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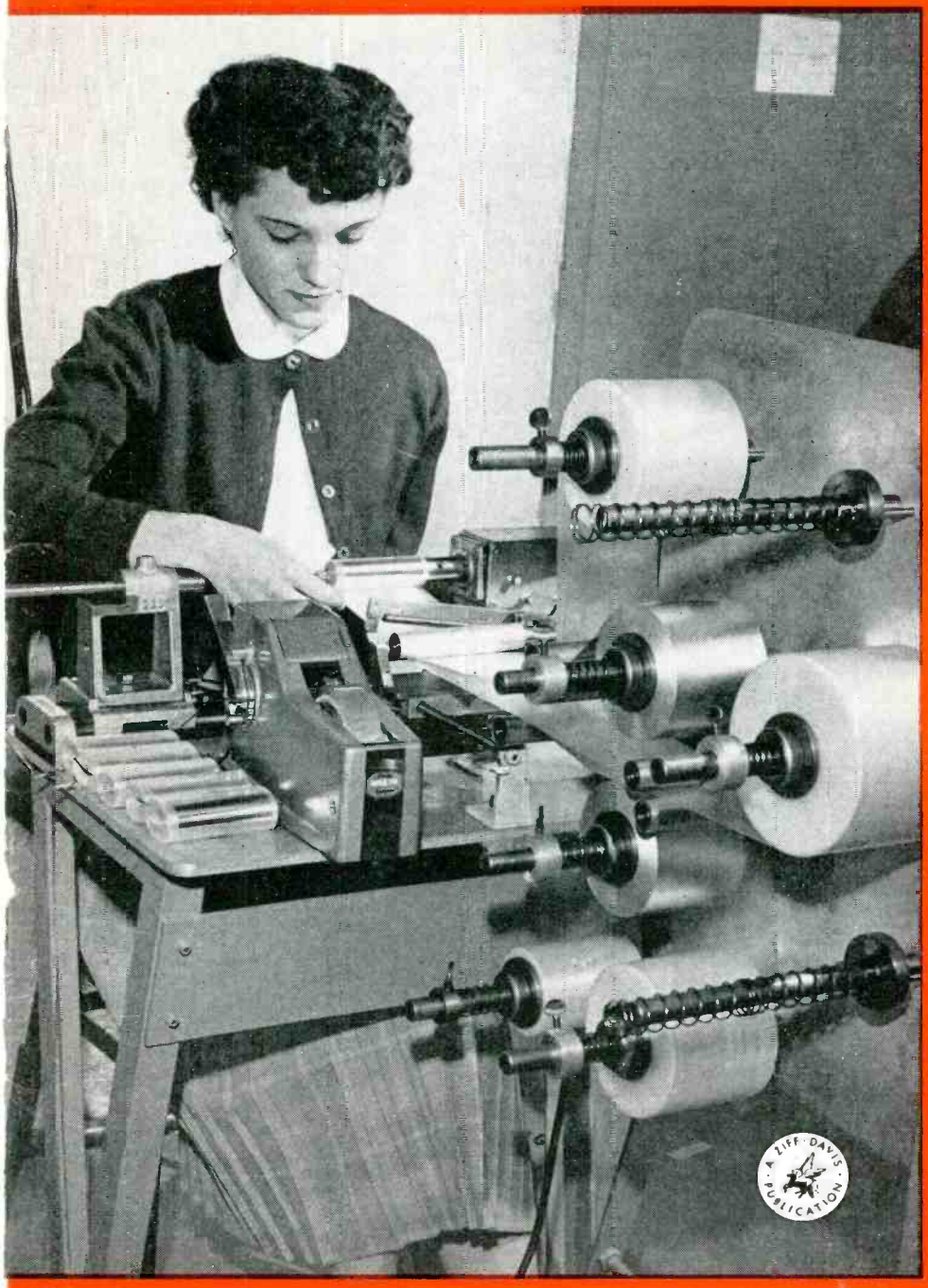

DECEMBER, 1954

DEPARTMENTS

Operator is winding four layers of Mylar between aluminum foil plates in the capacitor manufacturing process at *Condenser Products Company*, Chicago.

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THE STANDARD OF COMPARISON FOR OVER 20 YEARS

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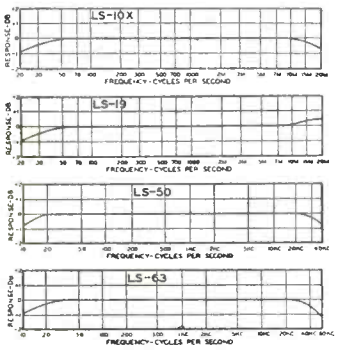
TYPICAL UNITS

LINEAR STANDARD series

Linear Standard units represent the acme from the standpoint of uniform frequency response, low wave form distortion, thorough shielding and dependability. LS units have a guaranteed response within **1db. from 20 to 20,000 cycles.**

Hum balanced coil structures and multiple alloy shielding, where required, provide extremely low inductive pickup.

These are the finest high fidelity transformers in the world. 85 stock types from milliwatts to kilowatts.

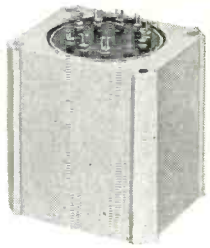


LS-10X Shielded Input
Multiple line (50, 200, 250, 500/600, etc.) to 50,000 ohms . . . multiple shielded.

LS-19 Plate to Two Grids
Primary 15,000 ohms.
Secondary 95,000 ohms C.T.

LS-50 Plate to Line
15,000 ohms to multiple line . . . +15 db. level.

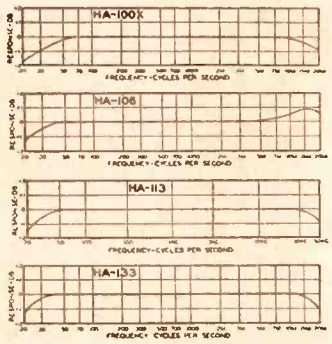
LS-63 P.P. Plates to Voice Coil
Primary 10,000 C.T. and 6,000 C.T. suited to Williamson, MLF, ul.-linear circuits. Secondary 1.2, 2.5, 5, 7.5, 10, 15, 20, 30 ohms. 20 watts.



CASE	LS-1	LS-2	LS-3
Length	3⅛"	4-7/16"	5-13/16"
Width	2⅝"	3½"	5"
Height	3¼"	4-3/16"	4-11/16"
Unit Wt.	3 lbs.	7.5 lbs.	15 lbs.

HIPERMALLOY series

This series provides virtually all the characteristics of the Linear Standard group in a more compact and lighter structure. The frequency response is within 1 db. from 30 to 20,000 cycles. Hipermalloy nickel iron cores and hum balanced core structures provide minimum distortion and low hum pickup. Input transformers, maximum level +10db. Circular terminal layout and top and bottom mounting.



HA-100X Shielded Input
Multiple line to 60,000 ohm grid . . . tri-alloy shielding for low hum pickup.

HA-106 Plate to Two Grids
15,000 ohms to 135,000 ohms in two sections . . +12 db. level.

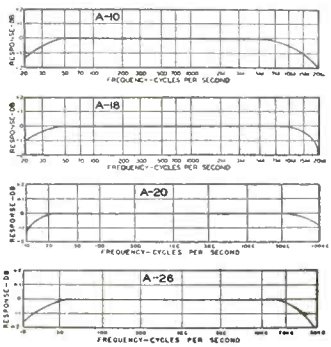
HA-113 Plate to Line
15,000 ohms to multiple line . . . +12 db. level . . . 0 DC in primary.

HA-133 Plate (DC) to Line
15,000 ohms to multiple line . . . +15 db. level . . 8 Ma. DC in primary.

Case	H-1	H-2
Length	2⅜"	3-9/16"
Width	1-15/16"	2-13/16"
Height	3⅛"	3½"
Unit Weight	2 lbs.	5 lbs.

ULTRA COMPACT series

UTC Ultra Compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. The frequency response is within 2 db. from 30 to 20,000 cycles. Hum balanced coil structure plus high conductivity die cast case provides good inductive shielding. Maximum operating level is +7db. Top and bottom mounting as well as circular terminal layout are used in this series as well as the ones described above.



A-10 Line to Grid
Multiple line to 50,000 ohm grid.

A-18 Plate to Two Grids
15,000 ohms to 80,000 ohms, primary and secondary both split.

A-20 Mixing Transformer
Multiple line to multiple line for mixing mikes, lines, etc.

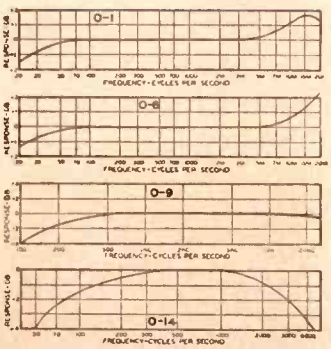
A-26 P.P. Plates to Line
30,000 ohms plate to plate, to multiple line.

A CASE

Length	1½"
Width	1½"
Height	2"
Unit Weight	½ lb.

OUNCER series

UTC Ouncer units are ideal for portable, concealed service, and similar applications. These units are extremely compact . . . fully impregnated and sealed in a drawn housing. Most items provide frequency response within 1 db. from 30 to 20,000 cycles. Maximum operating level 0 db. These units are also available in our stock P series which provide plug-in base. The O-16 is a new line to grid transformer using two heavy gauge hipermalloy shields for high hum shielding.



O-1 Line to Grid
Primary 50, 200/250, 500/600 ohms to 50,000 ohm grid.

O-6 Plate to Two Grids
15,000 ohms to 95,000 ohms C.T.

O-9 Plate (DC) to Line
Primary 15,000 ohms, Secondary 50, 200/250, 500/600.

O-14 50: 1 Line to Grid
Primary 200 ohms, Secondary .5 megohm for mike or line to grid.

OUNCER CASE

Diameter	⅞"
Height	1-3/16"
Unit Weight	1 oz.

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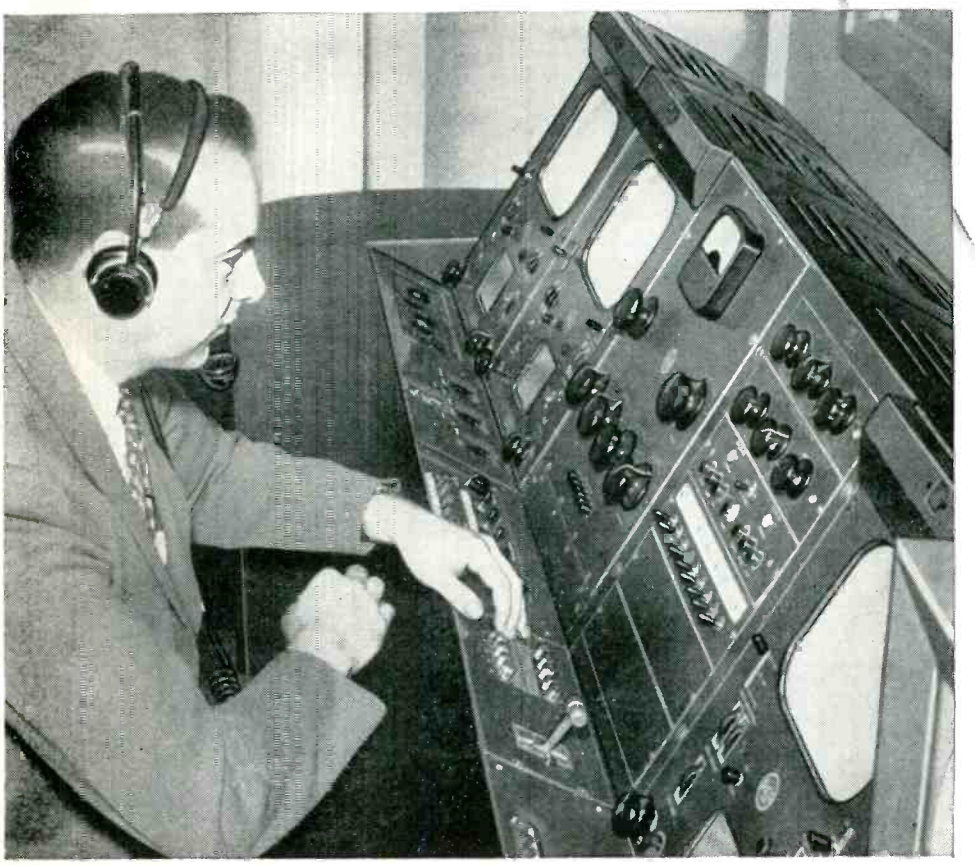
the RCA TV Switcher TS-5A

adds fades, lap-dissolves, super-positions to spice up your commercials



The RCA TS-5A Video Switcher is a flexible two-unit equipment designed to mount in a single standard console housing. The push-button and fader panel may be located as illustrated or in the upper face of the console. The TS-5A is designed for color use as well as for monochrome.

You are invited to ask your RCA Broadcast Sales Representative concerning the application of the TS-5A to your specific requirements, or write Dept. L-157, RCA Engineering Products Division, Camden, N. J.

A MUST FOR YOUR TC-4A!

RCA's new TS-5A Video Switcher will give increased flexibility to your programming. If yours is a "Basic Buy" switching layout, where video control functions are centered around the TC-4A Audio/Video Switching Console, the TS-5A will supplement your present equipment, greatly enhance the versatility of your station, give new spontaneity to your commercials.

5 EXTRA INPUTS PLUS "REHEARSAL" FOR YOUR TS-10A!

If your station already includes the TS-10A Studio Switcher and you need to provide for more inputs and rehearsal facilities—the TS-5A Switcher is the ideal answer. A typical arrangement of these two equipments will provide for independent studio rehearsal plus 5 extra inputs.

HANDY AS AN INDEPENDENT SWITCHER!

The TS-5A also may be used for independent switching systems where maximum program flexibility and economy are desired. The TS-5A can be conveniently mounted in a standard console housing adjacent to other console control units.

RCA Pioneered and Developed Compatible Color Television

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DIVISION — CAMDEN, N. J.

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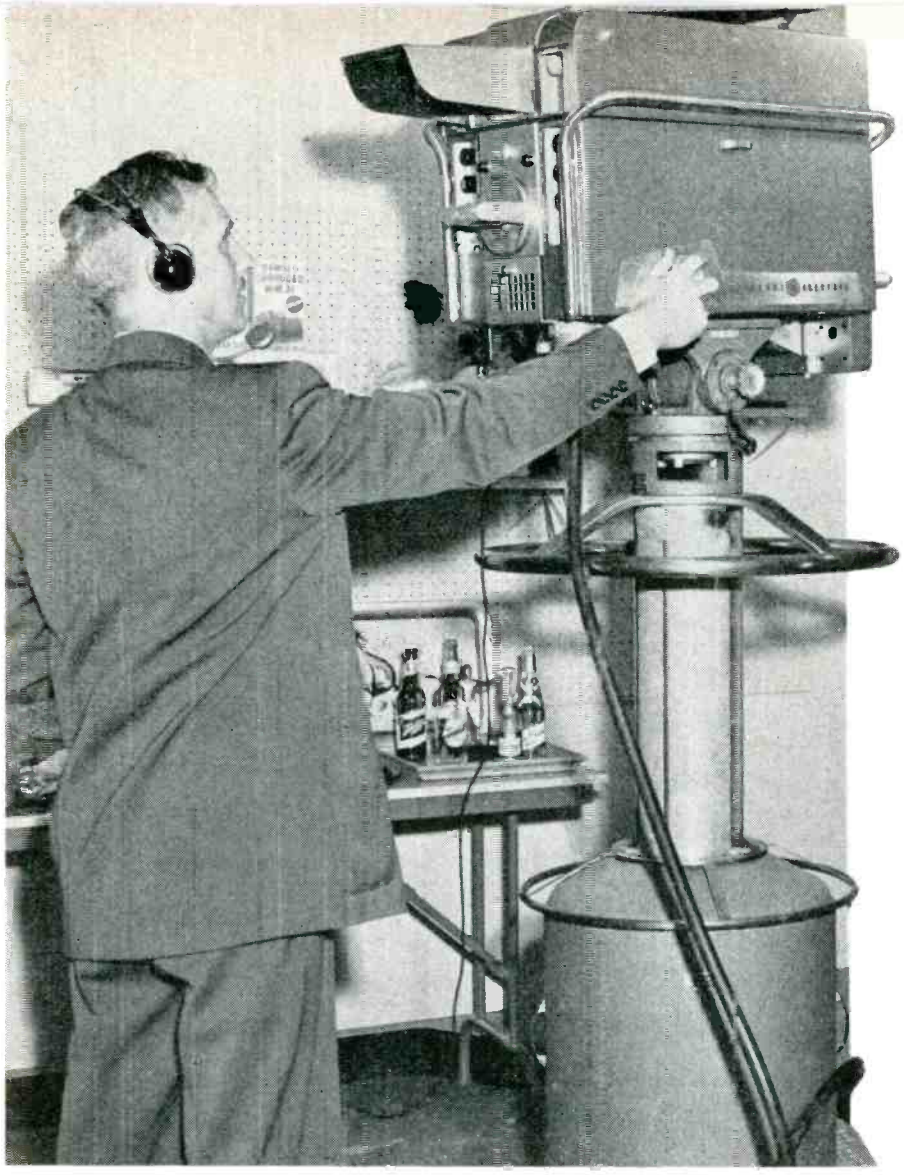
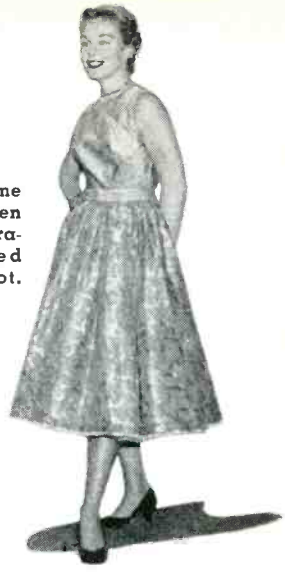


A conventional monochrome TV camera which has been modified for color operation is being adjusted for a studio color shot.



CHROMACODER COLORCASTING

By

C. G. LLOYD, Manager

and

P. H. BOUCHERON

Broadcast Equipment Engineering
General Electric Company

Modified conventional monochrome TV cameras, when combined with a chromacoder, can produce standard NTSC color signals.

COLOR television delivers an impact for the advertiser which is an order of magnitude greater than that of monochrome television. It provides the viewer with greatly increased entertainment and educational values. It also provides the engineers who must plan the technical facilities for the origination of live color programs with many opportunities to conquer new technical problems. To these engineers, it is a challenge to select the equipment that will produce and transmit the highest quality color pictures—equipment that will do so with proper regard for minimum investment, minimum operating cost and maximum operating ease and flexibility. It was with these thoughts in mind that the chromacoder system of colorcasting was developed.

Sequential color television, as once approved by the FCC, posed a serious technical and economic problem in that it was not compatible. Existing monochrome receivers were unusable for this type of color and would have become obsolete. Speaking more practically, color broadcasting would not have been successful because there would not be the large number of viewers who could also see the programs in black and white. This was unfortunate since sequential color is capable of producing the highest quality of color pictures in a relatively simple and straightforward manner.

Consistent and beautiful results can be obtained with a minimum of adjustment difficulties. A sequential color camera requires only the addition of a rotating disc and some electronic modifications, which result in a unit no larger than a conventional monochrome camera. As such, the camera is both maneuverable and portable, and still utilizes the same single cable. Switching, fading, dissolving, and superimposing can be accomplished in the usual manner without extremely careful adjustment of the camera and its associated equipment. In short, sequential color appears to have all the advantages of simplified technical operation. It would not be economically feasible, however, if there were insufficient receivers, both monochrome and color, to view it. What was needed was a means of translating the sequential color signal at the studio to a signal which could be transmitted in accordance with the FCC-approved NTSC color standards. This problem has been solved by the *Columbia Broadcasting System* Laboratories, under the capable direction of Dr. Peter Goldmark, and the equipment which is being manufactured and which will be described here follows their basic concept.

Color Cameras

The latest in portable monochrome camera chains has been modified to provide sweep speeds of 180 fields and 525 lines. This means 60 red, 60 blue, and 60 green fields per second, and 47,250

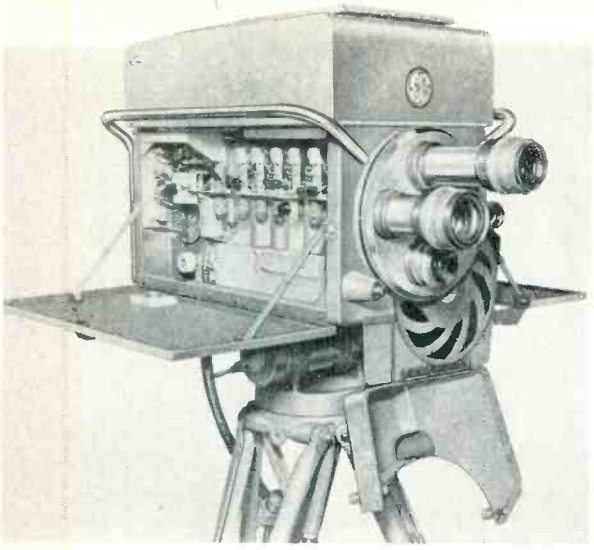


Fig. 1. Modified camera showing nine-segment color wheel in lower front corner.

