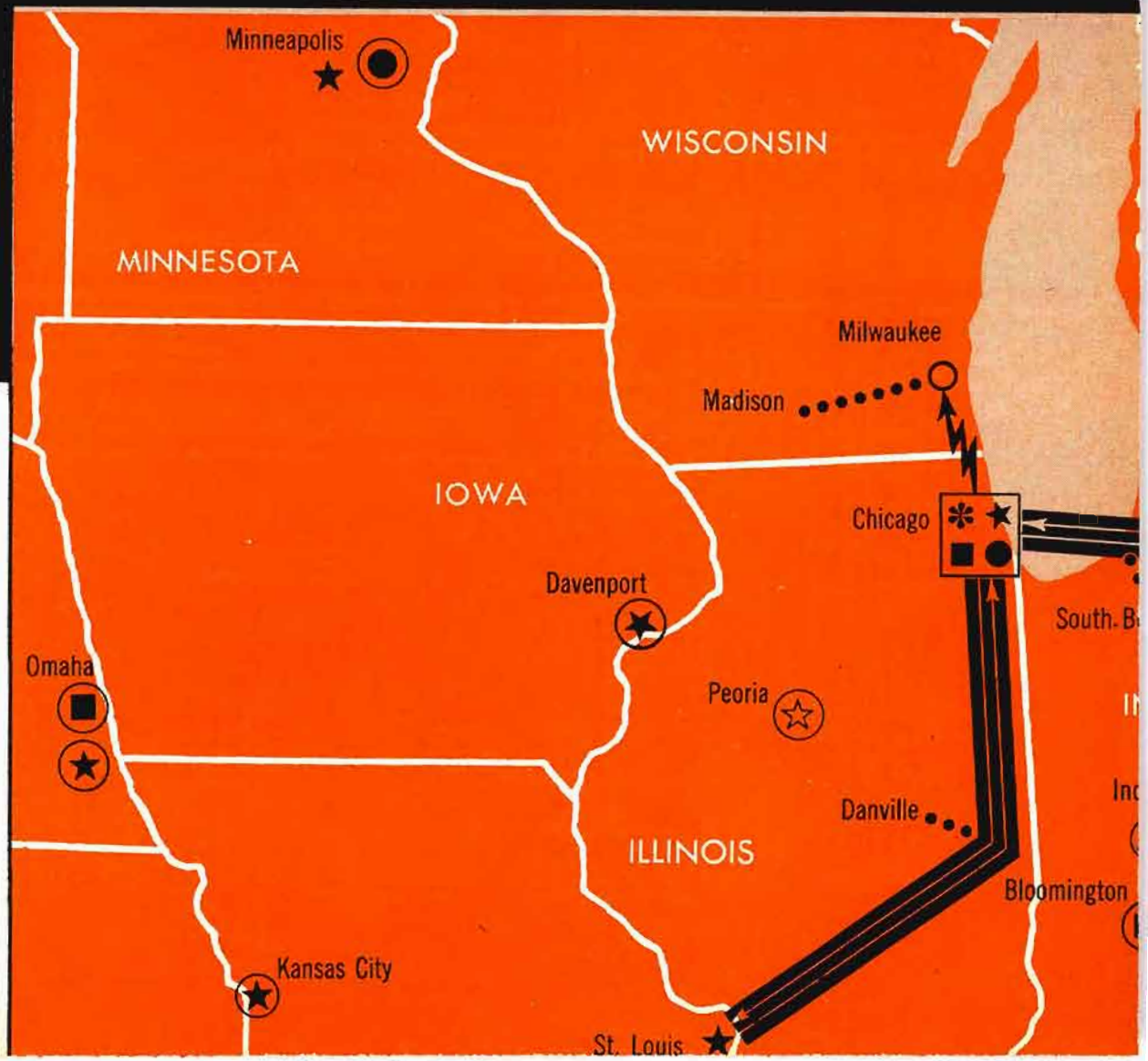
TELE-TECH
TELEVISION • TELECOMMUNICATIONS • RADIO

TELEVISION in 1949 —

TIMETABLE OF TELEVISION BROADCASTING, CHAIN AND RELAY FACILITIES THAT WILL BE IN OPERATION DURING THE YEAR

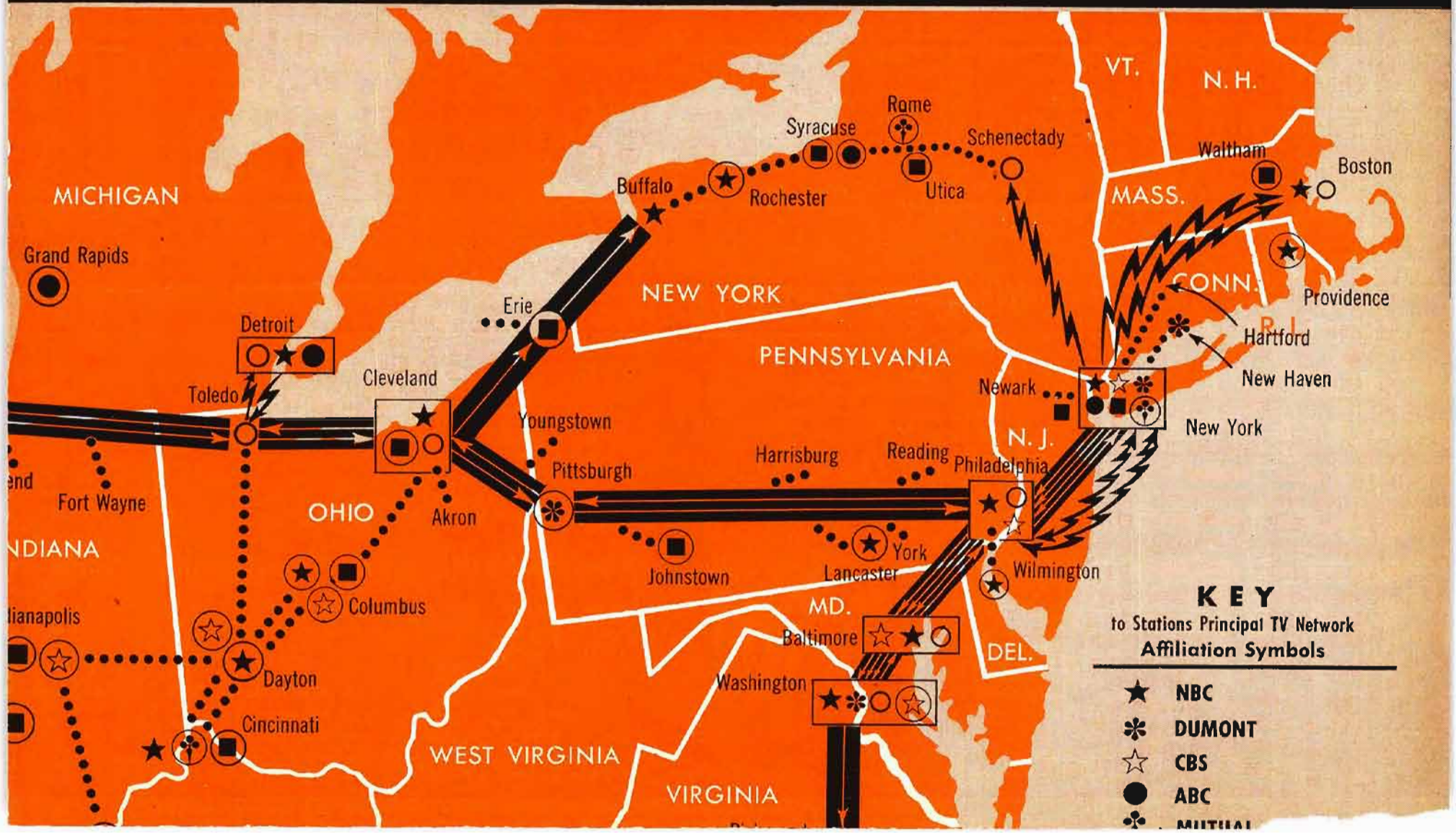
With the beginning of 1949 there will be more than one million television receivers in use throughout the country. Sales of new instruments in 1949 are expected to top the two million mark and represent a retail value of over 600 million dollars. Anticipated sales of antennas and accessories should swell this volume by an additional 43 million dollars. To show where this money will be spent, and what consumers can expect in the way of programming, the publishers present this authoritative forecast of TV broadcasting in 1949.

Reports received show that the 44 stations now on the air will be joined by 62 others in 1949. (This latter figure may be increased somewhat since some of the 18 other construction permit holders might start broadcasting sooner than in 1950 as they indicate.) These figures agree closely with those recently announced by the FCC where aside from the 122 concerns now actually engaged in various phases of television broadcasting, some 311 other applications for con- ...mits are pending.



– Stations & Networks

RADIO & TELEVISION RETAILING



RCA—First in TV research,

FIRST IN TELEVISION CAMERAS

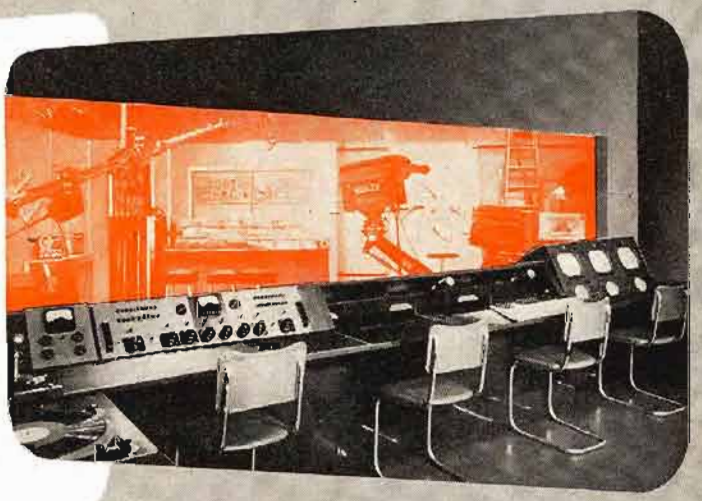
RCA engineers built the world's first electronic television cameras in the early thirties. Every notable improvement in camera design since that date has been due to their efforts. All of the television cameras in use today are similar in design to cameras first produced by RCA.

RCA produced a considerable number of commercial television cameras before the war—and since the war has produced several hundreds—of both field and studio types. RCA production of TV cameras far exceeds that of all other manufacturers combined.

FIRST IN TELEVISION CONTROL EQUIPMENT

RCA engineers, during their twenty years of television development work, designed and built a large amount of TV control equipment. Using this experience as a guide they have designed a system of standardized TV control units which can be assembled to form the control center for any TV station—large or small.

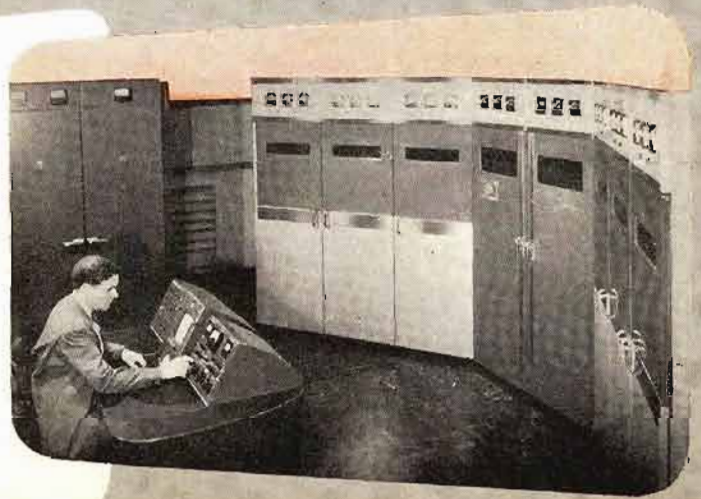
RCA is the leading producer of television control equipment. RCA has equipped most of the stations on the air today—is furnishing TV control equipment for most of the stations now under construction.



FIRST IN TELEVISION TRANSMITTERS

RCA engineers built their first television transmitter over twenty years ago—and have been continuously building bigger and better television transmitters ever since. Their experience in this field is evident in the finished design of post-war RCA Television Transmitters—the most successful electronic apparatus of this complexity ever built.

RCA has always led, and continues to lead, in the production of television transmitters. Already more than fifty RCA TV transmitters have been shipped and most of these are on the air. In fact, all but a few of the TV stations on the air today use RCA TV transmitters.



design, and production

FIRST IN TELEVISION FIELD EQUIPMENT

Portable television pick-up equipment—for making television broadcasts from points remote from the studio—was first introduced by RCA several years before the war. During the war, RCA produced portable television equipment of several types for the military services. Soon after V-J Day RCA began producing the Image-Orthicon type field equipment now in universal use.

RCA has produced more portable-type television cameras, more field-type microwave relay equipment, and more television mobile units than any other manufacturer. Nearly all the stations on the air today use RCA television field equipment.

FIRST IN THEATRE TELEVISION

RCA engineers have been working on large-screen television for more than ten years—demonstrated equipment of this size publicly as early as 1938. Using Schmidt optical systems of very large size they have recently demonstrated pictures as large as 15 ft. by 20 ft. or more.

In practical development of theatre television, RCA also leads. Joint developments have been undertaken by RCA with leading film companies under which RCA has furnished equipment to these companies for testing under actual operating conditions.

FIRST IN TELEVISION TEST EQUIPMENT

RCA introduced the first matched set-up for the precision alignment of television receivers. The RCA Television Calibrator, Sweep Generator and Cathode Ray Oscilloscope are high-precision instruments incorporating design features which reflect the wide experience of RCA engineers in television.

The RCA "TV Trio" meets all requirements for the testing and aligning of television receivers in the service shop, in the laboratory or in production and quality-check positions. Today, hundreds of these units in factory and field are serving to assure top television receiver performance.

tions Now on the Air — And Stations with Construction Permits (CP's) Scheduled to Start TV Broadcasting During 1949

Location State & City	Call Letters	Channel Number	Date On Air	Population[1] (Thousands)	Network Affiliate
Chicago	WGN-TV	9	April 1948	4,900	✲
Chicago	WNBQ	5	Jan. 1949	4,900	★
Peoria	WMBD	4	Summer 1949	500	✲ –CP
INDIANA					
Bloomington	WTTV	10	Spring 1949	250	■ –CP
Indianapolis	WFBM-TV	6	April 1949	1,500	✲ –CP
Indianapolis	WUTV	3	Spring 1949	1,500	■ –CP
IOWA					
Davenport	WOC-TV	5	July 1949	500	★ –CP
KENTUCKY					
Louisville	WAVE-TV	5	Nov. 1948	600	O –CP
Louisville	WHAS-TV	9	Summer 1949	600	✲ –CP
LOUISIANA					
New Orleans	WDSU-TV	6	Dec. 1948	1,200	● –CP
New Orleans	WTPS-TV	7	Summer 1949	1,200	■ –CP
MARYLAND					
Baltimore	WAAM-TV	13	Nov. 1948	1,200	O
Baltimore	WBAL-TV	11	Mar. 1947	1,200	★
Baltimore	WMAR-TV	2	Oct. 1947	1,200	✲
MASSACHUSETTS					
Boston	WBZ-TV	4	June 1948	2,900	★
Boston	WNAC-TV	7	June 1948	2,900	O
Waltham	WRTB	2	1949	2,000	■ –CP
MICHIGAN					
Detroit	WJBK-TV	2	Oct. 1948	2,500	O
Detroit	WWJ-TV	4	Mar. 1947	2,500	★
Detroit	WXYZ-TV	7	Oct. 1948	2,500	●
Grand Rapids	WLAV-TV	7	July 1949	1,000	● –CP
MINNESOTA					
Minneapolis	KSTP-TV	5	April 1948	1,200	★
Minneapolis	WTCN-TV	4	Feb. 1949	1,200	● –CP
MISSOURI					
Kansas City	WDAF-TV	4	Mar. 1949	1,234	★ –CP
St. Louis	KSD-TV	5	Feb. 1948	1,500	★
NEBRASKA					
Omaha	KMA-TV	3	Summer 1949	600	■ –CP
Omaha	WOW-TV	6	Summer 1949	600	★ –CP
NEW JERSEY					
Newark	WATV	13	May 1948	12,000	■
NEW MEXICO					
Albuquerque	KOB-TV	4	Nov. 1948	150	★
NEW YORK					
Buffalo	WBEN-TV	4	May 1948	1,010	★
New York	WABD	5	May 1944	12,000	✲
New York	WCBS-TV	2	July 1941	12,000	✲
New York	WJZ-TV	7	Aug. 1948	12,000	●
New York	WNBT	4	April 1939	12,000	★
New York	WOR-TV	9	Mar. 1949	12,000	✲ –CP
New York	WPIX	11	June 1948	12,000	■
Rochester	WHTM	6	June 1949	700	★ –CP
Rome	WKAL-TV	13	Summer 1949	619	✲ –CP
Schenectady	WRGB	4	Dec. 1947	1,500	O
Syracuse	WAGE-TV	10	Summer 1949	769	● –CP
Syracuse	WHEN	8	Dec. 1948	769	■ –CP
NORTH CAROLINA					
Charlotte	WBT-TV	3	Mar. 1949	717	✲ –CP
OHIO					
Cincinnati	WCPO-TV	7	Mar. 1949	1,542	✲ –CP
Cincinnati	WKRC-TV	11	April 1949	1,542	■ –CP
Cincinnati	WLWT	4	Jan. 1948	1,542	★
Cleveland	WEWS	5	Dec. 1947	1,500	O
Cleveland	WNBK	4	Oct. 1948	1,500	★
Cleveland	WXEL	9	Mar. 1949	1,500	■ –CP
Columbus	WBNT	10	Apr. 1949	760	✲ –CP
Columbus	WLWC	3	Mar. 1949	760	★ –CP
Columbus	WTVN	6	June 1949	760	■ –CP
Dayton	WHIO-TV	13	Feb. 1949	1,000	✲ –CP
Dayton	WLWD	5	Apr. 1949	1,000	★ –CP
Toledo	WSPD-TV	13	July 1948	1,500	O
OKLAHOMA					
Oklahoma City	WKY-TV	4	June 1949	575	★ –CP
Tulsa	KOVB	6	June 1949	466	O –CP
OREGON					
Portland	KTVU	3	June 1949	753	■ –CP
PENNSYLVANIA					
Erie	WICU	12	Jan. 1949	450	■ –CP
Johnstown	WJAC-TV	13	Summer 1949	750	■ –CP
Lancaster	WGAL-TV	4	Spring 1949	750	★ –CP
Philadelphia	WCAU-TV	10	May 1948	3,000	✲
Philadelphia	WFIL-TV	6	Sept. 1947	3,000	O
Philadelphia	WPTZ	3	Sept. 1941	3,000	★
Pittsburgh	WDTV	3	Dec. 1948	2,500	✲
RHODE ISLAND					
Providence	WJAR-TV	11	Feb. 1949	1,711	★ –CP
TENNESSEE					
Memphis	WMCT	4	Dec. 1948	650	★ –CP
Nashville	WSM-TV	4	Late 1949	405	★ –CP
TEXAS					
Dallas	KRLD-TV	4	Oct. 1949	1,500	✲ –CP
Fort Worth	WBAP-TV	5	Sept. 1948	720	O
Houston	KLEE-TV	2	Jan. 1949	1,287	✲ –CP
San Antonio	WOAI-TV	4	Fall 1949	700	★ –CP
UTAH					
Salt Lake City	KDYL-TV	4	July 1948	375	★
Salt Lake City	KSL-TV	5	Summer 1949	375	✲ –CP
VIRGINIA					
Richmond	WTVR	6	Apr. 1948	327	★
WASHINGTON					
Seattle	KRSC-TV	5	Nov. 1948	810	O
WISCONSIN					
Milwaukee	WTMJ-TV	3	Dec. 1947	1,000	O

[1] Estimated—50 mile radius

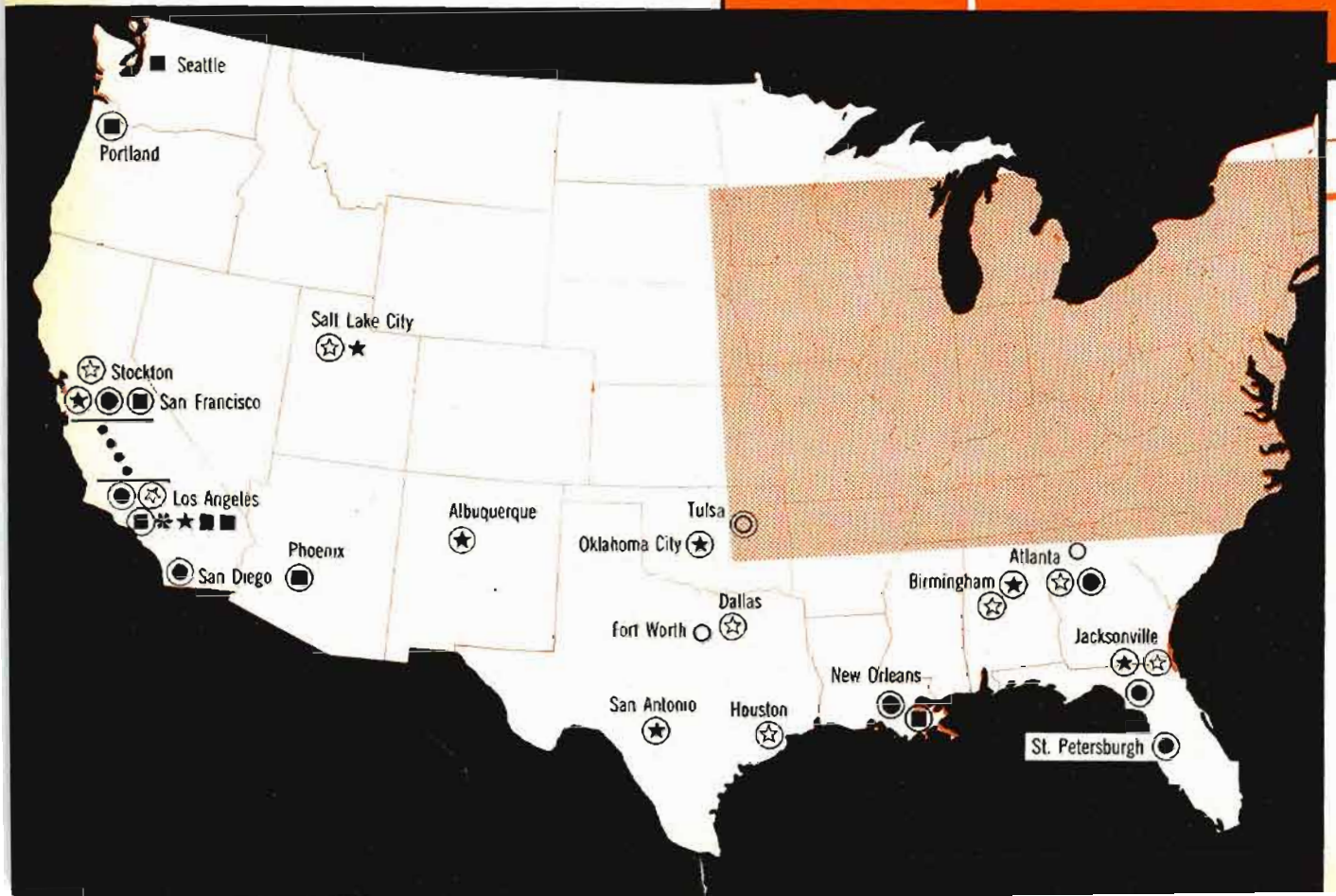
Construction Permit holders not listed because of incomplete data or data received after deadline date: KARO, Riverside, Cal.; WJHP-TV, Jacksonville, Fla.; WTVJ, Miami, Fla.; WEEK-TV, Peoria, Ill.; WHBF-TV, Rock Island, Ill.; WOI-TV, Ames, Iowa; WRTV, New Orleans, La.; WKZO-TV, Kalamazoo, Mich.; WJIM-TV, Lansing, Mich.; KTRV, Minneapolis, Minn.; WNBF-TV, Binghamton, N. Y.; WTTE, Syracuse, N. Y.; WYTL, Utica, N. Y.; WTLE, Greensboro, N. C.; KBTV, Dallas, Texas; KEYL, San Antonio, Texas; WTAR-TV, Norfolk, Va.; WSAZ-TV, Huntingdon, W. Va.

...he locations of all coaxial cable and microwave relay facilities have been included to illustrate the networking and programming possibilities in 1949. As a further aid in this connection, locations of all stations are shown with regard to their primary broadcasting network affiliate, although it must be borne in mind that, because of the current limitations in the number of facilities between points, network programming at any station may not necessarily be confined to those programs of its primary affiliate.

Compiled by

CALDWELL-CLEMENTS, Inc.