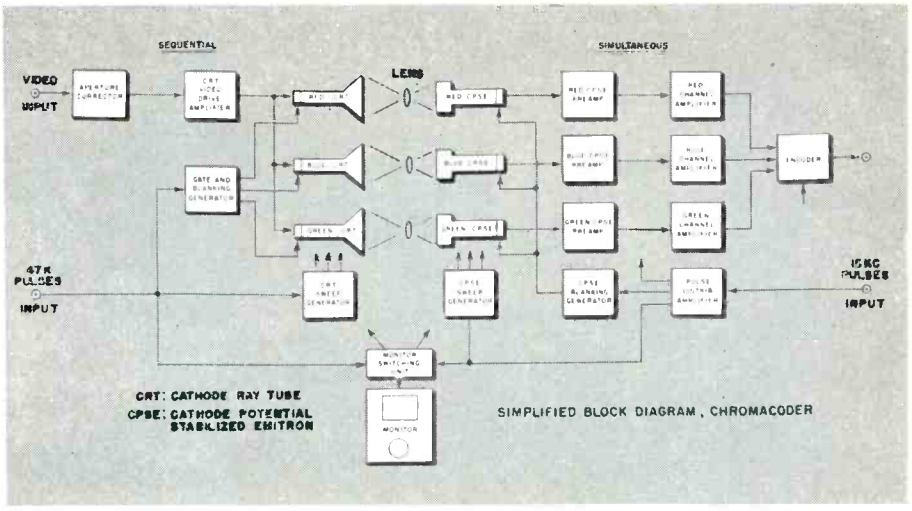


Fig. 2. Simplified block diagram of the chromacoder which converts the signal from the modified camera to a standard NTSC color signal.

scanning lines per second. To facilitate conversion to NTSC standards without moiré effects (beat patterns), the sweep yokes are rotated 90° so that the scanning lines are vertical and cross those of the conversion equipment at right angles instead of being parallel to them. The 3 by 4 aspect ratio is maintained, which shortens the length of the vertical lines and thereby lessens the high speed sweep problem.

A nine-segment color wheel about 8″ in diameter is mounted in a lower front corner of the camera, between the lens turret and the image orthicon compartment. The wheel is driven by a small synchronous motor which is almost completely contained within the original camera dimensions. (See Fig. 1.) By the addition of two video amplifier stages, the camera is modified to have a 12-mc. bandwidth. The image orthicon yoke is rotated 90° and driven with new sweep circuits for the higher rates. The view-finder is modified to accommodate the wider bandwidth and higher sweep frequencies, requiring a new deflection yoke and circuitry. Color telecasting imposes a reduced latitude on the light values which may be used, and this in turn makes exposure more critical. A remote iris control has therefore been added to permit the camera control operator to adjust any camera lens opening for optimum exposure at any time without involving the cameraman. The camera control unit is similarly modified, and clamping and shading circuits are altered to suit the new frequencies. Another color wheel is installed in front of the picture monitor so that all camera control functions are performed while viewing the full color picture.

Packaged in a manner similar to the rest of the equipment is a new unit—the color mixer. It contains a gamma correction amplifier, commutator or signal separator, individual gain and set-up controls, adder or mixer amplifier, and master contrast, setup, blanking, and clipping controls. It also contains the drive amplifier and phasing controls for the camera color wheel. The video bandwidth is 12 mc., and a feedback output stage provides two 1-volt outputs, one of which is used to feed the control monitor. An additional portable power supply is required with each channel to power the color mixer.

Alterations are made in the sync generator to provide the proper line and field rates which are exactly triple the original values. Two binary counters are added to obtain the 60-cycle color drive pulse which identifies the start of the red field and keeps the whole system in color synchronism. The field sequential sync generator may be operated in any of the conventional ways—locked to the 60-cycle line, sync-locked to a remote generator, or crystal-controlled. In any event, it need not have any tie with the NTSC sync generator which is always locked to the 3.58-mc. crystal.

The portable monochrome switcher can be easily modified to perform all of the same functions for four color chains that it now performs for four black-and-white chains.

Chromacoder Unit

Field sequential color pictures are fed to the scan conversion unit which *CBS* has named the "chromacoder." The primary function of the chromacoder is to convert the sequential color signal having 47-kc. top-to-bottom scan lines into three simultaneous color signals, red, blue and green, with 15-kc. side-to-side scan lines. Operation of the chromacoder is best described with reference to a simplified block diagram, Fig. 2. The conversion is accomplished by three channels, each of which carries the information on one color. Each channel consists of a display or picture tube and a pickup or camera tube.

Since information continuously flows from each of the three simultaneous RB&G output channels while it is supplied to the chromacoder sequentially—first red, then blue, then green, the equipment must perform a memory or storage function. For example, the red video is on for only 1/180 second, and is off for 1/90 second, but the output from the red channel is continuous. This memory function is achieved partly in the pickup tube, which has virtually 100% storage, and partly in the long-persistence P1 phosphor of the display or cathode-ray tube. The pickup tube will be covered in more detail later.

An aperture corrector amplifier receives the incoming sequential color signal. This amplifier is a phase distortionless high peaker which compensates for the spot size of the CRT's (cathode-ray tubes), maintaining the ultimate light level and spot size for best reproduction. The amplitude-vs.-frequency characteristic of the aperture corrector is adjustable from "flat" ±1 db up to 15 mc. to "peaked" +15 db at 15 mc. From the aperture corrector, the video signal continues to the CRT video drive amplifier—a high-gain, high-power amplifier capable of 60-70 volts grid drive for the three CRT's. The drive amplifier also has a 15-mc. bandwidth.

Drive pulses from the field sequential sync generator key the gate generator, principally the color drive pulse which identifies the red field. It turns on and off—or gates—the CRT's in their cathode circuits in synchronism with the filters in the color wheel. For example, when one of the red filters is in front of the picture tube in the camera, the red CRT is gated "on" to reproduce the red information, and the blue and green CRT's are gated "off."

A special aluminized type 7″ cathode-ray tube is used which has an extra fine P1 green phosphor and a fine spot gun structure. Each tube is operated at

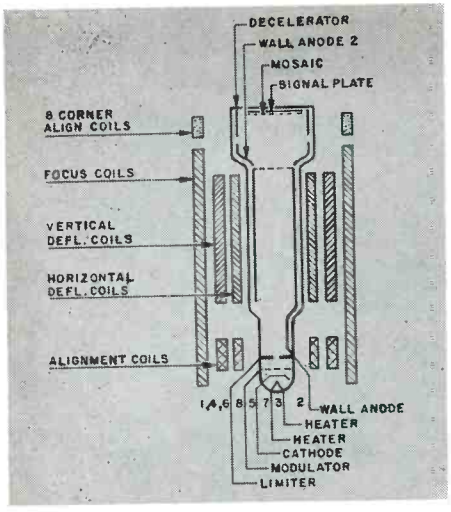


Fig. 3. The CPS Emitron with its associated scanning and field coils. It uses a charge-storage mosaic.

27-kv. potential. Special attention has been devoted to the design of the deflection yokes and sweep circuits used with the CRT's to achieve the ultimate in linearity and stability.

Each of the three CRT's is imaged with a conventional enlarging lens onto one of three pickup tubes which are CPS (cathode potential stabilized) Emitrons.

Emitron Tube

The CPS Emitron, developed in England by the *Electrical-Musical Industries Laboratories*, is a television camera pickup tube using a charge-storage mosaic. Figure 3 shows the Emitron with its associated scanning and field coils. The signal plate is separated from the mosaic by an insulating medium. The wall anode extends practically the whole length of the tube, but is made in two sections to eliminate the undesirable electrostatic coupling between the scanning coils and the signal plate. At the rear of the tube is the electron gun, comprising an indirectly heated cathode, a modulator or grid, and a limiter or first anode. The first anode has an aperture which limits the electron emission of the cathode to a narrow beam. The decelerator supplies a corrective field to overcome geometric distortion. Focus coils supply a uniform axial field, while deflection coils provide the line and frame sweep fields. Alignment coils apply a corrective field which adjusts the axis of the electron beam to coincide with the lines of force created by the focus coils.

Light striking the photosensitive mosaic (antimony caesium surface) causes photoelectrons to be emitted, and these are attracted to the wall anode. Having lost electrons proportional to the amount of light, the individual elements of the mosaic are charged positively. In scanning the mosaic, the electron beam successively discharges these elements through their capacity to the common signal plate. The circuit for signal current is completed through the load resistor, the cathode, and the beam, and the signal voltage developed across the load resistor is fed directly to the first grid of the preamplifier.

By virtue of the low velocity electron beam, the mosaic may be stabilized at a potential equal to the cathode; hence the name "cathode potential stabilized Emitron." The low velocity beam liberates practically no secondary electrons from the target so that there is no spurious shading in the picture signal. Freedom from secondary emission, together with the removal of all photoelectrons from the mosaic, results in high sensitivity and establishes a reliable black reference in the picture signal. While not as sensitive as an image orthicon, in this application where light levels are high and fully controlled, CPS Emitrons have other distinct advantages. The major ones are: unity and linear gamma (gray scale response), absence of sticking or burning in, longer life (approximately 1000 hours), minimum

(*Continued on page* 34)

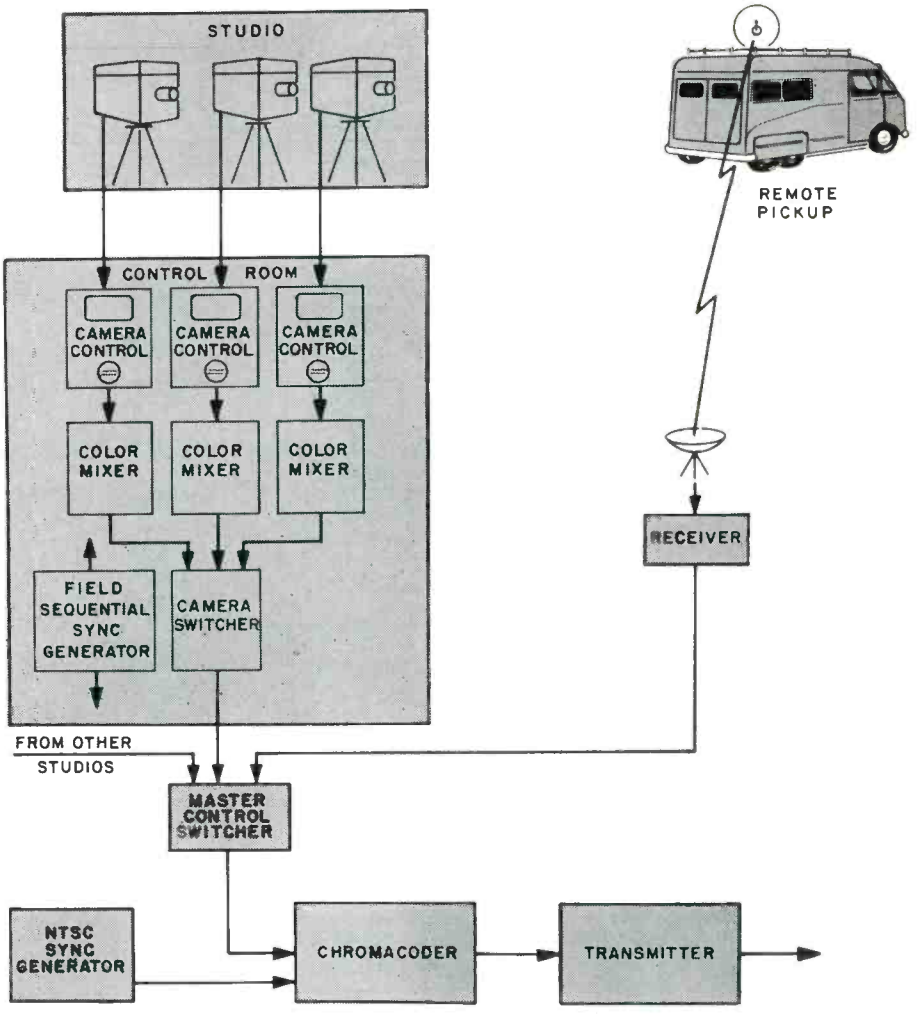
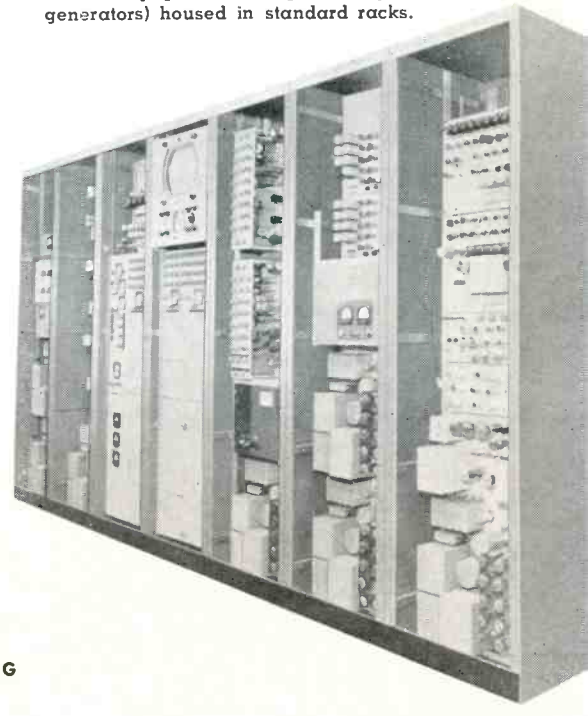


Fig. 4. Block diagram of the chromacoder system used with a number of different studio and remote cameras.

Fig. 5. Chromacoder, encoder, and related equipment (except for sync generators) housed in standard racks.



BROADBAND R.F. POWER METERS

By

IRVING STRAUSS, President

Bruno-New York Industries Corporation

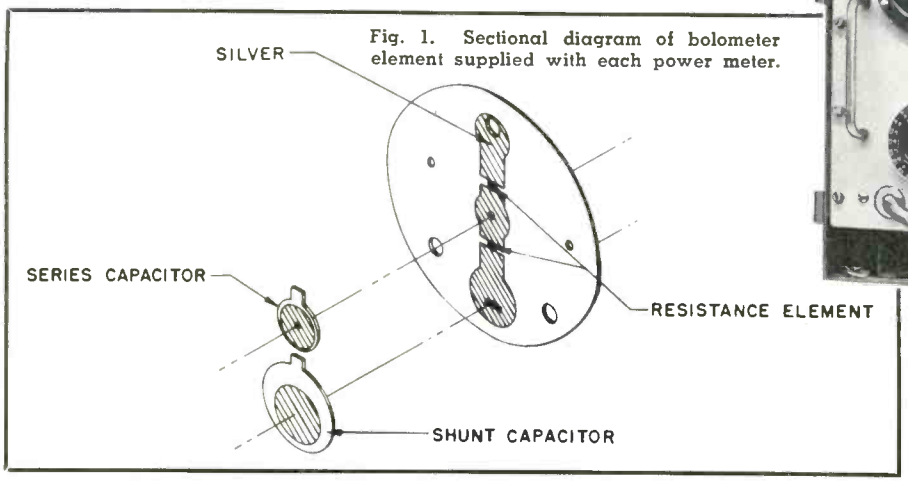


Fig. 1. Sectional diagram of bolometer element supplied with each power meter.

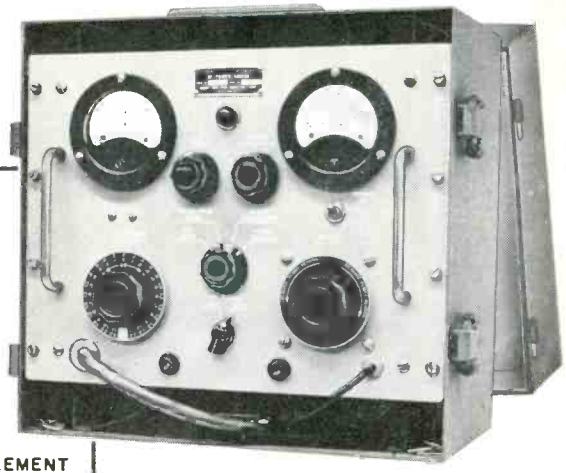


Fig. 2. Over-all view of power bridge.

Equipment for measuring average r.f. power from 5 microwatts to 5 watts in the 20-10,000 mc. range.

USE OF a series of three power meters makes possible direct, accurate c.w. or pulse power measurements over the entire frequency spectrum from 20 to 10,000 mc., with an over-all accuracy of 5% for average power levels up to 5 watts. These power meters, in completely self-contained packages, represent improved versions of the basic designs of the military series AN/URM-19 through AN/URM-24, which—within their range—have been adopted as the r.f. power measuring standards for all of the Armed Services. The broadband frequency coverage, plus high accuracy, portability and ruggedness, makes these three units suitable for both field and laboratory service.

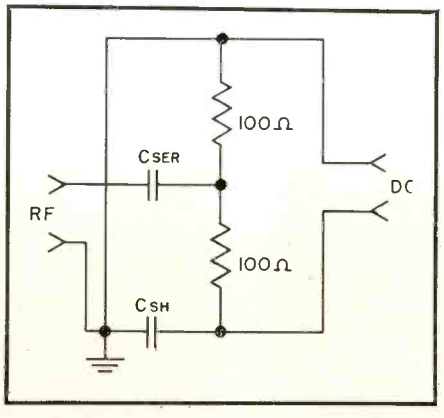
Each meter comprises two cases, one containing a power bridge, and the other containing a complete complement of r.f. components and accessories. Model 94A covers the frequency range from 20 to 1000 mc., Model 94B from 1000 to 4000 mc., and Model 94C from 4000 to 10,000 mc. Each instrument is provided with a switching arrangement so that either a high power or a low power (high sensitivity) bolometer element may be used interchangeably with the same mount. Since the basic construction of the three meters is identical, the following description applies equally to all three.

Circuit Details

Each model utilizes a direct-reading summation circuit in which a power-sensitive bolometer element acts as one arm of a d.c. Wheatstone bridge, while at the same time providing the correct resistive termination for r.f. power entering the power meter. At any given operating bias current, the resistance of a bolometer is proportional to the total power it dissipates. D.C. power is therefore used to establish the operating resistance of the bolometer and to balance the bridge. As r.f. power is added to the bolometer, d.c. power is subtracted to rebalance the bridge. The indicating meter, calibrated directly in milliwatts of r.f. power, measures the decrease in d.c. power and indicates the equivalent r.f. power dissipated in the bolometer.

A block diagram of a representative unit is shown in Fig. 5. Since the d.c. bias current determines the initial operating point of the bolometer element, it is essential that this current does not fluctuate during the measurement period. A highly regulated power supply is used to maintain a steady bias irrespective of variations in either line voltage or load.

Fig. 3. Schematic diagram of the bolometer element (see Fig. 1).



As illustrated, the bolometer element forms one arm of a balanced 200-ohm bridge. The element represents a nominal 200-ohm resistance to the bridge when the correct d.c. bias current is flowing. A "coarse" and "fine" potentiometer in the opposite bridge arm allow the bridge galvanometer to be balanced initially for a ±10-ohm resistance variation from nominal. When r.f. power is fed into the bolometer, either directly or through r.f. attenuators supplied as part of the equipment, the bolometer resistance changes and unbalances the bridge, deflecting the bridge galvanometer.

In order to rebalance the bridge, d.c. bias current is subtracted manually by means of a precision logarithmic attenuator which is ganged simultaneously to the bias current and metering circuits. This attenuator fulfills three functions: it (1) reduces the bias current to rebalance the bridge, (2) maintains the impedance constant looking back to the power supply, and (3) automatically reproduces on the power indicating meter a reading which is proportional to the d.c. power subtracted and, therefore, to the original r.f. power introduced.

Two unique features are the "compensate attenuator" and "calibration" circuits. The "compensate attenuator" circuit is a step series of precision d.c. attenuating elements which can be introduced into the metering circuit to compensate for r.f. attenuator varia-

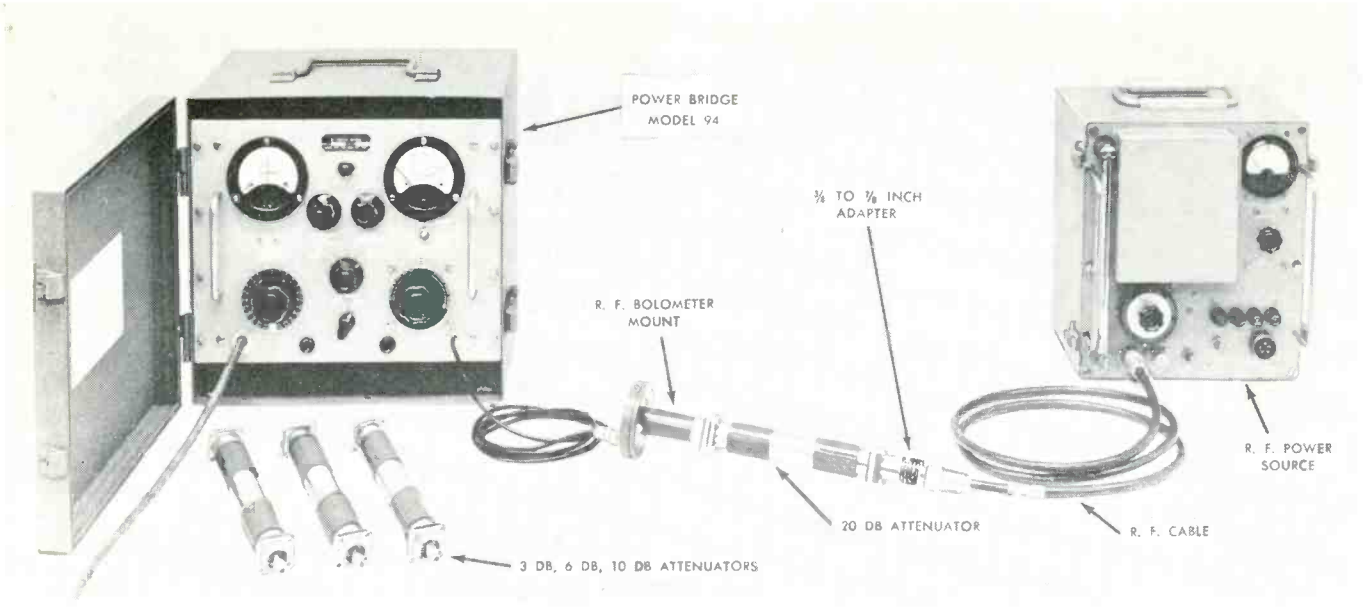


Fig. 4. Operational setup for Model 94A which covers the frequency range of 20 to 1000 mc.

tions due to frequency and temperature. For example, if a 10-db r.f. attenuator has an actual value of 9.6 db at a particular frequency and ambient temperature, a compensation factor of +0.4 db can be artificially introduced by means of the "compensate attenuator." This will allow measurements to be taken and the original source of r.f. power calculated by simply multiplying the meter reading by 10, as if the true attenuation of the r.f. attenuator had been exactly 10 db.

The "calibration" circuit sets the proper bias level to take into account the amount of compensation introduced into the "compensate attenuator" and to correct for temperature variations. During calibration, the bridge is replaced by fixed precision resistors to allow the level to be set independent of bolometer fluctuations.

Bolometer Element

Obviously, the bolometer element is the heart of the measurement system and the accuracy attainable depends to a large extent upon the quality of design and manufacturing of the element and its mount. Both high power and low power elements, interchangeable in the mount, are supplied with each power meter. The high power element, with a nominal 200-ohm value at 35-ma. d.c. bias current, is rated at 50 mw. average r.f. power; it is of the carbon film type with a negative temperature coefficient, and is capable of high overload without changing characteristics. The low power element is designed primarily for high sensitivity and accuracy, and is of the Wollaston wire positive-coefficient type, rated at 1 mw. average r.f. power over a 4.5-ma. bias.

Previous studies of the Wollaston wire-type bolometers have indicated sizable errors during pulse power measurement conditions, due to a large resistance and temperature excursion during the time the pulse is on and a decay characteristic between pulses which resulted in average power readings below the correct value. Special control of the time constant in the design and manufacture of the elements furnished with this equipment has largely eliminated these pulse power errors and resulted in the over-all accuracy being maintained for all r.f. power measurements, regardless of waveform.

A schematic representation of the bolometer element is given in Fig. 3, and a drawing of the element itself in Fig. 1. It is constructed of two resistive sections, each with a nominal resistance of 100 ohms at the proper bias current. These sections are in series with the d.c. circuit and so form one 200-ohm arm of the bridge. Two small blocking capacitors are mounted on the element so that the d.c. power is isolated from the r.f. section of the mount. At r.f. frequencies, the two capacitors have negligible reactance and may be considered as short circuits. Therefore, the effective r.f. input path parallels the two resistive sections to produce a 50-ohm termination which matches the coaxial r.f. circuit. The bolometer element simultaneously dissipates r.f. and d.c. power, and its exact resistance is proportional to the total power.

The broadband bolometer mount houses either the high power or low power bolometric element, and provides r.f. and d.c. connections so that the source of r.f. power may be coupled to the bridge.

Accessories

A set of precision r.f. attenuators is furnished with each model to increase the power range of the bridge. These units are of the metallized-glass type in which an extremely thin metallized resistive coating is deposited upon an inner insulator of glass. The broadband attenuation characteristics derive from the fact that this film thickness is small compared with the depth of penetration of the r.f. field so that essentially flat attenuation is achieved over

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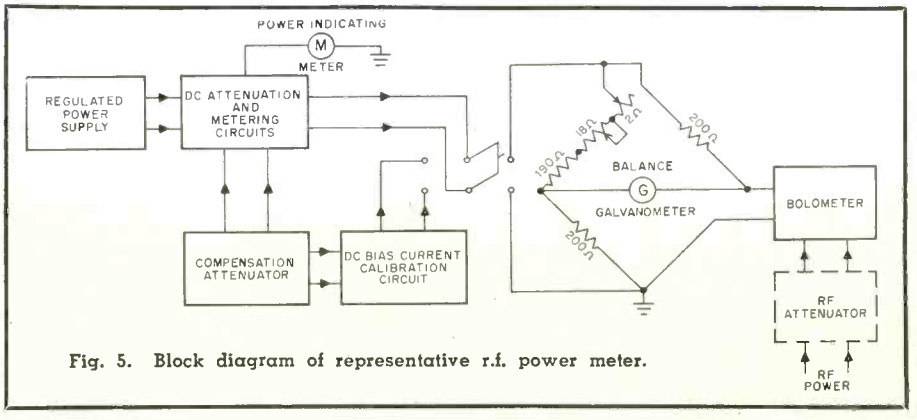


Fig. 5. Block diagram of representative r.f. power meter.

SUBWAY COMMUNICATIONS

By **LEO G. SANDS**
Radio Communications Consultant

Use of two-way radio in the u.h.f. range can provide adequate communication facilities for underground railway operation.

ADEQUATE MEANS for communications between train crews and personnel at fixed points is the missing link in present subway operations. Except for wayside signals, train crews are out of touch with train dispatchers and other supervisory personnel. Surface trains can be equipped with two-way radio to permit ground personnel to talk with train crews; however, when trains are operated underground, radio at most commonly used frequencies is ineffective because of extremely limited range and extremely high electrical noise level. Tests conducted recently in the Lincoln Tunnel under the Hudson River indicate that u.h.f. radio might be effectively utilized in providing communications facilities for subway trains.

Tunnel Tests

Two automobiles equipped with 460-mc. mobile radio units were operated within the Lincoln Tunnel and its environs to determine the range over which satisfactory car-to-car communications could be anticipated. With both cars inside the tunnel, excellent communication was maintained between the two cars for distances up to 2200 feet. The actual attainable range may be greater but it was impossible during these tests to separate the two cars by a greater distance without serious interference with tunnel traffic.

The tunnel extends downgrade from both the New Jersey and New York City terminals to the approximate midpoint of the tunnel. Solid communication between the two cars was maintained when both cars were in the same half of the tunnel. When one car entered the rising incline past the lowest point while the other car was still 1500 to 2000 feet behind, communication could be maintained until the lead car disappeared up the incline; apparently the vertical curvature of the tunnel blocked the radio signals. Excellent communication was also maintained while one car was outside on a surface highway near the tunnel entrance and the second car was inside the tunnel on the downgrade.

For the benefit of motorists driving through, the Lincoln Tunnel is equipped with a radio broadcasting system operating on 550 kc. This type of system depends upon wires strung the length of the tunnel which are energized by the radio transmitter. In subway operations, it would be costly and impractical to string wires for a great many miles through subterranean tunnels to provide a low frequency communications system. Furthermore, where electrically operated trains are used, severe electrical interference could be anticipated at low frequencies.

Inductive carrier systems operating in the vicinity of 150 kc. have been tested in subway tunnels, utilizing the third rail as the signal conveyor, and to date have proved inadequate because of excessive signal attenuation and extremely high electrical noise level. Radio systems operating in the 25-50 and 152-174 mc. bands do not provide adequate communications within long tunnels unless special transmission lines are installed.

Tests conducted at Union Station in Washington, D. C., utilizing 152-mc. band FM equipment on a diesel electric locomotive and a base station one and one-half miles from the tunnel entrance, revealed that contact with the radio-equipped locomotive could be maintained for about 500 feet inside of the tunnel which runs south from Union Station. It is relevant to note that communication was possible while the locomotive was under the catenaries of the electrified portion of the railroad which extended into the tunnel. As soon as the locomotive passed the point where catenaries were overhead, communications ceased.

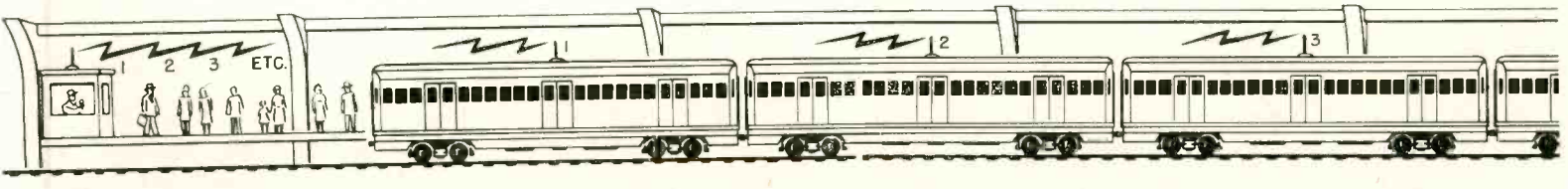
Train Radio

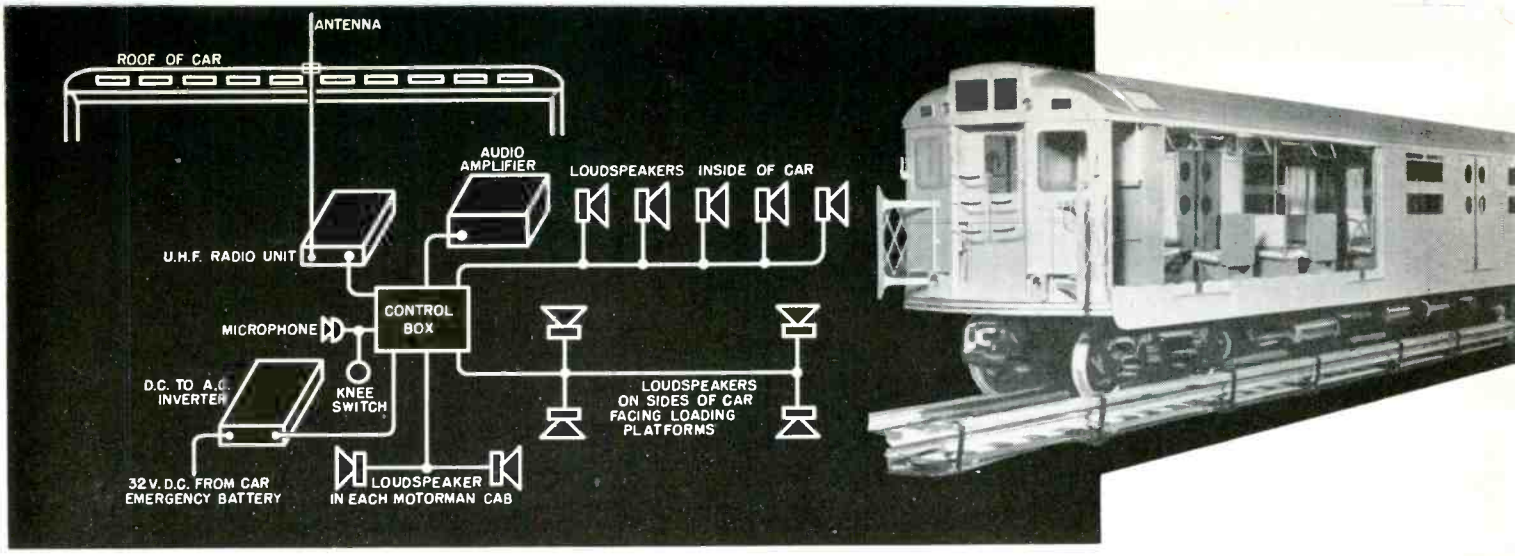
One of the problems the railroads face is that of providing radio communication with trains inside of tunnels. Freight trains are often more than a mile long. When the trains are outdoors, communication between the radio-equipped caboose and locomotive is seldom interrupted. However, when the head end plunges into a tunnel, communication with the caboose is generally cut off until both ends of the train are again outside.

The *Baltimore and Ohio Railroad* licked this problem by installing a lossy transmission line on the inside of the roof of the tunnel. Radio signals from the caboose were conveyed by the transmission line to the locomotive when both ends of the train were in the tunnel. The train antennas, of course, did not touch the transmission line but were in fairly close proximity.

The Lincoln Tunnel tests open a new field to be explored. It was demonstrated that noise-free radio communication could be maintained inside of subterranean tunnels over practical distances. Since tunnels used in subway train operations seldom have as steep vertical tangents as the Lincoln Tunnel, ranges greater than 2200 feet could be anticipated. However, even a 2200′ range would be adequate. By installing u.h.f. base stations at 2000′ to 2500′ intervals within the tunnels, coverage of an entire subway system could be realized. These base stations could be intercon-

Proposed method for communicating from station to motorman and cars, or—by remote control—from dispatcher to motorman.





Block diagram showing the essential equipment which could be installed in each subway car.

nected by telephone cables with the dispatcher's office and could be operated individually, in groups, or all simultaneously.

Since all subway cars are essentially alike, any car can be the lead car of a train. This might necessitate the equipping of all cars with radio or at least with the basic control equipment, antenna system, and shock-mounting for the mobile radio unit. Control equipment would be required at each motorman's cab, one at each end of the car, but a single mobile radio unit would suffice for each car.

The mobile radio unit for subway car service should preferably be operable direct from the 32-volt emergency battery which is standard equipment on most subway and elevated cars. For the sake of convenience, the FM transmitter, receiver, and vibrator power supply should be packaged in a single enclosure designed for easy removal and installation on a shock-mounted rack. Control equipment at each end of the car would consist of a control box, telephone handset and a loudspeaker. Arrangements could be provided for activating only the loudspeaker in the cab occupied by the motorman.

It would be most convenient to equip all subway cars with mobile radio units. However, from a cost standpoint, it would make more sense to equip all cars with control equipment, antenna system, and shock-mounted equipment rack only. Mobile radio units could be installed in a matter of minutes in the cars which would serve as lead cars of trains during the day.

In the Lincoln Tunnel tests, 10-watt u.h.f. mobile units were used. It appears that mobile units rated at 10 watts r.f. output would suffice for subway operations. Doubling of the power would not provide much improvement and increasing the power by ten times would greatly increase cost and power consumption. The antenna system could consist of a 6" flexible whip antenna on the roof of a subway car connected via coaxial cable with the mobile radio unit inside the car.

Passenger Considerations

Another problem faced by subway rapid transit system operators is that of providing means for communicating with passengers. It sounds easy. Loudspeakers and amplifiers could be installed in all cars through which the train conductor could make announcements. However, it is not that simple. Such a system would require special wiring run through all cars, including those not equipped for sound, plus rapid disconnect plugs at each end of the cars. With all cars of a train thus wired, the public address system would work. However, if an unwired car were inserted in the train, the audio link between cars would be broken and the public address system would be operable in only those cars on the "live" side of the unwired car.

This problem has been discussed by the writer with engineers and officials of the New York City Transit Authority, the *Hudson-Manhattan Railroad* and others. One solution suggested by the writer would be the equipping of every subway car with a u.h.f. mobile unit, and audio power amplifiers, control equipment, antenna system, and loudspeakers distributed inside the car. A pair of loudspeakers could also be installed facing outward from each side of the car so that patrons standing at loading platforms could hear announcements.

With such a system, the conductor could make announcements direct to passengers inside his car via a public address system, at the same time activating an FM transmitter which would transmit his voice via u.h.f. radio to the other cars in the train. On each of the other cars, the radio signal would be picked up by a u.h.f. receiver and the audio output of the receiver raised to the proper level by an audio power amplifier and distributed to the loudspeakers facing both into and outward from the car.

If all cars were equipped with both transmitters and receivers, announcements could originate from any car in a train. Announcements to passengers aboard nearby trains could be made from loading platforms through base radio stations located at loading platforms. To prevent announcements from being heard by passengers aboard other than desired trains, separate radio channels would be required for different services. For example, in a four-track operation, an individual frequency would be required for northbound express, northbound local, southbound express and southbound local trains. The mobile radio units on all cars, if used

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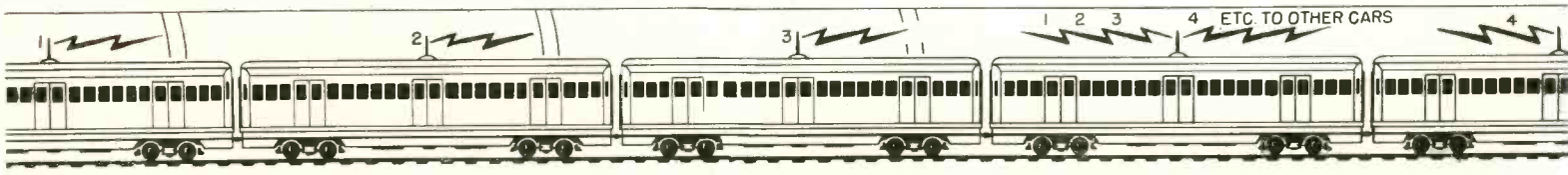
Setup for communicating from a special car to any other car, or from conductor or dispatcher to motorman.



Over-all view of the Model R5200 v.h.f. receiver.

V.H.F. COMMUNICATIONS RECEIVER DESIGN

By

JULES CARDON — Staff Engineer

HOWARD BENSEN — Development Engineer

FREDERICK G. RICHTER — Development Engineer

Servo Corporation of America, New Hyde Park, New York

Features include effective squelch, automatic noise limiter, b.f.o. and variable selectivity circuits.

THE v.h.f. part of the spectrum has in the past been severely neglected insofar as tunable receiver coverage is concerned. Need for such a receiver in general laboratory work as well as in the communication field initiated an intensive effort on the part of *Servo Corporation of America* to overcome this lacking facility.

First efforts to develop a v.h.f. receiver were governed by a philosophy that a very sensitive and stable unit with provision for AM and FM reception would satisfy almost all requirements. However, opinions of what special features should be provided were solicited from such sources as the airlines, CAA, and engineers concerned primarily with laboratory work. A careful analysis of these opinions indicated that to make this project worthwhile all features normally found in the better high-frequency receivers, such as automatic noise limiter, squelch, variable bandwidth, etc., should be incorporated. To this end, some novel and very effective circuits were developed which will be included in this article.

General Characteristics

The Model R5200 receiver is continuously tunable over its entire frequency range of 50-200 mc. without switching. Frequency calibration is displayed on a spiral-type dial with an effective scale length of 72", which employs both fast and slow tuning. The dial is calibrated directly in frequency. Calibration intervals are at 100-kc. points below 100 mc. and 200-kc. points above 100 mc. The following controls are available on the front panel: (1) fast tuning, (2) slow tuning, (3) antenna trimmer, (4) r.f. gain, (5) "on-off" switch and a.f. gain, (6) c.w.-AM-FM selector switch, (7) b.f.o. pitch control, (8) selectivity control, (9) man.-a.g.c. switch, (10) "on-off" squelch, (11) "on-off" ANL, and (12) "send-receive" switch. In addition, a self-contained speaker, a phone jack and an r.f. signal level meter are mounted on the front panel.

Sensitivity of the Model R5200 is

Fig. 1. Selectivity curves corresponding to values of Q from 33.3 to 200.