480 Lexington Ave., New York



Television Sta

Location State & City	Call Letters	Channel Number	Date On Air	Population¹ (Thousands)	Netw Affilic
ALABAMA					
Birmingham	WAFM-TV	13	Nov. 1949	600	✲ –C
Birmingham	WBRC-TV	4	July 1949	600	★ –C
ARIZONA					
Phoenix	KTLX	5	Nov. 1949	181	■ –C
CALIFORNIA					
Los Angeles	KECA-TV	7	Feb. 1949	3,700	● –C
Los Angeles	KFI-TV	9	Aug. 1948	3,700	★
Los Angeles	KLAC-TV	13	Sept. 1948	3,700	■
Los Angeles	KNBH	4	Jan. 1949	3,700	■ –C
Los Angeles	KTLA	5	Jan. 1947	3,700	■
Los Angeles	KTSL	2	May 1948	3,700	✲
Los Angeles	KTTV	11	Jan. 1949	3,700	✲ –C
San Diego	KFMB-TV	8	Mar. 1949	532	● –C
San Francisco	KGO-TV	7	Jan. 1949	2,000	● –C
San Francisco	KPIX	5	Dec. 1948	2,000	■ –C
San Francisco	KRON-TV	4	Mar. 1949	2,000	★ –C
Stockton	KGDM-TV	8	1949	1,252	✲ –C
CONNECTICUT					
New Haven	WNHC-TV	6	June 1948	673	✲
DELAWARE					
Wilmington	WDEL-TV	7	July 1949	2,373	★ –C
DISTRICT OF COLUMBIA					
Washington	WMAL-TV	7	Oct. 1947	2,500	○
Washington	WNBW	4	June 1947	2,500	★
Washington	WOIC	9	Jan. 1949	2,500	✲ –C
Washington	WTTG	5	Jan. 1947	2,500	✲
FLORIDA					
Jacksonville	WJAX-TV	2	June 1949	400	★ –C
Jacksonville	WMBR-TV	4	1949	400	✲ –C
Jacksonville	WPDQ-TV	6	Oct. 1949	400	● –C
St. Petersburg	WSEE	7	Sept. 1949	750	● –C
GEORGIA					
Atlanta	WAGA-TV	5	Nov. 1948	1,000	✲ –C
Atlanta	WCON-TV	2	Fall 1949	1,000	● –C
Atlanta	WSB-TV	8	Sept. 1948	1,000	○
ILLINOIS					
Chicago	WBKB	4	Oct. 1943	4,900	■
Chicago	WENR-TV	7	Sept. 1948	4,900	●

RCA -TV Equipment Headquarters

FIRST IN TELEVISION PICK-UP TUBES

The crowning achievement in the development of modern all-electronic television is the highly intricate and sensitive Image Orthicon camera pick-up tube. Conceived and brought to fulfillment by RCA scientists and engineers, the Image Orthicon is the outstanding means of "shooting" a television program . . . outdoors and indoors.

So complex and delicate are these super-sensitive "eyes" that the assembly of the more than 200 parts requires unprecedented precision and skill. Only RCA "know-how" can produce these in the quantities needed.

FIRST IN TELEVISION PICTURE TUBES

The point of focus in every television receiver—the picture tube—was pioneered by RCA. Today the RCA 10-inch kinescopes are being turned out by unique automatic mass production methods at the unprecedented rate of more than one a minute!

In anticipation of television's continued growth, RCA is embarked on a million dollar expansion program at its huge plant in Lancaster, Pa. . . . yet another step in RCA's continued leadership in the development and manufacture of high quality tubes at lowest possible cost.

FIRST IN TELEVISION SERVICE

RCA maintains an organization of technical specialists who pay strict attention to the correct installation, servicing, and maintenance of RCA products. This service provides all RCA dealers, distributors, and customers with whatever technical information and advice they need. It offers customers a variety of service contracts especially framed to fit their maintenance plans—and provides a nationwide staff to service such plans. Most widely known is the RCA Victor Television Owner Contract which helps RCA Victor TV set owners get best results from their receivers.

The One Equipment Source for Everything in TV—is RCA

RADIO CORPORATION of AMERICA

necessary to give the same output, with the two antennas connected to the receiver corrected for the difference in antenna mismatches. This correction would have been unnecessary (1) if the two antennas had been perfectly matched to the lines so that any difference in receiver signal would have been due to a difference in antenna directive gains alone, or (2) if the magnitudes of the standing wave ratios on the transmission lines of the antennas, (if used as transmitting antennas) had been equal.

If the transmitting and receiving antennas of the above measurements had been mounted so high (compared to their separations) that there were no near-reflecting objects, the plots of field strength/distance would have been smooth hyperbolas.

Two Antennas in Parallel

If two antennas of any input impedance are connected in parallel by a line of length equal to their separation, their mutual impedances cause the impedances seen at points 1 by the transmission lines, to differ from the input impedance of one of the antennas when isolated. If the separation is decreased to zero the configuration of Fig. 7 approaches that of a single isolated antenna and having equivalent impedance seen at point 3. Regardless of the input impedance of an antenna, the mutual impedance between two such antennas, irrespective of antenna feed point, must approach in both amplitude and phase the self-impedance of a single antenna as their separation is decreased to zero.

In the development of the array, impedance matches nearly as good as those of an individual element were obtained for separations up to three feet, but the gain in the low TV band was quite low. An individual element (similar to that of Fig. 2 but without its matching stub) had, when isolated, a resistive component slightly less than 300 ohms in the low band with a reactance changing from capacitive to inductive as frequency was increased through the center of the band. In the high band it had a resistance of the order of 75 ohms and was capacitive over most of the range. At a spacing of 6.5 ft. the mutual impedances between the two elements were approximately resistive in the centers of either band. Three hundred ohm twin lead lines 3.24 ft. long, approximately a quarter-wave length electrically at 61 mc in the low band and three-quarters of a wavelength at 182 mc in the high band, transform the individual element to values with resistive components approximately the same in the low band and higher than 300 ohms in the high band.

A series connection at the junction of the transmission lines causes the lead in transmission line to see twice the impedances at the inputs of either of the two lines leading to the dipoles. Thus the array's low band impedance is improved at the expense of that in the high band by the choice of a series connection rather than a parallel connection. This was thought desirable since the increased attenuation of the lead in transmission line at the higher frequencies decreases the amplitude of ghosts caused by reflections from imperfectly matched receivers and antennas more in the high than the low band.

In the high band the array input impedance was such that the reflection coefficient was of roughly constant amplitude but varied more than 180° in phase over the band. A computation of the position of a matching stub to correct for the mismatch over the whole band showed that such a stub would have to be located a "negative" distance from the antenna as measured along the transmission line toward the receiver. As such a position does not exist, a single capacitance of two micro-microfarads between screws in the terminal block located at the antenna and 21 in. from the transmission line junction was the only matching stub used. By increasing this capacitance the match at 185 mc could be made nearly perfect but at the expense of the match at 174 mc. The value of two micro-microfarads was chosen as a compromise for the frequencies 174 mc and 185 mc so that the mismatches at these frequencies were equal. It had substantially no effect in the low band.

More Gain Variation

As considerably more care was used in the selection of the gain measuring site for the antenna just described than would be used in an average installation, even greater apparent gain variations may be expected between two different television antennas used in a typical television installation. Only if antennas are placed high above ground in a location relatively isolated from nearly reflecting objects can the antenna with the highest free space gain be relied upon to give the greatest signal output. An antenna having only two or three db gain over another can be depended upon to provide a greater signal to the receiver only for the average of a large number of installations or for very good installations.

A properly designed and erected receiving array can provide improvements in television reception that cannot be obtained in the receiver no matter how complicated or expensive the receiver may be.

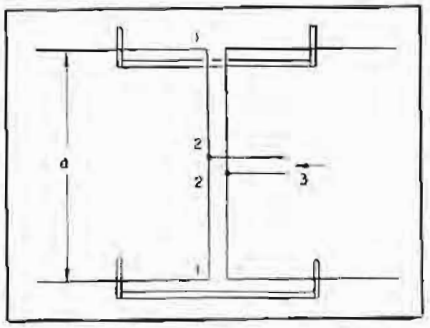
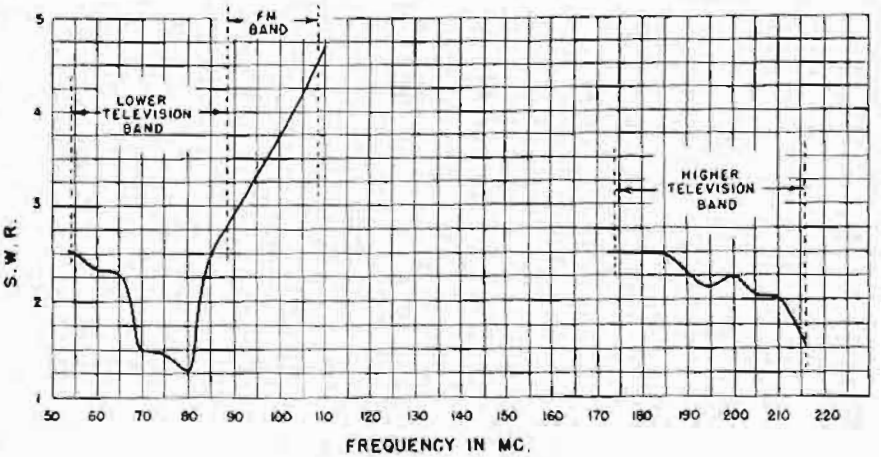


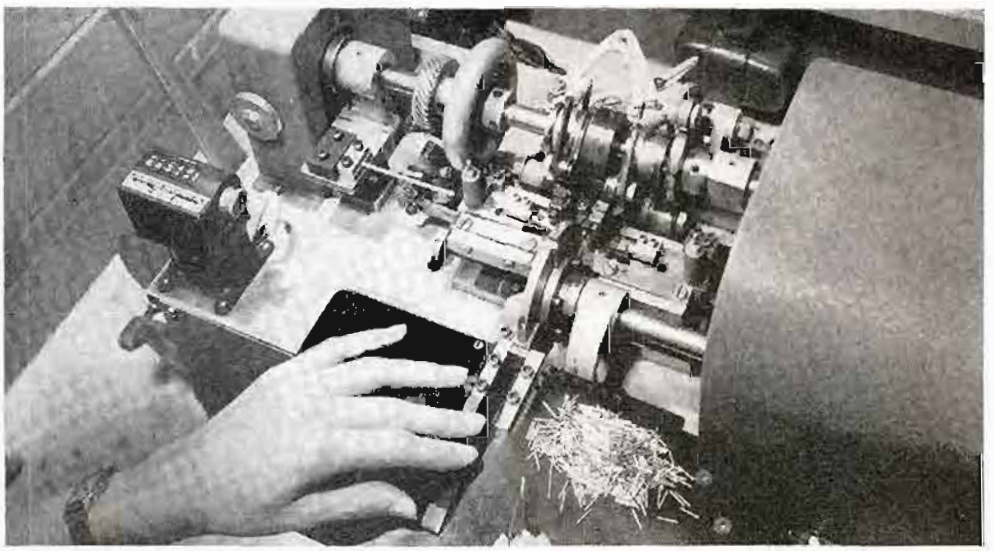
Fig. 7: (right) Dipoles connected in parallel by a distance equal to their separation

Fig. 8: (below) Standing wave ratio on 300 ohm transmission line of the array in Fig. 4



Western Electric's new Allentown plant, designed and built by the Austin Co., houses upwards of 2500 workers who can perform the hundreds of processing and assembly functions involved in the design and production of vacuum tubes and other communications equipment

Electron Tube Production Center



Cathode cylinders, about .025 inches in diameter, are placed in a machine which welds tiny wire tabs, .006 of an inch thick and .002 of an inch wide to both of their ends

In the miniature tube assembly section, each row operates as a team. So sensitive are these electronic tubes to dust and lint that employees wear special lint-free smocks

IN a pleasant setting overlooking the Lehigh River near Allentown, Pa., the Western Electric Company has recently set in operation a new plant incorporating all facilities needed in the development and manufacture of tubes and associated components in the electronic art. The layout has been based on the cumulative experience gained during 35 years of making tubes.

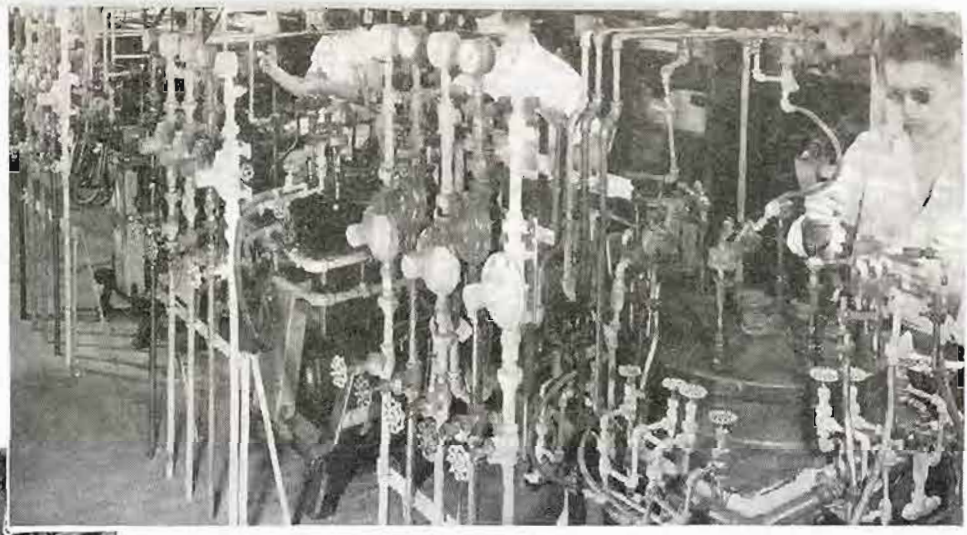
Even the architecture contributes a vital element in the production process, helping employees attain a precision in a manufacturing setup where tolerances of .0005 inches are not uncommon.

Because of the atmosphere control in this "sealed off" plant, employees work in temperatures ranging from 70 to 80° F. with 40 to 55% relative humidity. Every minute four miles of ducts and more than 500 diffusers associated with 15 air conditioning units process some 750,000 cubic feet of air and replaces anywhere from 100,000 to 300,000 cubic feet of process exhaust.

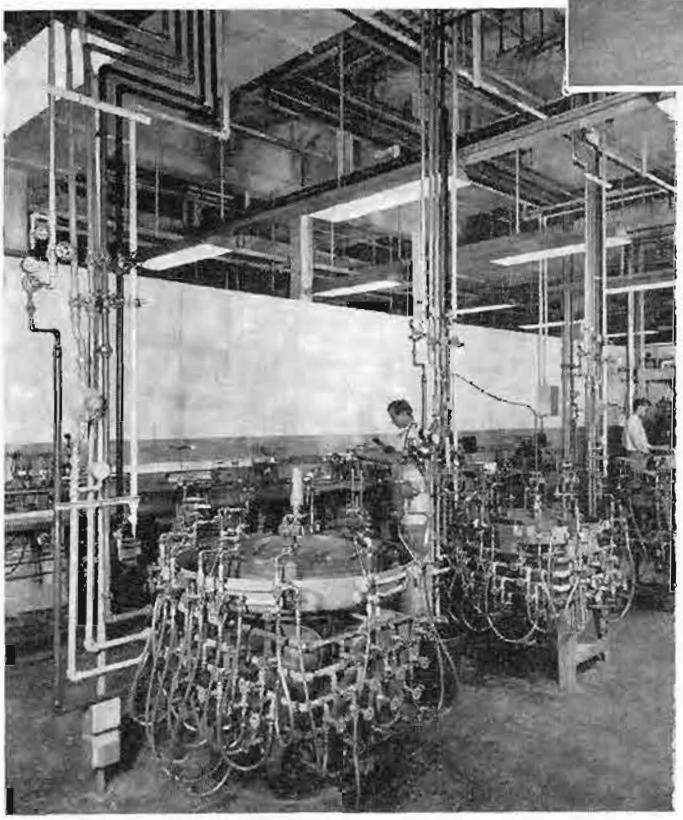
The pattern formed by the many piping systems is an intricate plaid-like design which divides the manufacturing floor into successively smaller areas, so that a hole made at any point cannot be more than 10 ft. away from a complete set of pipes.

More than 40 miles of piping carry twelve different services: house water, cold city water, steam, condensate return, cold soft water, and hot soft water, low pressure air, high pressure air, city gas, hydrogen, nitrogen, and oxygen. The photographs here show only a few of the many interesting processes in operation for producing millions of special purpose tubes.

New plant design affords ideal working conditions and provides highly flexible production facilities

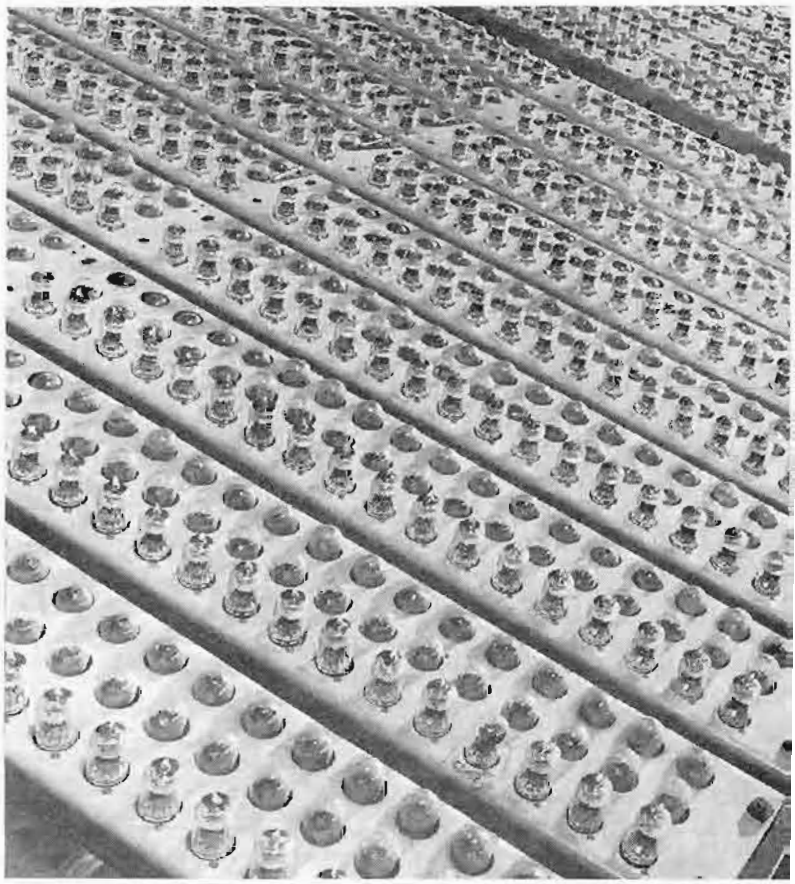


Above: An intricate array of color coded pipes and indicating gages supplies each machine with all necessary gas, air, water services

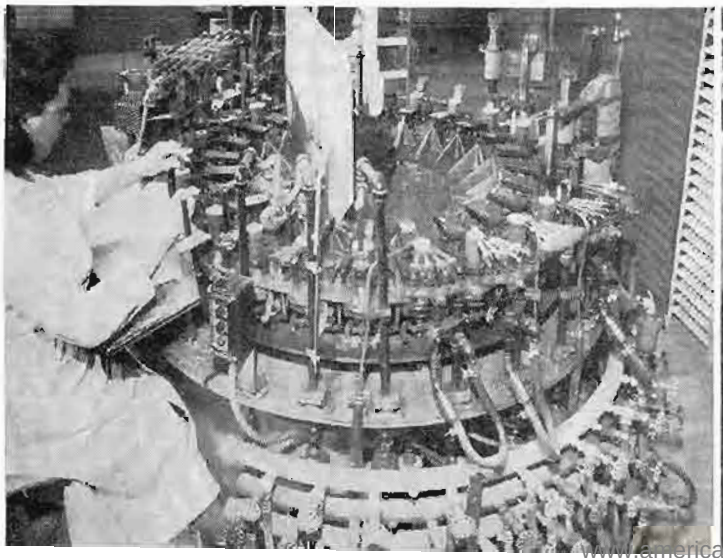


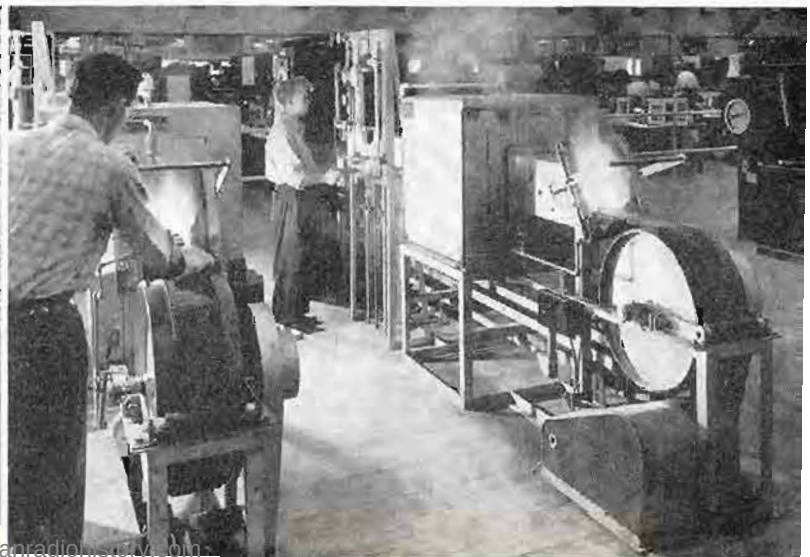
Above: A partial view of the glass development laboratory maintained as branch of Bell Telephone development system

Right: Aging rack where miniature tubes are aged under carefully-controlled conditions to assure stability and uniformity of performance. Here nearly 600 408A tubes are subjected to two hour and twenty minute aging cycle



Below: Rotary machine (left) prepares 7-pin glass bases for 408A miniature tubes. Belt conveyor type hydrogen annealing furnaces braze, anneal, and clean metal parts





Simplified TV Receiver

Hazeltine Lab's new radio frequency tuner incorporates a compact sliding carriage which carries tuning elements

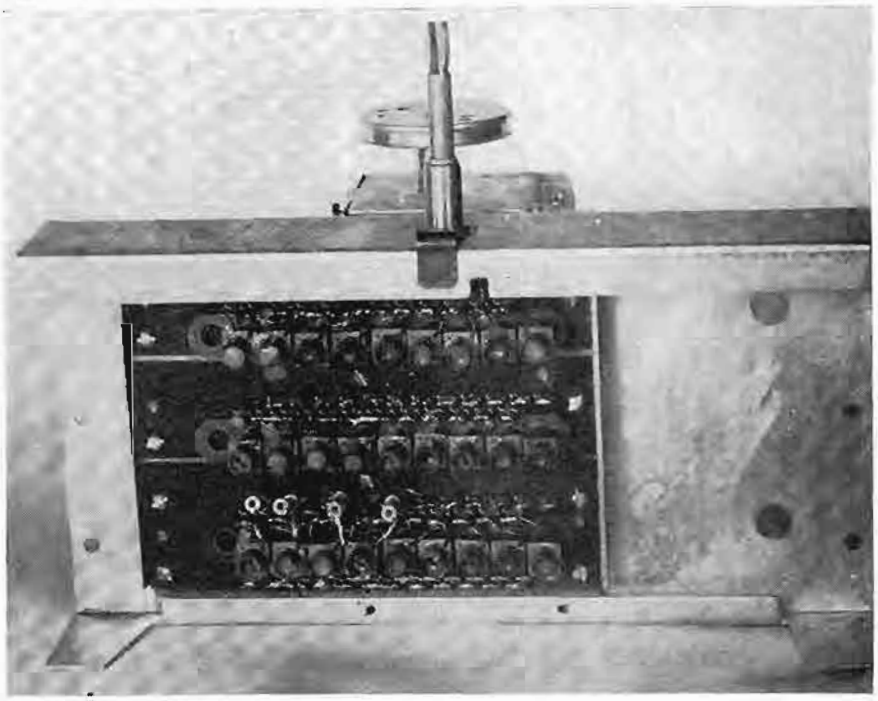
By J. A. HANSEN, Engineer in charge, License Laboratory, Hazeltine Electronics Corp.

DURING the postwar period a number of television tuners embodying various mechanical and electrical designs have been produced. These tuners have employed numerous methods for channel selection including wafer switches, rotating turrets, capacitive tuning, permeability tuning, and mechanically variable inductive tuning. Electrically there has been a wide variety of circuit arrangements. Some tuners have used three tuned circuits and others have used two; some have used triodes and others pentodes; some have had tuned input circuits; some have been push-pull and others single-ended. Each of these arrangements has its own particular advantages and disadvantages as regards electrical performance and mechanical convenience. In the interests of cost and manufacturability, it becomes necessary for the designer to make certain compromises; however, these compromises must be such that acceptable electrical performance and mechanical operating convenience are maintained.

The tuner to be described here is of novel mechanical design for television purposes in that it uses a sliding carriage or coil tray to mount the various tuned circuits and their associated switch contacts. For channel selection the carriage is moved back and forth across a set of fixed switch contacts. Such an arrangement has the electrical advantage of the turret type of construction in that lead lengths are held to a minimum. Mechanically it is somewhat superior to the conventional turret which, when completely assembled, usually does not permit ready access to its tuned circuits. As can be seen from the photograph of Fig. 1, the coils and associated components and switch terminals are readily accessible in this design.

The three main mechanical parts of the tuner are shown in the photographs of Fig. 1 and 2. These are: (1) a wrap-around or main frame, (2) the sliding carriage or coil tray, and (3) a small tube chassis. The sliding carriage slides in a track or V-groove located near the front of the wrap-around. Two tabs on the carriage which engage this V-groove insure correct mechanical alignment. Movement of the carriage is accomplished by a rack and pinion gear operated by the tuning shaft protruding from the front side of the unit. A detent mechanism is provided to insure accurate resetting to all channel positions.