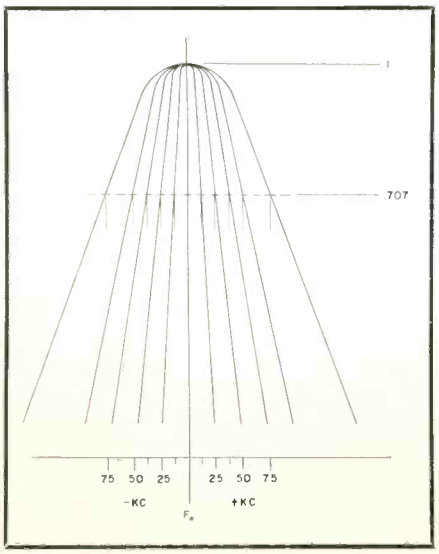
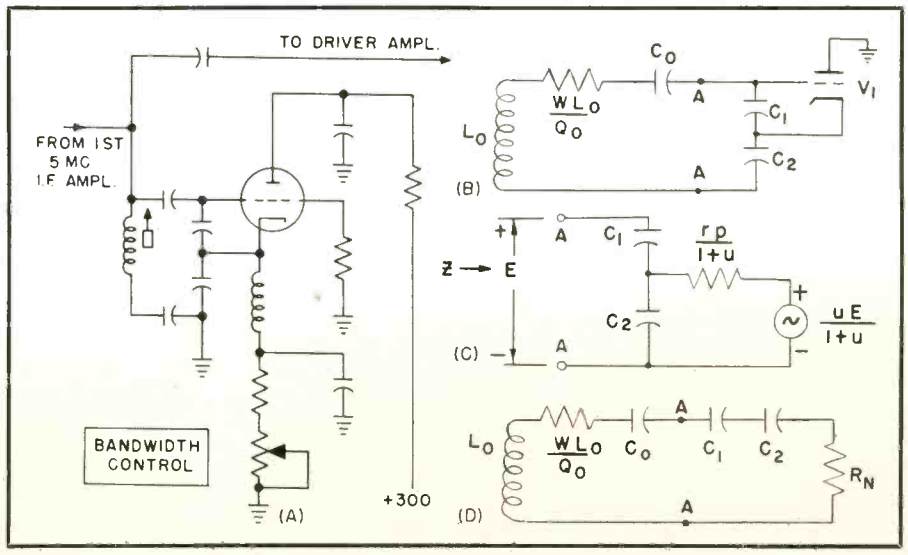


Fig. 2. (A) Schematic diagram of the complete bandwidth control, (B) basic circuit, (C) equivalent circuit, and (D) simplified equivalent circuit.



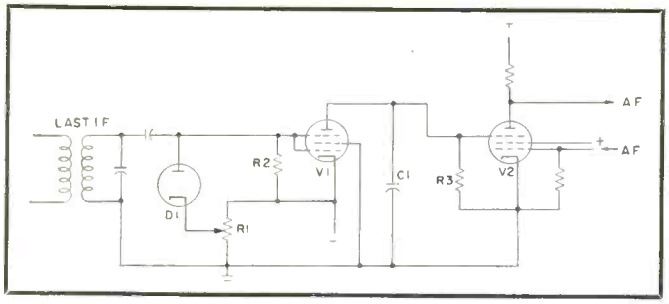


Fig. 3. Schematic diagram of the squelch circuit.

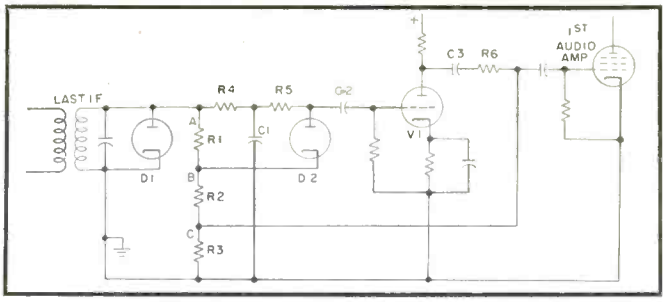


Fig. 4. Schematic diagram of automatic noise limiter.

such that a signal input of less than 1 μv. will produce a 10-db signal plus noise-to-noise ratio. For a 1-μv. input signal modulated 30% across the 50-ohm antenna terminals, the over-all power gain is 1 watt of audio power output. Image rejection and spurious responses are more than 100 db down at 50 mc. and more than 60 db down at 200 mc.

A *Mallory* four-gang inductuner serves as the tuning element for the two stages of tuned r.f. amplification. These two stages, together with the first mixer, produce an effective gain of 30 db. The first mixer is followed by a 30-mc. amplifier to preclude the possibility of the second mixer becoming a factor in the signal-to-noise ratio of the over-all receiver. Gain of the 30-mc. amplifier plus the second mixer and the 5-mc. i.f. amplifiers is 112 db.

Double conversion is employed with the first i.f. frequency at 30 mc. and the second at 5 mc. To improve over-all stability, the second conversion is accomplished through the use of a 25-mc. local oscillator with crystal control. The 5-mc. i.f. is made available at the rear of the receiver chassis through a standard 50-ohm coaxial connector. This feature further increases the versatility of the receiver, and is of particular importance in its use for direction-finding purposes or in conjunction with panoramic devices. In addition to the i.f. output, the following functions are also available at the rear of the receiver chassis: (1) 600-ohm audio output, (2) 50-ohm antenna input, (3) phono input, (4) FM output, (5) b.f.o. injection control, (6) r.f. signal level meter adjustment, (7) a.g.c. voltage, (8) internal speaker "on-off" switch, (9) "send-receive" relay connector, (10) fuse.

Selectivity

Bandwidth is variable over the range of 25-150 kc. The variation of this bandwidth is accomplished by effectively multiplying the Q of one of the i.f. tank circuit inductors. Since the bandwidth (bw) of a resonant circuit at the ½-power points is equal to F_0/Q_0, where F_0 is the frequency of resonance, it is readily apparent that rather large changes in bandwidth may be accomplished through reasonable changes in Q. The initial value of the coil Q_0 for this stage was chosen so as to give the maximum desirable bandwidth—in this case, a value of 33.3. It will now be noted that if the Q_0 value of 33.3 is multiplied by a factor of 6 there will be a resultant bandpass reduction of 6 (Fig. 1).

The method chosen to vary Q was to connect a negative resistance (R_N) in series with the inductance (Fig. 2D), resulting in an effective value of:

$$Q' = \frac{\omega L_0}{\omega L_0/Q_0 - R_N} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Referring to Fig. 2B, the element employed to achieve this negative resistance is V_1, used as a cathode follower coupled to inductor L_0 through the coupling capacitors C_1, C_2. Referring to the equivalent circuit, Fig. 2C, the impedance to the right of terminals A-A will vary as a function of g_m. Therefore, assuming a μ greater than 10:

$$Z = \frac{-g_m}{\omega^2 C_1 C_2} - \frac{j}{\omega}\left(\frac{1}{C_1} + \frac{1}{C_2}\right) \quad . \quad . \quad (2)$$

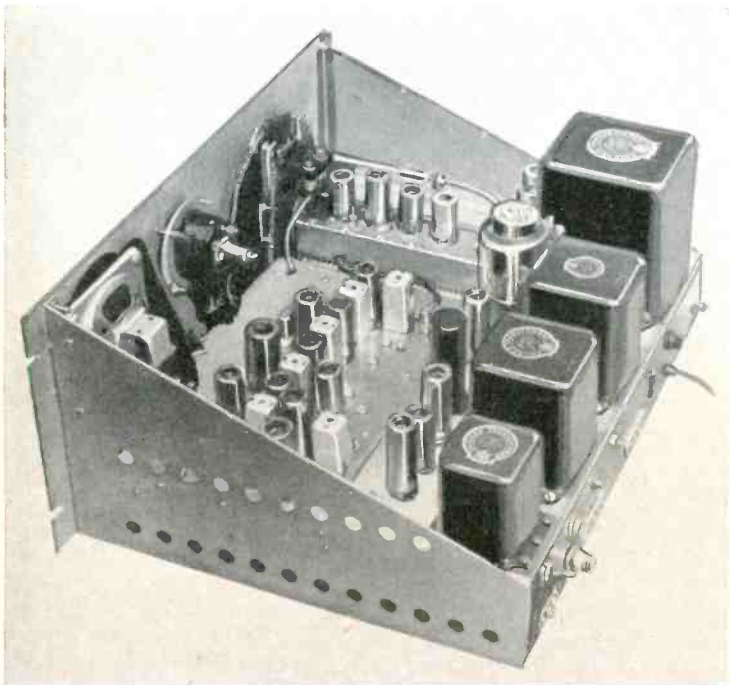
$$R_N = \frac{g_m}{\omega^2 C_1 C_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\text{bw} = \frac{F_0}{\omega L_0}\left(\frac{\omega L_0}{Q_0} - R_N\right) = \frac{F_0}{Q'} \quad . \quad (4)$$

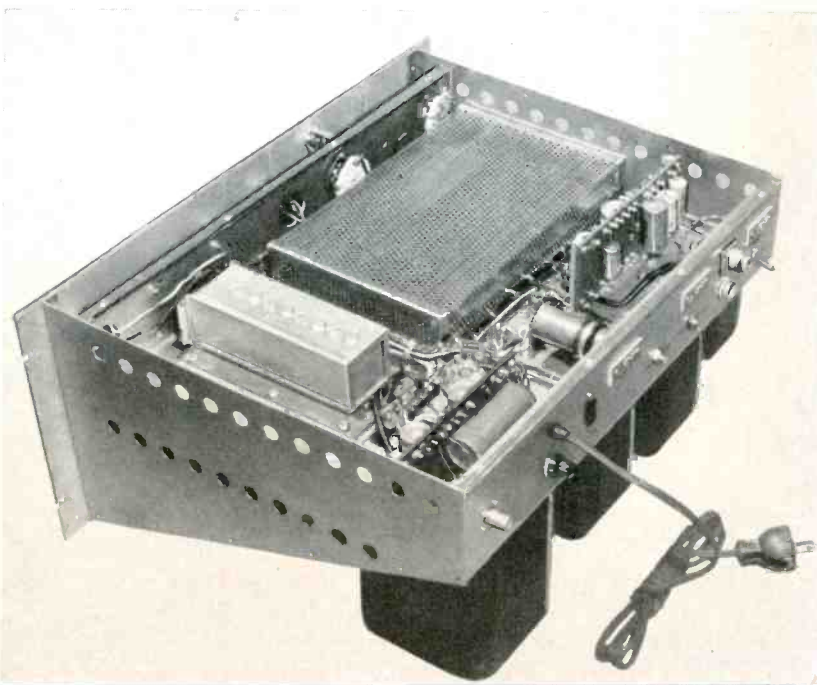
The inherent stability of a cathode follower permits close control of Q without undesirable detuning of the resonant circuit.

Advantages of this method of bandwidth control over others employing mechanical devices for varying the coupling between two resonant cir-

Top view of chassis removed from rack.



View of the chassis from the underside.



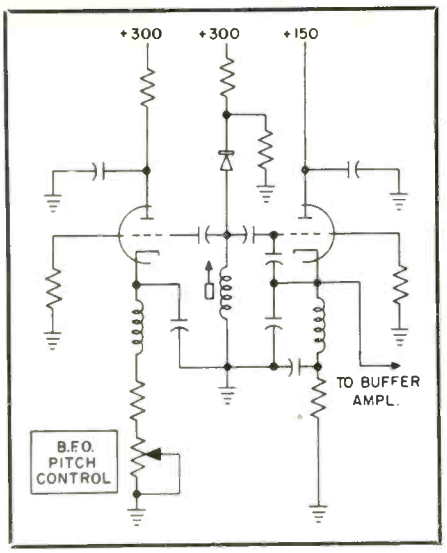


Fig. 5. Beat frequency oscillator circuit.

cuits are readily apparent. Components may be placed in any convenient place dictated solely by the electrical requirements of good design, and without regard to placement of control shafts normally associated with switching taps on coils or physically varying the coupling of coils. The control of Q in the foregoing description is accomplished by varying a d.c. bias on the Q multiplier tube.

Of special interest in the R5200 receiver are such features as squelch and automatic noise limiter (ANL) which employ unusual circuits that greatly improve the characteristics of these functions over those of more conventional circuitry.

Squelch Circuit

The most desirable characteristic of a squelch is the possession of crisp "on-off" action with very small changes in input signal level. The squelch employed in the R5200 receiver utilizes the principle of a gated beam pentode followed by a sharp-cutoff pentode with a gating type of suppressor. This principle permits a virtual step function in the "on-off" action without resultant deleterious effects of audio gain due to marginal carrier level.

Referring to Fig. 3, D_1 is used as a conventional negative type of detector with the exception that a bias is applied to the cathode to prevent conduction below a predetermined level. When V_1 —the gated beam tube—is in a conducting state, it prevents audio amplification from taking place, since its plate load resistor also serves as the suppressor return for the first audio tube V_2. When the carrier level exceeds the bias voltage on diode D_1, rectification takes place. The rectified voltage is then applied to both grids of V_1, so as to obtain the maximum g_m from the tube, and therefore achieve as closely as possible a step function in the plate current change. As V_1 ceases to conduct, the suppressor of the first audio tube V_2 is permitted to return to zero or the cathode potential, and normal amplification takes place.

This type of squelch was found to possess full "on-off" action in the R5200 receiver at a signal level of 1 μv. when the antenna signal was varied 0.4 μv.

Automatic Noise Limiter

Requirements of a good automatic noise limiter are: (1) that it should have large dynamic range, (2) that its activation should not load the normal detector circuit, and (3) that it should be independent of carrier level changes.

The ANL employs the following principles: (1) detection of random noise pulses "A", (2) detection of audio modulation "B" plus random noise pulses "A", and (3) linear mixing of the two signals in the form ("B" + "A") — "A."

Referring to Fig. 4, it will be noted that demodulated noise and audio signal voltages, plus a negative d.c. component due to carrier level, appear at points A, B and C. The relative amplitudes of the signals appearing at points A, B and C are proportional to the values of R_1, R_2 and R_3. R_1 is adjusted to produce a d.c. bias across diode D_2 that will prevent it from conducting on modulation levels determined by this negative potential. Since the d.c. voltage across R_1 is proportional to the carrier level, setting of R_1 for any modulation percentage will hold regardless of carrier amplitude changes.

Further, since the cathode of D_2 follows the demodulated audio and the plate will only respond to very low frequency changes due to a low-pass filter consisting of R_4 and C_3, a sharp burst of noise exceeding the instantaneous audio voltage can cause D_2 to conduct and apply the noise pulse to the grid of V_1. V_1 will amplify and invert the noise pulse which is then coupled back to point C through the phasing network consisting of C_3 and R_6. Both the amplified-and-inverted pulse and the original pulse are linearly mixed across R_2, causing their elimination. D_2 and V_1 may well be regarded as a negative feedback network for noise pulses only.

The gain characteristics on noise pulses for the feedback network are such that a noise pulse appearing at point B and of a magnitude M_1 will produce a noise pulse of opposite polarity and a magnitude of $(M_1 - 1R_2)$ at point B.

Beat-Frequency Oscillator

A major problem in any receiver design employing a b.f.o. is the placement of this particular circuit relative to the front panel, to permit the control of the b.f.o. frequency or pitch. In the design of the R5200, it was decided to minimize the number of mechanical controls, as the results would be twofold: (1) simplicity of construction, and (2) reduction of microphonics and instability due to chassis twist, etc.

With the foregoing thought in mind, a b.f.o. was designed (Fig. 5) which employs a passive element in the form of an electron tube across the oscillator-tuned circuit as a frequency control element. This type of circuit permits varying the b.f.o. frequency through the use of a potentiometer located at any convenient place on the front panel. To further insure stability of the b.f.o., it is operated as a class B oscillator through the use of a diode across the tank circuit. Frequency is varied by utilizing the change in input capacity of a triode tube as a function of gain. The input capacity of a tube is inversely proportional to g_m and can be expressed as input capacity $= C_{gp} + C_{gK}/(1 + g_m R_L)$, where C_{gp} is the grid-to-plate capacity, C_{gK} is the grid-to-cathode capacity, and R_L is the total load resistance.

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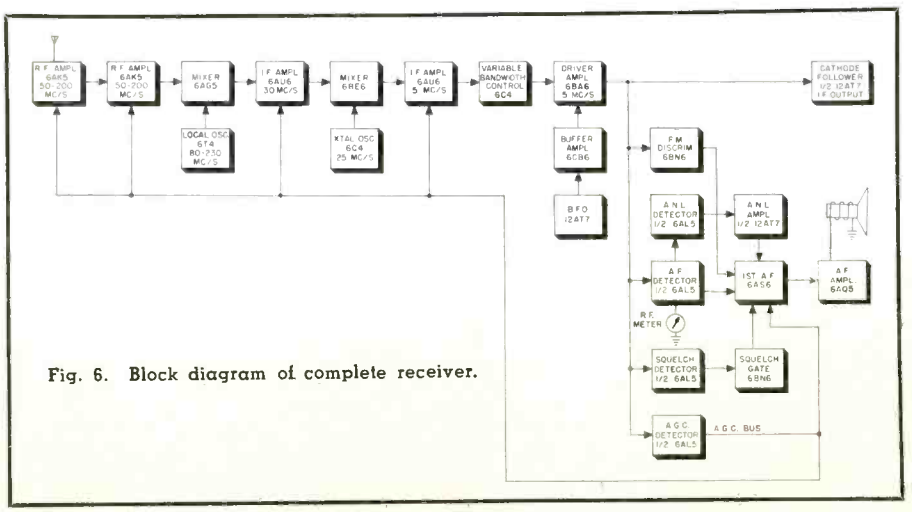
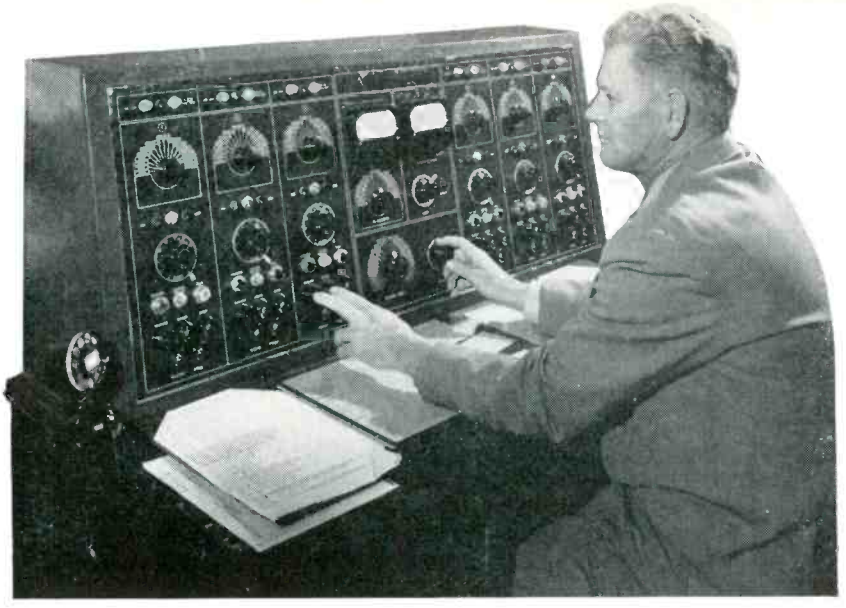


Fig. 6. Block diagram of complete receiver.

FLEXIBLE BROADCAST RECORDER INSTALLATION

By **RICHARD PARKS**

Assistant Chief Engineer
ABC Network, San Francisco



Vernon Harvey, project engineer, at control console.

Remote control console enables one man to handle entire network program delay operation without tape backup.

AT the *American Broadcasting Company*, in San Francisco, a network recording and delay system has been designed and built which is unique in its flexibility and the economy of operation achieved. Recording and delaying line transmittal for 40 stations and a recording studio in the Pacific Northwest and Mountain states, it is operated by one man at a console remotely controlling six *Ampex* 350 tape recorders. Customary use of a duplicate tape for protection on material going out over an extensive network has been discontinued. The network is protected from undue program risk by the flexibility of the system and the reliability of the recorders.

Noteworthy in the installation is the complete interconnecting of all lines and all recorders. Six selector switches of 15 positions each are used to direct the input or output of each of the six recorders. The switches are located on the control console, and their settings enable any one or more recorders to record any incoming program or programs. Also, any recorder can copy from any other. Only one recorder at a time can play back to the principal outgoing line, but changeover to another recorder can be made instantly. All recording and playback is adjusted to +4 vu line level, which is not affected perceptibly by several recorders operating simultaneously.

Though the system was designed for *ABC* network delay requirements, its design and the *ABC* operating procedure and experience should have advantages for any radio station needing two or more studio tape recorders.

Single Control Console

The one man who operates the six recorders handles functions that would ordinarily be covered by several men in any less flexible installation. Normally, from 6:30 a.m. until 10:30 p.m., there is always one program coming in over the line from Los Angeles and one program going out delayed one hour to the Pacific Northwest and Rocky Mountain circuit. In addition, *ABC* programs are recorded regularly on 7″ tapes for shipment to station KULA in Honolulu, and selected programs from *ABC*, *NBC* and *Mutual* are recorded for Station KUAM in Guam. Recording from any of four studios can also be handled at this one console.

Four recorders are normally used for the incoming and outgoing network delay. Two of these recorders alternate each half hour for continuous coverage of the incoming *ABC* network, while the other two recorders alternate each half hour for the outgoing network. Tapes are physically transferred from the recording machines to the playback machines and back for reuse. Although this transfer of tapes is not essential, it makes possible continuous use of the same two machines for outgoing network feed, thus minimizing chance for error and not materially increasing the operator's work.

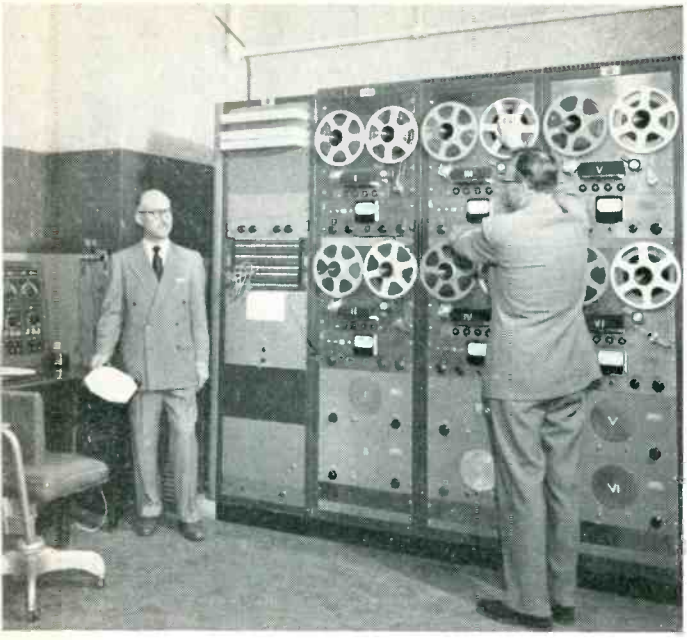
The remaining *Ampex* 350's are "spares" and complete the flexibility of the system. They can double for any of the four full-time record and playback machines, or they can make tape duplicates of either incoming, outgoing or separately played tapes. In addition, they can record from a second incoming line or play to a second outgoing line without disrupting the continuous routine of the other four recorders.

At 30-minute program change times, the operator uses the control console for all necessary transfers on both incoming and outgoing lines. Outgoing transfer is the most critical. A push-button operated relay instantly connects the desired playback machine to the outgoing network and disconnects the one that has finished. Recorders on the incoming lines are operated conventionally by push-button remote controls on the console. Stopping of the recorders that have finished is not critical; they can be stopped and tapes transferred at the operator's convenience once he has started all the incoming recorders.

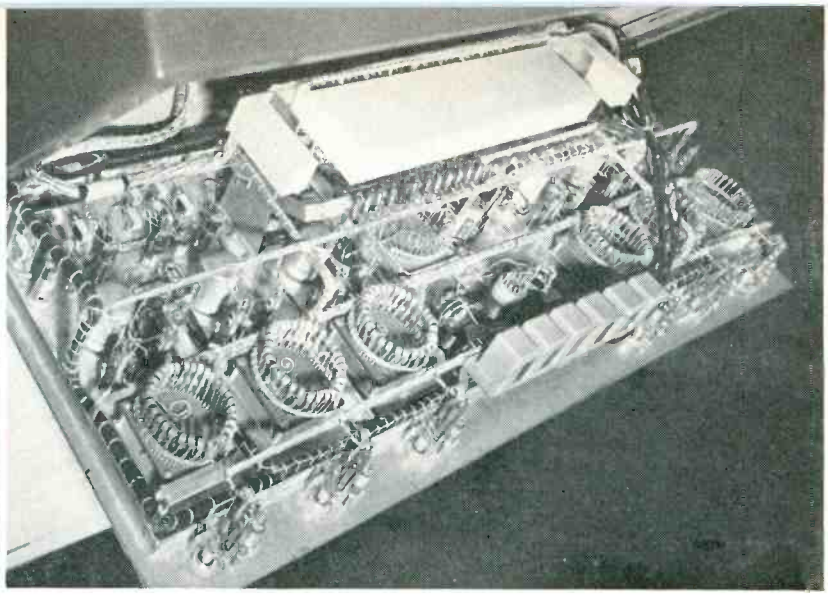
Backup Eliminated

Confidence in the setup and recorders has enabled *ABC* (San Francisco) to dispense with backup (parallel use of a second recorder on incoming and outgoing network programs). By this departure from conventional practice, the need for four additional recorders plus required floor space has been eliminated. However, with 40 stations on the line, the manpower and machine saving would not be worth while unless nearly all chance of failure had also been eliminated.

Tape breakage is practically a thing of the past. Unspliced tape is used on 10½″ plastic reels which have a thinner hub than the NARTB standard alumi-



The control console is shown at the left (next to author), with the six *Ampex* 350 recorders at right.



Internal wiring of the control panel. Over 1000 soldered connections are used in the installation.

num reels. This hub prevents the uneven winding which used to leave edges sticking up and thus vulnerable to damage and ultimate breakage.

The *Ampex* 350 recorders are extremely reliable and ideally adaptable to remote control. On the long daily schedule, the machines have already accumulated over 8000 hours of use as of this writing. During this time, there has been only one stoppage; it occurred in a preprogram warmup and lost no broadcast time. A monthly checkup is made on recorders. Only infrequently are any

(*Continued on page* 37)

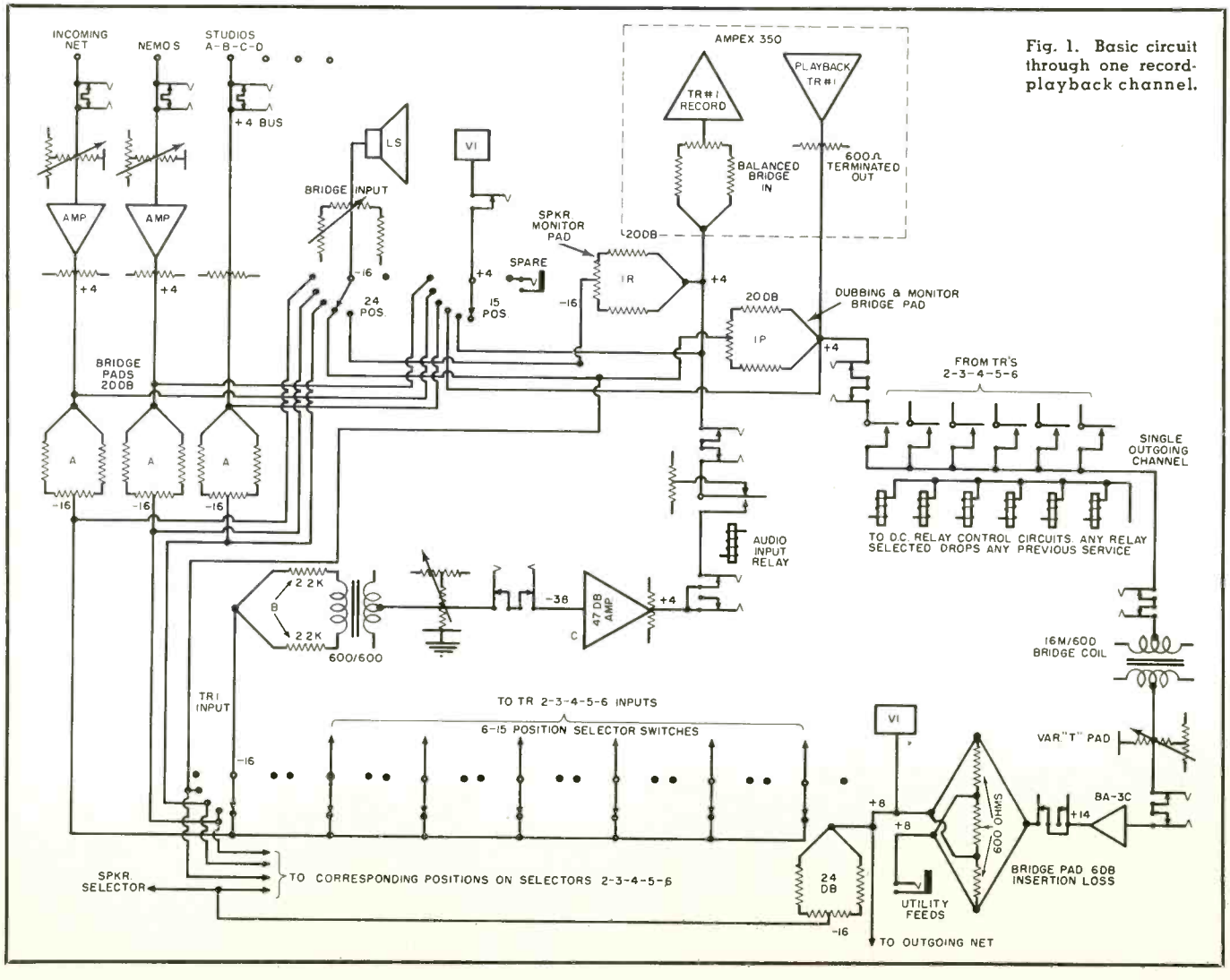
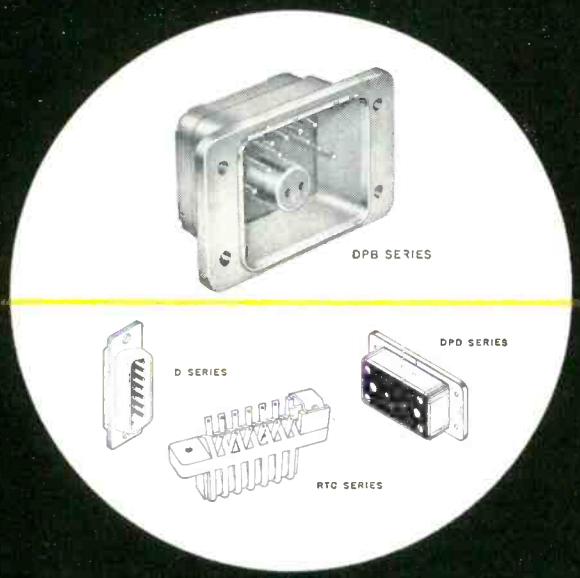


Fig. 1. Basic circuit through one record-playback channel.



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BIASTRE

CALIBRATION of ACCELEROMETERS

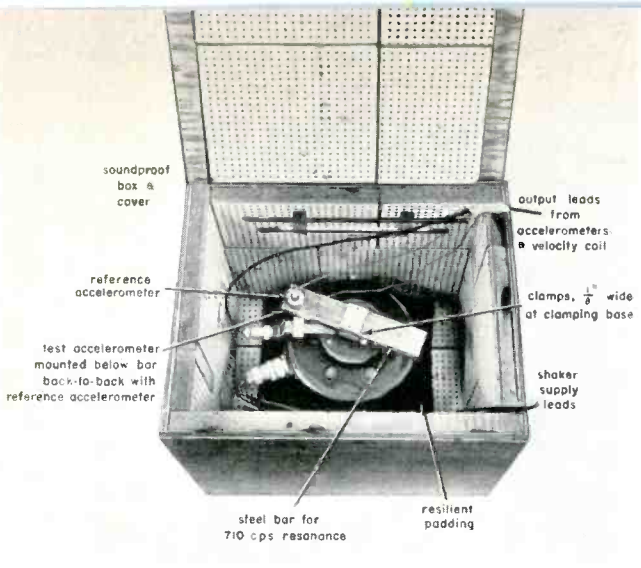


Fig. 1. Device for steady-state calibration of vibration pickups and accelerometers at accelerations up to 1090g.

Accurate methods of calibrating vibration pickups and accelerometers devised at NBS.

IN RECENT years, the widespread use of vibration pickups has introduced a serious calibration problem. The increase in the number of pickups has emphasized the need for rapid, reliable means of calibration over wide ranges of frequency, amplitude, and acceleration. Two methods which are proving useful in the accurate calibration of vibration pickups and accelerometers have recently been developed at the National Bureau of Standards in connection with a program of basic instrumentation research sponsored by the Office of Naval Research, Air Research and Development Command, and Atomic Energy Commission.

Chatter Principle

The "chatter" principle was first described by Sir William Bragg in 1919. Based on this principle, the chatter accelerometer is a device in which a loose mass on a vertically vibrating surface bounces or "chatters" when the peak acceleration of the sinusoidal motion exceeds $\pm$ 1 g. Using an improved accelerometer developed by C. W. Kissinger of NBS, both the chatter of the loose mass and the acceleration of the shaker table to which the device is attached are converted into an electrical signal which is displayed on the screen of an oscilloscope.

A mathematical relationship was derived showing (1) the amount by which the peak value of the sinusoidal acceleration exceeds 1 g and (2) the point in the cycle at which the first bounce occurs. If this mathematical relationship is applied to the accelerometer output as observed on the oscilloscope screen, acceleration levels from about 1.01 to 1.04 g may be set with an accuracy of approximately 0.2% at frequencies up to 60 cps, and with somewhat decreased accuracy up to about 150 cps. The accuracy of calibration was estimated by comparison with an optical calibration in which the peak-to-peak displacement of the chatter accelerometer was measured with a micrometer microscope. Stroboscopic illumination makes the accelerometer appear to be nearly motionless for ease of measuring displacement.

In the NBS-33-24 chatter accelerometer, the loose mass can be clamped by a screw and prevented from chattering. The accelerometer can then be used as a secondary standard for accelerations in excess of 1 g at frequencies up to 1200 cps.

Steady-State Calibration

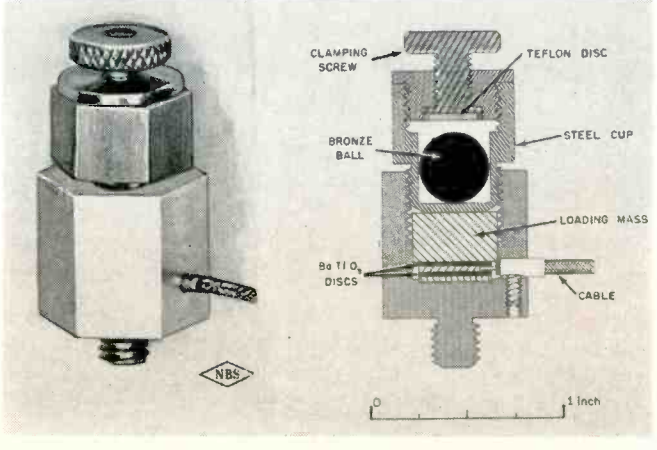
A method for steady-state calibration at high values of sinusoidal acceleration was developed by T. A. Perls and C. W. Kissinger of the NBS staff. In this method, a steel bar is clamped to the head of an electrodynamic shaker at its center point, so that both ends of the bar are free. The accelerometer being tested is clamped back-to-back with an NBS-33-14 secondary-standard accelerometer at one end of the bar, and a balancing weight is fastened to the other end, if needed. The whole system is driven at its resonant frequency by a 70-watt amplifier.

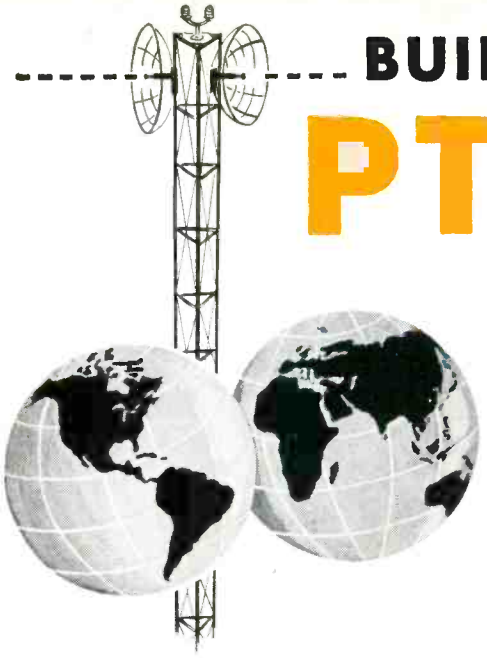
Steady-state accelerations have been measured with this system up to 1090 g, zero to peak, at 874 cps. When the resonant bar was additionally loaded with a 40-gram test accelerometer, accelerations up to 655 g were attained. In comparison, if the steel bar had not been used and the accelerometer had been mounted directly on the shaker head, the maximum attainable acceleration would have been only 50 g.

A series of tests was conducted at the Bureau in which the steel bars used as part of the resonant system were first tested in the annealed state, then heat-treated and again tested. Results obtained indicate that such heat treatment increases the maximum steady-state acceleration two-fold. In most cases, the vibrational amplitude did not remain proportional to the shaker excitation current over the full available power range. Thus, the elastic properties of the bars used in the tests limit the maximum steady-state vibratory amplitudes attainable.

In the steady-state calibration method, the armature of the electrodynamic shaker is part of the resonating system, and its amplitude of motion at resonance is proportional to the amplitude at the ends of the bar. This mode of operation makes it possible to determine that the output of an NBS-33-14 accelerometer from 25 to 1090 g at 874 cps is proportional, within 2%, to the output of a velocity pickup built into the armature of the shaker.

Fig. 2. The NBS-33-24 chatter accelerometer is used to determine very accurately the peak value of a sinusoidal acceleration when its value is slightly in excess of 1g.





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PTM and Other Microwave Milestones by IT&T System Companies:

- **FIRST** public demonstration of UHF communication (across the English Channel, 1931).
- **FIRST** commercial UHF link (Lympne, England to St. Inglevert, France, 1933).
- **FIRST** multi-channel radiotelephone link (Stranraer, Scotland to Belfast, Northern Ireland, 1936).
- **PIONEER** laboratory development of pulse systems of modulation—PTM (pulse time modulation), PCM (pulse code), PAM (pulse amplitude), and PWM (pulse width).
- **FIRST** public demonstration of PTM multiplex microwave point-to-point communication (New York City, 1945).
- **FIRST** public demonstration of PTM multiplex microwave broadcasting (New York City, 1946).
- **FIRST** commercial-type PTM microwave radiotelephone installation in: Eastern Hemisphere (the Netherlands, 1947); Western Hemisphere (Canada, 1948).
- **FIRST** private-line microwave installation (Keystone Pipe Line Co., United States, 1949).
- **FIRST** PTM microwave link for an aviation communication system (Mexico City Airport, 1949).
- **FIRST** television across English Channel, using portable microwave links (Calais-London, 1950).
- **FIRST** microwave television link to carry simultaneous sound (United States, 1951).
- **FIRST** long-distance intercity microwave television link in Eastern Hemisphere (Manchester-Edinburgh, 1952).
- **PIONEER** development of "Microstrip"—a substitute for wave guide. Announced to industry, 1953 (United States).

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MICROWAVE MOVIES

16 mm. color prints on "PTM" available without charge. Write to *Film Distributing Dept.*

COMMUNICATION REVIEW

"TELELINK" MICROWAVE SYSTEM

Engineered to provide reliable service for one- or two-channel operation, the TCR-12 "Telelink" communication microwave system features low equipment, installation and operational costs. Announced by the *Raytheon Manufacturing Company*, Waltham 54, Mass., it is expected to fulfill a definite need for many applications in the telephone industry, pipe line companies, railroads, power companies, air lines, etc. No out-

side housing is required, and standardized, long-life parts are used throughout. All components were selected to operate well within their rated values.

Circle No. 51 on Reader Service Card

USAF BUYS MICROWAVE EQUIPMENT

Two million dollars worth of microwave radio equipment has been purchased by the United States Air Force from the Electronics Division of *Westinghouse Electric Corporation*, Baltimore, Md. Comprising about 150 fixed stations, the equipment will be sent to friendly nations in Asia and Europe as part of the Mutual Defense Assistance Program. The 2000-mc. microwave radio (Type FR) and associated multiplex equipment (Type FJ) will supply almost 1000 complete circuits for private- and party-line duplex telephone and telegraphic communications.

Circle No. 52 on Reader Service Card

LONG-WAVE RECEIVER

A long-wave version of the Super Pro-600 receiver for operation in the frequency range of 10 to 540 kc. has been announced by *The Hammarlund Manufacturing Company, Inc.*, 460 West 34th St., New York 1, N. Y. The frequency range is covered in six bands, with receiver bandwidth variable in five steps from 300 to 7000 cps.

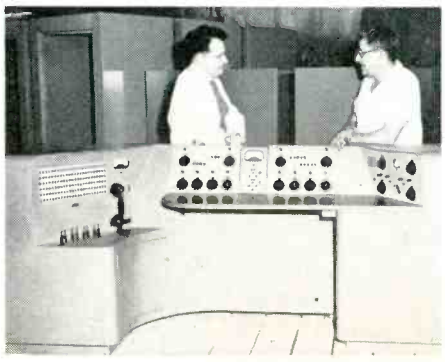
In general, this long-wave version incorporates the same characteristics as the standard Super Pro-600-JX receiver. It is a superheterodyne unit with self-contained power supply, and is designed for 19" relay rack mounting. Image response is at least 74 db below the desired signal anywhere within the frequency range, and the spurious response is equal to or less than the image response.

Circle No. 53 on Reader Service Card

USIA CONTRACT AWARDED

One of the largest and most modern studio and recording installations in the world is being supplied to the U.S. Information Agency (Voice of America) in Washington, D. C., by the *Gates Radio Company*, Quincy, Ill. Under the USIA contract, there will be sufficient audio and control equipment furnished for the equipping of 16 studios, 40 recording positions (both disc and tape), one master control console and a recording console. As many as 100 audio lines can be controlled by the master and recording consoles through an elaborate preset relay system. A total of 148 rack cabinets will house the many amplifiers, power supplies, and other components associated with the control equipment.