Fig. 1: Bottom view of tuner shows three bakelite strips carrying slug tuned coils and capacitors for channels 2 to 13, which connect successively to fixed contacts in circuit



The r-f coils are mounted on bakelite strips which carry one set of the switch contacts. Three separate strips are used, one for the tuned input circuit, one for the interstage coupling circuit, and one for the oscillator tuned circuit. These strips and coils can be assembled and wired as subassemblies before being mounted on the sliding carriage. The several sets of mating contacts are carried by another bakelite strip which is mounted on the main frame of the tuner. The contacts were designed to provide good contact pressure and to tolerate a reasonable amount of mechanical misalignment. In the tuner design, the mechanical misalignment is minimized by accurately locating the V-groove and the guiding tabs with respect to the bakelite strips carrying the contacts. The results of a life test in which a tuner was operated for over 10,000 cycles showed no appreciable change in

Channel Switching Mechanism

electrical or mechanical performance.

The tube chassis which mounts the three miniature tubes and their associated circuit components is located on the top of the main frame. This unit is also wired as a subassembly with the connections to the fixed contacts being made after assembly.

An oscillator trimmer capacitor is provided for vernier tuning. This capacitor is of the grounded "flatted-shaft" type which when rotated varies the capacitance between an outer sleeve and ground. The shaft of this capacitor may be operated by a drive coaxial with the main tuning shaft through a pair of friction discs or by means of a string or belt drive, as desired. A vernier tuning range of approximately 2 mc on the low frequency channels and of 3.5 mc on the high frequency channels is obtained.

The over-all dimensions of the wrap-around or main frame are 8-7/16 inches long by 4¼ in. wide by 1⅝ in. deep. The tube chassis extends approximately 2 in. above the top of the wrap-around. While originally intended for horizontal mounting on a chassis, other mounting positions have in some instances been found desirable. Fig. 3, for example, shows the tuner mounted vertically in a typical receiver chassis. The chassis area required in this installation is only slightly greater than that required for several of the small sized widely used tuners. A gear drive for the main tuning shaft and a belt drive for the vernier tuning, driven from coaxial shafts, have been provided. The gear ratios were chosen so that the carriage travels from its channel 2 position to its channel 13 position for about 305 degrees rotation of the tuning control, thus permitting the use of a normal type channel indicating device. A photograph of the tuner removed from the chassis appears in Fig. 4 and shows the gear drive mechanism.

As indicated on the circuit diagram of Fig. 5, the tuner uses three tubes: a type 6BH6 rf amplifier, a type 6AG5 modulator, and a type

(*Please turn to next page*)

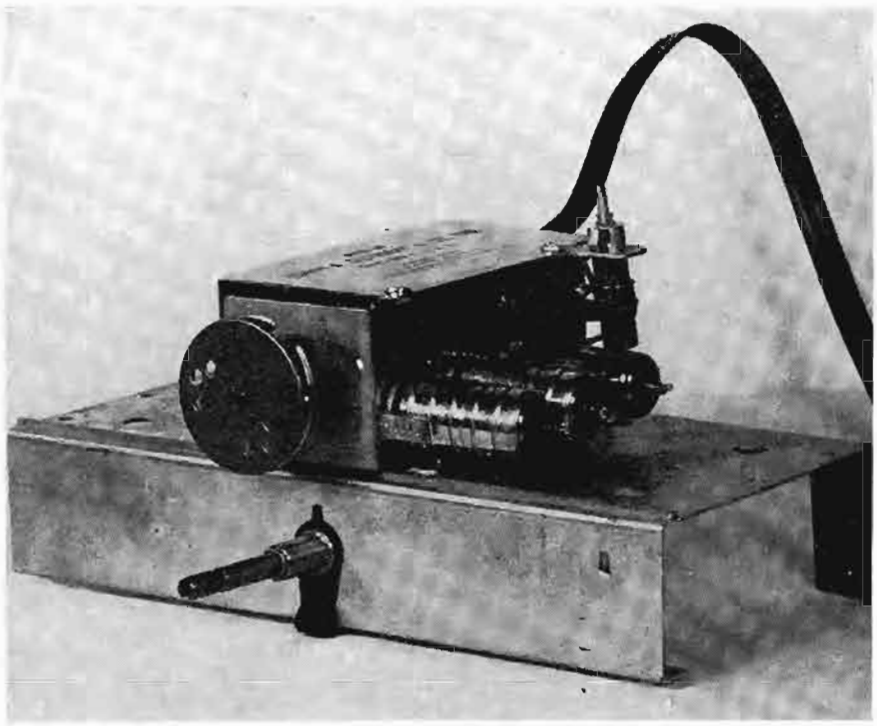
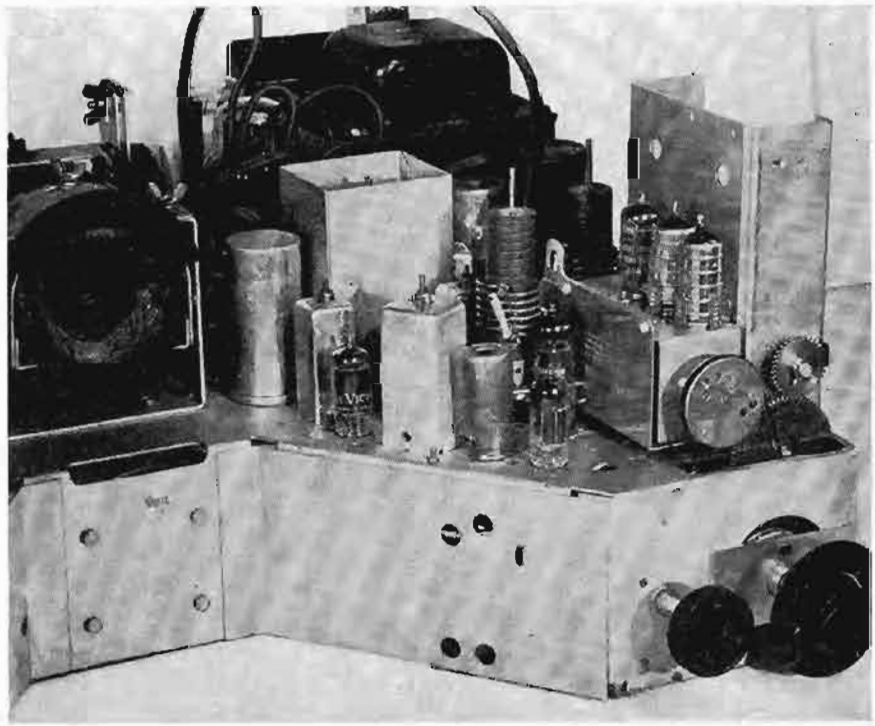


Fig. 2: Operating control with rack and pinion drive permits tuner to be mounted in several positions. Three tubes provide r-f amplification, mixer, and local oscillator

Fig. 3: Tuner may be mounted horizontally or vertically. In TV receiver shown, tuner is mounted vertically and vernier control of oscillator frequency is driven by a belt



TV CHANNEL SWITCHING MECHANISM (Continued)

6C4 local oscillator. Two tuned circuits, one ahead of the r-f amplifier and one in the interstage coupling, are provided.

The tuner is designed for use with a balanced 300 ohm transmission line which is coupled to the r-f amplifier grid through an antenna transformer which approximately matches the line to minimize reflections. The use of a tuned circuit ahead of the r-f amplifier stage aids materially in reducing cross-modulation effects, tends to reduce local oscillator radiation, and reduces the susceptibility of the tuner to interference caused by double conversion effects which can occur if substantial local oscillator voltage exists on the r-f amplifier grid.

The r-f amplifier output is fed to the modulator grid through a series-tuned circuit. This circuit is stagger-tuned with respect to the antenna circuit on the five low frequency channels but is tuned to the same frequency as the antenna circuit on the high frequency channels. This requires wider bandwidth for the high frequency channel circuits, a condition which normally occurs due to the increased tube loading at these frequencies. The series-tuned interstage coupling circuit effectively connects the two tube capacitances in series and permits the use of higher inductance coils than would be possible with shunt-tuning, in which case the tube capacitances would be in parallel.

Separate adjustable coils, tuned with brass slugs, are provided for the five low frequency channels and for four of the high frequency channels (channels 8, 10, 12, 13). For the remaining three channels (channels 7, 9, 11) incremental coils are used, each of which is in series with the corresponding coil for the next higher frequency channel. The use of individual slug-tuned coils for most of the channels makes for ease

(*Continued on page 72*)

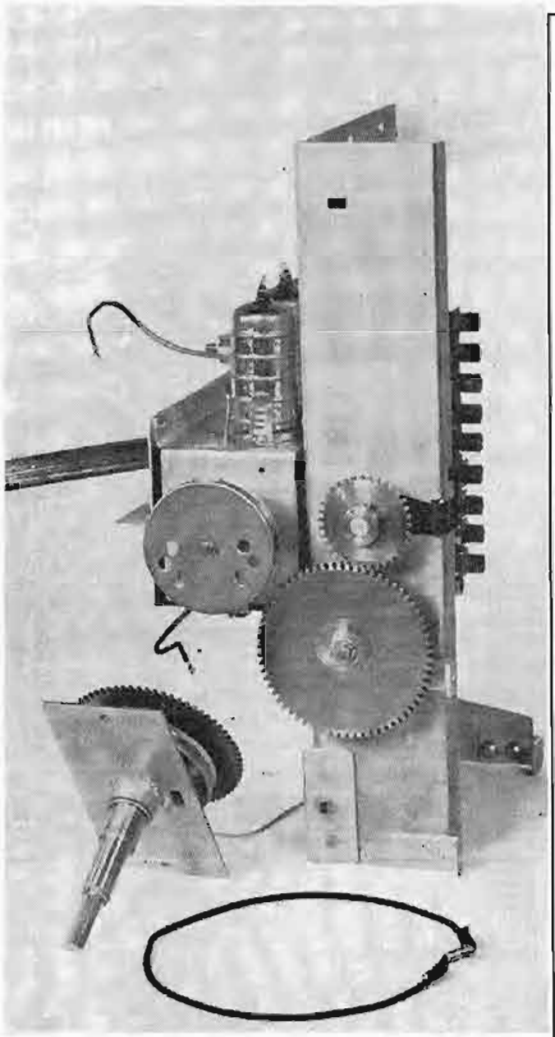


Fig. 4 (above): Photo of tuner removed from the chassis showing gear drive mechanism

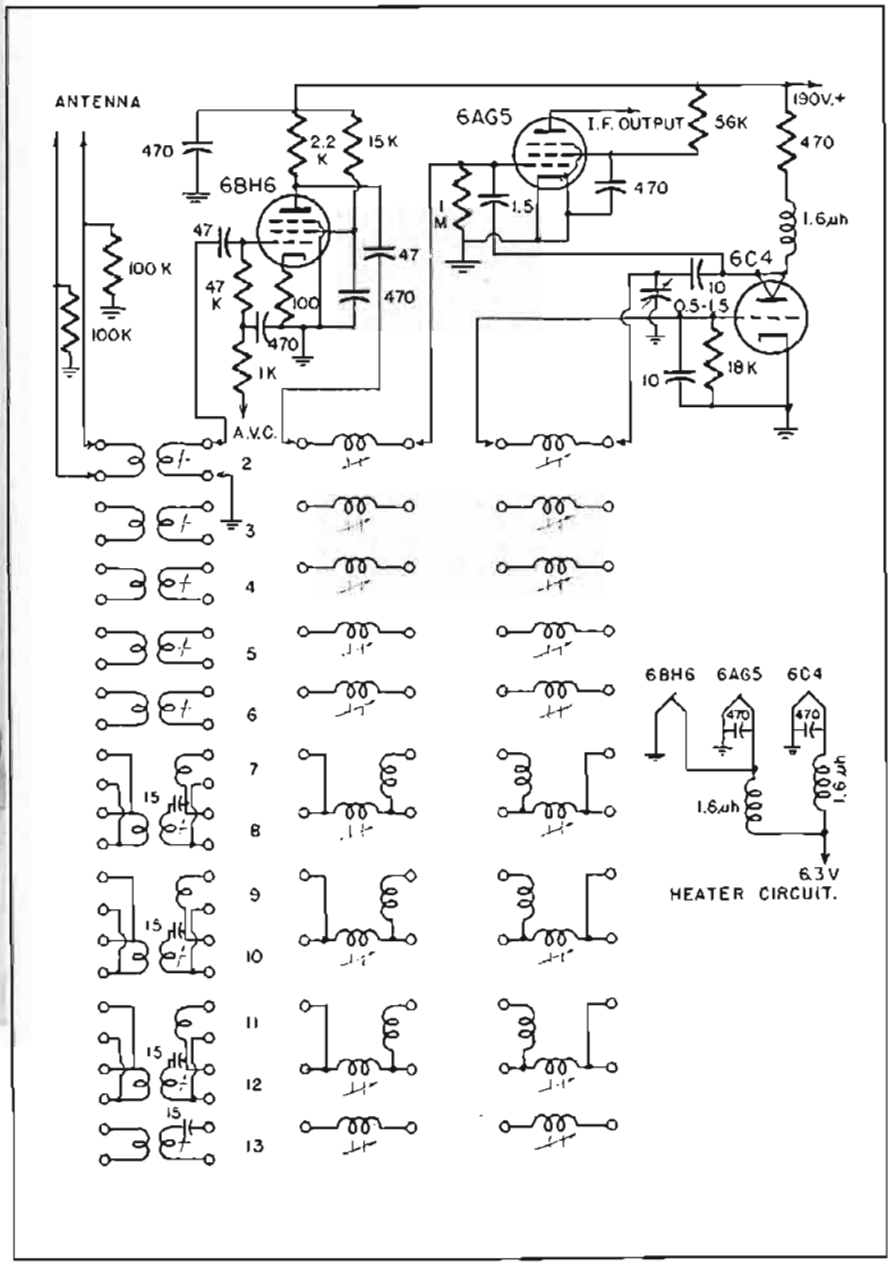
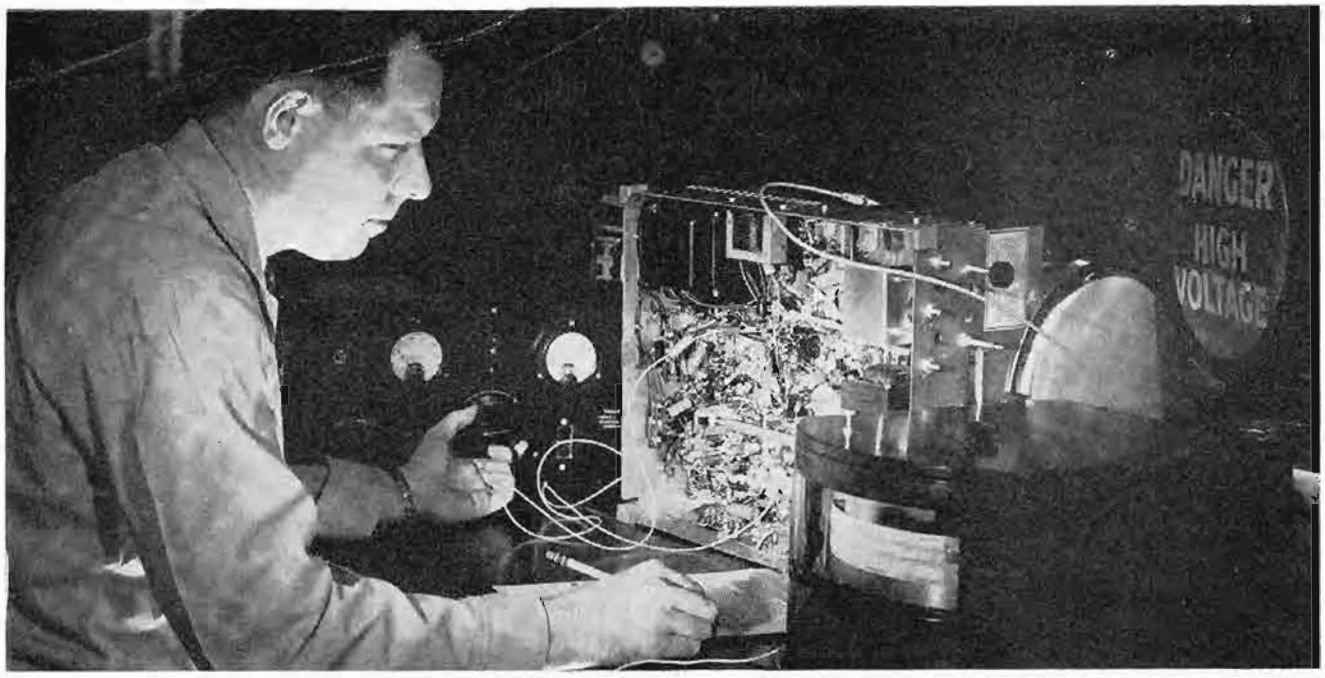


Fig. 5 (right): A complete circuit arrangement of the Hazeltine radio frequency tuner



An Underwriters' Laboratories engineer conducting one of the numerous tests which television receivers undergo before U.L. listing is granted

Underwriters' Laboratories Television Testing Technics

Tests are conducted according to standard developed by U. L. engineers

A NEW model radio or television receiver is not ready for production until it has withstood safety tests and been approved by Underwriters' Laboratories, Inc., a nonprofit testing organization with offices in New York, Chicago and San Francisco. While U.L. approval of communication equipment is obtained as a routine matter by manufacturers, probably little attention has been given to what happens to equipment submitted for test.

What does actually happen at the laboratories, how the tests are conducted and what standards are used are both of importance and interest. Manufacturers should be acquainted, for instance, with test standards and procedures likely to be established for television receivers which at present are being approved under tentative standards.

Currently, test and approval procedure is implemented when a manufacturer sends his equipment to any one of the three U.L. centers. The equipment is placed on a schedule and an engineer is assigned to conduct the exhaustive tests which will determine if the new model measures up to U.L. standards. While most tests are similar on checking wiring, voltage capacity and temperature, no test procedure used on one television set is imposed arbitrarily on another.

Wires of unrecognized types are exposed to a flame to determine resistance of the insulation to fire and extreme heat conditions. Conventional radio receivers which operate below 1,000 volts are subjected to extremely high overloads, sometimes three times the normal supply. (The percentage of the voltage overload decreases as the operating voltage of the equipment increases.) Television receivers which normally function at approximately 15,000 volts are usually loaded about 125%, but not more than 150%.

The test of the temperatures developed within the radio or television receiver is unique and thorough. When approximately 50 thermocouples have been installed at strategic locations within the cabinet and chassis, the set is pushed against the wall (with a one-inch air space between cabinet and wall) to simulate actual operating conditions in the home. The power is turned on and should any one of the thermocouples indicate a temperature in excess of the prescribed standard, the set is rejected.

A strain-relief device on a flexible power is tested under a tension of 35 lb. usually applied by a weight hanging free from the power cord. At least three samples are subjected to the 35 lb. force for 15 second periods; one sample may hold for less than 15 seconds, but not less than five. The device is deemed unsatisfactory "if the insulation or

(*Continued on page 43*)

Mobile FM Equipment Design

Efficient two-way engineering requires long maintenance, interchangeable parts and flexibility in any fixed or mobile combination of equipment

CONCLUSION

(Part Two)

EACH unit of equipment is suitably protected so that it may be handled, shipped and stored without mechanical injury to the tubes and component parts, covering normal handling, exposure to the weather or dirt and tampering and maladjustments of controls due to normal human curiosity. To accomplish this a one-piece, deep-drawn aluminum case was designed, light in weight and at the same time resilient and tough.

A point of mechanical design is the latching and locking mechanism. Figs. 3 and 4. Two simple cams mounted at each end of a rod extending the length of the case cover engage stainless steel pins in the two end brackets. A 90° rotation of cams is sufficient to pull the case cover down tight onto the four rubber mounts. The cam rod extends through the case handle into a bar knob. A small hole in the bar knob can be used to insert a meter seal which, when wired around the handle, locks the cover onto the unit.

The transmitter unit is phase modulated for either fixed or mobile operation on any frequency within the 152–162 mc band, Fig. 5. The output frequency is crystal-controlled from the oscillator through a series of multiplier stages to the final power amplifier. The transmitter is designed for two-frequency operation provided the frequencies are not spaced more than 1.2 mc apart. Two separate oscillators are used so as to avoid crystal switching. The output from the oscillator is fed into a modulator stage of the phase-shift type using two type 6BE6 pentodes. The rf signal is fed to the grids of the modulator tubes through an RC network.

Frequency Multiplication

The rf voltage output of the modulators is fed in turn to the first tripler (6AQ5) to the first doubler (6AQ5) to the second doubler (6AQ5) to the second tripler (820B) and to the final rf stage (829B). The final stage produces no frequency multiplication but amplifies the 36th harmonic of the crystal frequency to the required output power.

The studio section is designed to amplify the signal from a dynamic microphone having a rated level of —55db. The signal from the audio section is used not only for modulating the transmitter, but also to supply signal for an intercommunication system when used in conjunction with its companion receiver unit. As characteristic of phase modulation, it is necessary to limit the output voltage of the audio amplifier with respect to amplitude and frequency in order to prevent overmodulation and interference with other channels. To do this, audio current is fed back from the plate of the second audio stage to a type IN34 crystal diode rectifier through an RC network so that the current varies with frequency almost directly as the capacity reactance.

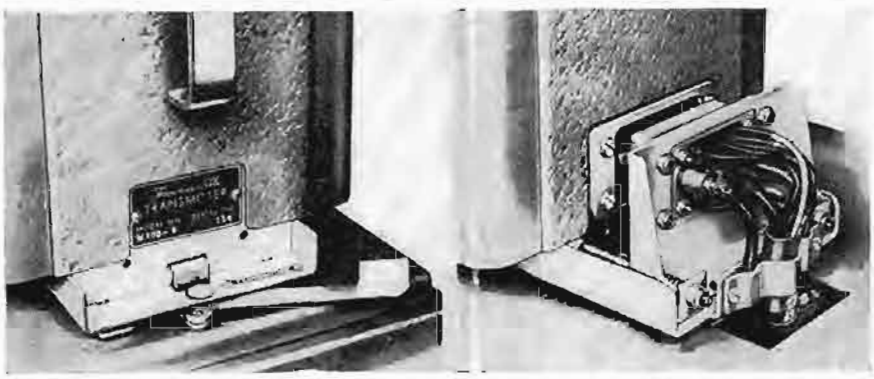
The crystal rectifier is so connected that a bias voltage is developed on the grid of the first audio stage when a predetermined value of audio voltage or frequency is reached at the output. This circuit allows relatively large amounts of audio voltage in the normal voice range (1000) to reach the modulator grids and hence more nearly approach maximum allowable deviation, whereas at higher frequency (3,000 cycles and up) increasingly large amounts of feedback occur, reducing the gain and preventing excessive deviation.

Transmitter Power Output

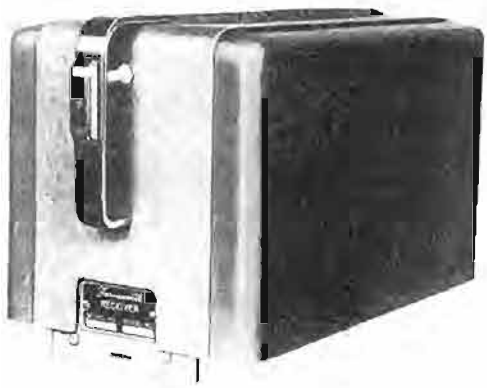
The transmitter has a minimum power output of 15 watts over an ambient temperature of −40° C. to +65° C. when used with a power supply delivering 300 volts to the driver stage. The power output can be increased to more than 30 watts without retuning or other changes in the transmitter by increasing the plate voltage on the final stage to 400 volts. The frequency stability of the transmitter over any condition of operation must be within .005%. Modulation is limited to plus or minus 15 kc under normal conditions of operation.

The receiver unit is a fixed-fre-

Fig. 3: Views of insertion and locking lever (left) and break-away connector (right)



for Railroads



By A. A. CURRY,
Product Engineer, Farnsworth Television & Radio Corp.

quency, temperature - stabilized, crystal-controlled, double-conversion superheterodyne FM receiver designed to operate on any single channel in the 152-162 mc band and with a frequency deviation of ±15 kc. Air trimmer capacitors in the harmonic amplifiers and the rf section provide low frequency drift circuits. Cascade limiters are used.

A combination carrier and noise-operated squelch is incorporated to suppress the extraneous noise which is inherent in highly sensitive receivers when a carrier is not being received. The signal is amplified by one stage in the carrier frequency before it is mixed with the 18th harmonic of the crystal oscillator. Both the primary and secondary of the antenna transformer are tuned to insure maximum gain and high rf selectivity.

Two different IF amplifier channels are used to provide high image and adjacent channel rejection, low IF drift with temperature changes, and to allow a high over all IF gain with freedom from regeneration. The frequency of the first IF amplifier varies between 13.76 and 14.78 mc, depending upon the frequency channel on which the receiver operates. The first IF signal after passing through one stage of amplification is mixed with the second harmonic of the crystal oscillator in the second mixer. The difference in frequency between the first IF and the second harmonic of the crystal oscillator is 1.6 mc. Following the second mixer and one stage of IF amplification are two conventional limiter stages.

As shown in Fig. 6 a squelch of automatic quieting tube is used to cut off output from the receiver except when a carrier is present. This squelch operation is accomplished by the action of rectified carrier voltages on the grid circuit of V9B. This voltage is amplified and changed in polarity to enable it to "gate" the audio amplifier section of the tube V9A. In order to prevent noise burst from opening the squelch and causing noise in the receiver, a IN34 crystal rectifier (CR1) is incorporated in the circuit. While the noise pulses produce a positive voltage in the grid circuit of the squelch tube by means of action of the IN34 crystal rectifier, a carrier signal of constant amplitude produces a negative voltage.

Operation of Squelch

If the carrier signal is great enough in proportion to any noise voltage that may be present, the squelch will open and allow the audio section to function. However, if noise alone is present, or if it is of sufficient strength to override the carrier, the voltage applied to the grid of the squelch tube will be such as to not allow the squelch to operate, thus keeping the receiver quiet.

The frequency of the crystal determines the channel on which the receiver will operate. The crystal varies between 7.68 and 8.18 mc, depending upon the frequency of the desired channel. The crystal frequency is doubled in the plate circuit of the oscillator tube and this output is fed both to the second mixer and to the first harmonic amplifier for subsequent multiplication. The first and second harmonic amplifiers are triplers. Therefore

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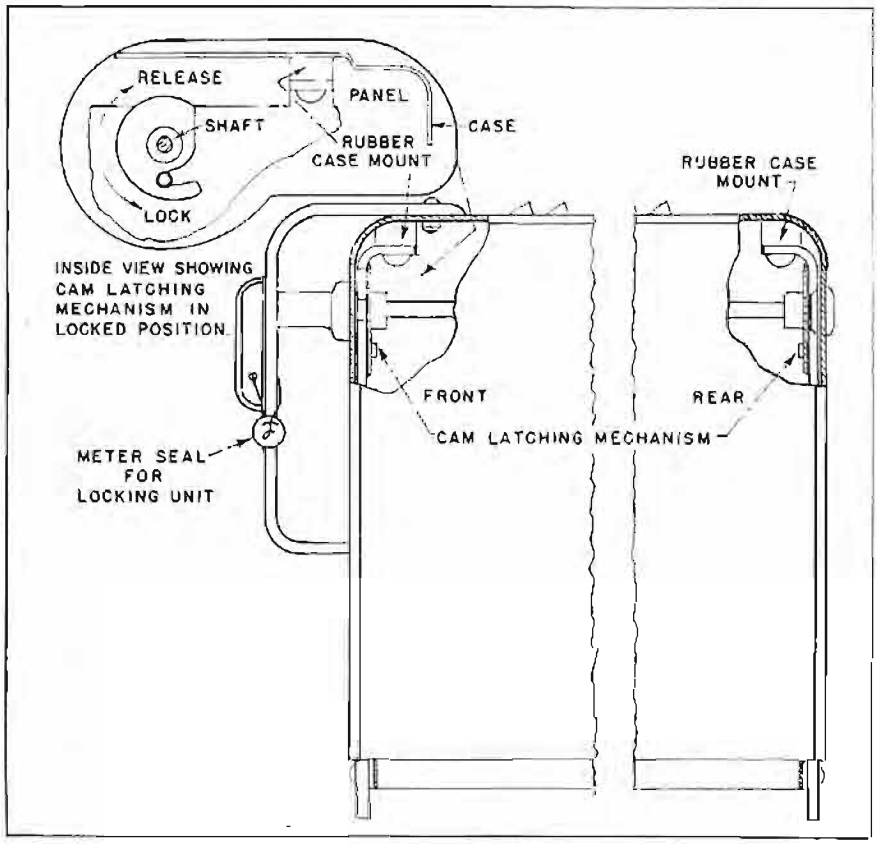
Fig. 4: Sectional view of case cover showing mounting, latching, and locking detail



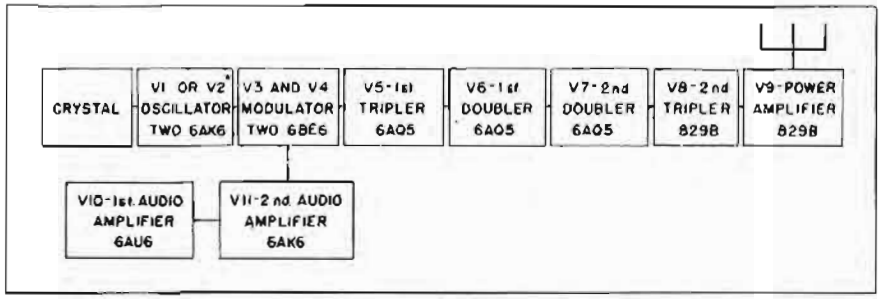


Fig. 5: Transmitter (*Two oscillator tubes are required for dual channel operation)

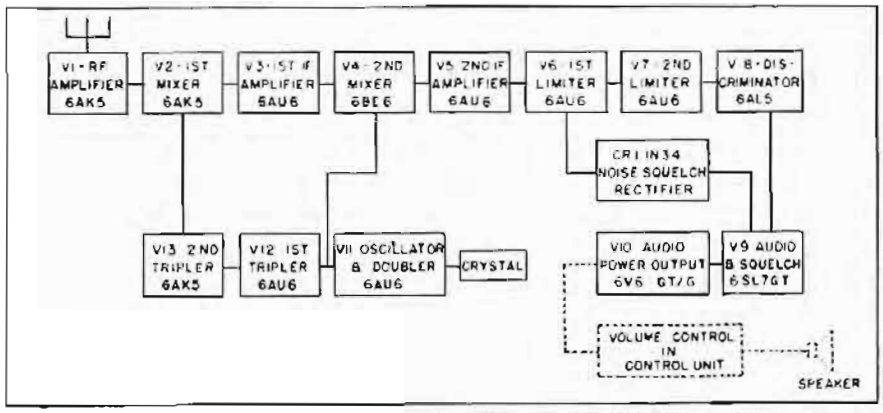


Fig. 6: Diagram of crystal-controlled, double conversion superheterodyne FM receiver

the output frequency is 18 times the crystal frequency. The output of this tripler is mixed with the rf signal in the first mixer to provide the first IF signal.

The receiver has an overall frequency stability of .005% over the full ambient temperature of −40° C. to +65° C. The sensitivity of the receiver is such that only half a microvolt is required to open the squelch, while one microvolt gives at least 20 db of quieting. The selectivity of the receiver is at least 80 db down at 120 cycles and all spurious response points are at least 76 db down.

The fixed-station control units, to control a transmitter and receiver, include an audio amplifier, a speaker, power supply and the relay controls for switching between transmitter and receiver. A number of remote units can function with a fixed-station control unit to provide intercommunication between units without the operation of special switches and without turning on the transmitter. Also, any control point can be operated either as dispatch point or as, if desired, another control point.

The audio amplifier in the control unit has an adjustable gain control and a maximum overall gain of 60 db. The output level of the control unit is approximately 0 db for intercommunication purposes and is adjustable for transmitting purposes between the limits of 0 and −23 db.

Typical combinations of equipment for a fixed station or mobile station can be easily accomplished by suitable housings and racks designed to interconnect the proper combination of units. Fixed racks are designed to group two units or three units. As illustrated in Fig. 7 these may be multipled up to give any desired combination of units.

Various Railroad Applications

A review of the application of radio to railroad operation indicates that in terminal and yard operation the radio makes it possible to rapidly and efficiently supply engine crews with the following: (1) Additional or changed orders. (2) Keep them advised on incoming and departing trains as to actual time and track numbers. (3) Give them information on the breakup of trains. (4) Receive from the train crews any report of delays or emergency conditions which arise during normal operation.

In end-to-end operation radio provides the crews with a means of communication for more efficient and quicker handling of the following types of information: (1) Information on defective equipment, such as hot journals, or other conditions which might develop into an emergency if not given immediate attention. (2) Clearance of the end of the train, especially at highway crossings, isolated sections of track used in railroad signal systems, or in clearance of switches

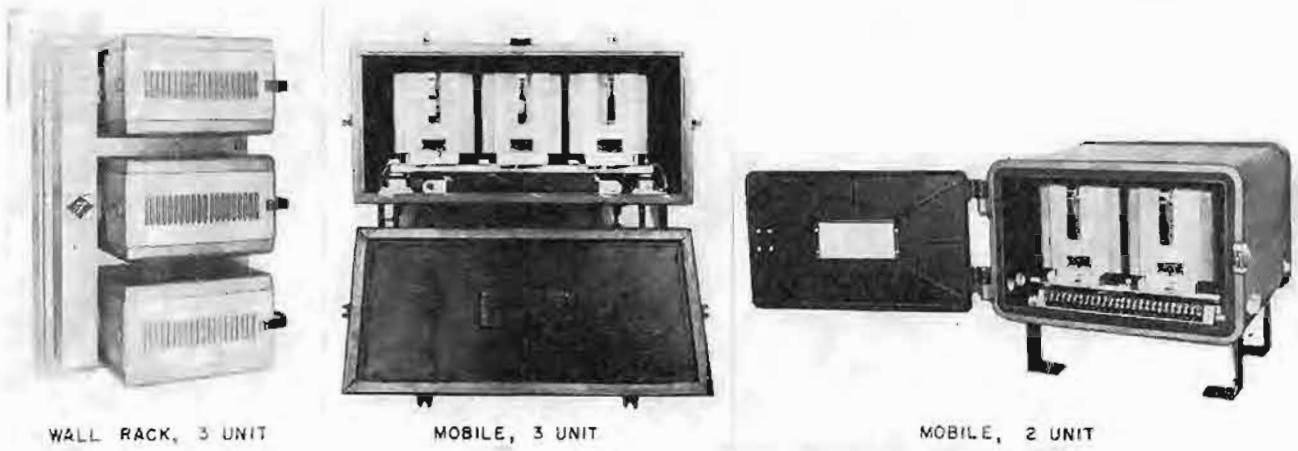


Fig. 7: Typical combinations of equipment for fixed and mobile installations. Fixed racks are designed to group two or three units

when pulling into sidings. (3) Information concerning completion of train tests, such as air and brake tests. (4) Facilitate the start of trains so as not to leave trainmen stranded. (5) Facilitate spotting, switching and breakup of trains. (6) Convey reasons and time to be involved in unscheduled stops.

Communication between trains enroute and way-stations facilitates communication in the following ways: (1) Keeps the dispatcher informed as to train progress. (2) Unusual stops, delays, accidents, equipment failures or other emergencies can be immediately reported. (3) Advance orders or a change in orders in the spotting, switching and breakup of trains.

The railroad market in the United States is much greater than one would ordinarily realize. More than 1,000 different railroad companies operate over 46,305 locomotives, 24,967 cabooses, and have a total track length of 227,335 miles. This vast potential market for railroad radio equipment warrants and stimulates careful design considerations of the many mechanical, electrical, operating and maintenance problems involved in this type of equipment. There is no other mobile communication field which presents a greater challenge to careful design than does the application of radio communication to railroad operation.

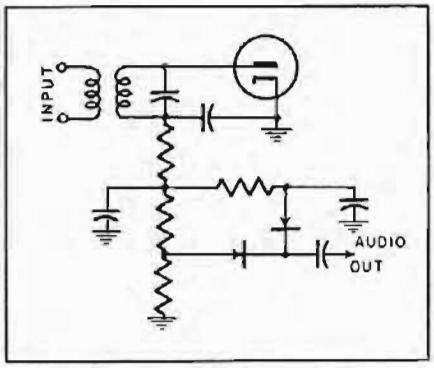
Twentieth Fall Meeting of IRE at Rochester

EXPERIENCE covering twenty years operation has made the Rochester Fall Meeting an annual mecca for radio receiver designers and communication engineers. The three day session this year contained a number of outstanding papers. Television receiver engineering problems received a great deal of attention on the program. The unusual features of the meeting, an appreciation of which is evident only to those who have attended these meetings in Rochester, are the many friendly group meetings where current developments are discussed informally and the interesting displays of the latest in technical components and instruments. This score of meetings have contributed a great deal toward the advancement of good engineering designs.

Among the technical papers, the problem of television image sharpness was ably discussed by Otto Schade (RCA) with a description of an unusual system for analyzing picture detail (of either photograpic and television reproductions). The "law of diminishing returns" was ably supported by his analysis. The expediency of retaining the 525 line scanning system was supported.

Several interesting papers were given on television tuners. The program started with a description of a station selector using stamped circuits by D. Sobel (A. W. Franklin Mfg. Co.). Production simplicity plus exact duplication of characteristics are features of this design. Another paper on "front end" tuners for television was given by J. O. Silvey (G. E. Co.). This paper will appear in a forthcoming issue of TELE-TECH.

Production methods in receiver manufacturing were given considerable attention ranging from setting up a receiver engineering department (by A. G. Rogers of Emerson) to TV test equipment descriptions. These included a pulse cross generator (Burr of Hazeltine), a laboratory TV signal distribution system (by Joseph Fisher of Philco) and a video and audio modulated signal generator, by Store of Hazeltine.



Noise limiter using germanium diodes; Martin & Heins, Sylvania Electric Co.

A symposium conducted by the IRE Audio Group (Harvey Fletcher, J. K. Hilliard and C. J. LeBel) brought out much valuable data on the matter of "High Fidelity". As might be expected considerable discussion followed.

A report on the characteristics and application of germanium crystals was given by Sylvania engineers—S. T. Martin and Harold Heins, described many circuit uses of standard rectifiers. Among the applications shown were AVC and AGC systems, bias sources, clippers, limiters, discriminators, noise limiters, etc. A typical circuit in the last category is shown below. He also presented a "comparatively" extensive survey of germanium triode characteristics based on experimental units they have made up.

Underwriters' Laboratories

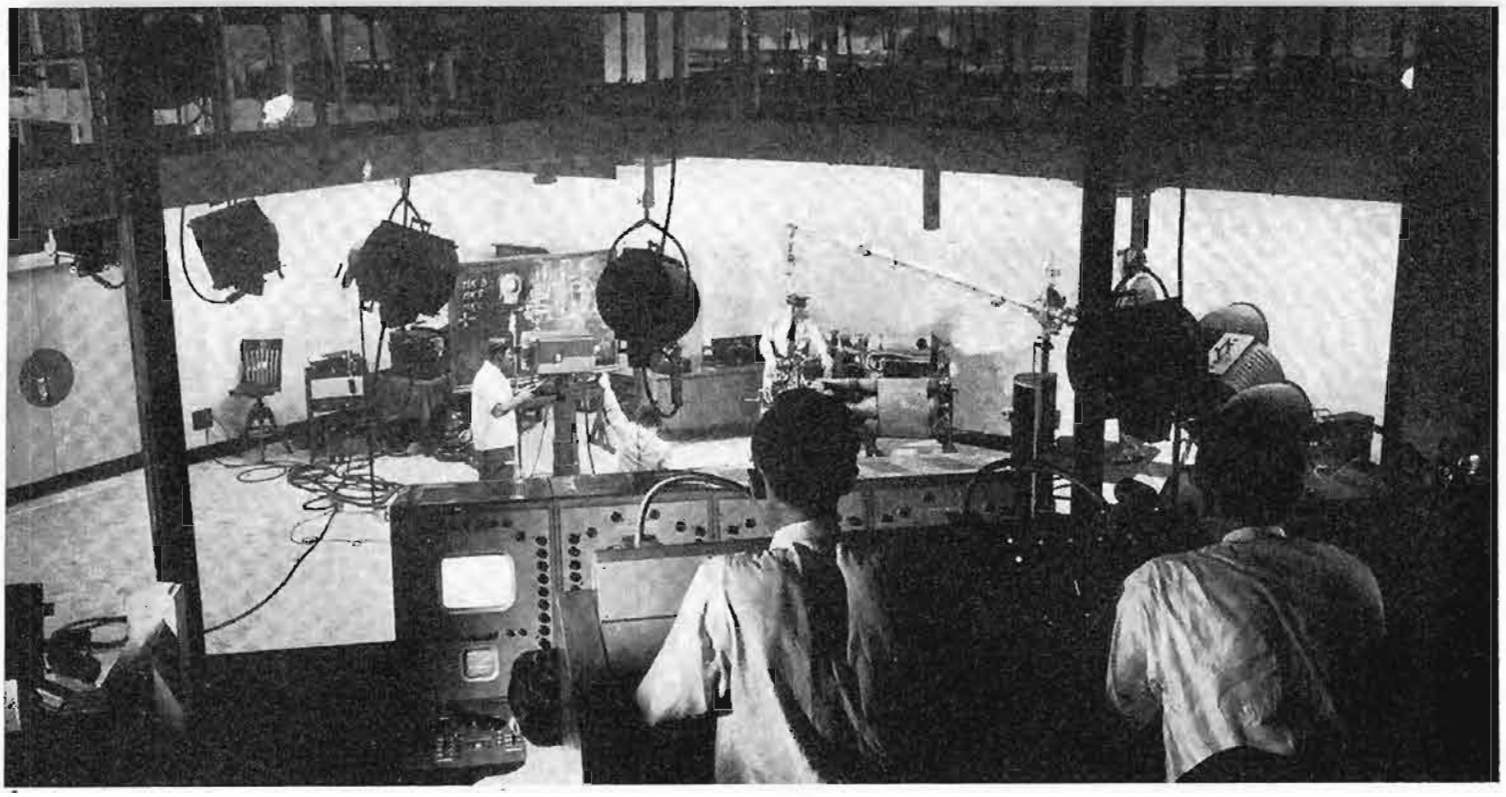
(*Continued from page 39*)

covering on the flexible cord is cut or torn, if the bushing slides through the hole in the chassis or enclosure, or if cemented-on bushings slide on the cord".*

Getting a U.L. approval may entail submitting a test model to one of the laboratories; making suggested improvements if the set is rejected; resubmitting the set for test; and when and if the sample meets the established standard, having U.L. engineers make a detailed inspection of the assembly line at the factory.

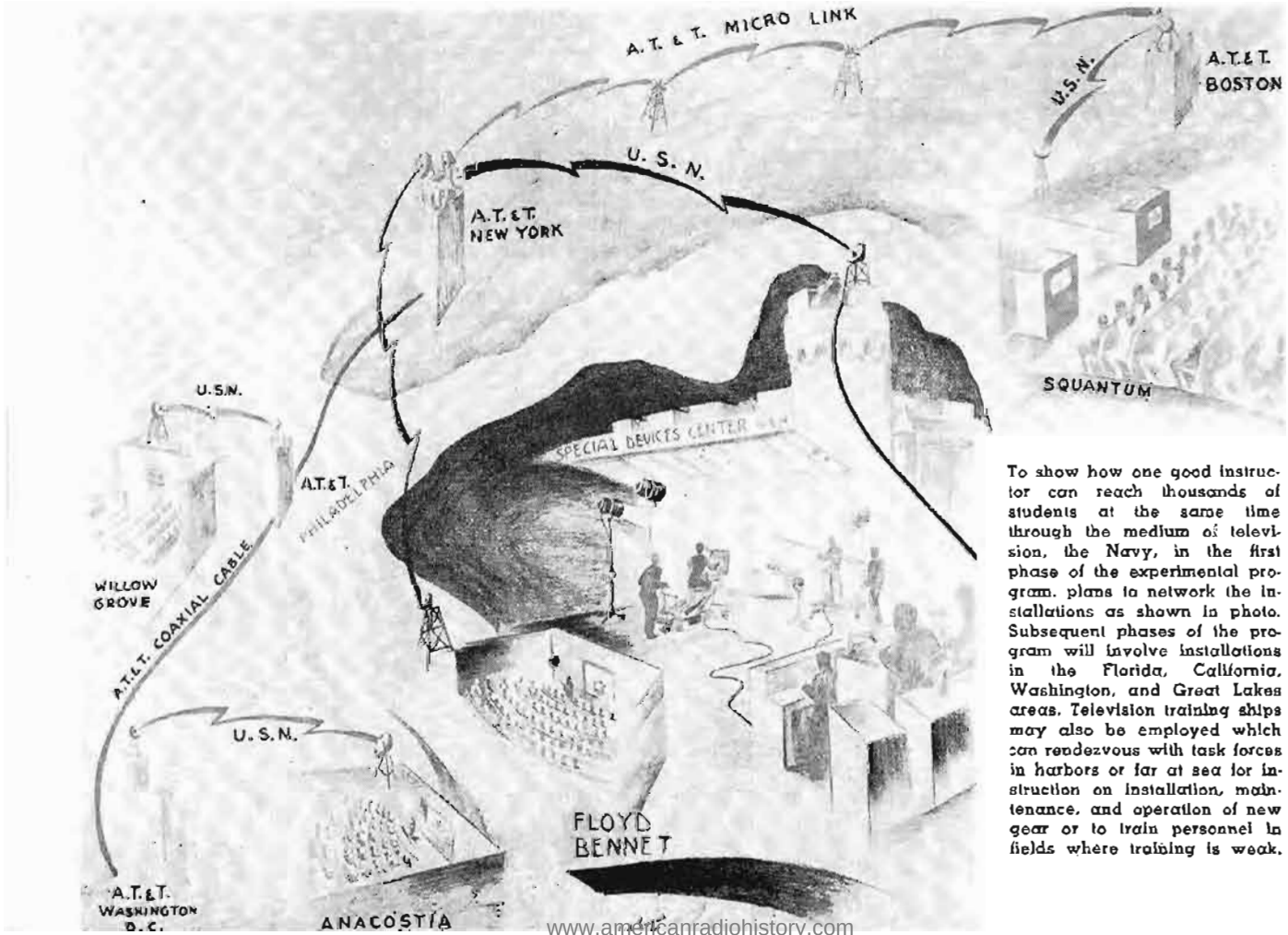
When officially approved, the new model is named in U.L.'s big green catalog, the "List of Approved Electrical Appliances" which is published annually with bimonthly supplements. In addition U.L. engineers are authorized to visit the plant unannounced at any time and inspect any listed model as it is assembled on the production line. Standard U.L. procedure is rigid and exact but most manufacturers have found that once their set has "gone through the mill" and been tagged with a U.L. label, the set will meet state and local safety regulations anywhere in the country.

*Paragraph No. 139, "Standard For Power-Operated Radio Receiving Appliances", Underwriters' Laboratories, Inc.

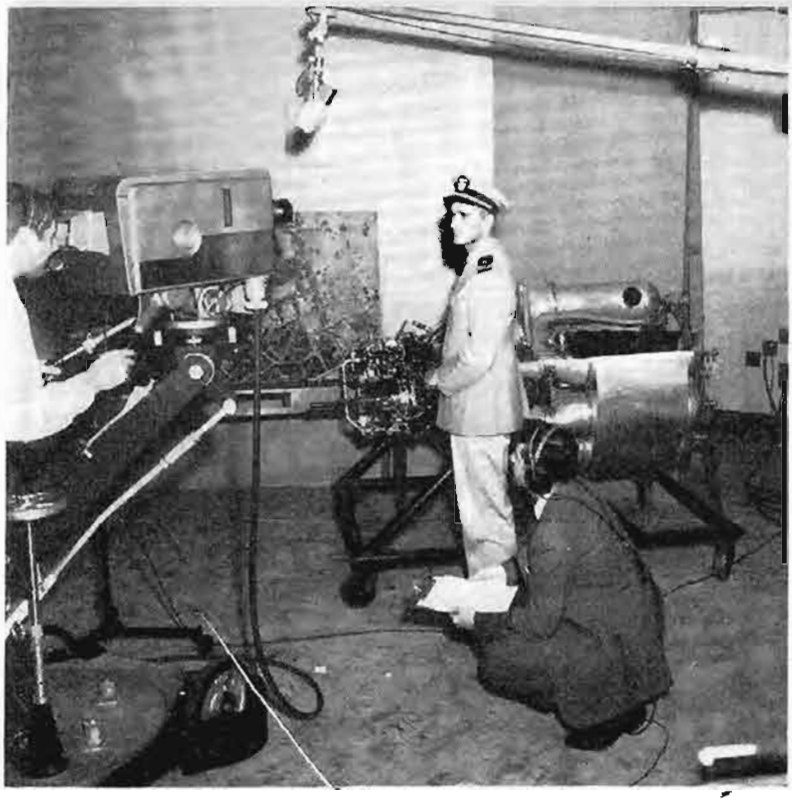


Looking into television studio from control room at U. S. Navy Special Devices Center, Sands Point, L. I., N. Y. Only commercially available TV equipment is installed which should facilitate use of existing coaxial cable and microwave relay facilities for future networking

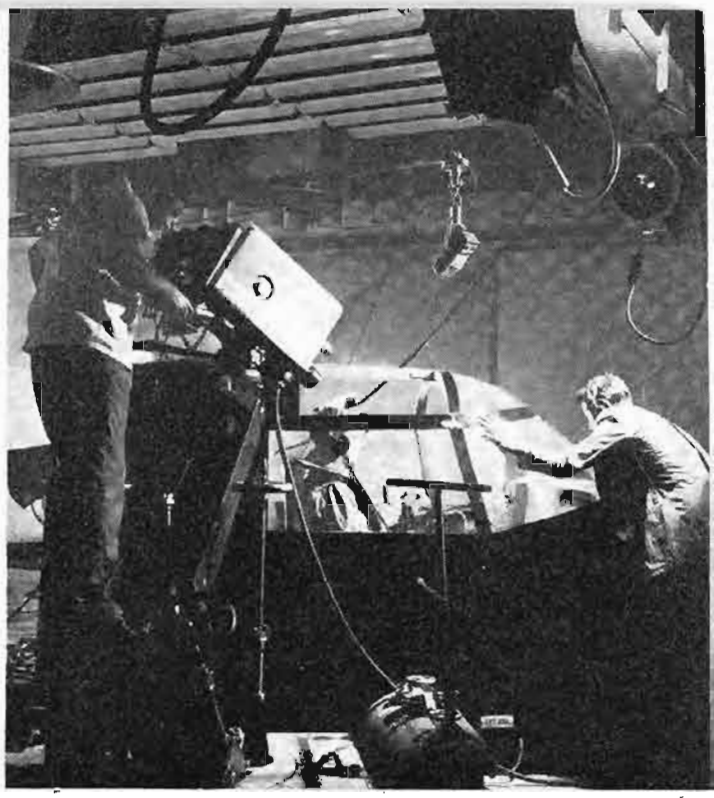
Navy Pioneers TV Visual Education



To show how one good instructor can reach thousands of students at the same time through the medium of television, the Navy, in the first phase of the experimental program, plans to network the installations as shown in photo. Subsequent phases of the program will involve installations in the Florida, California, Washington, and Great Lakes areas. Television training ships may also be employed which can rendezvous with task forces in harbors or far at sea for instruction on installation, maintenance, and operation of new gear or to train personnel in fields where training is weak.