Shipment of four of the Studio "C" consoles (as illustrated) and other as-

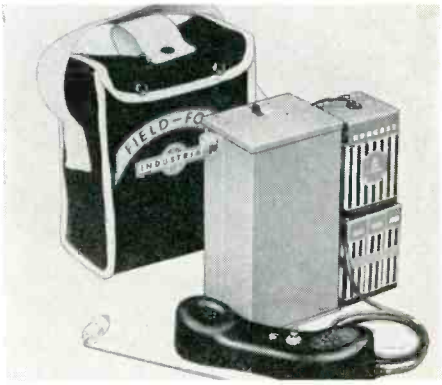


sociated equipment was made late in August. Electrically, this console offers complete facilities for mixing, signaling, cueing, monitoring and patching. All attenuators and rotary switches are equipped with illuminated lucite knobs and edge-lighted dials, providing positive knowledge of circuit conditions.

Circle No. 54 on Reader Service Card

"FIELD-FONE" RADIOTELEPHONE

Smaller and lighter than units of comparable power, the "Field-Fone" is a portable two-way radiotelephone which has just been announced by the *Indus-*



trial Radio Corporation, 428 N. Parkside Ave., Chicago 44, Ill. It is powered by self-contained long-life batteries and provides dependable FM quality voice communication over comparatively long distances.

This radiotelephone was designed particularly for use by police patrolmen, firemen, forest rangers, civil defense personnel, and others whose work requires instant two-way contact. Communications may be maintained with central fixed radio stations, mobile radio cars or with other "Field-Fones."

Circle No. 55 on Reader Service Card

"ALL-TONE" SUPERVISORY CONTROL

Supervisory control equipment designed for use with any type of communications equipment capable of carrying audio signals, including microwave and v.h.f. radio as well as power line carrier and wire lines, has been developed by *Motorola Communications and Electronics, Inc.*, 4501 Augusta Blvd., Chicago 51, Ill. Unlike conventional remote control apparatus using multiconductor cables, whose installation and maintenance costs can become prohibitive as distance increases, this system is well suited to operation over long distances.

Providing control and/or supervision of up to 90 individual points by using 12 different tones, the new *Motorola* system enables an operator to control and supervise remote circuit breakers, valves, pumps, generators, motors, etc., and at the same time automatically provides a continuous indication of their position. Alarms can be added to notify the operator of high or low voltages, liquid levels, temperatures, pressures, flows, etc.

Circle No. 56 on Reader Service Card

ANNOUNCING ANOTHER NEW AMPEX

but this time it's a superb amplifier-speaker

It's a 25 pound portable amplifier-speaker that matches the Ampex 600 tape recorder in appearance **and in quality, too!** The new Ampex 620 has FLAT ACOUSTIC RESPONSE from 65 to 10,000 cycles. This would be a great achievement in a speaker of any size, but in a 25-pound portable it's truly exceptional — in the Ampex tradition.

A quality demonstrator to sell broadcast time Program samples or auditions can now be demonstrated with a new impact and clarity that will make prospective time buyers sit up and take notice. The Ampex 620 can be carried anywhere. It has ample power for a group hearing in office, conference room or small auditorium.

A speaker to monitor with greater sensitivity The Ampex 620 is an extra sensitive monitoring unit usable anywhere inside the studio and outside with portable recorders as well. It will give operating personnel a much better indication of recording and broadcast quality than the usual monitor speaker. This can help forstall criticism from the growing percentage of your audience who listen through high quality amplifiers and speakers.

AMPEX 620 PORTABLE AMPLIFIER-SPEAKER
Connects with your studio console — or reproduces directly from tape recorders, turntables or pre-amplified microphones. The Ampex 620 is a perfectly integrated design including a 10-watt amplifier, loudspeaker, reciprocal network, level control, equalization control and acoustically correct enclosure. By standard test procedures **in air** it has low distortion and an acoustic response curve that is essentially flat from 65 to 10,000 cycles. Price is $149.50 complete.

AMPEX 600 PORTABLE TAPE RECORDER
Like the great Ampex studio tape recorders the 600 is the best of its kind. It weighs only 28 pounds, yet the Ampex 600 can serve every broadcast station need. For auditions and demonstrations it is the perfect sound source for the Ampex 620 amplifier-speaker. Prices: $498 unmounted, $545 in portable case.

For full description and specifications write Dept T-1977

Signature of Perfection in Sound

Distributors in principal cities (see classified section of your telephone directory under "Recording Equipment.")
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AMPEX CORPORATION

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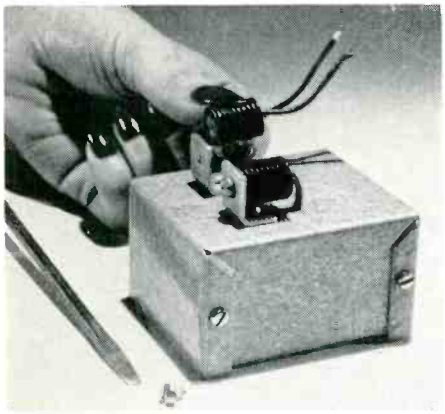
For more information, circle No. 8 on Reader Service Card

NEWS BRIEFS

ONE-WATT POWER TRANSISTOR

Now in pilot production at the Electronic Tube Division of *Westinghouse Electric Corporation*, Elmira, N. Y., is a germanium power transistor having



a one-watt rating made possible by a combination of mounting and physical design. The black ribbed surface provides cooling capacity for the one-watt collector dissipation rating, and additional cooling is accomplished by fastening the unit in thermal contact with a chassis, as shown in the photograph. This new *p-n-p* transistor (2N71) will be applicable to any low frequency circuit where output power is desired.

Circle No. 57 on Reader Service Card

MICROWAVE TV LINK DONATED

A KTR-100 microwave relay television link has been donated by the *Raytheon Manufacturing Company*, Waltham, Mass., to Station WGBH-TV,

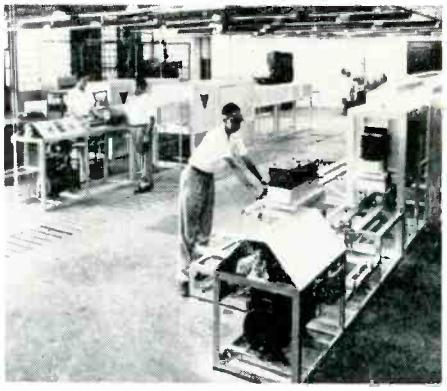
a new educational TV station. It will operate between the WGBH-TV studios in Cambridge and the transmitter on Great Blue Hill, some 10 miles away.

Sight and sound will be simultaneously transmitted and received at each end of the 10-mile path by a four-foot "dish" or aluminum reflector. The transmission from studio to transmitter cannot be interrupted by hurricanes or ice storms. After a program has been received by the "dish" on Great Blue Hill, it will then be sent out through the WGBH-TV transmitter.

Circle No. 58 on Reader Service Card

SECTIONALIZED TUNNEL KILNS

Factory-built electric tunnel kilns designed for easy sectional assembly on the job are being produced by *Pereny*



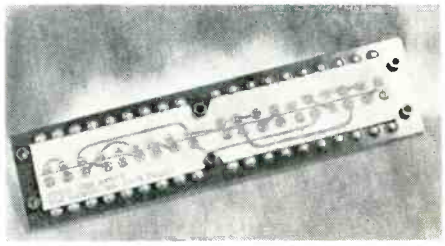
Equipment Company, 893 Chambers Road, Columbus 12, Ohio. Available in two models, TPH-31430 and TCH-81054, and suited to a wide variety of uses, these kilns have an operating temperature of 2500 to 2600°F, and an average time cycle of 10 hours.

The photograph shows an installation at the Indianapolis, Ind., plant of the *P. R. Mallory Company* which uses *Pereny* tunnel kilns in the manufacture of components for the electronic industry. While both sectionalized models are offered in a range of sizes and modifications to meet specific production requirements, the TPH-31430 unit in the photograph (at the left) is 3′ 2″ wide x 5′ ¾″ high x 33′ 2″ long, including the hydraulic pusher assembly. The complete unit consists of a pusher section, preheat zone, high-temperature zone, and two-section cooling zone.

Circle No. 59 on Reader Service Card

TIME-SAVING WIRING TECHNIQUE

Wiring jumper wires to resistor boards at *Martin Aircraft*, Baltimore 3, Md., is a simple matter. Until assembly line workers become so familiar with a particular new assembly procedure that reference data is no longer needed, a small removable paper template containing information ordinarily found only on a blueprint is taped to each resistor board. The templates are so placed



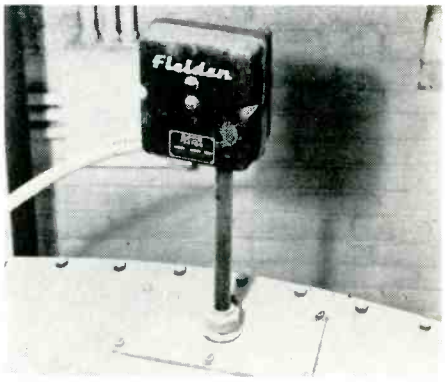
as to enable workers to hook up the various components merely by placing them directly over indicated locations.

This time-saving manufacturing technique was first introduced on the USAF B-61 Matador production line at *Martin Aircraft*. According to factory supervisors, a total of some 1500 man-hours of work was saved before the templates were discarded.

Circle No. 60 on Reader Service Card

CONTROLLING FLOUR LEVEL

At *Awrey Bakeries, Inc.*, Detroit, Mich., a new electronic instrument is being used to control the level of flour in a large holding tank. Called a Tektor, the device is actuated electronically by means of a simple plastic-covered or



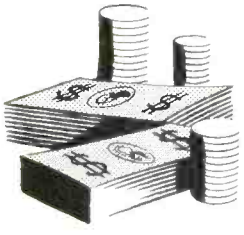
metal sensing probe extended into the tank. When the air surrounding the sensing probe is displaced by the flour, a signal is given at the instrument and level control is accomplished.

Flour flows from a sifting machine into dough mixing equipment, and must be maintained in the holding tank until removed in 200-lb batches for mixing into processed dough. The Tektor, which controls levels with an accuracy of ±1%, maintains an adequate supply of sifted flour in the holding tank and also prevents overfilling. It is a product of *Fielden Instrument Division, Robertshaw-Fulton Controls Company*, 2920 N. Fourth St., Philadelphia 33, Pa.

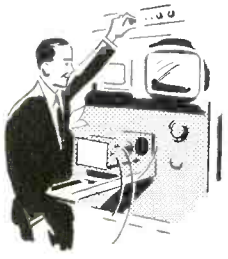
Circle No. 61 on Reader Service Card

What means most to an Engineer?

PROFESSIONAL RECOGNITION



GOOD SALARY



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Individual accomplishments readily recognized. Ample opportunity for increased income and professional advancement.

Join the team at RCA and grow with the world leader in electronics.

Personal interviews arranged in your city.

Please send a complete resume of your education and experience to:

MR. JOHN R. WELD

Employment Manager, Dept. 304L
Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

SYSTEMS—ANALYSIS—DEVELOPMENT—DESIGN—APPLICATION ENGINEERING

in the following fields:

AVIATION ELECTRONICS (FIRE CONTROL, PRECISION NAVIGATION, COMMUNICATIONS)—Radar—Analog Computers—Digital Computers—Servo-Mechanisms—Shock & Vibration—Circuitry—Heat Transfer—Remote Controls—Sub-Miniaturization—Automatic Flight—Transistorization—Automation

RADAR—Circuitry—Antenna Design—Servo Systems—Information Display Systems—Gear Trains — Stable Elements — Intricate Mechanisms

COMPUTERS—Digital and Analog—Systems Planning—Storage Technique—Circuitry—Servo-Mechanisms—Assembly Design—High Speed Intricate Mechanisms

COMMUNICATIONS — Microwave — Aviation — Mobile—Specialized Military Systems

MISSILE GUIDANCE—Systems Planning and Design—Radar and Fire Control—Servo-Mechanisms—Vibration and Shock Problems—Telemetering

COMPONENT PARTS (COLOR & MONOCHROME TV)—HV Transformers—Coils—Deflection Yokes

SEMI-CONDUCTORS—Transistors—Diodes

ELECTRON TUBE DEVELOPMENT — Receiving — Transmitting—Cathode-Ray—Phototubes and Magnetrons—Power Tubes—Camera Tubes

ELECTRONIC EQUIPMENT FIELD ENGINEERS — Specialists for domestic and overseas assignment on military electronic Communications, Navigational Aids, and Guided Missiles.

RADIO CORPORATION of AMERICA

For more information, circle No. 9 on Reader Service Card

NEW LITERATURE

CONTROL COUNTERS

Detailed descriptions of equipment and techniques for controlling industrial equipment by means of predetermined electronic counters are given in a 20-page booklet available from *Potter Instrument Company*, 115 Cutter Mill Road, Great Neck, N. Y. Equipment covered includes counters capable of being preset to apply control after any desired number of counts from one to a million, and a complete line of count detectors for converting physical increments into electrical impulses for counting. Over a dozen typical applications are explained and illustrated diagrammatically.

Circle No. 62 on Reader Service Card

MINIATURE CONNECTORS

Bulletin SR-KM1, available from *Cannon Electric Company*, 3209 Humboldt St., Los Angeles 31, Calif., presents the *Cannon* "K Miniature" series of connectors designed for the particular demands of the computer field. Complete test data is given, along with illustrations of the various units and dimensional drawings.

Circle No. 63 on Reader Service Card

TUNGSTEN BROCHURE

The manufacture, properties, and uses of tungsten are discussed in a 20-page brochure published by *Sylvania Electric Products Inc.*, 1740 Broadway, New York 19, N. Y. A colorful flow chart shows how *Sylvania* tungsten is quality-controlled from ore to finished products.

Circle No. 64 on Reader Service Card

GLASS-CASED CAPACITORS

Hermetically sealed high-voltage glass-encased GC-type paper dielectric d.c. capacitors are listed together with capacitance values and voltages in Bulletin GC-1, available from the *Gudeman Company*, 340 W. Huron St., Chicago 10, Ill. Operating temperature of the units ranges from $-55°C$ to $+105°C$. Data includes explanation of catalog numbers, general information, and complete engineering specifications.

Circle No. 65 on Reader Service Card

TOROID COILS

Hycor toroid coils are available in three forms: uncased, cased and Type "P" plastic-encapsulated coils. Complete technical data, including general characteristics, specification charts and standard case styles, is contained in Bulletin STP which may be obtained from K. T. Eckardt, Sales Manager, *Hycor Company, Inc.*, 11423 Vanowen St., N. Hollywood, Calif.

Circle No. 66 on Reader Service Card

POWDER CORES

Magnetics, Inc., Butler, Pa., has released a two-page bulletin on its line of performance-guaranteed molybdenum permalloy powder cores. Bulletin PC-103 lists standard sizes of cores, electrical specifications and tolerances, and types of core finishes.

Circle No. 67 on Reader Service Card

"TURBO" PRODUCTS CATALOG

A 1954 "TURBO" products catalog has been announced by *The William Brand and Company, Inc.*, Willimantic, Conn., that combines easy-to-use features with helpful information on wire

(*Continued on page* 36)

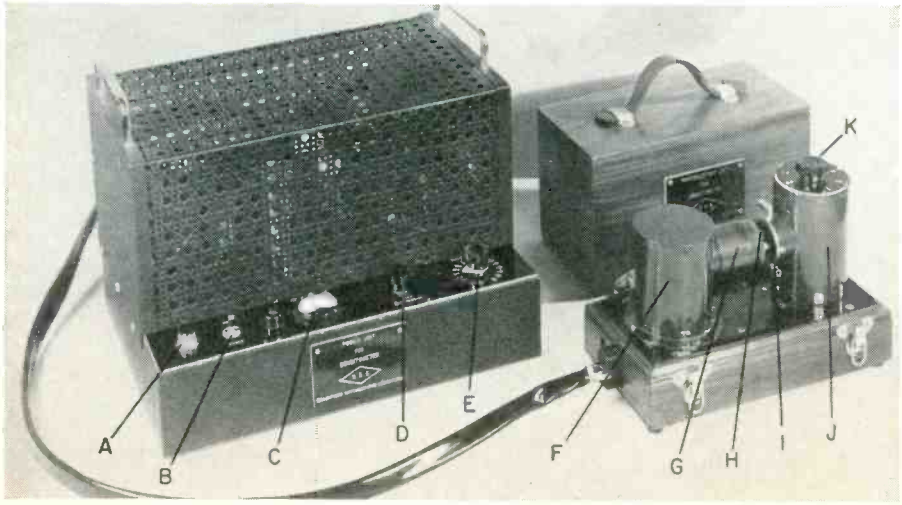
IMPROVED CUVETTE DENSITOMETER

IN medical practice and research, the cuvette densitometer is used to make a continuous record of the rate of dye dilution in the heart chambers by observing the blood flow from a peripheral artery. An improved densitometer recently developed by S. R. Gilford of the National Bureau of Standards, as part of a program on medical instrumentation carried out at the Bureau in cooperation with the Army Medical Service Graduate School, possesses several advantages over previous instruments: greater stability and sensitivity, smaller size, and greater convenience of application.

An organic dye is introduced into the heart through a vein, and the diluted material that issues from the heart is sampled at a peripheral artery. The change in the concentration of the dye with time is measured by diverting the blood through the transparent cuvette in the optical assembly. The variations in the opacity of the blood can then be measured and recorded with suitable electronic equipment. From this record, calculations can be made to determine the amount of blood pumped by the heart during each stroke.

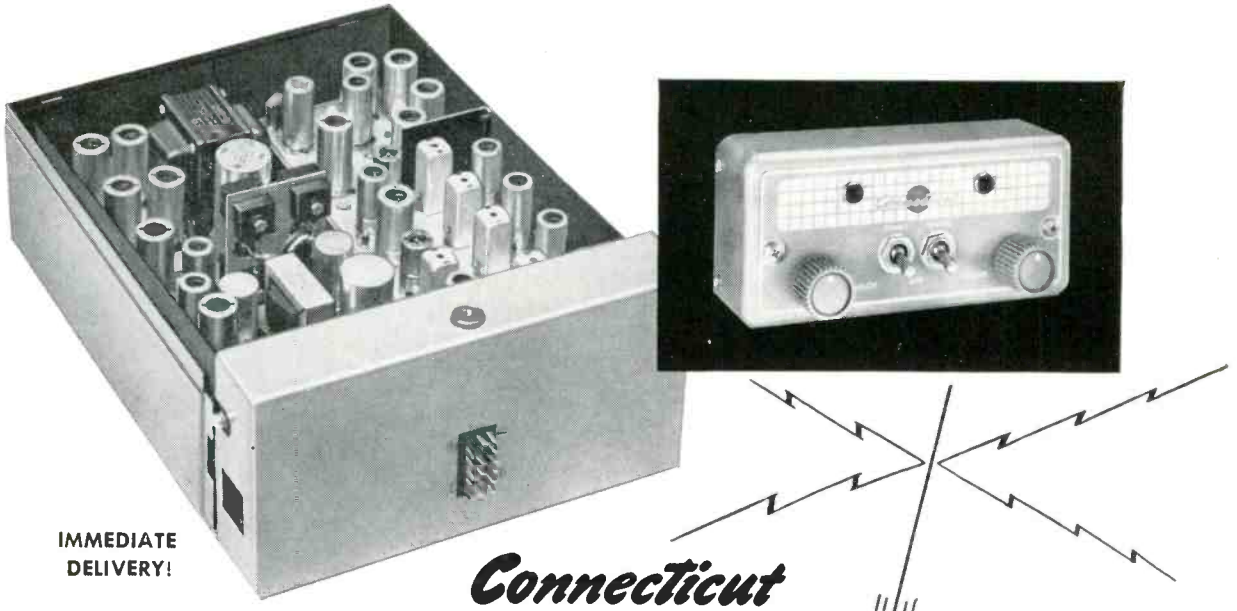
The optical system includes an incandescent lamp with filters to provide monochromatic light for illumination of the cuvette, and a photomultiplier tube to intercept the transmitted light. Cell fatigue effects are overcome by a feedback system in which the dynode potentials of the phototube are automatically decreased as the light level is increased. With the logarithmic function that is incorporated into the instrument, the scale factor does not require readjustment for successive dye injections after the initial determination has been made.

Over-all view of the NBS cuvette densitometer. See text for explanation of symbols.



Components of the NBS cuvette densitometer are divided into two units: the optical assembly and the electronic circuitry. The electronic unit contains: (A) pilot light, (B) power switch, (C) indicating galvanometer, (D) zero suppression control, and (E) scale-factor switch. The optical system contains: (F) lamp housing, (G) light-tight sliding tube, (H) cuvette housing, (I) cuvette, (J) phototube housing, and (K) neutral-density filter selector. For further technical details, see: Gilford, "An Improved Cuvette Densitometer," R.S.I., Vol. 24, p. 696, August, 1953.