Camera crew setting up in main television studio for lecture broadcast. Cut-away jet engine is for purpose of illustration



A G.E. television camera peering into the cockpit of a mock-up Navy bomber as the pilot demonstrates simplified control system

First phase of armed forces program applying television to simultaneous mass training projects begins in January

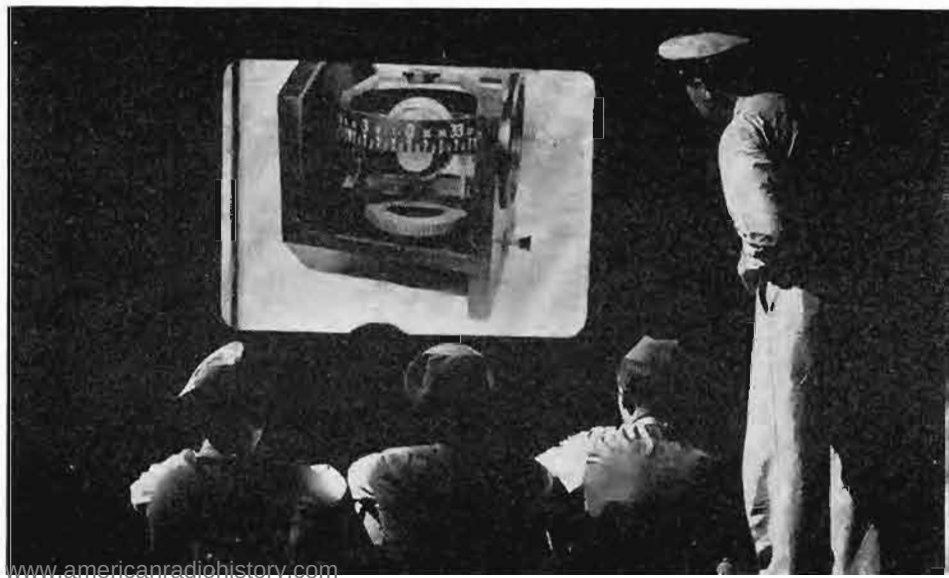
A SIX-MONTH investigation into the use of television as a training medium for armed forces personnel starts January 3, 1949 and marks the beginning of a new application for this mode of communication. Trial programs, on the subjects of Ordnance and Gunnery, will be transmitted from the Navy's Special Devices Center at Sands Point, L. I. for the benefit of classes at the Merchant Marine Academy four miles away at Kings Point, L. I. These initial transmissions will be made on a frequency of 6115 mc, at a power of 2 watts, using a Philco microwave relay system. As the experiments progress, it is probable that time on existing commercial coaxial and microwave networks will be obtained for the simultaneous instruction of personnel at other Navy installations such as those located at Squantum, Mass., Willow Grove, Pa., Floyd Bennett Field, N. Y. and Anacostia, Wash., D. C.

Since the experiments are primarily concerned with teaching methods employed in connection with television, only commercially available equipment is being used. The current technical facilities include a General Electric studio equipment for the television center, complete with cameras, communication units, monitoring consoles, slide and film projectors, etc. The classroom at the Special Devices center contains a Dumont 20-in. direct viewing receiver together with a Rauland 15 x 20-ft. projection installation. Students at Kings Point will view the programs from two General Electric 18 x 24-in. projection type receivers installed in the classroom.

An unusual feature of the planned instruction routine is the provision of "talk-back" circuits from classrooms at the receiving ends using conventional communication facilities. This will permit students to ask questions of the instructor in the television studio at Sands Point, and to receive answers just as if the latter were physically present.

Obviously this experiment suggests vast and interesting possibilities since once the joint armed services accept television as a mass instruction medium, an entirely new market will be created for transmitters, receivers and test instruments. TELE-TECH will report on the general progress of the program periodically.

Everyone has a "front-row seat" when studying equipment intricacies by television as can be seen from image formed by Rauland 15 X 20-ft. projection installation in classroom



Cathode-Ray Oscillograph

Some valuable tips for prospective purchasers of cathode ray oscilloscopes

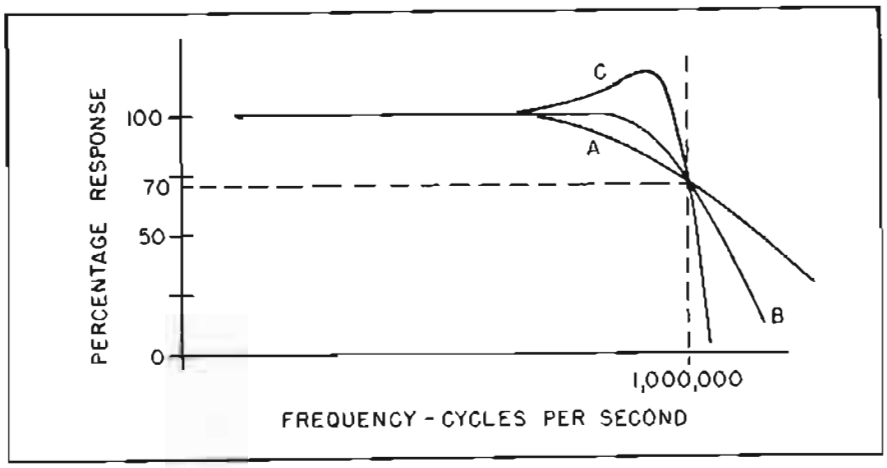


Fig. 1: Response curves for 3 oscillograph amplifiers with different degrees of compensation

THE analysis and comparison of equipment characteristics relating to cathode ray oscillography is hampered by the lack of universally agreed upon definitions. Different people may have many different expressions and interpretations of terms in stating their actual needs in oscillograph performance. Likewise some published oscillograph specifications are based upon average performance characteristics and thus, even though a number of instruments may give better performance than that specified, an almost equal number will not. Again, some oscillographs are designed to fit specifications so closely that normal aging of circuit components or replacement of vacuum tubes will result in performance which is inferior to the written standards. Other oscillographs are designed with no consideration for variations which occur in power line voltage and frequency. Some may not provide magnetic shielding for the cathode-ray tube. The following outline is presented to indicate these and many other points to be considered in appraising true performance.

Oscillographs are available which employ 7 or 9-in. tubes in which tube size alone is pointed out as a distinct feature. To be sure, the larger screen is desirable, but only if everything else is equal. Specifications should be examined to determine if the amplifiers in the instrument are capable of producing sufficient undistorted deflection to utilize the full area available. Otherwise there is no advantage in the large screen. Furthermore, since the area of a 7-in. screen is almost twice that of the 5-in. screen, accelerating voltage must be proportionately increased in order to maintain comparable brightness of pattern. In addition, the fluorescent spot-size in a 5-in. tube is usually smaller than in an equivalent tube of larger size, and better resolution is possible for studying pattern detail.

One method of evaluating performance of an amplifier in an oscillograph is in terms of its sinusoidal frequency-response characteristic, or its bandwidth characteristic. A specification may read: "Vertical amplifier response down 30% at a frequency of 1 mc per second." This, however, does not tell a complete story because another amplifier, while similarly specified, might give entirely different performance due to the shape of its frequency response curve.

Response curves can be drawn for three amplifiers, all of which have the same nominal bandwidth as shown in Fig. 1. Note, however, that curve A slopes gradually at the higher frequencies. It is typical of an amplifier without high-frequency

Fig. 2: Oscillograms showing response of three amplifiers represented by A, B, and C respectively (Fig. 1) to a square wave signal

Specifications

E. G. NICHOLS & R. I. MacCAULEY
Allen B. DuMont Laboratories, Inc.

compensation. Curve B is flat to a higher frequency, but then drops off more sharply, as is typical of an amplifier with compensation. Curve C rising slightly before a sharp fall is typical for an amplifier that is over-compensated in order that its response specifications may read the same as the others.

The oscillograms in Fig. 2 indicate the waveforms which might appear on the cathode-ray tube screen if a square pulse were applied to each of the three amplifiers. From them it is obvious that the performance of the three amplifiers are not at all similar. It is therefore essential that the information concerning the frequency-response characteristics of an oscillograph be examined closely in order that maximum performance in the amplification of complex as well as sinusoidal signals can be realized.

Many oscillographic specifications, particularly for those instruments which have wide-band amplifiers, give only the response of such amplifiers to a sinusoidal signal. However, the response of an amplifier to a complex signal (one which contains a number of sinusoidal frequency components) depends as well upon the constancy of delay through the amplifier at all these frequencies, the delay usually being expressed in terms of phase-shift of a sinusoidal signal. If the component frequencies in the complex signal are not all delayed by the same amount (i.e. — phase shift proportional to the frequency), the complex waveform will be distorted in passing through the amplifier. Therefore, cathode-ray oscillographs which are designed for the investigation of short pulses and other complex signals should have specifications for the response of their amplifiers to pulse waveforms.

In oscillographs which have high-impedance amplitude controls, the maximum amplifier bandwidth will only be available when that control is at its maximum position. At all other positions, because of the effects of stray capacities across the high-impedance, bandwidth may be seriously decreased.

The oscillograms of Fig. 3 illustrate what may happen if a square-wave signal is applied to an amplifier which has a high-impedance amplitude or gain control. The response in 3A is obtained when the gain control is at maximum position, while that in 3B is obtained with the control at an intermediate position. It shows distortion produced by the narrower bandwidth characteristic.

Specifications should be checked to see if amplifier frequency-response is specified at some particular gain-control setting, or whether it applies to all gain-control positions. The better, more-expensive oscillographs have low-impedance gain controls and, therefore, a bandwidth characteristic independent of ampli-

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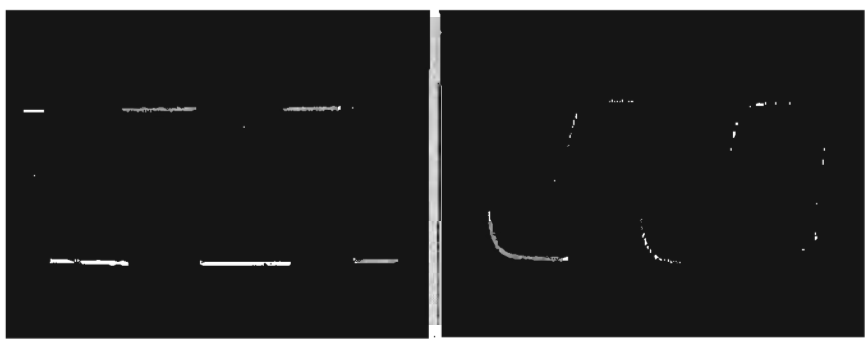


Fig. 3: Maximum (left) and reduced (right) gain control effects upon amplifier bandwidth

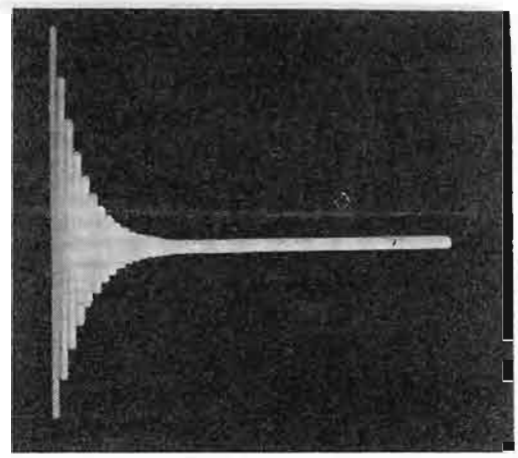
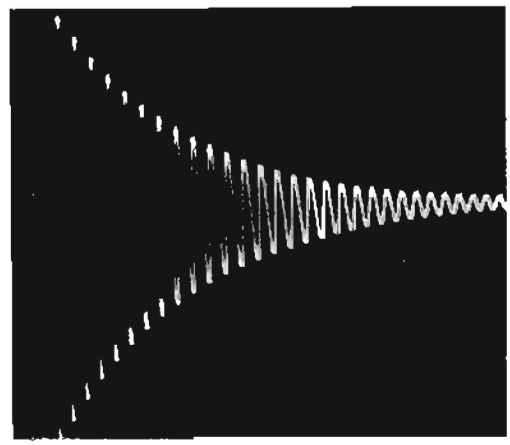


Fig. 4: Oscillograms showing limitations upon usable bandwidth of an oscilloscope due to insufficient sweep speed (above); insufficient pattern brightness (below)



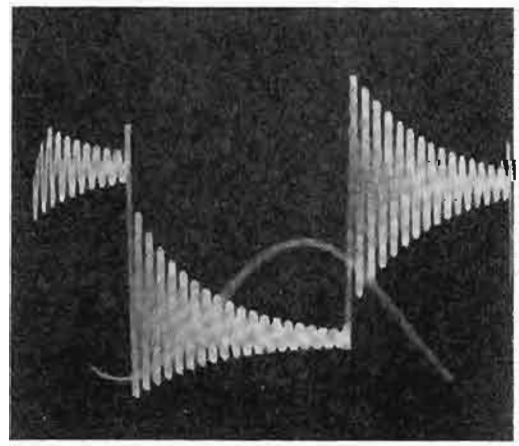
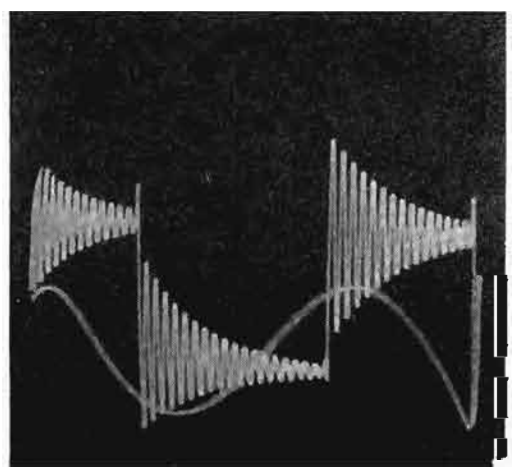


Fig. 5: Compare the resolving powers of low-voltage CR tube having a large spot size (above) and high voltage tube (such as the 5RPA type) with a smaller sized spot (below)



OSCILLOGRAPH SPECIFICATIONS (Continued)

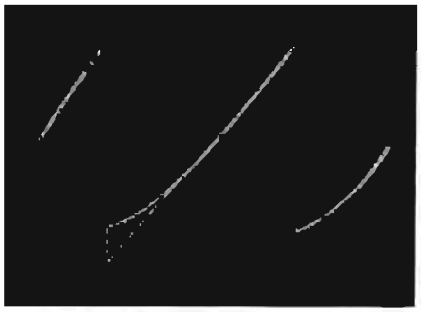


Fig. 6: Oscillogram compares non-linear sawtooth voltage (solid line) with one that is perfectly linear (shown dotted)

fier gain, an important characteristic in any oscillograph except for the most elementary applications.

Amplifier bandwidth by itself does not determine the usable bandwidth. Maximum available sweep speed and maximum brightness of the cathode-ray tube are also factors to be considered. In Fig. 4, a damped sine-wave oscillation is used as an illustration of this point. In 4A, brightness is satisfactory, bandwidth is assumed to be adequate, but sweep is not high enough to prevent crowding of the pattern at the frequency which is being plotted. The oscillogram 4B illustrates the effect when the sweep speed is high enough but brightness is insufficient because of an improper selection of the cathode-ray tube or its accelerating potential. Only the peaks of the sine-wave are visible during the first few cycles where the fluorescent spot is moving most raipdly. As the oscillation is damped, the spot moves more and more slowly until the complete cycles are finally visible.

In general, the use of single-ended or unbalanced deflection amplifiers is confined to the smaller, more inexpensive oscillographs. When a signal is applied to only one plate of a deflection-plate pair (the other plate being connected to the anode), it is ordinarily not possible to properly focus the resultant trace across the entire screen since the effective accelerating voltage is dependent somewhat on the deflection potentials, producing an "astigmatic" condition where either horizontal or vertical portions of the trace can be focused, but not both simultaneously. This effect is compensated for, however, in some oscillographs where, although unbalanced deflection is employed, an auxiliary focus control (in addition to a conventional focus control) provides perfect focusing over the entire screen.

Resolving Power

Comparisons between oscillograph performances cannot be made solely on the basis of deflection sensitivity. A better evaluation term is *deflection sensibility*, a factor which combines the characteristics of deflection sensitivity and tube spot-size, and which is, therefore, a figure of merit for resolving power of an oscillograph.

The oscillogram, Fig. 5A, is typical of that obtained on a cathode-ray tube operated at low accelerating potential and having good sensitivity but large spot-size. Note the incompleteness of resolution even though the pattern itself is of large size. Fig. 5B is typical of one obtained when the same signal is applied to a cathode-ray tube operated at high accelerating potential. Every detail shows up clearly because this tube has much smaller spot-size and therefore better *deflection sensibility*, even though deflection sensitivity is not nearly as great.

Deflection sensibility is particularly important in connection with the Type 5RP-A series of cathode-ray tubes. These are designed to operate with accelerating potential up to 29 kv. They have but little lower sensitivity than other tubes operated at 2 kv. to 3 kv. However, they have much smaller spot-size and actually greater resolving power.

A probe is furnished with some oscillographs in order to provide a high-impedance, low-capacitance, shielded input for the vertical amplifier. It is wise in these instances to check the specifications concerning input capacitance at the panel terminals. This capacitance may be so high that the panel-terminal input will impose too great a loading effect upon high-frequency signal sources and will make the use of the probe mandatory. If the use of the probe is absolutely required, then the specified sensitivity must (deflection factor) include the probe, because it may introduce a signal attenuation in the order of 20:1.

The time-base in most oscillographs is supposedly linear unless otherwise stated. However, not many oscillograph specifications include a statement concerning the linearity of their sweeps. Fig. 6 shows a waveform oscillogram of the voltage generated by the linear time-base generator; the solid line indicates a departure from true linearity (dotted) which occurs in many time-base generators.

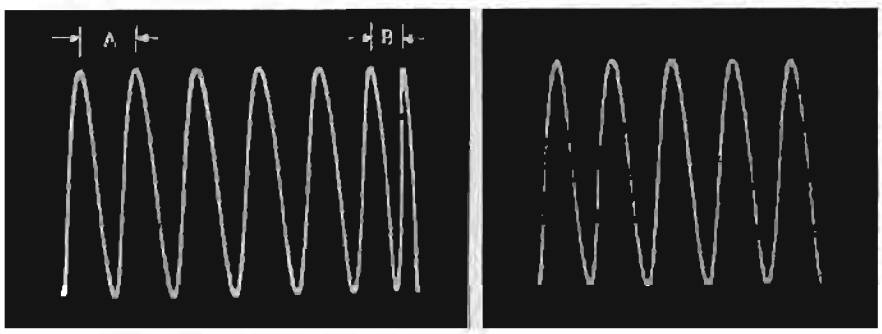
Similarly in Fig. 7, (A) represents the appearance of a sine-wave signal as plotted on the non-linear time-base, which (B) shows the same sine-wave plotted on the linear time-base. Linearity of the time-base may be noted from the spacing between peaks of a sine-wave as in Fig. 7A. The spacing is not uniform if the sweep is non-linear.

With certain low-priced oscillographs, sweep speeds are stated which approach ¼ microsecond per in. Actually such high speeds are useless if the sweeps are to be triggered at low repetition rates unless cathode-ray tube is sufficient to make the trace visible on the screen. An oscillogram of a phenomenon having a repetition rate of only 30 cps may be plotted on the 1 microsecond sweep of a cathode-ray oscillograph with an accelerating potential of 12 kv. In order to produce a trace of comparable intensity on an instrument operating at 3 kv., the repetition rate needs to be around 600 cps.

It is the energy furnished to the cathode-ray tube screen per unit of time which determines the brilliance of the trace. Since this energy is dependent upon accelerating potential, a cathode ray oscillograph which

(Continued on page 74)

Fig. 7: A sinusoidal voltage plotted on non-linear (left) and linear (right) time bases



Chicago IRE Conference Report

Wide variety of communication, industrial and management problems discussed at recent electronic conference in Chicago

By RALPH R. BATCHER, Consulting Editor, TELE-TECH

THE fourth National Electronics Conference held in Chicago November 4-6 again provided a medium where the year's advancements in the electronic art were discussed. The program was about equally divided between communication system details and non-communication applications. The Conference, a non-profit undertaking, is sponsored jointly by the Illinois Inst. of Tech., Northwestern Univ. of Ill., and the national organizations of the AIEE and the IRE.

In addition to the technical program of about 70 papers, the manufacturers' exhibits displayed a large number of new electronic instruments, systems and components. The program covered a wide variety of basic subjects. Space permits reporting only a few highlights of this technical schedule.

Among the papers relating to devices and materials receiving unusual attention was one on Transistors, by Brattain and Barden (BTL). This new contact type amplifying device, using a germanium or silicon crystal, can provide a gain of possibly 100. It was disclosed that the nominal operating potential of around 35 volts can be reduced to as low as one volt with selected conditions. This paper reported the characteristics of the germanium type transistors currently produced. An audio frequency oscillator using transistors was demonstrated (Fig. 1).

Another paper describing a new material possibility was one by J. V. Lebacqz (Johns-Hopkins) on the r-f properties of columbium nitride at a low temperature. When modulated r-f signals are applied across a strip of CbN, maintained at its transition temperature 15¾°, an audio voltage at the modulating frequency appears at its terminals, introducing interesting speculation on the phenomena of super-conductivity.

A foresight into the far reaching applications of ceramic dielectrics was given in a report by G. R. Shelton (National Bureau of Standards). Ceramic capacitors are useful in equipment size, weight and cost reducing programs. This paper was concerned with dielectrics having compositions represented in the systems BaO-SrO-TiO$_2$ and BaO-MgO-TiO$_2$. The properties of barium-calcium titanate dielectrics were reported showing the effects of a systematic variation in composition upon the dielectric constant and Q, at frequencies of 50 kc to 3,000 mc, and the temperature coefficient and stability of dielectrics stored 6 or more months.

A new design for a Sound Level meter was described and exhibited by H. H. Scott utilizing subminiature tubes and other components selected and assembled for minimum weight and bulk. The total weight of this instrument was slightly over two lbs., with performance characteristics (besides meeting all ASA requirements) at least as good as those of the larger types and in ruggedness, stability and dependability better. The meter included 512-AX Raytheon pentodes as voltage amplifiers, and a diaphragm type crystal microphone.

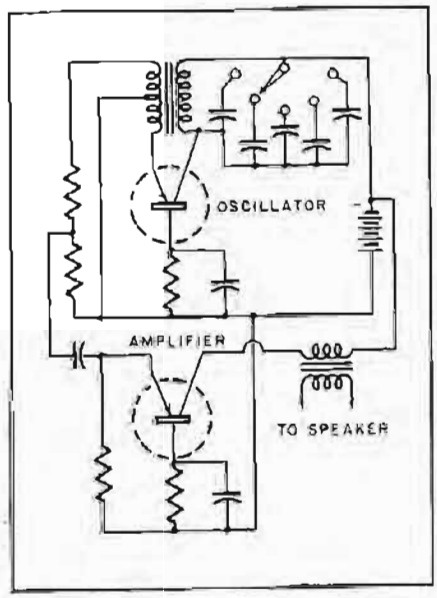


Fig. 1: Germanium crystal transistor used in audio oscillator, amplifier demonstration

Magnetic recording technics both for home and industrial recording received a lot of attention. In the former application, a report by Marvin Camras (Armour Research Foundation) mentioned that few of the far-reaching possibilities in the field of magnetic recording have been explored to date. It is possible to manufacture large quantities of magnetic records quickly and at low cost. Wide potentialities are apparent in the use of the new method in home recording: in purchasing, renting, or reprocessing of recorded entertainment; in "Voice snapshots" with pocket models; in stereophonic music; and in amateur photography.

For recording and handling industrial measurements a magnetic tape recording and data interpretation system was demonstrated by the Cook Research Laboratories. This system records transients with cyclical frequencies up to 100 cps on magnetic tape. Using only a small portable recorder the equipment is capable of recording virtually every conceivable measurement that can be converted into an electrical signal, including accelerations, stresses, pressures, temperatures, vibrations. The record obtained is then played back through a data interpretation system which transforms it into graphic forms. The demonstrations consisted of recording and playing back the output of various sensing

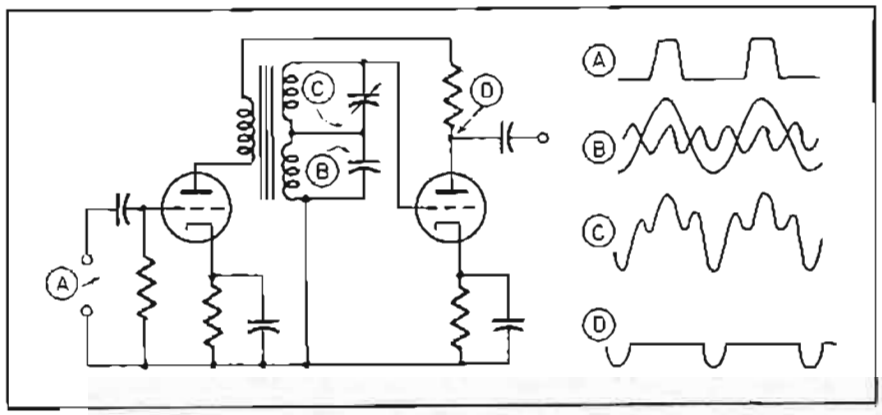


Fig. 2: Basic circuit and operating oscillograms of locked-in oscillator using sum of first and third harmonics in shock excited circuits to control horizontal sweep frequency

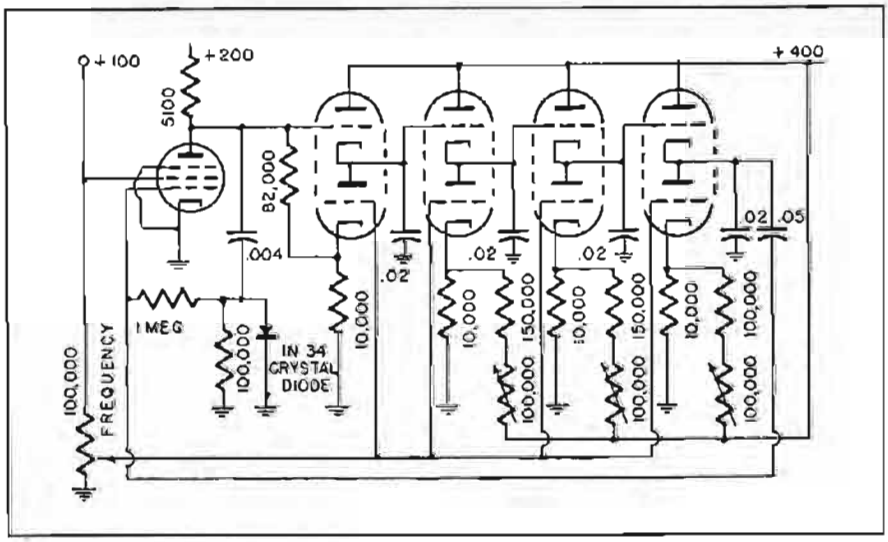
elements such as accelerometers, pressure transmitters, etc. Applications of the equipment range from aircraft flight test and upper atmosphere studies via V-2 rockets to the analysis of ride ability and durability of automotive test cars.

A description of the mass production methods used in the manufacture of television cathode ray tubes on an assembly line basis by D. Y. Smith (RCA, Lancaster), described new production machinery. Colored slides illustrated details of the unusual equipment in use.

Several new tubes were discussed. A new subminiature electrometer tube was shown by H. F. Starke (Raytheon). The tube is well suited to volume production using manufacturing technics similar to those used in producing hearing aid tubes. Typical applications include ionization chambers, use as a high impedance current source, and its use in photocells and mass spectrographs. A paper describing the approach to the design of a relatively high plate current dual control grid pentode for use in gating and control circuits was given by R. W. Slinkman, (Sylvania). By proper use of space charge effects and grid alignments a sharp No. 3 grid cut-off characteristic was obtained with a reasonable ratio of plate to screen current.

Further details and characteristics of the G.E. dyotron tube as a very high frequency oscillator were described by R. A. Dehn (G.E. Co.). Laboratory measurements show that 3:1 tuning range in the 900-3500 mc range is possible with a single tube in a simple coaxial cavity tuner. Power output throughout this band is adequate for signal generator and local-oscillator purposes. The frequency stability of this oscillator with reference to both thermal and electrical effect was mentioned. Stabilities of five parts per million are readily obtainable.

Fig. 3: Variable frequency oscillator with tube elements in frequency determining elements



A direct application of facsimile methods to engraving processes, described by J. A. Boyajean (Fairchild Camera & Inst. Corp.), provides a fast method of producing half-tone engravings from a picture without the usual photo-chemical etching process. The use of a carrier frequency modulated by the photocell pickup provides the required half-tone screen. The engraving consists of a series of regularly spaced, flat-printing surfaces of varying area, depending on the greyness of the picture.

This variation in reflection density of the subject picture modulates a photo cell to produce an amplitude-modulated signal which, amplified, actuates the stylus driver in a fashion similar to hill-and-dale recording. In this case, however, the stylus penetrates the surface of a celluloid plate burning a pyramidal-shaped hole therein during a portion of the alternate half-cycle and completely clears the surface during the in-between half-cycles.

Several papers were delivered on television. Kurt Schlesinger (Motorola) discussed possibilities and limitation of passive filters in locked-in oscillators, where high-Q circuits are used to select a narrow spectrum around the line scanning frequency (the flywheel effect). A practical filter which employs two shock-excited circuits tuned to the first and third harmonic of the line scanning rate is shown in Fig. 2. These tuned circuits offer considerable protection against noise. The end product of this development is a system which employs a locked oscillator, tuned to the average line frequency, and directly synchronized by the signal input.

Another timely paper was presented by R. D. Duncan, Jr. (RCA) on "Master Television Antenna and Signal Distribution Systems for Large Buildings." Two fundamental types of distribution systems, viz., video frequency and radio frequency were described and their characteristics, advantages and disadvantages, noted. RF systems which permit the use of standard commercial makes of receivers are subdivided into two classes: one where transmission is at high impedance and the other at low impedance, grounded. The Antenaplex system and equipment components were described in detail. Special types of directional receiving antennas required to discrimi-

(Continued on page 68)

TELE-TECH's NEWSCAST

S. L. Bailey New IRE President

Stuart L. Bailey, consulting radio engineer and partner of Jansky & Bailey, Washington, D. C., has been elected president of the Institute of Radio Engineers for 1949. The new vice-president is Arthur S. McDonald of Australia, a Fellow of the IRE since 1941 and currently chief engineer of the Overseas Telecommunication Commission, Sydney, Australia.

William L. Everitt, head of the Department of Electrical Engineering at the University of Illinois, and Donald G. Fink, editor of *Electronics*, have been named directors-at-large for the 1949-1951 term. New regional directors are: John V. L. Hogan, North Central Atlantic Region; George R. Town, East Central Region; Ben Ackerman, Southern Region; and Frank H. R. Pounsett, Canadian Region.

Signal Corps Purchasing

A list of items to be purchased and purchasing locations for the Signal Corps has been prepared by the Current Procurement Branch, Logistic Division, General Staff, U. S. Army. The equipment listed includes:

Batteries, Cable, Coils and Capacitors, Cord Sets, Crystals, Electron Tubes, Facsimile and Recording Equipment, Head Sets, Metal Fabricated Products, Microphones, Mine Detectors, Plugs, Power Units (Special Purpose Only), Public Address Systems, Radar and Associated Equipment, Radio Equipment, Reel Units, Resistors, Telephone Carrier Equipment, Telephone Equipment, Teletype Equipment, Test Sets and Meters, Transformers, Switches, Sockets, Visual & Sound Signaling and Ranging Equipment, Wire.

Educational and development items will be bought by Chief, Laboratory Office, Contracting Division, Signal Corps Procurement District, Fort Monmouth Area, Fort Monmouth, N. J. Motion picture films and supplies for Signal Corps Photographic center will be handled by Chief, Photographic Center Office, Signal Corps Procurement District, 35-11 35th Ave., Long Island City 1, New York, N. Y. All other items will be purchased by Commanding Officer, Signal Corps Procurement District, 2800 South 20th St., Philadelphia 45, Pa.

$50.5 Million Sales Total

RMA member-companies sold $50,318,006 worth of radio and television transmitting and communications equipment during the first six months of this year, according to a report issued by the Radio Manufacturers Association. Government purchases represented 67% of the total. Sales of civilian broadcast transmitting equipment, including AM, FM and television, amounted to $8,099,780 in the second quarter and brought the six months' total to $14,825,115.

Radio-Industry Mobilization Launched

Mobilization planning by the Electronics Equipment Advisory Committee, established jointly by the National Security Resources Board and the Munitions Board, has been successfully launched on the precept that in the formulation of plans for the utilization of the resources of the industry the government will lean on all manufacturers—large, medium and small.

F. R. Lack

This principle was emphasized at the first meeting of the group in Washington (Nov. 16), by the Committee's co-chairmen, F. R. Lack, vice president of Western Electric, and Capt. W. C. Wade, USN, chief of the Facilities Division, Munitions Board.

At the first meeting of the organization, which is charged with planning the marshalling of all equipment facilities in the electronics field in the event of a national emergency, provision was made for a special committee which will work with the military in standardization of government specifications and nomenclature. On those aims the group will work with the joint Army-Navy-Air Force Standards Agency at Fort Monmouth, N. J. In addition, other committees will study the various components of the overall mobilization "master" plan.

Attended by twenty-three executives of radio manufacturing companies, the advisory committee session was highlighted by the presentation by Chairman Lack of the Radio Manufacturers Association's mobilization plan which has been under study for months by the armed services. The government viewpoint on requirements in electronicic mobilization was detailed by a number of representatives of the armed services, the National Securities Resources Board and the Munitions Board.

Coming Events

Dec. 10 - 11 — Southwestern IRE Conference, Baker Hotel, Dallas, Texas.

Dec. 26-31—Mathematical Association of America, Southwestern Regional Meeting, Houston, Texas.

Jan. 10-12—Symposium on High Frequency Measurements, under sponsorship of AIEE, IRE and the National Bureau of Standards, Dept. of Interior Auditorium, Washington, D. C.

Jan. 22—Television Receiver Symposium, New York Section of IRE, Engineering Society Bldg., New York, N. Y.

March 7-10—IRE Annual Convention, Hotel Commodore and Grand Central Palace, New York, N. Y.

Tape Recordings Complete Transcontinental FM Network

Everett L. Dillard, president, announces that the Continental FM Network has completed arrangements with Orrin H. Brown, general manager of FM Station KSBR at San Francisco, to provide Continental Network programs by means of high-fidelity Rangertone-tape recordings to the West Coast FM audience.

KSBR thus becomes the first West Coast FM station to affiliate with the Continental FM Network, as well as the first to receive Continental shows by tape transcription on a regularly scheduled basis.

KSBR operates with a radiated power of 250,000 watts and is the highest power FM station in operation on the Pacific Coast. It is also one of the highest powered stations now operating on the North American Continent. The transmitter of KSBR is located on Mount Diablo in the San Francisco-Oakland Metropolitan District. The principal studios of the station are located at San Bruno, Calif.

The programs are transcribed in the studios of WASH (FM) in Washington, D. C. on the Rangertone machine at the same time that the Continental programs are being fed over its existing 15,000-cycle intercity telephone circuit to the Armstrong Stations, W2XMN and W2XEA at Alpine, N. J. and transmitted to other Continental East Coast affiliates by off-the-air relay. These tape transcribed shows are then immediately shipped by air express from the East to the West Coast for broadcasting by KSBR.

Sound Apparatus Consolidates

The main office and manufacturing plant of the Sound Apparatus Co. have been consolidated in Stirling, N. J. An engineering representative with facilities to demonstrate the company's products will be appointed for the convenience of visitors to New York City.

NEWS LETTER

ELECTION RESULTS MEAN GREATER EFFORT TO BOOST TELEVISION BY FCC—The election result spelled one thing certainly, that the FCC will continue its policy and objectives to make *Television* its No. 1 Task. Because all the Commissioners and, particularly, Chairman Wayne Coy are completely in accord that Television holds the greatest potential for the American public of any new industry on the horizon. In fact, since the FCC Commissioner lineup remains unchanged—and probably Commissioner E. M. Webster whose term is the first to expire on next July 1 will be reappointed—the broadcasting and communications services which are regulated by the FCC know better than probably any other segment of American business and industry what courses lie ahead for them. Chairman Coy, who has been doing a most notable job in the past six months of discussing in public addresses the future of broadcasting and television, envisions at least 1,000 Television stations in the United States in the next seven or eight years.

TV-FM ENGINEERING CONFERENCE OF FCC IS ALL-IMPORTANT—Most important for both the radio engineering profession and especially for the radio manufacturing industry and television and FM broadcasting services is the three-day engineering conference of the FCC on the proposed rules and engineering standards for Television and FM broadcasting which was scheduled for Nov. 30 and Dec. 1-2. The probing of the nation's radio engineers through the Joint Technical Advisory Committee of the Institute of Radio Engineers and the Radio Manufacturers Association, headed by RCA Frequency Bureau Chief Philip Siling, will blueprint the timetable when the present "freeze" on television station construction permits can be lifted. FM broadcasting which Chairman Coy and the FCC feel strongly is on the road to great strides of progress as the broadcast outlet for smaller communities of the nation will also greatly benefit from the engineering conference's determinations. There may also evolve the delineation of the long-standing issue of clear channel broadcasting stations in terms of power and coverage.

MILITARY SERVICES' PROCUREMENT OF RADIO-ELECTRONICS EQUIPMENT TO BE LARGER—With the certainty that the Armed Services will receive a budget for the next fiscal year, beginning July 1, of at least $15 billion, the allocations of procurement contracts by the Army Signal Corps, the Navy Electronics Division of the Bureau of Ships and the Air Force's Materiel Command at Wright Field to the radio-electronics manufacturing industry loom as large and in all probability greater than have been the production assignments of this current year. A comprehensive review of the mobilization planning and launching of an extensive study by the manufacturing industry itself of all elements of end-equipment and component production was launched in mid-November at the highly significant meeting of the Electronics Equipment Manufacturing Industry Advisory Committee to the Munitions Board and the National Security Resources Board held at the Pentagon. A most important subject was the outline of the Contingent Contract Plan by an outstanding Navy expert, Captain C. A. Rumble, chief of electronics under the Navy Operations Deputy Chief for logistics. This Plan provides that all manufacturing companies will be advised of their production task in event of a war emergency and for a stepped-up defense.

FINAL MOBILE RADIO ALLOCATIONS SLATED BEFORE END OF YEAR—Before the end of the year the FCC is planning to reach a decision on the final frequency allocations framework for the vast sphere of Mobile Radiotelephone Services. All during November the engineering and legal staff officials of the Commission assigned to the mobile services have devoted nearly all their time in the analysis and review of the two-week-long oral arguments on mobile frequencies which were presented by over 100 attorneys and engineers from those services. The staff group has been holding meetings at least once a week with Commissioner E. M. Webster, engineer-member of the FCC, to coordinate the frequency planning. It is anticipated that the Commission will place in its final allocations blueprint major emphasis on the present development of the multi-faceted mobile services, bracketed with the public demand and need, and will look to the expected future development in the parcelling out of channels, especially in the overcrowded 152-162 megacycle portion of the spectrum.

MISCELLANY—Radio manufacturers can well look to a fertile field of sales in Citizens' Radiocommunications when the FCC determines the final rules and engineering standards for that service, which is expected to expand rapidly in this field of short-distance, low power communications in the 460-470 mc band with this decision; it is significant that the FCC has received no comments or objections to its proposed rules issued last March. Therefore these are slated as final regulations with only minor modifications. . . . The Civil-Military air navigation program (installation of $1.3 billion worth of equipment in next fifteen years) received great impetus toward its goal with the series of CAA demonstrations of the electronic systems at the Indianapolis experimental airport.

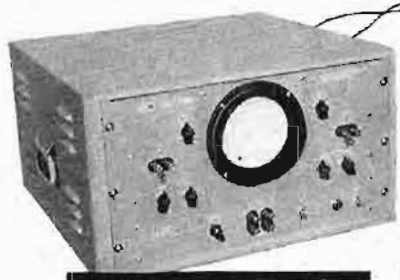
For wider frequency range...top writing rates... increased brightness...it's DU MONT *High-voltage Oscillography*

The basis is the Type 5RP-A Cathode-ray Tube operating at an accelerating potential up to 29,000 volts maximum. This achieves: (1) Greatly increased brightness; (2) Observation or recording of traces hitherto invisible; (3) Vastly increased writing rates even better than 400 inches per microsecond; (4) Optical magnification by projection lenses such as Du Mont Type 2542. Although deflection sensitivities are slightly less than those of low-voltage cathode-ray tubes, high-voltage oscillographs produce smaller spot size and higher brightness, thereby presenting a finer, better resolved trace.

And here's the Du Mont selection of high-voltage oscillographs:

10 CPS to 10 MC

Type 280: A precision time-measuring oscillograph with range of 10 cps to 10 mc. Sweep speeds as high as 0.25 microsecond/in. are available. Duration of any portion of signal measured on 0.25 microsecond/in. sweep to an accuracy of ±0.01 microsecond. Intervals greater than 5 microseconds read on calibrated dial to accuracy of ±0.1 microsecond. Ready application to precise measurement of duration of waveform of various components in the composite television signal. Accelerating potential adjustable from 7,000 to 12,000 volts. Recordable writing rates up to 63 inches per microsecond, with commercially available equipment.



WRITING RATES TO ABOVE 400 IN./MSEC.

Type 281-A: Devoid of internal deflection amplifiers, there are no frequency response limitations within the ratings of its Type 5RP-A tube. Phenomena have been recorded photographically at writing speeds of 85 inches per microsecond. With external power supply (such as Du Mont Type 286-A), photographic writing speeds of over 400 inches per microsecond may be examined. Recommended when oscillographic needs are extremely specialized or too advanced for standard commercial equipment. An accelerating potential as high as 29,000 volts is available with the Types 281-A and 286-A in combination.

Type 250-H: Covers range from d-c to 200 kc. Potentials containing both d-c and a-c components may be examined. Many special features for general usage include: linear time-base of unusual flexibility; automatic beam control on driven sweeps; internal calibrator of signal amplitude. This is a high-voltage oscillograph with maximum accelerating potential of 13,000 volts. Recordable writing rate of approximately 40 inches per microsecond.

D-C to 200 KC

20 CPS-5 MC

Type 248-A: Frequency range of 20 cps to 5 mc. Specifically intended for investigation of pulses containing high-frequency components of recurrent or transient nature. For this purpose it provides these necessary characteristics: High-frequency recurrent sweeps; short-duration driven sweeps; timing markers; signal delay network. Accelerating potentials up to 14,000 volts at recordable writing rate of approximately 69 inches per microsecond.

LITERATURE ON REQUEST

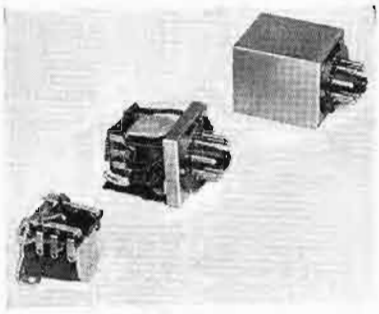
DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U.S.A.

New Parts For Designers

AC-DC Relay

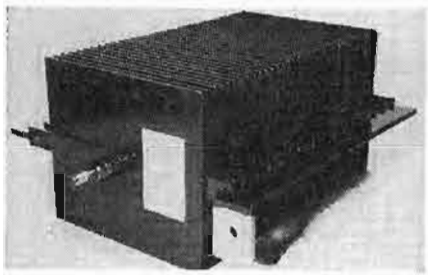
Type 118XBX small-size control relay can be used on ac and dc, as well as on half-way rectified ac and has DPDT contacts rated 2



amps., 115 volts ac. Normal dc operating power is .15 watts with a maximum coil resistance of 2,200 ohms. Operation of ac relays is approximately 9 volt amps. with coils up to 115 volts, 60 cycles. The open-type relay is 1½ x 1¼ x 1 in. and weighs almost two ounces.—**Struthers-Dunn, Inc., 150 N. Thirteenth St., Philadelphia 7, Pa.**

Selenium Rectifier

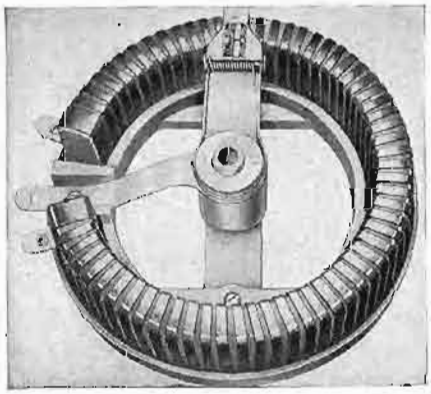
Each of the 34 (6¼ x 7¼) elements in this heavy-duty selenium stack is moisture-proofed, providing adequate protection against



corrosive atmosphere. The stack will deliver 1500 amps. and nine volts continuous load in a three-phase half-wave circuit. An air velocity of approximately 800 linear ft. per minute is required and the terminals are mounted so that they do not obstruct the air flow from the fan.—**International Rectifier Corp., 6809 S. Victoria Ave., Los Angeles 43, Calif.**

Round Rheostats

Seven sizes from 50 to 500 watts of vitreous-enameled round rheostats have maximum cur-



rent values ranging up to 22.4 amps. Insulating parts are made of strong ceramic material. Hence there is no shrinkage or loss of insulation though carbonization due to heating. Contact arm consists of a channel-shaped center truss spring hinged to a contact block holder. The hinge spring assures the correct contact pressure between the contact block of copper-graphite and the winding at all points of the sliding path.—**Rex Rheostat Co., Baldwin, L. I., N. Y.**

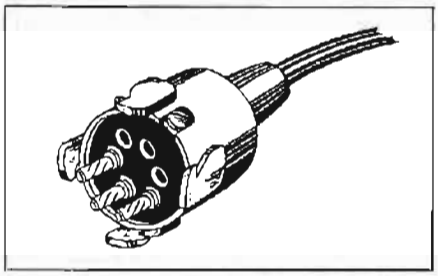
Audio Transformers

Special coil and core construction in the new Stancor "HF" and "WF" series of high fidelity audio transformers results in the reduction to a minimum of hum pickup, leakage reactance

and harmonic and intermodulation distortion. Both series are potted in gray enamelled cast cases with four tapped holes on top and bottom for flush mounting. Stud-type terminals are provided on a phenolic panel.—**Standard Transformer Corp., Dept. K, Elston, Kedzie & Addison Streets, Chicago 18, Ill.**

Rubber Connector

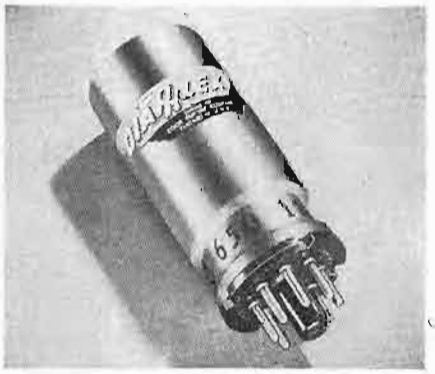
Most of the portable power transmission problems encountered in voice and picture transmission may be eliminated through use



of integrally molded Neoprene rubber connectors. Push-latch plug illustrated, developed originally for the Signal Corps, is one of the many styles available. Advantages claimed for this one piece cable to connector assembly are: increased safety; accidental disengagement prevention; positive polarization; and constant pressure contact.—**Mines Equipment Co., 1215 Clayton Ave, Dept. A24, St. Louis 16, Mo.**

Time Delay Unit

The Tarrytone time delay unit is provided with settings anywhere from one second to two minutes and is stable in operation when



subjected to as high as 12 G's acceleration. Heater currents may be ranged from six to 115 volts, ac or dc. It is furnished with an octal plug-in base which is interchangeable with similar time delays.—**Cook Electric Co., DiaPHlex Div., 2700 Southport Ave., Chicago, Ill.**

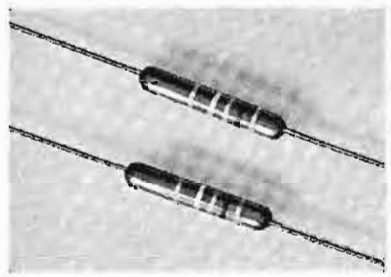
Miniature Switches

Designed to meet the need for a smaller lever-type switch, the MCT switches have the added advantages of shielding between switch

assemblies and provisions for mounting on all standard mounting centers. The MCT-4 has a total depth behind the panel of 2 21/32 in., including terminals. The frame face is ¾ x 1½ in. with a 15/16 x 9/64 in. panel slot. Total depth of the MCT-1 behind the panel is 2½ in., including terminals.—**General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.**

Molded Capacitors

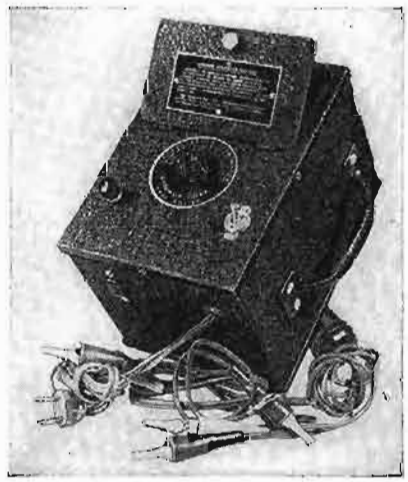
Said to be the smallest molded tubulars ever produced, Prokar capacitors are impregnated with a recently-developed high tem-