New circuit development obsoletes conventional UHF 2-Way Radio design



IMMEDIATE DELIVERY!

Connecticut FLEETWAY

FIRST FM 2-WAY RADIO

HIGHER OVERTONE • The patented Lister circuit uses a starting frequency of 75 Mc instead of the usual 6 Mc. Low 6-time frequency multiplication required to reach 450 Mc contrasts with 24-times or more in other types of equipment.

GREATER STABILITY • Direct circuitry and fewer components permit better control of signal output, greatly minimize drift and spurious radiation. Result is greater stability requiring minimum maintenance, producing clearest signal ever attained in mobile radio.

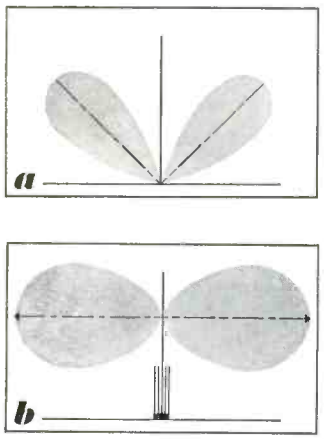
'FM' CLARITY MINUS NOISE • True frequency modulation — for the first time in mobile radio — produces noise-free, natural tone quality, and eliminates distortion so common in conventional equipment. *This is true FM, not commonly used phase modulation (PM).*

LOWER OPERATING COST • Simplified FLEETWAY circuitry requires fewer tubes and parts — uses standard, lower cost crystals and tubes, needs less servicing.

NEW 450-470 Mc BAND OPENS 2-WAY RADIO TO EVERY CITIZEN AND COMPANY • Even if you have not been able to obtain a license for 2-way radio for yourself or your business, the chances are you can now get an immediate assignment in the recently opened 450-460 commercial fleet band or in the 460-470 citizens' band. These new bands offer easy licensing requirements for anyone who does not qualify in one of the older channels. You can now enjoy the advantages of FLEETWAY mobile radio for business or private use.

See your **local FLEETWAY dealer or write for "Technical Comparison" booklet containing parts and performance comparison of leading mobile radio equipment.**

UNIQUE CONN-TENNA DESIGN BEAMS STRONG HORIZONTAL SIGNAL



More evidence of FLEETWAY's radical design is found in its new Conn-tenna. Sketch *A* shows how conventional monopole antenna dissipates much of its signal at 45° upward angle. Sketch *B* shows how multipole *Conn-tenna* concentrates radiation along a horizontal plane, transmitting a stronger signal with lower power requirement.

Connecticut

CONNECTICUT TELEPHONE & ELECTRIC CORP. 108 BRITANNIA ST. MERIDEN, CONN.

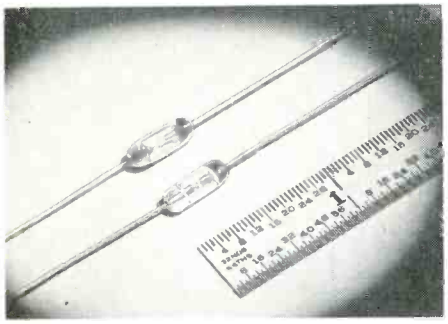
For more information, circle No. 10 on Reader Service Card

NEW TUBES

GERMANIUM DIODES

Three "all glass envelope" types have been added to the *Amperex* line of germanium diodes. Designed to meet the needs of users who are interested primarily in reliability of performance and stability, they feature unusual resistance to humidity and other environmental conditions.

Type 1N87G is a high quality video detector which offers high rectification



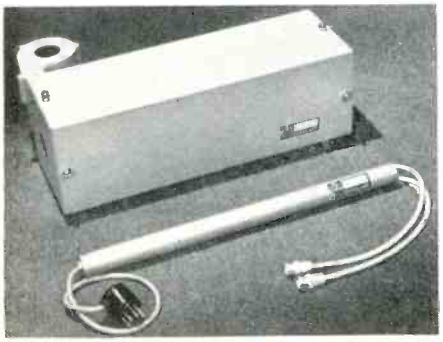
efficiency coupled with low loading on resonant circuits, while the OA71 is a high back-resistance type designed for computer and general-purpose applications. Type OA73 is also a video detector having advantages similar to the 1N87G, and is intended for higher level i.f. signals where its greater back resistance eliminates peak sync clipping.

Complete data is available from the Engineering Dept., *Amperex Electronic Corporation*, 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle No. 68 on Reader Service Card

TRAVELING WAVE AMPLIFIER

Huggins Laboratories, Inc., 711 Hamilton Ave., Menlo Park, Calif., has developed a traveling wave amplifier tube which will deliver 1-watt output with



1-mw. input from 2 to 4 kmc., without resorting to any electrical or mechanical tuning procedure. It has a gain of 30 db and a noise figure of 25 db.

This tube is expected to find its greatest application where wide bandwidth and medium power are required. It may be used as a power amplifier to raise the output of milliwatt signal generators in microwave measurement techniques, and as a driver amplifier in system applications.

Circle No. 69 on Reader Service Card

TRAVELING-WAVE TUBES

In a paper delivered at the National Electronics Conference, Paul R. Wakefield of the Tube Division of *Radio Corporation of America*, Harrison, N. J., disclosed the development of two unique types of *RCA* low-noise traveling-wave tubes which promise greater efficiency, range and sensitivity in microwave radio applications. Still developmental, but available to industry on a sampling basis, the new *RCA* tubes consist of an *S*-band type for the input stage of microwave receivers and amplifiers operating from 2700 to 3500 mc. and a *C*-band type for relay applications covering a 5900 to 6900 mc. range.

Both types have the lowest noise level of any comparable tubes developed for such applications, resulting from the utilization of a novel three-region velocity-jump electron gun which "deamplifies" shot noises in the tubes. The *S*-band tube will operate in a solenoid with a noise figure of less than 10 db for a gain of 20 db, while the *C*-band type—which utilizes a wave guide feed —has a noise figure of only 12 db, with a 20-db gain.

Circle No. 70 on Reader Service Card

CATHODE-RAY TUBE

Up to six independent or related phenomena may be displayed simultaneously on the 7"-diameter face of the cathode-ray tube developed by the *Electronic Tube Corporation*. The 76-RAP was designed for multichannel oscilloscopes which are required to display accurately or record a number of transient, random, or high frequency signals.

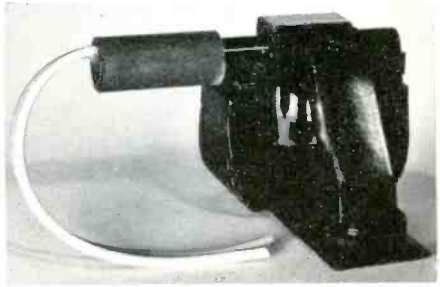
Electrostatic focus and deflection, with adequate shielding against crosstalk, are used for all six electron guns. Each of the guns scans all of the useful screen area and can be controlled independently. When the tube is operated at accelerating voltages of 2 and 4 kv., sensitivity of both the horizontal and vertical deflection plates is almost equal in each direction.

Full details are given in a technical data bulletin entitled "76RAP Cathode Ray Tube," which is available from *Electronic Tube Corporation*, 1200 E. Mermaid Lane, Philadelphia 18, Pa.

Circle No. 71 on Reader Service Card

MAGNETRON

Primarily for use in airborne radar gunsights, the Type GL-6527 is a 3-cm. pulse magnetron designed for reliable



operation without pressurization up to 60,000 feet. The tube's ability to operate at high altitudes without pressurization means a weight saving which may be applied to the plane's armament or fuel load.

Announced by the Tube Department of the *General Electric Company*, Schenectady, N. Y., the magnetron is a forced-air-cooled, fixed-frequency, pulsed-type oscillator, with 9-kw. peak power output. It operates at frequencies between 9345 and 9405 mc. Weighing three pounds, it is electrically and mechanically interchangeable with the type 2J42 magnetron.

Circle No. 72 on Reader Service Card

HYDROGEN THYRATRONS

A series of 13 hydrogen thyratron tubes of improved design has been announced by *Kuthe Laboratories, Inc.*,

Newark, N. J. Suitable for a wide variety of applications in industrial and military equipment, they range from the Type 1528, a miniature tube rated at a peak output of 10 kw. at an average power level of 25 watts, to the Type 1257, rated at 38,000 kw. peak, 45 kw. average. The life of the larger tubes is extended by the use of internal hydrogen reservoirs.

Circle No. 73 on Reader Service Card

NEW PRODUCTS

X-BAND HYBRID JUNCTION

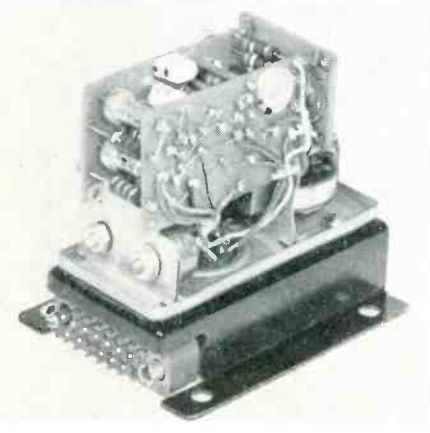
A hybrid junction for the *X*-band, operating from 8200 to 9700 mc., is being offered by *The Gabriel Laboratories*, 135 Cresent St., Needham Heights,

Mass. Top wall construction plus integral flanges makes this wave guide component small, compact, and easy to install. Input VSWR is less than 1.07, isolation is in excess of 35 db, and the coupling (power division) is 0.25 db. High precision casting of beryllium copper or aluminum to close tolerances assures excellent electrical performance and mechanical strength.

Circle No. 74 on Reader Service Card

FUEL MEASUREMENT SYSTEM

By receiving and sorting signals from two different tanks at the same time, the *Minneapolis-Honeywell* aircraft fuel



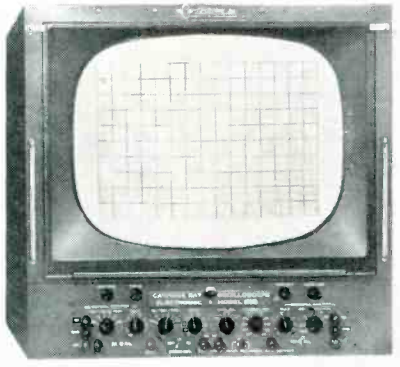
measurement system eliminates the need for a separate amplifier for every two indicators. Because a single amplifier power unit can serve several indicators, installation is simplified and both cost and weight are reduced.

Announced by the Aeronautical Division of *Minneapolis-Honeywell Regulator Company*, Minneapolis, Minn., the new system is known as a "multiplex fuel gage." For a three-unit installation using a separate tank sensing element, power amplifier and cockpit indicator, the power unit can be provided with either vacuum tubes or transistors. A transistorized power unit is shown in the photograph. Also available is a two-unit system in which the transistorized power unit and cockpit indicator are combined.

Circle No. 75 on Reader Service Card

LARGE SCREEN OSCILLOSCOPES

Large screen precision oscilloscopes have been developed by *Electromec, Inc.*, which provide more information in a



more readable form. Designed for data plotting, production testing, waveform analysis, education and display uses, these units are available in 21″ and 17″ rectangular tubes.

Features include high resolution, ±1% linearity, stable d.c. amplifiers, calibrated time base (from 10 μsec./in. to 1 sec./in.), gain controls calibrated in peak-to-peak volts/in. (10 mv. or 1 mv. peak-to-peak sensitivity), a low rate of drift, and excellent long-term stability. Performance is not affected by line voltage changes from 105 to 125 volts.

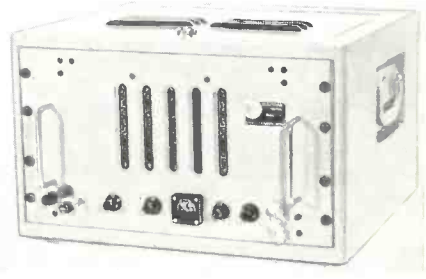
Further information on these oscilloscopes may be secured from *Electromec, Inc.*, Oscilloscope Department, 3200 North San Fernando Blvd., Burbank, Calif.

Circle No. 76 on Reader Service Card

ELECTRONIC COUNTER

Ruggedized for military field use, the *EECO* Model 111 electronic counter will operate in ambient temperatures from −20°F (−29°C) to 150°F (65°C). The circuits, mechanical construction, and components are designed for utmost reliability. Frequency division is all-digital, utilizing 11 special plug-in decade scalers.

Model 111 will count up to 99,999 at any rate up to 100,000 cps. The count-



ing interval is 1 second or 10 seconds, with an adjustable display time. No frequency adjustments are required because the counting interval is generated by digital division from a crystal oscillator, forestalling the possibility of miscounts.

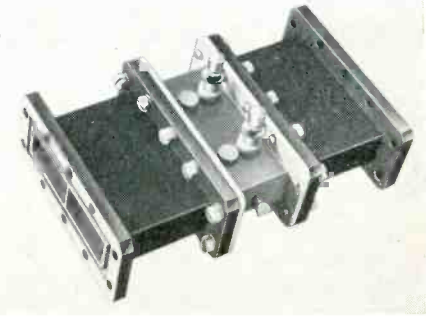
Complete information is available from R. B. Bonney, Chief Engineer, *Electronic Engineering Company of California*, 180 South Alvarado St., Los Angeles 57, Calif.

Circle No. 77 on Reader Service Card

BALANCED DUPLEXER

Broadband, high power operation with exceptionally low insertion loss is provided by the new *Airtron* balanced duplexer in the 1.250 x .625 O.D. wave guide size. It has the following characteristics for modern broadband radar applications: frequency range—8500 to 9600 mc.; power capacity—250 kw. (peak); high level VSWR—1.15 (transmit); low level VSWR—1.20 (receive); insertion loss—less than 0.6 db (function at *TR* tube).

The duplexer is composed of two *Airtron* precision-cast short-slot hybrids coupled to a dual *TR* tube. Rectangular r.f. and pressure gaskets are employed to insure intimate metal-to-metal con-



tact between the *TR* tube and the hybrid flanges, as well as to insure airtightness under pressurized conditions. Additional information is available without ob-

ligation from *Airtron, Inc.*, Dept. A, 1103 W. Elizabeth Ave., Linden, N. J.

Circle No. 78 on Reader Service Card

MICROSECOND MARKER GENERATOR

Now in production at *Middle Atlantic Development Associates, Inc.*, Binghamton, N. Y., is a crystal-controlled microsecond marker generator which provides an accurate standard for calibrating the sweep speed and sweep linearity of oscilloscope time bases. It is applicable wherever accurate time measurement is required, as in ranging instruments, ultrasonic delay lines, etc., and is especially useful in modernizing older oscilloscopes.

In operation, pulses of one-third microsecond width are emitted at time intervals of 1 μsec., accurate to one part

in ten thousand. Pulse amplitude is a minimum of 10 volts peak-to-ground; every tenth pulse is of double amplitude, 20 volts peak-to-ground minimum. All pulses are available simultaneously in a negative and in a positive sense.

Circle No. 79 on Reader Service Card

MICROWAVE "MEGA-NODES"

A new line of microwave random noise sources has been announced by *Kay Electric Company*, Pine Brook, N. J. In addition to its microwave MEGA-NODES which employ fluorescent tubes for radiating substantially monochromatic light, this company now offers MEGA-NODES utilizing gas tubes which have approximately zero temperature coefficient and are independent of operating temperatures. They are available in eight different sizes covering frequency ranges from 1200 to 26,500 mc. Accuracy is ±0.25 db, and noise output 15.8 db.

Circle No. 80 on Reader Service Card

FREQUENCY METER

Frequencies from 2400 to 10,200 mc. can be measured to 0.2% accuracy with the NARDA Model 802 frequency meter announced by *Nassau Research & Development Associates, Inc.*, 66 Main St., Mineola, N. Y. A transmission

(*Continued on page* 34)

Circle No. 14 on Reader Service Card

Personals

RICHARD H. BAKER, who has been carrying on independent research and acting as consultant on computing and control system design and application for equipment manufacturers and the Department of Defense, has now joined the staff of Stanford Research Institute, Stanford, Calif., as a systems engineer. He will work in the recently expanded electronic data processing unit—a section of SRI's division of industrial economics research.

RALPH R. BATCHER, as technical consultant for the *Hudson Wire Company*, Ossining, N. Y., will assist in the development of new types of magnet wire and associated products. Until recently chief engineer of the Radio-Electronics-Television Manufacturers Association, Mr. Batcher has been associated with the radio industry for many years, as well as with educational and publishing fields. He is the author of several handbooks on electronic subjects.

THOMAS B. FRIEDMAN, television engineer and consultant, has joined the *Adler Communications Laboratories* of New Rochelle, N. Y., where he will assist in the development and application of satellite television stations and television station systems. As chief television engineer with the *Empire Coil Company*, Mr. Friedman was instrumental in the planning and construction of WXEL in Cleveland, KPTV in Portland, and KCTY in Kansas City.

DR. LESLIE G. PECK will be in charge of the Computing Laboratory at *Arthur D. Little, Inc.*, Cambridge, Mass. Having a wide range of experience in the computing field, Dr. Peck has taught mathematics at Johns Hopkins University, and was responsible for much of the success of the computing program at Los Alamos Scientific Laboratory. Prior to joining *ADL*, he was a research associate at New York University, site of the AEC computing facility.

DR. RAGNAR THORENSEN has been appointed director of research for the *Magnavox Research Laboratory*, in Los Angeles, Calif., newly established by *The Magnavox Company* for research and development on high-speed digital computers, military control systems, and data processing equipment. With the National Bureau of Standards, Dr. Thorensen headed the computer section of the Institute for Numerical Analysis where the SWAC was developed.

CHARLES M. YOUNG is the new manager of engineering for the Industrial and Transmitting Tube Sub-Department of the *General Electric Company*, Schenectady, N. Y. Mr. Young, who joined *G-E* in 1937, spent 13 years on the *G-E* Aeronautics and Ordnance Systems Division engineering staff. He has had wide experience in electronic application engineering in this field, and holds five patents on automatic flight control equipment.

Subway Communications

(*Continued from page* 13)

in all four services, should be operable on any of four frequencies. Before the train starts on its runs, the frequency selectors could be set for the appropriate service.

Dispatcher-to-motorman communications which should not be heard by the passengers and passenger information announcement facilities could be integrated into the same system. A tone-gate squelch, for example, could be used to differentiate between dispatcher-to-train communications and public announcements. The tone might be used to switch on automatically the battery of loudspeakers inside and outside of the car preceding train announcements. Absence of the tone would permit operation of only the motorman's loudspeaker.

Many combinations would be possible. Special devices could be used to select certain categories of trains, wayside stations, etc. Since the communications range inside of tunnels is limited even at 460 mc., many functions could be provided more readily than if the range were several miles.

Conclusion:

Eight radio frequencies in the 450-460 mc. band have been allocated to the urban transit radio services. The band between 460 and 470 mc., allocated to the Citizens Radio Services, might be utilized. Whether the FCC would permit use by a single rapid transit system of four or all eight channels in the 450-460 mc. band assigned to the urban transit services in any one metropolitan area has not been determined. If the system were operated underground, it might be possible for a surface transportation company to operate on the same frequencies without mutual interference.

It is expected that u.h.f. radio communications in underground railway service will be tested in the near future. There are many systems problems to be solved but it appears that u.h.f. radio can be utilized to provide practical means for communications inside of subterranean tunnels.

The writer wishes to acknowledge the assistance and cooperation of Clayton R. Kielich of *Bogue Railway Equipment Division* in arriving at some of the conclusions stated here; and to express appreciation for the interest displayed by Henry K. Norton, president of the *Susquehanna Railroad* and a member of the New York City Transit Authority, William Reid, president of the *Hudson & Manhattan Railroad*, and John Swarner, electrical engineer of the *Pullman-Standard Car Manufacturing Company*.

TECHNICAL BOOKS

"ELECTROACOUSTICS—The Analysis of Transduction, and Its Historical Background" by Frederick V. Hunt, Rumford Professor of Physics and Gordon McKay Professor of Applied Physics, Harvard University. Published by *Harvard University Press* and *John Wiley & Sons, Inc.*, 440 Fourth Ave., New York 16, N. Y. 260 pages. $6.00.

One of the Harvard Monographs in Applied Science, this book presents a unified basis for the analysis of electroacoustical transducers. A modified formulation of the electromagnetic relations, involving the use of a "space operator," allows all transducer types to be represented by the same form of equivalent circuit.

A long introduction is devoted to the placement of electroacoustical transduction in its proper historical setting relative to the allied arts and basic sciences from which it derives. This is followed by a description of the new scheme for the analysis of both electrostatic and electromagnetic systems of electromechanical coupling in a single homogeneous frame of reference, and succeeding chapters contain examples of its application to three representative transducer systems.

"TELEVISION ENGINEERING Principles and Practice—Volume I" by S. W. Amos, B.SC. (Hons.), A.M.I.E.E., and D. C. Birkinshaw, M.B.E., M.A., M.I.E.E., in collaboration with J. L. Bliss, A.M.I.E.E. Published for "Wireless World" by *Iliffe & Sons Limited*, Dorset House, Stamford St., London S.E.1, England. 302 pages. 30s.Od. (postage 8d.)