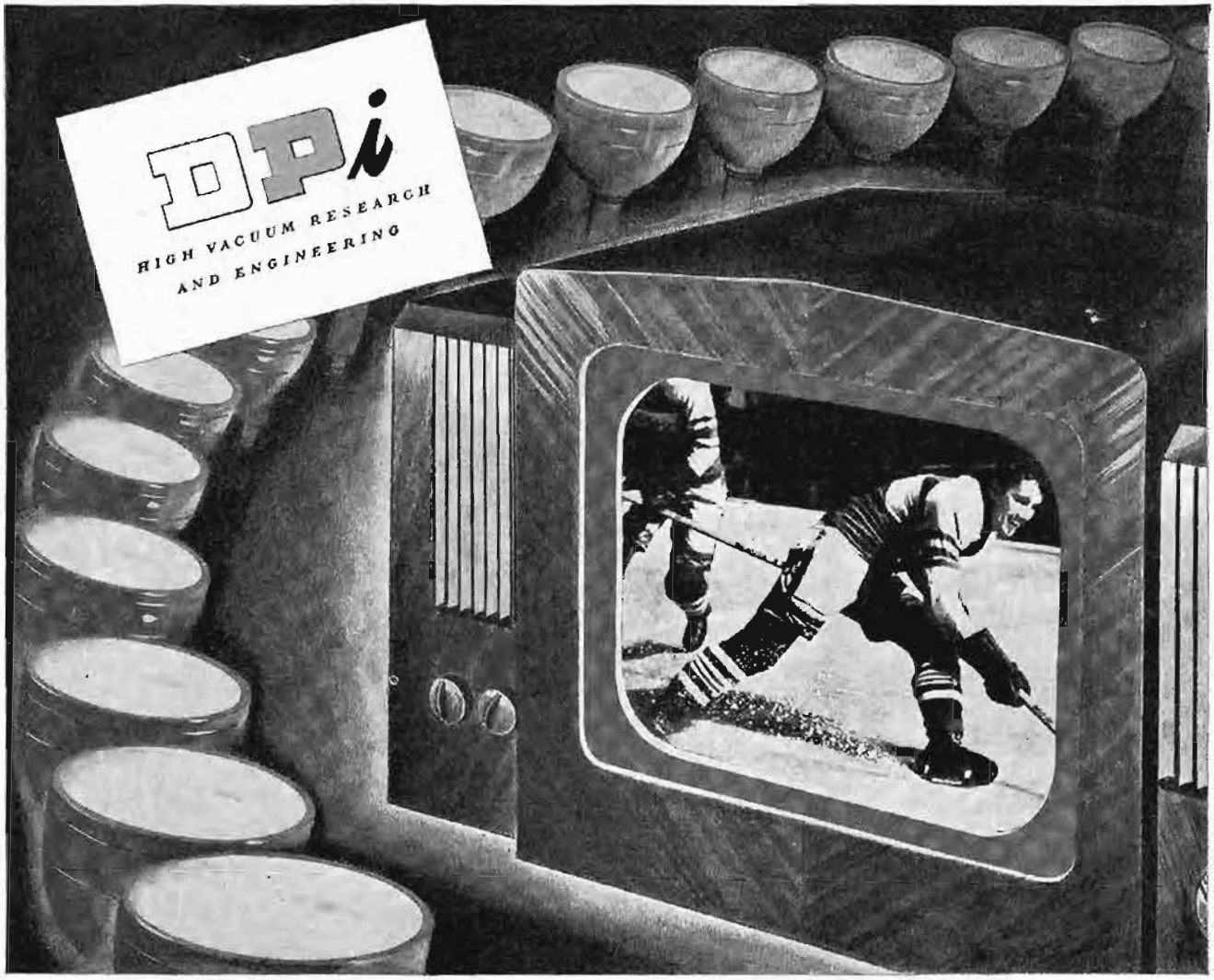
perature plastic which provides a considerable size and performance advantage at high temperatures over other known impregnants. They are rated for operation in temperatures from —55° C to + 125° C.—**Sprague Electric Co., North Adams, Mass.**

Interference Filter

The type filter to be used in a circuit, as well as the best connections are determined quickly and accurately by the new Aerovox



Interference Filter. The unit is mounted in a sturdy metal cabinet and is supplied with an assortment of connecting cords, plugs receptacles and clips which may be connected to the noise-producing appliance or equipment. Turning the control knob to different settings brings into the circuit the same circuit elements which are found in Aerovox interference filters of corresponding type number. When the satisfactory filter is determined, permanent installation may be made.—**Aerovox Corp., New Bedford, Mass.**



Gangway for a Billion Pin Points of Light

"High vacuum of 2 x 10^{-6} millimeters of mercury" is a scientific-sounding phrase, utterly meaningless to most people. Yet these same people are enjoying the benefits of high vacuum in scores of ways right in their own homes:

Perhaps *you* may be reading this under a light that shines brighter because of high vacuum in bulb or fluorescent tube. Your radio plays sweeter because of higher vacuum in radio tubes: Without high vacuum you couldn't have television. Better removal of air from the receiving tube means greater clarity; more faithful images on the television screen.

The plastic ash tray at your elbow—many of the vitamins and miraculous pharmaceuticals in your medicine cabinet—the cosmetics on the dressing table—are among many products which have been—or can be—made better in quality, lower in cost because of distillation, dehydration or metallic evaporation under high vacuum.

New ways of using high vacuum are constantly being discovered in refining industries, in medical science, in metallurgy, in dehydration, in food concentrates, in textiles, in atomic energy!

DPI can aid in research in setting up pilot operations and can advise on engineering and building complete installations for profitable commercial applications of high vacuum. We invite inquiry.

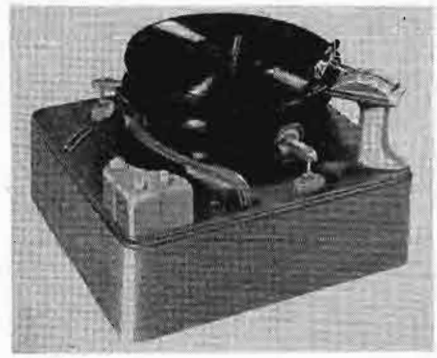
DISTILLATION PRODUCTS, INC.
777 RIDGE ROAD WEST • ROCHESTER 13, N. Y.

Manufacturers of Molecular Stills and High-Vacuum Equipment; Distillers of Oil-Soluble Vitamins and Other Concentrates for Science and Industry

SOUND EQUIPMENT

Record Player

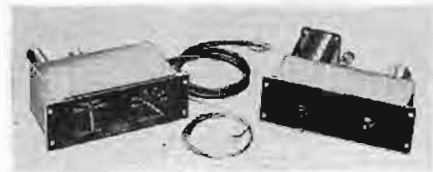
Two sides of a single record can be played without turning it over with the Markel Duo Playmaster, a new unit which may be at-



tached to any radio-phonograph combination. It is also supplied in a wood cabinet base for simple attachment to any radio. The Playmaster will play one side of any stack of records in sequence or both sides.—**Markel Electric Products, Inc., Duo Playmaster Div., Buffalo 8, N. Y.**

Amplifier and Power Supply

Model A65 amplifier and companion model P6-300 dc power supply are a useful amplifier-power supply combination when power is not



conveniently obtainable from the main amplifier chassis. The model A65 provides 18 combinations of bass and treble curves and turnover frequencies of 200, 500, and 800 cycles are accommodated. High frequency control permits adjustment to any of six response curves, ranging from flat response to slightly more than NAB slope-off. Power supply provides dc for the tube heater as well as the plate supply, providing exceptional low hum level.—**Brociner Electronics Laboratory, 1546 Second Avenue, New York 28, N. Y.**

Tape Recorder and Playback

A single "head" is utilized for recording and playback in the AudiAd, a new recorder which inscribes any message up to one minute in length on tape and plays it back. The tape is a continuous 37½ foot loop, eliminat-

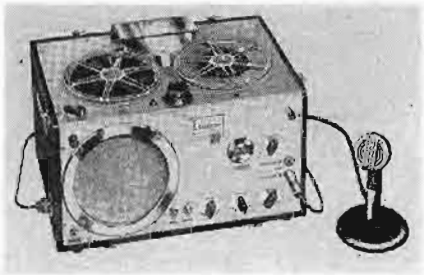
ing rewinding and rethreading, and permitting continuous operation. Announcements may be changed at will. The old words are automatically erased as a new message is recorded via the high quality crystal mike. Or an entire new message can be inserted by changing the tape magazine. The AudiAd will start automatically when connected with an electric eye, a concealed switch, or a push button.—**AudiAd Div., Magnecord, Inc., 360 N. Michigan Ave., Chicago 1, Ill.**

LP Tone Arm and Cartridge

The FL-33 pickup and LP-33 crystal replacement cartridge have been specifically designed for use with the new, long playing microgroove discs made by Columbia Records, Inc. A permanent sapphire needle in the LP-33 has a tip radius of .001-in. for microgroove recordings and is readily interchangeable with a companion cartridge (LP-78) for playing conventional 78 rpm records. Needle pressure of the FL-33 pickup is five grams and output is approximately .5 volt with a frequency range of 30 to 10,000 cps.—**Astatic Corp., Conneaut, Ohio.**

Portable Tape Recorder

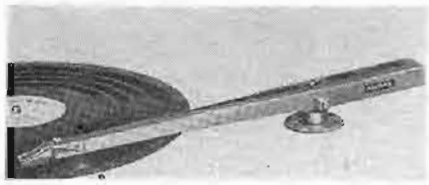
The design of the Ekotape portable tape recorder features a large powerful amplifier with separate channels for recording and listening, an 8-in. speaker and an oversize



motor with high inertia flywheel permitting guaranteed maximum instantaneous speed variation below one percent. The unit may be used as a recorder, a player or as a public address system, with its own or separate speakers, or may be coupled to a larger sound system. Motor drive and capstan operate continuously so that tape starts and stops without coasting. Tape may be spliced and edited or it may be erased and used over again.—**Webster Electric Co., Racine, Wisconsin.**

Tone Arm

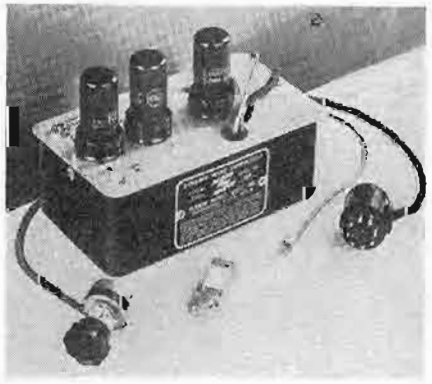
The LM series of Audax Tuned-ribbon reproducers operates with a point pressure of approximately six grams and is capable of a



range from 40 cps to over 10 kc. Four models are available in this new series which has been designed for performance with the recently-developed long playing discs.—**Audak Co., 500 Fifth Ave., New York 18, N. Y.**

Dynamic Noise Suppressor

Easily installed in most existing arc phonograph or radio-phonograph systems, the model 110-A dynamic noise suppressor is re-



motely controlled and available at low cost. A specially matched pickup is included for wide range performance and low needle-talk. Only one connection is necessary to install the 110-A between the pickup and the amplifier. —**Herman Hosmer Scott, Inc., Dept. T, 385 Putnam Ave., Cambridge, Mass.**

TV SLIDE PROJECTOR

A new slide projector (PF-3-C), designed by General Electric, supplies still projection facilities for television stations. Dual lenses provide dissolving action and iris control. Two images may be superimposed on each other or projected singly or simultaneously in any relative brightness

Studio Orchestra Stand

Finished in a deep maroon metallic enamel, the No. 300 studio orchestra and announcer's stand is equipped with nickelplated fittings

and plastic adjusting knobs. It is available in special colors when ordered in sufficient quantities.—**Krauth & Benninghofen, Hamilton, Ohio.**

Dry Air Purge Unit

Completely self contained and automatic, this new unit provides a continuous source of dry high pressure air for the purpose of preventing moisture condensation. It has

desiccant chambers which are automatically regenerated without interrupting the purge air supply. Features of the unit are: purge air-flow indicators, reducing regulators, totalizing air flow meter, and safety devices to prevent the use of damp air for purging. Operation is from 110 volts, ac or dc.—**Industrol Corp., 88-35 76th Ave., Glendale, Brooklyn 27, N. Y.**

BOOKS

Radio Engineering

By E. K. Sandeman. Published by John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. 775 pages. Price $6.50.

Originally planned as an instruction book for BBC maintenance engineers, this volume includes elementary working principles designed for the use of the beginner as well as more advanced material for experienced engineers and designers. A number of subjects not found in similar books are covered: rf resistance; inductance of straight wires; impedance characteristics of feeders; and curves for finding the spectra of frequency modulated waves.

Radio at Ultra-High Frequencies

Vol. II RCA Technical Book Series. Published by RCA Review. Cloth bound, 485 pages. Price $2.50, postpaid in U. S.

Developments in UHF during the years 1940-1947 are covered in the eighth and most recent release of the RCA Technical Series. Seven selected papers on transmission lines and antennas, three on propagation effects, five on reception, two on radio relays make up the contents as well as three papers each on microwaves, measurements, and aids to navigation. The author of each paper is a well known engineer in his chosen field (usually associated with RCA system).

Design of Crystal Vibrating Systems

By W. J. Fry, J. M. Taylor and B. W. Henvis. Published by Dover Publications, 1780 Broadway, New York 19, N. Y. 182 pages. Price $3.50.

Graphs based on fundamental piezoelectric relations in this new manual introduce a design method which applies to any system composed of a piezoelectric material, vibrating in thickness or longitudinal mode, in combination with any backing system and driving any medium. This information was originally published as a confidential war-time report of the NRL, U. S. Navy.

Vacuum Tube Amplifiers

M. I. T. Radiation Lab. Series #18. Edited by G. E. Valley, Jr. and Henry Wallman. Published by McGraw Hill. 743 pages. Price $10.

Theory is analyzed and design principles are presented for many types of amplifiers in this volume, particularly those having unusual characteristic requirements, such as very high gain, large bandwidth, great dynamic range, or precise response. Following a theoretical introduction, video amplifiers, wide-band high-frequency bandpass amplifiers, low-frequency bandpass amplifiers, and direct-coupled amplifiers are discussed.

Chicago IRE Conference

(*Continued from page 50*)

nate against multi-path reception of signals, and high gain antennas for use in weak signal regions, were described and their characteristics noted. The problem of reducing receiver oscillator radiation and feedback into the distribution system was discussed, with effective solutions given.

The latest RCA large screen television was described and demonstrated at an evening session. The light source, the optical system and the viewing screen were discussed with relation to the overall result. Special Conference programs were transmitted from Chicago stations to handle this session.

Among the new electronic circuits, an electronically deviable audio oscillator with wide band characteristics was described by M. E. Ames (Philco). It can cover as many as eight octaves by varying a single control voltage. The circuit consists of a band pass amplifier whose output is fed back to its input by means of a series of electronically controlled phase shift stages. Cathode follower amplifiers were found to be ideally suited as phase shift stages by using the effective resistance of the followers as series elements, and fixed condensers as a shunt element in an RC network. The effective resistance of three or four phase-shifters is varied in unison by changing the average grid potentials as in Fig. 3. An experimental circuit operating over the range of 2,000 to 200,000 cycles was also described.

A paper delivered by R. W. Slinkman (Sylvania) stressed the need for a new approach in radio receiving tube design. He stated that very little information in technical literature in the radio and electronics fields provides specific data on receiving tube design. Available data treats groups of receiving tubes in general classes of a few commercial types including bantam, miniature and subminiature but does not provide specific design formulas for specific tubes in any class. His paper outlined the theoretical approach; objective specifications; general design consideration; and specific design for type 7AK7 pentode with suppressor control for "gating" applications.

A new study of a tube to display magnetic fields (following the principles set up by Stormer and others many years ago, by the use of low velocity cathode rays) was dis-

cussed, by S.G. Lutz and S.J. Tetenbaum (New York Univ.). The tube has a glass envelope four inches in diameter by twelve inches in length, with a filament cathode surrounded by a perforated metal anode. In this tube, the electrons follow the magnetic field in such tight spirals that they appear to move in parallel paths, a feature which makes interesting, new applications possible.

A number of sessions were devoted to the many new applications of electronic methods to industrial uses. Also several sessions of general interest were scheduled. In particular, one group of papers on the organization and administration of research facilities should be mentioned. Five papers were presented here: "Organization of Research" by C. C. Furnas, Cornell Aeronautical Laboratory; "Development of Physical Facilities for Research" by R. B. Dittmar, Los Alamos Scientific Laboratory; "Personnel Administration in Research and Development Organizations" by C. E. Barthel, Jr., Armour Research Foundation; "Information Exchange as a Management Tool in a Large Research Organization" by Allen H. Schooley, U. S. Naval Research Laboratory; and "Research Ideas Go to Market" by Waldo H. Kiever, Minneapolis-Honeywell Regulator Co.

TV Tube Increase Predicted

Production of approximately 20,000 television tubes per month in the latter part of 1949 is anticipated by the National Union Radio Corp. of Orange and Newark, N. J. Kenneth C. Meinken, president of National Union, said that present production in the 7, 10 and 12½-in. types is gradually catching up to backlog demand.

BLUEPRINT CABINET FILE

Blueprints and drawings can be indexed and stored conveniently in this cabinet file which holds up to 1,000 prints. Suspension rods on hinges hold drawings; when front panel is opened, the rods slide apart. Cabinet is product of Empire Development Corp., 209 Union Trust Building, Washington, D. C.

Microwave Losses in Gases

Laboratory technics discussed by Instrument Society showed effects of atmosphere on UHF communications

At the third National Instrument Conference held in Philadelphia, Pa., in September, many new forms of measuring devices and improved technics were described, demonstrated and exhibited. The conference was attended by 12,000 registrants among whom were many radio engineers.

One paper of considerable interest to radio men was that on Radio Spectrometry by C. H. Townes of Columbia University. While dealing primarily with a new instrument using radar-inspired microwave methods that should prove of great value in chemical analysis of gases, liquids and solids, this type of spectroscopy has been applied to a number of fundamental problems in the various fields of nuclear physics, molecular structure, and physics of the solid and liquid states. In this application small amounts of microwave power, of the order of one milliwatt at 20,000 to 30,000 mc are directed through a waveguide having a length of a few feet or a few yards, which contains a sample of, say, a mixture of gases that is to be analyzed. The absorption spectra are determined by varying the applied frequency and noting the points where strong absorption of energy occurs.

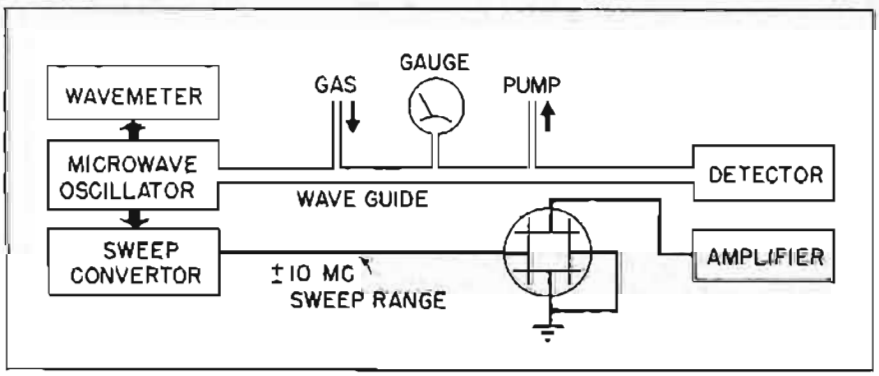
It was stated that the resolution obtained with radio spectroscopy was possibly 1000 times as sharp as with infrared methods and the frequency can be measured to one part in a million. Very small amounts of gas will show absorption provided the gas has molecules of the polar type. The effect of radio frequencies is to produce an "end-over-end" rotational effect on such molecules when tested at their own resonant frequencies.

Contrary to results found with other spectroscopic methods, different isotopes of a given molecule show up in narrow bands very far apart, making their detection quite easy. Very smaller quantities of gas can be used. For example, 10^{-10} gram of ammonia can be detected. A complete set of spectra can be taken in 1/60 second, showing up on an oscillograph with that sweep rate. Some gases can even be detected in 1/1000 of this time.

A communication engineer may wonder why all of this data about a purely industrial measuring device should interest him. One thing brought out was that enormous absorption losses over extremely narrow bands are found even over the short path lengths in a spectrometer (compared to the paths found in communication applications of the same frequencies). Either this range will have to be avoided for serious communication channels or extreme frequency stability must be attained to keep out of the absorption bands occupied by molecules normally found in the atmosphere.

Another interesting field of utility is that a new wavelength stand-

In a typical microwave spectrometer, gas which is under test flows through a wave guide



ard is available. Molecules of different gases provide sharp and simple check points in a frequency range where measurements are difficult using present radio technics. Again, in time, a capsule of concentrated gas may form some part of a feedback circuit to stabilize microwave oscillators.

In a number of other different fields, electronic measuring technics introduced by communication men have been taken up and advanced to a notable degree by others seeking better solutions to industrial problems.

Another conference and exhibit has been planned in 1949 to be held in St. Louis.

Sunspot Period '45-47

(*Continued from page 29*)

day fields rose from a value slightly in excess of 90 microvolts, when the sunspot number was 80, to values of 260 microvolts or more when sunspot numbers registered from 140 to 150 (see Fig. 3). Night fields on the 10 mc frequency, based on observations between 10 pm and 2 am, rose from 10 microvolts, with a sunspot number of 80, to values in excess of 30 microvolts, with sunspot numbers between 140 and 150. For practical purposes, it is to be noted that the continuous time signals from the National Bureau of Standards can best be received during high solar activity in the daytime on the 10 mc frequency, whereas during the night hours stronger fields will be received on the 5 mc frequency. This applies to reception comparable to the Washington-Needham path covering a distance of 373 miles.

If one examines the diurnal patterns month-by-month, it is found that during the years of low sunspot numbers a typical double maximum reception occurs in winter, with low night and midday values and with high values in the morning and afternoon. Night values rise and noonday values lower during the summer months due to increased ionization of the atmosphere accompanying longer days and higher solar altitudes. With the progress of the sunspot cycle a metamorphosis takes place, the winter pattern gives way to a summer pattern which has persisted through 1947 and into 1948. It may be anticipated that with the decline in sunspots from the maximum of 1947 the diurnal field intensity changes during the coming winters will again begin to

(*Continued on page 73*)

TV RECEIVER CHANNEL SWITCHING MECHANISM

(*Continued from page 38*)

of adjustment and reduces the time required for alignment.

The local oscillator operates at a frequency higher than signal frequency. The nominal intermediate frequencies produced are 21.75 mc for the sound carrier and 26.25 mc for the picture carrier. Sufficient range of adjustment is provided in the oscillator coils to permit the use of sound carrier intermediate frequencies in the range 21.25 to 21.9 mc.

The tabulated data indicates a minimum image rejection ratio of 36 db, unbalanced r-f rejection ratio of 13 db, balanced i-f rejection ratio of 30 db, and unbalanced i-f rejection ratio of 45 db. The oscillator radiation figures given represent the oscillator voltage as measured at the antenna terminals. In all these respects, this tuner compares favorably with other tuners in use at the present time. Measurements have indicated a rejection of greater than 50 db against the double conversion effects which can cause interference between high and low frequency television channels in certain localities.

The power requirements for the tuner are 0.6 amperes at 6.3 volts for heater supply, and 30 ma at 190 volts for plate and screen supply.

Channel	Tuner Transadmittance* db above 1 mmho	Image Rejection Ratio db	Unbalanced R-F Rejection Ratio db	I-F Rejection Ratio—db Bal.	I-F Rejection Ratio—db Unbal.	Oscillator Radiation Bal.—mv
2	12.0	53	17	30	>52	7
5	13.0	—	13	36	>52	28
7	9.0	38	14	43	46	16
9	8.5	36	16	42	45	28
13	8.3	—	13	49	46	—

*Measured at picture carrier frequency.

Performance data of a typical production tuner, manufactured by Edward I. Guthman & Co. and measured at the Hazeltine Electronics Corp. Lab.

Sunspot Period '45-47

(*Continued from page 71*)

simulate the double-maximum pattern previously observed at lower values of solar activity such as occurred in 1944 and 1945.

Observations on the broadcast band of Station WBBM, Chicago, 780 kc, received at Needham, a distance of 851 miles, show a general decline in field intensities from values in excess of 270 microvolts to values of but 45 microvolts as sunspot numbers increased from 20 to a maximum value of 150. In treating the WBBM data, midnight values were taken with 12-month moving averages to eliminate seasonal effects.

In conclusion, it is to be emphasized that while measurements of critical frequencies, as contributed by numerous ionospheric stations, yield values of electron densities at the region of maximum ionization in the layers observed, and therefore determine the possibility of reflection of given frequencies over given paths, the measurements of field intensities afford records of actual performance, thus indicating not only conditions at the reflecting layer but the degree of absorption introduced through the lower ionized atmosphere as well.

Illinois Central RR Uses 2-Way FM

After several years of planning and experiment, the Illinois Central Railroad is starting the use of two-way radio communication as an aid to more efficient yard operation. Its FM Station WMWK, near Chicago, operates on a frequency of 161.85 megacycles, with a power of fifteen watts. Its reasonably effective range is about fifteen miles.

WMWK has its principal transmitter and receiver in the northbound "hump" office at Markham, the Illinois Central's 3-mile-long freight-car classification yard 20 miles south of Chicago. There its talk is mainly with the crews of switch engines Nos. 3617 and 3619, which spend their days pushing long miles over the "hump," beyond which the cars roll by gravity, with the control of switches and car-retarders, to their proper places in new trains.

These locomotives are likewise equipped for 2-way radio conversation with the "hump" office, and orders are readily transmitted, received and interpreted wherever they are in the yard.

The radio system supplements the color light signals used for office-to-"hump" engine communication. The new equipment, which includes an antenna atop a 120-foot steel floodlight tower, was furnished by the Farnsworth Television and Radio Corp. The installation was handled by J. M. Trissal, superintendent of communication and electrical engineer for the railroad

CATHODE-RAY OSCILLOGRAPH SPECIFICATIONS

(Continued from page 48)

can operate with 12 kv. on the tube is far superior to the instrument operating with, say, 3 kv., for this type of application.

In a great many instances, the signal to be examined on an oscillograph has a dc component as well as an ac component. As an example, the potential at the plate of an amplifier tube is composed of the ac or signal potential, plus an average or dc potential. The input coupling circuits of an oscillograph should therefore be designed to withstand the sum of these components. The better types of oscillographs are generally designed to handle either 600 or 1000 volts dc plus peak ac input.

It may sometimes be necessary to investigate signals which contain frequency components beyond the frequency-response limits of the deflection amplifiers. Such signals may be directly connected to the deflection plates of the cathode-ray tube. Terminals are available for this purpose on the better oscillographs, for direct connections.

It is extremely desirable that positioning controls on the oscillograph retain their usefulness even when connections are made to the deflection plates. If positioning of the trace is not retained automatically precautions should be outlined in the instruction book.

It is very convenient to be able to synchronize the sweep in an oscillograph from signals of either positive or negative polarity, since many times only one of them is readily available. The more versatile oscillographs are equipped with provision for such sync-phase-selection.

An oscillograph should be sufficiently stable in operation that it is not affected by line-voltage changes of ordinary magnitude. Instability may exhibit itself as shifting of trace position, change of beam intensity, non-operative amplifiers, etc., any one of which renders the instrument more or less useless.

Some oscillographs, for instance, derive amplifier bias from a negative high-voltage supply, the regulation of which is extremely poor with respect to line-voltage changes. Line surges are thereby actually amplified, and will appear on the screen of the cathode-ray tube. A properly designed oscillograph should operate normally with line voltage fluctuations as high as ±10% of the nominal voltage.

The specifications of some oscillographs indicate that close tolerances on power-line voltage must be maintained. Overheating and reduced transformer life may result if line-voltage should be consistently higher than nominal. Properly designed instruments should operate satisfactorily with power-line voltage as much as 10% higher than normal, and they often have provision to allow operation from either 115-volt or 230-volt lines. It is also well to question whether the oscillograph can be operated from other than 60-cycle line frequency without severe increase in the external magnetic field of the power transformer.

The cathode-ray tube in an oscillograph should be shielded against magnetic disturbances to prevent undesirable deflection or modulation of the electron beam. Some oscillographs have no shield whatsoever. Others use shields of ordinary sheet-steel which offer some mechanical protection for the tube

but which are inadequate for magnetic shielding. Best possible shielding is provided by mu-metal, a material which has excellent magnetic properties.

While an oscillograph is primarily a test instrument which should not require much bench-space, it is nevertheless unwise practice to gain compactness at the expense of accessibility. Some small-size oscillographs are so compact that whole sections must be removed in order to reach a single component. This is particularly bad when the oscillograph is to be used under other than ideal laboratory conditions. The prospective user must depend mainly upon the reputation and integrity of the manufacturer in adhering to good engineering practice.

A variety of equipment such as time-base generators, voltage calibrators, electronic switches, recording cameras, high-voltage power supplies, projection lenses, etc., which are designed for use in conjunction with cathode-ray oscillographs do much to increase the value of any oscillographic investment. The manufacturer of such a complete line of instruments is automatically prepared to make recommendations regarding proper selection and utilization of equipment.

Before one makes an investment such as oscillographic equipment represents, one should first satisfy himself that the manufacturer from whom he makes his purchases is qualified by experience to specify and recommend instruments to fit his particular problems. Some have only recently entered this high-specialized field, and the major activities of others concern many types of products.

When a manufacturer guarantees his product, he provides both protection and service to the customer. Protection, in that no one makes a guarantee unless he feels that his product can meet it; service, in that any fault occurring in the guarantee period will be the responsibility of the manufacturer. Cathode-ray oscillographs should carry a guarantee for one year; cathode-ray tubes, for six months or 1000 hours of operation.

This outline tries to provide some insight into reading between the lines in interpreting cathode-ray oscillograph specifications. Similar reasoning applies to practically all electronic instruments. The major task which confronts a prospective purchaser is to read, understand, and interpret specifications provided by the manufacturer.

BULLETINS

Data Recorder System

Cook Research Laboratories' multichannel data recorder system is presented in a new bulletin (MR-311 which also includes information on three newly developed data recorders and a data interpretation unit. For a copy, write to 1157 Diversey Parkway, Chicago 14, Ill. (Mention T-T)

Tube Application Notes

RCA electron tube application notes with following titles are available from the Tube Dept., Harrison, N. J.: Adjustment of Filament Voltage of RCA-1B3-GT by Observation of Filament Temperature; Single-Section Filament Operation of Types 3S4 and 3V4; Overload Protection for the Horizontal Deflection Circuit in Television Receivers; Reduction in Peak Inverse Voltage Rating of Type 1B3-GT. (Mention T-T)

Laboratory Instruments

Catalog 12-A which has been issued by the Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif., describes the complete HP line of laboratory instruments with an enclosed supplement to cover the latest additions. A price list is appended. (Mention T-T)

Waterproof Connectors

Nearly 50 inserts which are available for type W waterproof connectors are described with specifications in bulletin W-248, published by the Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. These connectors may be used under water or in any outdoor applications where moisture conditions require thoroughly sealed fittings. (Mention T-T)

Fuses and Fuse Holders

Small dimension fuses, fusetrons and fuse holders are listed in a bulletin issued by the Bussman Manufacturing Co., St. Louis 7, Mo. Special designated fuse types have withstood severe vibration tests. (Mention T-T)

General Price List

A general price list has been published by the Andrew Corp., 363 East 75th St., Chicago 19, Ill. This new edition tabulates all transmission line, antenna and related equipment and includes type numbers, descriptions and prices for over 600 items. (Mention T-T)

Cabinets and Panels

"Modern Design for Instrument Panels and Cubicles" is the most recent catalog to be released by the Falstrom Co., Passaic, N. J., fabricators in steel and other metals. Standard panel units and accessories, industrial electronic control enclosing cases, and a few typical Falstrom installations are included. (Mention T-T)

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9290-9330 mc. 1.25 kw pk Pulse Output Power
100 mc. Tuning Range.
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NEW, GUARANTEED, ea. $65.00

KLYSTRONS

723A B	$12.50
707B w/CAV	20.00
726-A	15.00

MAGNETRONS

TUBE	FRQ. RANGE PK.	PWR. OUT.	PRICE
2J31	2820-2860 mc.	265 KW.	$35.00
2J21-A	9345-9405 mc.	50 KW.	25.00
2J22	3267-3333 mc.	265 KW.	25.00
2J26	2982-3019 mc.	275 KW.	25.00
2J27	2965-2992 mc.	275 KW.	25.00
2J32	2780-2820 mc.	265 KW.	25.00
2J38 Pkg.	3249-3263 mc.	5 KW	25.00
2J39 Pkg.	3267-3333 mc.	8.7 KW.	25.00
2J55 Pkg.	9345-9405 mc.	50 KW.	25.00
2J61	3000-3100 mc.	35 KW.	65.00
2J62	2914-3010 mc.	35 KW.	65.00
3J31	24,000 mc.	50 KW.	55.00
5J50			39.50
714AY			25.00
720BY	2800 mc.	1000 KW.	50.00
720CY			50.00
725-A	9345-9405 mc.	50 KW.	25.00
730-A	9345-9405 mc.	50 KW.	25.00

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For 2J21, 725-A, 2J22, 2J26, 2J27, 3J31, 2J32 and 3J31 ..... Each $8.00
4850 Gauss, 3/8" bet. pole faces, 3/4" pole dia. 8.00
1500 Gauss, 1 1/2" bet. pole faces, 1 3/8" pole dia. 8.00

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Step Down Transformer: Pri: 440/220/110 volts a.c. 60 cycles. 3 KVA. Sec. 115 v. 2500 volt insulation. Size 12" x 12" x 7" $40.00
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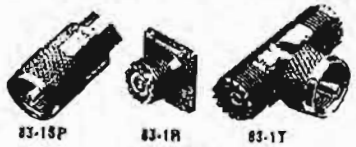

83-1SP 83-1R 83-1T

83 SERIES

No.	An. No.	Description	Price
83-1SP	(PL259)	Plug ..... ea.	22¢
83-1SPN	(PL259A)	Plug ..... ea.	22¢
83-16B	(UG176U)	Reducing adapter for RG 29, 55 and 58U. Use with 83-1SP or 83-1SPN. ..... ea.	12¢
83-1R	(S0239)	Receptacle ..... ea.	28¢
83-1AP	(M359)	Angle Plug adapter. ea.	22¢
83-1T	(M358)	Connector ..... ea.	$1.12
83-22R	(UG103U)	Receptacle ..... ea.	35¢
83-22SP	(UG102U)	Plug ..... ea.	35¢
83-1J	(PL-258)	Junction ..... ea.	70¢

Minimum Quantity — 100 of a type

COAXIAL CABLES

RG5U	per 1000 ft.	$70.00
RG6U	per 1000 ft.	120.00
RG7U	per 1000 ft.	70.00
RG8U	per 1000 ft.	40.00
RG9U	per 1000 ft.	135.00
RG10U	per 1000 ft.	90.00
RG11U	per 1000 ft.	100.00
RG12U	per 1000 ft.	175.00
RG13U	per 1000 ft.	175.00
RG18U	per 1000 ft.	320.00
RG22U	per 1000 ft.	120.00
RG29U	per 1000 ft.	37.50
RG34U	per 1000 ft.	175.00
RG39U	per 1000 ft.	55.00
RG54A/U	per 1000 ft.	60.00
RG54U	per 1000 ft.	65.00
RG57U	per 1000 ft.	75.00
RG58U	per 1000 ft.	59.00
RG59U	per 1000 ft.	45.00
RG62U	per 1000 ft.	50.00
RG71U	per 1000 ft.	120.00

Prices based on a minimum quantity of 500 ft.

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1F Special Repeater, 115 volts, 400 cycle. Will operate on 60 cycle at reduced voltage. PRICE $15.00 EACH NET
1CT Control Transformer, 50/55 volts, 60 cycle. PRICE $22.50 EACH NET
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2J1H1 Selsyn Differential Generator. 57.5/57.5 volts. 400 cycle. PRICE $3.25 EACH NET
5G Generator, 115 volts, 60 cycle. PRICE $25.00 EACH NET
W. E. KS-5950-L2, Size 5 Generator, 115 volts, 400 cycle. PRICE $3.50 EACH NET
Size 5 Generator, Army Ordnance Drawing No. C-78414, 115 volts, 60 cycle. PRICE $15.00 EACH NET

PIONEER AUTOSYNS

AY1, 26 volts, 400 cycle. PRICE $4.00 EA. NET
AY20, 26 volts, 400 cycle. PRICE $3.50 EA. NET
AY30, 26 volts, 400 cycle Price $10.00 EA. NET
AY31, 26 volts, 400 cycle. Shaft extends from both ends. PRICE $10.00 EACH NET
AY38, 26 volts, 400 cycle. Shaft extends from both ends. PRICE $10.00 EACH NET

PIONEER PRECISION AUTOSYNS

AY101D, new with calibration curve. PRICE—WRITE OR CALL FOR SPECIAL QUANTITY PRICES
AY131D, new with calibration curve. PRICE $85.00 EACH NET

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8DJ11-PCY Indicator, 24 volts. Dial marked —10° to +65°. PRICE $4.00 EACH NET
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PIONEER TORQUE UNITS

TYPE 12602-1-A. PRICE $30.00 EACH NET
TYPE 12606-1-A. PRICE $35.00 EACH NET
TYPE 12627-1-A. PRICE $70.00 EACH NET

PIONEER TORQUE UNIT AMPLIFIER

TYPE 12073-1-A. PRICE $17.50 EACH NET

RATE GENERATORS

PM2, Electric Indicator Company, .0175 V. per R. P. M. PRICE $7.25 EACH NET
FIG, Electric Indicator Company, two-phase, 22 V. per phase at 1600 R. P. M. PRICE $12.00 EACH NET
B-68, Electric Indicator Company, Drag Cup, 110 volts, 60 cycle, one phase. PRICE $14.00 EACH NET
336A, Eastern Air Devices, .02V. per R.P.M. PRICE $8.00 EACH NET

SPERRY PHASE ADAPTER

TYPE 661102, 115 volts, 400 cycle. Used for operating 3 phase equipment from a single phase source. PRICE $6.50 EACH NET

INVERTERS

12117-4, Pioneer. Input 24 volts D. C. Output 26 volts, 400 cycle. PRICE $15.00 EACH NET
12117, Pioneer. Input 12 volts D. C. Output 26 volts, 400 cycle. PRICE $17.50 EACH NET
12123-1-A, Pioneer. Input 24 volts D. C. Output 115 volts, 400 cycle, 3 phase, 100 V. A. Price $75.00 Ea.
153F, Holtzer Cabot. Input 24 volts D. C. Output 26 volts, 400 cycle, 250 V. A., and 115 volts, 400 cycle, 3 phase, 750 V. A. PRICE $150.00 Ea. Net
MG750, Wincharger, PU16. Input 24 volts D. C. Output 115 volts, 400 cycle, 1 phase, 6.5 amps. PRICE $35.00 EACH NET
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149F, Holtzer Cabot. Input 28 volts at 36 amps. Output 26 volts at 250 V. A. 400 cycle and 115 volts at 500 V. A. 400 cycle PRICE $29.00 EACH NET

SINE-COSINE GENERATORS (Resolvers)

FJE 43-9, Diehl, 115 volts, 400 cycle. PRICE $20.00 EACH NET

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5067127, Delco, 27 V., 250 R. P. M. PRICE $2.90 EACH NET
5069600, Delco, 27 V., 250 R. P. M. PRICE $4.00 EACH NET
5069166, Delco, 27 V., 10,000 R. P. M. PRICE $3.00 EACH NET

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5069635, Delco Constant Speed, 27 volts, 120 R. P. M. Built-in reduction gears and governor. PRICE $4.35 EACH NET
A-7155, Delco Constant Speed Shunt Motor, 27 volts, 2.4 amps., 3600 R. P. M., 1/30 H. P. Built-in governor. PRICE $6.25 EACH NET
5BA10J18D, General Electric, 27 volts, 0.7 amps., 110 R. P. M. PRICE $2.90 EACH NET
5066665, Delco Shunt Motor 27 volts, 4000 R. P. M. Reversible, flange mount. PRICE $4.50
C-28P-1A, John Oster Shunt Motor, 27 volts, 0.7 amps., 7000 R. P. M., 1/100 H. P. PRICE $3.75 EACH NET

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ANNUAL INDEX—1948

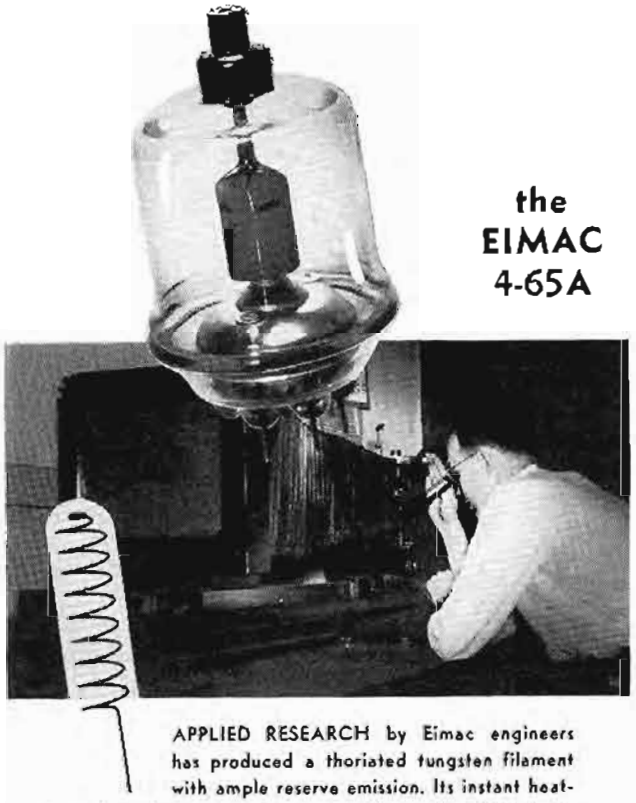
The Annual Index has been arranged by subjects for easy reference to related topics. The first figure indicates the month in which the article appeared; the second figure indicates the page

TELE-TECH

Advertisers Dec. 1948

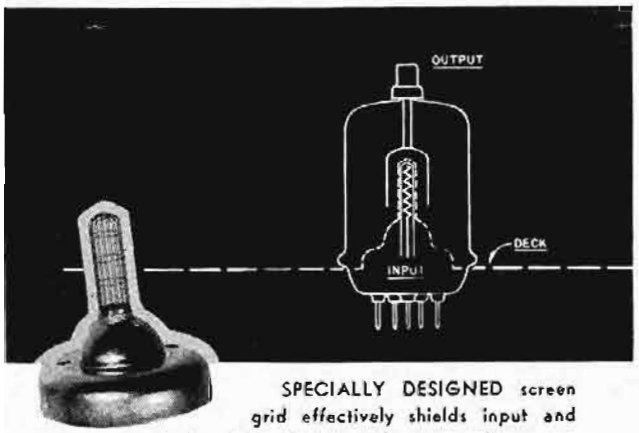
AUTHOR INDEX—1948

THEY'RE BETTER BECAUSE...



the EIMAC 4-65A

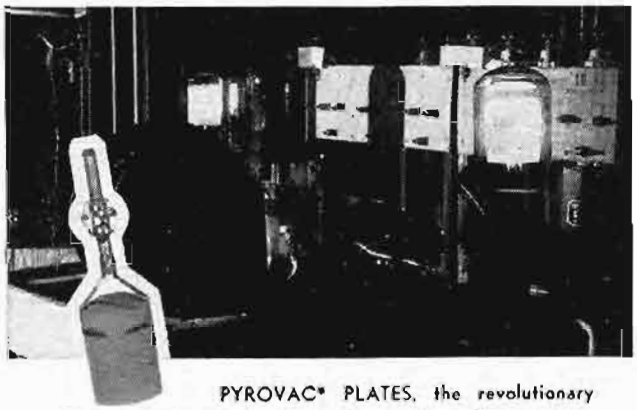
APPLIED RESEARCH by Eimac engineers has produced a thoriated tungsten filament with ample reserve emission. Its instant heating characteristics make the 4-65A well adapted to mobile application.



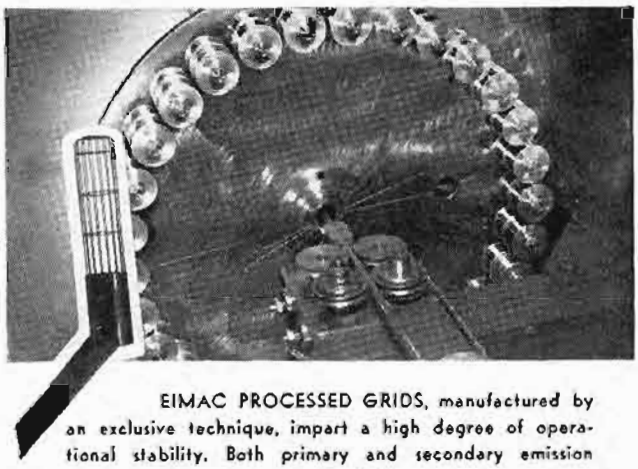
SPECIALLY DESIGNED screen grid effectively shields input and output circuits, within the tube, without excessive screen power. All internal structures are self supporting without the aid of insulating hardware.

These are but some of the features that combine to make the Eimac 4-65A a better tetrode. It is unexcelled in its category as a power amplifier, oscillator or modulator. For example, in typical operation as a power amplifier or oscillator (class-C telegraphy or FM telephony) one tube with 1500 plate volts will supply 170 watts of output power with less than 3 watts of driving power. A complete comprehensive data sheet on the 4-65A has just been released. Write for your copy today.

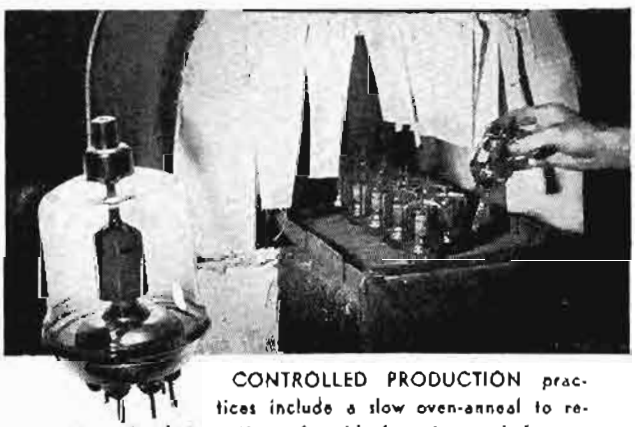
EITEL-McCULLOUGH, INC.
204 San Mateo Ave., San Bruno, California
Export Agents: Frazer & Hansen, 301 Clay Street, San Francisco 11, California



PYROVAC* PLATES, the revolutionary Eimac development, withstand excessive abuse. Manufactured by an advanced technique, these plates can handle momentary overloads in excess of 1000%, consequently they contribute appreciably to the tube's life.



EIMAC PROCESSED GRIDS, manufactured by an exclusive technique, impart a high degree of operational stability. Both primary and secondary emission are controlled.



CONTROLLED PRODUCTION practices include a slow oven-anneal to remove the last vestige of residual strains, and four to eight hours of testing under severe VHF conditions.

*Trade Mark Reg. U. S. Pat. Off.

Follow the Leaders to

Eimac TUBES

The Power for R-F

RCA-the pioneer in miniatures-

...presents three new types of major importance

● Here are three new miniature tubes... additions to RCA's large family of miniature types... that have particular significance in FM receiver design and voltage reference applications.

RCA 6BA7 and 12BA7 are pentagrid converters—alike except for heater ratings. They have high conversion gain, because of their high conversion transconductance; and a separate connection for direct grounding of the suppressor. These features in combination with the short internal leads characteristic of miniature tubes, result in efficient operation of either type in the 88 to 108-megacycle FM band. In addition to realizing substantial gains at the higher frequencies, the RCA 6BA7 and 12BA7 contribute a highly favorable signal-to-noise ratio.

RCA-5651 is a voltage reference tube of the cold-cathode, glow-discharge type. It maintains a dc operating potential of 87 volts, has an operating current range of 1.5 to 3.5 ma., an operating characteristic essentially independent of ambient temperature, and a voltage stability at any current level of better than 0.1 volt.

• • •

RCA Application Engineers will be pleased to consult with you on the incorporation of these new miniatures in your equipment designs. For further information write RCA, Commercial Engineering, Section LR63, Harrison, N. J.

RATINGS AND CHARACTERISTICS

6BA7 and 12BA7 Pentagrid Converters

	6BA7	12BA7	
Heater Voltage (ac or dc)	6.3	12.6	Volts
Heater Current	0.3	0.15	Ampere
Characteristics — Separate Excitation*			
Plate Voltage	100	250	Volts
Grid No. 5 and Internal Shield	Connected directly to ground		
Grids No. 2 and No. 4	100	100	Volts
Grid No. 3	—1.0	—1.0	Volt
Grid No. 1 Resistor	0.02	0.02	Megohm
Plate Resistance (Approx.)	0.5	1.0	Megohm
Conversion Transconductance	900	950	Micromhos
Conversion Transconductance (approx.) Grid No. 3 at —20 volts	3.5	3.5	Micromhos
Plate Current	3.6	3.8	Ma.
Grids Nos. 2 and 4 Current	10.2	10	Ma.
Grid No. 1 Current	0.35	0.35	Ma.
Total Cathode Current	14.2	14.2	Ma.

*Characteristics correspond very closely with those obtained in a self-excited oscillator circuit operating with zero bias.

5651 Voltage-Reference Tube

	Min.	Av.	Max.	
DC Starting Voltage	—	107	115	Volts
DC Operating Voltage	82	87	92	Volts
DC Operating Current	1.5	—	3.5	Ma.
Regulation (1.5 to 3.5 Ma.)	—	—	3	Volts
Stability*	—	—	0.1	Volt
Ambient Temperature Range	—55 to +90° C			

*Defines as the maximum voltage fluctuation at any current level within operating current range.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

TUBE DEPARTMENT

RADIO CORPORATION of AMERICA

HARRISON, N. J.