This is the first volume of a textbook on television engineering written by members of the Engineering Training Department of the *British Broadcasting Corporation*, primarily for the instruction of *BBC's* own operating and maintenance staff. It is intended to provide a comprehensive survey of modern television principles and practice for both transmitting and receiving.

In this volume, the video waveform derived from synchronizing and picture signals is discussed in detail; various camera tubes and lenses are described; and in the final chapters attention is given to electron optics, involving a study of electric and magnetic lenses. Mathematical argument has been presented in several appendices for particular subjects.

Circle No. 16 on Reader Service Card

New Products

(*Continued from page* 31)

indication is obtained on a built-in sensitive 50-μa. meter, and a reactive indication is obtained by means of an external tee section.

The resonant elements consist of two high Q coaxial cavities tuned by a precision micrometer head. A vernier-type crank knob allows rapid tuning as well as precise setting of frequency, and broadband noncontacting shorts are used to eliminate all sliding contacts. The cavities are plated with silver and rhodium, insuring a high conductivity surface that will not tarnish or corrode.

Circle No. 81 *on Reader Service Card*

CALORIMETRIC WATTMETER

Power measurements of better than 5% accuracy from 10 mw. to 10 watts can be made with the calorimetric wattmeter announced by *Alto Scientific Company*. Designated as the Model L-20, it provides for the first time a compact, portable instrument offering fast, accurate and simplified power measurements over the whole frequency range from d.c. to 10 kmc.

Model L-20 employs the basic calorimetric principle, yet is completely self-contained. Input VSWR is less than 1.1, full range, and response time less than 1 minute at 10 mw. or 5 seconds at 10 watts.

Operating and application details are available from *Alto Scientific Company*, 3404 Cowper St., Palo Alto, Calif.

Circle No. 82 *on Reader Service Card*

MICROWAVE MIXER

The Electronics Division of *Sylvania Electronic Products Inc.*, 2936 East 46th St., Los Angeles, Calif., has announced the "Addleman" mixer—the first super-high-frequency mixer to be developed covering the 1000 to 10,000 mc. range. Displacing several narrow-band mixers, it will make possible broadband coverage without intricate switching.

Named for its inventor, Lloyd A. Addleman, *Sylvania* scientist, the mixer has a flat response from 1000 to 10,000 mc. Input and output coaxial connectors are of the RG-58/U type. Sensitivity is 88 db minimum in a specified test circuit, and dimensions are approximately 1" x 1" x 3".

Circle No. 83 *on Reader Service Card*

VARIABLE SCALE COUNTER

Built around a new beam switching tube, the *Burroughs* high-speed variable scale counter is basically a decimal counter but also has a self-contained electronic reset circuit that can be set to count by any number from 2 to 10. In straight decimal counting, it will handle pulse inputs up to 500 kc. Announced by the Electronic Instruments Division of *Burroughs Corporation*, 511 N. Broad St., Philadelphia 3, Pa., the new unit uses the multiple outputs of the beam switching tube to perform a wide range of counting, control and sequencing operations.

A separate pulse control panel, a sequence gater developed for use with the counter, converts its ten d.c. outputs to a form suitable for direct gating of other pulse control equipment. In combination with the sequence gater, the variable scale counter permits rapid assembly of complex pulse distribution networks and pulse sequencing systems with a minimum of pulse equipment.

Circle No. 84 *on Reader Service Card*

Chromacoder

(*Continued from page* 9)

noise in the blacks, and stable operating characteristics.

Signals emanating from the CPS Emitrons go through low noise, high gain preamplifiers of feedback design to individual channel amplifiers. The channel amplifiers provide separate control of gain, setup, gamma, and clipping.

Emitrons are supplied with a composite blanking signal applied to the cathodes to extinguish the beam during retrace. This signal is formed from H and V drive pulses in the CPS Emitron blanking generator. The widths of both components of the signal are independently variable. Focus and deflection yokes specially designed to work with the Emitron are used in the chromacoder. As with the CRT sweep circuits, special consideration has been given to the circuitry of the Emitron sweep generator, linearity and stability being the prime design factors. In the chromacoder system of color television, the problem of registration appears only once, here in the rack-mounted converter, and an all-out effort has been made to simplify and stabilize the problem.

Related Equipment

The encoder receives the separate red, blue, and green signals from the channel amplifiers, and from these forms the Y, I, and Q signals specified by the NTSC/FCC standards. Y is the luminance or brightness component of the color signal, the one that is viewed on a monochrome receiver. I and Q are the "in phase" and "quadrature" signals respectively, which modulate the 3.58-mc. subcarrier in both amplitude and phase. The modulated subcarrier supplies the "chrominance" or color information. In order to detect the phase modulation of the subcarrier, a reference phase must be transmitted, and this is supplied by the "color burst" applied to the "back

porch" of the composite signal by the encoder. The encoder has been carefully designed to be stable and easy to set up, with self-contained phase checking circuits.

A monochrome calibration monitor, combined with a unique switching unit, permits the observation of picture and waveform in any of the following combinations, without adjustment, at the touch of a button: R, B, G, RB, RG, BG, RBG, G-R, G-B, NTSC video, and sequential video (waveform only). Its prime function is in setting up the CRT's and CPS Emitrons for registration, linearity, level, etc.

Any existing sync generator may be used for NTSC color, but it must be locked to the color subcarrier of 3.579545 mc. rather than its own crystal or the power line. Sync generator adapters are available which provide the subcarrier frequency and a subdivided frequency of approximately 31.5 kc. to drive the existing sync generator.

For the sake of clarity, power supplies have been omitted from the block diagram. Seven regulated power supplies furnishing +285 volts at 900 ma. each are required. While most of the chassis have self-contained bias supplies, a regulated −150 volt supply is incorporated for the CRT and CPS Emitron controls. All filament transformers are supplied through an electronic 115-volt a.c. line regulator for greater operating stability. A separate, highly regulated, 12-volt d.c. source is added to provide yoke centering currents which are independent of other loads. A regulated high voltage supply of the r.f. type furnishes up to 30 kv. for the CRT's. All a.c. power required by the chromacoder, approximately 7-kva., 115-volt, 1- or 3-phase, is fed through circuit breakers for protection and ease of control.

The chromacoder, the encoder, and all the necessary related equipment, with the exception of the sync generators, are housed in seven standard racks. (See Fig. 5.) These may be located in the studio control room, or centrally in the station, remote from camera equipment.

When sequential color camera equipment is taken out on remote, only the color mixer suitcases and associated power supplies are added to the equipment required for a monochrome pickup. The extra equipment necessary to telecast parades, football games, etc., in color remains in the studio and is the same chromacoder used for studio origination. Figure 4 shows such an overall system from the remote cameras through a microwave link to the chromacoder and from studio cameras to the chromacoder. The studio sync generator is locked to the remote sync generator so that there will be no problems in switching from studio to remote or vice versa. Commercially available microwave equipment has been successfully modified to carry the wider bandwidth necessary with the sequential color signals.

Advantages

Some advantages of chromacoder colorcasting are as follows:

1. Because the cameras so closely resemble their monochrome counterparts and because the additional equipment necessary for color is housed in racks and not repeated for each camera chain, the initial investment required in a chromacoder system with two cameras is less than that for other presently used systems. As the number of cameras to be used increases, this advantage becomes even more apparent.
2. There are fewer expensive camera tubes used than in other systems, and for those which are used, cooling to give long life is no problem. Very satisfactory life has been obtained from the Emitrons in studio service in England, and longer life can be expected when they are used in rack equipment. With a two-camera system, the tube cost per hour is only 65% of that of other systems; and as the number of cameras is increased, the saving is even greater.
3. In preparation for a color show, it is necessary to set up only one piece of equipment where linearity, registration, and phase must be carefully adjusted, rather than having to go through all these steps for each camera to be used. As a result, the setup time is considerably reduced. The adjustments for strikingly beautiful color pictures are made on the sequential color camera chains where such adjustments are relatively simple. Only in the chromacoder must careful adjustments be made for color, and these are simplified because the equipment has more than ample control for all the variables encountered; the equipment has excellent stability once adjustments are made. Consistent results from camera to camera are obtained with very little effort.

There is no doubt that colorcasting requires more money, more space, and more effort than monochrome telecasting. The *General Electric* chromacoder colorcasting system, utilizing straightforward engineering design principles, allows the broadcaster to achieve the best color pictures while at the same time causing the least additional strain on his pocketbook and operating staff.

New Literature

(*Continued from page* 26)

and tubing, an appendix which defines technical terms, and tables of insulation resistance temperature coefficients and temperature conversion.

The product index consists of 44 pages of specific information concerning wires and cables, plastic tubing, coated tubing and sleeving, and identification markers. Complete ordering information is included to speed up customer service.

Circle No. 85 on Reader Service Card

TOWERS

Tower Structures, Incorporated, Lodi, N. J., has issued an eight-page two-color brochure on guyed and self-supporting towers for AM, FM, TV and microwave applications. Design and construction facilities are discussed, and fabrication techniques described. Also included are diagrams of typical antenna attachments and photographs of typical installations.

Circle No. 86 on Reader Service Card

"MINI-CATALOG"

Of pocket size, the *G-E* 40-page "Mini-catalog"—a condensed catalog on audio equipment—was designed to be used as a quick reference book by radio and television station engineers. Some 21 different items are illustrated, accompanied by specifications and prices.

Copies of the "Mini-catalog" may be obtained free on request from the *General Electric Company,* Broadcast Equipment, Electronics Park, Syracuse, N. Y.

Circle No. 87 on Reader Service Card

V.H.F. Receiver Design

(*Continued from page* 16)

With this method of frequency control, a change of ± 5 kc. can readily be realized at the b.f.o. frequency of 5 mc.

Mechanical Design

In the past, it has been found that the servicing of certain communication receivers can be akin to a nightmare. Consequently, a great deal of effort went into the mechanical design of the R5200 to preserve simplicity in servicing, such as realignment or repair. Designed for cabinet or rack mounting, its over-all dimensions are 19" wide, 8¾" high and 14" deep, not including a cabinet.

With the above philosophy in mind, it was decided to build the r.f. tuner as an integral unit which could readily be removed from the main chassis. The tuner includes the two stages of r.f. amplification, the first mixer, and the first local oscillator. The complete i.f. strip, with both FM and AM detectors, was also constructed as a single unit which can be readily removed from the main chassis. Not only are the r.f. and i.f. units removable from the main chassis but they may be operated in conjunction with each other or separately, once removed.

Broadband Power Meters

(*Continued from page* 11)

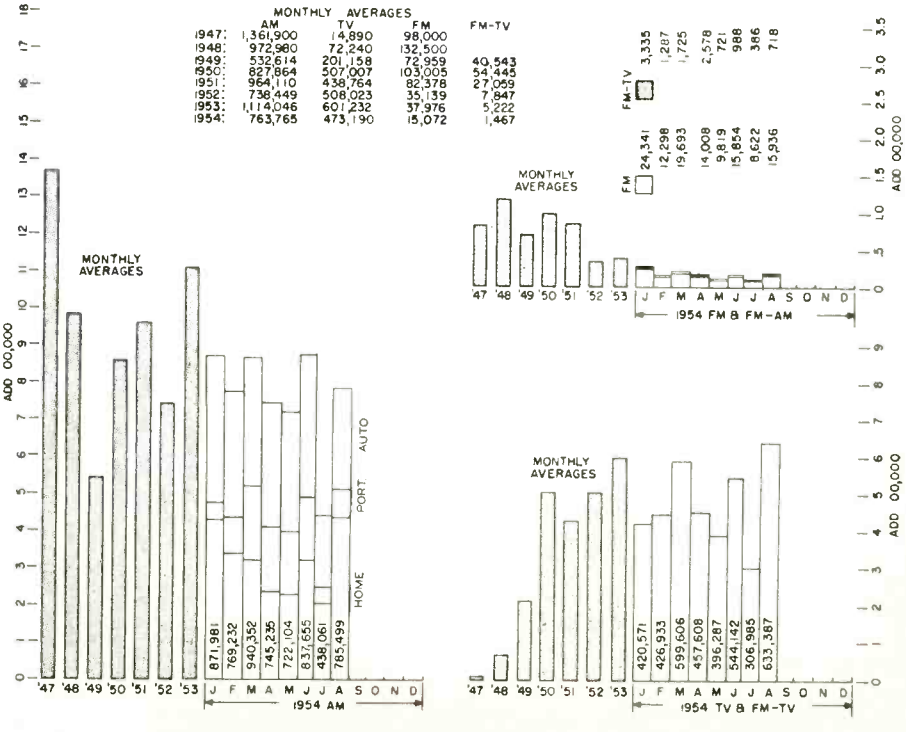
the rated frequency range. In addition, the attenuators are calibrated for attenuation drift due to either frequency or temperature, and this data may be supplied to the "compensate attenuator" portion of the bridge as described above to compensate automatically for these deviations.

For the range of 20 to 4000 mc., an adapter is also supplied to couple the ⅜" and ⅞" coaxial systems used. An r.f. cable, also calibrated for attenuation at three frequencies, is furnished with each model to couple to the r.f. power source.

The three models are constructed to meet all the rigid service conditions, such as extremes of temperature, humidity, shock, vibration, etc., which the original military equipment successfully met. For those attenuators whose glass elements are subject to damage, specially designed shock pads enable any combination of vibration and shock to be met without damage.

TV-AM-FM SET PRODUCTION

Information based on latest reports from RETMA.



Broadcast Recorder

(*Continued from page* 18)

parts replaced, but with these machines carrying 40 stations, a thorough checking procedure is economically justified. This is particularly true since many hundreds of dollars per month are being saved through the use of the *Ampexes* without backup.

If—in spite of precautions—a sudden failure should occur, the setup permits extremely fast emergency procedures. If failure occurred on an incoming program, the other incoming recorder (which would normally begin at the next half hour) would be switched on to the incoming line. Loss of program could be held to as little as two or three seconds. If the failure occurred on an outgoing program, the tape would have to be transferred to a spare machine with a loss of a few seconds time. Thus far, neither emergency procedure has been necessary.

Uniform Line Level

A basic requirement for flexible switching between recorders is that all incoming and outgoing levels be the same. Plus 4 vu is used here. Adequate isolation of individual machines was a further consideration in the circuitry.

Isolation of the individual machines was accomplished through the use of bridging pads as shown in the schematic drawing, Fig. 1. With this bridging input, it would be possible to put all six recorders onto the same line without appreciably affecting recording level. Also, failure or short circuit in the feed circuit of any recorder would not affect other recordings made on the same line.

Audio input to one tape recorder may be traced in Fig. 1. A total loss of 42 db occurs in bridge pad A and bridging resistors B. Audio level is built up to + 4 vu by the amplifier at C. This amplifier in the input circuit of each recorder is the "price" of isolation and uniform recording level.

The output of any recorder can be fed back into any tape recorder input except its own, as shown in Fig. 1. Uniform level is maintained by proper setting of the tape recorders with *Ampex* standard tape.

As the many hundreds of wires within the control console include lines operating at audio levels varying from − 38 to + 8 db, plus relay control circuits carrying d.c., precautions were taken to avoid crosstalk and switching transients. Audio lines at each operating level occurring within the console were cabled separately and kept at a safe distance from those at other levels. Relay control lines were also separated. These precautions have proven adequate, since no crosstalk problems have arisen.

The flexible recorder control system was designed and built in a "crash program." The job was accomplished in three weeks with the expenditure of about 500 man-hours of effort. Vernon Harvey, project engineer, designed the entire circuitry and supervised fabrication; and Robert Wood, George Willis and Sidney Damron, maintenance technicians, built the whole system with the exception of basic components (*Ampex* 350's, switches, amplifiers, etc.). Flexible enough to adapt to almost any foreseeable changes in network operation, it is estimated that the system will save 2500 man-hours per year in operator time at the present rate of use.

PHOTO CREDITS

7, 8, 9.....General Electric Co.
10, 11. Bruno-New York Industries
14, 15.....Servo Corp. of America
17, 18.....Ampex Corp.
20.....Nat. Bureau of Standards

Circle No. 21 on Reader Service Card

CALENDAR of Coming Events

NOV. 29-DEC. 2—First International Automation Exposition, 244th Coast Artillery Armory, New York, N. Y.

DECEMBER 8-10—Fourth Annual Eastern Joint Computer Conference and Exhibition, Bellevue-Stratford Hotel, Philadelphia, Pa.

JANUARY 17-19, 1955—Fourth Biennial Conference on High Frequency Measurements, NBS, Washington, D.C.

JAN. 31-FEB. 4, 1955 — AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

RADIO-ELECTRONIC ENGINEERING

INDEX TO VOLUMES 22-23 (1954)

INDEX TO ADVERTISERS

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1. The names and addresses of the Publisher, editor, and business managers are: Publisher, Ziff-Davis Publishing Company, 64 E. Lake St., Chicago 1, Ill.; Editor, Oliver Read, 366 Madison Ave., New York 17, New York; Managing Editor, Wm. A. Stocklin, 366 Madison Ave., New York 17, New York; Business manager, G. E. Carney, 366 Madison Ave., New York 17, New York.

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4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

G. E. CARNEY, Business Manager

Sworn to and subscribed before me this 27th day of September, 1954.

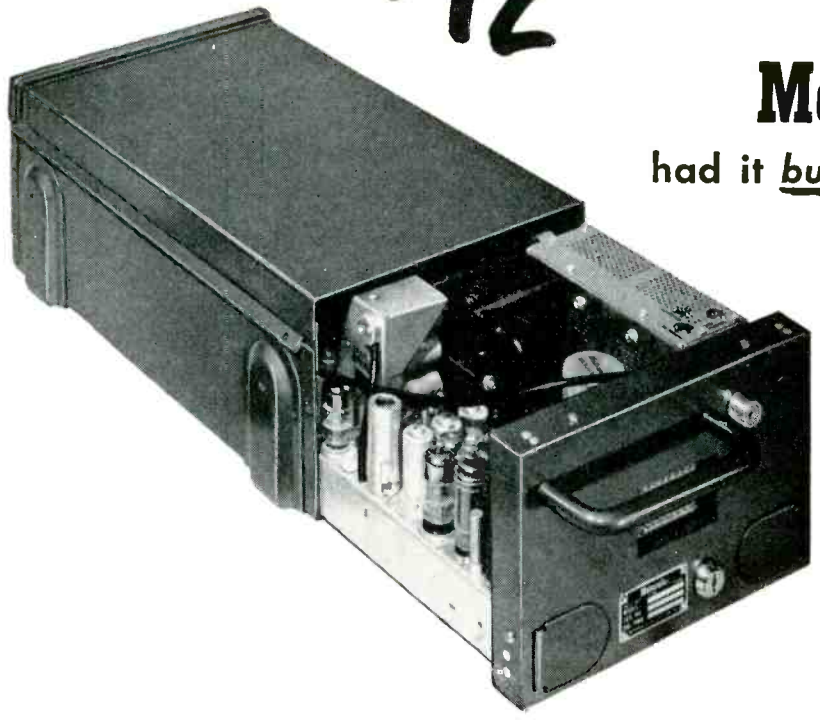
[SEAL] Hershel B. Sarbin, Notary Public.

(My commission expires March 30, 1956)

6/12 ?

Motorola

had it *built-in* a year ago



A growing number of automobile manufacturers are changing from 6 to 12 volt electrical systems. Motorola 2-way radio now gives you built-in protection against expensive obsolescence should any part of your fleet be affected by this trend.

WHAT IT IS — It's truly universal 6/12V equipment—2-way radio that can be interchanged in mixed 6 and 12-volt fleets without modification of power supplies, jumpers, plugs, connectors, cables or switches. When re-installing in a 12-volt car, no cable replacement is required. It is so foolproof that you can safely make changeovers in the dark without worry of burning out tubes or damaging a power supply.

FEATURES—The *all-vibrator* power supply attains over 70% power conversion efficiency with a resultant power drain reduction of up to 40%—for more power per unit size per ampere drain than any other sets on the market—all this, plus the superior performance of Motorola's famous Sensicon with guaranteed permanent selectivity and seven other exclusive features.

ACCEPTANCE—Again anticipating the trends, Motorola offers freedom from obsolescence, and superior performance at lower cost. You can easily see and hear the difference—greater signal strength, more audio power, longer battery and generator life, lower maintenance costs. You get all this in Motorola's truly universal 6/12-volt mobile units—available in the following classes:

- 25-54 mc., 25-30 and 50-60 watts R.F. output
- 144-174 mc., 10 and 25 watts R.F. output
- 450-470 mc., 18-20 watt R.F. output

Here is a partial list of Motorola customers who have 6/12 volt interchangeable mobile units—

Michigan State Police	Community Public Service Co.	Florida State Police
Ohio State Police	County of Orange, Calif.	Iowa State Police
Boston Edison Co.	El Paso National Gas Co.	State of South Carolina

national **Motorola 2-way Radio** service

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